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Tri-wheel vehicles - Steering gear

三轮汽车 转向器

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Tri-wheel vehicles - Steering gear

1 Scope

This document specifies the technical requirements, test methods, inspection rules, marking, packaging, transportation, and storage of steering gear assemblies of tri-wheel vehicles.

This document is applicable to the design, manufacturing, and product quality inspection and testing of recirculating-ball, rack-and-pinion, and worm-roller steering gear assemblies (excluding power steering) for tri-wheel vehicles.

2 Normative references

The contents of the following documents, through normative references in this text, constitute indispensable provisions of this document. Among them, for dated references, only the edition corresponding to that date applies to this document. For undated references, the latest edition (including all amendments) applies to this document.

GB/T 2828.1 Sampling procedures for inspection by attributes - Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection

JB/T 5673-2015 Agriculture and forestry tractors and machinery - General requirements of painting

3 Terms and definitions

The following terms and definitions apply to this document.

3.1

Rated output torque (force)

The output torque (force) specified for safe use when the steering gear is designed.

3.2

Displacement-angle ratio for the rack and pinion steering gear

I_{LR}

The ratio OF the rack displacement increment TO the pinion rotating angle increment of a rack-and-pinion steering gear.

Remove 30° from both ends of the input shaft data collected in the test. At the same time, remove the data corresponding to the rocker arm shaft. According to formula (1), calculate the angular transmission ratio. Draw the relationship curve between the input shaft angle and the angular transmission ratio. For non-variable-ratio steering gear, calculate the average value. For variable-ratio steering gear, according to the transmission ratio curve required by the manufacturer, respectively calculate the average transmission ratios in the middle and on both sides.

5.4.2 Determination of displacement-angle ratio for the rack and pinion steering gear

5.4.2.1 Method of determination

Fix the steering gear. The input shaft is connected to the angle sensor. The rack is connected to the displacement sensor. It is required that there is no gap in the connection. Rotate the input shaft from the limit position at one end to the limit position at the other end; measure the instantaneous angle values of the input shaft and rocker arm shaft.

5.4.2.2 Displacement-angle ratio for the rack and pinion steering gear

The displacement-angle ratio for the rack and pinion steering gear is calculated according to formula (2).

$$I_{LR} = \frac{dL}{d\theta} \approx \frac{\Delta L}{\Delta \theta} \qquad \cdots\cdots (2)$$

Where:

L - Rack displacement distance, in millimeters (mm);

θ - Rotating angle of input shaft, in degrees (°);

I_{LR} - Displacement-angle ratio for the rack and pinion steering gear, in millimeters per degree [mm/(°)].

5.4.2.3 Data processing

Remove 30° from both ends of the input shaft data collected in the test. At the same time, remove the data corresponding to the rack. According to formula (2), calculate the displacement-angle ratio for the rack and pinion steering gear. Draw the relationship curve between the input shaft angle and the displacement-angle ratio. For non-variable-ratio steering gear, calculate the average value. For variable-ratio steering gear, according to the transmission ratio curve required by the manufacturer, respectively calculate the average transmission ratios in the middle and on both sides.

5.5 Determination of transmission clearance characteristics

5.5.1 Rack-and-pinion steering gear

Fix the steering gear. Fix the displacement sensor on the housing at the rack end; use the probe to contact the back of the rack (if possible, fix it directly at the adjusting screw plug); zero the displacement sensor; add positive and negative torque to the rack. The loading torque shall comply with the manufacturer's requirements. If the manufacturer does not require it, a torque of ±(7 N · m~10 N · m) shall be applied, to measure the variation value of the displacement sensor. Rotate the input shaft; repeat the above measurement; measure within the full stroke of the rack. The sampling point shall not be larger than 3 mm. Remove 3 mm of data from both ends of the displacement and clearance relationship curve obtained from the test; draw the displacement and clearance relationship curve; calculate the average clearance.

5.5.2 Other types of steering gear

5.5.2.1 First measurement method

Fix the rocker arm shaft and housing; load ±2 N · m torque on the input shaft end; measure the input shaft’s rotating angle difference, which is the clearance at this point.

5.5.2.2 Second measurement method

Connect the angle sensors to the input shaft and rocker arm shaft respectively; make sure there is no gap in the connection of the sensors. Apply a 10 N · m load to the rocker arm shaft; drive the input shaft forward at a speed of 10 r/min~15 r/min. Measure the instantaneous corresponding angle value between the input shaft and the rocker arm shaft. Then at the same speed, drive the input shaft in reverse direction to measure the same data.

5.5.2.3 Data processing

Use the rocker arm shaft’s rotating angle as the benchmark. The difference between the two corresponding input shaft’s rotating angles measured is the clearance at this point. Remove 30° from both ends of the input shaft data collected in the test. At the same time, remove the corresponding clearance; draw the relationship curve between the input shaft’s rotating angle and the clearance. Calculate the average clearance at +30° and -30° at the middle position of the input shaft AND the average clearance at the remaining rotating angles on both sides.

5.6 Determination of transmission efficiency

5.6.1 Determination of transmission efficiency of recirculating-ball and worm-pin steering gears

5.6.1.1 Transmission efficiency

test, check the damage of the parts.

5.8 Impact strength test

The mass of the drop weight used in the test is 50 kg. Fix the steering gear on the test bench; place the steering rocker arm horizontally or place the rack vertically; fix the steering rocker arm or rack in the middle position. Raise the drop weight to a height of 0.3 m and then drop it freely, to impact the end of the rocker arm or the top of the rack.

5.9 Durability test

5.9.1 Durability test of recirculating-ball and worm-pin steering gears

When driving forward, the output shaft applies rated output torque (the loading waveform is a trapezoidal wave or sine wave; the rated loading force is its peak value; the loading waveform shall not have commutation spike burrs). Drive the input shaft. The left and right rotating angles, from the middle position, are not greater than +180° and not less than -180°. The driving speed is 30 r/min~45 r/min. When driving in reverse, the input shaft applies torque. The applied torque shall be converted according to the transmission ratio and rated output value. Drive the output shaft. The left and right rotating angles, from the middle position, are not less than +180° or not greater than -180°. The driving speed is 30 r/min~45 r/min. Choose either forward drive or reverse drive durability test. The number of test cycles is 1.0×10^5 times. During the test, the steering gear is allowed to be disassembled and inspected every 25000 cycles; but parts are not allowed to be replaced.

5.9.2 Durability test of rack-and-pinion steering gear

When driving forward, the angle between the pull rod and the rack is the same as the installation angle of the steering gear on the vehicle. Apply he rated output force on the pull rod (the loading waveform is a trapezoidal wave or sine wave; the rated loading force is its peak value; the loading waveform shall not have commutation spike burrs). Drive the input shaft not less than +180° or not more than -180°; the driving speed is 30 r/min~45 r/min. When driving in reverse, apply torque on the input shaft. The applied torque shall be converted according to the transmission ratio and rated output value. Drive the rack. The left and right rotating angles, from the middle position, are not less than +180° or not more than -180°. The driving speed is 30 r/min~45 r/min. Choose either forward drive or reverse drive durability test. The number of test cycles is 1.0×10^5 times. During the test, the steering gear is allowed to be disassembled and inspected every 25000 cycles; but parts are not allowed to be replaced.

5.10 Sealing test

Pour dry compressed air with the pressure shown in Table 2 into the steering gear housing; immerse the steering gear in water for no less than 30 s; observe whether bubbles emerge from the steering gear.

5.11 Inspection of other items

5.11.1 Use visual inspection or conventional methods to check the steering gear's rotational flexibility, anti-rust, and coating appearance quality.

5.11.2 The adhesion performance of the paint layer shall be inspected in accordance with the provisions of JB/T 5673-2015.

6 Inspection rules

6.1 Exit-factory inspection

6.1.1 Each steering gear assembly shall pass the inspection by the manufacturer before it can leave the factory. When leaving the factory, documents proving product quality conformity shall be attached.

6.1.2 The exit-factory inspection items and their nonconformity classifications are shown in Table 3. Fully inspect each steering gear assembly for 4 items: total rotating angles of input shaft, rotational flexibility, anti-rust, and coating. All 4 items shall be conformity. Carry out sampling inspection on 3 items: transmission clearance characteristics, input torque, and sealing. Sampling inspection and determination disposal rules shall be in accordance with the provisions of GB/T 2828.1. Adopt a normal inspection one-time sampling plan. The inspection lot is the monthly (or daily) output or one-time order lot. The inspection level is general inspection level II. The acceptance quality limit (AQL) is 4.0.

6.2 Type inspection

6.2.1 In any of the following situations, it shall carry out type inspection:

a) New product finalization appraisal or old product conversion trial-production;

b) After formal production, if there are major changes in structure, materials, and processes AND product quality may be affected;

c) For products produced in lots or in large quantities, at least once every two years;

d) When the product has been out of production for more than one year and production is resumed;

e) When the exit-factory inspection results are significantly different from the last type inspection results;

f) When the national quality supervision agency requests type inspection.

6.2.2 The inspection items and nonconformity classifications of type inspection are

nonconformity classifications are determined as nonconformity, the final assessment is nonconformity.

- If a malfunction occurs due to product quality issues, testing shall be stopped; the product will be treated as nonconformity.

6.3 Inspection under special circumstances

For other forms of inspection, according to the corresponding requirements, the sampling quantity and determination rules can be determined. The test results shall comply with the provisions of this document.

7 Marking, packaging, transportation, and storage

7.1 When the steering gear leaves the factory, it shall have a certificate of conformity from the manufacturer; it shall be marked with the manufacturer's name or factory logo.

7.2 When packaging products, moisture-proof, vibration-proof, and dust-proof measures shall be considered, to meet the requirements of transportation and loading-unloading. In special circumstances, packaging can be carried out according to the conditions agreed upon by both the supply and demand sides.

Each packaging box shall be accompanied by a packing list, an instruction manual, and a certificate of conformity. The certificate of conformity shall include the following:

a) Manufacturer’s name or factory logo;

b) Product name, model, and assembly number;

c) Signature of the manufacturer’s quality management department;

d) Executive standard number;

e) Manufacturing date or production lot number.

7.3 The text and markings on the outer wall of each packaging box shall include the following:

a) Manufacturer’s name or factory logo;

b) Product model, assembly number, and product name;

c) Packaging quantity, gross weight, and net weight;

d) Manufacturing date or production lot number;

e) Marked with "Handle with care" and "Keep away from moisture".

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