Road vehicles - Retarder road test procedure

1. Scope

This standard applies to vehicles with retarders, but not retarders operated only when service brake is applied.

2. Normative reference

The following standards, when referred to in this standard, constitutes a part of the specifications of this standard. As required, the most recently updated version of the applicable standard (including addenda) shall be applied.

JIS D0106: Road vehicles -- Brake types, braking mechanics and brake operation -- Vocabulary
JIS D0210: General rules of brake test method of automobiles and motor cycles
JIS D1011: Road vehicles -- Speed of meters -- Methods of calibration

3. Definitions

The definitions of the main terms used in this standard shall be in accordance with **JIS D0106** and as follows.

a) Highest gear position
The shift position of the transmission at which the highest speed listed on the vehicle specification table can be obtained.

b) Normally used shift position
The highest shift position of the transmission that can maintain the specified initial speed of braking.

c) Shift position one step lower than normally used shift position
The shift position one step lower than the normally used shift position among those shown in the vehicle running performance curve.

d) Neutral position
The state where the shift position is set to neutral or the clutch is disconnected before brake operation.

e) Representative temperature of retarder
The temperature that represents the condition of retarder and which affects retarder performance.
Remark: Precisely, the representative temperature for electromagnetic retarders or retarders by electric traction motor, hydrodynamic retarders, and permanent magnetic retarders shall be that of the electromagnetic coil, the fluid, and permanent magnet or the drum, respectively. Temperature measured on an equivalent portion may also be allowed.

4. Test conditions

4.1 Conditions of vehicle

The test vehicle conditions shall be as specified in **JIS D0210**.

4.2 Conditions of each component of retarder

Each component of the retarder when tested shall be composed of parts having standard specifications and normal functions, and adjusted appropriately where necessary.

4.3 Road surface conditions and weather

The road surface conditions and weather shall be as follows.

a) Test road surface
The test road shall be a straight, flat, level, dry, hard paved road.

b) Wind velocity
The wind velocity during testing shall be preferably 5 m/s or less so that wind velocity does not have a significant influence on test results.

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5. Test method

5.1 Test item

The retarder road test items shall be as follows.

a) Vehicle deceleration speed measurement test when retarder is operated

b) Retarder braking force measurement test

5.2 Common items

5.2.1 General

During the test, the vehicle speed and the elapsed time shall be measured while the retarder is operated. Note that the following shall be carried out prior to measurement; (1) warming up of the engine and running-in shall be carried out, (2) the temperature of the retarder cooling medium and the retarder representative temperature shall be measured and recorded in the datasheet shown in **Attached Table 2**, as the temperature at the start of measurement, in addition to the portions where temperature is measured.

When the measurements are taken repeatedly, note that these temperatures should be as similar as possible, taking reproducibility into consideration.

5.2.2 Measuring instruments

The following measuring instruments shall used. Using other methods shall be allowed if the equivalent function and accuracy can be achieved.

a) The vehicle speed shall be measured with an onboard speedometer after calibration. The calibration method shall be as specified in **JIS D1011**.

b) The elapsed time shall be measured with a stopwatch.

5.3 Vehicle deceleration speed measurement test when retarder is operated

5.3.1 Purpose

This test shall be carried out to measure the deceleration of a vehicle during ordinary running.

5.3.2 Test

a) Operation of retarder

The retarder shall be operated immediately after the test vehicle speed reaches the specified test speed.

b) Range of measured speed

The range of measured speed shall be as specified in **Table 1**. If the specified test speed cannot be achieved, select the suitable test classification according to **Table 1**.

c) Shift position

The shift position shall be as specified in **Table 1**.

Table 1 Shift position of transmission used during test

Classification	Range of measured (km/h)		Shift position	Remark
	Initial speed of braking	Final speed of braking		
A	100	50	Highest shift position	Evaluation during high speed running
B	60	30	Normally used shift position	Evaluation during normal running
C	60	30	Shift position one step lower than normally used position	Evaluation during descending
D	40	20	Lowest shift position that can maintain 40 km/h	

Remark: When the vehicle cannot achieve 100 km/h, measurement shall be taken at the maximum speed that is determined by the test shift position.

d) Measurement interval

Vehicle speed and elapsed time shall be measured every 5 km/h from the specified initial speed of braking until the final speed of braking.

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e) Test count

Twice (once following, and once against the wind)

5.3.3 Recording procedure

The recording procedure shall be as follows.

a) Creation of graph

The values obtained after measuring twice in accordance with **5.3.2** shall be recorded in the datasheet as shown in **Attached Table 2**, and their mean value shall be plotted in the graph shown in **Attached Table 3**.

b) Calculation of deceleration

Deceleration shall be calculated as a representative value in accordance with **Table 2** and the following formula.

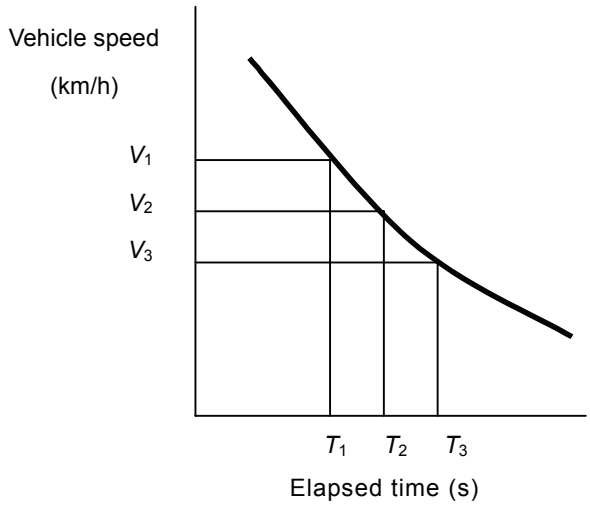
Table 2 Representative speed for calculating deceleration

Classification	Representative speed for calculating deceleration V_2 (km/h)	Speed for calculating deceleration	
		V_1 (km/h)	V_3 (km/h)
A	80	85	75
B	50	55	45
C	50	55	45
D	30	35	25

$$G = \frac{V_1 - V_3}{T_3 - T_1} \times \frac{1}{3.6} = \frac{2.78}{T_3 - T_1}$$

where, G: deceleration (m/s^2)
V_1: initial speed of braking (km/h)
V_3: final speed of braking (km/h)
T_1: time at start of braking (s)
T_3: time at end of braking (s).

Deceleration shall be obtained to the second decimal place.



c) Comment column

If functional abnormalities are found such as a delay in activation of the retarder, abnormal working noise, or abnormal vehicle speed change after retarder activation is cancelled, those findings shall be entered in the comment column of the datasheet as shown in **Attached Table 2**.

5.4 Retarder braking force measurement test

5.4.1 Purpose

This test shall be carried out for analysis and to measure the braking force generated by the retarder only.

5.4.2 Test

a) Operation of retarder

Immediately after the test vehicle reaches the specified measurement initial speed of braking, the retarder shall be operated.

b) Measurement conditions

The range of measurement speed and the retarder representative temperature shall be as specified in **Table 3**.

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Table 3 Test classification on measuring retarder performance

Classification	Range of measured (km/h)		Shift position	Retarder representative temperature	Remark
	Initial speed of braking	Final speed of braking			
1	100	20	Neutral position	(Retarder not operated)	Measurement of running resistance
2	100	Speed determined by idling speed	Shift position at which speed at start of braking is the closest to the maximum speed	Temperature A (atmospheric temperature)	Measurement of braking force according to vehicle speed and temperature
3				Temperature B	
4				Temperature C	
5				Temperature D	
6				Temperature E (the highest temp. that guarantees functions)	

Remark 1: When the vehicle cannot achieve 100 km/h, measurement shall be taken at the maximum speed that is determined by the test shift position.

Remark 2: In Classification 1, the deceleration obtained from the running resistance may be regarded as the vehicle **deceleration** performance when the retarder of which the performance is subject to evaluation is not operated. However, when the retarder is used in combination in Classification 1, the retarder should not be affected by temperature.

c) Measurement interval

Vehicle speed and elapsed time shall be measured every 10 km/h from the specified initial speed of braking until the final speed of braking. An overlapped timing of 5 km shall be provided when measuring at equal intervals, such as 100 to 90 km/h, 95 to 85 km/h, etc.

In the case of non-temperature dependent retarders, the tests shall be performed up to **test Classification 2**. In the case of temperature dependent retarders, the tests shall be performed using temperature as a variable.

In this case, the tests shall be performed using five temperature variables at equal intervals, from low temperature (equivalent to the atmospheric temperature) to the highest temperature where retarder function is guaranteed. Within the same test Classification, every effort shall be made to make the retarder representative temperature when starting measurement and the retarder cooling medium temperature match.

d) Test count

Twice (once following, and once against the wind)

5.4.3 Recording procedure

The recording procedure shall be as follows.

a) Creation of graph

The values obtained after measuring twice in accordance with **5.4.2** shall be recorded in the datasheet as shown in **Attached Table 4**. Braking torque and retarder speed shall be calculated using the formula shown below. The mean value of these measurement items shall be entered in the graph shown in **Attached Table 5**, and braking torque at the representative speed shown in **Table 2** shall be entered in the graph shown in **Attached Table 6**.

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b) Calculation of braking torque

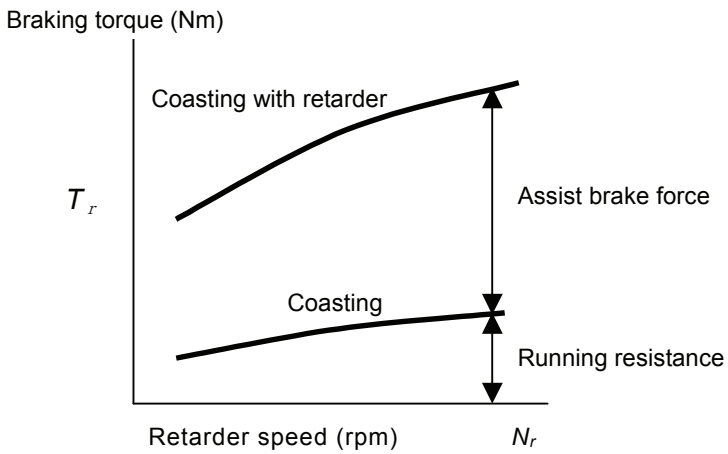
Retarder braking torque (Tr) shall be calculated in two ways as below, depending on the position where the retarder is mounted.

1) When retarder mounted on propeller shaft is used:

$$Tr = \frac{(G_1 - G_2) \times (W + W_1) \times r}{\beta \times (\frac{1}{\varepsilon_2})}$$

2) When engine retarder and exhaust system retarder is used:

$$Tr = \frac{(G_1 - G_2) \times (W + W_1) \times r}{\alpha \times (\frac{1}{\varepsilon_1}) \times \beta \times (\frac{1}{\varepsilon_2})}$$



where,

$$G_1 = \frac{V_1 - V_3}{T_3 - T_1} \times \frac{1}{3.6}$$

$$G_2 = \frac{V_1' - V_3'}{T_3' - T_1'} \times \frac{1}{3.6}$$

T_r: braking torque (Nm)
G_1: assist brake deceleration (m/s^2)
G_2: coasting deceleration (m/s^2)
V_1: speed at start of braking of assist brake (km/h)
V_1': coasting speed at start of braking (km/h)
V_3: final speed of braking of assist brake (km/h)
V_3': coasting final speed of braking (km/h)
T_1: time when assistant brake starts to be applied (s)
T_1': time when coasting brake starts to be applied (s)
T_3: time when assistant brake stops being applied (s)
T_3': time when coasting brake stops being applied (s)
W: vehicle total mass (kg)
W_1: inertia mass of rotating portion (kg)
r: tyre dynamic loaded radius (m)
α: transmission gear ratio
β: final gear ratio
ε_1: transmission gear efficiency
ε_2: final gear efficiency.

The retarder braking torque shall be obtained to the second decimal place.

c) Calculation of retarder speed

Retarder speed shall be calculated in two ways as below, depending on the position where the retarder is mounted.

1) When retarder mounted on propeller shaft is used:

$$Nr = \frac{(\frac{V_1 + V_3}{2}) \times \beta \times 1000}{2 \times \pi \times r \times 60}$$

where, Nr is mean retarder speed (rpm).

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2) When engine retarder and exhaust system retarder is used (retarder shall be calculated assuming that it is equivalent to engine speed):

$$N = \frac{\left(\frac{V_1 + V_3}{2}\right) \times \alpha \times \beta \times 1000}{2 \times \pi \times r \times 60}$$

where, N is mean engine speed (rpm).

6. Recording formats

Recording formats shall be as follows.

a) Vehicle and retarder specifications table

As shown in **Attached Table 1**.

b) Retarder road test datasheet

As shown in **Attached Table 2**.

c) Retarder road performance graph

As shown in **Attached Table 3**.

d) Retarder performance datasheet as single unit

As shown in **Attached Table 4**.

e) Retarder performance graph as single unit

As shown in **Attached Table 5**.

f) Retarder road performance graph according to temperature

As shown in **Attached Table 6**.

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