ANALYSIS OF THE INFLUENCE OF EXTERNAL FORCES ON THE LIFTING-TIPPING DEVICE OF A LARGE-SCALE TRACTOR TRAILER

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ABSTRACT

The article discusses the external forces affecting the tractor trailer lifting-tipping device. According to it, it was considered that the increase in the trailer's load capacity and the lifting-tipping device angle depend on the influence of external forces.

Key words: *Lifting-tipping device, tractor, trailer, force, load, process, surface, density.*

INTRODUCTION

The load tipping process is important in the operation of the tractor-trailer tipper, as it determines how the tipper is loaded and how reliable it is.

Determining changes in the mass, moment of inertia and center of gravity coordinates of the load in the process of overturning is one of the most important issues.

If it is assumed that the density of the load does not change in the volume of the body, the change in the mass of the load can be expressed by the following formula.

$$m_G = \rho_G \cdot V_G = \rho_G \cdot L \cdot S$$

ρ_G– load density, kg/m^3; V_G – volume of cargo in the body, m^3; L – body length, m; S is the area of the side surface of the load, m^2.

The behavior of the load overturning depends on the type of unloading, and the ratio of the load to the area of the side surface changes proportionally, taking into account the change in the load mass ρ_G and L. There are three main views of the load transfer process, which are as follows:

- the method of overturning the scattering load. In this process, the load overturning starts immediately with the start of the rise of the body and ends until the tangent of the angle of rise of the body bottom (tgph) is greater than the coefficient of friction of the load with the bottom of the body;

- viscous load unloading process. This process is carried out by simply pushing the load along the bottom and finally tipping over. In this case, there are difficult conditions for the overturning mechanism to work, because at the end of the overturning, the load moves to the edge of the body and creates a torque;
- a mixed method of cargo tipping. For this type, at the initial time of loading, the load is tipped in the form of a spreading load tipping method, and then in the form of a sticky load unloading process.

For the first type of overturning, it is assumed that the load drop size changes according to the geometric shape of the load body. In it, the side surface of the load is calculated using the geometric method as the side surface of the body (Fig. 1), that is, the simple shapes that make up the side surface of the load are calculated by the formula as the sum of the surfaces.

$$S = \frac{a \cdot b - a^2 \cdot tg(\alpha + \varphi)}{2} - a_1 \cdot (b - a \cdot \mathrm{tg}(\alpha + \varphi)) \quad (1)$$

a – body height, m; *b* - body width, m; φ - turning angle, degrees; a_1– the height of the body filled with cargo, m; *a*– load central angle, degrees.

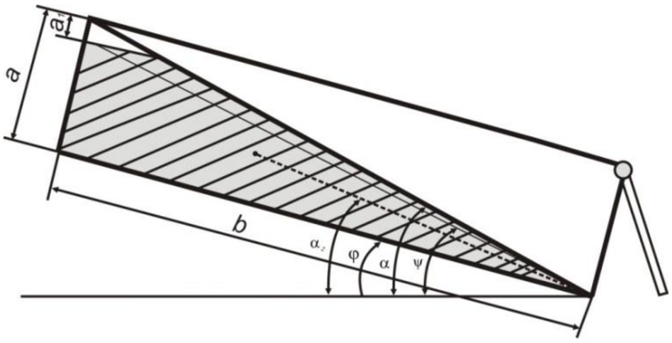


Figure 1. Parameters for changing the load side surface

For the second type of overturning, the volume of the load is explained by the change of the side surface as follows:

$$S = b \cdot a - \Delta b \cdot a - a_1 \cdot b \quad (2)$$

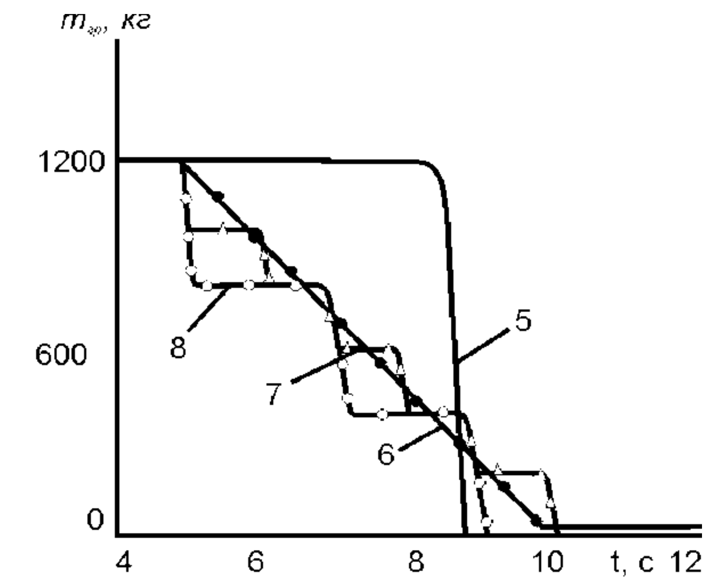
where $\Delta b = \frac{g[\sin(\varphi) - f \cdot \cos(\varphi)] - t^2}{2}$

For the third type, formulas (1) and (2) are used together.

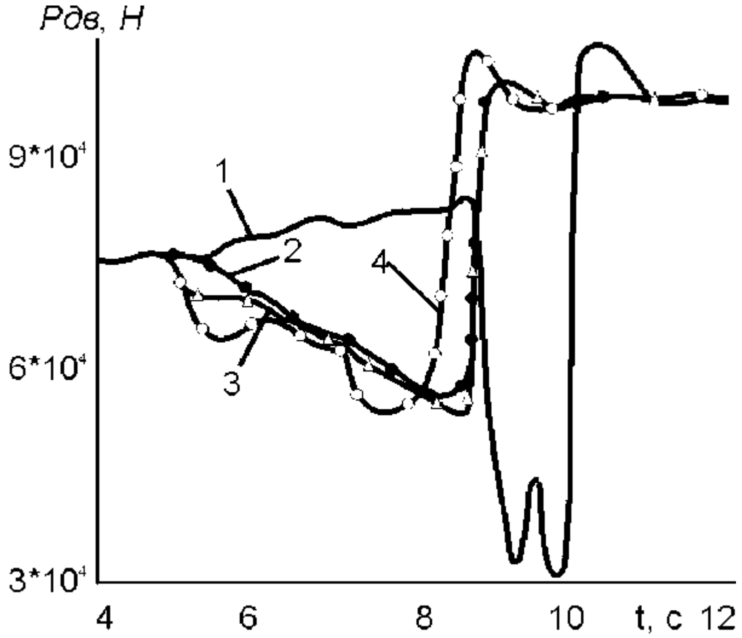
The modeling process was carried out using the mathematical model of the lift-over device presented in [1]. The drag force, driving force and mass change are shown in Figure 2.

The analysis of the results shows that the load mass change for the considered type of overturning is close to momentum (Fig. 2, curve 1), which leads to a sharp change in the resistance force and driving forces (Fig. 2, curves 9, 5). The readjustment of the driving force is about 15 %.

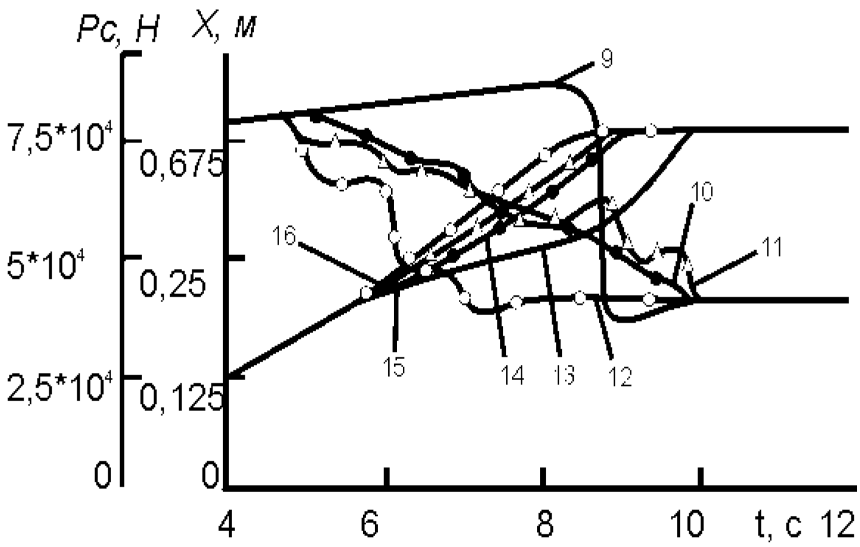
Various variants of mass change and their effect on the dynamics of lifting and tipping devices were considered. Figure 2 shows the linear (curves 2, 6, 10, 14 for dry soil, dry or wet soil), stepped with a step of 1 second (curves 3, 7, 11, 15), stepped with a step of 2 seconds (Curves 4, 8, 12, 16), the transition processes of the change of the main parameters in motion are presented.



a)



b)



c)

Figure 1. The dynamics of changes in the main parameters of the lifting device under the influence of mass changes: dynamics of changes in a) load mass (5-8), b) driving force (1-4), c) resistance force (9-12) and shaft movement (13-16)

The results showed that the best dynamics of the overturning process is obtained in the linear variation of the load mass. In this case, the recovery of the driving force does not exceed 4%.

As the mass change deviates from the linear character, the dynamics deteriorates. The readjustment of line 8 is 8%.

REFERENCES

1. Шермухамедов А.А., Усманов И.И., Салимджанов Р.Т., Тогаев А.А. Методы расчета и испытания автотракторных прицепов отечественного производства / Монография. – Ташкент, 2012. – 132 с.

2. Shermukhamedov, A., Ergashev, N., & Azizov, A. (2021). Substantiating parameters brake system of the tractor trailer. In *E3S Web of Conferences* (Vol. 264, p. 04019). EDP Sciences.

3. Khakimzyanov, R., & Rashidov, A. (2022, June). Definition of bending moment and curvaturein the plastic zone of elastic-plastic calculation of the carcass construction. In *AIP Conference Proceedings* (Vol. 2432, No. 1, p. 030076). AIP Publishing LLC.

4. Khakimzyanov, R., Togaev, A., & Rashidov, A. (2021). The stress-strain state of the universal chassis of the tractor trailer in T-Flex. In *E3S Web of Conferences* (Vol. 264, p. 02008). EDP Sciences.

5. Шермухамедов, А. А., Усманов, И. И., Салимджанов, Р. Т., & Тогаев, А. А. (2012). Методы расчета и испытания автотракторных прицепов отечественного производства. *Ташкент:«ТАДИ*.

6. Убайдуллаев, Г. К., Эргашев, Н. Т., & Рашидов, А. М. (2022). Основные закономерности и современные тенденции развития транспортных машин. *RESEARCH AND EDUCATION*, *1*(7), 138-142.

7. Азизов, А., Азизов, Х., & Эргашев, Н. Т. у. (2023). Физические и механические свойства поверхностей движения пустынного четырехколесного пропашного трактора. *RESEARCH AND EDUCATION*, *2*(4), 376–383. Retrieved from https://researchedu.org/index.php/re/article/view/3261

8. Ибрагимов, Б. Д., Турсунов, И. С., & Эргашев, Н. Т. у. (2022). Сервис электромобилей и проблемы его организации. *international conference dedicated to the role and importance of innovative education in the 21st century*, *1*(8), 171–175. Retrieved from https://openidea.uz/index.php/conf/article/view/227

9. Убайдуллаев , Г. К., Жуманиязов, Х. Ж., & Эргашев , Н. Т. у. (2022). Отклонение геометрических показателей поверхностей деталей при их обработке. *RESEARCH AND EDUCATION*, *1*(9), 298–302. Retrieved from https://researchedu.org/index.php/re/article/view/1055

10. Abdulaziz, S., & Nurillo, E. (2022). Analysis of studies on the justification of the parameters of the brake system of auto-tractor trailers. *RESEARCH AND EDUCATION*, *1*(6), 91-94.

11. Ubaydullaev, G., Riskaliev, D., Ergashev, N., Rashidov, A., & Shadiev, S. (2021). Determination of installation bases of parts during their mechanical processing. In *E3S Web of Conferences* (Vol. 264, p. 05046). EDP Sciences.

12. Азизов, А. А., Эргашев, Н. Т., & Муталиев, В. А. (2022, November). Методика расчета безотказности элементов проектируемого автомобиля с применением коэффициентов коррекции. In *International conference dedicated to the role and importance of innovative education in the 21st century* (Vol. 1, No. 8, pp. 160-165).

13. Азизов, А. А., Эргашев, Н. Т., & Шадиев, С. Р. (2022, November). Изменение свойств резины в процессе старения. In *International conference dedicated to the role and importance of innovative education in the 21st century* (Vol. 1, No. 8, pp. 155-159).

14. Shermukhamedov, A. A., ugli Ergashev, N. T., & Jumaniyazov, H. J. (2022, November). Katta hajmli kuzovlari almashinuvchi traktor tirkamalari tormoz tizimi tadqiqotlari tahlili. In *International conference dedicated to the role and importance of innovative education in the 21st century* (Vol. 1, No. 8, pp. 176-180).

15. Аннакулова, Г. К., Астанов, Б. Ж., & Саидов, С. А. (2020). Математическая модель исследования вертикальных и угловых колебаний корпуса пустынного трактора. In *19-я Международная конференция «Авиация и космонавтика»* (pp. 517-521).

16. Shermukhammedov, A. A., Togayev, A. A., & Astanov, B. J. (2012). Choice of design parameters of tractor trailers category. 03. *Vestnik TADI–Tashkent*, (1-2), 60-65.

17. Холдаров, Ф. Э. Ў. (2022). МАХСУС ТРАНСПОРТ ВОСИТАЛАР ТИЗИМИДА ИННОВАЦИОН ИНТЕЛЛЕКТУАЛ ЁНДАШУВ. *Academic research in educational sciences*, *3*(TSTU Conference 1), 124-129.

18. Шермухамедов Абдулазиз Адилхакович, & Холдаров Фидокор Эркинбой ўғли. (2023). Методика расчета интенсивности износа и пробега шин специализированных транспортных средств. RESEARCH AND EDUCATION, 2(4), 231–247. https://doi.org/10.5281/zenodo.7881078