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FORMATION OF THE HAGHARTSIN LANDSLIDE (ARMENIA) AS A CONSEQUENCE OF THE VIOLATION OF THE EQUILIBRIUM STATE OF THE SLOPE DURING ENGINEERING

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Summary: *The Haghartsin landslide is located on the right bank of the Aghstev River, near the village of Haghartsin. It is an activated part of a large structural ancient landslide formed during a strong earthquake in the Pliocene-Upper Quaternary time. The first landslide phenomena began to be observed in this area in the 80s of the XX century, literally as soon as the pruning of the slope for the construction of roads and railways began. Significant movements first occurred in 1985 on the slope between the railway track and the highway, as well as on the slope above the railway track. In the 90s of the XX century, this section of the railway was completely destroyed, and already in 1996 a landslide body blocked the highway. Currently, landslide movements cover all new areas. The tongue of a landslide almost every year in May blocks the riverbed of the Aghstev River with the corresponding flooding of rural houses.*

Key Words: *Aghstev, Haghartsin, highway, landslide, railway.*

Introduction. The occurrence of landslide displacements of rocks is possible under certain conditions and the presence of a so-called "trigger" [1, 2] or "reason" – the main reason that triggered the landslide mechanism [3, 4]. Usually, the formation of landslides is influenced by a number of factors: geomorphological, geological and physico-geographical conditions, as well as anthropogenic impact. And one of the factors seems to "overflow the bowl", violates the limit of stability of rocks, causing displacement. Therefore "... it is rarely possible to explain a landslide by one specific cause, if at all possible" [5, p. 70].

Human economic activity has a great impact on the formation of new and activation of existing landslides. One of such landslides in Armenia is the Haghartsin, whose current activity is due to the pruning of the body of the seismogenic landslide of the same name for the laying of roads and railways. At the same time, protective measures were not carried out to strengthen the slope.

Methods. The ancient seismogenicHaghartsin landslide was identified by the author in the late 70s of the twentieth century when deciphering aerial photographs and a topographic map of 1:25,000 scale and confirmed as a result of field research. In 1986-1988, employees of the Moscow State University carried out a repeated phototheodolite survey of an active landslide site formed at the site of the slope trimming for engineering purposes. In subsequent years, observations of the landslide condition were carried out by employees of the Ministry of Emergency Situations of Armenia and the Dilijan expedition of the IGS of the National Academy of Sciences of the Republic of Armenia [6].

Results and discussion. The Haghartsin landslide is located within the Dilijan basin, on the right bank of the Aghstevriver, opposite the village of Haghartsin. The upper absolute mark of the landslide site is 1100m, the basis of erosion is at an altitude of 995m. It is an activated part of a large structural (tectonic-seismogravitational) ancient landslide (see Fig. 1).

The first landslide phenomena began to be observed at this site in the eighties of the XX century, when the slope was cut for the construction of roads and railways without assessing its stability and the necessary engineering protection. Significant progress first occurred in 1985 on the slope between the railway track and the highway. At the same time, landslide processes began on the slope above the railway track, which contributed to the complete destruction of this section of the railway in the 90s, and already in 1996 a landslide body blocked the highway (see Fig. 2).

Fig. 1. General view of the Haghartsin landslide site.

a) b) c)

Fig. 2. The railway destroyed by a landslide - a); blocked by climb down masses the railway track - b); the bypass road - c).

The Haghartsin landslide as a whole, according to the mechanism of manifestation, refers to a block shift landslide, and its eastern part (the eastern block) with its characteristic hydrogeological regime and obvious signs of suffusion phenomena refers to a viscoplastic landslide with suffusion removal. The landslide site covers an area of 82,000 m^2, its length is 270 m, width is 300 m, the volume of the landslide mass is 2,184,000 m^3. Within this landslide, three blocks are allocated with the following parameters (see Table and Fig. 3).

Table 1.The ratio of the parameters of the landslide blocks of the site "Haghartsin" [7]

Block name	**Area**		**Volume**		**Depth of capture, m**	**Mechanism of manifestation**
	m^2	%	m^3	%		
Eastern	37 000	45,2	102 600	46,9	23	Viscoplastic with suffusion removal
Central	28 000	34,1	638 000	29,3	22	Block shift
Western	17 000	20,7	520 000	23,8	30,5	Technical shift

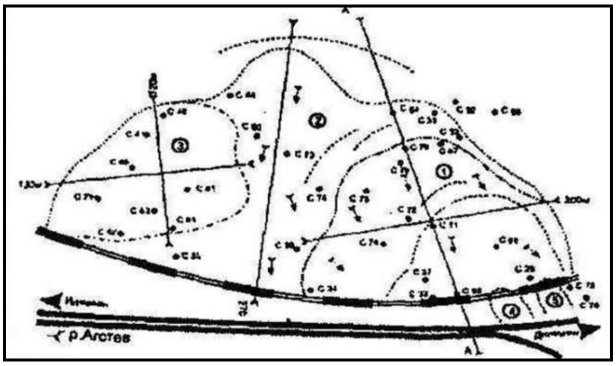

Fig. 3. Schematic plane of landslide Haghartsin [7].

The upper boundary of the landslide body is expressed by a wall of disruption with a length of 70-80m and a height of up to 12m. The western wall of the breakdown reaches a height of 17 m, the eastern wall is indistinct, but its location coincides with the fracture zone recorded in 1993.

The Haghartsin landslide developed on a slope composed of a volcanogenic-sedimentary complex of rocks of the Middle Eocene, covering mid-quaternary landslides and modern (proluvial, alluvial-proluvial, eluvial-deluvial and lacustrine) formations [7]. The Eastern block (block 1) is characterized by the greatest activity, in the body of which a number of local landslide stabs are distinguished. The active state of block 1 provoked the movement of neighboring blocks and the formation of a single landslide array with one breakaway point, as well as a change in vectors and displacement velocity. The landslide block 1 has a length of 190m, a width of 200m, an area of 37,000 m^2, the volume of the displaced mass is 1,026,000 m^3. The sliding plane passes at a depth of 15 to 23 m in deluvial-proluvial formations, sometimes captures hydrothermally altered bedrock. The structure of block 1 involves loose-block slope formations (deluvium, defluction), technogenic accumulations, deluvial-proluvial formations (lenses of bentonite clays, clay-loamy soils with layers of gravel and gravel), alluvial and alluvial-proluvial accumulations of terraces of the river Aghstev, as well as Middle Eocene andesites and andesite-dacites and their modified differences. In the period from 2000 to 2010, the entire landslide site was activated as a result of the termination of engineering protection works (the creation of a buttress and drainage system, unloading measures, partial unloading of the tongue part of the landslide zone along the railway track, as well as the construction of wall drainage and upland ditches to intercept atmospheric and man-made waters) due to lack of funding [6]. The consequence of this was a catastrophic displacement of the earth masses and the actual unification of all three landslide blocks into a single whole. The railway track was completely destroyed, the bypass road was put out of operation. In April 2001.the tongue of the landslide dammed 75% of the riverbed of the Aghstev river, which required large expenses for its cleaning from the debris of the soil (see Fig. 4).

a)

b)

Fig. 4. A bypass road blocked by a landslide - a); landslide masses that collapsed into the riverbed of the Aghstev river - b).

New landslide movements with riverbed closure occurred on May 27, 2005 and April 28, 2006. At the same time, the lower floors of more than 20 houses with their homesteads, a rural school (in its northern building, the height of the water level was 1.2 m) were flooded. After 2006, almost every year in the spring, landslide masses block the riverbed, creating a lot of problems not only for the villagers, but also for the

Ministry of Emergency Situations of the republic. The houses of the residents of the village of Haghartsin are destroyed as a result of constant flooding (see Fig. 5).

Fig. 5. Destroyed buildings on the left bank of the Aghstev river (05.07.2013).

Conclusion. To date, the situation at the landslide site “Haghartsin" is extremely critical. Landslide movements cover all new areas not only in breadth, but also up the slope and down the depth (see Fig. 6).

To stop a landslide, comprehensive protective measures are needed: drainage of watered rocks; piercing with piles buried in the underlying rocks below the sliding mirror; artificial improvement of the properties of sliding soils (cementation, the use of Uisit powder - developed by employees of the former Dilijan expedition of the IGS NAS RA together with geologists of Moscow State University, etc.). However, all this requires large financial investments, which the republic is currently unable to implement.

References

1. Emelyanova E.P. Basic patterns of landslide processes. // M.: Nedra, 1972, 310 p.
2. Sowers G.B., Sowers G.F. Introductory soil mechanics and foundations. // New York: Macmillan, 1970, 556 p.
3. Lomtadze V.D. Engineering Geology.Engineering geodynamics. // L.: Nedra, 1977, 479 p.
4. Maslov N.N. Conditions of stability of slopes and slopes in hydropower construction. // M.-L.: Gosenergoizdat, 1955, 468 p.
5. Varns D.D. Slope movements, types and processes Landslides. Research and strengthening. // Moscow: Mir, 1981, pp. 32-85.
6. Landslides of Armenia. // Yerevan: ASOGIK, 2009, 308 p.
7. Stepanyan V.E., Gurdjian Yu.G., Sereda M.N. Conceptual approaches to risk management processes from the manifestation of dangerous natural landslide processes // Proceedings of the III Central Asian International Symposium, vol. 2, Dushanbe, 2005.