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Modified Method for Estimating the Static Lateral Stability of Vehicles as Amended by the Design Changes

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Abstract

Testing methods for vehicles for static lateral stability are considered. The objects of research are vehicles (trucks and specialized vehicles) that are in operation and have undergone the amendment process. The subject of research is the motor vehicle testing procedure for static lateral stability and errors arising therefore. The aim is to provide a method for testing the vehicle for static lateral stability eliminating the need for applying a bench with a tipping platform and providing equivalent measurement to the method regulated by GOST 31507-2012.

The authors propose an original way to test vehicle [Blyankinshtein (2016)] that includes placing the vehicle on the supporting horizontal surface, creating a tilting moment relative to the longitudinal axis of the vehicle until the wheels on one side are detached from the bearing horizontal surface with force attached to the sprung portion of the vehicle perpendicular to its longitudinal axis in a plane passing through the geometric center of mass, and the lean angle φ of the sprung mass is measured, the height of the center of mass h is determined, the static lateral stability angle αcy of the vehicle is calculated. The results of primary testing method are given, variants of application of the tilting moment and the determining the lean angle of the sprung mass are considered.

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Keywords: Testing method, motor vehicle amendments, assessment of compliance with safety requirements, static lateral stability.

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1. Main text

Transport support of the emerging industries of Siberia and the Far North (oil and gas, timber, mining, metallurgy, etc.) is based on road transport, most of which is carried out in the winter time via the temporary roads (winter roads). In the off-season and during summer the rolling stock is left on the "mainland", amended and used on public roads, if necessary. Most of the amendments of commercial vehicles consist in the replacement of superstructures with a lot of variation, both for the functional purpose, and for weight and size parameters. Due to the remoteness of the service depots from motor vehicle manufacturers, these works are carried out at the regional specialized maintenance and repair stations, where the experts perform all basic technological operations to change the design of the vehicle.

Although the goal of the amendment is to improve functional, operational, economic and other characteristics of the vehicle, the amendment process inevitably affects the motor vehicle safety settings. It can be argued that almost half of the changes made to the motor vehicle design can significantly affect the handling characteristics and stability. This makes it urgent to assess the conformity of design of the amended motor vehicles to the established safety requirements in terms of handling and stability.

In the world practice, regulations establishing requirements for handling and stability of vehicles and procedures for evaluating these properties have been developed and applied at the legislative level. For example, in the United States, the Society of Automotive Engineers (SAE) formulated these requirements in the standard J2180 [SAE International Surface Vehicle recommended practice (2011)]. In Europe there is the UNECE Regulation No. 111 [UNECE (2000)], which is also applied in our country. In Russia, the technical requirements for the stability of vehicles are set out in the technical regulations of the Customs Union 018/2011 [Customs Union Commission (2011)], and the testing method for static lateral stability is given in GOST 31507-2012 [Standartinform (2013)].

UNECE Regulation No.111 displays classical testing procedures for static lateral stability with the use of the test bench with a tipping platform, they apply only to tank vehicles of category N_2, N_3, O_3 and O_4 intended for the transport of dangerous cargo and establish strict requirements for static stability.

GOST 31507-2012 also implies that during the testing the test bench with a rigid platform should be used, the dimensions of which allow to fully accommodate a vehicle, the standard applies to motor vehicles of category M, N and O (regarding the M_1 category - only for vehicles of category G), so the dimensions of the test bench must comply with the maximum dimensions of the motor vehicles under testing.

SAE J2180 covers heavy-duty motor vehicles, it has a more flexible procedure of testing, in particular, the option of using a test bench with a rigid platform (in the size of the car), as well as the option of using several small platforms that are placed just under the vehicle axes and synchronously perform leaning of a motor vehicle, thus reducing the design metal consumption.

All three of the above regulatory documents provide the use of a test bench with a tipping platform, the design of which must be either solid and conform to the dimensions of the vehicle, or to ensure a smooth synchronous tipping of axes of the vehicle at a predetermined angular velocity in the range of 0.25º/s to 0.5º/s. All the attention in the regulations is paid to safety issues, configuring hardware adjustment and debugging - the test bench design must provide the use of stops to prevent the vehicle from slipping during tipping, as well as of safety devices that prevent full tipping of motor vehicle.

In the context of motor vehicle use, as a rule, there are no benches and alternative methods to determine the angle of the static lateral stability. In addition, this parameter is not determined during technical inspections of motor vehicles. These circumstances are explained by the shortcomings of existing methods, involving the use of tipping benches to lean motor vehicles to the angle, at which there is detachment of wheels on one side from the bearing surface. These shortcomings include:

- Large dimensions and weight of the test bench;
- Metal consumption and complexity of the design of both the tipping platform and its drive mechanism of its longitudinal axis rotation;
- Occasional use and, as a result, high operating costs and long payback period.

Thus, the current method of experimental assessment of the motor vehicle static lateral stability cannot be implemented in the absence of the test bench with a tipping platform, and if the bench is available, is characterized by complexity and high cost of testing.