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ANALYSIS OF POTENTIAL HAZARDS WHILE WORKING WITH TRUCK MIXER

Teplyakova S. V., Kotesova A. A., Nedoluzhko A.I.
Don state technical University, Rostov-on-Don, Russian Federation

svet-tpl@yandex.ru
a.kotesova@mail.ru
alexsander1948@yandex.ru

The paper considers hazards of production factors and engineering solutions to labor protection based on physical laws taking into account new solutions of scientific and technical progress. This study will allow implementing labor protection measures in design and development, as well as in industries. The development and implementation of safe equipment, safe methods and types of work includes a wide range of solutions that can ensure the safety of certain types of work, improve working conditions. The paper considers these issues on the example of the design and operation of a mixer truck.

Keywords: risk factors hazards, prediction, engineering solutions, labor protection, development and introduction of safe equipment, mixer truck.

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АНАЛИЗ ПОТЕНЦИАЛЬНЫХ ОПАСНОСТЕЙ ПРИ РАБОТЕ АВТОБЕТОНОСМЕСИТЕЛЯ

Теплякова С. В., Котесова А. А., Недолужко А. И.
Донской государственный технический университет, г. Ростов-на-Дону, Российская Федерация
svet-tpl@yandex.ru
a.kotesova@mail.ru
alexsander1948@yandex.ru

С учетом новых решений научно-технического прогресса изучаются опасности производственных факторов, разрабатываются инженерные решения охраны труда на основе физических законов. Настоящее исследование позволит внедрить мероприятия по охране труда в проектно-конструкторских разработках, а также в условиях производства. Разработка и внедрение безопасной техники, безопасных приемов и видов работ включает в себя широкий круг решений, которые позволяют обеспечить безвредность выполнения тех или иных видов работ, улучшить условия труда. В данной работе эти вопросы рассмотрены на примере конструкции и функционирования автобетоносмесителя.

Ключевые слова: опасности производственных факторов, прогнозирование, инженерные решения, охрана труда, разработка и внедрение безопасной техники, автобетоносмеситель.

Introduction. The development of science and technology has led to the fact that the person during work is now practically freed from high physical activity, as the working bodies of machines do the hardest physical part. On the other hand, the complexity of the process of controlling the equipment, increase in the amount of simultaneously incoming information on the work of the machine increase the neuropsychic load on the operator.

Analysis of potential hazards while working with truck mixer. Analyzing the operation of a truck mixer, it is possible to distinguish a number of the following hazards for the operating personnel health [1, 2]:

• hazard from rotating elements, which, in addition to the parts that transmit motion, include a mixing drum rotating during the concrete mixture preparation. The rotation of these elements and the operation of the car engine lead to noise;

• vibration sources similar to noise sources. In case of uneven operation of the engine, the wear of supporting members of rotating elements increases noise and vibration. In addition, roadway roughness can cause a significant vibration, especially when driving at high speed;

• increased concentration of harmful substances in the air caused by the emission of exhaust fumes during engine operation. This hazard is also possible when repairing a truck mixer in a closed room (garage, hangar) with the running engine without ventilation. Increased dust concentration in the driver's cab caused by roadway dust, especially without hard surface, as well as in the area of the mixing drum feed inlet with dry fine concrete mixture components;

• hazard of an emergency on the road in case of failure of a unit or a part affecting traffic safety [3, 4];

• hazard of tipover (sliding) of a truck mixer when driving on soft grounds near pot holes, pits, when driving on slopes with an angle exceeding the permissible level;

• hazard of accidental ingress and subsequent winding of the operator's clothing on rotating structural elements.

Technical and technological solutions to reduce hazards.

For protection from the rotating elements, there are protective covers to prevent the possibility of winding of operator’s clothes. Noise insulation of the cabin with soundproof screens is used to protect a driver against noise. The noise coming from the mechanical drive of the mixing drum is eliminated using the design of the hydraulic drive.

The main element that protects the driver from vibration is his seat. A seat has special elements to perform these functions, (springs, insulating material, shock absorbers) designed to absorb vibration. To protect the car from vibrations caused by road surface irregularities, a suspension system including shock absorbers and springs is used. Vibration reduction from the rotating elements is achieved through timely maintenance services and repairs of the nodes, preventing them from excessive wear.

To protect against high concentrations of harmful substances (dust), the feed inlet has a protective cover. For protection against poisoning by exhaust fumes of a car it is forbidden to start the engine in closed rooms (hangars, garages) which are not equipped with ventilation. To improve air exchange there are hatches, ventilators in the driver's cab. To maintain the optimum temperature in the cabin a heating unit is used in winter and air conditioning in summer.

The reduction of driver fatigue is achieved by reducing levers and pedals force to regulatory limits: the steering wheel force is 20 N, the force on the levers is 20-60 N, the force on the pedals is 80-120 N.

Firefighting equipment on truck mixers are extinguishers. Kits are used as a means of first aid, the completeness of which is determined by regulatory documents.

To prevent an emergency on the road, truck mixers undergo technical inspection before leaving to determine the serviceability of the main car systems. To prevent injuries during the inspection and repair of concrete mixers with tipping cab, the latter is equipped with a locking mechanism to prevent its spontaneous lowering. Repair and maintenance of machines is carried out at specially equipped stations that meet safety requirements. Repair and adjustment work is carried out at the switched-off engine (except for separate types of adjustment works).

In order to prevent the truck mixer tipover, the driver is prohibited to move on the surface, the angle of inclination of which exceeds the limit values.

Methods for calculating the truck mixer stability. Under the machine stability, we understand its ability to move in various environments without tipping over and without lateral sliding of the wheels of all axles of the chassis or one of them. The stability of the truck mixer is checked for the most unfavorable case when the maximum volume of concrete mixture is prepared in accordance with the technical characteristics of the unit.

The preliminary analysis showed that the most dangerous is the machine transverse stability loss with its subsequent tipover or sliding. Lateral stability checking is the determination of the limit angle of the slopes α, at which the truck mixer can move without tipping over.

We assume that the concrete mixture is evenly distributed in the mixing drum, due to its rotation, as well as the presence of blades. The stability condition is an inequality of overturning and restoring moments, with respect to the tipping axis, this axis passes through the point A (Fig.1). The calculation method is given in table 1.

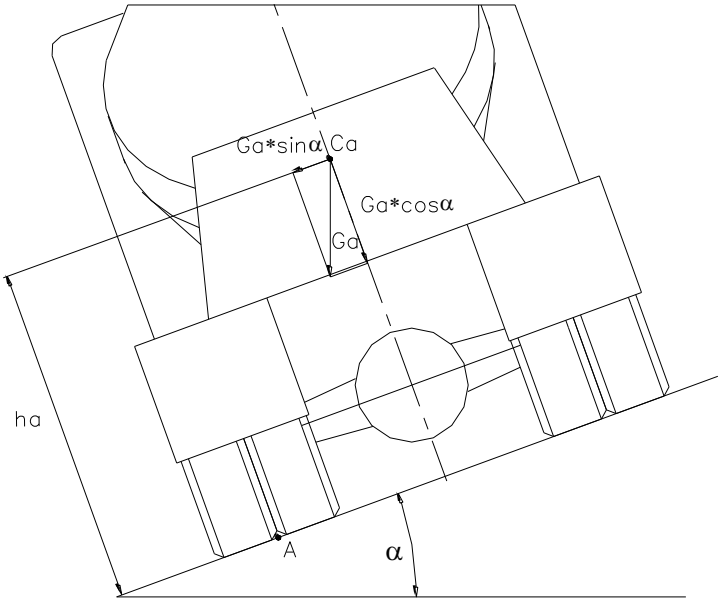

Fig.1. Scheme for calculation of lateral overturning stability

Table 1

Summary table of stability check of a truck mixer

Risk factor	Moment inequality	Tipping and sliding limit angles
Stability condition	$G_A \cdot h_A \cdot \sin\alpha \le G_A \cdot 0.5B \cdot \cos\alpha$	limit angle of transverse inclination: $\alpha = \arctan\frac{0.5B}{h_A} = \arctan\frac{0.5 \cdot 1.77}{1.58} = 31^0$
Slippage	$G_A \cdot \sin\alpha \le G_A \cdot \varphi_{СЦ}' \cdot \cos\alpha$	– for dry road surface: $\varphi_{СЦ}' = (0.6...1) \cdot 0.75 = 0.6$ – for wet road surface: $\varphi_{СЦ}' = (0.6...1) \cdot 0.5 = 0.4$
Sliding	$G_A \cdot \sin\alpha \le G_A \cdot \varphi_{СЦ}' \cdot \cos\alpha$	– for dry road surface: $\alpha = \arctan\varphi_{СЦ}' = \arctan 0.6 = 30^0$ – for wet road surface: $\alpha = \arctan\varphi_{СЦ}' = \arctan 0.4 = 22^0$

*G_A — weight of a truck mixer, including concrete mix

Conclusion. The analysis is conducted of the main potential hazards during the operation of a truck mixer, as well as the main technical and technological solutions to reduce hazards. The method for calculating the truck mixer stability is formulated, in which the limiting angles of tipover and sliding in the transverse plane for a stationary and moving machine are determined.

Implementation of the above-mentioned solutions and recommendations will improve the comfort of the operator and prevent possible negative consequences from the impact of harmful and dangerous production factors while working with the mixer truck.

References

1. Nadezhnost’ v tekhnike (SSNT). Terminy i opredeleniya: GOST 27.002-2015. Mezhgosudarstvennyy Sovet po standartizatsii, metrologii i sertifikatsii. [Reliability in technology (SAST). Terms and definitions: GOST 27.002–2015. Interstate Council for Standardization, Metrology and Certification.] Moscow: Standartinform, 2015, 23 p. (in Russian).

2. O promyshlennoy bezopasnosti opasnykh proizvodstvennykh ob’ektov: feder. zakon No. 116-FZ. Elektron. Fond pravovoy i normativ.-tekhn. dokumentatsii. Konsoetsium "Kodeks". [On industrial safety of hazardous production facilities: Federal law No. 116–FZ. Electron. fund of legal and norm.-tech. documentation. Consortium "Kodeks".] Available at: http://docs.cntd.ru/document/9046058/ (accessed 03.03.2017) (in Russian).

3. Teplyakova, S.V. Analiz printsipov obespecheniya absolutnoy bezotkaznosti detaley mashin. [Analysis of the principles of ensuring the absolute reliability of machines' parts.] Vestnik Donetskoy akademii avtomobil'nogo transporta, 2015, no. 1, pp. 65-70 (in Russian).

4. Kotesova, A.A. et al. Analiticheskoe opredelenie parametrov raspredeleniya veybulla dlya sovokupnosti konechnogo ob'ema po tverdosti stali. [Analytical determination of Weibull distribution parameters for population of final volume on steel hardness.] Novye tekhnologii, 2012, no. 4, pp. 56-61 (in Russian).

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Autors:

Teplyakova Svetlana Viktorovna,
assistant of the Department "Motor vehicles, construction and road facilities, Don State Technical University, (1, Gagarin sq., Rostov-on-Don, 344000, Russia), candidate of techn. sciences,
svet-tpl@yandex.ru

Kotesova Anastasiya Aleksandrovna,
associate professor of the Department "Motor vehicles, construction and road facilities", Don State Technical University, (1, Gagarin sq., Rostov-on-Don, 344000, Russia) candidate of techn. sciences,
a.kotesova@mail.ru

Nedoluzhko Aleksandr Ivanovich,
associate professor of the Department "Motor vehicles, construction and road facilities", Don State Technical University, (1, Gagarin sq., Rostov-on-Don, 344000, Russia) candidate of techn. sciences,
alexsander1948@yandex.ru