



SURFACE VEHICLE RECOMMENDED PRACTICE

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Wear Test Procedure on Inertia Dynamometer for Brake Friction Materials

RATIONALE

Increasing prevalence of regenerative braking systems has prompted a need for wear evaluations that invoke the proper conditioning sequences to reflect the presence of regeneration. Modifications to this procedure will involve optional burnish conditions that simulate regen braking.

FOREWORD

The harmonization efforts by different industry groups and associations from the European community, the United States, and Japan cover several aspects to characterize brake friction materials used in automotive applications. Brake lining wear life, its dynamics, and behavior under different temperatures and speeds are critical to the successful development and production of commercially available disc brake pads and linings, both for the original equipment and the aftermarket segments. Equally important is evaluating the wear characteristics of the given friction material and its mating part when subjected to a series of brake stops or snubs derived from an actual driving pattern. Different combinations of speed, temperature, and deceleration, closer to what the vehicle experiences during regular driving, yield different levels of wear and transfer layer phenomena. When tested under a control testing environment on an inertia dynamometer, this driving pattern replication could provide information on the wear behavior and level of a given lining and rotor or drum combination.

This SAE Recommended Practice (RP) harmonizes test procedures to evaluate wear characteristics of automotive brake lining and pads. This RP establishes a standardized dynamometer procedure related to the actual condition of vehicles on the market. Therefore, this committee is making two different test sequences available. The first Method, Method A, is equivalent to the Japanese standard JASO C427 to quantify the wear sensitivity to the temperature experienced by the lining and rotor/drum combination. The second method, Method B (also known as block wear), includes variable speed, deceleration, and temperature levels.

This RP may be used in conjunction with other applicable standards or test procedures (ISO, SAE, Federal Codes, or other specific testing programs) to fully assess a friction material's adequacy for a particular application or vehicle platform.

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1. SCOPE

- 1.1 This RP specifies a dynamometer test procedure to characterize wear rates of automotive service brake linings (brake shoes) and disc brake pads.
- 1.2 Unique motor vehicles, motorcycles, and trailers with nominal gross combination weight rating exceeding 40000 kg are not part of this document.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (U.S. and Canada only) or +1 724-776-4970 (Outside U.S. and Canada), www.sae.org.

SAE J2789 Inertia Calculation for Single-Ended Inertia-Dynamometer Testing

SAE J2986 Brake Pads, Lining, Disc, and Drum Wear Measurements

SAE J3111 Brake Rotor Thickness Variation and Lateral Run-Out Measurements

2.1.2 JSAE Publications

Available from Society of Automotive Engineers of Japan, 10-2 Gobancho, Chiyoda-Ku, 102-0076 Japan, Tel: +81-3-3262-8211, www.jsae.or.jp/en.

JASO C427 Automobile Parts - Brake Lining and Disc Brake Pad - Wear Test Procedure on Inertia Dynamometer

3. DEFINITIONS

Apply the following terms and definitions to facilitate the application of this document.

3.1 INITIAL SPEED

The speed at the time brake application is initiated and read using a calibrated rotational speed sensor.

3.2 FINAL SPEED

Unless otherwise stated, the speed at the time of brake release. Unless otherwise noted on the different test, the final speed is 0.5 km/h.

3.3 BRAKING DECELERATION

Reduction in the equivalent vehicle speed due to an active braking torque between two points in time. The braking torque is provided by controlling and modulating the brake pressure. In a practical test, convert the deceleration level into an equivalent brake torque using the equations given in 4.7 (see Equations 2 and 3).

3.4 INITIAL BRAKE TEMPERATURE

The temperature of the drum(s) or disc(s), according to the procedure when the brake application is initiated. When testing more than one brake simultaneously, the initial brake temperature is the highest of all brakes measured on the drum(s) or disc(s).

4. SYMBOLS AND ABBREVIATIONS

Use the symbols and abbreviations from Table 1 to perform the calculations needed during the test.

Table 1 - Symbols and abbreviations

Symbol	Description	Units
a	Required braking deceleration	g
A	Area of the rubbing surface on linings or pads	cm ²
E _k	Total mechanical work for a brake event	kgf·m, N·m, J
GVWR	Gross vehicle weight rating	kg
I _{front}	Required inertia on the front axle	kgf·m·s ² , kg·m ²
I _{rear}	Required inertia on the rear axle	kgf·m·s ² , kg·m ²
I'	Effective inertia for a given brake event	kgf·m·s ² , kg·m ²
N	Total number of brake applications at a given step of the test sequence	--
RPM	Revolutions per mile	revs/mile
RR	Tire dynamic rolling radius	m
T _{hk}	Sum of average thickness loss of the inner and outer pad or leading and trailing lining	mm
T _{front}	Required braking torque on the front axle	kgf·m, N·m
T _{rear}	Required braking torque on the rear axle	kgf·m, N·m
T'	Effective braking torque for a given brake event	kgf·m, N·m
X	Percentage of brake torque provided by the front axle, according to SAE J2789	%
Y	Percentage of brake torque provided by the rear axle, according to SAE J2789	%
W	Vehicle weight	kg
V	Specific wear rate	10 ⁻⁷ cm ³ /kgf·m, 10 ⁻⁷ cm ³ /N·m, 10 ⁻⁷ cm ³ /J
ω _i	Initial angular velocity of the brake at the start of the brake event	rad/s
ω _f	Final angular velocity of the brake at the end of the brake event	rad/s

4.1 Required Braking Deceleration, a

The nominal rate of change in vehicle speed during braking after the initial transient condition. This rate does not include the brake achieving the target deceleration level indicated for a specific event.

4.2 Effective Braking Deceleration, a'

The actual rate of change in vehicle speed during braking is computed (after the initial transient condition) as a function of brake rotational speed and tire dynamic rolling radius for a specific event.

4.3 Gross Vehicle Weight Rating, GVWR

The maximum vehicle weight specified by the manufacturer.

4.4 Required Inertia, I_{front}, I_{rear}

Calculate test inertias (front or rear) according to SAE J2789 and the closest value achievable by the dynamometer utilizing mechanical and electric (simulated) inertia. Determine the inertia level for vehicle deceleration below 0.65 g, with the vehicle loaded to the gross vehicle weight rating (GVWR), indicated by the test requestor.

4.5 Effective Inertia, I'

Inertia reflected at the foundation brake computed as a function of the torque readings, angular deceleration of the brake, and the tire dynamic rolling radius.