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Heavy commercial vehicles and buses — Vehicle dynamics simulation and validation — Lateral dynamic stability of vehicle combinations

Véhicules utilitaires lourds et autobus — Dynamique du véhicule simulation et validation — Stabilité latérale des véhicules articulés

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 33, *Vehicle dynamics and chassis components*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

The main purpose of this document is to provide repeatable and discriminatory test results.

The dynamic behaviour of a road vehicle is a most important aspect of active vehicle safety. Any given vehicle, together with its driver and the prevailing environment constitutes a closed-loop system which is unique. The task of evaluating the dynamic behaviour is therefore very complicated, since the significant interaction of these driver-vehicle-road elements are each complex in themselves. A complete and accurate description of the behaviour of the road vehicle will inevitably involve information obtained from a number of different tests.

Since this test method quantifies only one small part of the complete handling characteristics, the results of this test can only be considered significant for a correspondingly small part of the overall dynamic behaviour.

Moreover, insufficient knowledge is available to correlate overall vehicle dynamic properties with accident prevention. A substantial amount of work is necessary to acquire sufficient and reliable data on the correlation between accident prevention and vehicle dynamic properties in general and the results of this test in particular. Consequently, proven correlation between test results and accident statistics is used for any application of this test method for regulation purposes.

Test conditions and tyres have a strong influence on test results. Therefore, only results obtained under comparable test and tyre conditions are comparable.

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Heavy commercial vehicles and buses — Vehicle dynamics simulation and validation — Lateral dynamic stability of vehicle combinations

1 Scope

This document specifies a method for comparing simulation results from a vehicle model to measured test data for an existing vehicle combination's lateral stability according to driving tests as specified in ISO 14791. The comparison is made for the purpose of validating the simulation model for this type of test. A complete validation comprises the comparison for at least one tested vehicle and one variant of this vehicle, covered by a parameter variation in the vehicle model.

The document applies to heavy vehicles, including commercial vehicles, commercial vehicle combinations, buses and articulated buses as defined in ISO 3833 (trucks and trailers with maximum weight above 3,5 tonnes and buses and articulated buses with maximum weight above 5 tonnes, according to ECE and EC vehicle classification, categories M3, N2, N3, O3 and O4).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 14791:2000, *Road vehicles — Heavy commercial vehicle combinations and articulated buses — Lateral stability test methods*

ISO 8855, *Road vehicles — Vehicle dynamics and road-holding ability — Vocabulary*

ISO 15037-2:2002, *Road vehicles — Vehicle dynamics test methods — Part 2: General conditions for heavy vehicles and buses*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 8855, ISO 15037-2 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
simulation
calculation of motion variables of a vehicle from equations in a mathematical model of the vehicle system

3.2
basic vehicle parameters
parameters not subject to model fitting, which are directly and accurately measurable on the test vehicle

EXAMPLE Masses and dimensions.

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3.3
estimated vehicle parameters
parameters that may be used for model fitting, which are typically hard to be determined

EXAMPLE Mass moment of inertia and tyre characteristics.

3.4
vehicle model validity range
basic vehicle parameters (3.2) which may be changed if the type of vehicle combination and tyre type are maintained

Note 1 to entry: For example, when wheel base is modified some of the estimated parameters may need to be updated accordingly.

4 Principle

The pseudo random and the single sine wave steering input according to ISO 14791 is used to determine lateral stability by calculating the rearward amplification (RA) and yaw damping (D) of heavy commercial vehicles and buses as defined in ISO 3833. Within this document, the purpose of the test is to demonstrate that a vehicle model can predict the vehicle behaviour within specified tolerances. The vehicle model is used to simulate a specific existing vehicle running tests as specified in ISO 14791. The maximum lateral acceleration in the first vehicle unit is limited to a conservative value to assure linear behaviour of the vehicle combination. The characteristic values from model results and physical testing are compared for validating the model. In this document a tolerance is given for when the model is valid. The tolerance depends upon the physical testing variation in repeatable results and the uncertainty in the input data to the model. The validated model can also be used for the single sine wave lateral acceleration input as specified in ISO 14791. The experimental variation sets the bounds within which the model is validated.

When the vehicle model is used outside its validity range, for example changing vehicle combination type or changing tyre parameters, a new validation is required. For proving good reliability of the simulation results, it is recommended to repeat the process of comparing simulation and measurement results for different vehicle parameters, for example laden conditions and vehicle longitudinal velocity.

5 Variables

The variables of motion used to describe the behaviour of the vehicle shall be related to the reference axis system (X, Y, Z) of the first vehicle unit (see ISO 8855) with the reference point as described in 3.1. The variables that shall be determined for conformance with this document are:

— longitudinal velocity, v_x;

— steering-wheel angle, δ_H;

— yaw velocity of the first vehicle unit and yaw velocity of each vehicle unit, ω_z;

— lateral acceleration of the front axle of the first vehicle unit at or below the height of the wheel centre, a_y.

It is recommended that the following variables are also determined:

— yaw angle of the first vehicle unit, ψ;

— lateral acceleration in the centre of gravity of each vehicle unit, a_y;

— articulation angles, $\Delta\psi$.

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