ENGINEER

international scientific journal

ISSUE 1, 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 1

MARCH, 2026

engineer.tstu.uz

TASHKENT STATE TRANSPORT UNIVERSITY

ENGINEER

INTERNATIONAL SCIENTIFIC JOURNAL
VOLUME 4, ISSUE 1 MARCH, 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.

Features of extending the service life of transport and technological machines in mountain and foothill conditions

B. Ibragimov[1][a], N.K. Tursunov[1], W. Shao[2]
[1]Tashkent state transport university, Tashkent, Uzbekistan

Abstract: When transport and technological machines are operated in mountain and foothill conditions, their bodies and parts are more susceptible to corrosion, which leads to premature failure and a sharp decrease in the reliability of joints and main load-bearing parts. Multifunctional anti-corrosion coatings with high physicochemical properties are therefore needed to extend the service life of bodies and units of such machines. The aim of the study is to propose an epoxyurethane anti-corrosion coating based on ED-16 epoxy resin modified with cyclocarbonate and a method for estimating the effect of the coating reapplication interval on the corrosion-limited service life of vehicle units operated in mountain conditions. In a preliminary screening test in 10% HCl, the mass changes of coated copper, steel and aluminum alloy specimens did not exceed 0.0003 g. Coating deterioration observed in operation is approximated by a power law of mileage, and the predicted service life of the unit is reported with 95% confidence intervals, the assumptions of the model and the limitations of the available data.

Keywords: corrosion, anti-corrosion coating, ED-16 epoxy resin, epoxyurethane, cyclocarbonate, service life, mountain conditions

1. Introduction

Mountain roads cross ridges and ranges through passes at high altitudes (1500–2000 m above sea level). Such roads have a number of unfavorable features: steep longitudinal gradients (up to 10–12%), serpentines (sharp hairpin turns, up to 10 per 1 km of road), a large number of small-radius (8–10 m) curves (15–18 per 1 km of road), insufficient width of the carriageway and roadbed, pavement deformation and poor visibility. Some road sections are damaged during heavy rains and downpours.

In addition, the weather in high-mountain areas is unstable, with large temperature fluctuations during the day. For example, in summer the temperature in the sun can reach +30…+40 °C in the daytime and drop to ±5…±10 °C at night. In winter, avalanches and icing are frequent [1].

These factors affect the reliability of vehicles, hinder traffic, reduce speed, increase operating costs and are a major cause of road traffic accidents.

The specific nature of mountain conditions is associated with a number of features of vehicle operation. For example, for every 1000 m above sea level, engine power decreases by 12% on average owing to the lower air density and the reduced mass of the cylinder charge, fuel consumption increases, and the performance of air-actuated brakes deteriorates.

The complexity and tortuosity of the vertical profile of mountain roads affect the operating mode and energy loading of vehicle braking systems. On mountain roads, the number of brake applications reaches 10–19 per 1 km, and on some sections the temperature of the friction surfaces reaches 460–490 °C in the rear brake mechanisms and 270–290 °C in the front ones [2-5].

Tires wear intensively because the driving wheels transmit high torques when climbing, because of frequent braking on long descents, and because of the large number of small-radius turns.

The condition of the road network and the complexity of the road profile adversely affect vehicle reliability. During driving, the engine and brakes operate under heavy loads, their reliability decreases, and fastening and adjustment mechanisms often fail. All this leads to rapid wear of parts and assemblies, fatigue phenomena in them and, ultimately, to failures.

In mountain conditions, especially in regions with a subtropical climate, increased air humidity causes rapid corrosion of electrical wiring terminals, parts, units and assemblies of vehicles, and especially of the cab, body, fenders and other panels.

All this shows that particular attention must be paid to the technical condition of vehicles operated in mountain conditions.

Polymer protective coatings are widely studied as a means of improving the durability of transport and technological machines [6]. Among them, coatings obtained by the reaction of cyclic carbonates with amines (non-isocyanate, hydroxyurethane systems) are of interest because they are formed without toxic isocyanates and combine good adhesion with chemical resistance [7, 8]. However, quantitative data relating the protective performance of such coatings to the service life of vehicle units in mountain operation remain scarce.

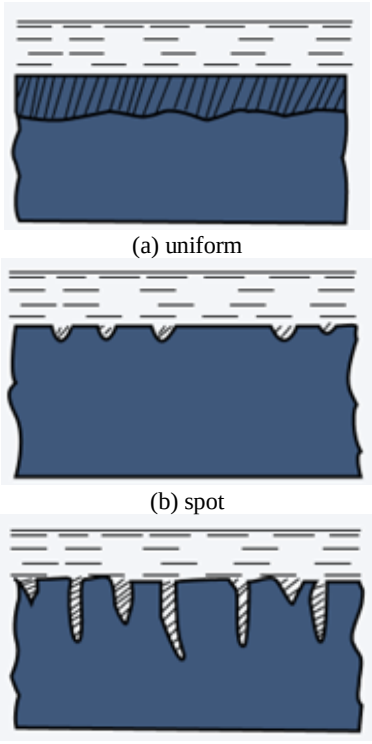
The aim of this study is to develop an epoxyurethane anti-corrosion coating based on ED-16 epoxy resin modified with cyclocarbonate, to evaluate its resistance in laboratory tests, and to estimate, using operational observations and a power-law deterioration model, how the coating reapplication interval affects the corrosion-limited service life of vehicle units operated in mountain conditions.

2. Research methodology

Corrosion of metals proceeds in stages, and five stages of corrosion have been identified. In the first stage, small

[a] https://orcid.org/0009-0003-5965-5933

blisters form and rust spots appear. In the second stage, iron oxide Fe_2O_3 forms and general rusting develops. In the third stage, the coating layer completely detaches from the substrate and corrosion proceeds at a high rate; this is the stage against which coatings protect the metal. In the fourth stage, deep cavities form and pitting corrosion occurs. In the fifth stage, large through-holes form, and corrosion proceeds intensively on both sides of the substrate.



(a) uniform

(b) spot

(c) pitting (deep localized)

Fig. 1. Types of corrosion

The term “corrosion” applies to many metals (including non-ferrous metals) and alloys, as well as to concrete and some plastics, whereas rust is a product of the corrosion process. The latter term refers only to the iron contained in steel and cast iron: when steel is said to rust (or corrode), this means that the iron it contains rusts (oxidizes).



Fig. 2. Corrosion damage observed on transport and technological machines

The extent of corrosion is assessed by the number of corrosion sites (the corrosion site index k_p). The corrosion depth k_t (mm/year) is the average or maximum depth of corrosion damage of the metal over a given period of operation of the product. The corrosion susceptibility k_c (hours or days) is the period of operation before the onset of corrosion; the onset of corrosion is defined as the moment when the corroded area reaches 1%, and it depends on the condition of the metal surface. The change in metal mass during operation due to the loss or accumulation of corrosion products is denoted k_t (g/(m^2·h)). In addition to the mass loss (gain) index, an important indicator of mechanical strength is the change (%) in the ultimate strength of the metal during operation.

Accelerated test methods reproduce the main factors of the operating conditions. However, the corrosion process must not be accelerated by changing its mechanism, for example by introducing a more aggressive component of a different nature. The test regime must be chosen so as to ensure a high corrosion rate throughout the entire test period [3, 4, 9].

The standard O‘z DSt 9.101-98 “Unified System of Protection against Corrosion and Ageing. Basic Provisions” establishes the main indicators of corrosion and corrosion resistance (chemical resistance) of metals and alloys and the methods for their determination for general, pitting, intergranular, exfoliation and spot corrosion, corrosion cracking and corrosion fatigue [10].

Paint and varnish coatings are the most widespread means of protecting transport and technological machines against corrosion. They are relatively inexpensive and easy to apply, damaged coatings are easy to restore, and they can be combined with other protection methods.

Proper selection of materials and of the method of applying these coatings in the atmosphere and in a number of corrosive media ensures sufficiently reliable corrosion protection of metal structures. A continuous film forms on the metal surface, which prevents the aggressive action of the environment and protects the metal from degradation.

The protective properties of composite polymer coatings are superior to those of paint coatings. The specific properties of composite polymer materials have enabled their use in various industries, in particular for the corrosion protection of metals [6, 11].

Plastics and resins exhibit high corrosion resistance in many aggressive media.

Pentaplast is a polymer material used to protect pipes, collectors for draining hydrochloric, nitric and other acids, and pump housings and impellers against corrosion [12, 13].

Thus, anti-corrosion coatings provide good adhesion to metal surfaces, mechanical strength and chemical resistance.

In addition, polymer coatings protect parts from mechanical damage; their possible vibration- and noise-damping effect is beyond the scope of this study.

3. Results and discussion

To develop the coating, the thermosetting oligomer ED-16 epoxy resin was selected as the base. Dibutyl phthalate (DBP) and dioctyl phthalate (DOP) were used as plasticizers to impart flexibility to the cured film [14]; polyethylene polyamine (PEPA) was used as the hardener, and the cyclocarbonate-modified oligomer obtained by reactions (1)–(2) served as the urethane-forming component. A

titanium-containing filler was introduced into the composition.

Special additives—both organic and inorganic fillers—are introduced into polymer materials to increase their mechanical strength, to improve their dielectric and frictional (or, conversely, antifriction) properties and thermal stability, to reduce shrinkage and to lower cost. In many cases, fillers determine not only the mechanical properties of polymer materials but also the type of coating.

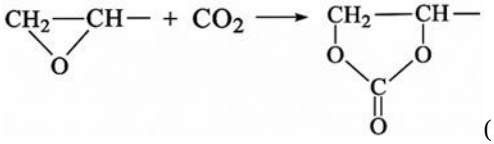
The use of hardeners increases the water resistance of the coating and improves the casting of the resin. Polyethylene polyamine and some other amines, added to the resin in an amount of 5–10%, are the most commonly used hardeners.

The present work is limited to the selection of the components and the synthesis route of the coating; optimization of its quantitative composition and application parameters (surface preparation, curing regime, dry film thickness) is the subject of further study. Here the coating is considered as a protective system whose effect on the service life of vehicle units is evaluated.

The epoxyurethane binder was synthesized in two stages, the cyclocarbonate component being obtained from local raw materials.

The epoxyurethane coating was obtained as follows.

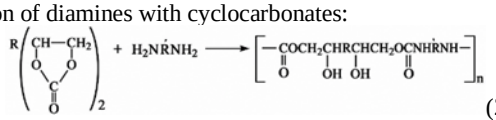
1. Cyclocarbonates were obtained by reacting epoxy compounds with carbon dioxide:



(1)

Epoxy oligomers were used as the starting materials.

2. The epoxyurethane coating was synthesized by the reaction of diamines with cyclocarbonates:



(2)

The reaction of cyclic carbonate groups with primary amines yields hydroxyurethane fragments without the use of isocyanates [7, 8].

The anti-corrosion properties of the coating were evaluated in a preliminary laboratory screening test in 10% hydrochloric acid (HCl) with reference to O‘z DSt 9.101-98 [10]: coated specimens of copper, steel and aluminum alloy AL-9 were weighed before and after exposure. The results are given in Table 1.

A 10% HCl solution was used as a severe chloride-containing screening medium: chloride ions are the main corrosive agent of the de-icing salts (NaCl, $CaCl_2$) applied on mountain roads in winter, and the acidic medium strongly accelerates the attack [3, 4]. Because acid exposure may differ in mechanism from atmospheric corrosion under de-icing salts, the test is used only to rank the barrier properties of the coating; it does not reproduce the combined action of humidity, temperature cycling, road salts, abrasion and ultraviolet radiation. Transfer of the laboratory result to operating conditions is therefore qualitative; neutral salt-spray tests according to ISO 9227 [9] and cyclic climatic tests are required to quantify it.

Table 1

Mass of coated specimens before and after exposure to 10% HCl (preliminary screening test)

Sample	Mass, g		Mass loss, g	Note
	Before test	After test		
Copper M	5.1072	5.1069	0.0003	Resistant
Steel D	10.8331	10.8330	0.0001	Resistant
Aluminum AL-9	2.0691	2.0690	0.0001	Resistant

The recorded mass changes (0.0001–0.0003 g) correspond to one to three units of the last reported digit, i.e. they are at the resolution limit of the weighing. Since these results are not supported by replicate specimens or by comparison with uncoated controls, they are regarded only as qualitative evidence that the coating does not undergo noticeable degradation under the test conditions; the designation “Resistant” in Table 1 is used in this sense.

Operational observations of the coating were carried out on trucks and special technological machines used for road construction and winter snow clearing on the Qamchiq pass.

The coating deterioration U (%) recorded at mileages of 60–240 thousand km is given in Table 2; U = 100% corresponds to complete loss of the protective function of the coating on the observed surface.

Studies to determine the dependence of the service life of units and systems on the coating application interval were carried out using the following method.

In mountain and foothill conditions, the service life of transport and technological machines largely depends on the interval at which the anti-corrosion coating is applied. This dependence is expressed by the following function:

$$L_p = \varphi(L_Q) \quad (3)$$

where L_p is the service life of the object, thousand km; L_Q is the coating application interval, thousand km.

The change in the condition of the object surface with mileage during operation is given in Table 2.

Table 2

Change in the condition of the coating on the object surface with mileage

Mileage, thousand km	Coating deterioration, %	
	Experimental	Theoretical
60	10	9.989
120	25	25.025
180	40	42.824
240	65	62.695

The change in the coating condition on the object surface with mileage is described by a power function:

$$U = B \cdot L^{\alpha} \quad (4)$$

where U is the coating deterioration, %; L is the mileage, thousand km; B is a scale coefficient, %·(thousand km)$^{-\alpha}$; α is a dimensionless exponent.

The parameters were estimated by the least-squares method after linearization, $\ln U = \ln B + \alpha \ln L$, using the four mean values of Table 2 (n = 4, two degrees of freedom). This gave

$$B = 0.044,\ \alpha = 1.325$$

The 95% confidence interval of the exponent is α = 1.10–1.55 and that of the coefficient is B = 0.015–0.129 (the two estimates are strongly correlated). The coefficient of determination in logarithmic coordinates is R^2 = 0.997; the deviations of the fitted values from the experimental ones are

https://doi.org/10.56143/3030-3893-2026-1-139-143

+0.01, −0.02, −2.82 and +2.31 percentage points (Table 2), i.e. the maximum relative deviation is about 7%. Because only four points are available, the intervals are wide, and the model is regarded as an empirical approximation valid within the observed mileage range of 60–240 thousand km.

Thus, the theoretical value of the coating deterioration is determined by the formula

$$U = 0.044 \cdot L^{1.325} \quad (5)$$

The theoretical values calculated with this formula are given in the third column of Table 2.

The experimental and theoretical dependences of the coating deterioration on mileage are shown in Figure 3.

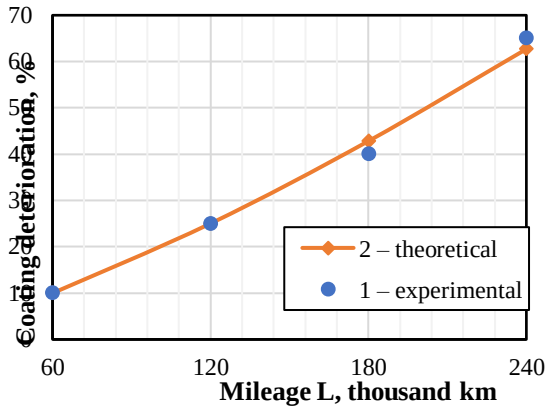


Fig 3. Change in the deterioration of the coating applied to the object with mileage: 1 – experimental; 2 – theoretical

If the coating is applied to the object surface once and is not reapplied, the service life of the object is determined by the formula

$$L_{p1} = \left(\frac{U_{ch}}{B}\right)^{1/\alpha} \quad (6)$$

where U_{ch} is the limiting (critical) value of coating deterioration, %. In this work U_{ch} = 100% is taken: the protective function of the coating on the inspected surface is considered exhausted when the entire surface is affected, after which the base metal of the unit is exposed to direct corrosion. Accordingly, L_p denotes the corrosion-limited service life of the unit, i.e. the mileage over which the unit remains protected by the coating, rather than its mechanical failure.

Otherwise, during operation the coating is reapplied with interval i (Figure 3). In this case, the condition $L_{Qi} < L_{p1}$ is satisfied, and the change in the coating condition $\Delta U = \Delta U_{Qi}$ depends on the interval. It is determined as follows:

$$\Delta U_{Qi} = B \cdot L_{Qi}^{\alpha} \quad (7)$$

If the coating is applied to the object with interval i, its service life L_{pi} is determined by the formula

$$L_{pi} = \frac{U_{ch}}{\Delta U_{Qi}} L_{Qi} \quad (8)$$

As a result, the service life of the object is determined as

$$L_p = \frac{U_{ch}}{B \cdot L_{Qi}^{\alpha-1}} \quad (9)$$

Expressions (8)–(9) rest on the following assumptions: (i) each reapplication fully restores the protective layer, so that deterioration accumulates identically in every interval according to (7); (ii) no irreversible damage of the base metal occurs between reapplications, since $L_{Qi} < L_{p1}$; (iii) the parameters B and α do not change after repeated application; (iv) the unit is considered to have reached its limit state when the accumulated deterioration equals U_{ch}. Under these assumptions the values below are calculated predictions for the observed operating conditions, not experimentally established service lives. The overall durability of transport components also depends on mechanical loading, which is assessed by separate analytical and numerical models [15–17].

With U_{ch} = 100%, formula (6) gives a predicted corrosion-limited service life of the unit with a single coating application of about 341 thousand km (95% confidence interval 287–411 thousand km, obtained by propagating the uncertainty of B and α).

The predicted service life for different coating reapplication intervals is given in Table 3.

Table 3

Predicted corrosion-limited service life of the unit for different coating reapplication intervals

Coating application interval (L_{Qi}), thousand km	30.00	40.00	60.00
Change in coating condition per interval (ΔU_{Qi}), %	3.99	5.84	9.99
Service life (L_p), thousand km	752.46	685.30	600.69

Under the stated assumptions, regular reapplication of the coating increases the predicted corrosion-limited service life to about 752, 685 and 601 thousand km for intervals of 30, 40 and 60 thousand km (95% confidence intervals 536–1074, 517–922 and 491–747 thousand km, respectively). The width of these intervals reflects the small number of observations; it must be reduced with further operational data before the model is used for maintenance planning.

The present results have the following limitations. The laboratory test is a screening test in an acid medium without replicate and control specimens; only four values of U are available for fitting the deterioration model; the mechanical, adhesive and damping properties of the coating were not determined. Further work will therefore include salt-spray tests according to ISO 9227 [9], assessment of coating degradation according to ISO 4628 [18], determination of adhesion, hardness, flexibility, impact and abrasion resistance, comparison with industrial reference coatings, and accumulation of operational data to validate the service-life model.

4. Conclusion

1. An epoxyurethane anti-corrosion coating based on ED-16 epoxy resin modified with cyclocarbonate and plasticized with DBP and DOP has been formulated for the protection of transport and technological machines operated in mountain and foothill conditions.

2. In a preliminary screening test in 10% HCl, the mass changes of coated copper, steel and aluminum alloy specimens did not exceed 0.0003 g, which is at the resolution limit of the weighing. This result is qualitative and requires confirmation by replicate, salt-spray and cyclic climatic tests with uncoated controls.

3. Operational observations on the Qamchiq pass showed that coating deterioration increases with mileage according to the power law $U = 0.044 \cdot L^{1.325}$ (L in thousand

km; $R^2 = 0.997$ in logarithmic coordinates; $\alpha = 1.10–1.55$ at 95% confidence).

4. A calculation method relating the coating reapplication interval to the corrosion-limited service life of a unit is proposed. With $U_{ch} = 100\%$, the predicted service life is about 341 thousand km for a single application and about 752, 685 and 601 thousand km for reapplication every 30, 40 and 60 thousand km, respectively; these values are model predictions valid under the stated assumptions and within the observed mileage range.

5. The quantitative composition of the coating, its mechanical and adhesive properties, and the validity of the service-life model on an extended set of operational data are to be established in further work.

References

[1] "Why car bodies rust: a little theory and a scary bedtime story," ABS Auto, 12–27 (December 2015) (in Russian), available at https://abs-magazine.ru/article/pochemu-rzhavejut-avtomobilnye-kuzova-nemnogo-teorii-i-strashnaja-skazka-na-noch

[2] A. A. Gerasimenko, Protection of Machines, Equipment and Structures against Corrosion, Ageing and Biodeterioration, Vol. 1 (Mashinostroenie, Moscow, 1987) (in Russian).

[3] M. I. Karyakina, Testing of Paint and Varnish Materials and Coatings (Khimiya, Moscow, 1988) (in Russian).

[4] GOST 9.908-85, Unified System of Corrosion and Ageing Protection. Metals and Alloys. Methods for Determination of Corrosion and Corrosion Resistance Indices (1985).

[5] A. D. Yakovlev, Chemistry and Technology of Paint and Varnish Coatings (Khimiya, Leningrad, 1981) (in Russian).

[6] P. A. Sørensen, S. Kiil, K. Dam-Johansen, and C. E. Weinell, "Anticorrosive coatings: a review," J. Coat. Technol. Res. 6, 135–176 (2009), https://doi.org/10.1007/s11998-008-9144-2.

[7] G. Rokicki, P. G. Parzuchowski, and M. Mazurek, "Non-isocyanate polyurethanes: synthesis, properties, and applications," Polym. Adv. Technol. 26, 707–761 (2015), https://doi.org/10.1002/pat.3522.

[8] H. Blattmann, M. Fleischer, M. Bähr, and R. Mülhaupt, "Isocyanate- and phosgene-free routes to polyfunctional cyclic carbonates and green polyurethanes by fixation of carbon dioxide," Macromol. Rapid Commun. 35, 1238–1254 (2014), https://doi.org/10.1002/marc.201400209.

[9] ISO 9227:2022, Corrosion Tests in Artificial Atmospheres — Salt Spray Tests (ISO, Geneva, 2022).

[10] O'z DSt 9.101-98, Unified System of Protection against Corrosion and Ageing. Basic Provisions (Tashkent, 1998).

[11] Polyethylene and Other Polyolefins, translated from English, edited by P. V. Kozlov and N. A. Plate (Mir, Moscow, 1989) (in Russian).

[12] Yu. A. Marchuk and I. K. Yartsev, Pentaplast (Khimiya, Leningrad, 1975) (in Russian).

[13] Properties, Processing and Application of Pentaplast, Collection of Scientific Papers of ONPO "Plastpolimer" (Leningrad, 1975) (in Russian).

[14] V. N. Kestelman, Physical Methods of Modification of Polymer Materials (Khimiya, Moscow, 1975) (in Russian).

[15] A. A. Tadjibayev, Study of Vehicle Reliability in Operation, Monograph (Tashkent, 2024).

[16] S. Absattarov, S. Yunusov, and N. Tursunov, "Research of the stress-strain state and durability of freight wagon trolley springs by the method of finite element modeling in ANSYS," Vibroengineering Procedia, Vol. 60, pp. 664–669, Dec. 2025, https://doi.org/10.21595/vp.2025.25532.

[17] S. Absattarov, N. Tursunov, B. Erkin, and K. Khojakhmedova, "Numerical simulation of the spatial distribution of temperature fields in spring elements of freight wagons of railway transport," Vibroengineering Procedia, Vol. 60, pp. 670–675, Dec. 2025, https://doi.org/10.21595/vp.2025.25533.

[18] ISO 4628-1:2016, Paints and Varnishes — Evaluation of Degradation of Coatings — Designation of Quantity and Size of Defects, and of Intensity of Uniform Changes in Appearance — Part 1: General Introduction and Designation System (ISO, Geneva, 2016).

Information about the author

Botir Ibragimov	Toshkent davlat transport universiteti "Avtomobilsozlik va ishlab chiqarish muhandisligi" kafedrasi dotsenti E-mail: bd.ibragimov@tstu.uz Tel.:+998977281183 https://orcid.org/0009-0003-5965-5933
Nodirjon Tursunov	Toshkent davlat transport universiteti "Materialshunoslik va mashinasozlik" kafedrasi mudiri DSc, professor
Wenjun Shao	Uxan texnologiya universiteti, Transport va logistika muhandisligi maktabi professori

CONTENT / MUNDARIJA

E. Tokhirov, R. Aliev, M. Aliev
Methods and solutions for reducing the amount of dust in order to ensure the sustainability of cities.....**84**
E. Tokhirov, R. Aliev
Details and solutions to safety issues at railway LC **89**
Z. Adilova, S. Asenova, M. Yokubjonov, A. Sadikova
Selection of a method for market segmentation in the field of transport and logistics services **96**
S. Boltaev, Z. Toshboev, I. Yoldashev, B. Ganijonov, Sh. Kholboev
Enhancing the reliability of railway track circuit power supply systems using a microcontroller-based self-checking dual-channel architecture.....**101**
M. Karimova, R. Bozorov, E. Asatov
Analysis of the freight transportation technology efficiency on the "Bukhara – Miskin" and "Angren – Pap" railway lines.....**106**
I. Maturazov, D. Sarsenbaev
Smart maintenance scheduling via predictive logistics for post-flight engine maintenance in Central Asia.....**110**
Sh. Tillaeva
Comparative analysis of neural network architectures for adaptive control of nonlinear thermal systems.....**113**
E. Ruklinskaya, M. Ubaydullaev, S. Khudoyarov, N. Khavasova
Development of a non-autoclave technology for producing liquid glass from microsilica dust of ferroalloy production.....**118**
R. Koldobskiy, M. Ubaydullaev, U. Kosimov, E. Ruklinskaya
Design and engineering of a laboratory-industrial setup for low-temperature liquid carbonitriding with an integrated ammonia neutralization system.....**122**
J. Turgaev, V. Soy, N. Mukhammadiev
Non-autoclaved aerated concrete with a modified carbonate-sulfate additive based on soda ash production waste.....**126**
S. Khudayberganov, Sh. Kayumov, J. Tukhtaev
A model for determining employee compliance with professional requirements in human–machine systems of railway transport.....**130**
A. Tukhtakhodjaev, O. Turdiev
AI-based university KPI system: React.js, ASP.NET Core, and PostgreSQL architecture.....**134**
A. Tukhtakhodjaev
Architecture of an AI-based university KPI system: React.js, ASP.NET Core, and PostgreSQL **137**
B. Ibragimov, N. Tursunov, W. Shao
Features of extending the service life of transport and technological machines in mountain and foothill conditions **139**