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Commercial Vehicle Drive Axles Assembly

商用车驱动桥总成

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Commercial Vehicle Drive Axles Assembly

1 Scope

This document specifies the technical requirements and bench test methods for commercial vehicle drive axle assembly.

This document is applicable to commercial vehicle drive axle assembly, and passenger vehicle drive axle assembly and electric drive axle assembly can be implemented with reference to this document.

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.

QC/T 1126 Automotive Drive Axle Terminology and Definition

3 Terms and Definitions

For the purpose of this document, the following terms and definitions given in QC/T 1126 *Automotive Drive Axle Terminology and Definition* apply.

3.1 Axle housing vertical bending static strength safety factor

The ratio of the vertical bending failure load to the fully loaded axle load of the axle housing.

$$K_n = \frac{P_n}{P} \dots\dots\dots (1)$$

Where:

K_n – vertical bending static strength safety factor;

P_n – vertical bending failure load, in N;

P – fully loaded axle load, in N.

3.7 Saturated temperature difference

The difference between the saturated temperature and the ambient temperature measured at the corresponding moment.

3.8 Drive axle assembly static torsional strength safety factor

The ratio of the static torsional strength failure torque of the drive axle assembly to the maximum test torque, M_{in} , of the drive axle assembly.

$$K_k = \frac{M_k}{M_{in}} \dots\dots\dots (3)$$

Where:

K_k – drive axle assembly static torsional strength safety factor;

M_k – drive axle assembly static torsional failure torque, in N • m;

M_{in} – drive axle assembly maximum test torque, in N • m.

4 Technical Requirements

4.1 Axle housing vertical bending rigidity

When fully loaded with axle load, the maximum deformation per meter of wheelbase shall be no greater than 1.4mm.

4.2 Axle housing vertical bending static strength

Axle housing vertical bending static strength safety factor K_n : tractors shall be greater than 5, trucks and passenger cars shall be greater than 6.

4.3 Axle housing fatigue

The minimum vertical bending fatigue life: The tractor shall be no less than 8×10^5 times; and the truck and passenger car shall be no less than 6×10^5 times.

The minimum brake fatigue life shall be no less than 8.8×10^4 cycles.

The minimum lateral bending fatigue life shall be no less than 2×10^5 times.

4.4 Drive axle assembly temperature-rise

The upper limit of the saturation temperature difference is shown in Table 1; and the lubricating oil temperature-time relationship curve shall be smooth without sudden

quantity shall be no less than 1 piece.

5.1.1.3 During the test, the drive axle housing of the full-floating half-shaft structure shall be equipped with a matching reducer housing, and the rear cover and accessories (welding accessories of the axle housing, oil drain plug, etc.) shall also be retained or installed on the axle housing. During the test, the drive axle housing of the semi-floating half-shaft structure, in addition to installing and retaining the above-mentioned related parts and accessories, the half-shaft and other components shall also be installed on the axle housing in accordance with the actual working conditions.

5.1.2 Test equipment and devices

Hydraulic servo test system or other devices capable of applying loads, as well as deformation measuring devices, force sensors, etc. The error of deformation measurement shall be within $\pm 0.01\text{mm}$; the relative error of force measurement shall be within $\pm 1\%$.

5.1.3 Test method

5.1.3.1 Install the sample according to the actual load state, the loading position is the centre of the stress point where the axle housing bears the weight of the vehicle, and the fulcrum is the corresponding position of the axle housing wheel track.

5.1.3.2 After installation, it shall be ensured that the direction of the applied load is perpendicular to the centreline of the axle tube of the axle housing; and the degree of freedom of the fulcrum along the centreline of the axle tube of the axle housing is not limited; so as to adapt to the test loading deformation without movement interference.

5.1.3.3 After the sample is installed, it is preloaded to the fully loaded axle load for 2~3 times; and then the formal measurement is carried out after unloading.

5.1.3.4 After unloading to zero, adjust the deformation measuring device to the zero position; and the measuring point position shall be no less than 9 points. The locations of the measuring points are shown in Figures 1 and 2.

measured at each measuring point, thereof, the maximum value is selected as the final deformation value of the measuring point.

5.1.4.2 Calculate the ratio of the maximum amount of deformation of the axle housing (mm) to the wheel track (m) under fully loaded axle load.

5.1.4.3 Draw the deformation amount of each measuring point under the fully loaded axle load and the specified load (all need to subtract the error value caused by the fulcrum), and connect them into a line.

5.2 Axle housing vertical bending static strength

5.2.1 Test sample

The same as 5.1.1.

5.2.2 Test equipment and devices

Hydraulic servo test system or other devices capable of applying loads, force sensors, etc. The relative error of force measurement shall be within $\pm 1\%$.

5.2.3 Test methods

5.2.3.1 Perform in accordance with 5.1.3.1~5.1.3.3.

5.2.3.2 Continuously and slowly load until the sample is broken, without repeating it in between. Record the failure (fracture or severe plastic deformation) load.

5.2.4 Data processing

Calculate the axle housing vertical bending static strength safety factor according to formula (1).

5.3 Axle housing fatigue test

5.3.1 Test sample

The number of fatigue samples for each axle housing shall be no less than 3, and the other requirements are the same as 5.1.1.

5.3.2 Test equipment and devices

Hydraulic servo test system or other devices capable of applying loads, force sensors, etc. The relative error of force measurement shall be in the range of $\pm 1\%$; and the relative error of force control shall be in the range of $\pm 1\%$.

5.3.3 Test methods

5.4.2 Test equipment and devices

Oil flow temperature-rise test bench or similar test device, temperature sensor, etc. The error of speed measurement shall be within the range of $\pm 2\text{r/min}$; and the error of temperature measurement shall be within the range of $\pm 0.5^\circ\text{C}$.

5.4.3 Test methods

5.4.3.1 Add lubricating oil according to the technical requirements of the product.

5.4.3.2 The installation inclination angle of the drive axle is consistent with the no-load state of the actual vehicle.

5.4.3.3 Install the temperature sensor on the oil drain plug. For wheel-side reduction drive axles, temperature sensors shall be installed in the left and right wheel-side reducers at the same time.

5.4.3.4 Under no-load conditions, the sample shall be operated continuously at an input speed equivalent to $(80\pm 2)\text{ km/h}$ forward vehicle speed (when the maximum vehicle speed is lower than 80 km/h , the maximum vehicle speed is taken). When the lubricating oil temperature does not change more than 0.5°C within 60 min , the test shall end.

5.4.3.5 Record the sample lubricating oil temperature and ambient temperature at least once every 30 min .

5.4.4 Data processing

Draw the temperature-time relationship curve of the sample lubricating oil, and calculate the saturated temperature difference.

5.5 Drive axle assembly lubrication test

5.5.1 Test sample

The same as 5.4.1.

5.5.2 Test equipment and devices

Oil flow temperature rise test bench or similar test device. The error of speed measurement shall be within $\pm 2\text{r/min}$; and the error of temperature measurement shall be within the range of $\pm 1^\circ\text{C}$.

5.5.3 Test methods

5.5.3.1 Ensure that the lubrication of the sample bearing, and gear meshing is visible.

5.5.3.2 The samples are installed in the no-load state of the actual vehicle.

5.6.3.4 Operate at no-load at a test input speed equivalent to 50km/h forward speed for 2h; and control the lubricating oil temperature within 90°C.

5.6.3.5 The sample is operated under the following conditions, and the noise is measured at each measuring point at the same time.

5.6.3.5.1 The temperature of the lubricating oil is controlled within the range of 85°C ~ 90°C.

5.6.3.5.2 Load: No-load, 5% M_{in} , 10% M_{in} , ..., 40% M_{in} . The operating point that exceeds the rated power of the drive axle shall be exempted from being tested.

NOTE: Only no-load noise measurement is allowed.

5.6.3.5.3 Test input speed: Equivalent to 30km/h, 50km/h, 80km/h (when the maximum speed is lower than 80km/h, take the maximum speed) forward speed. The reverse speed is not included.

5.6.3.6 When the difference between the background noise and the noise of the measurement sample is greater than or equal to 10dB (A), no correction is necessary. When it is less than 10dB (A), correct it according to Table 2.

Table 2 --Noise Correction Value of Drive Axle Assembly Unit: dB (A)

Noise difference value	3	4	5	6	7	8	9
Correction value	-3	-2		-1			

5.7 Drive axle assembly transmission efficiency test

5.7.1 Test sample

5.7.1.1 The test sample shall meet the requirements of the design drawing, and the quantity shall be no less than 1 piece.

5.7.1.2 During the through axle assembly test, the inter-axle differential shall not be locked.

5.7.2 Test equipment and devices

Transmission efficiency test bench or similar device, torque, speed sensor, etc. The relative error of torque measurement shall be in the range of $\pm 0.2\%$; the error of speed measurement shall be in the range of $\pm 1\text{r/min}$; the error of temperature measurement shall be in the range of $\pm 1^\circ\text{C}$.

5.7.3 Test methods

5.7.3.1 Add lubricating oil according to the technical requirements of the product.

5.8.3.3 Load slowly in the forward direction; and record the torque-angle relationship curve until any one part fails. Record the torque and rotation angle when the sample fails, and the damaged part of the sample.

5.8.4 Data processing

Take the lowest value of the torque when the three samples fail, and calculate the static torsional strength safety coefficient according to Formula (3).

5.9 Drive axle assembly gear fatigue test

5.9.1 Test sample

The number of samples is no less than 6; and the others are the same as 5.7.1.

5.9.2 Test equipment and devices

Gear fatigue test bench, deformation measuring device and installation ring, etc. The mounting ring shall not be deformed during the test. The relative error of torque measurement shall be in the range of $\pm 1\%$; the error of speed measurement shall be in the range of $\pm 2\text{r/min}$; and the error of deformation measurement shall be in the range of $\pm 0.01\text{mm}$.

5.9.3 Test methods

5.9.3.1 Take a sample for the gear support rigidity test; and record the test results. The test procedures are as follows.

5.9.3.1.1 The test input speed shall be no greater than 10r/min

5.9.3.1.2 The position of the measuring point shall be able to measure the deformation of the driving and driven bevel gears and cylindrical gears against the drive axle housing (or reducer housing). After the position is determined, a hole is drilled on the corresponding housing and the corresponding surface of the tested part is polished to arrange the measuring device. The measuring point position of the rear drive axle main reducer is shown in Figure 7. Among them, measuring points 1 and 2 shall indicate the distance from the drive wheel axis. The through axle main reducer, except for the same as the rear drive axle main reducer, measuring points 1, 2, ..., 12 (points 1 and 2 shall be arranged on the end face of the driving bevel gear shaft), the additional measuring point positions are shown in Figure 8. Due to the different structures of various drive axles, these two layout schemes are only for reference.

gear against the housing at the same time. Each working condition shall be tested 3 times, and the arithmetic mean value shall be taken as the deformation value of each working condition.

5.9.3.2 Take 1 sample for the gear meshing mark test; and record the meshing marks in the forward and backward directions under each torque. The test procedures are as follows.

5.9.3.2.1 Install the drive axle assembly on the test equipment. Divide the driven bevel gear into 4 equal portions; and use powdery yellow paint (or substitute paint) to lightly coat 3 driven bevel gear teeth at each equal portion.

5.9.3.2.2 Before each torque test, the same gear teeth of the driven bevel gear must be painted repeatedly.

5.9.3.2.3 The test input speed shall be no greater than 10r/min.

5.9.3.2.4 According to 0, 25% M_{in} , 50% M_{in} , 75% M_{in} , M_{in} , the five torques are carried out from small to large; and the driven bevel gear of the main reducer shall run for at least 1 cycle under each torque.

5.9.3.3 Take 5 samples for gear fatigue test. The test procedures are as follows.

5.9.3.3.1 Add lubricating oil according to the technical requirements of the product.

5.9.3.3.2 Lubricating oil temperature: During gear bending fatigue and coast gear fatigue tests, the light and medium drive axles are controlled within the range of 70°C~90°C; and heavy drive axles are controlled within the range of 85°C~120°C. In the gear contact fatigue test, the light and medium drive axles are controlled within the range of 100°C~110°C; and the heavy drive axles are controlled within the range of 120°C~130°C.

5.9.3.3.3 During gear bending fatigue and coast gear fatigue, the output speed of the drive axle shall be within the range of 50r/min~150r/min. During the gear contact fatigue test, the output speed of the light and medium drive axles shall be 150r/min; and the output speed of the heavy drive axles shall be 100r/min.

5.9.3.3.4 Gear bending fatigue is run-in according to the three torques of 25% M_{in} , 50% M_{in} , 75% M_{in} from small to large; coast gear fatigue and gear contact fatigue run-in are based on two torques of 25% M_{in} and 50% M_{in} from small to large. The number of run-in under each type of torque shall be 1×10^4 times of drive axle output operation (every revolution of drive axle assembly output is recorded as 1 time).

5.9.3.3.5 Gear bending fatigue test: Take 3 samples, after running in, and load them according to M_{in} until the output revolution of the drive axle assembly reaches the specified times or until any part of the assembly fails.

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