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Motorcycles — Test and analysis procedures for research evaluation of rider crash protective devices fitted to motorcycles —

Part 6:
Full-scale impact-test procedures

Motocycles — Méthodes d'essai et d'analyse de l'évaluation par la recherche des dispositifs, montés sur les motocycles, visant à la protection des motocyclistes contre les collisions —

Partie 6: Méthodes d'essai de choc en vraie grandeur

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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.

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.

This part of ISO 13232 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 22, *Motorcycles*.

At the request of the United Nations Economic Commission for Europe, Group for Road Vehicle General Safety (UN/ECE/TRANS/SCI/WP29/GRSG), this International Standard has been prepared by ISO/TC 22/SC 22, *Motorcycles*, as eight interrelated parts, on the basis of original working documents submitted by the International Motorcycle Manufacturers Association (IMMA).

This is the first version of the standard.

ISO 13232 consists of the following parts, under the general title *Motorcycles — Test and analysis procedures for research evaluation of rider crash protective devices fitted to motorcycles*:

— *Part 1: Definitions, symbols and general considerations*

— *Part 2: Definition of impact conditions in relation to accident data*

— *Part 3: Anthropometric impact dummy*

— *Part 4: Variables to be measured, instrumentation and measurement procedures*

— *Part 5: Injury indices and risk/benefit analysis*

— *Part 6: Full-scale impact-test procedures*

— *Part 7: Standardized procedures for performing computer simulations of motorcycle impact tests*

— *Part 8: Documentation and reports*

Annexes A, B, C and D form an integral part of this part of ISO 13232. Annex E is for information only.

Introduction

This International Standard has been prepared on the basis of existing technology. Its purpose is to define common research methods and a means for making an overall evaluation of the effect that devices which are fitted to motor cycles and intended for the crash protection of riders, have on injuries, when assessed over a range of impact conditions based on accident data.

It is intended that the methods and recommendations contained in this International Standard should be used in all basic feasibility research. However, researchers should also consider variations in the specified conditions (for example, rider size) when evaluating the overall feasibility of any protective device. In addition, researchers may wish to vary or extend elements of the methodology in order to research issues which are of particular interest to them. In all such cases which go beyond the basic research, if reference is to be made to this International Standard, a clear explanation of how the procedures used differ from the basic methodology should be provided.

In order to apply this International Standard properly, it is strongly recommended that all eight parts be used together, particularly if the results are to be published.

To the extent, if any, that any products identified in this International Standard may be subject to patent rights, and to the extent, if any, that licenses may be available relative to such patents, potential manufacturers of such products are advised that individual patent inquiries should be made and alternative products considered. A record of patent holders' statements, if any, regarding their willingness to negotiate licenses under patent and like rights with applicants throughout the world under reasonable terms and conditions is on file with the ISO Central Secretariat.

Motorcycles — Test and analysis procedures for research evaluation of rider crash protective devices fitted to motorcycles —

Part 6:
Full-scale impact-test procedures

1 Scope

This International Standard specifies the minimum requirements for research into the feasibility of protective devices fitted to motor cycles, which are intended to protect the rider in the event of a collision.

This International Standard is applicable to impact tests involving

- two wheeled motor cycles;
- the specified type of opposing vehicle;
- either a stationary and a moving vehicle or two moving vehicles;

- for any moving vehicle, a steady speed and straight line motion immediately prior to impact;
- one helmeted dummy in a normal seating position on an upright motor cycle;
- the measurement of the potential for specified types of injury by body region;
- evaluation of the results of paired impact tests (i.e., comparisons between motor cycles fitted and not fitted with the proposed devices).

This part of ISO 13232 specifies minimum requirements for

- paired comparison tests;
- the preparation of the dummy, motor cycle, and opposing vehicle;
- the repeatability and reproducibility of impact test conditions within and between test sites;
- the minimization of variation in secondary test variables;
- realistic and representative impact conditions for full-scale impact tests;
- a means to verify analytical evaluations of proposed rider crash protective devices fitted to motor cycles, such as computer simulation.

This International Standard does not apply to testing for regulatory or legislative purposes.

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 part of ISO 13232 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 13232-1: 1996, Motor cycles - Test and analysis procedures for research evaluation of rider crash protective devices fitted to motor cycles - Part 1 - Definitions, symbols and general considerations.

ISO 13232-2: 1996, Motor cycles - Test and analysis procedures for research evaluation of rider crash protective devices fitted to motor cycles - Part 2 - Definition of impact conditions in relation to accident data.

ISO 13232-3: 1996, Motor cycles - Test and analysis procedures for research evaluation of rider crash protective devices fitted to motor cycles - Part 3 - Anthropometric impact dummy.

ISO 13232-4: 1996, Motor cycles - Test and analysis procedures for research evaluation of rider crash protective devices fitted to motor cycles - Part 4 - Variables to be measured, instrumentation and measurement procedures.

ISO 13232-7: 1996, Motor cycles - Test and analysis procedures for research evaluation of rider crash protective devices fitted to motor cycles - Part 7 - Standard procedures for performing computer simulations of motor cycle impact tests.

ISO 13232-8: 1996, Motor cycles - Test and analysis procedures for research evaluation of rider crash protective devices fitted to motor cycles - Part 8 - Documentation and reports.

49 CFR Part 572, subpart E: 1993: Anthropomorphic test dummies, United States of America Code of Federal Regulations issued by the National Highway Traffic Safety Administration (NHTSA). Washington, D.C.

SAE Engineering aid 23: 1986: User's manual for the 50th percentile Hybrid III test dummy. Disassembly and assembly, p. 5-20. Warrendale, Pennsylvania, USA.

E/ECE/TRANS/505 Rev. 1/Add. 21/Reg. 22/Rev. 3: 1992: Uniform provisions concerning the approval of protective helmets and of their visors for drivers and passengers of motor cycles and mopeds, Genève, Switzerland.

3 Definitions

For the purposes of this part of ISO 13232, the definitions given in ISO 13232-1 apply, of which the following are of particular relevance to this part of ISO 13232.

- baseline MC;
- dummy K index;
- dummy preparation areas;
- dummy S index;
- group of tests;
- head hook;
- hexagonal key tool;
- knee centre line index;
- lower arm clamping fixture;
- modified MC;
- motor cycle K point;

- motor cycle S point;
- multiple paired comparison;
- overall length of the MC;
- pivot;
- rotate;
- secondary test variables;
- single paired comparison;
- structural element of the MC;
- upper torso reference line;
- weight hanger.

4 Requirements

4.1 Opposing vehicle

The opposing vehicle (OV) shall be a production Toyota Corolla 4-door saloon, Japan domestic model, model year 1988 to 1990[1], inclusive; or, if not the Japan domestic model, a model of the Toyota Corolla 4-door saloon which is or is made to be structurally equivalent to the Japan domestic model, with full explanation given in the test report. It shall be in sound, unmodified mechanical condition, except for modifications as may be required, above. The OV allowable test mass shall be 1 100 kg ± 20 kg.

NOTE - The specified vehicle is to be used as a standard OV until a replacement is needed.

The OV shall be set up following the procedures described in 5.2.1.

4.2 Motor cycle

The motor cycle (MC) shall be set up following the procedures described in 5.2.2.

4.3 Dummy and instrumentation

4.3.1 Motor cyclist anthropometric impact dummy

The motor cyclist impact dummy used shall meet all of the requirements described in ISO 13232-3.

Prior to use in impact testing the dummy head, neck, thorax, and knees shall be tested to conform to the calibration requirements and procedures as described in paragraphs 572.32, 572.33, 572.34, and 572.35 of U.S. 49 CFR Part 572, using the test conditions and instrumentation described in paragraphs 572.36 of U.S. 49 CFR Part 572. The number of full-scale tests between calibrations shall not exceed ten. The number of full-scale tests since the last calibration shall be documented according to ISO 13232-8.

All frangible components shall be new and not previously used either in full-scale or component testing.

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1) The Toyota Corolla 4-door Sedan is a product supplied by Toyota Motor Company, Ltd., Tokyo, Japan. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of the product named.

4.3.2 Instrumentation

The dummy shall be equipped with the instrumentation described in ISO 13232-4.

4.3.3 Sensor, data acquisition, and post processing systems verification

Prior to each impact test, the operation of the head sensors and data acquisition and post processing systems shall be verified by applying an impact to the unhelmeted head of the dummy, as described in 5.3.1. The resulting time histories shall be included in the documentation of test results. Between the time of such verification test and the full-scale impact test, none of the sensors, data acquisition or post processing hardware, or gains, scale factors or ranges shall be changed in any way.

4.3.4 Joint tensions

The dummy joint tensions shall be adjusted, as described in 5.3.2, according to the procedures described in annex A.

4.3.5 Clothing

The dummy shall be fitted with long sleeved close fitting thermal knit underwear. The underwear shall have holes cut in it to accomodate the lower arm pre-mount positioning procedure, described in table B.1, and the upper torso angle measurement procedure, if performed as described in C.2.4.2. The dummy feet shall be fitted with leather racing type boots which shall have the following dimensions:

2,0 cm ± 0,5 cm heel height;

1,0 kg ± 0,3 kg mass per boot.

The same boot make, model, and size shall be used for all tests within a paired comparison, as described in 4.5.4.4.

4.3.6 Position on motor cycle

The dummy shall be positioned on the motor cycle, as described in 5.3.4 and 5.3.5.

4.3.7 Helmet

The dummy shall be fitted with a Bieffe model B10[1] helmet according to the procedures described in annex D. The helmet shall be new (i.e., the helmet shall not be used for more than one test) and shall meet the following specifications:

- size designation: Either small (56 cm) or medium (58 cm);
- certified to ECE Reg 22-03 on a 57 cm headform.

The same helmet make, model, and specifications shall be used for all tests within a paired comparison, as described in 4.5.4.4.

4.4 Photographic equipment

High speed cameras having the specifications given in ISO 13232-4 shall be used.

Photographic targets shall be placed on the MC, OV, and ground at the locations described in 4.3 of ISO 13232-4, and on the dummy at the locations described in 5.3.6 of this part of ISO 13232.

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1) Bieffe, model B10 is a product supplied by Bieffe Helmets S.r.l., Lucca, Italy. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of the product named.

4.5 Impact conditions

In order to do an overall evaluation of the feasibility of a given protective device according to this International Standard, paired comparison tests using at least the seven full-scale impact configurations defined in 4.3.1 of ISO 13232-2 shall be done. The protective device shall also be evaluated in the remaining 193 impact configurations defined in table B.1 of ISO 13232-2, and this evaluation should be done by computer simulation according to ISO 13232-7.

The impact condition shall be selected as described in 5.1.

The impact test shall be performed such that it meets the following requirements.

4.5.1 Pre-test measurement

The static measurements which are required to determine impact conditions shall be performed as defined in 5.6 of this part of ISO 13232.

4.5.2 Post-test measurement

Measurements of impact conditions at the time immediately preceding first MC/OV contact shall be performed as described in 5.3 of ISO 13232-4. The measurements shall be used to determine accuracy of impact conditions, as described in 4.5.4 of this part of ISO 13232.

When comparing the pre-test set up photograph with the film frame immediately preceding first MC/OV contact, the positions of the dummy helmet centroid point and of the dummy joint locations, with respect to the motor cycle, shall agree to within ± 2 cm.

4.5.3 Vehicle speed control

The MC and OV shall be free wheeling at the time of impact, and thereafter, except

- if the OV impact speed is zero, then the OV parking brake, adjusted to the manufacturer's specification, shall be fully applied during the entire impact test;

- if the OV impact speed is non-zero, then between 0,5 s and 1,0 s after impact, the OV shall be decelerated to a stop with braking equivalent to a brake pedal force of at least 400 N.

4.5.4 Paired comparisons

4.5.4.1 Required relative tolerances

The difference between two tests in a single paired comparison or among all members of a group of tests in a multiple paired comparison shall not be greater than the following values:

- relative heading angle: 3°;

- OV impact speed: 5% of the target speed;

- MC impact speed: 5% of the target speed;

- MC roll angle: 5°;

- OV contact point: see table 1 for the seven required impact configurations described in ISO 13232-2.

Table 1 - OV contact point relative tolerances for the seven required impact configurations described in ISO 13232-2

OV contact location	Relative heading angle deg	OV/MC speeds m/s	OV contact point relative tolerance cm
Front	90	9,8/0	5
Front	135	6,7/13,4	10
Front corner	180	0/13,4	3
Side	90	0/13,4	5
Side	135	6,7/13,4	15
Side	90	6,7/13,4	15
Side	45	6,7/13,4	15

4.5.4.2 Recommended OV contact point relative tolerances for other impact configurations

For the other 193 impact configurations described in ISO 13232-2, the OV contact point relative tolerance should be as described in table 2.

Table 2 - OV contact point tolerances for other impact configurations

OV contact location	Relative heading angle deg	OV contact point relative tolerance cm	
		For zero OV or MC speed	All other speed combinations
Front or rear	all	5	10
Front corner or rear corner	all	3	6
Side front, side middle, or side rear	90	5	15
Side front, side middle, or side rear	45, or 135	5	15

4.5.4.3 Required absolute tolerances

For a given impact condition and for each impact condition variable, the difference between the target condition and each of the tests in a single or multiple paired comparison, shall be less than or equal to the values specified in 4.5.4.1 and 4.5.4.2.

4.5.4.4 Number of tests

For paired comparison impact tests, at least one test with the protective device fitted to the MC and at least one test without the protective device fitted to the MC shall be done.

Multiple runs may be performed provided that the same number of multiple runs are performed and documented for both the baseline MC and the modified MC.

4.5.5 Ambient conditions

The air temperature of the area used for long term storage of the dummy should be between 13° C and 30° C. Beginning at least 3 hours before the planned time of impact, the air temperature in each of the dummy preparation areas shall be measured and documented while the dummy is in each area.

If the temperature measured in each of the dummy preparation areas is between 13° C and 30° C, then no additional temperature soaking procedures shall be used.

If the temperature in any of the dummy preparation areas is outside this range, and the total exposure time to the out of range temperature exceeds the time given by the equation below, where first area is the soak area and the second area is the out of range area, then the dummy shall be soaked following the temperature soaking procedure given in 5.7.

$$t = \tau \ell n [(T_2 - T_1)/(T_2 - T_0)]$$

where

t is the total exposure time required to reach the limit of the temperature range, in hours;

T_1 is the air temperature in the first area, in degrees Celsius;

T_2 is the air temperature in the second area, in degrees Celsius;

T_0 is the critical temperature, in degrees Celsius: 13° C for moving to or from temperatures colder than the required range; 30° C for moving to or from temperatures warmer than the required range;

τ is 2.9, the dummy thorax thermal time constant, in hours.

Any further exposure to out of range temperatures shall be treated as described in 5.7.

The wind velocity at the point and time of impact shall be no greater than 4,2 m/s. The test surface shall be substantially level with a maximum gradient of 2%.

5 Impact test methods

5.1 Impact conditions

From the list of required and other, permissible impact configurations given in 4.3 of ISO 13232-2, select the impact configuration to be tested and specify the impact conditions using the variables described in ISO 13232-2.

5.2 Vehicle set up

5.2.1 Opposing vehicle

Remove the battery cable and fuel. Weigh the vehicle. Weigh the brake actuator system and the portion of the guidance system mounted on the OV. Add this mass to the measured OV mass and compare the total mass to the allowable test mass given in 4.1. Add or remove ballast or components as necessary to attain the allowable test mass. Install the brake actuator and guidance systems in the OV.

Leave the steering wheel and steering system free to steer. Put the transmission in neutral gear. Completely close all doors, windows, the bonnet, and the boot lid.

Measure and adjust the ride height to that which is specified in table 3. Adjust the ride height by adjusting any of the tyre pressures to between 138 kPa and 276 kPa, or by adding spring spacers and/or compressors.

Table 3 - OV ride heights

OV contact location	OV ride height measurement location	Height above ground cm
Front and front corner	Leading edge of the bonnet at the bonnet centre line	68,0 ± 1,0
Side	Top of the rain gutter at the top rear corner of the front door	131,2 ± 1,0
Rear	Bottom of the boot lid at the boot lid centre line	59,8 ± 1,0

5.2.2 Motor cycle

Remove the fuel. If the MC is equipped with a rear wheel adjuster to accommodate a chain or belt, adjust the rear wheel to the most forward position. Remove the chain or belt, if present. Set the tyre pressures to the vehicle manufacturer's recommendations. Set the suspension ride height and damping settings to the vehicle manufacturer's recommendations, or to the mid-range point, in the absence of a recommendation. Weigh the MC. Put the MC in neutral gear.

For impact configurations in which the overall MC length measurement is required (e.g., 143-9,8/0 in ISO 13232-2), place the dummy on the motor cycle in a riding position which approximates that to be used in the full-scale impact tests, with the hands on the hand grips and the feet on the foot rests. Ballast the motor cycle to simulate the mass of any additional equipment related to the conduct of the test. Place a bump, like the one shown in figure 1, approximately 1,5 m in front of the MC, such that the bump is perpendicular to the MC longitudinal centre line. Roll the laden MC a total distance of at least 3 m, perpendicularly across the bump. Place a target on the intended MC contact point and document the MC overall length as specified in clause 6. Remove the dummy from the MC.

For impact configurations in which the MC is moving, install the MC in the guidance system, such that

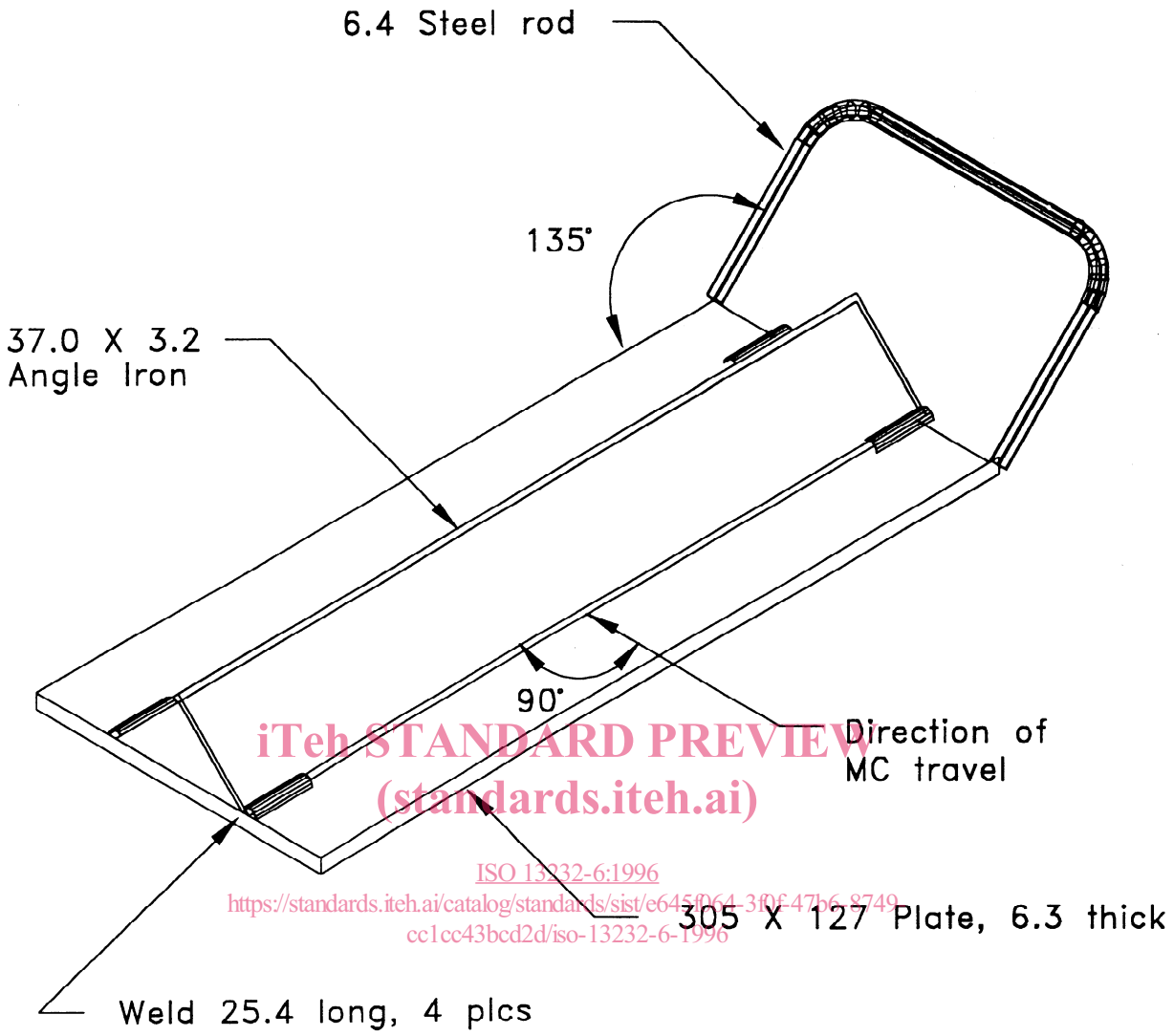
- the steering system is free to steer after release from the guidance system and prior to impact, except for interaction with the dummy's hands;
- the front wheel is pointed in the straight ahead direction;
- the front and rear facing MC upper and lower centre line targets form a vertical line with respect to gravity.

For impact configurations where the MC is stationary, construct two wooden support stands with a nominally square cross section; a maximum length and width of 50 mm; and of suitable height to support the MC in a vertical position. Use metal shims having a maximum outside diameter of 25 mm and a maximum thickness of 2 mm, on top of each support stand to level the MC on the stands.

5.3 Dummy set up

5.3.1 Sensor, data acquisition, and post processing systems verification

Mark the dummy head skin with the impactor target point and line-of-motion centre as indicated in figure 2. Seat the dummy on a rigid, flat, horizontal surface with the thoracic spine box, upper arms, and lower legs in a vertical orientation. Adjust the lower neck adjustment joint so that with the helmet alignment tool (shown in figure D.1) fitted to the front of the head, the helmet alignment tool upper edge is horizontal, ± 2° with respect to gravity. Pitch the dummy torso/head assembly forward about the hip joints by adjusting the lateral separation of the legs, if necessary, so that the helmet alignment tool upper edge is inclined 45° ± 2° from horizontal.



NOTE: All dimensions in mm

Figure 1 - Motor cycle overall length measurement bump