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Motorcycles — Measurement methods for moments of inertia

Motocycles — Méthodes de mesure des moments d'inertie

Reference number
ISO 9129 : 1988 (E)

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. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

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Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

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Motorcycles — Measurement methods for moments of inertia

0 Introduction

The stability of a motorcycle is a very important element of its active safety. The motorcycle/rider combination and the environment in which this combination is used form a unique closed-loop system. However, the evaluation of the motorcycle/rider combination stability is extremely complex because of interaction of the intrinsic motorcycle stability, the influence of the position of the rider and his response to continuously changing conditions.

In the evaluation of motorcycle stability, the determination of the kinetic characteristics of the motorcycle/rider combination is to be considered an important part of the design parameters of the vehicle itself.

The test procedure described in this International Standard deals with one aspect of the kinetic characteristics: the determination of the moments of inertia of the motorcycle and of the motorcycle/rider combination.

1 Scope and field of application

This International Standard specifies a measuring method for determining the moments of inertia of the motorcycle and of the motorcycle/rider combination. It applies to two-wheeled motorcycles.

Other measuring methods can be used if it is demonstrated that the results are equivalent.

The measuring results obtained by the method given in this International Standard alone (see the annex) cannot be used for an evaluation of the vehicle stability because they deal with only one aspect of this very complex phenomenon.

2 References

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

49 CFR Part 572, subpart B [*Code of Federal Regulations*, issued by the National Highway Traffic Safety Administration (NHTSA)].

3 Equipment

3.1 The motorcycle shall be placed on a platform that is as light as possible, while being sufficiently rigid.

3.2 The motorcycle shall be fixed on the platform in such a way that the sprung mass keeps the position obtained under the condition quoted in item 1.11 in the annex, when the motorcycle mounted on the platform is swung about the pivots.

3.3 The rider shall be simulated by an anthropomorphic test dummy [1].

3.4 The dummy shall be fixed on the motorcycle by means of a rigid restraint jig.

4 Definition of axis systems

4.1 The motorcycle axis system (x, y, z) is a right-hand orthogonal axis system fixed in the motorcycle such that when the motorcycle is moving in a straight line on a level road, the x-axis is substantially horizontal, points forwards and is in the longitudinal plane of symmetry. The y-axis points to the rider's left side and the z-axis points upwards.

4.2 The earth-fixed axis system (X, Y, Z) is a right-hand orthogonal axis system fixed on the earth. The X- and Y-axes are in a horizontal plane and the Z-axis points upwards.

5 Position of dummy

5.1 The hands of the dummy shall be on the steering handlebar grips and the feet shall be on the footrests in such a way that the front part of the heel touches the footrest and the foot is at 90° ± 5° to the lower leg.

In the case of a motorcycle with platform, the position of the feet shall be in accordance with the requirements of the manufacturer.

1) Test dummy as specified in 49 CFR Part 572, subpart B or equivalent.

5.2 The projection of the position of the dummy on the x-z plane shall be defined by

— measuring the angle A between the x-axis and the line drawn from the knee pivot to the bottom of the heel;

— measuring the angle B between the x-axis and the line drawn from the shoulder pivot to the H-point.

6 Position of motorcycle

The roll angle of the motorcycle in relation to the platform shall be zero with a tolerance of ± 0,5°.

7 Measuring procedure

7.1 Abbreviations and symbols

The following abbreviations and symbols are used in 7.2, 7.3 and 7.4:

RMP : Rider/Motorcycle/Platform combination;

MP : Motorcycle/Platform combination;

P : Platform;

RM : Rider/Motorcycle combination;

M : Motorcycle;

m : Mass, in kilograms;

T : Period, in seconds;

i : RMP, MP, P, as appropriate;

j : RM, M, as appropriate;

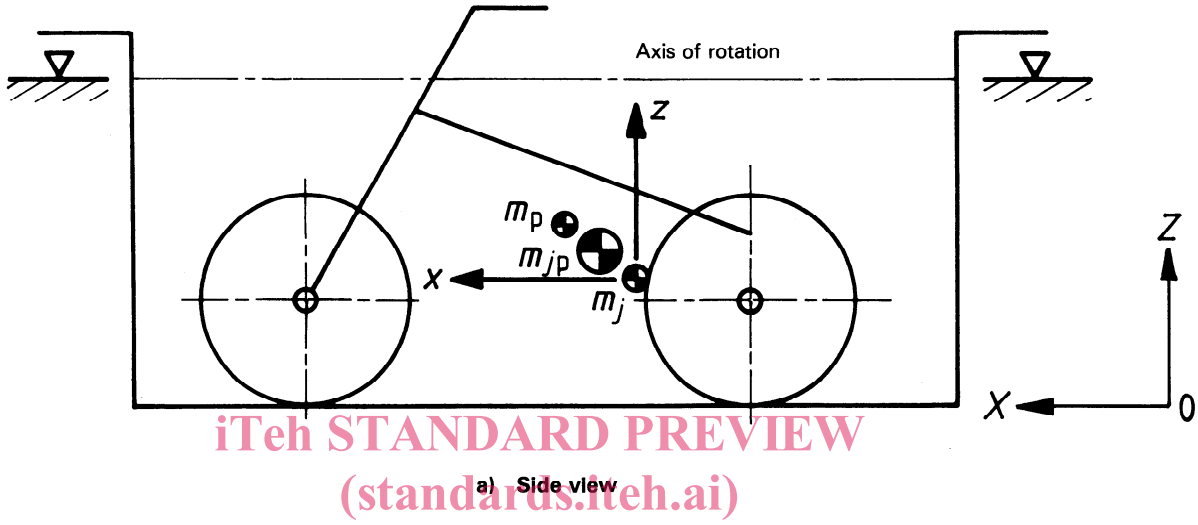
g : acceleration due to gravity, in metres per second squared.

NOTE — Further symbols are explained in the respective figures.

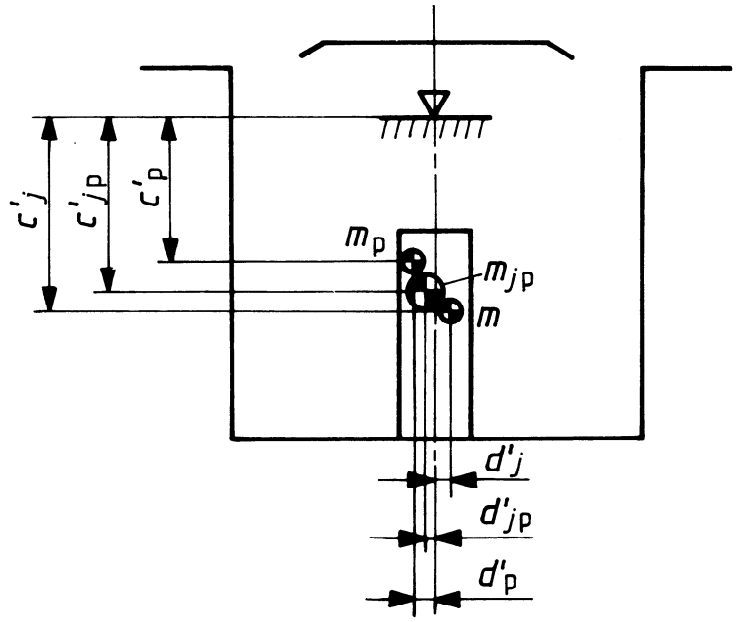
7.2 Roll moment of inertia about x-axis

The roll moment of inertia, I, in kilograms metre squared, about the x-axis may be calculated from the following equation (see figure 1):

$$I_{xxj} = \left(\frac{T_{jP}}{2\pi}\right)^2 \sqrt{c'^2_{jP} + d'^2_{jP}}\ m_{jP}\, g - \left(\frac{T_P}{2\pi}\right)^2 \sqrt{c'^2_P + d'^2_P}\ m_P\, g - m_j\,(c'^2_j + d'^2_j)$$



a) Side view



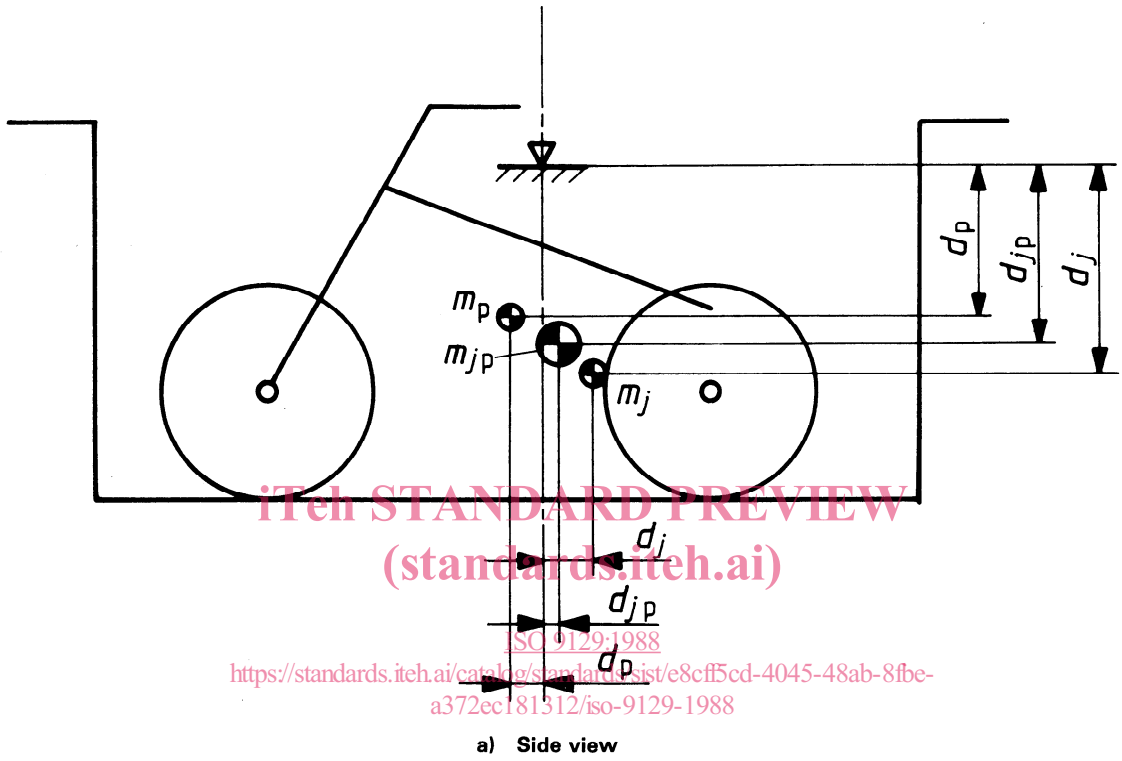
b) Rear view

Figure 1 — Measurement procedure for roll moment of inertia (procedure with physical pendulum principle using platform)

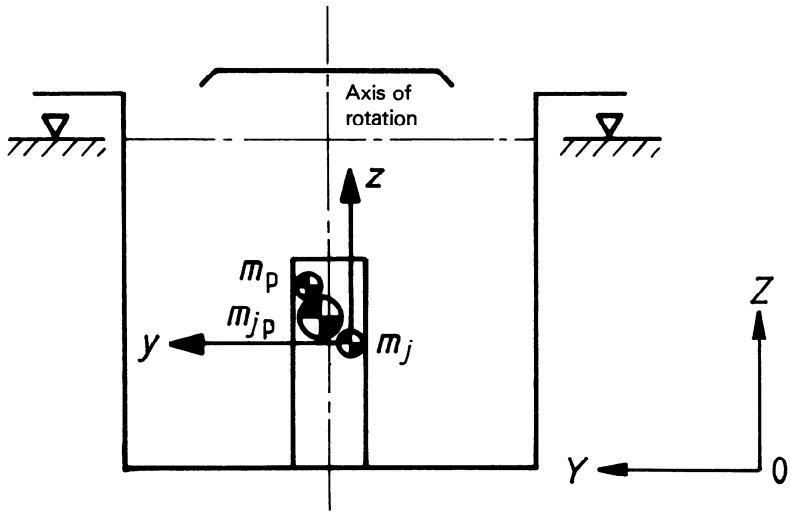
7.3 Pitch moment of inertia about y-axis

The pitch moment of inertia, I, in kilograms metre squared, about the y-axis may be calculated from the following equation (see figure 2):

$$I_{yyj} = \left(\frac{T_{jP}}{2\pi}\right)^2 \sqrt{c_{jP}^2 + d_{jP}^2}\ m_{jP}\, g - \left(\frac{T_P}{2\pi}\right)^2 \sqrt{c_P^2 + d_P^2}\ m_P\, g - m_j\,(c_j^2 + d_j^2)$$



a) Side view



b) Rear view

Figure 2 — Measurement procedure for pitch moment of inertia (procedure with physical pendulum principle using platform)

7.4 Yaw moment of inertia about z-axis

The yaw moment of inertia, I, in kilograms metre squared, about the z-axis may be calculated from the following equation (see figure 3):

$$I_{zzj} = \left(\frac{T_{jP}}{2\pi}\right)^2 \frac{m_{jP}\, g\, a_{jP1}\, a_{jP2}}{l} + m_{jP}\, d'^2_j - \left(\frac{T_P}{2\pi}\right)^2 \frac{m_P\, g\, (a_{jP1} - d'_P)\, (a_{jP2} + d'_P)}{l} - m_P (d'_P + d'_j)^2$$

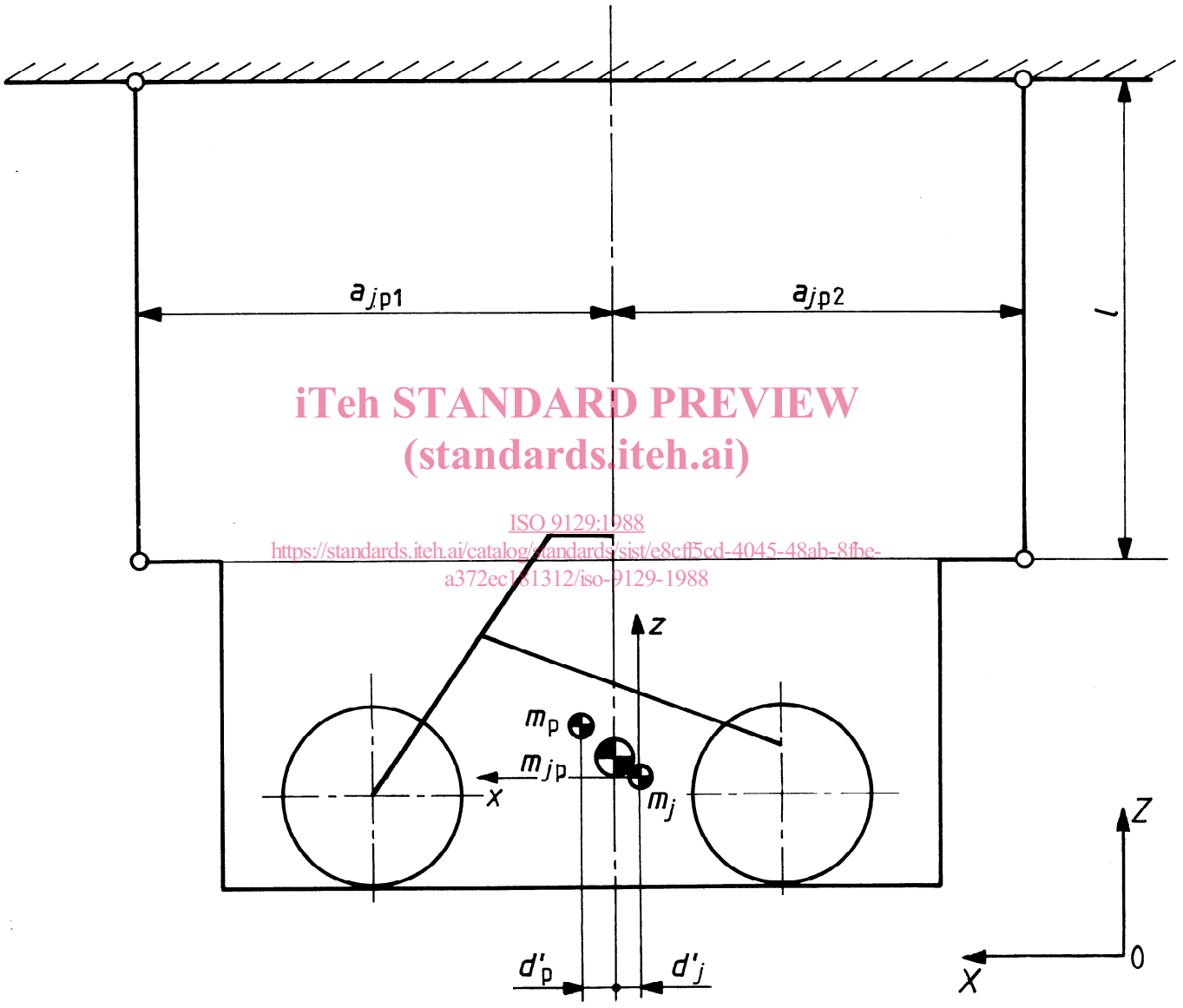


Figure 3 — Measurement procedure for yaw moment of inertia (procedure with bifilar pendulum principle using platform) — Side view

8 Test results

Test results shall be presented as indicated in the annex.

Annex

Format for measurement results

The format shown in this annex shall be used to record the measurement results of moments of inertia for motorcycles, calculated in accordance with this International Standard.

Motorcycle — Moments of inertia — Measurement results to ISO 9129

1 Vehicle identification

1.1 Make, model, type: .....

1.2 Year model: .....

1.3 Vehicle Descriptor Section (VDS) (see ISO 3779): .....

1.4 Tyre size: front: ..... /rear: .....

1.5 Tyre pressure: front: ..... kPa/rear: ..... kPa

1.6 Castor angle: ..... °

1.7 Wheel-base: ..... mm

1.8 Handlebar identification: .....

1.9 Description of handlebar position: .....

1.10 Seat identification: .....

1.11 Suspension setting (if adjustable): .....

2 Test conditions

2.1 Vehicle with/without [1] dummy

2.2 Dummy reference (if applicable) .....

2.3 Height from the centre of the steering head pipe to the ground: [2] ..... mm

2.4 Height from the centre of the rear suspension upper fixation bolt to the ground: [2] ..... mm

2.5 Angle A (see 5.2; if applicable): ..... °

2.6 Angle B (see 5.2; if applicable): ..... °

3 Test results

3.1 (See 7.2 and figure 1)

Roll moment of inertia about the x-axis of the rider/motorcycle combination, I_{xxRM}: ..... kg·m²

Roll moment of inertia about the x-axis of the motorcycle, I_{xxM}: ..... kg·m²

3.2 (See 7.3 and figure 2)

Pitch moment of inertia about the y-axis of the rider/motorcycle combination, I_{yyRM}: ..... kg·m²

Pitch moment of inertia about the y-axis of the motorcycle, I_{yyM}: ..... kg·m²

3.3 (See 7.4 and figure 3)

Yaw moment of inertia about the z-axis of the rider/motorcycle combination, I_{zzRM}: ..... kg·m²

Yaw moment of inertia about the z-axis of the motorcycle, I_{zzM}: ..... kg·m²

1) Delete as applicable.

2) If 2.3. and 2.4 cannot be measured, describe a reference point at the front and at the rear of the vehicle, and indicate the distance from these points to the ground.

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Descriptors : road vehicles, motorcycles, tests, determination, moment of inertia.

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