

ISSN (Print) 2616-6844  
ISSN (Online) 2663-1318

Л.Н. Гумилев атындағы Еуразия ұлттық университетінің

# ХАБАРШЫСЫ

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## ВЕСТНИК

Евразийского национального  
университета имени Л.Н. Гумилева

## BULLETIN

of L.N. Gumilyov  
Eurasian National University

**ТЕХНИКАЛЫҚ ҒЫЛЫМДАР ЖӘНЕ ТЕХНОЛОГИЯЛАР** сериясы

**THE TECHNICAL SCIENCES and TECHNOLOGY Series**

Серия **ТЕХНИЧЕСКИЕ НАУКИ И ТЕХНОЛОГИИ**

**№ 2(131)/2020**

1995 жылдан бастап шығады

Founded in 1995

Издается с 1995 года

Жылына 4 рет шығады

Published 4 times a year

Выходит 4 раза в год

Нұр-Сұлтан, 2020

Nur-Sultan, 2020

Нур-Султан, 2020

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Мерзімділігі: жылына 4 рет

Қазақстан Республикасының Ақпарат және коммуникациялар министрлігінде 27.03.2018 ж.

№16991 -ж тіркеу куәлігімен тіркелген

Басуға 07.06.2020 ж. қол қойылды.

Тиражы: 25 дана

Типографияның мекенжайы: 010008, Қазақстан, Нұр-Сұлтан қ., Қажымұқан к-сі 12/1

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**Bulletin of L.N. Gumilyov Eurasian National University.**

**TECHNICAL SCIENCES and TECHNOLOGY Series**

Owner: Republican State Enterprise in the capacity of economic conduct «L.N. Gumilyov Eurasian National University» Ministry of Education and Science of the Republic of Kazakhstan

Periodicity: 4 times a year

Registered by the Ministry of Information and Communication of the Republic of Kazakhstan

Registration certificate №16991-ж from 27.03.2018. Signed in print 07.06.2020.

Circulation: 25 copies

Address of Printing Office: 12/1 Kazhimukan str., L.N. Gumilyov Eurasian National University, Nur-Sultan, Kazakhstan 010008

Tel: +7 (7172) 709-500 (ext.31-428). Website: <http://bultech.enu.kz>

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**Серия ТЕХНИЧЕСКИЕ НАУКИ И ТЕХНОЛОГИИ**

Собственник: РГП на ПХВ «Евразийский национальный университет имени Л.Н. Гумилева» МОН РК

Периодичность: 4 раза в год

Зарегистрирован Министерством информации и коммуникаций Республики Казахстан

Регистрационное свидетельство №16991-ж от 27.03.2018 г. Подписано в печать 07.06.2020 г.

Тираж: 25 экземпляров. Адрес типографии: 010008, Казахстан, г. Нур-Султан, ул. Кажимукана, 12/1,

Евразийский национальный университет имени Л.Н. Гумилева

Тел.: +7(7172)709-500 (вн.31-428). Сайт: <http://bultech.enu.kz>

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## Fault analysis of steering control of the car

**Abstract:** *The article deals with the most characteristic faults of steering and their relationship with the quality of the road surface.*

*Steering is one of the most important systems of any car, ensuring road safety. Only professionals should be trusted with repair and adjustment.*

*With the development of the automotive industry, the design of the steering drive has become more complicated. It began to introduce amplifiers. In the course of the proposed study, statistical materials collected at one of the car service enterprises in Karaganda. The list of the most typical faults and their causes given in the table.*

*The study conducted a survey of car owners, which was asked to assess the quality of roads in the city of residence, as well as the period of manifestation of the first operational faults of steering.*

**Keywords:** *steering, technical operation of cars, reliability, backlash, tie rods, power steering, steering wheel.*

DOI: <https://doi.org/10.32523/2616-68-36-2020-131-2-45-51>

Steering is one of the most important systems that affect the reliability of the road. Improving steering reliability is an important task. In the proposed study, the most characteristic steering failures and their relationship are considered with the quality of the road surface.

Steering is one of the most important systems of any car, ensuring road safety. The first designs of a steering drive were simple and reliable enough; they included rubber or leather belts, metal steering rods and a steering wheel. This design made it possible to transfer the driver's efforts to the controlled axle directly, immediately and with clear feedback.

The main reason is the unsatisfactory condition of roads. The suspension of the car smoothes the bulk of the blows that fall on the wheels, but some of them are still transmitted to the steering nodes. It is worth noting that fans of low-profile rubber risk much more than adherents of the use of standard wheels-low tires are not able to smooth out the blows, and this significantly reduces the life of both the suspension and the steering [1].

But car owners should remember that even with extremely accurate driving on perfectly flat roads still have to change the individual elements of the steering. Their service life is limited, and some parts do belong to consumables.

The main faults of the steering are quite easy to determine-the car noticeably loses control, there are extraneous sounds in the front of the car, there is a backlash of the steering wheel. Backlash is the idle motion of the steering wheel, in which the rotation of the wheels are not carried out. Traffic rules set the maximum value of backlash for passenger cars no more than 10 degrees - if it exceeds the operation of the car is impossible.

Backlash can occur for several reasons:

- increased the gap in the broken tie rods;
- the output of the steering rods;

- severe wear of the steering rack;
- failure of the steering shaft cross;
- wear of the bearing located on the steering shaft;
- breakage of EUR or Gur.

Strong backlash is fraught with a significant loss of controllability of the car. The matter is that at backlash front wheels of the car lose stability, and begin to “dangle” within the limits equal to backlash of a steering wheel. When driving at high speed, the car will noticeably “float” on the road, and the driver will have to constantly steer to keep the car in its lane. In conditions of ice backlash wheels fraught with a complete loss of control of the car, with all the ensuing consequences [3].

Every car owner should know the typical steering faults and how to fix them. After all, this directly affects the safety of both him and other road users.

Figure 1. The dynamometer luttmer



It should be borne in mind that the steering rails have a special adjusting bolt that allows you to tighten it, thereby eliminating the backlash in the event of wear. However, excessive tightening of the rack leads to heavier control and, in some cases, to its wedging, which when driving a car can be deadly.

Since the safety of the driver and passengers depends on the serviceability of the steering, only professionals should be trusted with the repair and adjustment. Otherwise, there is a high risk at a critical moment not to cope with the management, which will entail a serious accident.

Unstable operation of the control system, according to experts, is a serious factor destabilizing traffic. Indeed, such a state of the car thoroughly “beats” the safety on the road. The driver is deprived of the opportunity to adequately control the trajectory of his vehicle, which can lead to the loss of its controllability and, as a consequence, to disastrous consequences [4].

This determines the effect of the following legal norm, prescribed in the traffic rules: the driver is strictly prohibited from driving with such malfunctions. If they occur, it is necessary to stop immediately, trying to eliminate them on the spot. In the event that this is not possible, you should abandon the operation of the car.

The specified malfunctions of steering are provided by the special normative-legal act- «the Basic provisions on the admission of the vehicle to operation...».

- The total backlash in the steering of the car exceeds the established values: for cars-10 degrees; for buses, trucks-20, and 25 (respectively).

- There are movements of units and parts of the system, not provided by the design of the car. There is an unfixed threaded connection.

The power steering provided by the design is missing or in a faulty condition.

Even a cursory analysis of this list of faults will allow drawing a conclusion about their extremely negative role in ensuring safety on the road. Serious administrative sanctions for driving a faulty vehicle are also justified.

With the development of the automotive industry, the design of the steering drive has become more complicated. It began to introduce amplifiers - first hydraulic, then electric and electrohydraulic, it was possible to change the transfer force, as well as additional steering wheels driven axles. Currently, manufacturers are actively working on a steering design that completely eliminates the

mechanical connection between the steering wheel and the control rail (steer-by-wire or steering by wire) .

This would open up opportunities for Autonomous driving. In the proposed study, the steering of a particular brand of foreign-made car is considered. This passenger car is equipped with a fairly simple steering system, with a steering mechanism of the “gear-rail” type. The steering column of the investigated car is injury-proof.

It is equipped with an energy-absorbing device that increases the passive safety of the car, and an anti-theft device in the ignition lock that blocks the steering wheel shaft from turning. The steering column also has controls for headlights, direction indicators, horn, washer and window cleaner.[5]

Depending on the year of manufacture, the design of the power steering of this brand of car is different (hydraulic or electric). The pressure of the working fluid in the hydraulic booster is created by a pump of the blade type, which is installed on the engine and is rotated by a V-belt. If the power steering fails, the ability to control the car is maintained, but the effort on the steering wheel increases.

The electric power amplifier monitors all steering controls and increases the torque transmitted through the steering wheel according to a specific algorithm, specially selected for this model of car, depending on the speed of its movement.[6]

The electric power amplifier actively supports the return of the controlled wheels to the middle position (active self-installation of the wheels). Thanks to this, the driver feels the middle position of the steering wheel better, it is easier to drive the car in a straight line when exposed to various external forces. Due to the simplicity of the design, the steering of the cars of the brand in question is a very reliable node, but faults still occur. In the course of the proposed study, statistical materials were collected at one of the car service enterprises in Karaganda. The list of the most typical malfunctions and their causes is given in the table.

According to the collected statistical materials, steering malfunctions are manifested mainly after a run of 80 thousand km. at the same time, some of them arise as a result of the operation of the car in difficult road conditions.

In the current study, a survey of owners of cars of this brand, using the resources of the Internet, was carried out, in which it was proposed to assess the quality of roads in the city of residence, as well as the period of manifestation of the first operational faults of steering.

**Table 1 - Steering malfunctions and their causes**

Fault	The cause of the malfunction
Increased stroke (backlash) of the steering wheel and knocks in the steering	Loosening of tightening of nuts of fastening of ball fingers of steering rods
	Loosening the steering gear
	Increased clearance in steering rod ball joints
	Steering shaft joint wear
Difficulty turning the steering wheel	Damage to the upper support of the shock strut
	Damage to steering rod ball joints
Vibration on the steering wheel	Presence of air plugs in the hydraulic system
	Mechanical damage to the elements of the steering gear
	Unsatisfactory condition of tires



Ambient noise during amplifier operation	Low fluid level in the system
	The negative pressure in the system
	The fluid discharge through the relief valve
Reverse force on the steering wheel	Weak tension on the timing pump belt
	Wear on the drive belt
Increased looseness in the steering rack, the biting the steering mechanism upon rotation	Wear of bushings and ball joints of the mechanism
	Mechanical damage of elements
Leakage of working fluid	Leakage of the steering gear (wear dust boot tie rod)
	Loosening the attachment or damaging the hoses

For rice. 1 the results of the survey on the assessment of the quality of the road surface are presented. For convenience, the survey used the concept of maintenance (TI-1, TI-2, TI-3, etc.). At the same time, the interval between planned technical services for the cars in question is 15 thousand km. In addition, the survey did not take into account the production defect of steering elements, as well as recall companies.[2]

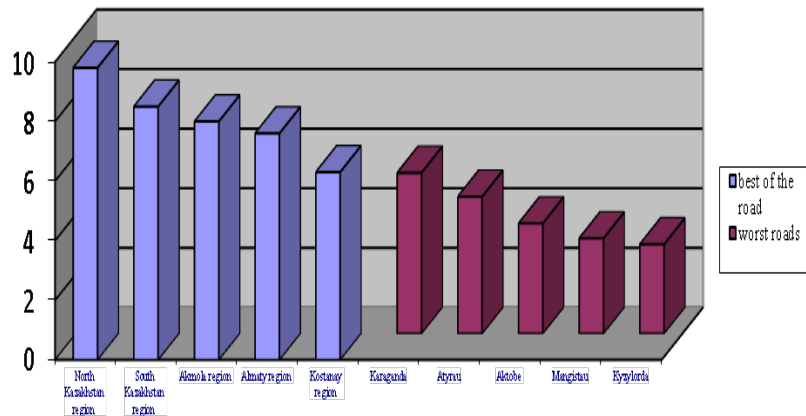


Figure 1. The quality of roads in the cities of Kazakhstan (subjective scores)

Comparison of the data presented in Fig. 1 and Fig. 2, shows that the degree of manifestation of steering faults of the studied cars depends significantly on the quality of the road surface in the region where the car is operated.

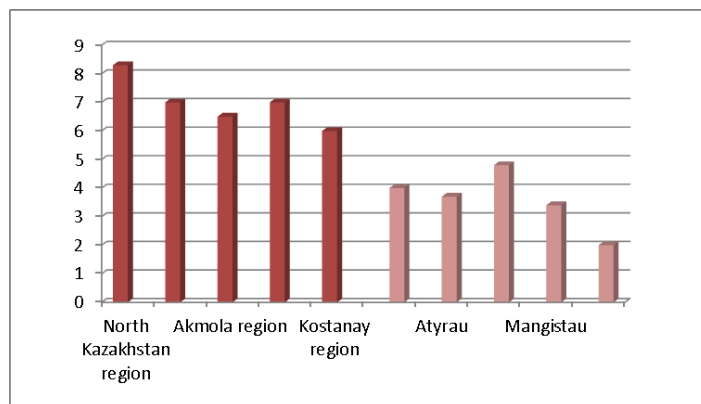


Figure 2. Timing of the first operational faults of steering

Due to the subjectivity of road quality assessment at this stage of the study, it is impossible to say definitely about the nature of the dependence.

At the same time, it can be noted that the early manifestation of faults is typical for regions with a sharply continental climate. Changes in temperature, especially in winter time, contribute to increased wear of the rubber-metal steering components.

The obtained results are the basis for a further, more detailed study, which assumes a specific assessment of the degree of influence of individual operational factors on the reliability of steering elements. In particular, the city of Karaganda has a number of features that can affect the reliability indicators: sharply continental climate, long length of the city, low quality of the road surface and others.

**Table 2 - Malfunctions of a steering with the hydraulic booster and methods of their elimination**

Fault symptom	The cause of the malfunction	Methods of elimination
Unstable movement of the car on the road (required regular adjustment of the specified direction of motion by the steering wheel) and a thud in the steering gear	1. The presence of a gap in the engagement ‘» nut-piston – gear sector shaft Pitman arm” 2. Play in the splined joint of the bipod with the bipod shaft. 3. Loosening the steering mechanism to the spar.	1. Adjust the gearing gaps. 2. Tighten the nut attaching the Pitman arm. 3. Tighten the fastening parts.
Increased effort on the steering wheel	1. Insufficient tension of the pump drive belt. 2. The faulty pump.	1. Tighten the belt. 2. To replace the pump.
Abrupt change of effort on a steering wheel at its rotation or jamming of the steering wheel when changing the direction of rotation.	1. The presence of air in the hydraulic system (turbid oil, foam in tank) steering amplifier. 2. Clogging of the pump valves.	1. Pump the hydraulic system. 2. Flush valve.
Increased noise in the steering amplifier hydraulic system.	1. Insufficient oil level in the tank 2. The presence of air in the hydraulic system.	1. Add the oil. 2. Pump the hydraulic system.
Increase the noise of the hydraulic system in extreme position of the steering wheel when the stops on the bipod touch the spars.	The pump has partially lost performance (lifted working ends of parts of the pumping set)	To replace the pump.
Jamming the pump or a decrease in the efficiency of power steering (constant increased force on the steering wheel).	1. Ingress of abrasive or metallic particles into the pump. 2. Destruction of the filter element	Drain contaminated oil from hydraulic system, replace pump and the tank, fill and pump the hydraulic system.

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### Жеңіл автомобильдің рөлдік басқару ақауларын талдау

**Аңдатпа.** Мақалада рөлдік басқарудың ақаулықтары және олардың жол жабынының сапасымен өзара байланысы қарастырылған.

Рөлдік басқару жол қозғалысы қауіпсіздігін қамтамасыз ететін кез келген автомобильдің маңызды жүйелерінің бірі болып табылады. Автокөліктің ақауларын жөндеу мен реттеуді тек кәсіби мамандарға ғана сеніп тапсыру керек.

Автоөнеркәсіп дамуымен рөлдік жетектің конструкциясы күрделене бастады. Оған күшейткіштер енгізе бастады. Ұсынылған зерттеу барысында Қарағанды қаласындағы кәсіпорындарының бірінде статистикалық материалдар жиналды. Ең басты ақаулықтар мен олардың себептерінің тізбесі кестеде келтірілген.

Жүргізілген зерттеуде автокөлік иелерінің сұрағы қарастырылды, қалада тұратын жолдардың сапасын, сондай-ақ, рөлдік басқарудың алғашқы пайдалану ақауларының пайда болу кезеңін бағалау ұсынылды.

**Түйін сөздер:** рөлдік басқару, автомобильдерді техникалық пайдалану, сенімділік, люфт, рөлдік тартқыштар, гидросилитель, рөлдік штурвал.

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### Анализ неисправностей рулевого управления легкового автомобиля

**Аннотация.** В статье рассмотрены наиболее характерные неисправности рулевого управления и их взаимосвязь с качеством дорожного покрытия.

Рулевое управление является одной из важнейших систем любого автомобиля, обеспечивающих безопасность дорожного движения. Доверять ремонт и регулировку следует только профессионалам.

С развитием автопромышленности конструкция рулевого привода стала усложняться. В неё начали внедрять усилители. В ходе предлагаемого исследования были собраны статистические материалы на одном из предприятий автосервиса в г. Караганда. Перечень наиболее характерных неисправностей и их причин приведены в таблице.

В проводимом исследовании выполнялся опрос владельцев автомобилей, в котором было предложено оценить качество дорог в городе проживания, а также период проявления первых эксплуатационных неисправностей рулевого управления.

**Ключевые слова:** рулевое управление, техническая эксплуатация автомобилей, надежность, люфт, рулевые тяги, гидросилитель, рулевой штурвал.

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*Редакцияға 23.12.19 қабылданды.*