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**Method for Measuring Relative Wet Grip Performance of
Passenger Car Tyres**

轿车轮胎湿路面相对抓着性能试验方法

(ISO 23671:2015, Passenger Car Tyres – Method for Measuring Relative Wet Grip
Performance – Loaded New Tyres, MOD)

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Method for Measuring Relative Wet Grip Performance of Passenger Car Tyres

1 Scope

This Standard specifies the method for measuring relative wet grip braking performance index to a reference under loaded conditions for new tyres for use on passenger cars on a wet-paved surface.

This Standard uses the test method comparing with standard reference candidate tyres.

This Standard applies to new passenger car tyres.

2 Normative References

The following documents are essential to the application of this Document. For the dated documents, only the versions with the dates indicated are applicable to this Document; for the undated documents, only the latest version (including all the amendments) is applicable to this Document.

GB/T 6326 Tyre Terms and Definitions (GB/T 6326-2014, ISO 4223-1:2002, NEQ)

GB 9743 Passenger Car Tyres

ASTM E303-93 (re-confirmed in 2013) Standard Test Method Measuring Surface Frictional Properties Using the British Pendulum Tester

ASTM E965-96 (re-confirmed in 2006) Standard Test Method for Measuring Pavement Macrottexture Depth Using a Volumetric Technique

3 Terms and Definitions

For the purposes of this Document, the terms and definitions given in GB/T 6326 and the following apply.

3.1 Candidate tyre

Candidate tyre (set) that is part of an evaluation programme.

3.2 Standard reference test tyre; SRTT

A dedicated set of test tires used as a benchmark in the evaluation system. In order to minimize their variation, these tires have strictly controlled design characteristics and are produced, controlled and stored according to relevant standards.

3.3 Control tyre

Tyre (set) that is part of an evaluation programme; it is an intermediate tyre (set) which is used when the candidate tyre and the reference tyre cannot be directly compared on the same vehicle.

3.4 Braking force of a tyre

Longitudinal force, expressed in newtons, resulting from braking torque application.

3.5 Braking force coefficient of a tyre; BFC

Ratio of braking force to vertical load.

3.6 Peak braking force coefficient of a tyre

Maximum value of tyre braking force coefficient that occurs prior to wheel lockup as the braking torque is progressively increased.

3.7 Lockup of a wheel

Condition of a wheel in which its rotational velocity about the wheel spin axis is zero and it is prevented from rotating in the presence of applied wheel torque.

3.8 Vertical load

Normal reaction of the tyre on the road.

3.9 Tyre test vehicle

Dedicated vehicle which has instruments to measure the vertical and the longitudinal forces on one tyre during braking.

4 Classification of Test Method

There are two ways to test the grip performance of tires on wet roads:

- vehicle method consisting of testing a set of tyres mounted on a standard vehicle;
- test method using a trailer or a tyre test vehicle equipped with the candidate tyres.

deviation of the braking position on the test road surface during the test is required to be within 2m.

$$\text{Temperature correction} = 0.0035(t - 20) \dots\dots\dots (3)$$

$$\text{Average of peak braking force coefficient } (\mu_{\text{peak ave}}) = \text{Peak braking force coefficient (measured)} + \text{Temperature correction} \dots\dots\dots (4)$$

Where:

t – test road surface temperature under wetting condition, in °C.

5.2 Spraying requirements of test road surface

5.2.1 The water spraying device shall be installed on the side of the test road or on the tire test vehicle (trailer). If the roadside spraying is used, it shall be sprayed at least 0.5h before the test to achieve the balance between the test road surface temperature and the water temperature.

5.2.2 During the whole test process, the water spraying state shall be maintained. The water film thickness measured from the middle position of the test road surface shall be controlled within the range of 1.0mm±0.5mm; and the water film thickness shall be uniform throughout the test cycle.

5.3 Climatic conditions

5.3.1 The interference of excessive wind speed on the slippery road surface shall be avoided, and barrier devices can be used if necessary.

5.3.2 When testing snow tires, the temperature of the wet road and the surrounding environment shall be 2°C~20°C; and when testing ordinary tires, it shall be 5°C~35°C. During the test, the temperature change of the wet road surface shall not exceed 10°C. The ambient temperature shall be similar to the wet road surface temperature, and the temperature difference shall not exceed 10°C.

5.4 Standard test tires

The standard test tire specification is 225/60R16 97S, and the standard test tire of this specification shall meet the requirements of the standards of relevant Chinese organizations.

6 Vehicle Method

6.1 Principle

The test method covers a procedure for measuring the deceleration performance of passenger car tyres during braking, using an instrumented passenger car having an Antilock Braking System (ABS). Starting with a defined initial speed, the brakes are applied hard enough on four wheels at the same time to activate the ABS. The average deceleration is calculated between

6.5 Tyres and rims

6.5.1 Tyre preparation and pre-running

6.5.1.1 The candidate tyres shall be new tyres produced in the same batch that meet the requirements of GB 9743; and all test tires shall have no tread vent beard and mold seams.

6.5.1.2 Use conventional installation methods to install the candidate tyre on the rim used by the test vehicle. For ease of installation, it is allowed to use suitable lubricants, but the use of lubricants shall not be excessive to prevent the tyre from slipping on the rim.

6.5.1.3 All assembled candidate tyres shall be placed under the same environmental conditions at the test site for at least 2 hours to ensure the same temperature as the surrounding environment. Protect from heat from the sun.

6.5.1.4 Carry out at least 2 braking runs according to the provisions of 6.4 as the pre-running of the candidate tyre.

6.5.2 Tyre load

The test load of the tyre shall be 60 % ~ 90 % of the tyre load capacity. Tyre loads on the same axle shall not differ by more than 10 %.

6.5.3 Tyre inflation pressure

Before the test, check the inflation pressure of the tyre at ambient temperature. The inflation pressure of the standard tyre and the enhanced tyre is both 220kPa.

6.6 Test procedures

6.6.1 First, mount the set of reference tyres on the vehicle. Accelerate the vehicle in the starting zone up to (85 ± 2) km/h. The brakes shall always be activated at the same area on the track, and same direction, with a longitudinal tolerance of 5 m and a transverse tolerance of 0.5 m.

6.6.2 According to the structure of clutch, two cases of braking are possible.

- a) Manual transmission: As soon as the driver is in the measuring zone and having reached (85 ± 2) km/h, release the clutch and depress the brake pedal sharply, holding it down as long as necessary to perform the measurement.
- b) Automatic transmission: As soon as the driver is in the measuring zone and having reached (85 ± 2) km/h, select neutral gear and then depress the brake pedal sharply, holding it down as long as necessary to perform the measurement.

In order to reduce the test error, the recognition system can be installed on the test road section and the test vehicle respectively. Once the test vehicle enters the test road, it will automatically prompt to start the brake, so that it can be more strictly controlled to test in the same area of the test road.

--- if there is no external water spraying facility, it shall be equipped with a sprinkler device, and the amount of watering shall be controlled;

--- data recorder.

7.2.1.3 Under the maximum load, the maximum change of the toe-in and camber angle of the tyre on the test road surface shall be less than $\pm 0.5^\circ$. The suspension arm and bushing shall be rigid enough to prevent loosening during braking. The suspension system of the test vehicle shall have sufficient bearing capacity to eliminate the resonance of the suspension device.

7.2.1.4 The hydraulic brake device of the test vehicle shall have an automatic function, and once it enters the test road surface, it can be automatically activated to generate a braking force that meets the requirements.

7.2.1.5 The braking system shall be in accordance with the provisions of 7.4.3.2, and maintain effective control from the beginning of braking to the time when the maximum braking torque is generated.

7.2.1.6 The trailer can be equipped with tyres of various specifications that need to be tested.

7.2.1.7 The load of the test vehicle shall be adjusted according to the requirements in 7.5.

7.2.2 If the test vehicle is used to sprinkle water on the test road surface, install the water storage tank on the tractor. Sprinkler nozzles shall spray water evenly on the area where the test tire shall pass, and splash as little as possible. The direction of sprinkling water forms an angle of $20^\circ \sim 30^\circ$ with the road surface, and the sprinkling water should fall 0.25m~0.45m in front of the center of ground contact of the candidate tyre. The installation height of the nozzle is 25mm from the road surface. In order to prevent the nozzle from hitting obstacles, it is allowed to raise the nozzle position appropriately, but it shall not exceed 100mm. The sprinkler area on the test road surface shall be at least 25mm larger than the tread width of the candidate tyre and ensure that the sprinkler area is symmetrical on both sides of the tread contact point. The amount of water delivery shall be able to ensure that the depth of the water film is 1.0 ± 0.5 mm; and the amount of water sprinkled is in a corresponding relationship with the test speed. When the test speed is 65km/h, the depth of the water film must be 1.0mm. The sprinkling amount should be 18L/s, with a tolerance of $\pm 10\%$ every 1m wide of test road.

7.2.3 Test apparatus.

7.2.3.1 Basic requirements

The test wheels of trailers or special tire test vehicles shall be equipped with tachometers and sensors for measuring braking force and vertical load.

Under the ambient temperature of $0^\circ\text{C} \sim 45^\circ\text{C}$, the whole measurement system shall meet the following requirements:

--- Force measurement accuracy: $\pm 1.5\%$ of the full scale of the vertical load or braking force;

- Speed measurement accuracy: $\pm 1.0\text{km/h}$ or $\pm 1.5\%$ of full scale, whichever is greater;
- Can withstand 100% humidity and other harsh environmental conditions, such as dust, shock, vibration and other conditions that may be encountered.

7.2.3.2 Speed measuring device

Use a special five-wheel instrument, GPS or other non-contact speedometer to measure the vehicle speed. It is required that the vehicle speed can be directly displayed and recorded at the same time during the test.

7.2.3.3 Braking force measuring device

The scale of the braking force sensor shall meet the 0%~125% vertical load requirement of the tyre to be tested. The sensor shall be designed and positioned to minimize the effects of inertial effects and mechanical resonance.

7.2.3.4 Vertical load measuring device

Use a force sensor to measure the vertical load, and the specific requirements are as described above.

7.2.3.5 Signal processing and recording devices

The data processing and recording device shall provide linear output and data resolution as previously described, and shall also meet the following requirements:

- The minimum response rate within 1% of full scale is 0Hz~100Hz;
- The signal-to-noise ratio is no less than 20/1;
- the gain shall be sufficient to provide a full-scale display for a full-scale input signal;
- The input impedance shall be no less than 10 times the output signal source impedance;
- The testing equipment shall be able to withstand vibration, acceleration and changes in ambient temperature.

7.3 Preparation and selection of candidate tyre

7.3.1 The candidate tyre be new tyres that meet the requirements of GB 9743, and all tyres to be tested shall be free of tread vent bead and mold seam rubber edges during the test.

7.3.2 Assemble the tyre on the rim of the test vehicle according to the conventional method; and check whether the bead and the rim are securely attached. It is allowed to use an appropriate amount of lubricant to facilitate the installation of the tyre, but the use of lubricant shall not be excessive to prevent the tire from slipping with the rim.

7.5 Test load

The test load is 75%±5% of the tyre load capacity.

7.6 Test procedure

7.6.1 The test vehicle goes straight to the test road at the specified speed of 65km/h±2km/h.

7.6.2 Turn on the recording system.

7.6.3 Sprinkle water on the test road surface about 0.5s before starting the brake test.

7.6.4 When the tyre to be tested enters the test point, the brake is started, and each test is required to be strictly controlled in the same area and direction of the test road.

7.6.5 Stop recording.

7.6.6 Steps 7.6.1~7.6.5 shall be repeated at least 6 times for each tyre, and the driving direction of each test is the same. If it is a new tyre, the first two tests are used as pre-running, and the test results are discarded.

7.6.7 Under the same test cycle, a maximum of three sets of candidate tyres can be tested; and the entire test cycle shall be completed within the same day.

7.6.8 If three sets of candidate tyres are tested in the whole test cycle, the candidate tyres and standard test tires shall be tested in the following order: R-T₁-T₂-T₃-R-T₄-T₅-R, R stands for standard test tyres, T_n represents n set of test tyres. Between the front and rear tests of standard test tyres, a maximum of three sets of candidate tyres shall be tested.

A maximum of 3 test tyres can be tested in one group, and then the standard test tyres shall be tested. See 6.6 example for the specific sequence.

7.7 Processing of test data

7.7.1 Calculate the braking force coefficient according to Formula (11).

$$\mu(t) = \left| \frac{f_h(t)}{f_v(t)} \right| \dots\dots\dots (11)$$

Where:

$\mu(t)$ - (instantaneous) braking force coefficient;

$f_h(t)$ - (instantaneous) braking force, in N;

$f_v(t)$ - (instantaneous) test load, in N.

7.7.2 The measured data shall be processed first; the interference caused by noise shall be

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