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***Research Article** (Open Access)*

MECHANISM OF DEVELOPMENT OF THE TECHNOGENIC LANDSLIDE (NORTHERN) AT THE ANGREN COAL MINE

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ABSTRACT
The article presents the mechanism of development of the technogenic Northern landslide. The Northern landslide area is composed in the upper zone of 50-90m thick dumps lying on 80-100m of thick boulder-pebble deposits on Neogene sandstones, siltstones and sandy clays. The territory is characterized by a complex tectonic structure, the development of multidirectional faults (vents, vents-thrusts). This landslide is a secondary one, which is located on the border of the old landslide of 1999. The type of landslide belongs to the block and is divided into 4 blocks. The formation mechanism of the landslide took place from the top down, through the formation in the upper and middle area of the masses, July 2019, large cracks, and the displacement mechanism of the bottom- up, which began on 8 June 2019 and ended on July 7-8, 2019. The trigger, the beginning of active movement of the landslide may have been the Hindu Kush earthquakes. In the future, there may be repeated displacements of individual blocks inside the landslide circus.

Keywords: *Landslide, Monitoring, Earthquake, Slope, Technogenic*

INTRODUCTION
The Angren coal mine is the largest coal Deposit in Central Asia, and in terms of kaolin reserves, it is one of the largest deposits in the world. Mining of a coal Deposit is carried out by a quarry method. The complex geological and tectonic structure and high-water content of the sides of the quarry contribute to the formation and development of technogenic landslides on the sides of the coal mine.
The investigated landslide site is located in the Eastern part of the Northern non-working side of the Angren coal mine in the Akhangaran district of the Tashkent region. The landslide is represented in the upper and middle zone by a lateral type, and in the lower part by a liquefied type, the volume of which is 22.5 million m^3. The landslide is secondary and it is located in the border of the old Northern landslide on the horizon (1030) with a volume of 3.0 million m^3.

MATERIALS AND METHODS
The main goal of the research is to study the formation and development mechanism of modern technogenic landslides at mining facilities for timely prevention of landslide displacements. In the course of research, the following tasks are solved:
- Study of features of formation of modern technogenic landslide processes;
- Analyzing the main factors that affect the dynamics and mechanism of activation of technogenic landslides;
- Assessment and timely prevention of landslide displacements by using modern geological, geodesic, geophysical and remote sensing methods.

In this work, the author personally participated and led the research conducted at the Northern landslide site, where he analyzed the results of long-term observations and materials of geodetic works carried out by GPS measurement.

RESULTS AND DISCUSSION
The Northern landslide section, which formed on July 7-8, 2019, is located in the Eastern part of the Northern non-operational side of the Angren coal mine. The type of landslide is complicated, the volume

of the landslide in the upper and middle zone of the block type and at the bottom of the liquefaction is 22.5 million m^3 (800x800x35). The secondary landslide is located in the border of the old (1999) Northern landslide on the horizon (1030) - with a volume of 3.0 million m^3 (400x350x40) (Bimurzaev, 2018). Until May of 2019, the rate of displacement in the lower part of the landslide (Rp3) was 3.3-26.8 mm/day.

At the beginning of May of 2019, cracks up to 500 m long with a vertical amplitude from 0.5 to 2.0 m were formed in the upper and middle part of the embankment slopes, and along the flanks from 4.0 to 10.0 m. the speed of displacement of the reference points varied from 144.5 to 228 mm/day. For 4 days before the landslide, that's on July 4, it was in the upper part, horizontal displacements changed from 6.6 to 322.6 mm/day, in the middle zone Vg-changed from 524.3 to 857mm/day, and vertical Vh-from +34.2 to-198mm / day.

The modern landslide "Nothern" 2019, was formed on July 7-8, 2019, when the displacement rate in the middle part ranged from 1902.7 mm/day to 3673.5 mm / day, and vertical from 253.7 to 1047.9 mm/day.

On July 8, 2019, there was a one-time simultaneous displacement of rocks over the entire area of 64km^2 at 10:30 o`clock, the volume of rocks is 22.5 million m^3. In the upper and middle zone in the form of 3 large blocks, and in the lower zone in the form of a crushed liquefied mass with a width of 2-3 m. The Total horizontal displacement in the upper and middle part was 140-180 m, the vertical displacement in the upper part up to 80-100 m, in the middle 50-57 m. In the lower zone, the landslide masses moved horizontally along the ledges of the Board at a distance of up to 600 m, to the abs.m 882m. The landslide has an oval shape, where its width is 1.7 times greater than its upper zone. In General, the width of the landslide in the upper zone is 540m, in the middle and lower zone up to 900m, the length of the landslide in the formation zone is 850m, the total length is 1.5 km.

Lateral cracks of the landslide, with the height of 3-5m, timed right to the borders of the buried channel Tuganbashi river, to the left they are controlled by the buried channel Bodam river. In the right-side border, small lakes were formed in 3-4 places. In this side of area was formed a series of small longitudinal cracks aimed in the direction Tuganbashi river. This characterizes that repeated movements occur along the contact of Quaternary and Neogene strata.

The entire surface of the landslide is divided into 4 ledges: the left upper scarp of the landslide is located in the zone of dumping of high dumps up to 100m, has a deep Graben-like shape, up to 120m high, and up to 240m wide at the top (abs.1153). Lower abs.m. was taken from the topographic map 974,3 m, which characterizes in the upper zone occurred stretching.

Figure 1: The Head scarp of the landslide Northern

Figure 2: Photo of the right side of the landslide Northern

The second block was formed immediately after the graben, dropped to a height of 50-60m for about 300m and in the lower zone of 5-10 meters rose the Central part of the vertical did not change in the terrain. The entire area of the landslide in this zone is covered with longitudinal cracks of the amp. 1.0-2.0 m.

The third block shifted to a height of 30-40m. for 100m it has a flat terrain, which is heavily covered with numerous cracks.

The fourth block completely shifted in the lower zone with a height of 20-25m. Here, in the lower zone, the movement of crushed and liquefied rock masses took place in the form of a stream at a distance of 450 to 600 m, with a capacity of 1.0 to 2.5 m. along the fixed ledges of the quarry.

The area is characterized by complex tectonic structure, development of differently directed faults (reverse faults, thrust faults-thrusts). The upper part of the site passes the Eastern stretch rise. In terms of the left side of the landslide coincides with the buried bed of Tuganbashi river, the right side coincides with the blocked bed of Bodomzor river, which are filled with alluvial-proluvial boulders and pebbles with an admixture of clays and sand layers. Along the contact of these deposits with Neogene siltstones, it passes subrustal flow of ground water, wedging on the Northern side of the profile. According to employees of the STS (The State Tracking Service Uralov), the sliding surface of the landslide is presumably located in the middle zone in at a depth of 80-100m and is timed to the contact of boulder-pebble deposits with clay rocks of the Neogene. The mechanism of formation of the landslide passed from top to bottom, by forming large cracks masses in the upper and middle zone of the lanslide, in the months of 2019, and the mechanism of displacement from the bottom to the top, which began on July 7-8, 2019 and ended on June 8, 2019. at 11-12 a.m. The trigger of the beginning of the active movement of the landslide may have caused the Hindu Kush earthquakes. According to the catalog of Hindu Kush earthquakes, they occurred twice on July 7, the first at 9h 33min M-4.1 N-194km, the second half an hour later at 10h 04min M-4.4 m, N-192.2 km. This caused the liquefaction of sand-clay rocks in the middle and lower zone and its movement of liquefied and fragmented rocks at a distance of 465.7 m and vertically Rp 50 n-z, dropped by 57.2 m. The lower part of the landslide that's toe rose by 2-3m which was heavily watered and fragmented.

In the future, repeated displacements of individual blocks inside the landslide circus are possible. The cracks formed above the scarp in the dump rocks will pass through the collapse of the rocks. The movement of liquefied rocks in the lower zone and the extension of the landslide distance may be very small. The Tashkent-Osh highway which is located, above the crown is under the threat of this landslide.

Geological structure of the landslide

The Northern landslide section is composed of boulder-pebble deposits on Neogene sandstones, siltstones and sandy clays in the upper zone of 50-90M thick dumps lying on 80-100m thick, hollow lying according to the fall of the slope and all Paleogene deposits according to the geological profile of the

AUR geological service, on the contrary, hollow lying deep into the slope. At the same time during the process of developing a career in the work ledges were opened series of upthrow-thrust tectonic faults of two types: steep South-easterly direction and with a variable angle of incidence (steep at the top of the incision and subsequent reduction of the angles of incidence to very gently sloping, which ends in Suzak species level). Studies have shown that such violations served as the bed of the Central and Northern landslide (Niyazov and Bimurzaev, 2019).

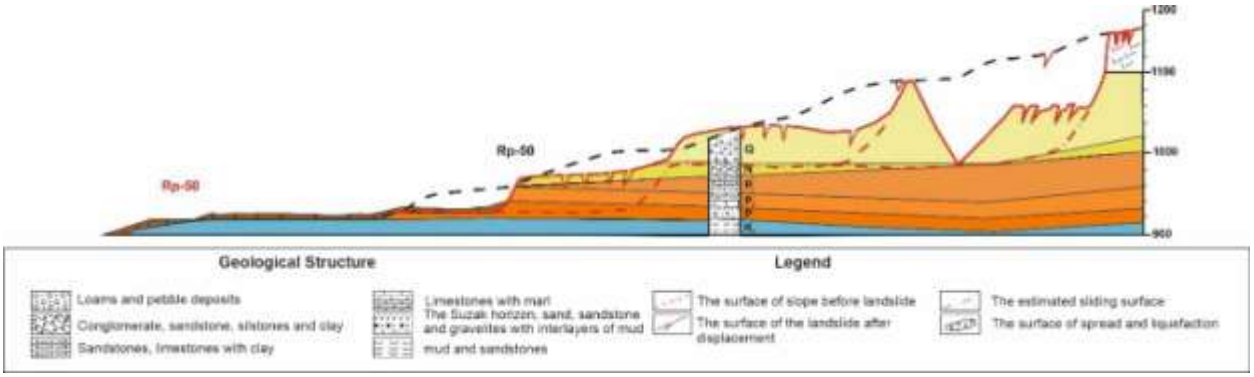

Figure 3: Geological section along the Central part of the landslide Northern

The width of Suzak layer is 10-40m, and is composed of sandstones, clays, gravelites, conglomerates, and opokoid clays. Sandstones is white color, different-grained on lime clay cement. In water-saturated sections of the sandstones pass in wetlands Sands, forming olivine and suffusion. Depending on the porosity and humidity, the density varies from 1.79-2.64 g / cm3, humidity to 26% and porosity 50.2%. The underlying clays are plastic, the number of plasticity is 18-19, the compressive strength is 0.53-4.0 MPa, when wet, they swell by 22-24%, the porosity is 31.4% and the humidity is 13-14%.

This information and the nature of the displacement of the landslide suggests the presence of two sliding surfaces: the first by the contact of Quaternary and Neogene strata in the upper and middle zone and the second contact Suzak sand and clay Alai layer of the Paleogene in the lower area.

Depth and surface of the slide of the landslide

In order to determine the depth and location in the section of the sliding surface, was built a profile, through the center of the landslide Fig. For this purpose, a topographic plan of m 1:2000 was used after and before the landslide. In addition, the geological profiles of the AUR geological survey were used along the lines of PK-27 and PK-30; 35;36, passing across the landslide in the Central and lower zone, which determined the depth of the Suzak deposits of Sandstone and clay in the zone of contact with limestone. Based on the results of this geological profile, the Suzak deposits located on the abs.m. were compared in the lower zone.abs. m.920-930m. in average on abs.m. 930-940m. in the upper and partially in the middle zone, the sliding surface passes through the contact of the Quaternary and Neogene strata, where its location is taken by the lowest point depth of 120m on the abs.m. 980m. In the lower and partially in the Central zone of the sliding surface is on the abs.m. 930m on Suzak Sands and clays. These assumptions are based on the fact that with a long vibration of 110-130 seconds, low-frequency vibrations of 1.2-2.5 Hz, this layer of sand turns into a quicksand, which causes the movement of the landslide. The sliding surfaces have a slight slope of 4-6º and a slight 0.6-0.8 m width, which is heavily watered, both in the Quaternary and Paleogene strata of Suzak.

Mechanism of formation and development of the «Nothern» landslide

Since the beginning of 2019, the geodesic unit of the STS continued to conduct monthly measurements on the landslide site. Of the reference points after the landslide displacement, there are preserved two reference points 50 H-3, which is located in the lower Central zone, and Rp.90-located on the right side of the middle zone of the landslide. According to observations until May 2019, the displacement rate was

3.3-16.8 mm/day. At the beginning of May, cracks formed in the upper and middle part of the embankment slopes. The length of the cracks is up to 500 m, with a vertical amplitude from 0.5 to 2.0 m, and on the flanks from 4.0 to 10.0 m. The displacement Rate of the 50 H-3 - the most active in the month of May, changed from 178.3 (14.05.19) to 289.6 min/day on 26.05.19

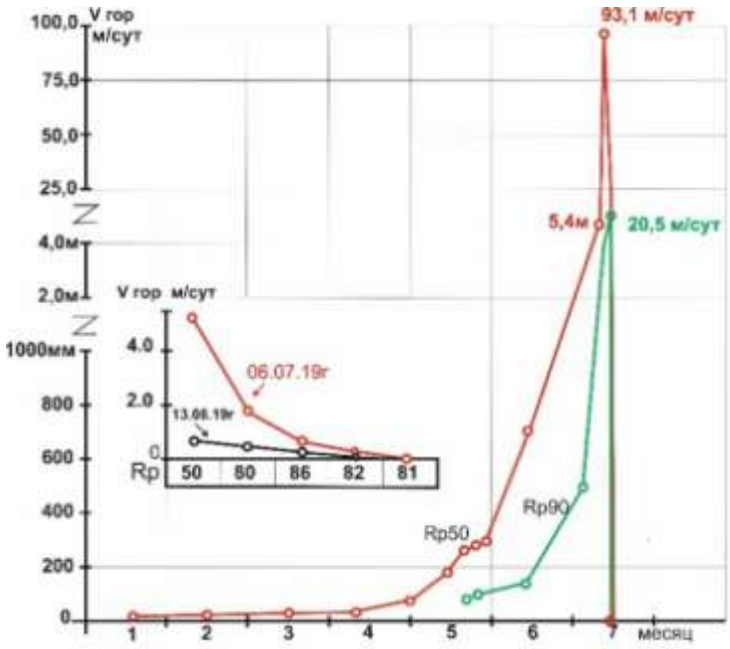

Figure 4: The graph of changing rate of horizontal displacement by Rp 50 and Rp90, over period (I-VII 2019). The graph of changing rate of displacement depending on the location of reference points from bottom to top, on separate days 13/06/19 and 06/07/19

On 13.06.19-it was 728.7 mm/day. The mechanism of landslide formation occurred from the bottom to up (photo.), so on 13.06 the speed of the lower reference point 50 H-3 was 728mm/day, and the upper Rp-82 168 mm / day. After 23 days on 6.07.19, the high horizontal displacement rates still remained in the lower zone and increased 7.5 times, reaching 5.464 mm/day, according to the above-placed benchmarks 80.82 Vq=1.902; 444 mm / day.

At the same time, the maximum vertical deformations were highest at the upper Rp 80-1.017 mm/day. and Rp 82-672mm/day, and on the lower Rp H-3 they were-272 mm/day, namely 3-5 times less. On July 7, horizontal displacement speeds reached up to 3.5-4.0 m / day. On June 8, the main displacement of rocks occurred in the area at 10h 30m o`clock, which lasted about 1.5 hours. As a result, in the lower 50 zone, H-3 moved 465m and dropped 57.2 m, in the middle zone, Rp 90 moved horizontally by 164.4 m, and vertically by 45.0 m.

The scarp of the landslide is vertical, the height is about 80-100m and a length up to 510m. Repeated geophysical observations, after 4 days, 12.07 and 22 days 30.07.19, showed that the movement of the landslide was stabilized, amounting to 0.4-0.6 mm/day. Azimuths of the direction of movement of the landslide of all reference points, up to the main displacement of the landslide, from the bottom to the top had the same direction of movement 192-196º. During the shift to 145º, the rest of the reference points continued to have Az-192-194º.

After the shift, the remaining reference point 50 was again stabilized Az-196º, Rp 90-azimuth changed to 270-310º and began to have a direction in the line of the side channel of the Tuganbashi.

The formation of the landslide, is the thixotropic liquefaction of watered sand and clay rocks of the Suzak layer in the lower zone of the landslide. The trigger or trigger of the beginning of the active movement of

the landslide was a long 110-140 second low-frequency deep-focus 120-220 km Hindu Kush earthquake. According to the catalog of Hindu Kush earthquakes (Berkeley), in the month of May there were 6 earthquakes, in June 10, with a magnitude of 4.2 to 4.4 at depths from 110 to 220 km.

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