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Қазақстан Республикасы Ұлттық ғылым академиясы «ҚР ҰҒА Хабарлары. Физикалық-математикалық сериясы» ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Webof Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын усынады. ҚР ҰҒА Хабарлары. Химия және технология сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді химиялық ғылымдар бойынша контентке адалдығымызды білдіреді.

НАН РК сообщает, что научный журнал «Известия НАН РК. Серия физико-математическая» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по химическим наукам для нашего сообщества.

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DATA COLLECTION FOR INTELLECTUAL FORECASTING: METTHODS AND RESULTS

Abstract: there searchispart of the “Design of an intelligent system to forecast landslides' processes and their influence on the roads' technical and operational characteristics” project financed by the Ministry of Education and Science of the Republic of Kazakhstan by AP 09260066 program.

The research goal is in surveying deformed parts of “Almaty-Cosmostation” automobile road nearby critical slopes to identify in the next phases the causes of pavement degradation and formulate then the recommendation to prevent such degeneration.

Cracks formation is estimated by visual methods according to PRRK 218-27-2014. The geo-radar research is made by AB-400 complex.

Main results. Detailed engineering and geological research of deformed parts of “Almaty-Cosmostation” automobile road nearby critical slopes are provided.The article results with the field researches to formulate causes of deterioration of the road pavement and formation of longitudinal and transversal cracks on it.

Conclusions: The surface smoothness of the road pavement is partly below the minimum permissible level. The causes of the “irregular” (unusual) transversal cracks should be associated with slides of the rock masses and water falling from the rock slopes. Suggested causes of the grading’sslide slopes’erosion are the faint provision of surface drainage for the road pavement.The unevenness of the pavement on a micro level is connected to the uncompacted enough asphaltic concrete pavement and other pavement’s layers.The field researches’ results will be used for training and testing of intellectual models.

Key words: automobileroaddiagnostics, geodynamical processes, landslides, roadpavement, forecasting.

Introduction. Until now, questions of a road destruction due to natural hazards like landslides are understudied in the field of automobile road management of Kazakhstan. The causes of the longitudinal and tiny transversal cracks on the researched parts of “Almaty-Cosmostation” automobile road are also of its kind. Moreover, there is a high risk of spanning the river that is flowing alongside the researched road because of the sliding slope.

Group of European scientists has analyzed data from 21 national and 8 regional geological agencies in a period from 2015 till 2017 with the consideration of legislative regulations in the countries. The research results show that risk of landslides is almost unconsidered in urban planning even in developed European countries, which leads to economic and more importantly human losses [1].

The outcomes of the landslide in 2013on thetransport net of Austria and the following effect of the disaster on economics and politics of the country are described in research [2]. As a result, affected region lost out additional 1 million Euro on a transportation costs and nearly 9-10 million Euros calculated losses on a tourism. The calculation shows necessity of landslides tracking not only in basic form but also implemented on transport infrastructure. The similar economic value is in a core of the research from USA [3]. Landslide processes’ impact on the road infrastructure of Oahu Island (Hawaii) are analyzed there.As a result, road parts are grouped into several categories according to the landslide expectancy (very high, high, acceptable, low and stable). Thefuzzy model to estimate the life expectancy of automobile roads in Reggio Calabria (Italy) according to landslide processes’ probability is designed for the similar task in research [4].

Typhoon rainfalls' impact on landslide processes nearby automobile roads of Taiwan is researched in article [5]. Remote sensing data have been a part of the database in the research. The synthetic-aperture radar (SAR) is used in similar research [6] for the region alongside to the highway in Mexico.

The road pavement's deterioration caused by landslide processes is forecasted by data from different sources including distance sensing in article [7].

According to Italian scientists in [8], classical mathematical models of landslide processes are based on biased data. Each model addresses only part of the key factors, which leads to no uniformity in the results of landslide's forecasts of the models. If the key factor used in the model has a significant impact in the exact region, the resulting forecast is very precise. However, if the main factor is left unconsidered, the result of the model does not reflect the actual situation.

Therefore, formation and tuning of forecasting models for landslide processes and their impact on roads' technical and operational characteristics urge for a field research of road pavement's conditions, thicknesses of road pavement's constructional layers, capacities and states of grounds in grading and underlayer base.

Material and methods. The "Almaty-Cosmostation" road passes through mountain gorge in high mountain area of the Trans-Ili Alatau, North Tian Shan. Highest point of the road in a final spot (Cosmostation) matches 3336 meters above sea level on the Jusali-Kezen passage. The total length of the traffic route from Al-Farabi Streetuntil Cosmostation is nearly 40 kilometers.

Climate of Almaty region has continental characteristics with unique features of mountains and valleys. Mid-mountain part has relatively moderate climate, while high-mountain area is known for more severe climate. The average annual air temperature in submountain regions changes between +7° Cand +9°C, decreasing in a highland up to -2°C. The air temperature's amplitude hits up to 30-35 °C. The coldest month is January with average temperature from -8 up to-16°C. The minimal air temperature hits -42-45°C in submountain regions, -35-40°C in a highland and down to -20°C in a glacial zone. The warm time is in June with average temperature from 16 until 28 °C. The evaporability is 10-15 times more than the annual rainfall sum. Annual rainfall number is up to 800-1000 mm in mountain region, while 70-80% of rainfalls is in spring and autumn-winter months [9].

The territory of Almaty region is in the V road-climatic zone according to the road-climatic zoning. The short description of climatic characteristics shows that highland and submountain regions highlyenables the accumulation of atmospheric humidity as a source of the groundwater.

Geological processes and phenomena. The region is a highly seismic zone with a magnitude from 7 till 9. Locally typical geological processes are erosions, mudflows, subsidental and deflationary processes, soil salinization and bogging. Mudflows bring down huge amount of mud and rock materials to the submountain foreslopes and inclined valleys with heavy increase of water volume in a river. Such disaster wrecks bridges, roads, power transmission lines and other buildings in unprotected valleys. Erosion phenomena in plain river valleys mostly reveals as a riverside underwashing, a gullying of the valley's' slopes, a formation of plunge pool nearby bridge arms and land abutments [10, 11]. Last researches of geological structure of the area nearby the "Almaty-Cosmostation" road has shown that the slope is characterized mostly by development of different metamorphic, sedimentary and magmatic masses from Pre-Paleozoic and Paleozoic period. Huge intermountain basins are Mesozoiclayers. Cenozoic layers are mainly in inner and intermountain basins, erosion valleys and mountain slopes. They are represented by shists, quartzites, rarely by gneisses with marble and amphibole layers. Contrast tectonic movements led to formmountain ranges and intermountain basins, where heavy depths of lightly lithified friable fragmental materials was accumulated [12, 13].

Several features characterize rocks on the mountain slopes of the Ili Alatau, where the researched "Almaty - Cosmostation" road is passing. For the granites of medium and line grain structures compressive resistance is 150-174 MPa of dry rocks, 146-171 MPa in the water-saturated state and 139-169 MPa after 10 freezing cycles. While their softening coefficient is 0.94, cold resistance is 0.07-0.16, water absorption – 0.18-0.32 % [14-16].

The road diagnostics in automobile road industry of Kazakhstan is provided according to [17] and leads to receive full information about road's traffic and operational state as well as the difference between road's application properties and demands from intensity and composition of a traffic steam.

Preparation to the field research of the specialists of LLP «Institute of Ionosphere»started with request for the permission from the JSC "NC" Kazavtozhol"". It legitimizes field researches on the "Almaty-Cosmostation" road in a planned periods including visual estimation of operational conditions of the road pavement by the road laboratory from L. B. Goncharov Kaz ADI and the geo-radar surveying by the AB-400 complex.

The visual strength assessment is classified into the three-point scale.Aroad sector with visually solid pavement is classified as I class. Afterwards the pavement should be examined to find deformations that do not lead to inadequate strength, but can affect traffic speed. Visual examination led to allocation of separate sectors with features and defects (repairs, roadway narrowing, local deformations etc.) and land marking of specific sectors. The researched road is divided into patterns by pavement types' change, pavement construction, number of traffic lanes, traffic intensity, ground type on humidity conditions and grading thickness. Traffic and natural factors deform and deteriorate grading and drainage structures while they are in service. Thereby a road pavement's stability is declining. The visual examination of road borders and side slopes is done in parallel with visual estimation of pavement strength and condition. Information about grading and drainage structures also is recorded in field notes.

The field research of the "Almaty-Cosmostation" road is done according to [17]. The five test sites with 50-meter length is chosen as objects for more deep examination. Each test site is examined with next methods:

- visual examination of the road pavement and grading;
- the longitudinal and transversal smoothness of the pavement are measured by the 3-meter surveying rod in three points (beginning, middle, ending);
- the grading's width is measured;
- the coefficients of longitudinal and transversal adherence are measured by portative device IKSp;
- the hardness index of the road pavement is measured by the hardometer of Beldor N II;
- the thickness of the road pavement is found by the caliper;
- the longitudinal, transversal and diagonal cracks' lengths are checked by the measuring tape and the opisometer;
- the geo-radar examination by the AB-400 complex including:checking the thicknesses of constructional layers in the road pavement and rock layers of grading; measuringthe depths of soft soils under the grading; detection of defects in the road pavement and grading rocks.

Formulation of the problem. Field data about a road pavement is part of a database necessary for formation and tuning of forecasting models for landslides processes and their impact on the roads' technical and operational characteristics.

In such a manner, Slovak scientists showed in research [18] that all the road pavement state forecasting modelsused worldwide ask for wide spectrum of data. The simple and mostly inaccurate models require data from road construction, while theadvanced models claim for more information about construction materials, which is not always available. When it comes to the road pavement in service a road state forecasting calls for parameters of pavement and grading materials, climatic, traffic load and other operational data. Road management units usually collect traffic load data, whereas meteorological stations of a country collect climatic data. The scientists recommend nondestructive testing methods for determination of road pavement's actual parameters. One of the main parameters in diagnostics of a road pavement according to [19] is identification of cracks on a pavement. The specialists from Iran urge to consider such parameter as smoothness of a road pavement in a road diagnostic in research [20]. While two methods are requested to examine properties of materials in [21]: a long-term monitoring with a special traffic load simulator (part of a road pavement is examined in the laboratory) and a field research of a pavement by a mobile hardometer.

Nevertheless, according to the analyzed scientific research including [18-21], three above listed diagnostic measurements will be enough to form and tune an intelligent system to forecast landslides' processes and their influence on the roads' technical and operational characteristics for mountainous areas.

During forecasting landslides' processes and their influence on roads' technical and operational characteristics for mountainous areas, the scientific group have to address both factor directly affecting landslide processes and road state's factors. Meteorological data is in both lists. However, at first it is necessary to understand which exact weather conditions has to be incorporated. According to [22] landslide state's factors has to be:

- usable in mathematical functions;
- estimable and measurable;
- with uneven distribution of data.

Besides that, a parameter can be indirectly connected to the landslide processes through transitionary direct factors.

In research [23] stated that addressed factors should be not only connected to landslide processes or road conditions but also accessible. Data accessibility is usual problem for developing countries, where landslide risk is high for sparsely populated areas and subsequently there are much less meteorological stations for data collection. Other problem is in time resolution of the data, which is usually accessible only for daily but not for hourly basis as described in [24].

According to [25] the main group of the preferable factors has to be chosen on the assumption of landslides triggers. The forecasting result depends on rainfalls data, reviewed period and geographical area's size in article [26]. The research [27] showed that the most frequently used parameters for studying rainfall's impact on landslides are intensity, duration and volume of previous rainfalls. For the researched in [28] region and registered landslidesa forecasting with daily and 3-, 5-, 10-, 15-, 20- and 30-days values of rainfalls are examined. The best result for that exact case is 86% accuracy by forecasting with combination of daily rainfall and 15 days rainfall sum.

An asphalt pavement is widely spread for road constructions because of its smooth jointless surface, comfort driving and fast laying. The article [29] clears that there are two main load types affecting an asphalt pavement: a mechanical load, especially by heavy trucks, and a climatic influence from moisture, temperature and freezing-defrosting cycle.

To conclude all reviewed researches the rainfall level and temperature are chosen for forecasting of landslides processes, while the solar radiation and sudden temperature changes are considered for forecasting of a road pavement's state. That is why http://meteocenter.net/ becomes the main source of historical meteorological data for the project.

After development, training and testing of an intellectual forecasting system most effective combination of historic meteorological factors will be specified. In the same manner, the factors less contributing on a landslide processes and aroads' technical and operational characteristics will be substantiated.

Results and discussion. *The results of field research to estimate cracks' formation on the road pavement.*

Visual assessment. The road pavement at the beginning of the automobile road from Al-Farabi Street until 7th kilometers (+800 meters) is in excellent state. There are practically no striking defects. The roadway width at this interval is varying form 8.5 up to 9 meters. Then it is narrowing to 7.5 meters. The transversal and longitudinal cracks on the road pavement starts from 8th kilometer. In addition, tiny holes and moderate crack network appear. Traffic pretermits from 13th kilometer due to construction works done on a road for 3 kilometers up. The new road that started to operate just in 2021 passes from 16th up to 18th kilometers. The roadway narrowing to 7.2 meters from 18th kilometer.

The five test sites for 50 meters long (fig. 1) are selected for the field research on the automobile road. First four test sites have the naked-eye landslide processes on the slopes nearby the road. The fifth site down the 16th kilometer is the reference as it passes through comparatively flat part of the road operating just since 2021. The yellow lines on fig. 1 show the numbers of geo-radar profiles from the AB-400 complex.

Fig. 1 – A placing of the testing sites' on a map

The visual method described in [17] is used for an assessment of the crack formation. Transversal cracks are classified by their length into 0-1 meters, 1-2 meters etc. Longitudinal cracks are divided into left and right by the roads axial and then by their net length.

The table 1 demonstrates the field examination results for the road pavement's defects.

Table1 –The field examination results for the road pavement's defects

Testing№	Beginning/ ending coordinates	Transversal cracks, length					Longitudinal cracks, meters			Crack net-work	Defects found by geo-radar	Comments
		0-1 m	1-2 m	2-3 m	3-4 m	4-5 m	left side	axial	right side			
1	$43^0$04'49''N $76^0$59'09''E/ $43^0$04'49''N $76^0$59'06''E	6	3	1	-	-	∑11.5	∑16.9	∑12.1	2	decompaction of an underlayer	-
2	$43^0$04'49''N $76^0$59'05''E/ $43^0$04'51''N $76^0$59'04''E	8	3	2	-	-	∑8.0	∑17.0	∑13.9	5	-	-
3	$43^0$04'51''N $76^0$58'59''E/ $43^0$04'51''N $76^0$58'57''E	7	6	3	2	-	∑17.8	∑19.3	∑7.4	3	-	road grading's slope erosion
4	$43^0$05'02''N $76^0$58'51''E/ $43^0$04'59''N $76^0$58'51''E	11	6	3	3	1	∑34.8	∑3.3	∑22.2	2	decompaction of an underlayer	tiny holes d_{avg}=0.3 m; h_{dth}=6,5 cm; road grading's slope erosion
5	$43^0$04'59''N $76^0$58'27''E/ $43^0$05'01''N $76^0$58'24''E	5	4	2	1	1	∑6.8	∑18.1	∑15.6	2	decompaction of an underlayer	tiny holes d_{avg}=0.2m, h_{dth}=2,5 cm;

The transversal cracks' formation on the first site have clear specific due to their length. The maximum length of the transversal cracks is not exceeding 3 meters. It is straightly connected to a low traffic load, as the traffic flow is less than 150 automobiles a day.

Fig. 2 shows the longitudinal cracks on the first site. The deep axial and diagonal cracks characterize the road passing territory and the impact of soil sliding. The same kind of cracks can be observed on the other sites too. Make oneself conspicuous that longitudinal cracks are not alongside the road axis or expected ruts as a deep heavy line. A variety of tiny crack lines forms an assembled complex of longitudinal cracks. Moreover, the lines are not on the road axis or ruts.

It is impossible to state that such unconventional longitudinal cracks formed because of technological faultsor an intensive traffic. Clearly, both factors cannot cause longitudinal cracks showed in fig. 2.

Beside those unforeseen longitudinal cracks, the first testing site has deep transversal cracks and unevenness as can be observed in fig. 3. These transversal cracks is below the standard for automobile roads of Kazakhstan[30].The deep transversal and diagonal cracks' formation is connected to natural phenomena. A sliding of soil masses from the neighboring rock slopes increases the inner pressure of the road grading which leads to the transversal cracks of the road pavement.

Fig.2 – The longitudinal cracks on the road pavement

Fig. 3 – The roadunevenness and deep transversal cracks

The transversal cracks on the fourth testing site have different specific as this site is on a sharp turns and what is more have a faint provision of a road drainage. Therefore, the grading slope is washing away as shown in fig. 4. The length of the transversal cracks on this site essentially exceeds the width of the roadway. The thickness of the road pavement is 5 cm and the transverse slope of the road in the slope's erosion is 80%. The geo-radar examination showed here the decompaction of the underlayer.

The fifth testing site is operating since 2021. Despite such a short operational period, the pavement has tiny longitudinal cracks and up to 5-meter long transversal cracks – fig. 5. The geo-radar examination of the site showed the decompaction of the underlayer, which matches the holes and cracks on the pavement.

Fig. 4 – The erosion of the grading slope because of a faint provision of the road pavement's drainage

Fig. 5 –The tiny cracks and holes on the fifth testing site

The field research also includes the measurement of the longitudinal and transversal grading slopes, the longitudinal and transversal smoothness of the roadway, the adherence coefficients for longitudinal and transversal displacement and the road pavement's hardness. The weather during the field research has been set fair with a temperature between +14-17 ºC.

Table 2 shows the measurement results for the roadway smoothness, the adherence coefficients and the pavement's hardness.

Table 2 – The technical and operational parameters of the road pavement

№	The transversal slope, %	The road pavement's smoothness by 3-meter surveying rod, mm		The adherence coefficient		The hardness, mm
		longitudinal	transversal	longitudinal	transversal	
1	72	0-2	0-2	0.75	0.80	3.0
	66	0-1	0-3	0.76	0.78	3.5
	87	**0-7**	0-3	0.70	0.77	3.0
2	76	0-3	**0-55**	0.78	0.79	3.5
	30	0-2	**0-35**	0.74	0.78	5.0
	41	**0-14**	**0-30**	0.80	0.76	3.2
3	20	**0-7**	**0-8**	0.8	0.75	3.5
	22	**0-9**	**0-28**	0.73	0.80	4.2
	82	**0-12**	**0-11**	0.73	0.75	4.2
4	22	**0-13**	**0-50**	0.70	0.80	5.5
	30	**0-8**	**0-27**	0.75	0.71	4.5
	31	**0-9**	**0-27**	0.70	0.75	4.1
5	30	0-3	0-2	0.75	0.80	3.0
	22	0-1	0-3	0.76	0.78	3.2
	3	0-7	0-3	0.70	0.77	2.8

The minimum permissible level of a clearance for a satisfactory estimation of a pavement's smoothness differs: it is less than 10 mm for heavy-duty pavements, less than 11 mm for light-duty pavements and less than 30 mm for intermediate pavements.The measurements by the 3-meter surveying rod from the table 2 shows that the longitudinal clearance at some sites is 14 mm, while the transversal clearance is 55 mm.

The adherence coefficient of all testing sites is in range between 0.7 and 0.8. That is totally matching the standard value for a dry asphalt pavement.

Conclusion. *Such conclusions are made on the basis of the results from the field research:*

The deformation characteristics of the road pavement is mostly similar for all the testing sites. All the sites have the tiny transversal cracks and the complex of longitudinal cracks as a variety of tiny ones.The transversal and longitudinal cracks' formation is not connected with a traffic as there is no speed limits and the daily traffic intensity is less than 100-150 units.The "irregular" (unusual) transversal cracks' formation could be associated with the impact of the rock masses sliding and the water flow from neighboring slopes.The trigger for the road grading's slope erosion is the faint provision of the road drainage.The surface smoothness of the road pavement at some parts is far below the minimum permissible level.The cause of the unevenness on the road pavement on a micro level is in the uncompact enough asphaltic concrete pavement and other pavement's layers.

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ЗИЯТКЕРЛІК БОЛЖАУҒА АРНАЛҒАН МАҒЛҰМАТ ЖИНАУ: ӘДІСТЕР МЕН НӘТИЖЕЛЕР

Аннотация: бұл зерттеу "Көшкін процестерін және олардың автокөлік жолдарының техникалық-эксплуатациялық сипаттамаларына әсерін болжайтын интеллектуалды жүйесін құру" тақырыбында АР09260066 бағдарламасы бойынша ҚР БҒМ қаржыландыратын жобаның бір бөлімі болып табылады. *Зерттеудің мақсаты* "Алматы–Космостанция" автомобиль жолы өтетін аудандағы көшкін бөктерін зерттеу және зияткерлік модельдерді оқыту және анықталған бұзылулардың алдын алу бойынша ұсынымдар әзірлеу үшін автомобиль жолының бұзылу себептерін анықтау болып табылады. Жол жабындыларына жарықшақ түзілуі ПР RK 218-27-2014 сәйкес визуалды әдіспен бағаланды. Георадарлық зерттеу АБ-400 кешенімен жүргізілді.

Негізгі нәтижелер. "Алматы-Космостанция" автожолы өтетін ауданда көшкін беткейіне егжей-тегжейлі инженерлік-геологиялық зерттеу жүргізілді. Зерттелетін жол жабынының бетінде бойлық және көлденең жарықтардың пайда болу себептерін анықтау бойынша далалық зерттеулер жүргізілді және жол төсемінің бұзылу себептері анықталды.

Қорытындылар: кейбір жерлерде жол төсемдерінің беткі тегістігі шекті рұқсат етілген деңгейден асады. "Стандартты емес" (дәстүрлі емес) көлденең жарықтардың пайда болу себептері тау сілемдерінің ығысуы мен тау баурайларынан су ағынының әсерімен байланысты болуы мүмкін. Жер төсемі еңістерінің шайылу себептері жол төсемдерінен бетін судан оқшауландыру әлсіз қамтамасыз етілуімен байланысты. Жабын бетінде шамалы бұзылулардың пайда болуы асфальтбетон жабынының және жол төсемінің басқа қабаттарының нашар тығыздалуымен байланысты. Далалық зерттеулердің нәтижелері зияткерлік модельдерді оқыту және баптау үшін қолданылады.

Түйін сөздер: автомобиль жолдарының диагностикасы, геодинамикалық процестер, көшкін, болжау.

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СБОР ДАННЫХ ДЛЯ ИНТЕЛЛЕКТУАЛЬНОГО ПРОГНОЗИРОВАНИЯ: МЕТОДЫ И РЕЗУЛЬТАТЫ

Аннотация: данное исследование является одной из разделов финансируемого МОН РК проекта по программе AP09260066 на тему «Разработка интеллектуальной системы прогнозирования оползневых процессов и их влияния на технико-эксплуатационные характеристики автомобильных дорог в горной местности». *Целью* исследования является обследование оползневого склона в районе прохождения автомобильной дороги «Алматы–Космостанция» и выявление причин разрушения автомобильной дороги для обучения интеллектуальных моделей иразработки рекомендаций по предотвращению выявленных разрушений.Трещинообразования дорожных покрытий оценивались визуальным методом в соответствии с ПР РК 218-27-2014. Георадарное обследование проводилось комплексом АБ-400.

Основные результаты. Проведено детальное инженерно-геологическое обследование оползневого склона в районе прохождения автодороги «Алматы–Космостанция». Проведены полевые исследования по определению причин появления продольных и поперечных трещин на поверхности покрытия исследуемой дороги и выявлены причины разрушения дорожной одежды.

Выводы: Поверхностная ровность дорожных покрытий местами превышает предельно-допустимый уровень.Причинами появления «нестандартных» (нетрадиционных) поперечных трещин может быть связано с влиянием сдвига горных массивов и водного потока с горных склонов. Причины размыва откосов земляного полотна связаны со слабым обеспечением поверхностного водоотвода от дорожных покрытий.Появление микронеровностей на поверхности покрытия связано с недоуплотнением асфальтобетонного покрытия и других слоев дорожной одежды. Результаты полевых исследований будут использованы для обучения и отладки интеллектуальных моделей.

Ключевые слова: диагностика автомобильных дорог, геодинамические процессы, оползень, прогнозирование.

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