Influence of engineering and geodynamic processes on stability of transport infrastructure

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Abstract. The article deals with the issues of the mechanism of development of landslides and the factors acting on them, the classification of engineering and geodynamic processes, the division of landslides by types and volumes, as well as the development of landslides by years, and periods (seasons) on the new railway line "Tashguzar-Baisun-Kumkurgan". The number of dangerous geological processes on the adjacent Tashguzar-Boysun-Kumkurgan railway from 2006 to 2020 was 370. In quantitative terms, their activity by year fell on 2007-2010, and the next phase continued in 2012-2014.

1 Introduction

To create favorable conditions for the economic and social development of transport communications in the country, Kashkadarya, and Surkhandarya regions accelerate the implementation of projects for the development of natural resources, as well as the development of social infrastructure in the southern regions of the republic, the Cabinet of Ministers in 1995 adopted a resolution [1-5] on the design and construction of a new railway line "Tashguzar-Boysun-Kumkurgan".

2 Objects and methods of research

Decree of the President of the Republic of Uzbekistan dated October 26, 2007, No. 717 was approved on the start of operation of the new Tashguzar-Boysun-Kumkurgan railway line with a total length of 223 km and an estimated capacity of 14 pairs of trains per day [2].

This railway line, built at an altitude of more than 1800 meters above sea level, crossing the foothills and mountain slopes, created the soil (basis) for developing dangerous geological processes.

Geographically, the area in which the observations were made is in the range of 38°00′-38°00 feet north latitude and 66°02′ feet east longitude.

The object of study consists of clay, sandstone, gilded stones, and limestone rocks, the basis of which belongs to the Cretaceous period. Above them, 3 to 30 m thick, diluvial Lesotho rocks are common in almost all areas of the Quaternary period. Sandy-argillaceous

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rocks of the Cretaceous period are characterized by the following physical and water properties: sand particles 3-8%, dust particles 20-43%, clay 50-75%, filtration coefficients characteristic of dense clays 0.0004-0.073 m/day, specific gravity 2 .73-2.76 g/cm3, bulk density 1.85-1.90 g/cm3. Liossian rocks are widely developed in the area, the main characteristics of which are lower: sand particles in the composition are 4-10%, dust particles 65-80%, clay particles 13-20%, density 1.15-1.25-2.4 g/cm3, porosity 18-60%. The region's climate is sharply continental, with long hot summers and short cold winters. The hottest month is July, with a monthly average temperature of +25.3°C (maximum 33.7°C), and the coldest month is January, with a monthly average temperature of 0.2°C (maximum -12°C). The average monthly atmospheric precipitation is 407 mm; about 85% of annual precipitation falls in spring and winter, 12% in autumn, and only 3% in summer. Because of the influence of engineering and geodynamic processes on the occurrence and change in the intensity of geological processes occurring on the slopes of mountains in our time, this section focuses on the volume of precipitation (Fig. 1).

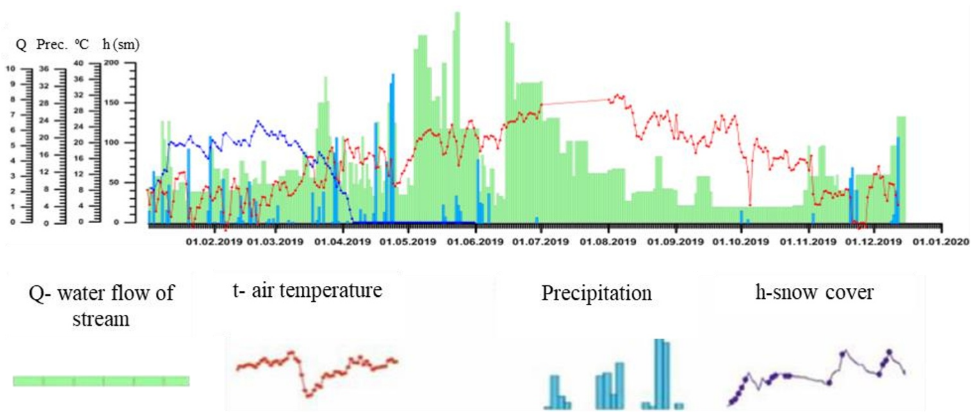

Fig. 1. Dekhkanabad weather station data based on rainfall (mm), air temperature (t), water flow of stream (Q), and a summary graph of the thickness of the snow cover (h, sm)

The number of dangerous geological processes on the adjacent Tashguzar-Boysun-Kumkurgan railway from 2006 to 2020 was 370 [6-13]. In quantitative terms, their activity by years fell on 2007-2010, and the next phase continued in 2012-2014. The increase in the activity of dangerous geological processes during this period coincides with the period of development of the infrastructure of road and rail transport and the development of mountain and foothill massifs (Fig.2).

3 Results and discussion

In the period 2004-2007. in the study area, large-scale work was carried out to clear the slopes to prepare the territory for the construction of roads and railways, as a result of which the natural balance of the mountain slopes was disturbed, landslides that formed earlier developed, new landslides arose due to changes in the groundwater movement system, changes in relief indicators, i.e., the natural slope of the earth's surface.

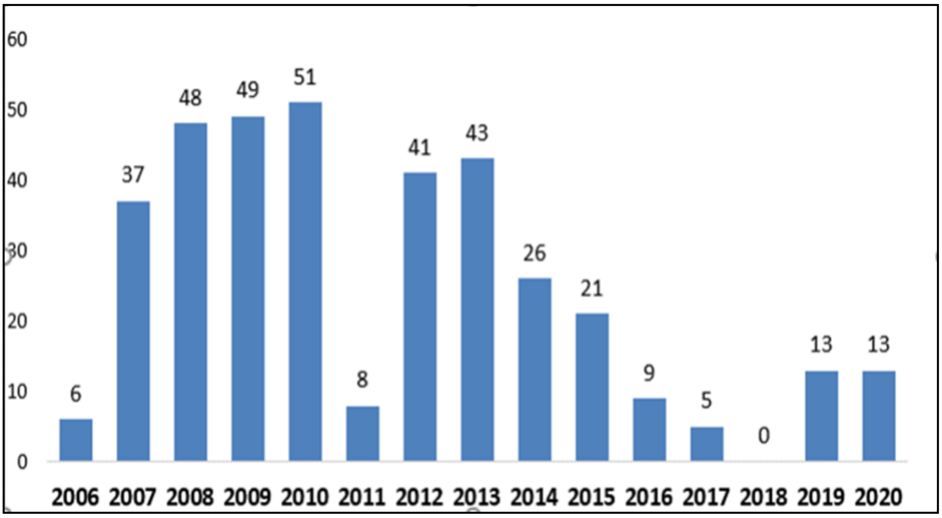

Fig. 2. Dangerous engineering-geological processes recorded in areas adjacent to the Tashguzar-Boysun-Kumkurgan railway

From the moment of observation of dangerous geological processes to the present time, several processes have occurred, which are distributed by type as follows: landslides - 34%, stone falls - 21%, the formation of avalanche faults - 21%, fluid landslides -20%, other processes less than 4% (Fig. 3).

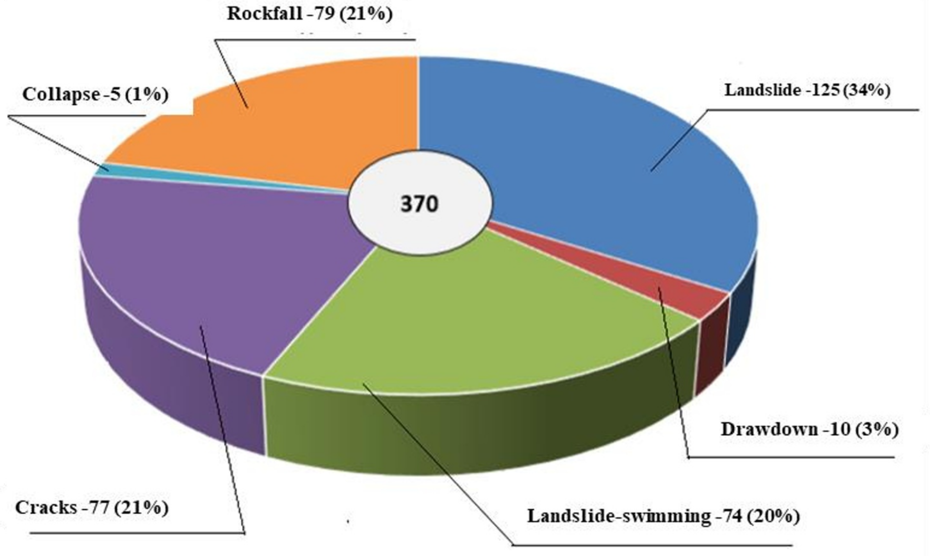

Fig. 3. Distribution by types of dangerous engineering and geodynamic processes

The most common process in terms of the types of engineering and geodynamic processes in the area where the railway passes is the avalanche process. Landslides along the Tashguzar-Boysun-Kumkurgan railway also vary in volume (Fig. 4). Most landslides, i.e., 40%, have a volume of 1000-10000 m3. At the same time, landslides with a volume of 1,000,000 m^3 make up 7%.

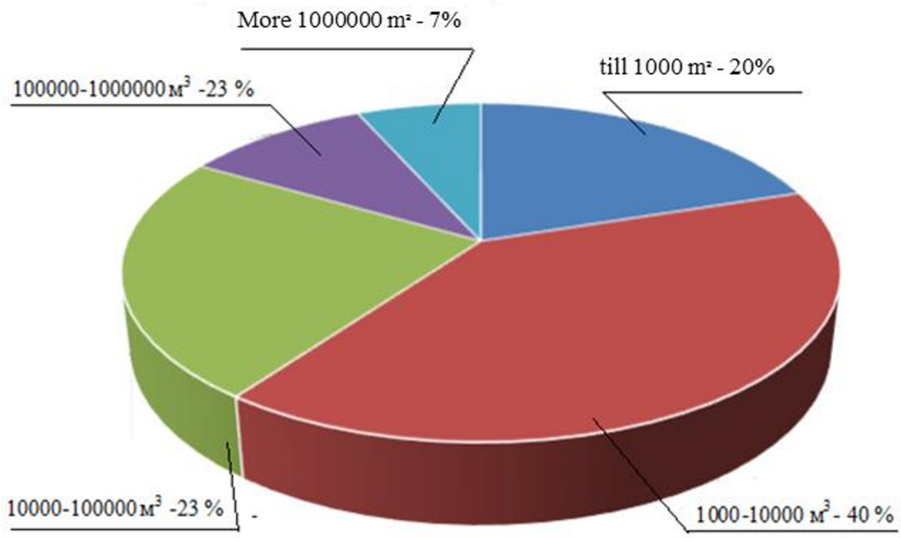

Fig. 4. Distribution of landslides by volume along the railway line Tashguzar-Boysun-Kumkurgan

Landslides along the Tashguzar-Boysun-Kumkurgan railway are distributed according to the formation mechanism (Fig. 5). In this case, the main part of landslides refers to the sliding mechanism. If we consider avalanche faults, they make up 73% of the total number of landslides.

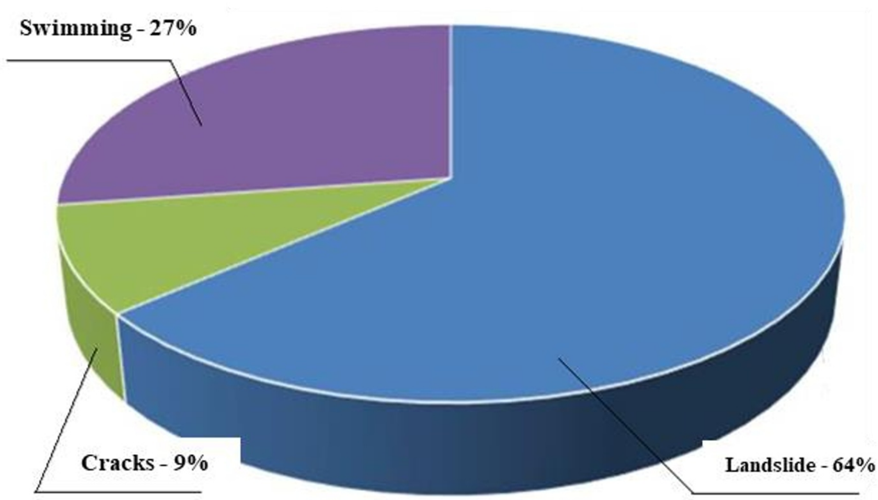

Fig. 5. Distribution of landslides according to the mechanism of their occurrence

It should be noted that the activation of landslides is seasonal. This is mainly due to precipitation. When analyzing the period of formation of recorded landslides, it was found that they are activated mainly in the spring months; in the last months of autumn and winter, landslides cease to be activated due to soil freezing.

Statistical data analysis showed that landslide activity dropped sharply in 2015-2018, and stagnation has been observed since 2020, resulting from measures taken by Uzbek

Railways JSC to reduce the technogenic impact on mountain slopes. Work is underway to create a safe slope and divert groundwater to protect the railway from landslides [9-11].

The formation process of a large landslide that occurred at 103 km of the Tashguzar-Boysun-Kumkurgan railway is clearly shown in space photographs (Fig. 5). They show the first signs of a landslide appeared in 2004. Still, the landslide intensified in 2014 due to the construction of the railway and its commissioning. Later in 2017, a landslide pushed back the railway line, jeopardizing the operation of the railway. The appearance of an astronaut in 2019 indicates that Cuchini has become more active.

The study results showed that all landslide processes are secondary since they originated in the area of ancient landslides that had moisture content. The simultaneous interaction of atmospheric precipitation, groundwater, and seismic vibrations determines the place of their formation and the time of onset.

Currently, work is underway to create a safe angle of inclination of the rail to protect against landslides, drain groundwater and drain it into a pipe located at PK 983+76 and PK 990+72.

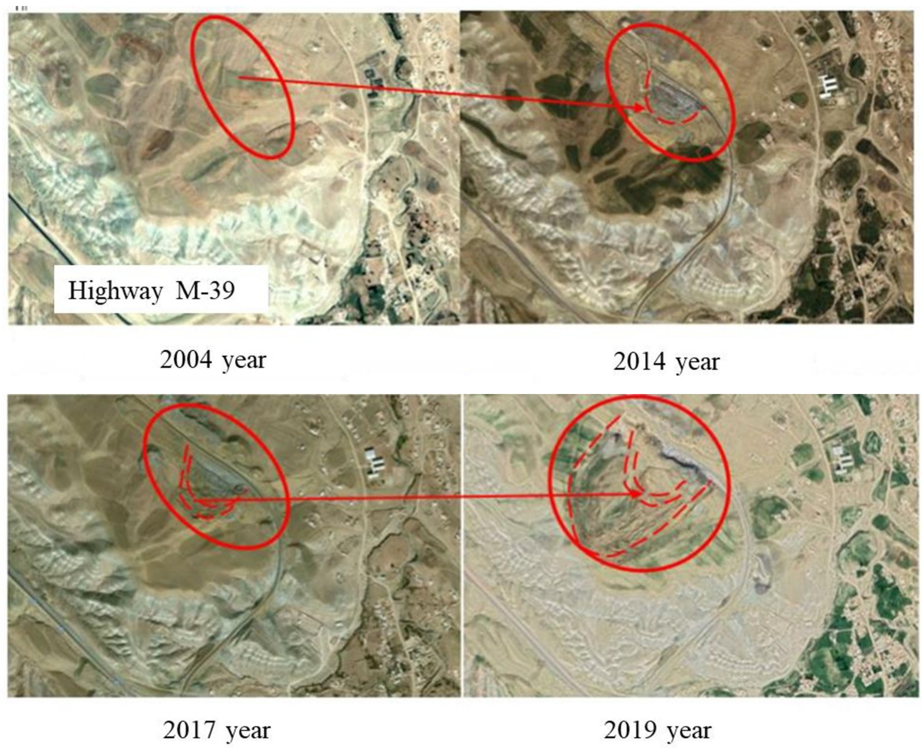

Fig. 6. Satellite image of the 103.5 km section of the Tashguzar-Boysun-Kumkurgan railway

The results of observations of this avalanche are presented in Figure 6. The vertical and horizontal landslide speed in the presented graph varies depending on the season. For example, in the upper part of the avalanche zone, RP 22 is installed, on the left - RP 14 - 15, on the right - RP 4-24, and in the lower - RP 16-17-18. The horizontal offset of Rp 22 was 10.6 cm, and the vertical offset of -14.8 was 0.9 mm/milk horizontally and -0.9 mm/milk vertically. The horizontal displacement, according to RP 14-15 was 0.7-16.0 cm, and the vertical displacement was 0.7-6.8 cm. The vertical displacement was 0.1-0.5 mm/milk, vertical 0.0-0 .1mm/milk. The horizontal displacement of RP 4-24 is 6.4-18.5

cm, and the vertical displacement is 0.0-4.9 cm. .2 mm/milk. The horizontal displacement of RP 16-17-18 is 0.7 - 3.6 cm, vertical - + 0.5-2.3 cm. Their speed was 0.6-1.4 mm/milk horizontally and 0.6 - 0.8mm/milk vertically.

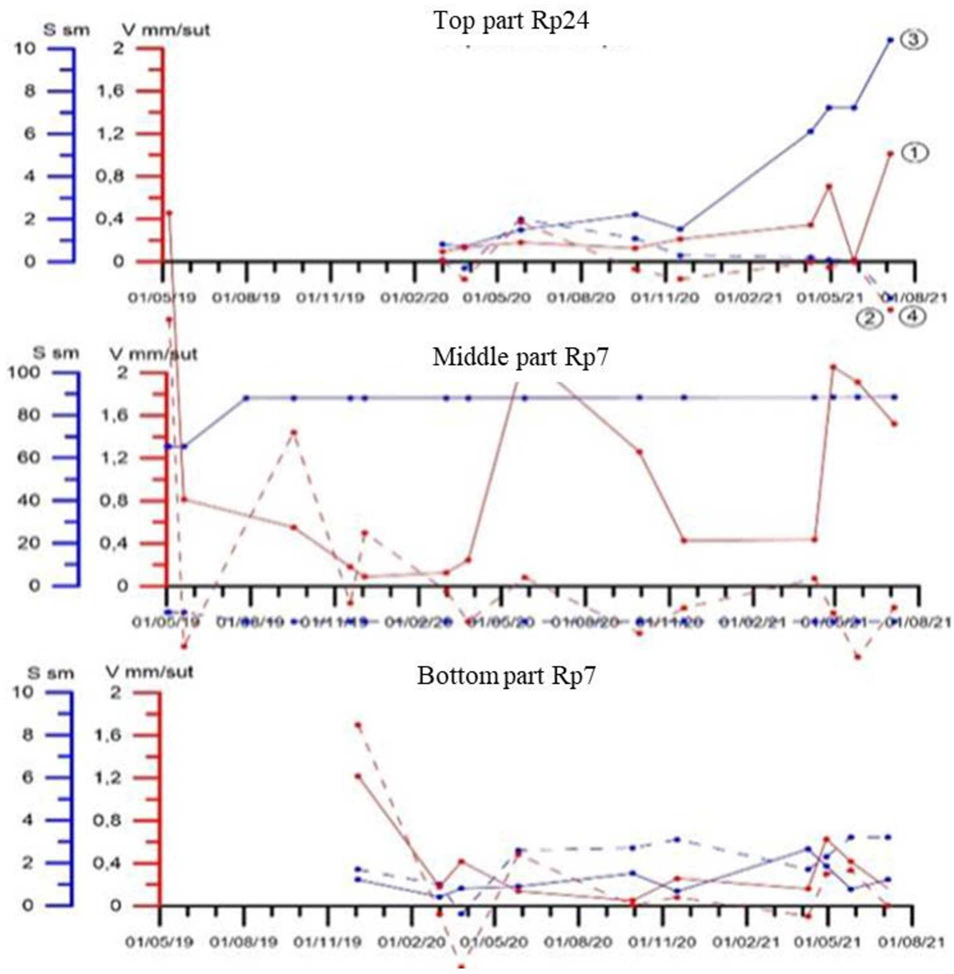

Fig. 7. 103.5 km of the Tashguzor-Boysun-Kumkurgan railway the speed of the horizontal and vertical displacement of the avalanche on the graph and a graph of their total displacement

4 Conclusion

As a result of monitoring hazardous areas and studies of areas adjacent to the railway, the following features of the development of landslides were identified. The presence of cracks on the surface of the deposits of the Cretaceous period, located under the diluvial deposits, has been established. This is evidenced by the existing sources and groundwater movements between the identified layers. As a result of an increase in the humidity of diluvial deposits (due to precipitation), the presence of cracks, and an increase in bulk density, the landslide massif loses its stability. Change in hydrodynamic pressure over the Cretaceous deposits and increase in the speed of groundwater movement along the slope.

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