INTERNATIONAL STANDARD

ISO 789-6

Second edition
2019-02

Agricultural tractors — Test procedures —

Part 6: Centre of gravity

Tracteurs agricoles — Méthodes d'essai —

Partie 6: Centre de gravité

Reference number
ISO 789-6:2019(E)

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Published in Switzerland

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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 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 2, *Common tests*.

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.

This second edition cancels and replaces the first edition (ISO 789-6:1982), which has been technically revised. It also incorporates the Amendment ISO 789-6:1982/Amd.1:1996. The main changes compared to the previous edition are as follows.

— The terms and definitions have been updated to reference ISO 789-13.

— A requirement for a mass in the driver's seat has been added in 5.2.

— A requirement for locking the suspension has been added in 5.4.

— A new method has been added for alternative determination of vertical coordinate ($\bar{h}$) in 6.3.8.

— Figures 4 to 12 and Tables 1 to 4 have been added to support the method described in 6.3.8.

A list of all parts in the ISO 789 series can be found on the ISO website.

Introduction

This document specifies test procedures for agricultural tractors. It deals with the centre of gravity.

Although there are many possible methods of determining the centre of gravity, the purpose of this document is to specify a simple, practical method, which requires the use of a weighbridge and crane. Alternative methods can be used if they locate the centre of gravity with respect to the specified reference planes and within the specified tolerances.

Agricultural tractors — Test procedures —

Part 6: Centre of gravity

1 Scope

This document specifies a method of determining the position of the centre of gravity of agricultural tractors.

The method is applicable to agricultural tractors having at least two axles fitted with wheels or tracks.

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 789-13:2018, *Agricultural tractors — Test procedures — Part 13: Vocabulary and specimen test report*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 789-13 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
agricultural tractor
self-propelled agricultural vehicle having at least two axles and wheels, or endless tracks, particularly designed to pull agricultural trailers and to pull, push, carry and operate implements used for agricultural work (including forestry work), which may be provided with detachable loading platform

Note 1 to entry: The agricultural vehicle has a maximum design speed of not less than 6 km/h and may be equipped with one or more seats.

[SOURCE: ISO 12934:2013, 3.1]

3.2
wheelbase
L
horizontal distance between the two vertical planes passing through the rotational centrelines of the wheels, where one plane is for the front wheels and the other for the rear wheels

Note 1 to entry: In the case of a tractor equipped with a rear tandem, it is the distance between two vertical planes passing through the centres of the front wheel and the vertical plane midway between the wheel centres of the two axles of the tandem.

[SOURCE: ISO 789-13, 3.2, modified]

4 Apparatus

The following apparatus are required.

4.1 Weighbridge or load cells.

4.2 Crane.

4.3 Decking with knife edges.

4.4 Level.

4.5 Plumb rule.

4.6 Squares.

4.7 Scribing board, shall be at least 600 mm high by 450 mm wide, rigidly constructed, and attached to the tractor in a suitable position with a smooth face vertical and parallel to the side or other appropriate plane.

4.8 Marking materials.

4.9 Tape measure.

5 General requirements

5.1 The tractor shall be clean and shall be tested in normal working conditions or in a specified condition agreed between the manufacturer and the testing authority.

5.2 The radiator, sump, hydraulic and other reservoirs shall be filled to specified working levels. The fuel tank shall be full and the driver replaced by a weight of 75 kg on the driver's seat, the tractor being otherwise unballasted.

5.3 Tools, spare tyre, and loose accessories and equipment shall be complete as supplied and shall be in the normal storage positions.

5.4 Any suspension system shall be locked in the normal height position. If locking the suspension system is not possible, then inflate all tires up to the maximum permissible pressure as specified by the tyre manufacturer. The difference in radius of the wheels on the fixed axle between horizontal and raised position shall not be higher than 1,5 % of the wheel radius.

5.5 Articulated tractors shall normally be tested locked in a straight line, but it may be necessary to conduct the test with the joint set at the maximum or any intermediate angle.

5.6 If testing a sprung tractor, no special measures shall be taken to lock the suspension of the machine.

5.7 In conducting the test, the following measurement tolerances shall be observed:

a) distance: ±0,5 %;

b) mass: ±0,5 %;

c) tyre pressure: ±5 %.

Tyre pressure should be in accordance with the manufacturer's recommendations.

6 Procedure

6.1 General principle

The centre of gravity is determined by the suspension and ground reaction method. This involves measuring the ground reactions with the tractor:

a) in a horizontal position;

b) tilted with one end lifted;

c) tilted with the other end lifted.

The calculated horizontal distance of the centre of gravity from a ground contact point is measured in each case and verticals are drawn on the scribing board (4.7) fixed to the tractor. The intersection of the verticals indicates the centre of gravity.

6.2 Determination of horizontal fore-and-aft coordinate ($\bar{x}$)

6.2.1 Tracked tractors [see Figure 1 a)]

Determine the mass (m) of the whole tractor on the weighbridge.

Measure the reaction (F_1) under the knife edge due to its mass and part of the decking.

Move the tractor on to the decking, part supported by the weighbridge, and measure the reaction at the front knife edge due to the mass of the tractor, the decking and knife edge ($F_1 + F_2$). Calculate the reaction of the front knife edge due to the tractor mass only (F_2) by subtraction.

Measure the distance (d) between the knife edges.

The horizontal fore-and-aft coordinate is given by Formula (1):

$$\bar{x} = \frac{d \cdot F_2}{m} \tag{1}$$

6.2.2 Wheeled tractors [see Figure 1 b)]

In the case of wheeled tractors, it is not necessary to use decking or knife edges. With the brakes off, measure the axle loads and calculate $\bar{x}$ from the mass and the wheelbase of the tractor using Formula (1) (using the wheelbase as the value for d).

6.3 Determination of vertical coordinate ($\bar{h}$) (see Figure 2)

6.3.1 Suspend the tractor from one end at an angle of 20° to 25° to the horizontal, the other end resting on the weighbridge. For some tractors, it may not be practical or safe to use an angle this large. In this case, a lesser angle may be used but shall not be less than 15° to the horizontal. (The method is applicable either to wheeled or tracked tractors, the main difference being in establishing the exact location of the point of application of the ground contact. In the case of wheeled tractors, which shall be unbraked, this is vertically below the axle. In the case of tracked tractors, it is necessary to manoeuvre until the contact grousers are in the line of ground contact BB' on either side, or to make contact through a knife-edge on the ground contact line BB'. In all cases, the suspension cable shall be vertical as tested by plumb rule.)

6.3.2 Measure the reaction (F_3) at the ground contact on the weighbridge.

6.3.3 Measure the horizontal distance (d) from the ground contact to the line of suspension.

6.3.4 Calculate the horizontal distance (c) from the centre of gravity to the line of suspension using Formula (2):

$$c = \frac{F_3 \cdot d}{m} \quad (2)$$

where m is the mass of the tractor.

6.3.5 Draw a vertical line on the scribing board at a distance c from the line of suspension.

6.3.6 Repeat the procedures specified in 6.3.1 to 6.3.5 with the tractor suspended from the other end. The suspension angle need not be the same for both ends.

6.3.7 The intersection of the two lines on the scribing board, determined as specified in 6.3.5 and 6.3.6, gives the vertical coordinate of the centre of gravity ($\bar{h}$).

NOTE 1 The tractor can be conveniently run on to the weighbridge, square, using chalked lines. This will assist in drawing the plan. If, in the case of tracked tractors, the grousers are not in the ground contact line BB' (see Figure 2), the tractor can be driven in varying circles until the required result is attained at the last approach.

NOTE 2 An alternative method is to use a tilting platform and load cells respectively.

6.3.8 Alternative determination of vertical coordinate ($\bar{h}$) (See Figures 4 to12).

Repeat the procedures specified in 6.3.1 to 6.3.4 with the tractor suspended from the other end. The suspension angle need not be the same for both ends.

Vertical coordinate ($\bar{h}$) of the centre of gravity is determined by means of calculation (see Tables 1, 2, 3 and 4)

NOTE The tractor can be conveniently run on to the weighbridge, square, using chalked lines. This will assist in drawing the plan. If, in the case of tracked tractors, the grousers are not in the ground contact line BB' (see Figure 2), the tractor can be driven in varying circles until the required result is attained at the last approach..

6.4 Determination of lateral coordinate in the horizontal plane ($\bar{y}$) (see **Figure 3**)

Measure the left-hand (F_4) and right-hand (F_5) wheel or track loadings. Calculate the offset (b) of the centre of gravity using track gauge or wheel track (d_t) as the moment arm, i.e. Formula (3):

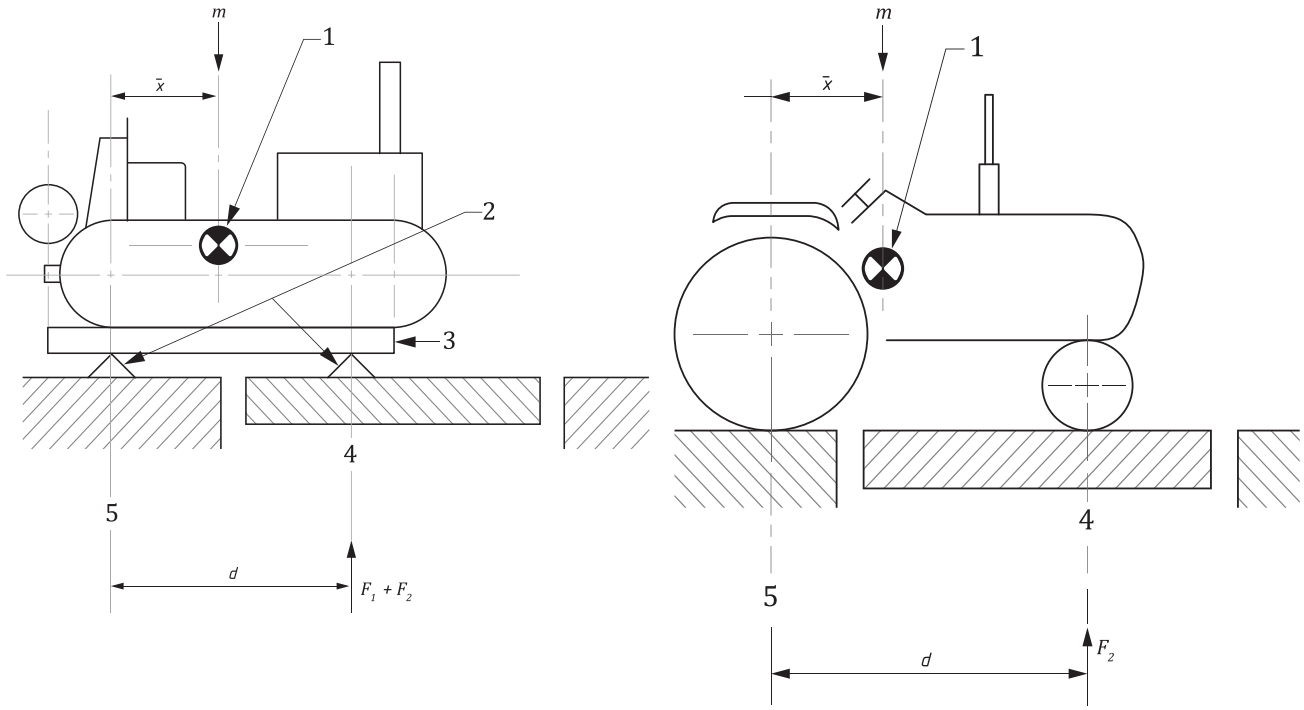
$$b = \frac{F_5 d_t}{m} \quad (3)$$

The lateral coordinate in the horizontal plane is given by the Formula (4);

$$\bar{y} = \frac{d_t}{2} - b \quad (4)$$

NOTE The right-hand and left-hand side loads usually do not exactly total the mass of the tractor due to small differences in level between the weighbridge deck and the surround. Any error is minimized by equalizing the overlap of the side being weighed in both cases.

It is preferable to use the total right-hand side and left-hand side wheel (track) loadings to determine the mass of the tractor (m).

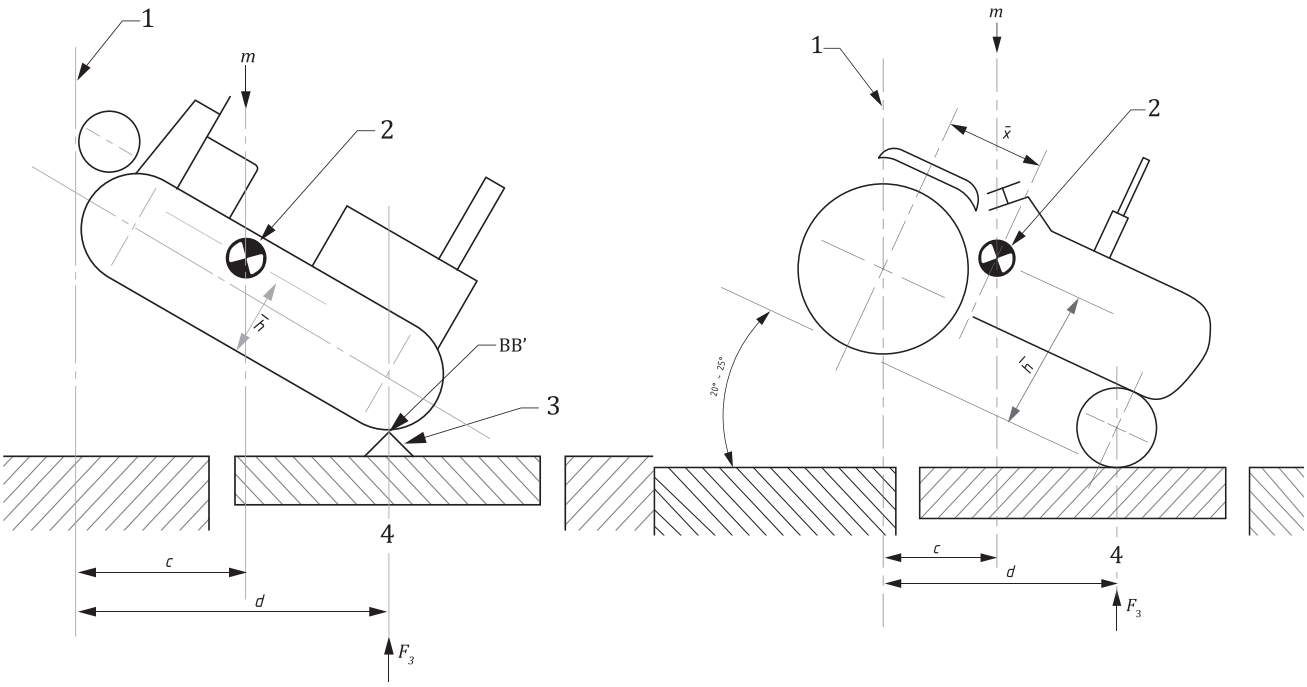


a) Tracked tractor **b) Wheeled tractor**

Key

1 centre of gravity
2 knife edges
3 decking
4 weighbridge
5 vertical reference plane

Figure 1 — Determination of horizontal fore-and-aft coordinate ($\bar{x}$)



a) Tracked tractor **b) Wheeled tractor**

Key

1 suspension cable
2 centre of gravity
3 knife edges
4 weighbridge

Figure 2 — Determination of vertical coordinate ($\bar{h}$)