
International Standard



789/6

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

**Agricultural tractors — Test procedures —
Part 6 : Centre of gravity**

Tracteurs agricoles — Méthodes d'essai — Partie 6 : Centre de gravité

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up 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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 789/6 was developed by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, and was circulated to the member bodies in May 1981.

It has been approved by the member bodies of the following countries :

Australia	Finland	New Zealand
Austria	France	Poland
Belgium	Germany, F. R.	Portugal
Brazil	India	Romania
Bulgaria	Iran	Spain
Canada	Italy	Sweden
Czechoslovakia	Korea, Dem. P. Rep. of	Switzerland
Denmark	Korea, Rep. of	USA
Egypt, Arab Rep. of	Mexico	USSR

The member body of the following country expressed disapproval of the document on technical grounds :

United Kingdom

Agricultural tractors — Test procedures — Part 6 : Centre of gravity

0 Introduction

This International Standard specifies test procedures for agricultural tractors. This part deals with the centre of gravity. Other parts of this International Standard will be as follows :

Part 1 : Power tests.

Part 2 : Hydraulic power and lifting capacity.

Part 3 : Turning and clearance diameters.

Part 4 : Exhaust smoke measurement.

Part 5 : Partial power p.t.o. — non-mechanically transmitted power.

Part 7 : Power and torque of the drive wheels.

Part 8 : Engine air cleaner.

Although there are many possible methods of determining the centre of gravity, the purpose of this part of ISO 789 is to specify a simple, practical method, which requires the use of a weighbridge and crane. Alternative methods may be used if they locate the centre of gravity with respect to the specified reference planes and within the specified tolerances.

1 Scope and field of application

This part of ISO 789 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 Reference

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

3 Definitions

For the purpose of this part of ISO 789, the following definitions apply.

3.1 agricultural tractor :

See ISO 3339/1 (in preparation).

3.2 wheelbase :

See ISO 612.

3.3 tractor mass : The mass of a tractor as submitted for test.

3.4 reference planes :

3.4.1 vertical reference planes :

a) transverse plane

1) for wheeled tractors : vertical plane containing the centreline of the rear axle;¹⁾

2) for crawler tractors : vertical plane containing the centreline of the driving sprocket axle;

b) median longitudinal plan (or symmetric longitudinal plane) : vertical plane through the major fore-and-aft axis, i.e. midway between the tracks or wheels (see ISO 612).

3.4.2 horizontal reference plane : Ground level. (A hard contact shall be assumed.)

3.5 coordinates of the centre of gravity :

3.5.1 horizontal fore-and-aft coordinate (symbol \bar{x}) : The horizontal distance of the centre of gravity from the transverse reference plane.

3.5.2 vertical coordinate (symbol \bar{h}) : The vertical distance of the centre of gravity from the horizontal reference plane.

3.5.3 lateral coordinate (symbol \bar{y}) : The horizontal distance of the centre of gravity from the median longitudinal plane (see ISO 612) of the tractor.

4 Apparatus

The following apparatus is 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.

The 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

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.

5.1 The radiator, sump, hydraulic and other reservoirs shall be filled to specified working levels; the fuel tank shall be full or empty or in a specified condition as agreed between the manufacturer and the testing authority.

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

5.3 Tyre pressures shall be as specified in the manufacturer's operating instructions or, if a range of pressures is allowed, at the highest recommended pressure. In the case of tractors fitted with hydro-inflation tyres, they shall be filled in accordance with the manufacturer's operating instructions.

5.4 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.

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

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

- a) distance : $\pm 0,5 \%$
- b) mass : $\pm 0,5 \%$
- c) tyre pressure¹⁾ : $\pm 5 \%$

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 (4.5) 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 the formula

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

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

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 by the formula given in 6.2.1 (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. (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 from the formula

$$c = \frac{F_3 \cdot d}{m}$$

where m is the mass of the tractor.

6.3.5 Draw a vertical 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}).

NOTES

1 The tractor may 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), it is necessary to resort to trial and error by running the tractor in varying circles until the required result is attained at the last approach.

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

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.

$$b = \frac{F_5 d_t}{m}$$

The lateral coordinate in the horizontal plane is given by the formula

$$\bar{y} = \frac{d_t}{2} - b$$

NOTE — It will usually be found that the right-hand and left-hand side loads 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).

7 Test report (see the annex)

7.1 The test report shall include the identification of the tractor and test parameters, together with the coordinates of the centre of gravity as follows :

- the horizontal fore-and-aft coordinate (\bar{x}) : the distance from the vertical reference plane;
- vertical coordinate (\bar{h}) : height above horizontal ground level;
- the lateral coordinate in the horizontal plane (\bar{y}) : the displacement from the median longitudinal plane through the major fore-and-aft axis.

7.2 The position of the centre of gravity shall be reported in millimetres from three reference planes.

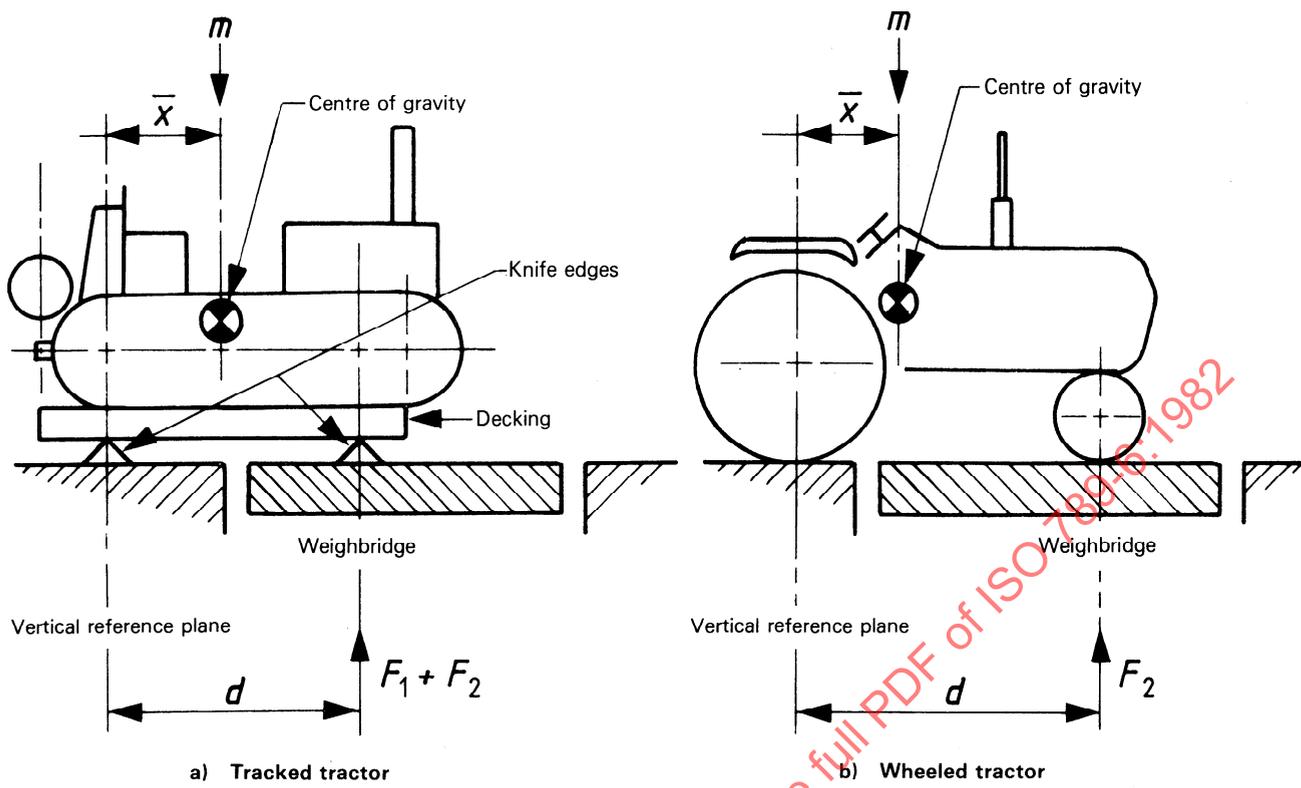


Figure 1 — Determination of horizontal fore-and-aft coordinate (\bar{x})

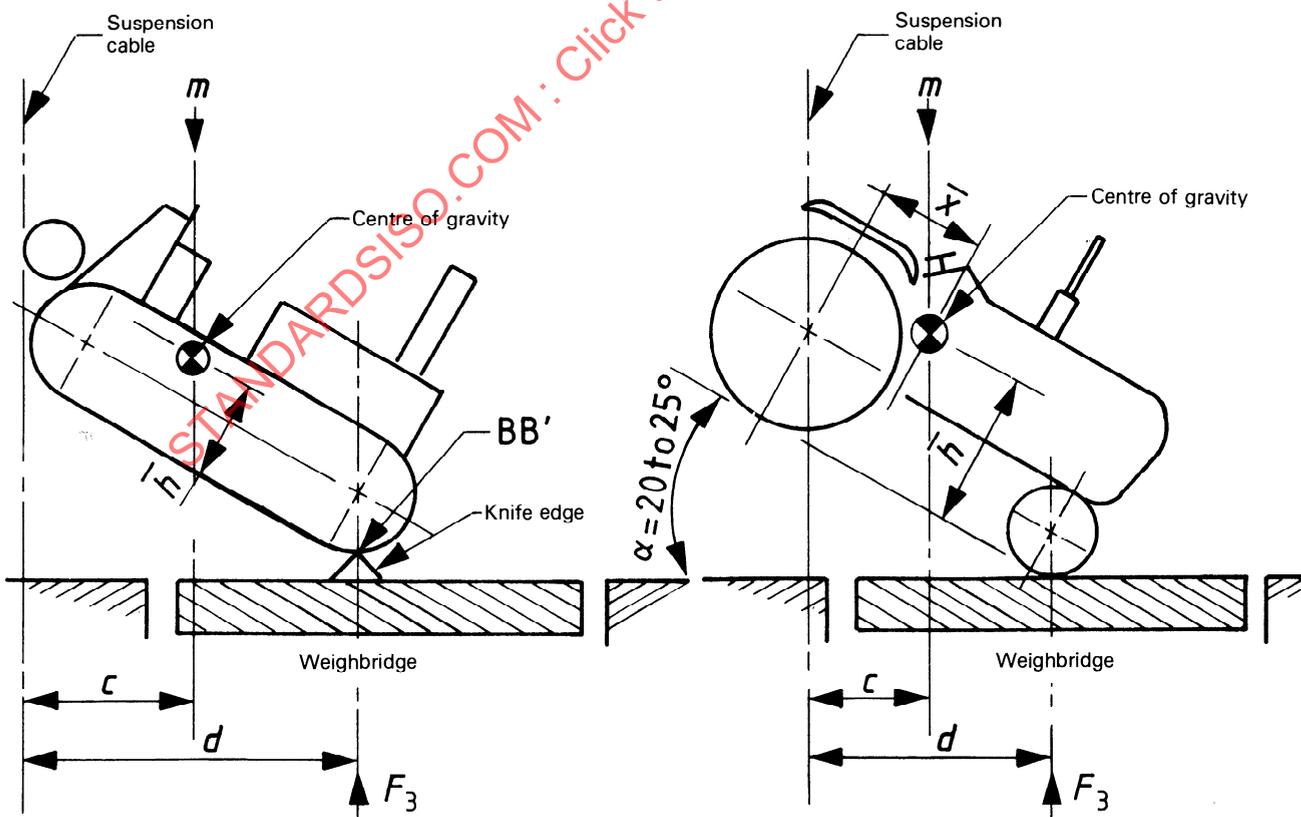


Figure 2 — Determination of vertical coordinate (\bar{h})