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**Coast-by methods for measurement of tyre-to-road sound
emission**

轮胎惯性滑行通过噪声测试方法

(ISO 13325:2003, Tyres - Coast-by methods for measurement of tyre-to-road
sound emission, MOD)

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Coast-by methods for measurement of tyre-to-road sound emission

1 Scope

This standard specifies the test method for measuring the noise of the tyre mounted on a test vehicle or trailer under coast-by conditions. Coasting refers to the condition in which the engine is off, there is no power drive, the transmission is in neutral, and the test tyre is in a free rolling state. The tyre noise test results of the vehicle method are closer to the actual effect than the trailer method, but the tyre noise is affected by the suspension parameters; the trailer method test results are closer to the actual noise produced by a single tyre.

This standard applies to new passenger car tyres and truck tyres. It is neither suitable for measuring the tyre noise (sound field distribution) of vehicles under normal driving conditions, nor is it suitable for measuring the traffic noise and the degree of harm of vehicles at a given position under normal driving conditions.

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 standard.

GB/T 3785.1-2010 Electroacoustics - Sound level meters - Part 1: Specifications (IEC 61672-1:2002, IDT)

GB/T 6326 Tyre terms and definitions (GB/T 6326-2014, ISO 4223-1:2002, Definitions of some terms used in tyre industry - Part 1: Pneumatic tyres, NEQ)

GB/T 15173-2010 Electroacoustics - Sound calibrators (IEC 60942:2003, IDT)

ISO 362.1 Measurement of noise emitted by accelerating road vehicles - Engineering method - Part 1: M and N categories

ISO 10844 Acoustics - Specification of test tracks for measuring noise emitted by road vehicles and their tyres

requirements of GB/T 3785.1-2010 and GB/T 15173-2010 at intervals not exceeding 1 year.

When the wind speed reaches 2 m/s or more, the microphone shall use a windshield.

The test site and the road surface shall comply with the requirements of ISO 10844, as shown in Figure 1. In addition, there are no acoustic reflectors within the radius shown in Figure 1.

6.2 Microphone

Two microphones shall be used in the test, one on each side of the vehicle (or trailer). There shall be no acoustic reflectors near the microphones, and no person shall stand between the sound source and the microphones. The observer who makes the measurement shall also stand at least 20 m away from the microphone so as not to affect the measurement results of the instrument.

The microphone shall be located $1.2 \text{ m} \pm 0.02 \text{ m}$ above the ground and $7.5 \text{ m} \pm 0.05 \text{ m}$ from the centerline of travel of the vehicle. Its reference axis shall be horizontal and perpendicular to the centerline of travel of the vehicle.

6.3 Temperature measurement

6.3.1 General remarks

For air and test road surface temperatures, the accuracy of the thermometer or other temperature-measuring instruments shall be within $\pm 1 \text{ }^{\circ}\text{C}$. Infrared thermometers cannot be used to measure air temperature.

The type of temperature sensor used shall be documented.

The temperature can be continuously recorded by instruments and equipment. If conditions are not available, single values can be measured and recorded.

Air temperature and test road surface temperature measurements are mandatory, and the final readings shall be rounded to the nearest integer of degrees Celsius from the actual measured value.

Whether it is the vehicle method or the trailer method, the temperature measurement shall be throughout the whole process of the tyre noise measurement, or the average value of the temperature at the beginning and end of the test shall be used.

6.3.2 Air temperature

The temperature sensor shall be placed in a sheltered place near the microphone, e.g.,

it is exposed to air currents and out of direct sunlight; a sunshade screen or similar device can be used to achieve the same effect. The temperature sensor shall be located $1.2 \text{ m} \pm 0.1 \text{ m}$ above the test road surface to reduce the influence of low airflow caused by heat radiation from the test road surface.

6.3.3 Test road surface temperature

The temperature sensor shall be placed in a position where the temperature is representative of the temperature in the wheel tracks, without interfering with the measurement of the tyre noise.

If a contact temperature sensor is used, an adhesive with good thermal conductivity shall be used between the road surface and the sensor to ensure adequate thermal conduction.

If a thermal radiation thermometer is used, the height shall be chosen to ensure that a measuring spot that is $\geq 0.1 \text{ m}$ from the thermometer is covered.

The test road surface shall not be artificially cooled before and during the test.

6.4 Measurement of the wind speed

The accuracy of the anemometer shall be within $\pm 1 \text{ m/s}$. The anemometer shall be at the height of the microphone, between A-A and B-B, and not more than 20 m from the centerline of travel (see Figure 1); it shall record the wind direction at the same time.

6.5 Measurement of the speed

The speed measuring device shall be able to test the speed of the test vehicle or trailer and ensure that the error is within $\pm 1 \text{ km/h}$.

7 Meteorological conditions and background noise

7.1 Meteorological conditions

Measurements shall be taken in good weather conditions. During the test, the wind speed at the height of the microphone shall not exceed 5 m/s. When the air temperature is within the range of 5 °C to 40 °C or the road surface temperature is within the range of 5 °C to 50 °C, the test can be carried out. It shall be noted that the measurements shall not be affected by gusts of wind.

7.2 Temperature correction

The temperature correction is only applicable to passenger car tyres and truck tyres (the

Appendix A

(Normative)

Vehicle method

A.1 Overview

A.1.1 Test vehicle

The test vehicle shall have two axles, each with two tyres, and shall be able to withstand the load specified in A.1.4.

A.1.2 Wheelbase

The wheelbase between the two axles on which the test tyres are installed shall be:

- a) ≤ 3.5 m, suitable for passenger car tyres.
- b) ≤ 5.0 m, suitable for truck tyres.

A.1.3 Measures to reduce the impact of the vehicle on tyre noise during the test

In order to ensure that tyre noise is not affected by the structure of the test vehicle, the following requirements and suggestions shall be put forward for the test vehicle:

- a) Requirements:
 - 1) Mudguards or other additional devices shall not be installed;
 - 2) No additional components that may affect noise radiation are allowed near the edge of the wheel (tyre and rim);
 - 3) Wheel alignment (toe-in of the front wheel, camber of the front wheel, kingpin caster angle of the vehicle) shall be checked on the vehicle without load, and it shall fully meet the factory requirements of the vehicle manufacturer;
 - 4) Sound-absorbing materials cannot be installed on the guards around the wheels or on the bottom of the vehicle;
 - 5) The windows and sunroof of the vehicle shall be closed during the test.
- b) Recommendations to avoid additional noise:

- a) For passenger car tyres and truck tyres (the single-tyre load index is ≤ 121 and the speed category is N and above), the speed shall be 70 km/h~90 km/h.
- b) For truck tyres whose single-tyre load index is less than or equal to 121 and the speed category is M and below or truck tyres whose single-tyre load index is ≥ 122 , the speed shall be 60 km/h~80 km/h.

See A.2.2 for relevant reference speeds.

A.1.8 Determination of test data (A-weighted sound level)

Each time the test vehicle passes between the A-A line and the B-B line, the maximum sound pressure level of the two microphones shall be recorded.

If there is a significant difference (abnormal) between the recorded maximum sound pressure level and the actual sound pressure level, the measurement is invalid. For example, under the same speed conditions, repeated tests are carried out many times, and the repeatability of the results is poor (the maximum A-weighted sound level varies greatly), then the measurement is considered invalid.

A.1.9 Number of measurements

For each microphone located on the left and right sides, the measuring shall be carried out at least 4 times at a speed higher than the reference speed (see A.2.2), and at least 4 times at a speed lower than the reference speed. These speeds shall be evenly distributed within the range of test speeds specified in A.1.7 roughly. It shall be ensured that the measuring is carried out with the reference speed used as the standard for 4 times.

A.1.10 Recommended frequency spectrum measurement

It is recommended to measure the one-third-octave band frequency spectrum curve of “A” frequency weighting characteristic at the same time, and the result shall be consistent with the result of “F” time weighting characteristic. The data shall be the one-third-octave band frequency spectrum curve corresponding to the maximum A-weighted sound level when the vehicle passes by.

A.2 Data processing

A.2.1 Temperature correction

See 7.2.

A.2.2 Reference speeds

In order to obtain the standard noise at a certain speed, the reference speed V_{ref} is defined

Appendix B

(Normative)

Trailer method

B.1 Towing vehicles and trailers

B.1.1 Overview

The test equipment consists of a towing vehicle and a trailer.

B.1.1.1 Towing vehicle

B.1.1.1.1 A-weighted sound level

The rolling sound of the towing vehicle can be minimized by appropriate measures, such as the use of low-noise tyres, shielding, and aerodynamic skirts. Ideally, the A-weighted sound level of the tyre measured in the towing vehicle test is at least 10 dB(A) lower than the A-weighted sound level measured in the combination test of the towing vehicle and the trailer. In this case, multiple measurements on the towing vehicle alone are not necessary. Since the noise emitted by the towing vehicle does not need to be deducted, the measurement accuracy of the noise emitted by the trailer tyres can be greatly improved. The A-weighted sound level difference and the A-weighted sound level of the tyre shall be recorded.

B.1.1.1.2 Load

In the combination test of the towing vehicle and the trailer and the test of the towing vehicle only, the load on the tyres of the towing vehicle shall not change. In order to obtain a constant load, a counterweight shall be added during the test of the towing vehicle alone.

B.1.1.2 Trailer

B.1.1.2.1 Single-axle trailer

The trailer shall be a single-axle, two-wheel trailer with a drawbar and facility for varying wheel loads. In order to minimize the impact of baffle reflections, closed floors and paneling cannot be used. The tyres shall be exposed, not covered by tyre covers or mudguards.

B.1.1.2.2 Drawbar length

B.3 Measurement procedure

B.3.1 Overview

In this test, two sets of measurements shall be made:

- a) Carry out the towing vehicle test alone, and record the measured A-weighted sound level according to the following procedure.
- b) Carry out the combination test of towing vehicle and trailer, and record the test results of the A-weighted sound level.

B.3.2 Vehicle position

The towing vehicle or towing vehicle and trailer combination shall approach the line E-E with the engine off (the transmission in neutral and the clutch disengaged), and the centerline of the vehicle shall be as close as possible to the centerline of the travel, as shown in Figure B.1.

B.3.3 Reference speed

Before the towing vehicle enters the test zone (E-E or F-F, as shown in Figure B.1), it shall reach a sufficient speed, so that when the engine of the towing vehicle is turned off, the vehicle and the trailer can coast into the test zone. Between A-A and B-B, for passenger car tyres and truck tyres (the single-tyre load index is less than or equal to 121 and the speed category is N and above), the reference speed shall be (80 ± 1) km/h; for truck tyres whose single-tyre load index is less than or equal to 121 and the speed category is M and below or truck tyres whose single-tyre load index is 122 and above, the reference speed shall be (70 ± 1) km/h.

B.3.4 Data collection

B.3.4.1 Noise measurement

In the test zone between A-A and B-B, as shown in Figure B.1, the sound pressure level and maximum sound pressure level of the tyre that vary with the position and the time during the test shall be recorded throughout the test. In addition, during the test tyre passes through the entire measurement area, it is necessary to record the sound pressure level of each microphone based on the F weighing time interval of no more than 0.01 s. In the subsequent analysis, this latter set of data will be used as the time history sound pressure level.

The time history measurement starts when the trailer is at the A-A line and ends when it is at the B-B line (see Figure B.1).

a) Preparation:

- 1) Set the time trigger point on the trailer.
- 2) Measure the distance from the trailer to the towing vehicle.
- 3) As shown in Figure B.1, determine the locations of E-E, A-A, P-P, B-B, and F-F on the test site; set the trigger device so that the sound pressure level recording begins at E-E and stops at F-F.
- 4) For passenger car tyres and truck tyres (the single tyre load index is less than or equal to 121 and the speed category is N and above), the reference speed between A-A and B-B shall be (80 ± 1.0) km/h; for truck tyres whose single tyre load index is less than or equal to 121 and the speed category is M and below or whose single tyre load index is 122 and above, the reference speed shall be (70 ± 1.0) km/h. Measure the speed of the test tyre from A-A to B-B, which is equivalent to the section from A-A to B-B displayed by the trailer's time indicator.
- 5) Set the data collector so that the time history is always from E-E to F-F for the towing vehicle alone test or the combination test of the towing vehicle and the trailer. According to B.3.6, set the trigger to generate the indication pulse when P-P is reached, and compare the time history records.
- 6) Check air temperature and wind speed measuring instruments.

b) Solo test (towing vehicle alone), at least five times:

- 1) When the towing vehicle passes each microphone position, record the maximum A-weighted sound pressure level and the time history of this sound pressure level; carry out this measurement procedure continuously until the five maximum sound pressure levels are within ± 0.5 dB compared with their arithmetic mean, and record the position of each microphone.
- 2) Five time histories shall be temperature-corrected.
- 3) Use these five time histories to determine the time history of the average sound pressure level.
- 4) Carry out 1) to 3) in b) of this test at the beginning and end of each series of tests. If the air temperature does not change by more than 5 °C during the test period, the trailer test can be carried out.

c) Combination test (towing vehicle and trailer), at least five times:

- 1) When the towing vehicle passes each microphone position, record the maximum A-weighted sound pressure level and the time history of this sound pressure level; carry out this measurement procedure continuously until the five maximum sound pressure levels are within ± 0.5 dB compared with their arithmetic mean, and record the position of each microphone.
- 2) Five time histories shall be temperature-corrected.
- 3) Use these five time histories to determine the time history of the average sound pressure level.

B.4 Determination of the sound pressure level of tyre noise

B.4.1 Taking into account the influence of the towing vehicle

Before the calculation of the A-weighted sound level of the coast-by tyre, a test shall be carried out to ensure the data is valid. The difference between the measured values from the towing vehicle alone test and the combination test of towing vehicle and trailer shall be sufficient enough to ensure accurate calculation of the A-weighted sound level of the tyre.

This difference is judged by the following two methods.

- a) Maximum sound pressure level difference ≥ 10 dB

For two microphones, if the average value of the maximum A-weighted sound level of the towing vehicle alone is at least 10 dB less than the average value of the maximum A-weighted sound level of the towing vehicle and trailer combination, then the measurement is valid; it means that all environmental conditions and background sounds, etc. have met the requirements. In this case, the A-weighted sound of the tyre level is the average value of the maximum A-weighted sound levels measured during the combination test of the towing vehicle and the trailer, as shown in the formula (B.2):

$$L_{\text{tyre}} = \bar{L}_{\text{TP}} \dots\dots\dots (\text{ B.2 })$$

where:

L_{tyre} --- A-weighted sound level of the test tyre (that is, the value in the report).

- b) Maximum A-weighted sound level difference < 10 dB

For one or two microphones, if the difference between the average maximum sound pressure level of the towing vehicle alone and the average maximum A-weighted

alone and the combination (towing vehicle and trailer) are correct; if the difference is <10 dB, then the tyre A-weighted sound level is calculated by the logarithmic subtraction of the combination (towing vehicle and trailer) and the towing vehicle sound pressure levels as given in the following formula. For this logarithmic subtraction, the average time history values noted in Figure B.2 above are applied. The tyre A-weighted sound level in the report is the calculation result of the formula (B.3).

$$L_{\text{tyre}} = 10 \lg [10^{(L_{\text{TP}}/10)} - 10^{(L_{\text{T}}/10)}] \text{ dB} \quad \dots\dots\dots (\text{ B.3 })$$

where:

L_{TP} --- The maximum A-weighted sound level of the test pass (the combination of towing vehicle and trailer);

L_{T} --- A-weighted sound level measured by the towing vehicle at the same position as L_{TP} without a trailer.

B.4.3 Determination procedure of sound pressure level

If the average maximum A-weighted sound level of the combination (towing vehicle and trailer) measured by the left and right microphones is 10 dB greater than the average maximum A-weighted sound level of the towing vehicle alone, then the sound pressure level of the combination is equal to the tyre A-weighted sound level [as calculated by steps a), b), and c) in B.3], the following procedures are unnecessary.

If the difference is less than 10 dB, proceed as follows:

- a) Align the appropriate solo towing vehicle and the combination average A-weighted sound level time histories and determine the arithmetic difference for each increment in time. Record the A-weighted sound level difference at the point of the maximum sound pressure level of the combination (towing vehicle and trailer). Repeat this step for each test.

If the difference is >10 dB, then the A-weighted sound level of the combination is equal to the A-weighted sound level of the tyre.

- b) If the calculated difference is less than 10 dB and greater than 3 dB, determine the logarithmic difference of the maximum average time history A-weighted sound levels of the combination (towing vehicle and trailer) and the towing vehicle alone when the maximum A-weighted sound level of the combination (towing vehicle and trailer) occurs.
- c) If the difference is less than 3 dB, the measurement is invalid. The A-weighted

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