International Standard 5696

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Trailed agricultural vehicles — Brakes and braking devices — Laboratory test method

Véhicules agricoles remorqués — Freins et dispositifs de freinage — Méthode d'essai de laboratoire

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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. Every 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.

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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Trailed agricultural vehicles — Brakes and braking devices — Laboratory test method

1 Scope

This International Standard specifies a method of bench testing of brakes and their control devices in order to determine their suitability for use on trailed agricultural vehicles.

2 Field of application

This International Standard is applicable to assisted mechanical braking devices, using either compressed air or hydraulic fluid under pressure, for mounting on trailed agricultural vehicles.

3 References

ISO 611, *Road vehicles — Braking of automotive vehicles and their trailers — Vocabulary.*

ISO 1728, *Road vehicles — Pneumatic braking connections between motor vehicles and towed vehicles — Interchangeability.*

ISO 5669, *Agricultural trailers and trailed equipment — Braking cylinders — Specifications.*

ISO 5676, *Tractors and machinery for agriculture and forestry — Hydraulic coupling — Braking circuit.*

4 Definitions

4.1 friction brakes: See ISO 611.

4.1.1 drum brakes: See ISO 611.

The characteristic dimensions of these drum brakes are:

the internal diameter of the drum, d;

the working width of the drum, i.

4.1.2 pivoting shoes: Shoes supported by one or two fixed pivots.

4.1.3 floating shoes: Shoes shouldered one upon the other.

4.1.4 disc brakes: See ISO 611.

The characteristic dimensions of disc brakes are:

the diameter of the disc, d;

the length, L_1, and width, e_1, of the plates;

the distance from the centreline of the disc to the centre of the plates, h_1.

4.2 automatic braking device: See ISO 611.

4.3 supplementary (braking) **device on the towing vehicle for the towed** (agricultural) **vehicle**: See ISO 611.

NOTE — If the pressure transmitted to the coupling head is used directly by the brake, the brake shall only be tested using the parameters of the control device — values of the pressure of compressed air or fluid transmitted by the brake control device.

4.4 coupling head: A connecting device between the hydraulic or pneumatic installation of the towing vehicle and the trailed vehicle.

4.5 wheel: For the purpose of this International Standard, "wheel" is taken to mean the rim and tyre assembly.

4.6 braking torque: See ISO 611.

4.7 cam torque; control torque: Torque applied to the drive shaft of a single brake of the axle.

NOTE — The maximum cam torque which the brake can withstand, indicated by the manufacturer, has the symbol C_{max}. If the brake has a control with linear travel, the term is replaced by **control force**, F_c.

$F_{c,max}$ is the symbol for maximum control force.

4.8 moderability curve (see figure 1): Curve representing the braking torque of a wheel as a function of the cam torque or control force.

4.9 mean gradient of braking force as a function of cam torque, G (see figure 1): Braking torque obtained by the brake, relative to the maximum cam torque (or control force) corresponding to zero braking torque. The gradient is expressed without unit or in newton metres per newton.

4.10 mean gradient of cylinder force as a function of pressure, J (see figure 2): Force of the cylinder at maximum pressure relative to maximum pressure minus the corresponding pressure at zero force. This gradient is expressed in newtons per kilopascal.

4.11 maximum deviation related to brake linearity, E (see figure 1): Ratio of the maximum difference between the actual moderability curve and the straight line which it subtends at the maximum braking force.

4.12 maximum deviation related to linearity of the braking device, e (see figure 2): Ratio of the maximum difference between the actual moderability curve and the straight line which it subtends at the maximum force produced by the cylinder.

5 Tests

Brakes and braking devices shall be the objects of separate tests.

5.1 Brake tests

5.1.1 Sample

The tests shall be carried out on one of the brakes of the axle presented. The brake shall be tested in the condition in which it is supplied by the manufacturer; moreover, no adjustment shall be made during testing.

The manufacturer shall indicate:

a) the radius under load, R_1, in metres, of the largest wheels which can be fitted to the axle;

b) the radius under load, R_2, in metres, of the smallest wheels which can be fitted to the axle;

c) the maximum braking mass, m, in kilograms, of the brake under test.

5.1.2 Test bench

5.1.2.1 Description

On the test bench, the maximum brakable load specified by the manufacturer is represented by a rotating inertia flywheel. There is no ventilation system allowing the brake under testing to be cooled.

The test bench shall enable the measurement of:

a) the cam torque, expressed in newton metres, or the control force, in newtons;

b) the braking torque, in newton metres;

c) speed of rotation, in radians per second, of the brake;

d) angle of rotation, in radians, of the drive shaft for brakes with rotating control, or the travel, in metres, of the control for brakes with linear control;

e) external temperature, in degrees Celsius, of the drum or disc.

5.1.2.2 Adjustments

The moment of inertia, I, of the flywheel shall be between

$$I_1 = 0{,}9\ m \left(\frac{R_1 + R_2}{2} \right)^2$$

and

$$I_2 = 1{,}1\ m \left(\frac{R_1 + R_2}{2} \right)^2$$

where

m is the maximum braking mass, in kilograms, of the brake under test;

R_1 and R_2 are the radii under load, in metres, of the largest and smallest wheels, respectively, which can be fitted to the axle.

The speed of rotation, ω, in radians per second, at the start of braking is given by the equation

$$\omega = \frac{14}{(R_1 + R_2)}$$

5.1.3 Service cam torque tests (or tests on service control forces)

5.1.3.1 Hydraulic control

If

p_h is the normal service pressure, in kilopascals, measured at the coupling head of the hydraulic control;

P_h is the maximum permissible pressure, in kilopascals;

C_{max} is the maximum cam torque indicated by the brake manufacturer;

then the service cam torque, C_h, is given by the equation

$$C_h = \frac{p_h}{P_h} \times C_{max}$$

5.1.3.2 Pneumatic control

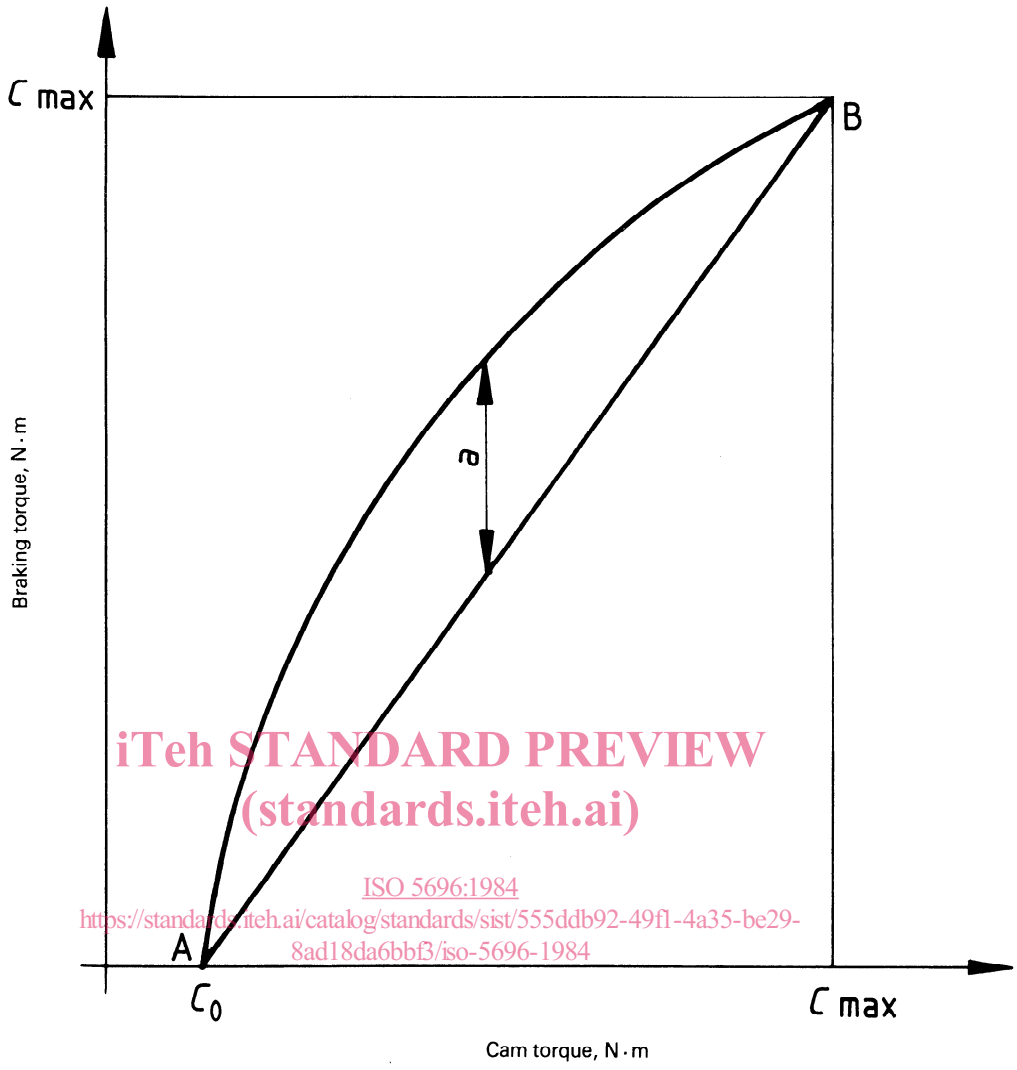
If

p_a is the normal service pressure, in kilopascals, measured at the coupling head of the pneumatic control;

P_a is the maximum permissible pressure, in kilopascals;

then the service cam torque is given by the equation

$$C_a = \frac{p_a}{P_a} \times C_{max}$$



Maximum deviation from linearity, $E = a/C_{max}$.

The mean gradient of braking torque as a function of cam torque is the slope of the straight line AB.

Figure 1 — Moderability curve: braking torque as a function of cam torque

5.1.3.3 Testing

The test consists of five series of 20 braking operations with the "pneumatic" cam torque carried out alternately with five series of 20 braking operations with "hydraulic" cam torque. The braking operations shall be spaced at intervals of between 30 and 35 s.

Between two consecutive series, a brake is allowed to cool to a temperature of less than or equal to 50 °C.

NOTE — Where $(p_a/P_a) = (p_h/P_h)$, the service cam torque is the same regardless of the type of control.

5.1.3.4 Measurements

With each braking operation, measure the cam torque applied and the mean braking cam torque.

5.1.3.5 Results

Calculate and note the values of the braking torques shown in table 1.

Table 1 — Braking torques obtained

Parameter	Value of braking torque N·m	
	Hydraulic control	Pneumatic control
Mean value of 100 braking operations	$C_1 =$	$C_2 =$
Minimum value obtained during 100 braking operations	$C_3 =$	$C_4 =$
Mean of minimum values from five series of braking operations	$C_5 =$	$C_6 =$
Mean of maximum values from five series of braking operations	$C_7 =$	$C_8 =$
Mean of first tests of each series	$C_9 =$	$C_{10} =$
Mean of last tests of each series	$C_{11} =$	$C_{12} =$

5.1.4 Test of the moderation of the braking torque as a function of cam torque

Carry out several braking operations, selecting cam torque values between 0 and C_{max}. Measure the cam torque obtained. The braking operations shall be sufficiently spaced for the temperature of the brake not to exceed 100 °C.

Plot the moderability curve (see figure 1) and record in addition

C_0, the maximum cam torque, in newton metres, for zero braking torque;

C_{max}, the maximum cam torque, in newton metres, for maximum braking torque;

G, the mean gradient, in newton metres per newton, of braking torque as a function of cam torque;

E, the maximum deviation, expressed as a percentage, with regard to linearity.

5.1.5 Test of mechanical resistance at maximum cam torque

Carry out a series of 20 braking operations at intervals of 30 s, applying a cam torque of C_{max}.

Record

a) the effects of any deterioration;

b) any distortion or fracture observed;

c) the maximum angle of rotation, α, in radians, of brake control; or

d) the travel, l, in metres, of the linear control.

5.1.6 Second test of the moderation of braking force as a function of cam torque

Carry out this test in a similar manner to that described in 5.1.4.

Comparison of the two moderability tests enables the evaluation of the loss of braking force in the series of tests at maximum cam torque C_{max}. Record this loss as a percentage.

5.2 Tests on braking devices

5.2.1 Sample

The braking devices subjected to test shall be series appliances which comply with the specifications of the manufacturer, and which satisfy the specifications of ISO 5669. The unit shall be mounted on the test bench.

5.2.2 Test bench

The test bench shall enable the measurement of:

a) the pressure, in kilopascals, delivered to the coupling head;

b) the force, in newtons, produced at the cylinder head (jack);

c) the stroke, in metres, of the cylinder (jack).

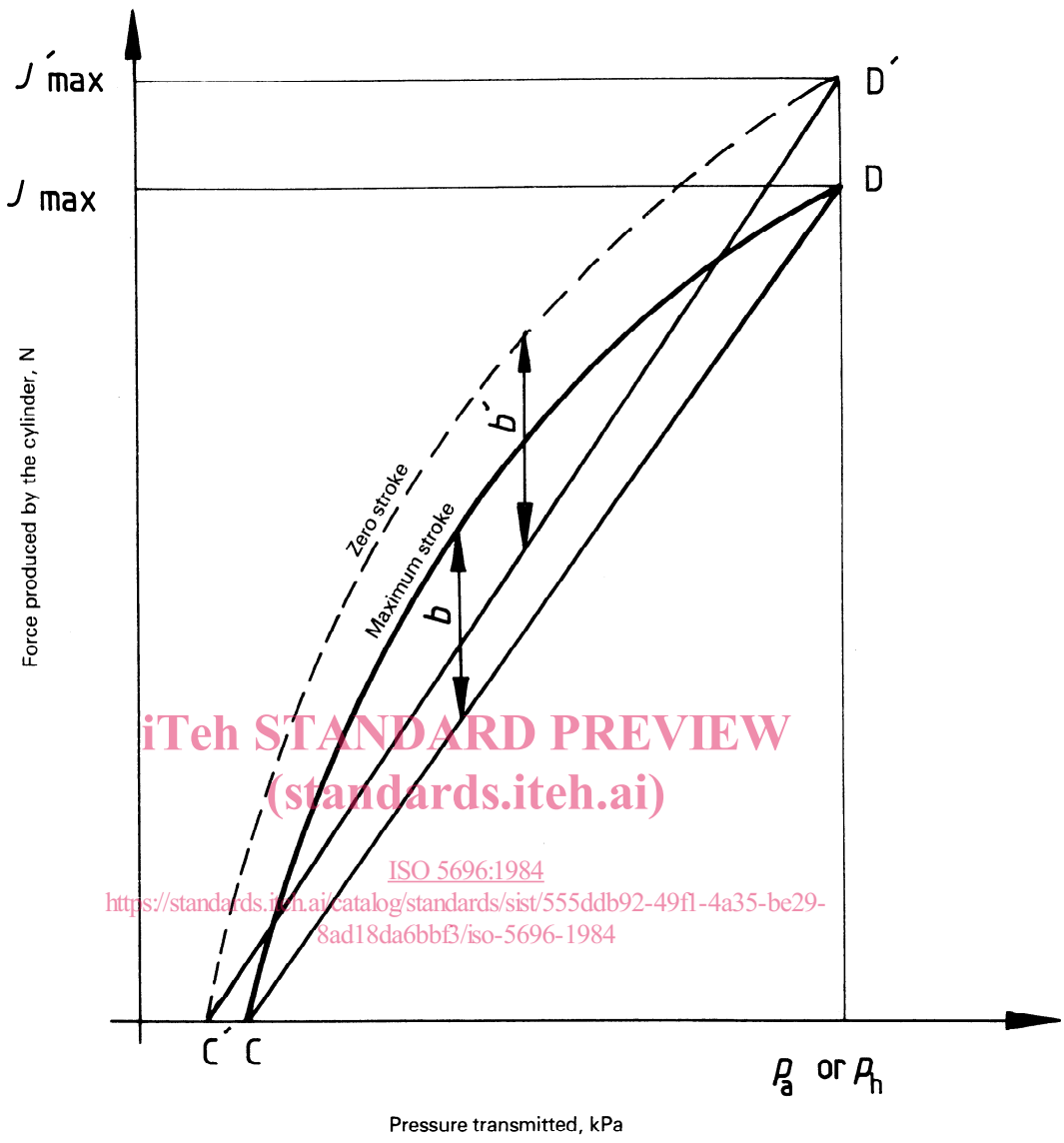
5.2.3 Verifications

Verify the conformity of the coupling heads between the tractor and the trailed vehicle with ISO 1728 and ISO 5676.

5.2.4 Test of the moderation of the force produced by the cylinder as a function of the pressure delivered to the coupling head

Vary the pressure delivered to the coupling head and measure the force produced by the cylinder.

Plot the curves representing the force as a function of the pressure for a zero stroke and for the maximum stroke of the control cylinder (see figure 2).



Maximum deviation from linearity: $e = b/J_{max}$; $e' = b'/J'_{max}$.

The mean gradient of the force as a function of the pressure transmitted to the coupling head is the slope of the straight line CD or C'D'.

Figure 2 — Moderability curve: force produced by the cylinder as a function of the pressure transmitted to the coupling head

Measure the stroke between the fixing of the cylinder and the coupling fork of the brake lever. Note the results, as shown in table 2.

Table 2 — Moderation test results

Parameter	Value	
	For zero stroke of cylinder	For maximum stroke of cylinder
Maximum pressure for zero force, kPa	P_1 =	P'_1 =
Minimum pressure for maximum force, kPa	P_2 =	P'_2 =
Mean gradient of the force as a function of pressure, N/kPa	J =	J' =
Maximum deviation with regard to linearity, %	e =	e' =

5.2.5 Test of force produced by the cylinder

5.2.5.1 Pressure

Apply to the coupling head:

a) normal service pressure, p_a or p_h;

b) maximum permissible pressure, P_a or P_h.

5.2.5.2 Test

Repeat the test 25 times with a zero cylinder stroke and 25 times with a maximum cylinder stroke at normal service pressure then at maximum permissible pressure.

5.2.5.3 Measurements

Using a dynamometer, measure the force, in newtons, produced by the cylinder for each test and record the pressure, in kilopascals, applied to the coupling head.

Measure, to the nearest 2 mm, the maximum stroke of the cylinder.

Measure any deteriorations or losses of force observed during the test at maximum permissible pressure.

5.2.5.4 Results

Calculate and record the values of the force, in newtons, produced by the cylinder at normal service pressure, as shown in table 3.

Table 3 — Force produced at normal service pressure

Cylinder stroke m	Force produced at normal service pressure N		
	Minimum	Maximum	Mean of 25 tests
Zero	J_2 =	J_3 =	J_4 =
Maximum	J'_2 =	J'_3 =	J'_4 =

Record the maximum stroke, K, in metres, of the cylinder.

Calculate and record the values of the force produced by the cylinder at the maximum permissible pressure, as indicated in table 4.

Table 4 — Force produced at the maximum permissible pressure

Cylinder stroke m	Force produced at maximum permissible pressure N		
	Minimum	Maximum	Mean of 25 tests
Zero	J_5 =	J_6 =	J_7 =
Maximum	J'_5 =	J'_6 =	J'_7 =

Record the maximum stroke, K', in metres, of the cylinder.

5.2.6 Second test of the moderation of the force produced by the cylinder as a function of the pressure transmitted to the coupling head

Perform this test in the same way as described in 5.2.4.

The comparison of the two moderation tests enables the loss of braking force to be estimated. Record this loss as a percentage.

Annex A

Example of a test report on axle brakes of trailed agricultural vehicles

Applicant: .....

1 Characteristics of the equipment tested

1.1 Brakes

Type of brake: .....
Make: .....

Drum dimensions [1]:
— internal diameter: d = ... mm
— working width: i = ... mm

Drum equipment [1]: .....

Disc dimensions [2]:
— diameter: d_1 = ... mm
— length of plates: L_1 = ... mm
— width of plates: e_1 = ... mm
— distance from centreline of disc to centre of plates: h_1 = ... mm

Disc equipment [2]: .....

Type of plates [2]: .....

Linings
Make: .....
Type: .....
Fitting: .....
Thickness: ..... mm
Length: ..... mm
Width: ..... mm
Brake control: .....
Maximum cam torque indicated by the manufacturer: C_{max} = ... N·m

1.2 Wheels

Radius under load of largest wheels: R_1 = ... m
Radius under load of smallest wheels: R_2 = ... m

1.3 Copy of the identification plate fixed to the axle

1) For drum brakes.

2) For disc brakes.