

ENGINEER



international scientific journal

ISSUE 3, 2026 Vol. 4

E-ISSN

3030-3893

ISSN

3060-5172



SLIB.UZ
Scientific library of Uzbekistan



A bridge between science and innovation



**TOSHKENT DAVLAT
TRANSPORT UNIVERSITETI**

Tashkent state
transport university



ENGINEER

A bridge between science and innovation

E-ISSN: 3030-3893

ISSN: 3060-5172

VOLUME 4, ISSUE 3

SEPTEMBER, 2026



engineer.tstu.uz

TASHKENT STATE TRANSPORT UNIVERSITY

ENGINEER

INTERNATIONAL SCIENTIFIC JOURNAL
VOLUME 4, ISSUE 3 SEPTEMBER, 2026

EDITOR-IN-CHIEF

SAID S. SHAUMAROV

Professor, Doctor of Sciences in Technics, Tashkent State Transport University

Deputy Chief Editor

Miraziz M. Talipov

Doctor of Philosophy in Technical Sciences, Tashkent State Transport University

Founder of the international scientific journal “Engineer” – Tashkent State Transport University, 100167, Republic of Uzbekistan, Tashkent, Temiryo‘lchilar str., 1, office: 465, e-mail: publication@tstu.uz.

The “Engineer” publishes the most significant results of scientific and applied research carried out in universities of transport profile, as well as other higher educational institutions, research institutes, and centers of the Republic of Uzbekistan and foreign countries.

The journal is published 4 times a year and contains publications in the following main areas:

- Engineering;
- General Engineering;
- Aerospace Engineering;
- Automotive Engineering;
- Civil and Structural Engineering;
- Computational Mechanics;
- Control and Systems Engineering;
- Electrical and Electronic Engineering;
- Industrial and Manufacturing Engineering;
- Mechanical Engineering;
- Mechanics of Materials;
- Safety, Risk, Reliability and Quality;
- Media Technology;
- Building and Construction;
- Architecture.

Tashkent State Transport University had the opportunity to publish the international scientific journal “Engineer” based on the **Certificate No. 1183** of the Information and Mass Communications Agency under the Administration of the President of the Republic of Uzbekistan. **E-ISSN: 3030-3893, ISSN: 3060-5172.** Articles in the journal are published in English language.

3	
engineer.tstu.uz	A bridge between science and innovation

Study of the impact of heavy trucks on the smoothness of asphalt concrete pavement

A. Urakov¹, E. Ashurov²

¹Tashkent State Transport University, Tashkent, Uzbekistan

²Termez State University of Engineering and Agrotechnologies, Termez, Uzbekistan

Abstract:

This article examines the significant increase in traffic flow on the 1315–1458 km section of the M-39 “Almaty–Bishkek–Tashkent–Shahrisabz–Termez” highway located in the southern region of the republic, and investigates the effect of heavy freight vehicles on the smoothness of asphalt concrete pavement, particularly the formation of wheel-path rutting. The study analyses the elastic and plastic deformations occurring in the pavement under heavy truck loads, the deterioration of pavement smoothness and the reduction in pavement service life. The longitudinal roughness of the 1360–1425 km section was surveyed in both directions with the “TRASSA” mobile road laboratory complex and evaluated against the International Roughness Index (IRI). The mean measured index is 1.76 m/km in the Tashkent–Termez direction and 1.49 m/km in the Termez–Tashkent direction, while 8.4 % and 3.7 % of the surveyed length respectively exceed the permissible value of 3 m/km established for category I roads; the maximum recorded value reaches 8.08 m/km. On this basis engineering recommendations were developed to improve the transport and operational condition of the pavement.

Keywords:

asphalt concrete pavement, smoothness, heavy truck, deformation, IRI, deflection, traffic flow

1. Introduction

At present, the increasing traffic volume on highways, especially the growth in the number of heavy trucks, has a significant impact on the operational condition of road pavements. The axle loads of heavy freight vehicles operating on national and international roads cause various deformations in asphalt concrete pavements, leading to a deterioration of the pavement smoothness indicators.

The smoothness of a road pavement depends on several factors and is one of the main parameters determining traffic safety, fuel consumption, driving speed and passenger comfort. The deterioration of pavement smoothness results in increased vehicle operating costs and a reduction of the pavement service life [1].

Therefore, investigating the impact of heavy trucks on the smoothness of asphalt concrete pavement is considered one of the urgent scientific and practical issues in the field of highway engineering. The aim of the present work is to determine, from field measurements on an operating international highway, how the share of heavy trucks in the traffic flow is reflected in the longitudinal roughness of the asphalt concrete pavement, and to compare the measured values with the permissible standard indicators.

2. Research methodology

The methodology of this study is aimed at determining the impact of heavy trucks within the traffic flow on the smoothness of asphalt concrete pavement, evaluating the deformations formed in the pavement, and identifying the patterns of change in the smoothness indicators.

The smoothness of the asphalt concrete pavement was evaluated on the basis of the International Roughness Index (IRI). A number of scholars have conducted research in this field, including O.A. Krasikov, E.V. Uglova, F.B. Matvienko, A.K. Birulya, A.P. Vasilev, I.S. Sadikov, A.X. Urakov and A.G. Yunusov [3].

Smoothness is a transport-operational indicator that characterises the levelness of a road pavement surface. Pavement smoothness is evaluated through the vertical vibrations generated during vehicle movement. In international practice, pavement smoothness is mainly determined using the IRI (International Roughness Index) indicator [2].

The longitudinal smoothness of highway pavements is assessed in accordance with IQN 05-2011 “Rules for diagnostics and evaluation of highway conditions” by comparing the measured values with the permissible standard indicators (Table 1); the road categories themselves are assigned in accordance with ShNQ 2.05.02-07 [6]. If the actual value of the smoothness indicator is less than or equal to the allowable value, the pavement is considered to meet the required operational standards in terms of smoothness [5].

^a <https://orcid.org/0000-0001-8404-3013>

^b <https://orcid.org/0009-0005-5885-0133>



Table 1

Permissible values of the longitudinal roughness index according to IQN 05-2011

Traffic intensity, veh/day	Road category	Pavement type	Longitudinal roughness index based on IRI, m/km
more than 7000	I	Capital	3.0
3000–7000	II	Capital	3.5
1000–3000	III	Capital	4.0
1000–3000	III	Lightweight	4.5
500–1000	IV	Lightweight	5.0
200–500	IV	Transitional	5.5
less than 200	V	Lower	6.0

The reconstruction project of the 1315–1458 km (143 km) section of the international M-39 “Almaty–Bishkek–Tashkent–Shahrisabz–Termez” highway, passing through the Surkhandarya region in the southern part of the republic, was implemented with international investment funds [9, 10]. Currently, the traffic flow along this road section is increasingly composed of foreign-made vehicles with high dynamic characteristics.

In this area, the Sherabad Cement Plant and several Sherabad construction material quarries are located. The excessive axle loads of the transported cargo, which exceed the permissible axle load standards, as well as the formation of wheel-path rutting on the pavement surface, have resulted in noticeable pavement roughness and unevenness [4].



Fig. 1. Wheel-path rutting and pavement roughness deformations on the 1400–1420 km section of the M-39 “Almaty–Bishkek–Tashkent–Shahrisabz–Termez” highway

The process of the development of pavement smoothness deformations under the impact of heavy trucks within the traffic flow is occurring very rapidly on these highways.

During the experimental studies carried out on the research section, investigations were conducted using the “TRASSA”

mobile road laboratory complex, which is designed to evaluate the transport-operational characteristics of highways. The pavement condition was assessed on the basis of the International Roughness Index (IRI) indicator [2].



Fig. 2. “TRASSA” mobile road laboratory complex: a) general view; b) operator workstation; c) measuring equipment

Using the FORD “TRASSA” mobile road laboratory complex, monitoring studies were conducted on the 1360–1425 km (65 km) section of the M-39 “Almaty–Bishkek–Tashkent–

Shahrisabz–Termez” highway. As a result of these investigations, the following parameters were measured,

evaluated and simultaneously analysed in an electronic database:

- geometric parameters (longitudinal and transverse smoothness, traveled road length);
- longitudinal smoothness based on the International Roughness Index (IRI);
- pavement structural strength using the DINA 4 (FWD) dynamic loading device, in accordance with MKN 52-2008 [7] and GOST 32729-2014 [8];
- traffic intensity and traffic flow composition.

3. Results and discussion

The results of the monitoring studies conducted on the 1360–1425 km section of the M-39 “Almaty–Bishkek–Tashkent–Shahrisabz–Termez” highway showed that as the proportion of heavy trucks in the traffic flow increases, the smoothness indicators of the asphalt concrete pavement deteriorate. The measurements cover 67.7 km of carriageway in each direction with a recording step of 100 m.

Particularly in the southern regions, under high summer temperatures, the softening of the asphalt concrete pavement accelerates the formation of longitudinal ruts (wheel-path rutting). On roads with a high daily volume of heavy trucks, pavement deflection increases significantly. According to the results, the increase in the number of freight vehicles accelerates pavement unevenness and deformation processes [4].

Table 2

Longitudinal roughness indicators measured on the 1360–1425 km section of the M-39 “Almaty–Bishkek–Tashkent–Shahrisabz–Termez” highway

Indicator	Tashkent–Termez	Termez–Tashkent
Surveyed length, km	67.7	67.7
Mean IRI, m/km	1.76	1.49
Median IRI, m/km	1.54	1.31
Maximum IRI, m/km	8.08	5.44
Length with IRI > 3 m/km, %	8.4	3.7
Length with IRI > 4 m/km, %	3.1	0.9
Length with IRI > 5 m/km, %	1.2	0.3

The measured roughness profiles are presented in Figures 3–5. In the Tashkent–Termez direction the mean value of the index is 1.76 m/km and 8.4 % of the surveyed length exceeds the permissible value of 3 m/km established for category I roads; in the Termez–Tashkent direction the corresponding

values are 1.49 m/km and 3.7 %. The maximum recorded value, 8.08 m/km, is 2.7 times the permissible one. The asymmetry between the two directions corresponds to the predominant direction of loaded heavy vehicles moving from the Sherabad quarries and cement plant.

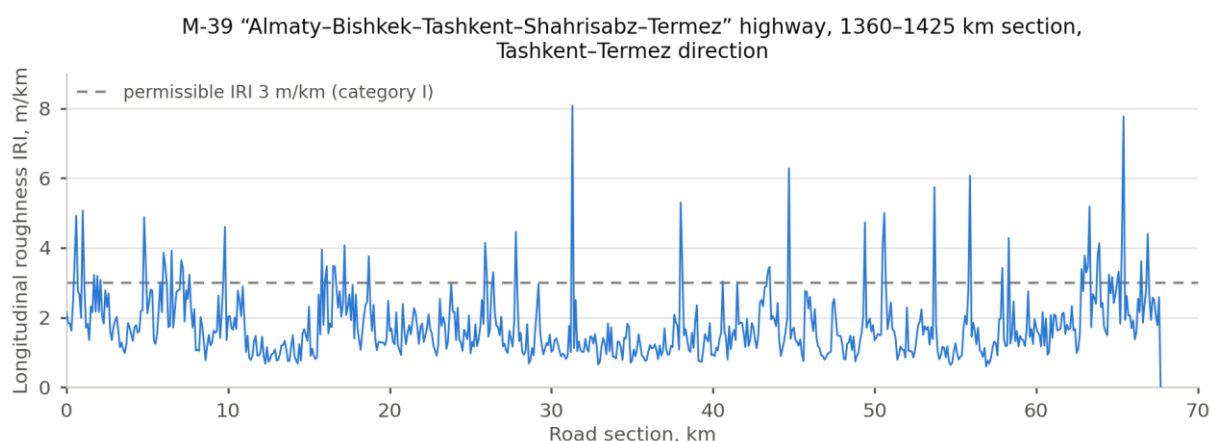


Fig. 3. Longitudinal roughness along the Tashkent–Termez direction on the 1360–1425 km section of the M-39 “Almaty–Bishkek–Tashkent–Shahrisabz–Termez” highway



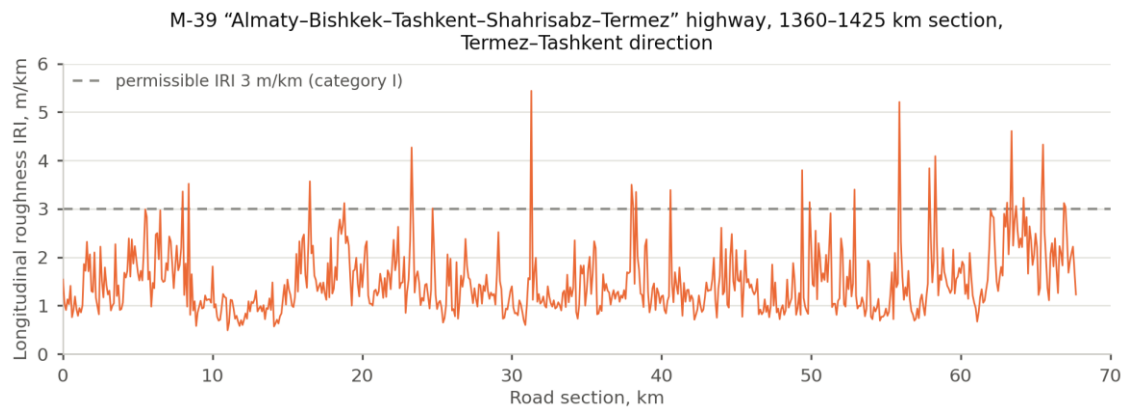


Fig. 4. Longitudinal roughness along the Termez–Tashkent direction on the 1360–1425 km section of the M-39 “Almaty–Bishkek–Tashkent–Shahrisabz–Termez” highway

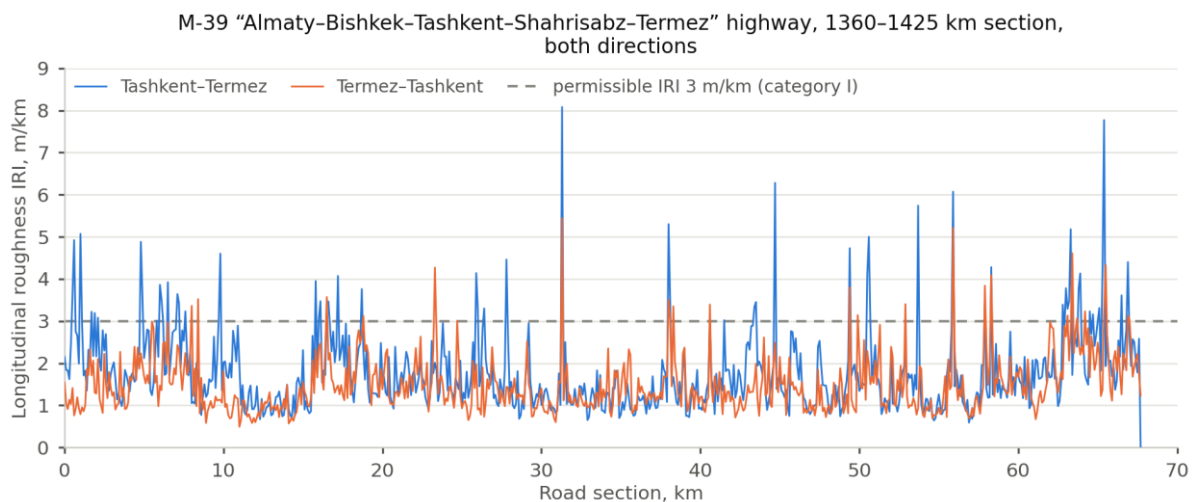


Fig. 5. Comparison of the longitudinal roughness in both directions on the 1360–1425 km section of the M-39 “Almaty–Bishkek–Tashkent–Shahrisabz–Termez” highway

The pavement smoothness of the carriageway was evaluated against the required International Roughness Index values, and the corresponding permissible limits are shown in Figures 3–5 as a dashed line. The sections where the measured index systematically exceeds this limit are concentrated in the zones of intensive heavy-vehicle loading, which confirms the connection between the traffic flow composition and the rate of deterioration of the pavement smoothness.

4. Conclusion

1. The research findings revealed that the increasing longitudinal pavement irregularities (wheel-path rutting) observed on the 1360–1425 km section of the M-39 “Almaty–Bishkek–Tashkent–Shahrisabz–Termez” highway indicate the negative impact of heavy trucks within the traffic flow on the smoothness of the asphalt concrete pavement. Repeated exposure to high axle loads causes elastic and plastic deformations in the pavement structure, resulting in the deterioration of the pavement smoothness indicators.

2. In the Tashkent–Termez direction 8.4 % of the surveyed length, and in the Termez–Tashkent direction 3.7

%, do not meet the permissible roughness value of 3 m/km for category I roads; the mean values are 1.76 and 1.49 m/km respectively. The difference between the directions reflects the predominant direction of the loaded heavy vehicle flow.

3. The studied highway is located in a hot climatic region, where not only the intensity of heavy freight transportation is increasing, but pavement deflection and deformation are also becoming more severe under such conditions. Therefore, during the design and operation of highways, it is essential to take into account the composition of the traffic flow, particularly the proportion of heavy trucks.

4. For the sections where the permissible roughness value is exceeded, it is advisable to carry out axle-load control of heavy vehicles, to plan levelling layers within the maintenance programme, and to repeat the IRI survey after the repair works in order to evaluate their effectiveness.

References

- [1] Sodikov I.S. Transport and operational performance indicators of highways. Textbook. Tashkent: TAYLQEI, 2019.
<https://library.samdpi.uz/ebooks/view?id=15478>



[2] Urakov A.X. Technologies for maintenance and repair of highways. Textbook. Tashkent: TAYLQEI, 2019. <https://unilibrary.uz/literature/50239>

[3] Yunusov A.G., Xoliqov B.A., Soataliev R.R. Modern methods for evaluating the transport and operational indicators of road pavements. Study guide. Tashkent: TAYLQEI, 2020. <https://unilibrary.uz/literature/104344>

[4] Urakov A.X., Ashurov E.T. Problems caused by heavy truck traffic on asphalt concrete pavement surfaces. <https://www.researchgate.net/publication/394724693>

[5] IQN 05-2011. Rules for diagnostics and evaluation of highway conditions. Tashkent, 2012.

[6] ShNQ 2.05.02-07. Highways. Tashkent: Davarxitektqurilish, 2008. <https://lex.uz/docs/4444014>

[7] MKN 52-2008. Guidelines for assessing the strength of flexible pavements and calculating their strengthening. <https://lex.uz/docs/1331535>

[8] GOST 32729–2014. Automobile roads of general use. Method for measuring the elastic deflection of flexible pavement structures to determine strength. Moscow: Standartinform, 2014.

[9] Committee for Roads of the Republic of Uzbekistan. Official site. <https://gov.uz/oz/uzavtoyul>

[10] “Surxondaryo avtomobil yo‘llari” unitary enterprise. Official site. <https://www.surxondaryoavtoyul.uz/>.

Information about the author

Asliddin Urakov Tashkent State Transport University, Faculty of Road Engineering, Doctor of Technical Sciences (DSc), Professor
Tel.: +998 97 784 26 08
<https://orcid.org/0000-0001-8404-3013>

Elyor Ashurov Termez State University of Engineering and Agrotechnologies, Department of Road Engineering, Assistant
E-mail: ashurovelyor18@gmail.com
Tel.: +998 90 247 33 90
<https://orcid.org/0009-0005-5885-0133>



O. Berdiev, O. Zafarov, E. Urishbaev*Complex chemical admixture intended for improving the properties of concrete mixture.....168***I. Kavaliova, A. Panov, E. Romashova,****U. Ziyamukhamedova, L. Marchenko, Y. Podgornaya,****V. Podgornaya***A risk-oriented approach to the development of transport systems with embedded information technologies.....175***Y. Abdukhalikov, T. Urazbaev, B. Abdunazarov,****O. Achildiev***Development and localization of a manufacturing technology for cast center plates for 1520 mm gauge freight wagons.....180***A. Urakov, E. Ashurov***Study of the impact of heavy trucks on the smoothness of asphalt concrete pavement.....186*