CALCULATION OF THE STABILITY OF A DESERT TRACTOR

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Annotation. This article examines the calculation of the stability of tractors operating in desert conditions. It was also emphasized that the stable movement of tractors in difficult climatic and soil conditions is an important factor in terms of maintenance and safety. In the study, stability was analyzed based on such parameters as the center of gravity of the tractor, the running gear, and the soil contact coefficient. At the same time, a balanced weight distribution and a low center of gravity were considered important factors for increasing the stability of the tractor. By comparing tractors of different models, effective design solutions were recommended, and it was established that the correct calculation of the stability of desert tractors is important for ensuring their effective operation and safety.

Keywords: tractor, turning, separation, vertical, stability, angle.

Annotatsiya. Ushbu maqolada cho‘l sharoitida ishlaydigan traktorlarning barqarorligini hisoblash masalasi o‘rganiladi. Traktorlarning og‘ir iqlim va tuproq sharoitlarida barqaror harakatlanishi ularning texnik xizmat ko‘rsatish va xavfsizlik nuqtai nazaridan muhim omil ekanligi alohida ta’kidlanadi. Tadqiqotda traktorning og‘irlik markazi, yurish qismi va tuproqqa tegish koeffitsiyenti kabi parametrlar asosida barqarorlik tahlil qilingan. Bunda muvozanatli og‘irlik taqsimoti va past og‘irlik markazi traktor barqarorligini oshirishning muhim omillari sifatida qaralgan. Turli rusumdagi traktorlarni taqqoslash orqali samarali konstruktiv yechimlar tavsiya etilgan va cho‘l traktorlarining barqarorligini to‘g‘ri hisoblash ularning samarali ishlashi hamda xavfsizligini ta’minlashda muhim ahamiyatga ega ekanligi aniqlangan.

Kalit so‘zlar: traktor, burilish, ajralish, vertikal, barqarorlik, burchak.

Аннотация. В данной статье рассматривается расчет устойчивости тракторов, работающих в условиях пустыни. Также было подчеркнуто, что устойчивое движение тракторов в сложных климатических и почвенных условиях является важным фактором с точки зрения технического обслуживания и безопасности. В исследовании устойчивость была проанализирована на основе таких параметров, как центр тяжести трактора, ходовая часть и коэффициент контакта грунта. При этом сбалансированное распределение веса и низкий центр тяжести считались важными факторами

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повышения устойчивости трактора. Путем сравнения тракторов разных моделей были рекомендованы эффективные конструктивные решения, а также установлено, что правильный расчет устойчивости пустынных тракторов важен для обеспечения их эффективной эксплуатации и безопасности.

Ключевые слова: трактор, поворот, сепарация, вертикаль, устойчивость, угол.

Introduction

Today, the role of technology in agriculture, land reclamation, construction, and other types of external production is increasing. Especially in areas with difficult climatic conditions, hard and sandy land, the rational use of technical means determines not only labor productivity, but also worker safety. In this regard, the issue of ensuring the stability of tractors used in desert and semi-desert areas remains of urgent scientific and practical significance. The reliability of tractors in such a complex geophysical and climatic environment is directly related to their structural design and dynamic characteristics.

The operation of agricultural universal row crop tractors and machine-tractor units (MTA) based on them depends on their stability of movement. The loss of stability of a tractor is expressed in its spontaneous deviation from the given direction, lateral displacement, or overturning. Depending on the direction of rolling, it is distinguished between longitudinal and transverse stability[1].

Tractor stability - the ability to resist rollover or complete elimination of tire adhesion to the supporting surface (sliding or sliding). It is characterized by the angles of the longitudinal and transverse slopes of the supporting surface, the increase of which leads to the overturning or sliding of the tractor[2].

In desert zones, the land area is usually soft, sandy, sometimes saline and uneven, and in such conditions it is much more difficult to maintain the stability of tractors. Such factors as low soil lifting capacity, creep of the sandy layer, exposure to high temperatures, and wind erosion negatively affect the reliability and safety of tractor movement. These aspects necessitate a thorough study of the issues of determining, assessing, and optimizing the stability of tractors [3].

Large desert areas are located in the Republic of Karakalpakstan, Bukhara, Navoi, Khorezm, and Kashkadarya regions, located in the southern and western regions of Uzbekistan. Since these lands are involved in agricultural and land reclamation works, the effective and stable operation of tractor equipment is one of the important issues. Also, the requirements for desert tractors differ significantly from those for equipment operating under normal conditions. For example, in desert conditions, problems such as rapid cooling or heating of

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equipment, sinking of the roadway, sliding over a sandy layer, and uneven distribution of the center of gravity are common. Therefore, in this scientific work, special attention is paid to the calculation and assessment of the stability of desert tractors [4]. Such indicators as the general design scheme of the tractors, the location of the center of gravity, the traction characteristics of the running gear, and the coefficient of contact with the soil were selected as the main criteria for determining stability. Indeed, unpleasant situations such as a tractor turning over or tilting sideways while in motion pose a great danger not only to the technical vehicle itself but also to the life and health of the operator operating it. From this point of view, the preliminary calculation of the tractor's stability, simulation of its trajectory, and the adoption of necessary measures, i.e., the development of technical and mechanical recommendations, are of particular importance today [5].

The stability of tractors directly depends, first of all, on the coordinates of their centers of gravity, the configuration of the chassis, mass, and load distribution. For example, tractors with a high center of gravity can deviate faster, especially when moving on uneven terrain. The coefficient of contact with the soil determines how the traction forces are distributed, which has a great influence on sliding and stability. The choice of wheels on the chassis or wheels and tracks is also an important factor.

In the research process, the stability state of tractors was analyzed based on various models, and their structural shortcomings and advantages were identified based on real-world data. Design solutions have been developed, such as reducing the center of gravity of the tractor, balancing the mass distribution, and adapting the chassis to the desert. Also, the possibilities of creating a model of a tractor capable of working efficiently and safely in desert conditions have been expanded.

METHODOLOGY

The issue of ensuring the stability of tractors in desert conditions is one of the urgent problems in the field of agricultural engineering. Among the scientific research conducted in this direction, the research of Uzbek and foreign scientists occupies an important place.

One of the scientists of Uzbekistan, Salimov (2018), in his research, paid special attention to such parameters as the tractor's sliding angle, shear resistance, and angle of elevation when working with desert soils with sandy, saline, and compacted layers. In his opinion, to ensure stability of movement, the center of gravity should be positioned as low as possible, which reduces the likelihood of the tractor's deviation [6].

Another important source is the research conducted at the Tashkent State Technical University. The models and recommendations developed here are aimed

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at modernizing the running gear of the equipment in desert conditions, increasing traction characteristics [7].

Among foreign scientists, such specialists as R. McKyes and J. Koolen conducted fundamental research on the movement of tractors and their interaction with the soil. In the monograph "Soil Cutting and Tillage," created by McKyes (1985), the relationship between the tractor's chassis and the soil is analyzed based on mathematical models. He analyzes in depth the relationship between wheel profile, pressure distribution, and soil density in ensuring driving stability, especially in desert and dry climates [8]. Koolen and Kuipers (1983) in their work experimentally studied the factors influencing the stable movement of tractors and tested them under special testing conditions. In their opinion, the full stability of the tractor depends not only on the center of gravity and mass, but also on the travel speed, turning radius, and soil deformation coefficient [9].

In several European engineering centers (especially at the DLG Institute in Germany), special running tests and stabilization mechanisms have been developed for desert tractors, which serve to optimize stability [10].

Analysis of research by scientists shows that the issue of ensuring the stability of tractors in desert conditions has been studied by Uzbek and foreign scientists through various approaches. However, since the climatic and soil characteristics of each region are different, the development of models and constructive solutions adapted to local conditions is required.

RESULT AND DISCUSSION

During this study, a number of practical and theoretical results were obtained on the assessment and optimization of the stability of tractors operating in desert conditions.

Disengagement is the rotational movement of the tractor around some axis, which is called the axis of rotation. The axis of rotation is a straight line around which the tractor can be rotated at a certain angle in a vertical plane.

Disengagement is the rotation of the tractor around the axis of rotation in such a way that

$$M_{op} \geq M_{stab}, \qquad (1.1)$$

Here:

M_{op} - turning moment, Nm;

M_{stab} - moment from forces striving to return the tractor to its original position, Nm.

Turnover occurs when the wheels rise above the supporting surface, at which point the angle of rotation of the skeleton reaches its limit value, and its subsequent movement along the roll under the influence of gravity and inertia becomes irreversible. The main criteria for the stability of any tractor against overturning are

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the characteristics of its geometric parameters and the location of the center of mass relative to the support wheels, which determine the limits of static stability, called the limiting angles of ascent and descent. The tractor's ability to resist overturned movement around the transverse axis of overturning is called longitudinal stability of the tractor against overturning. In this case, the overturning occurs when the support reactions are redistributed along the tractor bridges, and one of them is equal to zero.

The stability of the tractor is also related to its operation. Before the loss of stability, a violation of the tractor's control capability occurs. Checking the stability of tractors and MTAs is carried out from the control conditions.

Lateral stability of a desert tractor

The angle of the start of the turn on the slope is determined by the following formula (2.2).

$$\beta_{\text{п}}^{\text{I}} = \text{arctg}\left(\frac{A_y^{\text{I}}}{h_{\text{цт}}^{\text{I}}}\right); \qquad (2.1)$$

$$\beta_{\text{п}}^{\text{II}} = arctg\left(\frac{A_y^{\text{II}}}{h_{\text{цт}}^{\text{II}}}\right). \qquad (2.2)$$

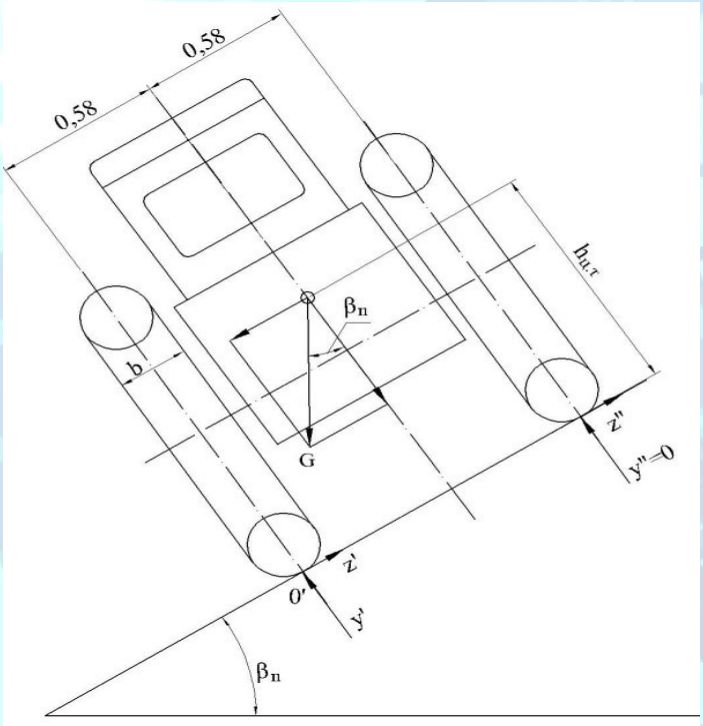


Figure 1. Calculation Scheme.

Starting angle of the slope (2.2)

$$\beta_{\varphi} = arctg(0{,}8 \cdot \varphi_c). \qquad (2.3)$$

Dynamic angle of lateral stability in the presence of dynamic impacts from road micro-levels (2.3)

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$$\beta_{один} = (0{,}4 \div 0{,}6) \cdot \beta_n . \quad (2.4)$$

State of transverse stability of the tractor against overturning

$$tg\,\beta_{\text{п}} \geq \varphi_y . \quad (2.5)$$

The parameters of the transverse stability of the single-project tractor are determined. The calculation results are summarized in tables 1.1, 1.2.

Table 1.1

Tractor (V_1/V_2 = 1420/1410 mm)	Rotation angles Supporting surface on the slope (bentness).
TTZ 1082 (*I* position)	26.07
TTZ 1082 (*II* position)	26.07
Parameter change, %	0

Table 1.2

Tractor (V_1/V_2 = 1820/1810 mm)	Rotation angles on the slope (rotation).
TTZ 1082 (*I* position)	32.11
TTZ 1082 (*II* position)	32.11
Parameter change, %	0

Analyzing the obtained results, it should be noted that an increase in the distance by 28.4% leads to an increase in the stability of the designed tractor by 23.2%. The change in the base does not affect the lateral stability of the tractor. The condition of guaranteed transverse stability of the designed tractor on the slope (beard) is met only on the maximum distance. (B_{max}).

Rear drive wheels in front of sliding angles of one tractor, projected on a slope with two simultaneous braking (L_{max}, L_{min}), minimum and maximum track (B_{max}, B_{min}). Results are summarized in Tables 1.3, 1.4

Table 1.3

The tractor's rear wheels are braked on the rod.		
Tractor (V_1/V_2 = 1420/1410 mm)	Angles of inclination of the OP to the length (displacement)	
	on the hill	on a slope
TTZ 1082 (*I* position)	36.22	15.87
TTZ 1082 (*II* position)	31.86	16.99
Parameter change, %	-12.04	7.06

Calculations showed that when braking the rear drive wheels on the slope, an increase in the foundation by 29.3% leads to a decrease in the sliding angle on the climb by 12% and an increase in the sliding angle on the slope by 7%.

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Table 1.4

The tractor's rear wheels are braked on the rod.		
Tractor (V_1/V_2 = 1820/1810 mm)	Angles of inclination of the OP to the length (displacement)	
	on the hill	on a slope
TTZ 1082 (*I* position)	36.22	15.87
TTZ 1082 (*II* position)	31.86	16.99
Parameter change, %	-12.04	7.06

Conclusion

As a result of the above studies, it was once again proven that the calculation of the stability of tractors operating in desert conditions is an important and urgent problem. Analysis shows that the effectiveness of tractors in harsh climatic and complex soil conditions directly depends, first of all, on their structural design and stability indicators. During the study, it was established that such parameters as the location of the center of gravity, the structure of the chassis, and the coefficient of contact with the soil significantly affect the stability of the tractor.

Based on the research results, effective ways to increase the stability of the tractor were proposed. In particular, the lowest possible placement of the center of gravity, balanced distribution of loads, and adaptation of the running gear to desert conditions were identified as the most important constructive solutions. Also, various tractor models were compared, and their design advantages and disadvantages were analyzed.

In conclusion, the correct calculation of the stability of desert tractors is important not only from the point of view of technical efficiency, but also from the point of view of ensuring the safety of the operator. The recommendations and calculation methods presented in this work will serve as a scientific and practical basis for further improvement of the tractor design and its reliable operation in harsh natural conditions.

REFERENCES

1. Akhmetov A.A. History of soil cultivation machines // Agrotechnical world No02 (03) February 2018, Tashkent.
2. Akhmetov A.A. Trends in improving the design of chisel cultivators // Agrotechnical World No03 (04) March 2018, Tashkent.
3. Akhmetov A.A., Akhmedov Sh.A., Functional front mirror equipped with a telescopic transverse link control mechanism // World of Agrotechnology, No 02 (03) 2018, Tashkent.

ISSN 3030-3907

4. E. Ahmadi, "Development of a tractor dynamic stability index calculator using some tractor specifications," Turk. J. Agric. For., vol. 37, no. 2, pp. 203-211, 2013.
5. R. Vidoni, M. Bietresato, A. Gasparetto, and F. Mazzetto, "Evaluation and stability comparison of different vehicle configurations for robotic agricultural operations on side-slopes," Biosyst. Eng., vol. 129, pp. 197-211, 2015.
6. A. K. Salimov, "Analysis of Dynamic Characteristics of Tractors in Desert and Semi-Desert Conditions," Agricultural Mechanization, vol. 4, pp. 25-31, 2018
7. Tashkent State Technical University, "Scientific Research on the Optimization of the Running Part of Tractors in Desert Conditions," Collection of Scientific and Technical Information, vol. 2, pp. 10-19, 2020.
8. R. L. McKyes, Soil Cutting and Tillage, Amsterdam: Elsevier Scientific Publishing Company.
9. H. Koolen and H. Kuipers, Soil Mechanics for Agricultural Engineers, Wageningen: Wageningen University Press.
10. Deutsche Landwirtschafts-Gesellschaft (DLG), "Field tests on tractor stability in desert and semi-desert soils," DLG Test Report No. 201, Frankfurt, Germany, 2019.

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