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Two-wheeled motorcycles — Antilock braking systems (ABS) — Tests and measurement methods

Motocycles à deux roues — Dispositifs antiblocage (ABS) — Essais et méthodes de mesure

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 12364 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 22, *Motorcycles*.

Annex A of this International Standard is for information only.

Two-wheeled motorcycles — Antilock braking systems (ABS) — Tests and measurement methods

1 Scope

This International Standard specifies tests and measurement methods for solo motorcycles (defined in ISO 3833) equipped with one or more antilock, and one or more independent, braking systems. Its purpose is to establish uniform worldwide test procedures for such systems.

This International Standard sets out procedures for the following types of straight-line braking tests:

— utilization-of-adhesion test;

— wheel-lock check test;

— tests with ABS failed;

— complementary tests that could assist in the assessment and development of braking systems.

NOTE Reference is made in this International Standard to L-category vehicles, generally referring to solo motorcycles (L3), drawn from Regulation No. 78 and the Consolidated Resolution on the Construction of Vehicles (R.E.3) of the United Nations Economic Commission for Europe (UN-ECE). The values given in this International Standard enclosed by square brackets are from the same regulation (02 series of amendments), and are included for information.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 3779, *Road vehicles — Vehicle identification number (VIN) — Content and structure*

ISO 6726, *Mopeds and motorcycles with two wheels — Masses — Vocabulary*

ISO 7117, *Motorcycles — Measurement of maximum speed*

ISO 8710:1995, *Motorcycles — Brakes and braking devices — Tests and measurement methods*

3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply.

3.1
category L3
two-wheeled vehicle with engine capacity exceeding 50 cm^3 or design speed exceeding 50 km/h

3.2
antilock system
component of service braking system which automatically controls the slip ratio, in the direction of wheel rotation, on one or both of the motorcycle's wheels during braking

3.3
sensor
component designed to identify and transmit to the controller the conditions of rotation of the wheels or other dynamic conditions of the motorcycle

3.4
controller
component designed to evaluate and operate on data transmitted by a sensor and transmit signals to the modulator

3.5
modulator
component designed to vary braking force in accordance with the signal received from the controller

3.6
outrigger
equipment intended to limit the motorcycle roll angle to a pre-set value

3.7
wheel lock
condition that occurs when there is a slip ratio of 1,00

NOTE In practice wheel lock is judged to have occurred when motorcycle speed exceeds 15 km/h while wheel speed falls below 5 km/h.

3.8
braking system
combination of parts (excluding engine) consisting of control, transmission(s) and brake(s) which progressively reduce or otherwise control the speed of a moving motorcycle, halt it, and keep it stationary if already stopped

3.9
control
part operated directly by the rider to supply to the transmission the energy required for braking or controlling the motorcycle

3.10
transmission
combination of components providing the functional link between the control and the brake

3.11
brake
part of the braking system in which the forces opposing the movement of the motorcycle are developed

3.12
independent braking system
system acting on only one wheel

3.13
laden motorcycle
motorcycle laden so that it reaches its “manufacturer’s maximum total mass”, as defined by ISO 6726, including the mass of the rider and test equipment, with the mass distribution on the axles as stated by the motorcycle manufacturer

NOTE See 5.2 and 5.3 for a description of the mass of the rider and of the test equipment.

3.14
unladen motorcycle
motorcycle in the condition “vehicle kerb mass”, as defined by ISO 6726, with the mass of rider and test equipment added

NOTE See 5.2 and 5.3 for a description of the mass of the rider and of the test equipment.

3.15
maximum speed
v_{max}
speed the motorcycle can attain when tested in accordance with ISO 7117

3.16
test speed
motorcycle speed measured at the moment the rider begins to actuate braking system control or controls

4 Test site conditions

4.1 Test surfaces

Tests on the following two surfaces are specified in this International Standard:

— one with a coefficient of adhesion not exceeding [0,45];

— one with a coefficient of adhesion of not less than [0,80].

The test surface shall be substantially level (i.e. it shall not contain a gradient exceeding 1 %) and shall be free of extraneous materials.

For wetted surfaces, inconsistent results can occur due to aquaplaning or varying brake performance. Therefore, water depth should not exceed 3 mm.

NOTE It is recognized that certain surface parameters are not well defined and that sound engineering judgement is needed to ensure the proper surface.

4.2 Wind speed

The average wind speed shall not exceed 5 m/s.

4.3 Ambient temperature

The ambient temperature shall be recorded in the test report (see annex A).

4.4 Test lane

The test area immediately after the point at which the test is to commence shall be marked with a lane of sufficient length and width for the motorcycle to be brought to a stop.

In the interests of safety, a wide, flat area should surround the test lane.

5 Motorcycle preparation

5.1 Tyres

The tyres shall be inflated to the motorcycle manufacturer's recommended pressure levels.

5.2 Rider and masses carried

5.2.1 The minimum mass of the rider and any test equipment carried on the motorcycle shall be 85 kg; these masses, as well as the mass distribution on the axles, shall be noted in the test report.

5.2.2 The total mass of the test equipment and instrumentation on the motorcycle should not exceed 10 % of the unladen motorcycle. In any case, the total mass and the location of the test equipment shall be noted in the test report.

5.3 Test equipment

The motorcycle shall be prepared for the tests specified in Table 1 by the provision and/or calibration of existing instruments, as required.

Extra equipment may be added to provide data and improve rider safety, but care shall be taken to ensure that this does not significantly affect the braking system performance or the dynamic characteristics of the motorcycle.

Table 1 — Test equipment

Test	Equipment function		Example of equipment
	Required	Optional	
Utilization of adhesion	To measure time history of motorcycle speed	—	Recording speedometer, third wheel [a]
	To measure control force	—	Control force transducer. Brake fluid pressure [a]
	To measure time history of wheel speeds for each braked wheel	—	Pulse, DC generators [a]
	To measure motorcycle mass	—	Load cells
	—	To provide constant control force	Brake fluid pressure cut-off valve or pneumatic actuator
	—	To prevent motorcycle fall down	Outrigger
	—	To measure brake temperature	Rubbing thermocouple, infrared sensor
Wheel-lock check (Additional to above)	To mark test surface change point	—	Photo electronic marking pulse [a]
	To check for antilock system full cycling	—	Brake fluid pressure transducer [a]
	—	To check motorcycle behaviour	Rate sensors for yaw and/or roll velocity, roll angle sensor, steer angle and/or torque sensors [a]

[a] These items should be used with a multi-channel recorder, which shall have a bandwidth at least equal to the ABS cycling frequency and a storage capacity at least equal to maximum stop length.

5.4 Preparation for the determination of the coefficient of adhesion

The function of the antilock system of the test motorcycle shall be disabled during the carrying out of the test specified in 7.2.

5.5 Preconditioning

When submitting a motorcycle for testing, the presenter shall state those preconditioning measures (e.g. bedding) taken in respect of any braking-system component.

6 Test requirements

6.1 Brakes

Brakes and braking systems shall not be manually adjusted at any time during the test.

6.2 Brake temperature

In the interests of repeatability, the temperature measured on each tested disc or drum exterior should not exceed 100 °C before each stop.

6.3 Antilock systems

Antilock systems shall not be manually adjusted at any time during the determination of the adhesion utilization or the wheel-lock check test procedure, except for the antilock system disabling specified in 5.4.

6.4 Application of control forces

Control forces shall be rapidly applied by the rider up to the prescribed level and then maintained constant during the stop. In the interests of repeatability, it is recommended that “rapidly applied” be given to mean within a time of 0,2 s to 0,5 s to reach the prescribed, or full, force. This is the maximum force prescribed in ISO 8710:1995, 8.3, for vehicle category L3: [200 N] for hand controls, [350 N] for foot controls. A higher force may be used if required to activate the antilock system.

The control forces may be measured at the control or as fluid pressure at the outlet of the master cylinder.

6.5 Test sequence

The motorcycle may be submitted to either an individual test or a series of tests.

6.6 Rider

During every test, the rider shall be seated on the saddle as for normal riding and shall maintain this position throughout the test run.

6.7 Performance

The performance of an antilock system shall be established by means of the tests set out in clauses 7, 8, 9 and 10 and by the calculation methods for the adhesion utilization described in those clauses.

6.8 Test speed tolerance

The specified test speeds are subject to a tolerance of ± 5 km/h.

6.9 Test conditions

6.9.1 For each test, the test lane shall be approached at a speed permitting the rider to apply the control at the specified test speed and at the point at which the test is to commence.

6.9.2 For the approach, a gear suitable for the test speed shall be used.

6.9.2.1 For motorcycles with a manual gearbox or an automatic transmission allowing the gearbox to be disengaged manually, the rider shall disengage the drive and enter the centre of the test lane immediately before passing the point at which the test is to commence. The rider shall then keep the drive disengaged for the remainder of the test.

6.9.2.2 For motorcycles with a fully automatic transmission, the rider shall fully close the throttle and enter the centre of the lane immediately before passing the point at which the test is to commence. The remainder of the test shall then be carried out under the normal operating conditions of the automatic transmission, with throttle closed.

6.9.3 After the motorcycle has passed the point at which the test is to commence, the rider shall actuate the control.

6.10 Test report

The following information shall be recorded in the test report (see annex A):

a) test condition details (speeds, control forces, ambient conditions, motorcycle and antilock system identifications, motorcycle loading conditions, tyre information, etc.);

b) the result of each test (e.g. coefficient of adhesion, adhesion utilization);

c) the sequence in which the tests were performed, where applicable;

d) any deviation of the motorcycle from its course, abnormal behaviour, vibration, noise, etc.;

e) any deviation from the specified test conditions with an appropriate explanation.

7 Utilization-of-adhesion test procedure

7.1 General

7.1.1 The adhesion utilization, ε, shall be calculated in accordance with 7.3.3.

7.1.2 The adhesion utilization, ε, shall be measured on the road surfaces specified in 4.1.

7.1.3 The test shall be carried out with the motorcycle [unladen].

7.1.4 The determination of the coefficient of adhesion, k, is specified in 7.2.

7.1.5 These tests could be influenced by the addition of the test equipment. If this is the case, the complementary test given in 10.5 may be carried out; however, the results might not be comparable.

7.2 Determination of coefficient of adhesion (k)

7.2.1 The coefficient of adhesion, k, shall be determined from the maximum braking rate, without wheel lock, of the motorcycle with antilock systems(s) disabled and braking both wheels simultaneously.

7.2.2 Braking tests should be carried out by applying the brakes at a test speed of 60 km/h (or, in the case of motorcycles unable to attain 60 km/h, at a speed of 0,9 v_{max}) with the motorcycle unladen. Constant brake control forces shall be used throughout the tests.

7.2.3 To determine the maximum braking rate of the motorcycle, a series of tests may be carried out up to the critical point reached immediately before the wheel or wheels lock, or the rear wheel comes off the road surface, by varying both the front and rear braking forces. As an initial step to facilitate such preliminary tests, the maximum control force applied before the critical point may be obtained for each individual wheel.

7.2.4 The braking rate, z, shall be determined by reference to the time taken for the speed of the motorcycle to be reduced from 40 km/h to 20 km/h, using the formula:

$$z = \frac{0{,}56}{t}$$

where t is measured in seconds.

Alternatively, for a motorcycle unable to attain 50 km/h, the braking rate shall be determined by reference to the time taken for the speed of the motorcycle to be reduced from 0,8 v_{max} to (0,8 v_{max} – 20), where v_{max} is expressed in kilometres per hour.

The maximum value of z is equal to k.

7.3 Determination of adhesion utilization (ε)

7.3.1 The adhesion utilization, ε, is defined as the quotient of the maximum braking rate with the antilock system in operation (z_{max}) and the maximum braking rate with the antilock system disabled (z_m). Separate tests shall be carried out on each wheel equipped with an antilock system.

7.3.2 z_{max} shall be based on the average of three tests using the time taken for the speed of the motorcycle to achieve the reductions in speed given in 7.2.4. In the interests of repeatability, five tests should be performed, the maximum and minimum results from these discounted, and the average of the remaining three used.

7.3.3 Adhesion utilization is given by the formula:

$$\varepsilon = \frac{z_{max}}{z_m}$$

8 Wheel-lock check test procedure (motorcycle unladen)

8.1 Check whether or not a wheel controlled by an antilock system locks when the full force is rapidly applied to its control, on at least the two types of road surface specified in 4.1. The test speeds shall be up to 0,8 v_{max}. However, on low-adhesion surfaces ($\leqslant$ 0,35), the test speed may be reduced for safety reasons.

8.2 Check whether or not a wheel controlled by an antilock system locks when it passes from a high- to a low-adhesion surface as specified in 4.1, with the full force applied to the control.

The motorcycle speed and the instant of applying the brakes shall be calculated such that, with the antilock system fully cycling on the high-adhesion surface, the passage from one surface to the other is made at 0,5 v_{max}, but at a speed not exceeding 50 km/h.

8.3 Check whether or not the deceleration of the motorcycle, when passing from a low- to a high-adhesion surface, as specified in 4.1 and with the full force applied to the control, rises to the appropriate high value within a reasonable period of time.

The motorcycle speed and the instant of applying the brakes shall be calculated such that, with the antilock system fully cycling on the low-adhesion surface, the passage from one surface to the other is made at 0,5 v_{max}, but at a speed not exceeding 50 km/h.

8.4 In those cases where both independent braking systems are equipped with an antilock system, the tests described in 8.1, 8.2 and 8.3 may be performed using both systems together.

8.5 The motorcycle speed or speeds at or below which wheel lock occurs, either momentarily or for the remainder of the stop, shall be recorded.

8.6 During the tests given in 8.1 to 8.4, motorcycle stability shall be assessed. Observations shall be noted in the test report (see annex A).

9 Tests with ABS failed (electronically controlled systems)

9.1 For these tests, a failure condition is simulated by disconnecting the electrical power supply to the antilock system or external supply to the controller, or both.

9.2 Check that the warning light is visible in daylight and that it is easy for the rider to check that it is in working order.

9.3 Confirm the braking performance when an antilock system fails, based on the test methods specified in clause 8 of ISO 8710:1995.

10 Complementary tests

10.1 General

The following tests may be carried out in addition to the required tests or for the test given in 10.5 in place of the utilization-of-adhesion test specified in clause 7.

10.2 Determination of adhesion utilization when braking both wheels together

Repeat the tests described in 7.3 but with all brake controls applied together and simultaneously. The value of z_m may be taken from the results obtained from 7.2.4.

10.3 Fully laden tests

Repeat the tests described in clauses 7, 8, 9 and 10 with the motorcycle fully laden.

10.4 In-gear tests

Repeat the tests described in clauses 7, 8, 9 and 10 with the engine connected. The selected gear shall be noted in the test report.

10.5 Utilization-of-adhesion test with the motorcycle in a (more) realistic operating condition

10.5.1 General

During the tests specified in clause 7, the kinematics and behaviour of the motorcycle could be affected by the addition of test equipment. The following subclauses outline an alternative procedure for measuring k and ε, where the motorcycle is in as close to its normal operating condition as possible. It must be understood that the results from this test, given in 10.5.2 and 10.5.3, cannot be compared with those obtained from that of 7.2 and 7.3, due to

the different motorcycle condition and because the maximum braking rates z and z_m are obtained with the ABS in a different mode.

10.5.2 Determination of coefficient of adhesion (k)

Follow the procedure given in 7.2; however, for these tests, the antilock system or systems are not disabled. The coefficient of adhesion shall be determined from the maximum braking rate, without activation of the antilock system, and braking both wheels simultaneously.

10.5.3 Determination of adhesion utilization (ε)

Follow the procedure given in 7.3; however, for the measurement of z_m, the antilock system or systems are not disabled. The adhesion utilized is defined as the quotient of the maximum braking rate with the antilock system in operation (z_{max}) and the maximum braking rate without activation (z_m).

Annex A
(informative)

Specimen format for test result sheet

Report No.:.....

Test motorcycle

Manufacturer:.....

Model:..... Year:.....

Category:..... VIN (see ISO 3779):.....

Submitted by:.....

Engine type:..... Capacity:.....cm^3

Power rating:.....

Number of gears and selection means:.....

Maximum speed (ISO 7117):.....

ABS details

Modulator maker: ..... Serial No., etc.:.....

Controller maker: ..... Serial No., etc.:.....

System layout: .....

Special features: .....

Brake details

	Front	Rear
Brake type		
Transmission type		
Brake size		
Friction material (make/type)		
Disc/drum material		
Disc/drum treatment (holes, slots, plating, etc.)		

Brake system layout:.....

Special features: .....

Preconditioning: .....

Tyre details

	Front	Rear
Manufacturer		
Size		
Rating		
Type		
Pressure laden		
Pressure unladen		
Tread depth		

Test masses

Test rider:..... kg

Test equipment:..... kg

Test rider plus equipment as percentage of unladen motorcycle: .....%

Unladen

Total:..... kg Front:..... kg Rear: ..... kg

Laden

Total:..... kg Front:..... kg Rear: ..... kg

Test equipment

Test equipment and instrument fitted:.....

Location of test equipment and instrumentation:.....

Odometer reading (where fitted) Start: ..... Finish: ..... Total:.....

Test conditions

Date(s) of test: .....

Rider's name: ..... Observer's name:.....

Test site: .....

Ambient temperature: ..... °C

Wind speed:..... m/s

Other weather conditions:.....

High adhesive road surface type and condition: .....

Low adhesive road surface type and condition: .....

Other road surfaces:.....

Name of test organization:.....

Date of report:.....

Utilization-of-adhesion test results

Procedure used (refer to clauses 7 and 10 of ISO 12364:2001):.....

Coefficient of adhesion (k)

Test No: .....

Test date: .....

Odometer reading at start: .....

Road surface:.....

Motorcycle condition

Cut off valve used (yes/no): .....

Loading: .....

Gear selected (or automatic transmission):.....

Other conditions:.....

Stop No.	Control force N	Test speed km/h	Time [a] t s	Braking rate z	Remarks
					Max. braking rate with ABS disabled and braking both wheels

[a] Taken to reduce speed from 40 km/h to 20 km/h. For a motorcycle unable to attain 50 km/h, t is the time taken for its speed to be reduced from 0,8 v_{max} to (0,8 v_{max} – 20).

k (maximum value of z) = ...

Adhesion utilization (ε)

Test No: .....

Test date: .....

Odometer reading at start: .....

Road surface:.....

Motorcycle condition

Braked wheel (front/rear): .....

Cut off valve used (yes/no): .....

Loading: .....