INTERNATIONAL STANDARD

ISO 28981

First edition
2009-11-01

Mopeds — Methods for setting the running resistance on a chassis dynamometer

Cyclomoteurs — Méthodes pour fixer la résistance à l'avancement sur un banc dynamométrique

Reference number
ISO 28981:2009(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

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 2.

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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 28981 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 23, *Mopeds*.

Introduction

This International Standard is based on ISO 11486:2006[6], which specifies the measurement method(s) for determining motorcycle running resistance on the road, but adapted to the different vehicle category of mopeds. The most significant difference between this International Standard and ISO 11486:2006[6] is that use of chassis dynamometers with a fixed load curve is permitted and a specific verification method is specified.

Mopeds — Methods for setting the running resistance on a chassis dynamometer

1 Scope

This International Standard specifies the measurement method for determining the moped running resistance on the road, and two methods of setting the chassis dynamometer with the moped running resistance. It is applicable to mopeds as defined in ISO 3833.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3833, *Road vehicles — Types — Terms and definitions*

ISO 7116, *Mopeds — Measurement method for maximum speed*

3 Terms and definitions

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

3.1
running resistance
F
total force resistant to a running moped which, when measured by the coastdown method, includes the friction forces in the drive-train

3.2
reference speed
v_0
moped speed at which the running resistance of the moped is calculated and then used for setting the chassis dynamometer

3.3
specified speed
v
moped speed at which the running resistance on the road is measured to determine the running resistance curve

3.4
moped kerb mass
m_k
moped dry mass to which is added the mass of the following:

— fuel: tank filled at least to 90 % of the capacity specified by the manufacturer;

— oils and coolant: filled as specified by the manufacturer;

— auxiliary equipment usually supplied by the manufacturer in addition to that necessary for normal operation [tool-kit, carrier(s), windscreen(s), protective equipment, etc.]

3.5
moped reference mass
m_{ref}
kerb mass of the moped increased by a uniform figure of 75 kg which represents the mass of a rider

4 Symbols

For the purposes of this document, the symbols in Table 1 apply.

Table 1 — Symbols

Symbols	Definition	Unit
a	The coefficient of polygonal function	—
b	The coefficient of polygonal function	—
c	The coefficient of polygonal function	—
a_T	The rolling resistance force of front wheel	N
b_T	The coefficient of aerodynamic	N/(km/h)^2
d_T	The relative air density under test conditions	—
d_0	The standard ambient relative air density	—
F	The running resistance force	N
F_E	The set running resistance force on the chassis dynamometer	N
$F_E(v_0)$	The set running resistance force at the reference speed on the chassis dynamometer	N
$F_E(v_i)$	The set running resistance force at the specified speed on the chassis dynamometer	N
F_f	The total friction loss	N
$F_f(v_0)$	The total friction loss at the reference speed	N
F_j	The running resistance force	N
$F_j(v_0)$	The running resistance force at the reference speed	N
F_{pau}	The braking force of the power absorbing unit	N
$F_{pau}(v_j)$	The braking force of the power absorbing unit at the specified speed	N
$F_{pau}(v_0)$	The braking force of the power absorbing unit at the reference speed	N
F_T	The running resistance force obtained from the running resistance table	N
F^*	The target running resistance force	N
F^*_j	The target running resistance force at the specified speed	N
$F^*(v_0)$	The target running resistance force at the reference speed on the chassis dynamometer	N
$F^*(v_i)$	The target running resistance force at the specified speed on the chassis dynamometer	N
f_0	The rolling resistance	N
f^*_0	The corrected rolling resistance in the standard ambient conditions	N
f_2	The coefficient of aerodynamic drag	N/(km/h)^2
f^*_2	The corrected coefficient of aerodynamic drag in the standard ambient conditions	N/(km/h)^2
K_0	The temperature correction factor for rolling resistance	—

Table 1 (*continued*)

Symbols	Definition	Unit
m	The test moped mass	kg
m_a	The actual mass of the test moped	kg
m_i	The equivalent inertia mass	kg
m_{fi}	The flywheel equivalent inertia mass	kg
m_k	The moped kerb mass	kg
m_r	The equivalent inertia mass of all the wheels	kg
m_{ref}	The moped reference mass	kg
m_{rid}	The rider mass	kg
m_{rf}	The rotating mass of the front wheel	kg
m_{r1}	The equivalent inertia mass of the rear wheel and the moped parts rotating with the wheel	kg
p_0	The standard ambient pressure	kPa
p_T	The mean ambient pressure during the test	kPa
T_T	The mean ambient temperature during the test	K
T_0	The standard ambient temperature	K
v	The specified speed	km/h
v_j	The specified speeds which are selected for coastdown time measurement	km/h
v_0	The reference speed	km/h
v_1	The speed at which the measurement of the coastdown time begins	km/h
v_2	The speed at which the measurement of the coastdown time ends	km/h
ΔT_E	The corrected coastdown time at the inertia mass $(m_i + m_{r1})$	s
ΔT_i	The average coastdown time at the specified speed	s
ΔT_j	The average coastdown time of the two tests	s
ΔT_{road}	The target coastdown time	s
Δt	The coastdown time	s
$\overline{\Delta t}$	The mean coastdown time on the chassis dynamometer without absorption	s
Δt_E	The mean coastdown time on the chassis dynamometer at the reference speed	s
Δt_{ai}	The coastdown time measured during the first road test	s
Δt_{bi}	The coastdown time measured during the second road test	s
Δt_i	The coastdown time corresponding to the reference speed	s
Δv	The coastdown speed interval $(2\Delta v = v_1 - v_2)$	km/h
ε	The chassis dynamometer setting error	—
ρ_0	The standard relative ambient air volumetric mass	kg/m^3

5 Test moped, chassis dynamometer and instruments

A full description of the moped shall be provided in accordance with Annex A.

A full description of the chassis dynamometer and instruments shall be provided in accordance with Annex B.

6 Required accuracy of measurements

Measurements shall be made to the accuracies as specified in Table 2.

Table 2 — Required accuracy of measurements

Parameter	At measured value	Resolution
a) Running resistance force, F	+ 2 %	—
b) Moped speed (v_1, v_2)	± 1 %	0,45 km/h
c) Coastdown speed interval [$2\Delta v = v_1 - v_2$]	± 1 %	0,10 km/h
d) Coastdown time (Δt)	± 0,5 %	0,01 s
e) Total moped mass [$m_k + m_{rid}$]	± 1,0 %	1,4 kg
f) Wind speed	± 10 %	0,1 m/s
g) Wind direction	—	5°
h) Ambient temperature	—	2 K
i) Barometric pressure	—	0,2 kPa

7 Road test

7.1 Requirement for road

The test road shall be flat, level, straight and smoothly paved. The road surface shall be dry and free of obstacles or wind barriers that might impede the measurement of the running resistance. The slope of the surface shall not exceed 0,5 % between any two points at least 2 m apart.

7.2 Ambient conditions for the road test

During data collecting periods, the wind shall be steady. The wind speed and the direction of the wind shall be measured continuously or with adequate frequency at a location where the wind force during coastdown is representative.

The ambient conditions shall be within the following limits:

— maximum wind speed: 3 m/s;

— maximum wind speed for gusts: 5 m/s;

— average wind speed, parallel: 3 m/s;

— average wind speed, perpendicular: 2 m/s;

— maximum relative humidity: 95 %;

— air temperature: 278 K to 308 K.

Standard ambient conditions shall be as follows:

— pressure, p_0: 100 kPa;

— temperature, T_0: 293 K;

— relative air density, d_T: 0,919 7;

— air volumetric mass, ρ_0: 1,189 kg/m^3.

The relative air density when the moped is tested, calculated in accordance with the formula below, shall not differ by more than 7,5 % from the air density under the standard conditions.

The relative air density, d_T, shall be calculated by the following formula:

$$d_T = d_0 \times \frac{p_T}{p_0} \times \frac{T_0}{T_T} \qquad (1)$$

7.3 Reference speed

The reference speed or speeds shall be as defined in the test cycle.

7.4 Specified speed

The specified speed, v, is required to prepare the running resistance curve. To determine the running resistance as a function of moped speed in the vicinity of the reference speed, v_0, running resistances shall be measured using at least four specified speeds, including the reference speed(s). The range of specified speed points (the interval between the maximum and minimum points) shall extend either side of the reference speed or the reference speed range, if there is more than one reference speed, by at least Δv, as defined in 7.6. The specified speed points, including the reference speed point(s), shall be no greater than 20 km/h apart and the interval of specified speeds should be the same. From the running resistance curve, the running resistance at the reference speed(s) can be calculated.

7.5 Coastdown starting speed

The coastdown starting speed shall be more than 5 km/h above the highest speed at which coastdown time measurement begins, since sufficient time is required, for example to settle the positions of both the moped and rider and to cut the transmitted engine power off before the speed is reduced to v_1, the speed at which the measurement of the coastdown time is started.

7.6 Coastdown time measurement beginning speed and ending speed

To ensure accuracy in measuring the coastdown time, Δt, and coastdown speed interval, $2\Delta v$, the beginning speed, v_1, and ending speed, v_2, in kilometres per hour, the following requirements shall be met:

$$v_1 = v + \Delta v \qquad (2)$$

$$v_2 = v - \Delta v \qquad (3)$$

Δv shall be 5 km/h when v is less than 60 km/h, and shall be 10 km/h when v is 60 km/h or more.

7.7 Preparation of test moped

7.7.1 The moped shall conform in all its components with the production series, or, if the moped is different from the production series, a full description shall be given in the test report.

7.7.2 The engine, transmission and moped shall be properly run in, in accordance with the manufacturer's requirements.

7.7.3 The moped shall be adjusted in accordance with the manufacturer's requirements, e.g. the viscosity of the oils, tyre pressures, or, if the moped is different from the production series, a full description shall be given in the test report.

7.7.4 The kerb mass of the moped shall be as defined in 3.4.

7.7.5 The total test mass, including the masses of the rider and the instruments, shall be measured before the beginning of the test.

7.7.6 The distribution of the load between the wheels shall be in conformity with the manufacturer's instructions.

7.7.7 When installing the measuring instruments on the test moped, care shall be taken to minimize their effects on the distribution of the load between the wheels. When installing the speed sensor outside the moped, care shall be taken to minimize the additional aerodynamic loss.

7.8 Rider and riding position

7.8.1 The rider shall wear a close-fitting suit (one-piece) or similar clothing, a protective helmet, eye protection, boots and gloves.

7.8.2 The rider in the conditions given in 7.8.1 shall have a mass of 75 kg ± 2 kg and be 1,75 m ± 0,02 m tall.

7.8.3 The rider shall be seated on the seat provided, with his feet on the footrests and his arms normally extended. This position shall allow the rider at all times to have proper control of the moped during the coastdown test.

The position of the rider shall remain unchanged during the whole measurement period.

7.9 Measurement of coastdown time

7.9.1 After a warm-up period, the moped shall be accelerated to the coastdown starting speed, at which point the coastdown measurement procedure shall be started.

7.9.2 Since it can be dangerous and difficult from the viewpoint of its construction to have the transmission shifted to neutral, the coasting may be performed solely with the clutch disengaged. For those mopeds that have no way of cutting off the transmitted engine power prior to coasting, the moped may be towed until it reaches the coastdown starting speed. When the coastdown test is reproduced on the chassis dynamometer, the transmission and clutch shall be in the same condition as during the road test.

For safety reasons, a quick release device to be operated by the rider of the moped should be provided.

7.9.3 The moped steering shall be altered as little as possible and the brakes shall not be operated until the end of the coastdown measurement period.

7.9.4 The first coastdown time, Δt_{ai}, corresponding to the specified speed, v_j, shall be measured as the elapsed time from the moped speed $v_j + \Delta v$ to $v_j - \Delta v$.

7.9.5 The procedure from 7.9.1 to 7.9.4 shall be repeated in the opposite direction to measure the second coastdown time, Δt_{bi}.

7.9.6 The average ΔT_i of the two coastdown times Δt_{ai} and Δt_{bi} shall be calculated by the following equation:

$$\Delta T_i = \frac{\Delta t_{ai} + \Delta t_{bi}}{2} \quad (4)$$

7.9.7 At least four tests shall be performed and the average coastdown time, ΔT_j, calculated by the following equation:

$$\Delta T_j = \frac{1}{n}\sum_{i=1}^{n} \Delta T_i \quad (5)$$

Tests shall be performed until the statistical accuracy, P, is equal to or less than 4 % ($P \leqslant 4$ %).

The statistical accuracy, P, as a percentage, is calculated by the following equation:

$$P = \frac{ts}{\sqrt{n}} \times \frac{100}{\Delta T_{\mathrm{j}}} \quad (6)$$

where

t is the coefficient given in Table 3;

s is the standard deviation given by the following formula:

$$s = \sqrt{\sum_{i=1}^{n} \frac{(\Delta T_{\mathrm{i}} - \Delta T_{\mathrm{j}})^2}{n-1}} \quad (7)$$

n is the number of tests.

Table 3 — The coefficient for the statistical accuracy

n	t	$\frac{t}{\sqrt{n}}$
4	3,2	1,60
5	2,8	1,25
6	2,6	1,06
7	2,5	0,94
8	2,4	0,85
9	2,3	0,77
10	2,3	0,73
11	2,2	0,66
12	2,2	0,64
13	2,2	0,61
14	2,2	0,59
15	2,2	0,57

7.9.8 In repeating the test, care shall be taken to start the coastdown after observing the same warm-up procedure and at the same coastdown starting speed.

7.9.9 The measurement of the coastdown times for multiple specified speeds may be made by a continuous coastdown. In this case, the coastdown shall be repeated after observing the same warm-up procedure and at the same coastdown starting speed.

7.9.10 The coastdown time shall be recorded. An example of the record form is given in Clause C.1.

8 Data processing

8.1 Calculation of running resistance force

8.1.1 The running resistance force, F_j, in newtons, at the specified speed v_j shall be calculated by the following equation:

$$F_j = \frac{1}{3{,}6} \times (m + m_r) \times \frac{2\Delta v}{\Delta T_j} \tag{8}$$

m_r should be measured or calculated as appropriate. As an alternative, m_r may be estimated as 7 % of the unladen moped mass.

8.1.2 The running resistance force, F_j, shall be corrected in accordance with 8.2.

8.2 Running resistance curve fitting

The running resistance force, F, shall be calculated as follows.

This following equation shall be fitted to the data set of F_j and v_j obtained above by linear regression to determine the coefficients f_0 and f_2,

$$F = f_0 + f_2 v^2 \tag{9}$$

The coefficients f_0 and f_2 determined shall be corrected to the standard ambient conditions by the following equations:

$$f_0^* = f_0 \left[1 + K_0 \left(T_T - T_0 \right) \right] \tag{10}$$

$$f_2^* = f_2 \times \frac{T_T}{T_0} \times \frac{p_0}{p_T} \tag{11}$$

K_0 may be determined based on the empirical data for the particular moped and tyre tests, or may be assumed as follows if the information is not available: $K_0 = 6 \times 10^{-3}\ \text{K}^{-1}$.

8.3 Target running resistance force for chassis dynamometer setting

The target running resistance force, $F^*(v_0)$, on the chassis dynamometer at the reference moped speed, v_0, in newtons, is determined by the following equation:

$$F^*(v_0) = f_0^* + f_2^* \times v_0^2 \tag{12}$$

9 Chassis dynamometer setting derived from on-road coastdown measurements

9.1 Requirements for the equipment

9.1.1 The instrumentation for the speed and time measurement shall have the accuracies as specified in Clause 6.

9.1.2 The chassis dynamometer rollers shall be clean, dry and free from anything which might cause the tyre to slip.

9.2 Inertia mass setting

9.2.1 The equivalent inertia mass for the chassis dynamometer shall be the flywheel equivalent inertia mass, m_{fi}, closest to the actual mass of the moped, m_a. The actual mass, m_a, is obtained by adding the rotating mass of the front wheel, m_{rf}, to the total mass of the moped, rider and instruments measured during the road test. Alternatively, the equivalent inertia mass, m_i, can be derived from Table 4. The value of m_{rf}, in kilograms, may be measured or calculated as appropriate, or may be estimated as 3 % of m.

9.2.2 If the actual mass, m_a, cannot be equalized to the flywheel equivalent inertia mass, m_i, to make the target running resistance force, F^*, equal to the running resistance force, F_E, (which is to be set to the chassis dynamometer), the corrected coastdown time, ΔT_E, may be adjusted in accordance with the total mass ratio of the target coastdown time, ΔT_{road}, in the following sequence:

$$\Delta T_{road} = \frac{1}{3,6}\left(m_a + m_{r1}\right)\frac{2\Delta v}{F^*} \qquad (13)$$

$$\Delta T_E = \frac{1}{3,6}\left(m_i + m_{r1}\right)\frac{2\Delta v}{F_E} \qquad (14)$$

$$F_E = F^* \qquad (15)$$

$$\Delta T_E = \Delta T_{road} \times \frac{m_i + m_{r1}}{m_a + m_{r1}} \qquad (16)$$

with $0,95 < \dfrac{m_i + m_{r1}}{m_a + m_{r1}} < 1,05$

m_{r1} may be measured or calculated, in kilograms, as appropriate. As an alternative, m_{r1} may be estimated as 4 % of m.

9.3 Warming up of chassis dynamometer

Before the test, the chassis dynamometer shall be appropriately warmed up to the stabilized frictional force F_f.

9.4 Adjustment of tyre pressures

The tyre pressures shall be adjusted to the specifications of the manufacturer or to those at which the speed of the moped during the road test and the moped speed obtained on the chassis dynamometer are equal.

9.5 Moped warming up

The test moped shall be warmed up on the chassis dynamometer to the same condition as it was during the road test.

9.6 Procedures for setting chassis dynamometer

The load on the chassis dynamometer, F_E, is, in view of its construction, composed of the total friction loss, F_f, which is the sum of the chassis dynamometer rotating frictional resistance, the tyre rolling resistance, the frictional resistance of the rotating parts in the driving system of the moped and the braking force of the power absorbing unit (pau), F_{pau}, as shown in the following equation:

$$F_E = F_f + F_{pau} \qquad (17)$$

The target running resistance force, F^*, in 8.3 should be reproduced on the chassis dynamometer in accordance with the moped speed. Namely:

$$F_E(v_i) = F^*(v_i) \tag{18}$$

9.6.1 Determination of total friction loss

The total friction loss, F_f, on the chassis dynamometer shall be measured by the method in 9.6.1.1 or 9.6.1.2.

9.6.1.1 Motoring by chassis dynamometer

This method applies only to chassis dynamometers capable of driving a moped. The moped shall be driven by the chassis dynamometer steadily at the reference speed, v_0, with the transmission engaged and the clutch disengaged. The total friction loss, $F_f(v_0)$, at the reference speed, v_0, is given by the chassis dynamometer force.

9.6.1.2 Coastdown without absorption

The method of measuring the coastdown time is the coastdown method for the measurement of the total friction loss, F_f.

The moped coastdown shall be performed on the chassis dynamometer by the procedure described from 7.9.1 to 7.9.4 with zero chassis dynamometer absorption, and the coastdown time, Δt_i, corresponding to the reference speed, v_0, shall be measured.

The measurement shall be carried out at least three times, and the mean coastdown time, $\overline{\Delta t}$, shall be calculated by the following equation:

$$\overline{\Delta t} = \frac{1}{n}\sum_{i=1}^{n} \Delta t_i \tag{19}$$

The total friction loss $F_f(v_0)$ at the reference speed, v_0, is calculated by the following equation:

$$F_f(v_0) = \frac{1}{3,6}(m_i + m_{r1})\frac{2\Delta v}{\Delta t} \tag{20}$$

9.6.2 Calculation of power absorption unit force

The force, $F_{pau}(v_0)$, to be absorbed by the chassis dynamometer at the reference speed, v_0, is calculated by subtracting $F_f(v_0)$ from the target running resistance force, $F^*(v_0)$, as shown in the following equation:

$$F_{pau}(v_0) = F^*(v_0) - F_f(v_0) \tag{21}$$

9.6.3 Chassis dynamometer setting

According to its type, the chassis dynamometer shall be set by one of the methods described in 9.6.3.1 to 9.6.3.5.

9.6.3.1 Chassis dynamometer with polygonal function

If the chassis dynamometer has a polygonal function, in which the absorption characteristics are determined by load values at several speed points, at least three specified speeds, including the reference speed, shall be chosen as the setting points. At each setting point, the chassis dynamometer shall be set to the value, $F_{pau}(v_j)$, obtained in 9.6.2.

9.6.3.2 Chassis dynamometer with coefficient control

9.6.3.2.1 If the chassis dynamometer has a coefficient control, in which the absorption characteristics are determined by given coefficients of a polynomial function, the value of $F_{pau}(v_j)$ at each specified speed shall be calculated by the procedure in 9.6.1 and 9.6.2.

9.6.3.2.2 Assuming the load characteristics to be:

$$F_{pau}(v) = av^2 + bv + c \qquad (22)$$

The coefficients a, b and c shall be determined by the polynomial regression method.

9.6.3.2.3 The chassis dynamometer shall be set to the coefficients a, b and c obtained in 9.6.3.2.2.

9.6.3.3 Chassis dynamometer with F^* polygonal digital setter

9.6.3.3.1 If the chassis dynamometer has a polygonal digital setter, where a CPU is incorporated in the system, F^* is input directly, and Δt_i, F_f and F_{pau} are automatically measured and calculated to set the chassis dynamometer to the target running resistance force $F^* = f^*_0 + f^*_2 v^2$.

9.6.3.3.2 In this case, several points in succession are directly input digitally from the data set of F^*_j and v_j, the coastdown is performed and the coastdown time Δt_i is measured. After the coastdown test has been repeated several times, F_{pau} is automatically calculated and set at moped speed intervals of 0,1 km/h, in the following sequence:

$$F^* + F_f = \frac{1}{3{,}6}(m_i + m_{r1})\frac{2\Delta v}{\Delta t_i} \qquad (23)$$

$$F_f = \frac{1}{3{,}6}(m_i + m_{r1})\frac{2\Delta v}{\Delta t_i} - F^* \qquad (24)$$

$$F_{pau} = F^* - F_f \qquad (25)$$

9.6.3.4 Chassis dynamometer with f^*_0, f^*_2 coefficient digital setter

9.6.3.4.1 If the chassis dynamometer has a coefficient digital setter, where a CPU is incorporated in the system, the target running resistance force $F^* = f^*_0 + f^*_2 v^2$ is automatically set on the chassis dynamometer.

9.6.3.4.2 In this case, the coefficients f^*_0 and f^*_2 are directly input digitally, the coastdown is performed and the coastdown time, Δt_i, is measured. F_{pau} is automatically calculated and set at moped speed intervals of 0,06 km/h, in the following sequence:

$$F^* + F_f = \frac{1}{3{,}6}(m_i + m_{r1})\frac{2\Delta v}{\Delta t_i} \qquad (26)$$

$$F_f = \frac{1}{3{,}6}(m_i + m_{r1})\frac{2\Delta v}{\Delta t_i} - F^* \qquad (27)$$

$$F_{pau} = F^* - F_f \qquad (28)$$

9.6.3.5 Chassis dynamometer with fixed load curve

If the dynamometer has hydraulic or aerodynamic absorption, the setting can be done only at one speed point. The absorber shall be set to the value $F_{pau}(v_0)$ at the reference speed.

9.7 Verification of chassis dynamometer

9.7.1 Immediately after the initial setting, the coastdown time Δt_E on the chassis dynamometer corresponding to the reference speed, v_0, shall be measured by the same procedure as in 7.9.1 to 7.9.4.

If the chassis dynamometer has a fixed load curve, the running resistance shall be verified at least at two specified speed points, including the reference speed(s).

The measurement shall be carried out at least three times, and the mean coastdown time, Δt_E, shall be calculated from the results.

9.7.2 The set running resistance force at the reference speed, $F_E(v_0)$, on the chassis dynamometer is calculated by the following equation:

$$F_E\left(v_0\right)=\frac{1}{3{,}6}\left(m_i+m_{r1}\right)\frac{2\Delta v}{\Delta t_E} \tag{29}$$

9.7.3 The setting error, ε, is calculated by the following equation:

$$\varepsilon=\frac{\left|F_E\left(v_0\right)-F^*\left(v_0\right)\right|}{F^*\left(v_0\right)}\times 100 \tag{30}$$

9.7.4 The chassis dynamometer shall be readjusted if the setting error does not satisfy the following criteria:

$\varepsilon \leqslant 2$ % for $v_0 \geqslant 50$ km/h

$\varepsilon \leqslant 3$ % for 30 km/h $\leqslant v_0 < 50$ km/h

$\varepsilon \leqslant 10$ % for $v_0 < 30$ km/h

9.7.5 The procedure in 9.7.1 to 9.7.3 shall be repeated until the setting error satisfies the criteria.

9.7.6 The chassis dynamometer setting and the observed errors shall be recorded. The example of the record form is given in Clause C.2.

10 Chassis dynamometer setting using the running resistance table

10.1 Applicability

The chassis dynamometer can be set by the use of the running resistance table instead of the running resistance force obtained by the coastdown method. In this table method, the chassis dynamometer shall be set by the reference mass regardless of particular moped characteristics.

Care should be taken for the application of this method to mopeds having extraordinary characteristics.

10.2 Requirements for the equipment

10.2.1 The requirements for equipment shall be in accordance with 9.1.

10.2.2 The flywheel equivalent inertia mass, m_{fi}, shall be the equivalent inertia mass, m_i, specified in Table 4. The chassis dynamometer shall be set by the rolling resistance of front wheel, a, and the aero drag coefficient, b, specified in Table 4.

Table 4 — The classification of equivalent inertia mass and the running resistance

Reference mass, m_{ref} kg	Equivalent inertia mass, m_i kg	Rolling resistance of front wheel, a N	Aero drag coefficient, b N/(km/h)^2
$95 < m_{ref} \leqslant 105$	100	8,8	0,021 5
$105 < m_{ref} \leqslant 115$	110	9,7	0,021 7
$115 < m_{ref} \leqslant 125$	120	10,6	0,021 8
$125 < m_{ref} \leqslant 135$	130	11,4	0,022 0
$135 < m_{ref} \leqslant 145$	140	12,3	0,022 1
$145 < m_{ref} \leqslant 155$	150	13,2	0,022 3
$155 < m_{ref} \leqslant 165$	160	14,1	0,022 4
$165 < m_{ref} \leqslant 175$	170	15,0	0,022 6
$175 < m_{ref} \leqslant 185$	180	15,8	0,022 7
$185 < m_{ref} \leqslant 195$	190	16,7	0,022 9
$195 < m_{ref} \leqslant 205$	200	17,6	0,023 0
$205 < m_{ref} \leqslant 215$	210	18,5	0,023 2
$215 < m_{ref} \leqslant 225$	220	19,4	0,023 3
$225 < m_{ref} \leqslant 235$	230	20,2	0,023 5
$235 < m_{ref} \leqslant 245$	240	21,1	0,023 6
$245 < m_{ref} \leqslant 255$	250	22,0	0,023 8
$255 < m_{ref} \leqslant 265$	260	22,9	0,023 9
$265 < m_{ref} \leqslant 275$	270	23,8	0,024 1
$275 < m_{ref} \leqslant 285$	280	24,6	0,024 2
$285 < m_{ref} \leqslant 295$	290	25,5	0,024 4
$295 < m_{ref} \leqslant 305$	300	26,4	0,024 5
$305 < m_{ref} \leqslant 315$	310	27,3	0,024 7
$315 < m_{ref} \leqslant 325$	320	28,2	0,024 8
$325 < m_{ref} \leqslant 335$	330	29,0	0,025 0
$335 < m_{ref} \leqslant 345$	340	29,9	0,025 1
$345 < m_{ref} \leqslant 355$	350	30,8	0,025 3
$355 < m_{ref} \leqslant 365$	360	31,7	0,025 4
$365 < m_{ref} \leqslant 375$	370	32,6	0,025 6
$375 < m_{ref} \leqslant 385$	380	33,4	0,025 7
$385 < m_{ref} \leqslant 395$	390	34,3	0,025 9
$395 < m_{ref} \leqslant 405$	400	35,2	0,026 0
$405 < m_{ref} \leqslant 415$	410	36,1	0,026 2
$415 < m_{ref} \leqslant 425$	420	37,0	0,026 3
$425 < m_{ref} \leqslant 435$	430	37,8	0,026 5
$435 < m_{ref} \leqslant 445$	440	38,7	0,026 6
$445 < m_{ref} \leqslant 455$	450	39,6	0,026 8
$455 < m_{ref} \leqslant 465$	460	40,5	0,026 9
$465 < m_{ref} \leqslant 475$	470	41,4	0,027 1
$475 < m_{ref} \leqslant 485$	480	42,2	0,027 2
$485 < m_{ref} \leqslant 495$	490	43,1	0,027 4
$495 < m_{ref} \leqslant 505$	500	44,0	0,027 5
At every 10 kg	At every 10 kg	$a = 0{,}088\ m_i$ [a]	$b = 0{,}000\ 015 m_i + 0{,}020\ 0$ [b]

[a] The value shall be rounded to one decimal place.

[b] The value shall be rounded to four decimal places.

10.3 Setting the running resistance force on the chassis dynamometer

The running resistance force on the chassis dynamometer, F_E, shall be determined from the following equation:

$$F_E = F_T = a + b \times v^2 \qquad (31)$$

The target running resistance force, F^*, shall be equal to the running resistance force obtained from the running resistance table, F_T, because the correction for the standard ambient conditions is not necessary.

10.4 The specified speed for the chassis dynamometer

The running resistance on the chassis dynamometer shall be verified at the specified speed, v. At least three specified speeds, including the reference speed(s), should be verified.

If the chassis dynamometer has a fixed load curve, the running resistance shall be verified at least at two specified speed points, including the reference speed(s).

The range of specified speed points (the interval between the maximum and minimum points) shall extend either side of the reference speed or the reference speed range, if there is more than one reference speed, by at least Δv, as defined in 7.6. The specified speed points, including the reference speed point(s), shall be no greater than 20 km/h apart and the interval of specified speeds should be the same.

10.5 Verification of chassis dynamometer

10.5.1 Immediately after the initial setting, the coastdown time on the chassis dynamometer corresponding to the specified speed shall be measured. The moped shall not be set up on the chassis dynamometer during the coastdown time measurement. When the chassis dynamometer speed exceeds the maximum speed of the test cycle, the coastdown time measurement shall start.

The measurement shall be carried out at least three times, and the mean coastdown time, Δt_E, shall be calculated from the results.

10.5.2 The set running resistance force, $F_E(v_j)$, at the specified speed on the chassis dynamometer is calculated by the following equation:

$$F_E\left(v_j\right) = \frac{1}{3{,}6} m_i \frac{2\Delta v}{\Delta t_E} \qquad (32)$$

10.5.3 The setting error at the specified speed, ε, is calculated by the following equation:

$$\varepsilon = \frac{\left|F_E\left(v_j\right) - F_T\right|}{F_T} \times 100 \qquad (33)$$

10.5.4 The chassis dynamometer shall be readjusted if the setting error does not satisfy the following criteria:

$\varepsilon \leqslant 2$ % for $v \geqslant 50$ km/h

$\varepsilon \leqslant 3$ % for 30 km/h $\leqslant v < 50$ km/h

$\varepsilon \leqslant 10$ % for $v < 30$ km/h

10.5.5 The procedure in 10.5.1 to 10.5.3 shall be repeated until the setting error satisfies the criteria.

10.5.6 The chassis dynamometer setting and the observed errors shall be recorded. The example of the record form is given in Clause C.3.

Annex A
(normative)

Moped description

A.1 Moped

Category: two wheeler/three wheeler

Tradename (-mark): ....

Model: ....

Engine model: ....

Cycle: two stroke/four stroke

Number and layout of cylinders: ....

Engine displacement: .... cm^3

Gear-box: manual/automatic

Number of gear ratios (speeds): ....

Drive ratios: — primary: ....

— final: ....

Maximum speed (should be measured in accordance with ISO 7116): ....km/h

Reference speed: .... km/h (and .... km/h)

Mileage accumulated at test: ....km

Others, if there is any alteration: ....

A.2 Test moped mass

Moped mass: — kerb: ....kg

— reference: ....kg

Rider mass: ....kg

Instruments mass: ....kg

Front wheel loaded mass: ....kg

Rear wheel loaded mass: ....kg

Test moped mass: ....kg

A.3 Equivalent inertia mass of rotating parts

Drive wheel:

— drive train: ....kg

— rear wheel and tyre with brake drum or disc: ....kg

Steering wheel:

— front wheel and tyre: .... kg

— percentage of test moped mass: .... %

On-road rotating mass: .... kg

— percentage of test moped mass: .... %

On-bench rotating mass: .... kg

— percentage of moped mass: .... %

A.4 Tyres

Sizes: front: .... rear: ....

Make: ....

Pressures and dynamic tyre radius:

	Specified pressure	Actual pressure	Dynamic tyre radius
On-road testing:			
— Front:	.... kPa	.... kPa	.... mm
— Rear:	.... kPa	.... kPa	.... mm
On-bench testing:			
— Drive wheel:	.... kPa	.... kPa	.... mm

A.5 Frontal area determination

Rider height: .... m

Frontal area: .... m^2

Annex B
(normative)

Chassis dynamometer and instruments description

B.1 Chassis dynamometer

Tradename (-mark) and model: ....

Diameter of roller: .... m

Chassis dynamometer type: DC/ED

Capacity of power absorbing unit (pau): .... kW

Speed range: ....km/h

Power absorption system: polygonal function/coefficient control

Resolution: ....N

Type of inertia simulation system: mechanical /electrical

Inertia equivalent mass: ....kg

in steps of: ....kg

Coastdown timer: digital/analogue/stop-watch

B.2 Speed sensor

Tradename (-mark) and model: ....

Principle: ....

Range: ....

Position of installed sensor: ....

Resolution: ....

Output: ....

