pISSN:2349-5707 Volume:13,Issue 4, April -2026 eISSN:2349-5715

INFLUENCE OF NATURAL PHENOMENA (NE) ON MATERIAL DAMAGE ON RAILROAD AREAS AND ITS CONSTRUCTION IN MOUNTAINOUS PLACES

Sh. X. Abdazimov, DSc Professor
Student: **Asal Qilichboyeva**
Tashkent State Transport University.

Key words: Landslides, railway, transportation, passenger, cargo, mountain roads, emergencies, danger, throughput.

Abstract: This article examines the issue of optimal operation of the railway as a result of a landslide, which leads to a decrease in capacity in the mining sections of the Republic during the transportation of goods and passengers. To determine the impact of natural disasters on the technical and economic indicators of the railway, the train schedule was modeled in two versions in the mountainous areas of the Republic.

1. INTRODUCTION

Angren - Pap, Tashguzar - Kumkurgan with one-way traffic along the direction of the train in natural emergencies - under the influence of landslides, the capacity of the sections is reduced as a result of unforeseen (force majeure) train stops. In the event of such a natural disaster, economic losses incurred during the transportation of goods and passengers will not be compensated by any party (carrier and shipper). However, the general indicators of the railway and economic losses can be determined by the decrease in the sectional speed of trains and all related indicators (average weight of trains, cars and locomotives, cost of cargo delivery) [1-3, 6-8,10].

Fig. 1 Dangerous lines of the Tashguzar – Kumkurgan railway

Fig. 2. Dangerous railway lines in the mountain ranges of the Republic (Angren-Pap)

Optimal operation of the railway under the influence of landslides leads to a decrease in the capacity of the section for the transportation of goods and passengers and a decrease in transport capacity in general [10].

2. RESEARCH METHODOLOGY

To ensure the safety of the railway and its structures in emergency situations arising from the impact of mountain avalanches and mudflows and the sustainability of the functioning of railway

pISSN:2349-5707 Volume:13,Issue 4, April -2026 eISSN:2349-5715

transport, the works of Russian scientists such as V.M.Ponomareva [Ponomareva, 2021,25], as well as scientists from Uzbekistan Sulaymanova S.S., Makhkambaeva P.A., Razikova R.S., Akhmedova M.A., Salyamov K.D. [Abdazimov, 2022: 8]. Currently, scientific development of the theoretical foundations of safety, risk assessment, assessment of the safety level, and risk management, taking into account the specifics of transport processes, is being widely carried out. These problems were studied in their works by Scientists of our Republic
M.Kh. Rasulov, Sh.M. Suyunbaev, S.K. Khudayberganov, A.Kh.Tulaganov and others [Abdullayev, 2023: 8].

3. ANALYSIS OF LITERATURE ON THE SUBJECT

The length of the Angren-Pap section is 121.2 km, the maximum directional slope is 27‰, the minimum radius of curvature is 300 m on the route there are 7 intermediate stations [3].
To calculate the mass of a freight train and determine the standard mass of trains on the Angren-Pap section of the railway, we use the method of S.Yu. Frenkel [9]. All calculations were carried out on site using AC electric locomotives of the 2O'ZEL series (made in China).
Considering that the Angren-Pap section of the railway is a new line, the traction force of electric locomotives is less than the calculated 5%, and the resistance of tracks with a radius of curvature of 300 m is also taken into account. To perform calculations of locomotive traction, a diagram of the resultant forces was constructed and acts on the train equally.
For additional calculations, information was obtained from the design documentation:
- altitude above sea level (H) 1400-1500 m (pressure 640 mm Hg);
- outdoor air temperature in summer (t) –+40ºC;
- guide slope (i_p) – 27‰;
- estimated traction force ($F_{кп}$) and mass (P) of the electric locomotive in sequence:
- special – 390000 N.

When designing new railway lines, the current standards for traction calculations for diesel locomotives were taken into account. In order to prevent the operation of locomotives in overload conditions, taking into account the inevitable deviations from the actual conditions accepted in the calculations, increasing failures and disrupting the rhythm of movement, the tangential traction force - the actual traction force of the edge of the driving wheels of the locomotive is determined as follows [5]:

$$f_k = f_{kn}\ (1-k_p)\text{, N} \qquad (1)$$

It is assumed that the amount of additional resulting resistance to movement equal to the value of the slope is equal to the value of the slope

4. ANALYSIS AND RESULTS

The speed of the train and the height of the outer rail are also taken into account when carrying out calculations that require high accuracy.
We determine the estimated weight of the locomotive for electric locomotives:

$$Q_{br} = \frac{F_k - (\omega_0^{'} + \omega_0^{''} + i_p)\ P}{\omega_0^{''} + \omega_p + i_p} \qquad (2)$$

where: F_k – estimated traction power of the locomotive;
$\omega_0^{'}$ – the main resultant resistance affecting the movement of the locomotive;
i_p – accepted design slope;
P – design weight of the locomotive;
$\omega_0^{''}$ – main resultant resistance affecting the movement of freight cars;
ω_p – additional resistance affecting movement.
$\omega_0^{'}, \omega_0^{''}$ – values and is determined for the design speed of the locomotive ϑ_p. Calculations were carried out taking into account the full power of the electric locomotive and the design speed of 55 km/h.

pISSN:2349-5707 Volume:13,Issue 4, April -2026 eISSN:2349-5715

Graphical relationships $\omega_0' = f(\vartheta)$ the main resulting resistance of a diesel locomotive is calculated using the following formula:

$\omega_0' = 1,9 + 0,01\ \vartheta_p + 0,0003\ \vartheta_p^2$ (3)

Main resultant resistance of a loaded four-axle car, N/kN:

$\omega_{04}'' = 0,7 + \dfrac{3 + 0,01\ \vartheta_p + 0,0025\vartheta_p^2}{q_{04}}$ (4)

where: q_{04} – weight corresponding to one pair of axles of a 4-axle car, t.

To calculate the traction acting on the train, a diagram of the resultant forces was constructed.

As a result, the weight of the train for the two-section electric locomotive of the 2O'zEL series was 2100 tons. Train travel times were calculated using a net resultant force diagram.

In two versions, the train schedule for the Angren – Pap section was modeled and traction calculations, technical and operational indicators of the locomotive were calculated:

I. Trains are placed evenly on the schedule, that is, even and odd trains are placed on the same schedule;

II. taking into account the fact that train traffic is in a natural emergency situation - due to the impact of landslides on the tracks in an unforeseen state (force majeure) and, as a result, the throughput of the section is reduced.

In this option, the Angren-Pap section was electrified; a landslide occurred at the 71st kilometer; train traffic was stopped for 14 hours (mandatory technological break) as accepted. For these two options, the following indicators were calculated: sectional and technical speed of trains; schedule speed coefficient and operational indicators of locomotives (freight turnover of locomotives, average daily mileage of locomotives, production capacity of locomotives).

An economic analysis of the increase in costs determined by the standard tariff (Tables 1-6) for economic damage caused by technical failures was carried out on the basis of a document approved by the forecasting department on September 6, 2019

1. For passenger trains:

Table -1.

Regulatory tariffs for increasing the cost of passenger trains at JSC “Uzbekistan Temir Yollari”

Indicators	Amount, soum	Passenger trains	Suburban passenger trains
Car-kilometer	1452		
Transportation - hours	11896		
Locomotive - kilometers	13321		10792
Lokomotiv - hours	68583		23582
Locomotive brigade, brigade - watch	54805		75219
Electric locomotive - kilometer	13548		
Electric locomotive - watch	45437	604016	39190
Electric locomotive brigade, brigade - hours	74787	273038	141659
Electricity	450		

pISSN:2349-5707 Volume:13,Issue 4, April -2026 eISSN:2349-5715

consumption			

Table -2.
Train stop cost, train-hours

Train / Locomotive	Passenger trains, soum
In the locomotive	808 034
By electric train	656 871

Table -3.
Cost of parking a locomotive on passenger trains for 1 hour in working condition

Train / Locomotive	Passenger trains, soum
In the locomotive	387 198
By electric train	217 247

2. For freight trains:
Table -4.
Train stop cost, train-hours

Train / Locomotive	Freight trains, soum
In the locomotive	572 841
By electric train	300 604

Table -5.
Cost of standing for 1 hour on a freight train locomotive in working order

Train / Locomotive	Passenger trains, soum
In the locomotive	525 545
By electric train	250 689

Regulatory tariffs for increasing the cost of measuring cargo work at “Uzbekistan Temir Yo‘llari” JSC

Measurements	Total, soum
Car - kilometer	255
Transportation - hours	973
Locomotive - kilometers	21 752
Locomotive - hours	114 270
Locomotive brigade, brigade - watch	157 585
Fuel consumption	5 797
Maneuvering locomotive - hours	218 913
Electric locomotive - kilometer	26 252
Electric locomotive - watch	34 760
Electric locomotive brigade, brigade - hours	106 202
Electricity consumption	450

pISSN:2349-5707 Volume:13,Issue 4, April -2026 eISSN:2349-5715

In general, we will calculate the economic damage caused by a technical malfunction of the railway based on the following example. Movement of trains during natural emergencies - due to landslides, closure time (period) of the Angren-Pap railway section is 14 hours, number of trains traveling along the railway section during this period: 6 passenger trains, 11 freight trains.
Train traffic is disrupted in the event of a natural disaster - landslides and trains may arrive at their destinations up to 14 hours late. Thus, according to the cost of a ticket for one seat on a passenger train, each passenger on this train will be refunded 100% of the ticket price. 200 passengers will be refunded 100% of the ticket price when seats on the passenger train are considered 100% full. So, with an average ticket price of 100,000 soums:
$E_b = 100000\ \ 200\ \ 1\ \ 6 = 120000000$ soums damage occurs.
In addition to the money returned from the fare due to the landslide, the cost of an electric locomotive-hour and crew-hour (driver) per hour is 604,016 soums per electric train-hour and 273,038 soums per crew-hour, that is, the total cost is 877,054 soums. So in 14 hours and 6 passenger trains
$E_n = 877054\ \ 14\ \ 16 = 73672536$ soum.
Thus, $E = 120000000 + 73672536 = 193672536$ the soums may be damaged as a result of a delay of 6 passenger trains for 14 hours due to a landslide.
1. Due to a technical malfunction, the cost of 1 hour of electric locomotive-hour and crew-hour (driver) also applies to 1 passenger train.
2. According to the costs of stopping trains:
$E_{ost} = 656781\ \ 14\ \ 6 = 55177164$ soum.
Thus, the cost of 6 passenger trains with a delay of 14 hours is 55,177,164 soums.
3. According to the schedule, the cost of an electric locomotive-hour and a crew-hour (driver) for a technical malfunction is 300,604 soums for 1 freight train. Thus, the cost of 11 freight trains with a delay of 14 hours is 4,629,856 soums
Thus, the damage caused by the closure of the railway for 14 hours due to a technical malfunction (when studying 17 pairs of trains during this period) amounts to
193072536+55177164+4622856=252879556 soum.
is that the period of railway closure was taken to be 14 hours, and during this period the electric locomotives were considered non-working, electricity costs were taken into account, and losses due to cargo delays were not taken into account.
The technology for transferring the electrified Angren-Pap railway from emergency situations (taking into account the consequences of landslides) trains were considered more faithful to the schedule [5].
Based on the diagram and the influence of forces, the train movement time was determined and compared with the standard schedule, which showed the correctness of the calculations. Two options for train schedule indicators were calculated. To compare performance, the cost of electricity used to drive trains was compared using current curves.
The comparison result showed that the final electricity consumption under the first option was 49 kWh/t-km less than under the second option. The increase in the cost of electricity under the second option is an emergency situation - due to the impact of the landslide, the movement of trains on the railway track was stopped, and the speed of the section decreased. The above-mentioned comparative calculations showed that in order to prevent a decrease in the cargo-passenger capacity of railways under the influence of landslides in emergency situations, it is necessary to develop measures to reduce the impact of landslides in mountain and foothill areas.

CONCLUSIONS AND SUGGESTIONS

This article examined the issue of the impact of emergency situations affecting railway lines and their facilities located in the mountainous and foothill regions of the Republic. The consequences

pISSN:2349-5707 Volume:13,Issue 4, April -2026 eISSN:2349-5715

of landslides leading to train downtime and material damage to the railway were studied. The economic damage caused by a technical malfunction of the railway during mudflows and landslides in mountainous areas has been calculated. The impact on train movement during emergencies of a natural nature - in connection with landslides, the time (period) of closure of the Angren - Pap railway section. To calculate the mass of a freight train and determine the standard mass of trains on the Angren-Pap section of the railway, the method of S.Yu. Frenkel was used. All calculations were carried out on site using AC electric locomotives of the 2O'ZEL series (made in China).

REFERENCES:

[1] O‘zbekiston Respublikasi Prezidenti Shavkat Mirziyoyevning "O‘zbekiston temir yo‘llari" aksiyadorlik jamiyati jamoasiga tabrigi "Xalq so‘zi", 2018 yil, 4 avgust. [In Uzbek: Greetings from the President of the Republic of Uzbekistan Shavkat Mirziyoev to the team of Uzbekistan Railways].

[2] Ramatov J. S., Yuldashev B. E. “Jelezniye dorogi Uzbekistana - istoriya, segodnya, perspektivi”. Statya Transport Shyolkovogo Puti №1–2, 2019.

[3] Ibragimov U. N., Abdualibekov A. T., Dadaboyeva Z.S. «Puti povisheniya tranzitnogo potensiala jeleznix dorog Uzbekistana» Elektronniy nauchno – prakticheskiy jurnal «Ekonomika menedjment i innovatsionnoy-texnologii». Jurnal razmeshayetsya na portale eLIBRARY.RU (Nauchnaya elektronnaya biblioteka), RINS..

[4] Пономарев, В. М. Методы и средства повышения безопасности и устойчивости функционирования железнодорожного транспорта в чрезвычайных ситуациях.

[5] Ukaz Prezidenta Respubliki Uzbekistan 28.01.2022 g. N UP-60 «O strategii razvitiya novogo Uzbekistana na 2022-2026 godi.

[6] Ukaz Prezidenta Respubliki Uzbekistan, ot 07.02.2017 g. № UP-4947 «O strategii deystviy po dalneyshemu razvitiyu Respubliki Uzbekistan».

[7] Ukaz Prezidenta Respubliki Uzbekistan, ot 22.01.2018 g. № UP-5308 «O gosudarstvennoy programme po realizatsii strategii deystviy po pyati prioritetnim napravleniyam razvitiya respubliki Uzbekistan v 2017 - 2021 godax v «god podderjki aktivnogo predprinimatelstva, innovatsionnix idey i texnologiy».

[8] Zakon respubliki Uzbekistan, ot 20.08.1999 g. № 824- «O zashite naseleniya i territoriy ot chrezvichaynix situatsiy prirodnogo i texnogennogo xaraktera».

[9] Polojeniye o Gosudarstvennoy sisteme preduprejdeniya i deystviy v chrezvichaynix situatsiyax Respubliki Uzbekistan (Prilojeniye N 1 k Postanovleniyu KM RUz ot 24.08.2011 g. N 242).

[10] .«O‘zbekiston temir yo‘llari» AJning 2023 yil uchun biznes – rejasi.

[11] Abdullaev, Z., Rasulov, M., & Masharipov, M. (2021). Features of determining capacity on double-way lines when passing high-speed passenger trains. In E3S Web of Conferences (Vol. 264, p. 05002). EDP Sciences. https://doi.org/10.1051/e3sconf/202126405002

[12] Abdazimov Sh. Kh. Ways to ensure safety in the railway and national economy objects under natural emergency situations in the Republic of Uzbekistan. (Volume 3 | Issue 5 | 2022) Academic Research in Educational Sciences. https://ares.uz/storage/app/uploads/public/629/276/810/629276810dd25638764024.pdf