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Road vehicles — Measurement of impact velocity in collision tests

Véhicules routiers — Mesure de la vitesse d'impact dans les essais de collision

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FOREWORD

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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 3784 was drawn up by Technical Committee ISO/TC 22, *Road vehicles*, and circulated to the Member Bodies in May 1975.

It has been approved by the Member Bodies of the following countries :

Australia	Germany	Spain
Austria	Hungary	Sweden
Belgium	Iran	Switzerland
Brazil	Italy	Turkey
Bulgaria	Japan	United Kingdom
Chile	Netherlands	U.S.A.
Czechoslovakia	Poland	Yugoslavia
Finland	Romania	
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No Member Body expressed disapproval of the document.

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Road vehicles — Measurement of impact velocity in collision tests

1 SCOPE AND FIELD OF APPLICATION

This International Standard lays down the accuracy of measurement of the impact velocity in collision tests on road vehicles. In addition, some typical methods suitable for the measurement of this impact velocity are described in the annex. These methods are intended to facilitate the comparison of data obtained in similar tests by different laboratories.

2 PERFORMANCE

2.1 The accuracy of velocity measurement shall be ± 1 %.

2.2 The impact velocity measurement shall be made within 0,2 s prior to impact.

3 METHODS OF MEASUREMENT

Typical methods for measuring impact velocity are described in the annex. Other methods may be used provided they meet the requirements of 2.1 and 2.2.

ANNEX

TYPICAL METHODS OF MEASUREMENT OF VELOCITY

Velocity measurement methods can be classified in three general categories :

a) Doppler effect method;

b) summation of the units of distance in a given time (fifth wheel method);

c) measurement of the time needed to cover a given distance.

A.1 DOPPLER EFFECT METHOD

This effect utilizes the apparent frequency variation of a wave in motion. This variation is proportional to the speed of the body in relation to the observer and is governed by the following formula :

$$f = \frac{v_1 f_0}{v_1 - v_2}$$

where

f is the apparent frequency;

f_0 is the emitted frequency;

v_1 is the speed of the wave emitted in an ambient medium;

v_2 is the speed of the vehicle.

The emitted electromagnetic waves which are generally used are situated in two different wavelength bands :

a) centimetric waves : radar with an accuracy that is only of the order of 2 %;

b) micrometric waves : the laser.

The laser system, more perfected than the radar system, permits measurements with an error less than 1 %. It should be noted, however, that the cost of this type of equipment is very high.

A.2 SUMMATION OF THE UNITS OF DISTANCE IN A GIVEN TIME (FIFTH WHEEL METHOD)

A wheel attached to the rear of the vehicle by an articulated yoke is maintained in contact with the ground by a spring. Mounted axially on this wheel is a disc containing slits spaced regularly around the circumference. A photoelectric transmitter-receiver system is located on either side of the disc.

Passage of the slits in front of a photoelectric cell activates a series of impulses corresponding to the distance covered. The summation of these data permits direct reading from a galvanometer, or a recording on an ultra-violet oscillograph. Careful machining permits an accuracy of the order of 1 %.

An alternative method is to use an induction proximity sensor in place of the photoelectric receiver. Its advantages are simpler assembly and resistance to weather.

A further variation involves attaching the transmitter directly to a rear wheel of the vehicle instead of the fifth wheel. In this case it is difficult to calibrate the system and there must be no tyre slip at the road surface. However, the calibration must be carried out carefully.

A.3 MEASUREMENT OF TIME NEEDED TO COVER A GIVEN DISTANCE

The following typical methods are in general use :

A.3.1 System using a photoelectric barrier

A transmitter and a receiver are located on either side of a shutter in a U-shaped arrangement fixed rigidly on the vehicle.

The transmitter consists of a lamp emitting a light beam with essentially parallel rays which illuminate a photoelectric cell which constitutes the receiver.

Successive cutting of the light beam by the arms of the U start and stop a digital chronometer.

The transmitter is placed approximately 1 m from the receiver. A diaphragm can be placed on the receiver to limit parasitic reflections.

The cutting of the beam is effected by means of a shutter in a U shape mounted on the side of the vehicle. This mounting should be very rigid in order to avoid any deflection tending to spread or tilt the two arms, thus altering their separation. The spacing between the arms of the U should be known within approximately 0,2 %. The U is painted matt black to avoid any reflections.

The passage of the first arm of the shutter through the barrier produces a variation in voltage at the amplifier. This difference in potential applied at entrance A of a digital chronometer whose time base is regulated to 10^{-5} s, initiates the time recording. When the second arm obscures the receiver, it produces a new voltage variation at entrance B of the chronometer, stopping the recording.

The accuracy with this system is very high and can be better than 1 %.

A.3.2 System with induction proximity sensor

The receiver is of a cylindrical form and has dimensions of approximately 60 mm in length with a diameter of 11 mm. The receiver includes an electronic amplifier within the sensor.

The sensor is an oscillator which is stopped when a metallic body passes in front of the active extremity of the receiver. The power supply required by this receiver is 24 V d.c. The output current can attain 40 mA from a receiver having a resistance of 600 Ω, with a response time of 150 µs. A digital chronometer is started and stopped by the metallic body passing close by.

The accuracy of this sytem is better than 1 %. Durability is also very good due to the fact that there is no direct contact.

This procedure can only be utilized if the vehicle is perfectly guided, the maximum detection distance being 5 mm.

A.3.3 Equipment utilizing electromagnetic beam barriers

Two centimetric transmitters and two receivers are located on each side of the test track at an interval of at least 1 m. Passage of the vehicle interrupts the beams.

Interruption of the first beam actuates the circuit of the chronometer; interruption of the second stops the circuit. The major drawback of this system is its high cost.

Assuming that the axes of the beams from the two transmitters are perfectly parallel, the principal source of error comes from measurement of the spacing of the receivers.

It is considered that this system provides an accuracy better than 1 %.

A.3.4 Cinematographic procedure

The impact velocity can also be measured by use of high-speed cinematography, of the order of 500 to 2 000 images per second.

A clearly visible target is placed on the vehicle and its displacement in relation to a ground target is measured on a certain number of film images. The time is derived on the basis of the camera time based on an impression on the margin of the film of a small flash every 0,01 s or 0,001 s, contingent on the film speed chosen. To obtain the time measurement, another method can be utilized by filming a disc operated by a small synchronous motor.

The accuracy of this procedure depends on :

a) the grain of the film, which can cause blurring of the image;

b) the time base of the camera.

Analysis of the films must be effected with equipment permitting positioning of the film within ± 15 µm, a resolution of 1/20 mm in X and Y and 22′ of angle in θ.

In order to minimize parallax errors, the cameras must be positioned as far away as possible and be equipped with long focal length lenses compatible with the field to be filmed.

To obtain accuracies of 1 %, very detailed attention to equipment and technique is required.

A.3.5 System of plates actuated by the vehicle wheels

A.3.5.1 *Metallic plates*

Two flexible metallic plates, separated from each other and arranged across the test track, are put in contact by the pressure of the front wheels of the vehicle. Coupled with a direct current generator, this contact actuates a digital chronometer. The passage of the rear wheels re-closes the contact and stops the chronometer. Knowing the time required to cover a given distance, i.e. the wheelbase of the vehicle, it is simple to derive the velocity. This procedure is not very precise owing to the disparity of the pressures engendered by the front wheels and the rear wheels. This drawback leads to the use of a variation of this procedure which consists in placing two identical sets of plates across the track. The actuation and stopping of the chronometer are then caused by the front wheels alone.

If the contact is subjected to repeated actuation and wear is not apparent, it is possible that after several tests the velocity measurement would be affected by erratic release.

A.3.5.2 *Pneumatic plates*

In this version, the receiver consists of a rubber tube closed at one end. Passage of the vehicle over the tube produces a pressure variation, which actuates an electrical contact formed from a movable element and a stationary element.

Time measurement is achieved in the same manner as with the metallic plates equipment.

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