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Method for Judging Spring Effect of Commercial Vehicle Equipped with Air Suspension

装备空气悬架的商用车减振效果判定方法

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1 Scope

This Document specifies the technical requirements for judging the vibration reduction effect of commercial vehicles equipped with air suspension, as well as the vehicle test methods for natural frequency and damping ratio.

This Document applies to M_2, M_3, N_2, N_3, O_3, and O_4 category vehicles equipped with rear axle air suspension; other vehicles shall refer to this Document for guidance.

2 Normative References

The provisions in following documents become the essential provisions of this Document through reference in 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 1589 Limits of dimensions, axle load and masses for motor vehicles, trailers and combination vehicles

GB/T 3730.2 Road vehicle – Masses - Vocabulary and codes

GB/T 34591 Terms of air suspension for commercial vehicle

3 Terms and Definitions

For the purposes of this Document, the terms and definitions given in GB 1589, GB/T 3730.2, GB/T 34591 and the following apply.

3.1 Damping ratio

The ratio of the actual damping coefficient to the critical damping coefficient.

[SOURCE: GB/T 2298-2010, 3.96]

3.2 Sprung mass

The mass of the load above the suspension elastic elements, that is, the mass of the load borne by the suspension.

[SOURCE: GB/T 12549-2013, 6.2.2]

3.3 Air spring load ratio

The ratio of the mass carried by the air spring in the suspension to the sprung mass.

4 Judgment Technical Requirements

4.1 When all axles (or axle groups) of a vehicle are under maximum permissible axle load, the vibration reduction effect of all rear axles equipped with air suspension in M_2 and M_3 category vehicles shall meet the requirements of 4.3, 4.4, and 4.6. Failure to meet these requirements shall result in the vehicle not being considered as equipped with air suspension.

4.2 When all axles (or axle groups) of a vehicle are under maximum permissible axle load, the vibration reduction effect of all rear axles equipped with air suspension in N_2, N_3, O_3, and O_4 category vehicles shall meet the requirements of 4.3 to 4.6. Failure to meet these requirements shall result in the vehicle not being considered as equipped with air suspension.

4.3 When all axles (or axle groups) of a vehicle are under maximum permissible axle load, the air spring load ratio shall be no less than 50%. The air spring load ratio is calculated according to Formula (1). For axle groups, the air spring load ratio of each axle shall be calculated separately, and the calculation results shall be recorded with reference to Appendix A.

$$\eta = m_a / m \times 100\% \quad \cdots\cdots (1)$$

Where:

η – air spring load ratio, in %;

m_a – air spring load capacity, in kg;

m – sprung mass, in kg.

4.4 The natural frequency of the air suspension shall be no greater than 2.0 Hz.

4.5 The damping ratio of the air suspension shall be no less than 0.2.

4.6 The ratio of the damping ratio of the air suspension without damper to that with damper shall be no greater than 50%.

5 Vehicle Test Methods for Natural Frequency and Damping Ratio

5.1 Test Vehicle

5.1.1 The air suspension condition shall meet the vehicle manufacturer's technical requirements.

5.1.2 The tire tread depth shall be at least 50% of the original tread depth; and the tire inflation pressure shall meet the vehicle design technical requirements, with an error not exceeding ±3% of the specified inflation pressure.

5.1.3 The axles (groups) shall be under maximum permissible axle load.

5.2 Road conditions

The test road shall be a straight, firm asphalt or concrete surface; dry and flat; with a longitudinal slope not exceeding 1%; uniform unevenness without abrupt changes; and a road length no less than the minimum road length required for the test data collection time.

5.3 Wind speed

Wind speed shall not exceed 5 m/s.

5.4 Test instruments

5.4.1 Test instruments include accelerometers, data acquisition devices, etc.; suitable for impact measurement, and with stable and reliable performance.

5.4.2 The sampling frequency of the test instruments shall be no less than 100 Hz.

5.5 Test apparatus

The test shall use rigid, hard wedge-shaped bumps or other similar devices. The height (H) of the device shall be 80 mm to 85 mm (see Figure 1). The lateral width of the device shall ensure that all wheels of the test vehicle axle (group) are placed on it.

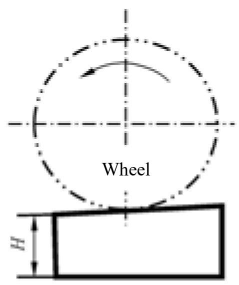

Figure 1 – Schematic diagram of wedge-shaped bump

5.6 Test procedure and data processing

5.6.1 Install an accelerometer at the corresponding position on the frame (or bus body) above each test axle.

5.6.2 Select the appropriate number of test devices of the same height based on the number of axles equipped with air suspension on the vehicle.

5.6.3 Drive the wheels of the test axle (group) onto the test device, brake the vehicle, shift to neutral, and stop the engine (or electric motor).

5.6.4 Start the free vibration acceleration recording device.

5.6.5 Release the brakes; and the vehicle moves along the wedge-shaped bump under gravity; with all wheels of the test axle (group) simultaneously falling from the test device. If using other similar devices, all wheels of the test axle (group) shall fall from the test device simultaneously. The wheels shall not touch the test device after landing.

5.6.6 Stop recording free vibration acceleration when the vehicle comes to a stop.

5.6.7 The test data is low-pass filtered with a cutoff frequency of 5 Hz and fitted to form a free vibration decay curve (see Figure 2). The curve shall be complete and without abnormalities. The time interval and peak value of the first and second suspension compression states of the vibration decay curve are read; and the natural frequency and damping ratio of the air suspension are calculated according to Formulae (2) and (3).

$$f = 1/T \quad \cdots\cdots (2)$$

$$\zeta = \frac{1}{2\pi} \ln \frac{A_1}{A_2} \quad \cdots\cdots (3)$$

Where:

f - natural frequency of the suspension sprung mass, in Hz;

T - time interval between the first and second suspension compression peaks, in s;

ζ - air suspension damping ratio;

A_1 - first suspension compression peak, in m/s²;

A_2 - second suspension compression peak, in m/s².

------ The End ------