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Braking Performance — Rubber Tired Skidders

SAE Standard
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Submitted for Recognition as an American National Standard

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OFF-HIGHWAY MACHINERY STANDARD

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Ø BRAKING PERFORMANCE - RUBBER-TIRED SKIDDERS

1. INTRODUCTION: No existing ISO document is applicable for rubber-tired skidder braking performance. This standard follows the format of ISO 3450 and SAE J1473.

2. PURPOSE: This SAE Standard specifies braking system minimum performance and test criteria to enable uniform evaluation of the braking capability of rubber tired skidders. Service, secondary and parking brake systems are included.

3. SCOPE: This SAE Standard applies to rubber-tired skidders as defined in SAE J1209 and J1116 (Section 4).

4. DEFINITIONS:

4.1 Rubber-Tired Skidder: A self-propelled machine designed to transport trees or parts of trees by trailing or dragging. Refer to SAE J1209.

4.2 Braking Systems: Includes all the elements which participate in stopping and holding the machine stationary. Such systems consist of a control, brake activation system, the brake itself, and all elements connecting the brake to the wheel and tire.

4.2.1 Service Brake System: The primary system used for stopping and holding the machine stationary.

4.2.2 Secondary Brake System: The system used for stopping the machine in the event of any single failure in the service brake system.

4.2.3 Parking Brake System: A system used to hold a stopped machine in a stationary position.

4.2.4 Brake System Components:

4.2.4.1 Control: The part directly activated by the operator to cause a control force to be transmitted to the brake(s).

4.2.4.2 Brake Activation System: All of the elements between the control and the brake(s) which connects them functionally, and transmits mechanical force, hydraulic or air pressure or electrical current as a means to apply the brake(s).

4.2.4.3 Brake(s): An energy absorbing device which directly applies a force to oppose movement of the machine and bring it to a controlled stop.

4.2.4.4 Retarder: An energy absorption device normally used to control machine speed while descending grades.

4.3 Common Component: A component that performs a function in two or more braking systems.

4.4 Machine Mass: Operating mass of a machine up to that which includes the heaviest combination of equipment approved by the manufacturer of the machine and with the machine fully fueled and serviced.

4.5 Stopping Distance: The distance travelled by the machine from the point on the test course at which the machine brake control actuation begins to the point where the machine is fully stopped.

4.6 Burnish: A procedure to condition the frictional surfaces of the machine brake(s).

4.7 Brake System Pressure: The gas or hydraulic pressure available at the brake mechanism.

4.8 Test Course: The surface upon which the test is conducted.

5. INSTRUMENTATION:

5.1 A means to measure and record these parameters within the specified accuracy:

Parameter	Instrument Accuracy
Brake System Pressure	± 3.0%
Machine Speed	± 3.0%
Machine Mass	± 2.5%
Stopping Distance	± 1.0%
Brake Control Actuating Force	± 3.0%
Grade	± 1.0%

6. GENERAL BRAKE REQUIREMENTS:

6.1 Required Brake Systems: All machines shall be equipped with:

6.1.1 A service brake system.

6.1.2 A secondary brake system.

6.1.3 A parking brake system.

6.2 Common Components: Braking systems may use common components; however, in the event of a failure of any single component other than a tire, the brake systems shall provide machine stopping capability meeting the secondary brake system performance requirements specified in Table I. An exception to this would be a failure of a common component between the operator's control input force and the master valve or between the brake and the wheel. Then a brake system shall exist to stop the machine within the distance calculated from:

$$l = \frac{v^2}{40}$$

Where: v is machine speed expressed in km/h immediately prior to the brake control being applied.

l is the stopping distance in metres.

6.3 Service Brake System:

6.3.1 Stopping Performance: The service brake system, when tested in accordance with Section 7, shall stop the machine within the distance defined by Table I.

6.3.1.1 The temperature of external brake components exposed to debris shall not exceed 120°C over ambient when measured within 1 min after completing stopping test.

6.3.2 Holding Performance: The service brake system shall have capability equivalent to holding the machine stationary, forward and reverse direction, on a 40% grade with machine mass as specified in paragraph 4.4.

If the machine slides or it is otherwise impractical to test on a 40% grade, use the surface specified in paragraph 7.2 with not more than 1% grade in the direction of travel. Apply a horizontal pulling force as near the ground as practical to the stationary machine with the service brake system applied and the transmission in neutral. An equivalent braking force in N is 3.64 times the machine mass in kg.

6.3.3 Service Brake System Recovery Capacity (Stored Energy System): With the machine stationary, the service brake system's primary power source shall have capability of delivering at least 70% of maximum brake pressure measured near the brakes when the brakes are fully applied 20 times in 10 s intervals with the engine at maximum governed RPM.

6.3.4 Warning Device (Stored Energy System): The service brake system using stored energy as its primary application force shall be equipped with a warning device which actuates before system energy drops below the greater of 50% of the manufacturer's specified maximum operating energy level or the level required to meet the secondary stopping requirements. The device shall readily attract the operator's attention by providing a continuing visual or audible warning. Gauges indicating pressure or vacuum do not meet these requirements.

6.4 Secondary Brake System:

6.4.1 Stopping Performance: The secondary brake system, when tested in accordance with Section 7, shall stop the machine within the distance defined by Table I.

6.4.2 Secondary Brake Application: The secondary brake system shall be capable of being applied by a person seated in the operator's seat. The system shall be arranged so that it cannot be released from the operator's seat after any application unless immediate reapplication can be made from the operator's seat to stop the machine. The system must be completely operable with transmission engaged or disengaged.

6.4.2.1 In addition to the manual control, the secondary brake system may also be applied automatically. If an automatic secondary brake system is used, the automatic application shall occur after a warning device is actuated.

6.4.3 Secondary Brake System Capacity (Stored Energy System): If the service brake system stored energy reservoir(s) are used to apply the secondary braking system, then, with the energy source disconnected and machine stationary, the capacity of the service brake system reservoir(s) shall be such that the energy remaining in the reservoir(s) after 5 full service brake applications is not less than that required to meet the secondary stopping requirements in paragraph 6.4.1.

6.5 Parking System: All machines shall be equipped with a parking brake system capable of being applied by a person seated in the operator's seat.

6.5.1 Parking Brake Performance: The parking brake shall have capability equivalent to holding the machine stationary, forward and reverse direction, under conditions described in paragraph 6.3.2.

6.5.2 Ramains Applied: The parking system while applied shall maintain the parking performance in compliance with paragraph 6.5.1 despite any expansion or contraction of brake parts, exhaustion of the source of energy or leakage of any kind.

6.5.3 Warning Device (Parking Brake): Any friction type parking brake system not automatically disengaged by engagement of the transmission, or which does not automatically disengage transmission, when applied, shall be equipped with a warning device which is activated when the engine is running, the transmission is engaged and the parking brake is engaged. The device shall provide continuous warning to the operator. Gauges do not meet these requirements.

6.6 Control Forces: Control forces needed to meet the required braking performance, for the systems defined in paragraph 4.2, shall not exceed these values:

Control Type	Force
Finger grasp (flip levers & switches)	20N
Hand grasp	
Upwards	400N
Fore-aft	300N
Sideways	300N
Foot pedal	700N
Foot treadle	350N

7. TEST CONDITIONS:

7.1 Manufacturer's precautions shall be observed while conducting performance tests.

7.2 The test course shall consist of a hard, dry surface with a well-compacted base. Ground moisture may be present to the extent that it does not adversely affect the braking test. The test course shall not have more than 3% grade at right angles to the direction of travel. Grade in the direction of travel shall be as specified for the test being conducted. The approach to the test course shall be of sufficient length, smoothness, and uniformity of grade to ensure reaching the required machine speed before the brakes are actuated.

7.3 Machine mass shall be as defined as paragraph 4.4 at the manufacturer's specified axle distribution.

7.4 All parameters related to brake systems shall be within the machine manufacturer's specification, that is, tire size and pressure, brake adjustment, warning device actuation point, etc. All power-assist pressures shall be within the machine manufacturer's specification range. No manual adjustment(s) shall be made to the brake system during any one performance test.

7.5 When the machine transmission provides a selection of gear ratios, the stopping tests shall be conducted with the transmission in the gear commensurate with the test speed specified. The power train may be disengaged prior to completing the stop.

7.6 Retarders shall not be used in these tests unless the retarder is simultaneously actuated by the applicable brake system control.

7.7 Blades, grapples, and other equipment shall be carried in the transport position recommended by the manufacturer.

7.8 Burnishing (conditioning) of brakes before testing is permissible. The burnishing procedure shall be indicated in the operator's and/or maintenance manual for the machine and shall be verified by consultation with the machine manufacturer.

7.9 Immediately prior to a test, the machine shall be operated, until the engine, transmission and machine fluids are at normal operating temperature.

8. STOPPING PERFORMANCE:

8.1 Test Requirements:

8.1.1 Brake performance shall be tested from a maximum machine speed of 32 + 3 km/h or the machine's maximum level surface speed if less.

8.1.2 Tests shall be performed in accordance with the test conditions specified in 7.

8.1.3 The test course shall not have more than 1% grade in the direction of travel.

TABLE I - STOPPING PERFORMANCE FOR RUBBER TIRED SKIDDERS

	STOPPING DISTANCE[1] (m)	
	SERVICE BRAKE SYSTEM	SECONDARY[2] BRAKE SYSTEM
	$\frac{v^2}{80}$	$\frac{v^2}{53}$

v is machine speed expressed in km/h (See paragraph 8.1.1).

[1]Machines with maximum level surface speed lower than 32 km/h shall add the following correction to the stopping distance formula:

$$+ 0.1 \times (32-v)$$

[2]Note 6.2 for common component exception.

9. TEST REPORT:

The test report shall contain the following information:

a. Reference to this SAE Standard.

b. The type of machine.

9. TEST REPORT: (Cont'd.)

c. The make of machine.

d. The model and serial number of the machine.

e. Condition of the machine; for example, new, 10 h in operation.

f. Mass and axle distribution of the machine in Kg.

g. Equipment or equivalent mass; for example, dozer or winch.

h. Tire size, ply rating, tread pattern and tire pressure in megapascals (MPa).

i. Description of brakes; for example disc or drum, hand or foot control.

j. Type of braking systems; for example, mechanical or hydraulic.

k. Identify tests conducted using a retarder. Describe retarder; for example, hydraulic or electric.

l. Test course surface; for example, asphalt, concrete or soil

m. Longitudinal and cross gradient of test course.

n. The results of stopping and holding tests shall be shown in the following form:

Braking System Tested	Holding Performance Grade % or Force N	Machine Speed v km/h	Stopping Distance l m

o. Percent brake system pressure after brake application test = _____%. (See paragraph 6.3.3)

$$\% = \frac{P_L}{P} \times 100$$

where: P = brake pressure during the first brake application.

P_L = lowest brake pressure measured during subsequent brake applications.

RATIONALE:

This document is revised as a result of its five year review. The new document is similar to the rubber tired earthmoving machine braking performance document, J1473. The uniqueness of the skidder document in regard to stopping distance and brake temperature limitations are retained due to the common steep and long slope operations and the debris filled environment. A separate document for skidders is desired to provide a guideline for an ISO document for skidders which is not included in ISO 3450.

MAJOR CHANGES:

There are six major changes in the J1178 Draft as compared to the current document:

1. Emergency stopping system is renamed secondary brake system.

2. An exception is added to the common components section to allow a greater stopping distance, $l = v^2/40$ or 2X service brake stopping distance for a failure between the operator's control input force and the master valve or between the brake and the wheel. This increase in stopping distance is equivalent to J1473. It is allowed because of the resulting unfavorable weight distribution for braking which requires longer stopping distances. Example: front driveline failure with driveline brakes. The statement, "these common components may be considered not susceptible to failure provided a brake system still exists that will" is replaced with, "then a brake system shall exist to".

3. An alternate means of testing the holding performance of the brake system is provided. An equivalent braking force in Newtons can be calculated to be approximately equal to the 40% grade holding force.

4. An expanded allowable control force chart is included which is identical to J1473. These control forces have been approved worldwide for rubber tired earthmoving machines and are also in ISO 3450.

5. The brake stopping distances tabulated for various speeds is replaced by a simple formula for calculating brake performance requirements. A footnote referencing paragraph 6.2 for the common component exception for secondary brake system stopping distance is added.

6. The separate set of stopping distances for skidders over 16 000 kg was eliminated. This was done for consistency with SAE J1473 and since there are few skidders over 16 000 kg.

RELATIONSHIP OF SAE STANDARD TO ISO STANDARD:

Not applicable.