INTERNATIONAL STANDARD

ISO 10392

First edition
1992-06-15

Road vehicles with two axles — Determination of centre of gravity

Véhicules routiers à deux essieux — Détermination du centre de gravité

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INTERNATIONAL ISO

Reference number
ISO 10392:1992(E)

Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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International Standard ISO 10392 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Sub-Committee SC 9, *Vehicle dynamics and road-holding ability*.

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Annexes A and B form an integral part of this International Standard. Annex C is for information only.

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International Organization for Standardization
Case Postale 56 • CH-1211 Genève 20 • Switzerland

Printed in Switzerland

Road vehicles with two axles — Determination of centre of gravity

1 Scope

This International Standard specifies a method to determine the location of the centre of gravity of a road vehicle, as defined in ISO 3833, with two axles. Other procedures may exist and be used, employing more elaborate and sophisticated methods and equipment, such as tilt-tables and cradles.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 612:1978, *Road vehicles — Dimensions of motor vehicles and towed vehicles — Terms and definitions.*

ISO 3833:1977, *Road vehicles — Types — Terms and definitions.*

ISO 8855:1991, *Road vehicles — Vehicle dynamics and road-holding ability — Vocabulary.*

3 Test conditions

3.1 Operating and other liquids

The fuel tank shall be completely full. If the displacement of other liquids (operating and other) due to the inclination of the vehicle, as measured in clause 4, is considered significant, this shall be taken into account.

3.2 Loading conditions, suspension and mechanical parts

Any load shall be held in place to avoid displacement due to the inclination of the vehicle.

After loading the vehicle to the desired loading conditions, the wheel suspension shall be blocked to avoid changes in deflection due to the inclination of the vehicle. This may also apply to other vehicle components which could affect the test result due to flexible mounting.

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When lifting the vehicle, the gear-box shall be in neutral. The parking-brake shall be released; rolling of the wheels of one axle only shall be avoided by wedges or other means. The front wheels shall remain pointing straight ahead as far as possible.

4 Measuring procedure

4.1 With the vehicle horizontal, and in accordance with the dimensions given in ISO 612 and ISO 8855, measure and record:

l_{left}, the wheelbase, left, in millimetres;

l_{right}, the wheelbase, right, in millimetres;

b_f, the track, front, in millimetres;

b_r, the track, rear, in millimetres;

m_1, the wheel load, front left, in kilograms;

m_2, the wheel load, front right, in kilograms;

m_3, the wheel load, rear left, in kilograms;

m_4, the wheel load, rear right, in kilograms;

$r_{stat,1}$, the static loaded radius[1)], front left, in millimetres;

$r_{stat,2}$, the static loaded radius[1)], front right, in millimetres;

$r_{stat,3}$, the static loaded radius[1)], rear left, in millimetres;

$r_{stat,4}$, the static loaded radius[1)], rear right, in millimetres.

4.2 Lift one axle in steps (three or more steps are recommended). Record the axle load of the other axle and the lifting angle for each position. The maximum lifting angle depends upon the accuracy of the scale which is used to measure the axle load. It shall be large enough to provide the accuracy required in clause 5.

4.3 To take the hysteresis into account, lower the lifted axle by steps back to the level position and record axle loads and lifting angle as described as above.

4.4 Plot the axle loads and the tangent of the corresponding lifting angles and determine the mean value of axle load for a corresponding lifting angle.

4.5 It is recommended that all the measurements be repeated lifting the other axle.

4.6 It may also be desirable to determine the lifting angle from the wheelbase and the elevation of the wheels above the ground for each inclination position. In this case the change in tyre deformation caused by lifting one end of the vehicle shall be taken into consideration.

5 Accuracy of determined parameters

The following accuracies are required:

— Absolute axle load value:		± 0,2 %
— Change in axle loads due to lifting (applies to scales, which do not measure absolute loads, but changes in loads):		± 2,5 %
— Dimensions:	⩽ 2 000 mm :	± 1 mm
	> 2 000 mm :	± 0,05 %
— Angles:		± 1 %

1) See annex A.

6 Determination of location of centre of gravity

6.1 Determination of coordinates in horizontal plane

6.1.1 Location of centre of gravity longitudinally

The horizontal distance between centre of front axle and centre of gravity, x_{CG}, in millimetres, is determined by the equation:

$$x_{CG} = \frac{m_r}{m_v} \times l$$

where

$m_r = m_3 + m_4$ (as defined in 4.1) = rear axle load, in kilograms;

$m_v = m_1 + m_2 + m_3 + m_4$ (as defined in 4.1) = total mass of vehicle, in kilograms;

$l = 0{,}5(l_{left} + l_{right})$ (as defined in 4.1) = wheelbase of the vehicle, in millimetres.

6.1.2 Location of centre of gravity laterally

The horizontal distance between the longitudinal median plane of the vehicle and the centre of gravity (positive to the left), y_{CG}, in millimetres, is determined by the equation

$$y_{CG} = \frac{b_l(m_1 - m_2) + b_r(m_3 - m_4)}{2m_v}$$

where all symbols are as defined in 4.1.

6.2 Determination of height of centre of gravity above ground

6.2.1 Determination of axle load and lifting angle

The following values are obtained from the plotted data by linear curve fitting:

m'_f and m'_r which are axle loads at front and rear respectively of the axle remaining on the ground while the vehicle is inclined;

θ the corresponding lifting angle.

6.2.2 Location of centre of gravity above ground

The height of the centre of gravity above ground, z_{CG}, in millimetres, is determined by the equations:

$$z_{CG} = \frac{l(m'_f - m_f)}{m_v \times \tan\theta} + r_{stat,f}$$

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or

$$z_{CG} = \frac{l(m'_r - m_r)}{m_v \times \tan\theta} + r_{stat,r}$$

where

$m_f = m_1 + m_2$ = front axle load, in kilograms;

$m_r = m_3 + m_4$ = rear axle load, in kilograms;

$r_{stat,f} = 0{,}5(r_{stat,1} + r_{stat,2})$ = static loaded radius, front, in millimetres;

$r_{stat,r} = 0{,}5(r_{stat,3} + r_{stat,4})$ = static loaded radius, rear, in millimetres;

l is as defined in 6.1.

For symbols not defined, see 4.1.

NOTE 1 m_f and m_r may be measured directly if only the height of the centre of gravity is required, in which case m_1, m_2, m_3 and m_4 are not needed.

7 Data presentation

Measured data and test results shall be presented in a test report as shown in annex B.

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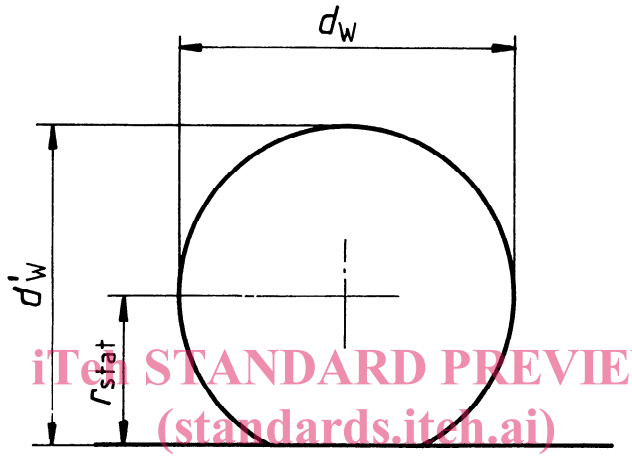
Annex A
(normative)

Determination of static loaded radius, r_{stat}

The static loaded radius given in 4.1 may be determined as shown in figure A.1: the formula is sufficiently accurate for the test procedure described in this International Standard.



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$$r_{stat} = d'_W - \frac{d_W}{2}$$

Figure A.1

Annex B
(normative)

Test report

B.1 Vehicle identification

B.1.1 Make: .....

B.1.2 Model: .....

B.1.3 Type: .....

B.1.4 Tyres:

Tyre size, front: ..... rear: .....

Tyre pressure, front: ..... rear: .....

B.1.5 Suspension setting (if adjustable): .....

B.2 Measurement data

B.2.1 Loading conditions (description of the loads, e.g. dummies, luggage, etc. and their locations in the vehicle):

.....

.....

B.2.2 Masses (loads):

Front left: ..... kg Rear left: ..... kg

Front right: ..... kg Rear right: ..... kg

Front total: ..... kg Rear total: ..... kg

Total, vehicle: ..... kg

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B.2.3 Track, front: ..... mm rear: ..... mm

B.2.4 Wheelbase, left: ..... mm right: ..... mm

B.2.5 Static loaded radii:

Front left: ..... mm Rear left: ..... mm

Front right: ..... mm Rear right: ..... mm

B.3 Test results

B.3.1 Longitudinal displacement between centre of front axle and centre of gravity: ..... mm

B.3.2 Distance between the longitudinal median plane of the vehicle and the centre of gravity (positive to the left):

..... mm

B.3.3 Height of the centre of gravity above the ground

B.3.3.1 Test with lifted front axle

lifting angle: ..... °

rear axle load (vehicle inclined): ..... kg

height of centre of gravity, front axle lifted: ..... mm

B.3.3.2 Test with lifted rear axle

lifting angle: ..... °

front axle load (vehicle inclined): ..... kg

height of centre of gravity, rear axle lifted: ..... mm

Annex C
(informative)

Bibliography

The following International Standards cover centre of gravity for other vehicles.

[1] ISO 789-6:1982, *Agricultural tractors — Test procedures — Part 6: Centre of gravity.*

[2] ISO 5005:1977, *Earth-moving machinery — Method for locating the centre of gravity.*

[3] ISO 8705:1991, *Mopeds — Measurement method for location of centre of gravity.*

[4] ISO 9130:1989, *Motorcycles — Measurement method for location of centre of gravity.*

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