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Test method for measuring impact resistance of passenger car tyres - Pendulum striker method

轿车轮胎耐撞击性能试验方法 摆锤法

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Table of Contents

Test method for measuring impact resistance of passenger car tyres - Pendulum striker method

1 Scope

This document describes the test equipment and accuracy, test conditions and test preparation, test procedures, data processing, and test reports for testing tire impact resistance using the pendulum method.

This document is applicable to testing the impact resistance of pneumatic tires of new passenger car.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 3487, *Rims for passenger car*

GB/T 6326, *Tyre terms and definitions*

3 Terms and definitions

For the purposes of this document, the terms and definitions defined in GB/T 6326 as well as the followings apply.

3.1 drop height

The height at which the center of gravity of the pendulum drops.

3.2 drop angle

When the striker is at drop height, the angle of the pendulum relative to when it is freely hanging.

3.3 striker mass center

When the pendulum is freely suspended, the intersection of the vertical line passing through the fulcrum of the pendulum and the horizontal line passing through the center of the front end of the striker.

The height to which a tire bulges after impact.

3.10 robustness factor; f

An evaluation index of tire impact resistance.

3.11 impact bulge energy; E_{bu}

The impact energy when a striker hits a tire causing a tire bulge or air leak.

4 Test equipment and accuracy

4.1 Impact test equipment (see Figure A.1 of Annex A) includes:

a) A pendulum: with a fulcrum at one end and a swing arm equipped with a striker at the other end, with a length of (1830.0±18.3) mm and an impact mass of (62.0±3.0) kg (see Figure A.2 and Figure A.3);

NOTE: The impact mass is the mass acting on the tire through the striker.

b) Frame: a solid component used to support the fulcrum of the pendulum;

c) A mechanism for lifting and releasing the pendulum;

d) Locking device: a clutch device that can lock the pendulum after a single impact to prevent a second impact;

e) Pivot with very small friction (self-aligning ball bearing);

f) Striker: a raised impactor fixed to the pendulum by bolts and used to impact the tire rim assembly (see Figure A.4; the technical requirements shall comply with the provisions of Annex B);

g) Striker bracket (see Figure A.5);

h) Striker assembly (see Figure A.6);

i) Base: a solid part used to secure the tire rim assembly fastening device;

j) Angle sensor: the error is not greater than ±0.1°.

4.2 Inflatable pressure gauge: the accuracy is ±5 kPa.

4.3 Bulge measuring instrument (see Annex C): the accuracy is ±0.02 mm.

4.4 Image recording equipment: be able to use colorful, clear, and storable images to record bulges or air leaks that occur during the test.

5 Test conditions and test preparation

5.1 The tires used in the test shall be parked indoors for at least 24 h after vulcanization. The test rim shall be a steel rim. The rim specification model shall be the measurement rim corresponding to the tire specification. Its contour curve shall comply with the provisions of GB/T 3487. Tires used on vehicles equipped with flexible rims shall be tested using flexible rims consistent with the requirements of the vehicle. Explain this in the test report.

NOTE: Steel rim refers to a rim that is machined and used only for indoor testing.

5.2 The test air pressure is 200 kPa.

5.3 The test environment temperature is 5℃~40℃.

5.4 The test samples are 2 tires. Determine test points equally spaced at approximately 30° intervals in the circumferential direction on the sidewall of each test tire. Mark and number them one by one.

5.5 Mount the test tire on the test rim. Fill with the air pressure specified in 5.2. Park at test ambient temperature for at least 3 h.

5.6 The tire rim assembly shall be mounted on the fastening device of the testing machine. Tighten the rim. The torque shall be 115 Nm ± 7 Nm. Make sure there is no rotation or looseness during impact.

6 Test procedures

6.1 A tire test procedure in the test sample

6.1.1 Readjust the tire pressure after parking to the pressure specified in 5.2.

6.1.2 Set the striker angle. The camber angle of the striker shall be fixed at 6°. The slip angle 0°. The deviation is ±0.5°.

6.1.3 Install the tire rim assembly on the tire rim fastening device. Tighten according to the torque specified in 5.6. Make sure the rim does not rotate circumferentially. When installing, adjust the pendulum to a free hanging state. Keep the tire's center of rotation on the same level as the center of the top of the striker. Adjust tires and their tightening devices. Allow the tire shoulder to touch the middle of the striker. The resulting angular displacement of the pendulum shall not exceed 0.1°.

6.1.4 Adjust the impact energy to 380 J or other suitable empirical values. Let the pendulum fall freely from the locked position. After an impact is made on the test tire (any test point away from the valve), check whether the tire has one of the conditions

specified in 6.1.9. If it does not occur, impact the same test point of the tire with an impact energy of 60 J increments each time until one of the conditions specified in 6.1.9 occurs. Use image recording equipment to record the location of the bulge or air leak (if any). Record the drop angle of the latest impact and the impact bulge energy E_{bu} of the bulge. If there is air leakage, indicate it.

6.1.5 For each impact, the pendulum shall be raised to the appropriate drop angle. Lock the device. The pendulum is then allowed to fall freely from the locked position to impact the test tire. When the pendulum rebounds, the locking device locks the pendulum.

6.1.6 The time interval between each impact shall be no less than 3 min. If a bulge or air leak occurs after each impact, the image recording equipment shall be used to record the bulge area. Measure the height of the bulge after 3 min and record it. Check tire pressure. If the air pressure loss exceeds 5% of the air pressure specified in 5.2 within 3 min, the test will be terminated. If there are no abnormalities, continue to the next test. Air pressure shall be corrected before impact. Check whether the fastening bolts of the striker are tight.

6.1.7 After completing the test steps 6.1.4, if the test tire does not leak, rotate the test tire to the next test point. When one of the situations specified in 6.1.9 occurs after the impact energy is set to the test step of 6.1.4, the corresponding impact energy is subtracted by 60 J, and the test tire is impacted once. Thereafter, before each impact, the test tire shall be rotated to the next test point. The impact energy is increased by 30 J until the test tire occurs one of the conditions specified in 6.1.9. Use image recording equipment to record the location of the bulge or air leak (if any). Record the drop angle of the latest impact and the impact bulge energy E_{bu} of the bulge. If there is air leakage, indicate it.

6.1.8 6.1.5 and 6.1.6 shall be repeated before and after each impact. It is allowed to change the tire to one side and continue the test.

6.1.9 During the test, if one of the following situations occurs, the test shall be stopped:

a) The impact point causes air leakage due to tire damage or the air pressure loss within 3 min exceeds 5% of the air pressure specified in 5.2.

b) During the impact point test or during the visual inspection after the test, there is obvious delamination, chipping, joint cracks, cracks or ply exposure.

c) During the impact point test, the rim is damaged due to impact and leaks, and the tire continues to leak during the inflation process after replacing the rim; or the air pressure loss when inspected 15 min after inflation exceeds 5% of the air pressure specified in 5.2; or cracks appear.

d) The height of the bulge at the impact point is not less than 1 mm.

specifications is used. Only reinforced tires do not have the specifications of standard tires. The load index is subtracted by 4 from the load index of reinforced tires.;

c - The constant, in millimeter (mm), c = 80 mm;

H - The nominal section height of the tire, in millimeters (mm), calculated using formula (2), rounded to an integer;

D - The outer diameter of the tire, in millimeter (mm), calculated according to formula (3), rounded to an integer.

$$H = S_N \times A_r / 100 \qquad \cdots\cdots (2)$$

Where,

S_N - The nominal section width of the tire, in millimeters (mm);

A_r - The nominal aspect ratio of the tire.

$$D = D_r + 2H \qquad \cdots\cdots (3)$$

Where,

D_r - The nominal diameter of the rim, in millimeters (mm).

8 Test report

The test report shall include the followings:

a) Name, trademark and specifications of the test tire manufacturer;

b) Test tire load index or level, maximum load capacity, speed symbol;

c) Test air pressure;

d) Test rim specifications (if non-steel rims or other special rims are used, please indicate);

e) Striker angle during test;

f) Drop angle, drop height, impact energy, and bulge height of each impact during the test;

g) Impact bulge energy or impact energy corresponding to 175°, robustness factor;

Annex B

(normative)

Technical requirements for strikers

B.1 Calculation of the radius of rotation about the axis by the center of gravity

The radius of rotation around the axis through the center of gravity is calculated according to formula (B.1):

$$k = \sqrt{\frac{9.806\ 65 \times a}{(2\pi \times n)^2} - a^2} \qquad \cdots\cdots (B.1)$$

Where,

k - The radius of rotation around the axis through the center, in meters (m);

a - The distance from the center of gravity to the fulcrum, in meters (m);

π - 3.1416;

n - Frequency, the number of oscillations per unit time, in oscillations/s.

B.2 Calculation of distance from center of gravity to center of impact

The distance from the center of gravity to the center of impact is calculated according to formula (B.2):

$$c = \frac{k^2}{a} \qquad \cdots\cdots (B.2)$$

Where,

c - The distance from the center of gravity to the center of impact, in meters (m);

k - The radius of rotation around the axis through the center, in meters (m);

a - The distance from the center of gravity to the fulcrum, in meters (m).

B.3 Calculation of equivalent mass at impact center

The equivalent mass at the impact center is calculated according to formula (B.3):

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