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Heavy commercial vehicles and buses — Centre of gravity measurements — Axle lift, tilt-table and stable pendulum test methods

Véhicules utilitaires lourds et autobus — Mesure du centre de gravité — Méthode d'essais du plateau incline, levage d'un essieu et pendule stable

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Contents

Page

Foreword ..... **v**

Introduction ..... **vi**

1 Scope **1**

2 Normative references **1**

3 Terms and definitions **1**

4 Principles **3**

5 Variables **3**

5.1 Reference system 3

5.2 Variables to be measured 3

5.2.1 Variables to be measured for location of x_{CG} and y_{CG} coordinates of centre of gravity in horizontal plane 3

5.2.2 Variables to be measured using the axle lift method for location of z_{CG} coordinates 4

5.2.3 Variables to be measured using the tilt-table method for location of z_{CG} coordinates 4

5.2.4 Variables to be measured using the stable pendulum method for location of z_{CG} coordinates 4

6 Measuring equipment **5**

7 Test conditions **6**

7.1 General 6

7.2 Ambient conditions 6

7.3 Test surface 6

7.4 Test vehicle 6

7.5 Operating and other liquids 6

7.6 Loading conditions, suspension and mechanical parts 6

8 Determination of the centre of gravity in the horizontal plane **7**

8.1 General 7

8.2 x_{CG} position of the centre of gravity in the horizontal plane 7

8.2.1 Two axle vehicles 7

8.2.2 More than two axles 7

8.3 y_{CG} position of the centre of gravity in the horizontal plane 8

8.3.1 Two axle vehicles 8

8.3.2 More than two axles 8

9 Determination of the centre of gravity height **8**

9.1 General 8

9.2 Axle lift method 8

9.2.1 General guidance 8

9.2.2 Procedure 10

9.2.3 Determination of the axle load and inclination angle 11

9.2.4 Location of the centre of gravity above the ground plane with loaded tyre radius 11

9.3 Tilt-table method 12

9.3.1 General guidance 12

9.3.2 Tilt-table procedures 14

9.3.3 Determination of the centre of gravity height z_{CG} 15

9.3.4 Data presentation 15

9.4 Stable pendulum method 15

9.4.1 General guidance 15

9.4.2 Stable pendulum procedure 17

9.4.3 Determination of platform properties 17

9.4.4 Determination of the applied torque 17

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9.4.5 Consideration of platform deflection 18
9.4.6 Determination of the centre of gravity height, z_{CG} 18
9.4.7 Data Presentation 18
Annex A (informative) **Determination of static loaded radius, r_{stat}** **19**
Annex B (informative) **Test report — Axle lift method** **20**
Annex C (informative) **Test report — Tilt method (up to 3 axles)** **23**
Annex D (informative) **Test report — Stable pendulum method** **26**
Bibliography **29**

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Foreword

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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).

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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

Methods are presented for measuring the location of the centre of gravity of an individual vehicle unit in the horizontal, lateral and vertical planes. Location of the longitudinal and lateral centre of gravity positions are obtained through successive use of wheel or platform scales. Three different methods are described for measurement of the vertical centre of gravity – the axle lift method, the tilt-table method, and the stable pendulum method. The selection of the method to use depends on the facility and resource availability, as well as constraints imposed by the vehicle design. Knowledge of a vehicle unit's centre of gravity supports vehicle modelling work, design validation and planning for other dynamic tests yet to be performed.

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Heavy commercial vehicles and buses — Centre of gravity measurements — Axle lift, tilt-table and stable pendulum test methods

1 Scope

This document describes a standard method for measuring a vehicle's longitudinal and lateral (horizontal plane) centre of gravity (CG) positions and three methods for estimating a vehicle's vertical CG position, the axle lift, tilt-table, and stable pendulum methods. It applies to heavy vehicles, that is commercial vehicles and 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). CG measurements are performed separately for each single unit.

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 612, *Road vehicles — Dimensions of motor vehicles and towed vehicles — Terms and definitions*

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

ISO 15037-2, *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
scale
instrument or device used to measure total vehicle, axle, track or individual wheel weights

3.2
crane
device used to lift one end of the test vehicle, with sufficient lift capacity

3.3
load cell
device for measuring force along a single axis

3.4
axle hoist
device used to lift an individual axle with the *crane* (3.2) and safety provisions to prevent the axle from leaving the hoist once lifted

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3.5
tilt-table
apparatus for supporting a vehicle on a nominally planar surface and for tilting the vehicle in roll by rotating that surface about an axis nominally parallel to the x-axis of the vehicle

Note 1 to entry: A tilt-table is composed of (1) a single structure supporting all tyres of the vehicle on a contiguous surface, or (2) multiple structures supporting one or more axles on separated, but nominally coplanar surfaces.

3.6
wheel dummy
surrogate solid wheel used to remove tyre compliance

3.7
trip rail
rail or kerb fixed to the *tilt-table* (3.5) surface and oriented longitudinally beside the low-side wheel dummies to prevent the vehicle from sliding sideways

3.8
tilt angle
Φ_T
angle between the ground plane and a vector that is in the plane of the *tilt-table* (3.5) surface and is perpendicular to the tilt axis

3.9
tilt angle variance
differences between the *tilt angles* (3.8) observed at each vehicle axle due to *tilt-table* (3.5) compliance, twist or misalignment of multi-platform tilt-tables

3.10
critical wheel lift
first moment when one or more wheels lifts from the table surface, following which stable roll equilibrium of the vehicle cannot be maintained

3.11
critical tilt angle
Φ_{Tc}
tilt angle at *critical wheel lift* (3.10)

3.12
tilt-table ratio
TTR
tan (Φ_{Tc}), as shown in Formula (1)

$$TTR = \tan(\Phi_{Tc}) \quad (1)$$

Note 1 to entry: It can also be expressed as tan (Φ_T) at the occurrence of *critical wheel lift* (3.10).

Note 2 to entry: See Figure 5.

3.13
central axis
axis defined as the intersection of the longitudinal median plane of the vehicle, Xv-Zv, and the ground plane

3.14
stable pendulum
pendulum apparatus for supporting a vehicle on a nominally planar surface where the combined vehicle and pendulum centre of gravity is below the pivot point

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