BS ISO 19380:2019

BSI Standards Publication

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

Documents
Document Sharing Hub

Full document details: BS ISO 19380:2019

National foreword

This British Standard is the UK implementation of ISO 19380:2019.

The UK participation in its preparation was entrusted to Technical Committee AUE/15, Safety related to vehicles.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© The British Standards Institution 2019
Published by BSI Standards Limited 2019

ISBN 978 0 580 90388 5

ICS 43.080.01

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 August 2019.

Amendments/corrigenda issued since publication

Date	Text affected

Documents
Document Sharing Hub

Full document details: BS ISO 19380:2019

INTERNATIONAL STANDARD

ISO 19380

First edition
2019-08

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

Reference number
ISO 19380:2019(E)

Documents
Document Sharing Hub

© ISO 2019

Full document details: BS ISO 19380:2019

COPYRIGHT PROTECTED DOCUMENT

© ISO 2019

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

© ISO 2019 – All rights reserved

Documents
Document Sharing Hub

Full document details: BS ISO 19380:2019

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

AVA Documents
Document Sharing Hub

© ISO 2019 – All rights reserved

Full document details: BS ISO 19380:2019

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**

© ISO 2019 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 19380:2019

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).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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.

© ISO 2019 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 19380:2019

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.

© ISO 2019 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO 19380:2019

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

© ISO 2019 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 19380:2019

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)

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

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

© ISO 2019 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO 19380:2019

3.15
unstable pendulum
pendulum apparatus for supporting a vehicle on a nominally planar surface where the combined vehicle and pendulum centre of gravity is above the pivot point

3.16
platform
nominally planar surface of the pendulum on which the vehicle unit or trailer is parked

3.17
vehicle restraint
means to constrain the vehicle unit or trailer in the longitudinal direction on the pendulum *platform* (3.16)

4 Principles

This document specifies a method to determine the longitudinal and lateral centre of gravity coordinates in the horizontal plane and three common methods to determine the vertical centre of gravity coordinate. The longitudinal and lateral centre of gravity coordinates, x_{CG} and y_{CG}, are determined in the horizontal plane using scales. Individual scales can be used at each wheel or axle location, or the vehicle wheels or axles can be moved across a single scale successively. The vertical centre of gravity coordinate (z_{CG}) is determined using either the axle lift, tilt-table or stable pendulum method.

The accuracy of the vertical centre of gravity measurements is dependent on the vehicle condition during measurement, measurement equipment accuracy and potential movement of heavy sprung or unsprung masses within the vehicle – such as engine and transmission assemblies and suspensions –, during the measurement process. Methods involving tilting the vehicle or lifting the vehicle axles are prone to movement of suspended components. Consequently, the required accuracy of the vertical centre of gravity measurement should be considered when selecting a measurement method. In general, the pendulum method results in less movement of suspended components, and does not require that the suspension be locked-out vertically.

5 Variables

5.1 Reference system

The reference system specified in ISO 15037-2 shall apply.

5.2 Variables to be measured

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

With the vehicle at rest on the ground plane and prepared with the load condition specified for the test, the following shall be measured and recorded in accordance with the dimensions given in ISO 612 and ISO 8855.

— F_z the total vehicle load (or weight);

— n_a number of axles;

— F_{zi} ith axle load (F_{z1} is the front axle load);

— $F_{zi,left}$ ith axle, left wheel track load;

— $F_{zi,right}$ ith axle, right wheel track load;

— $F_{z,left}$ total left track load;

© ISO 2019 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 19380:2019

— $F_{z,right}$ total right track load;

— l vehicle average wheelbase of 2-axle vehicle;

— l_{right} right track wheelbase of 2-axle vehicle;

— l_{left} left track wheelbase of 2-axle vehicle;

— l_{i-1} average axle distance (left and right track) from front axle to axle i;

— b_i ith axle track (b_1 is at the front axle).

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

In addition to the relevant variables listed above, measure and record the following.

— F_{zi}' ith axle load after lifting is initiated;

— $F_{zi,left}'$ left track axle load on the ith axle after lifting is initiated;

— $F_{zi,right}'$ right track axle load on the ith axle after lifting is initiated;

— θ vehicle pitch angle change in the X Z plane, relative to the initial orientation on the ground plane before lifting occurs;

— r_{stat} average static loaded radius of all tyres; see Annex A;

— $r_{stat\ i}$ the average static loaded radius on the ith axle; see Annex A.

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

In addition to the relevant variables listed above, measure and record the following.

— l_c longitudinal distance between the contact centres of the two axles contacting the trip rail;

— y_{mi} half-width across wheel dummy trip edges on ith axle;

— $r_{stat,\ dummy}$ average static radius of the wheel dummies;

— Φ_{Tc} critical tilt angle;

— Z_s height of the centre of gravity with the wheel dummies.

NOTE See Figure 7 for a description.

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

In addition to the relevant variables listed above, measure and record the following.

— h pivot height from the platform surface;

— h_p platform's CG distance below the pivot axis;

— W_p load of the platform including the restraint components;

— W_A applied load;

© ISO 2019 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO 19380:2019