Passenger car – light trailer combinations – Lane change test procedure

1. Scope

This standard specifies the lane change test procedure for combination vehicles of passenger cars or passenger car-type vehicles (hereinafter referred to as the "towing vehicles") and light trailers (hereinafter referred to as the "combination vehicles").

The light trailer herein refers to a trailer having a vehicle total mass of 750 kg or less, and is specified in the "Camping Trailers Structure Standards" stipulated by the Japan Automobile Manufacturers Association (JAMA) and the Japan Auto-Body Industries Association inc (JABIA). The light trailer herein also includes other equivalent trailers.

2. Normative reference

The following standards contain which, thorough reference in this Standard, constitute provisions of this Standard. The most recent editions of the standard indicated below shall be applied.

JASO Z117-1 Automobile - Steerability and safety test procedure – Part 1:Passenger car standard test conditions

3. Definitions

Definitions of main terms used in this standard shall be as follows.

a) Steering wheel angle

A rotation angle of a steering wheel of the towing vehicle, when the steering wheel is rotated from a straight driving condition. This angle is indicated by δ_H (°).

b) Towing vehicle and trailer lateral acceleration speed

A lateral acceleration speed at a position of the gravity center of the towing vehicle and trailer.

These speeds are indicated by a_Y (m/s^2) and a_Y' (m/s^2), respectively.

c) Lane change speed

A mean value of the vehicle speeds of the combination vehicle during lane change. This speed is indicated by *Vx* (km/h).

d) Reference line

A straight line that is a target of the lane change and aims to minimize variances in the test results. This consists of three zones, that is, entry zone, lane change zone, and exit zone (refer to **Figure 1**).

e) Lane change displacement

A lateral displacement as a result of lane change. This distance is indicated by b_1 (m) (refer to **Figure 1**).

f) Lane change distance

A distance between the entry zone and the exit zone. This is indicated by *L* (m) (refer to **Figure 1**).

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4. Test conditions

4.1 Vehicle conditions

The vehicle condition during testing shall be as follows.

a) A mass and an axial load of the towing vehicle in a non-hitched condition shall be as close as to a value specified in the specification under a condition in which test subjects and test equipment are onboard.

b) The total mass and axial load (such as a hitch load) of the trailer during testing shall be as close as to a value specified in the specification.

c) A condition of tyres and operation devices shall comply with **5.4.2** (Tyre) and **5.4.3** (Operation device) of **JASO Z117-1**.

d) Wheel alignment and play of a steering system of the towing vehicle shall be set to a value specified in the specification.

4.2 Test course and course form

A test course and course form shall be as follows.

a) Test course

A test course shall comply with 5.2 (Test course) of **JASO Z117-1**.

b) Test course form

The test course shall have the signs placed as shown in **Figure 1**. The lane change distance (L) shall be of two types, that is, 40 m and 60 m. The lane change displacement (b_1) shall be 3.6 m. Each of the entry zone (L_1) and the exit zone (L_2) shall have a lane length of 30 m with a width (b_2) of 3.0 m and sign intervals shall be 10 m. Each lane shall have four signs, that is, 16 signs in total. In addition, the reference line for the entry and exist zones shall preferably set long to the extent possible.

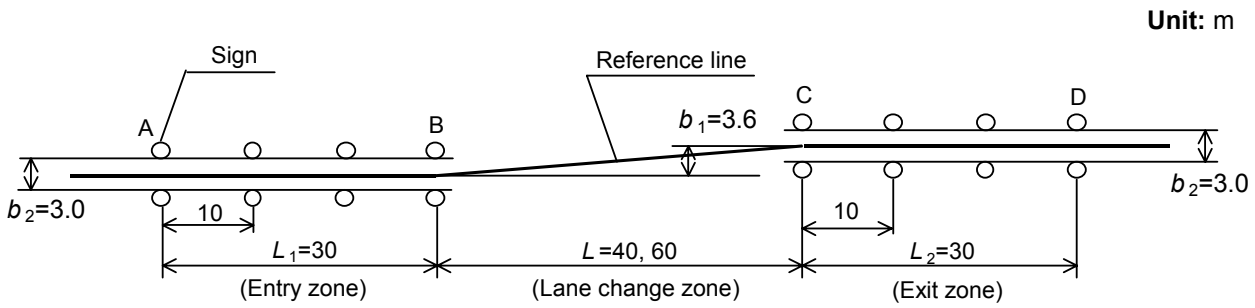

Figure 1 Sign placement and test course (when changing to the left lane)

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4.3 Test equipment

Test equipment shall be as follows.

a) Steering wheel angle measuring device

A device for measuring a steering wheel angle of the towing vehicle.

b) Lateral acceleration measuring device

A device that is set at a position of the gravity center of the towing vehicle and trailer to measure a lateral acceleration speed of the vehicle.

c) Vehicle speed measuring device or timer

A device for measuring a lane change speed or a test course pass time of the test vehicle.

d) Sign

A fixture required for defining the test course.

e) Other

Equipment necessary for taking measurements and recording data.

4.4 Wind speed

The test driving shall be conducted under a natural wind condition in which the wind speed is 3 m/s or less to minimize measurement variance.

5. Test procedure

5.1 Measurement preparation

Approximate values for the characteristics values to be measured shall be checked, and the measuring equipment shall be adjusted and set.

A towing vehicle shall be warmed up in accordance with **6.1** (Warming up) in **JASO Z117-1**.

5.2 Test driving procedure

A lane change direction shall be either one of the left and right directions. In the entry zone (A-B) and the exit zone (C-D), the vehicle shall travel straight along the reference line. When changing the lanes, a driver shall target the reference line with a smooth handling of the steering wheel to the extent possible.

In such a case as when changing lanes at a low speed, the driver shall steer the vehicle so that it travels along the reference line as close as possible. The travelling shall be smooth at a constant speed to the extent possible in accordance with the target vehicle speed. The target lane change speeds (Vx) shall be 40, (50)[(1)], and 60 km/h when the lane change distance (L) is 40 m. Meanwhile, when the lane change distance (L) is 60 m, the target lane change speeds (Vx) shall be 60, (70)[(1)], and 80 km/h. The test driving shall be repeated three times for each combination.

Note: [(1)]

A vehicle speed in the parenthesis is preferably recorded for reference.

Remark: If a maximum speed of the combination vehicle is equivalent to or less than the test vehicle speed specified above, the test shall be conducted up to the maximum speed of the combination vehicle.

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5.3 Measurement

a) A steering wheel angle and a lateral acceleration speed from the start of the test course entry to the completion of the lane change (when the response becomes steady) by the combination vehicle shall be measured.

b) A pass time T (s) or T' (s) in the zone B-C or A-D shall be measured.

5.4 Course pass judgment

When the vehicle touches or knocks down a sign, the relevant driving is considered invalid. When the lane change speed exceeds a range of ±3 km/h relative to a target test vehicle speed, and when a difference between the vehicle speeds at the entry zone and the exist zone exceeds 5 km/h in the visual measurement taken by a speedometer of the towing vehicle, the relevant driving shall be considered invalid

6. Test results evaluation and representation

6.1 Record creation

Each item in **Attached Table 1** shall be checked and filled out prior to the test.

6.2 Data organization and representation procedure

6.2.1 Calculation of lane change speed

A mean vehicle speed shall be calculated by the following equation in the unit of km/h. The speed shall be truncated to the first decimal place and indicated by integral number.

A vehicle speed detection procedure shall be recorded in **Attached Table 2**.

$Vx = 3.6\ L / T$ or $Vx = 3.6\ (L + L_1 + L_2) / T'$ (km/h)

where,

T: B-C pass time (s)

T': A-D pass time (s)

6.2.2 Organization of steering wheel angle and lateral acceleration speed

a) Select a driving cycle that can be considered as a representative driving from the response waveform obtained during three driving cycles. A steering wheel angle (δ_H), a towing vehicle lateral acceleration speed (a_Y) and a trailer lateral acceleration speed (a_Y') shall be recorded in **Attached Table 2** relative to each of the lane change distances (L) 40 m and 60 m, respectively.

b) A size per 1 cm-scale of a coordinate in **Attached Table 2** shall be as follows: time 0.5 s, steering wheel angle 20 °, and lateral acceleration speed 1 m/s^2.

c) A trailer lateral acceleration speed shall be indicated by dotted lines.

d) The origin of a time axis (horizontal axis) shall be a rise time of the steering wheel angle.

e) A lane change direction shall be recorded in **Attached Table 2**.

f) If any noticeable phenomena (such as a roll angle, wheel lift, and rollover risk) which need to be noted are identified, they shall be entered in the remarks column in **Attached Table 2**.

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6.2.3 Representation of maximum value (peak value) of lateral acceleration speed

a) In **Attached Table 3**, a lateral acceleration speed of the towing vehicle and trailer shall be recorded on the vertical axis and a lane change speed shall be recorded on the horizontal axis.

b) Normally, a first reverse response is obtained during steering operation for lane change and a second reverse response is obtained during steering wheel returning operation. These two responses have a peak value, respectively. Therefore, the first maximum peak value shall be entered on the (+) side and the second maximum peak value shall be entered on the (-) side. In this case, be sure to circle the values entered.

c) After the steering wheel returning operation, if there appears a peak that is greater than the second maximum peak value obtained, enter that greater value and put a triangle (△) around it.

This symbol shall be indicated on the (+) side when the direction is same as that for steering operation for lane change, and be indicated on the (-) side when the direction is same as that for steering returning operation.

d) The representative driving as recorded in **Attached Table 2** shall be indicated by blacking out the ● and ▲ symbols.

e) The size of 1 cm-scale of the coordinate as shown in **Attached Table 3** shall be as follows: Lane change speed 5 km/h and lateral acceleration speed 1 m/s^2.

Related standards:

JASO C708 Passenger car – light trailer combinations – Cornering performance test procedure

JASO C709 Passenger car – light trailer combinations – Pylon slalom test procedure

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