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Research and Application of Automobile Steering Knuckle Test Accuracy

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ABSTRACT: The automobile steering knuckle bearing the front axle load, support and drive the front wheel to rotate around the main pin, and realize flexible steering and normal driving, the reliability of the knuckle directly affects the normal running of the vehicle and vehicle personnel life safety. If the structure and mechanical properties of the steering knuckle can be driven in a few years, it can ensure the accurate and fast steering and normal driving, which is a decisive factor in determining the quality of steering knuckle. In order to solve this problem, this paper makes a research on the accuracy of steering knuckle test results based on the detection of steering knuckle performance.

Keywords: Steering knuckle; Test bed; Fatigue test; Accuracy

I. INTRODUCTION

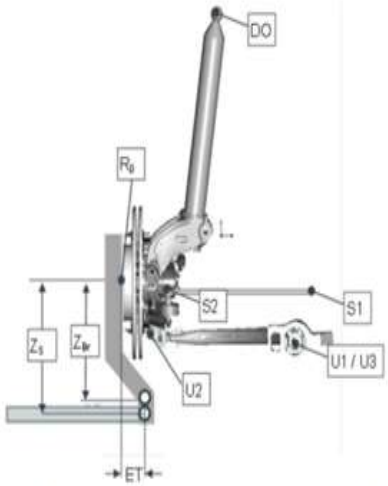
Automobile automotive steering knuckle is one of the main parts of the bridge, and vehicle suspension, front axle, steering system and brake assembly is connected with the front of the car carrying load, support and drive the front wheel to rotate around the main pin, and realize flexible steering and normal running for. Thesteering joint reliability directly affects the vehicle's normal driving and vehicle personnel life safety, especially the steering knuckle in the vehicle driving state is subject to the impact of changing loads, so on the strength and stiffness of the mechanical properties and have higher requirements. Therefore, in the product development cycle, one of the most important work is to verify the fatigue life of the product to meet the needs of various conditions.

Not only the front axle steering knuckle bearing load, also bear the ground impact and wheel sideslip, steering and brake the load, therefore, it has very high strength. In recent years, China's automobile industry is in an important period of vigorous development, with various models of development speed, vehicle development cycle shortens, continue to strengthen the steering knuckle bench test research and development efforts, improve the mechanical properties of the steering knuckle meet the traffic needs, has become an urgent demand for the development of automotive industry. Many domestic and foreign scholars have been on the structural strength analysis and bench test and vehicle test results show that the design of the steering knuckle, fully meet the requirements of working conditions, and also verified the finite element analysis of the reliability analysis of other scholars. Based on a vehicle steering section reliability test bench test problems in the process of research and analysis, to meet the ultimate stress and ultimate torque etc. Find out the reasons, and the improvement of its products, the final success through reliability test, meet the traffic demand.

II. TEST EQUIPMENT AND REQUIREMENTS

2.1 Power test

Position the steering knuckle in the vehicle design position as shown in figure 1. Integrate the wheel bearing, the ball hinge, the outer joint of the steering tie rod and the assembly of the brake device according to the original installation. In order to transmit the required braking torque, for example, the brake pads and the brake disc can be drilled and bolted together.



R_0 Wheel center
S1 Steering knuckle
S2 Steering knuckle tie
U1 Front transverse guide rod
U2 Ball hinge point
U3 Rear transverse guide rod
DO Shock absorber bearing point
ET Indentation depth value（mm）
ZBr Moving distance of the vertical rod when the braking force is applied（mm）
Zs The distance of the vertical bar when the lateral force is applied（mm）

Fig.1 Lateral force and braking force test

Another option is to use the hinge structure to replace the brake torque to the steering knuckle. The load applied to the steering knuckle test piece must be the same, and the shock absorber can be replaced by an elbow, and it will be positioned in the area of the upper damper support (DO). Steering pipe and horizontal guide rods can be used instead of the corresponding structure, and is placed together.

Applying the brake force to the structure by means of a wheel replacement. The load applied line is the same as the X axis of the vehicle coordinate system. In the process of guiding the application of force, can not affect the deflection of the steering knuckle, on the force line, the need for 2 joints.

2.2 Side dynamic test

Figure 1 to figure 3 placed in the design according to the position of the vehicle steering knuckle and wheel bearing with flange thickness for integrated brake disc, using the profiling piece is feasible. The steering knuckle is clamped on the test bench, to ensure that the adapter and the steering knuckle connection must be consistent with the original wheel bearing.

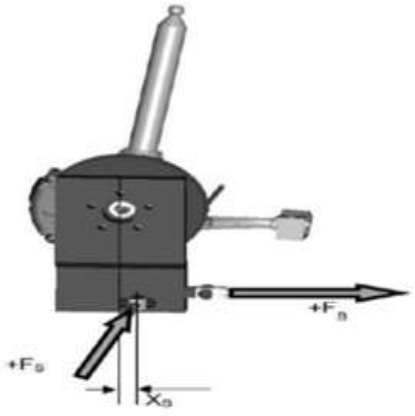


Fig.2 Lateral force Fa and braking force Fs, **Fig.3**Lateral force Fa, moving distance Xs

The lateral force is applied to the wheel replacement (XS=0) in the lower part of the wheel bearing, and the applied load is consistent with the Y axis of the vehicle coordinate system. In the process of guiding the force, the deflection of the steering knuckle can not be affected, and 2 joints are needed on the force line.

2.3 Steering knuckle arm test

As shown in Figure 4, the steering knuckle is firmly attached to the wheel bearing seat in accordance with the operating mode. The contact way between the steering knuckle and the test device is the same as that of the steering knuckle and the wheel bearing. The position of the joint in the steering tie rod shall meet the following requirements, i.e., the applied load line is perpendicular to the bearing flange surface of the wheel.

If the steering knuckle is equipped with different ball hinge pivots in the vehicle, the longest pivot type must be used during the test.

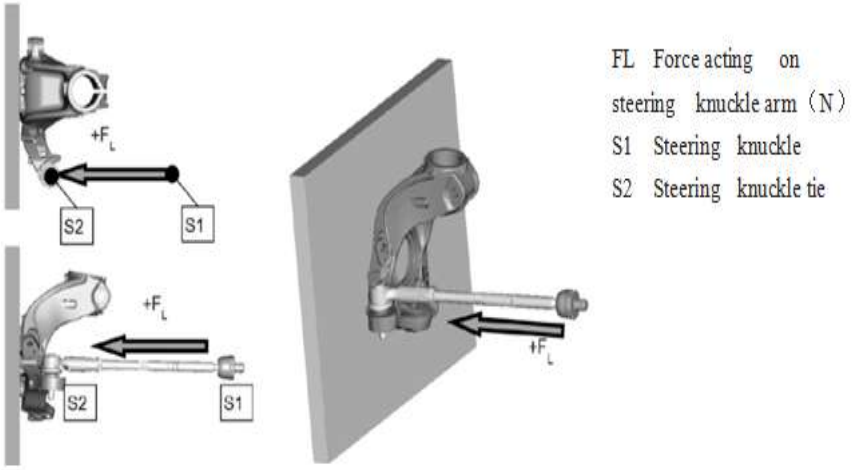


Fig.4 Test device of steering knuckle arm

2.4 Requirements (bench)

Cycle number Nerf for the residual rate of P =50% calculation, and regard it as the average value. The test shall be carried out in accordance with the load levels specified in the drawings before the failure criteria are met. When the number of cycles to Nmax=Nerf * 5, you can interrupt the test. For the standard deviation of the fitting line (structural fatigue curve), Slog, N0.20. The fatigue curve of the measured structural parts shall not intersect with the fatigue curve obtained in accordance with the average value in the range of the number of cycles 2 * 106.

III. FRAME LOAD TEST

3.1 Test stand

The test of the servo hydraulic test bench with adjustable force is to use the stress time signal. At the same time, ensure the simultaneous application of load.In the frequency range of 0 to 40 Hz, an iteration is performed at the following internal measurement positions:

①Steering tie rod force

②Ball hinge longitudinal force

③Ball hinge lateral force

If the test piece is made of cast steel or ductile cast iron, the test must be carried out in a dry environment. If the test piece is made from aluminium, it must be through the following parts: to test the

corrosion of circulating water and sodium chloride solution for 5 minutes spraying (weight percentage of 5% sodium chloride) and drying alternately for 25 minutes.

3.2Load diagram

Position the steering knuckle in the vehicle design position (see Figure 5). The following 3 loads are applied in the test: braking force

The longitudinal and lateral forces and torque. The connection between F3K-S1 and F3K-S2 through the modal two cylinder lateral force, lateral force and torque generated around the longitudinal axis.

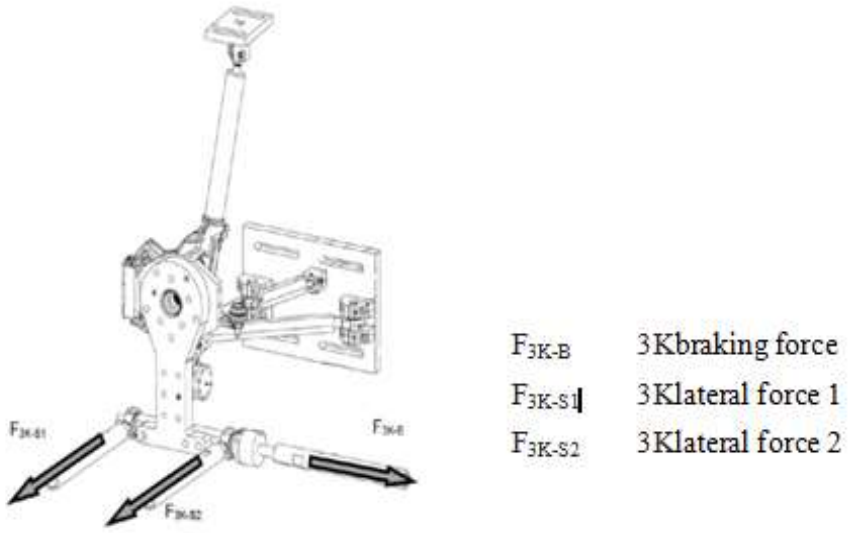


Fig.5 Schematic diagram of load test

3.3 Experimental requirements (signal)

The residual rate of Pu = 50% calculate the needed signal repetition number Werf, and regards it as the average value.

In the case of no more than the failure criterion, it should be shown that the discrete values of the Werf of the signal repetition number should not exceed Slog = 0.20.

3.4 Sampling and failure basis

To deal with the steering knuckle of the left and right were tested for the test load, should be in double logarithmic Waller field, according to the linear regression slope, K and log standard deviation Slog on structure crack before alternating analysis, according to the standard calculation method is adopted for statistical analysis.

Number of test pieces	Each batch of deformation or not less than 3
Failure criterion	Crack length >10mm

At the same time, in the test, but also records the crack location and location, each damage map related mileage pictures (such as crack, damage deformation, bolt slip or loose), and the expansion of the crack direction.

3.5 ball hinge support

The function of the ball hinge is to connect the steering knuckle and steering knuckle arm to the test bench, and the steering knuckle is firmly fixed on the wheel bearing seat according to the operation mode. The contact way between the steering knuckle and the test device is the same as that of the steering knuckle and the wheel bearing.

The test stand is to be tilted to the Z axis to form an alpha angle (see Figure 6). Force through the original ball hinge pivot. According to the available information in the latest data sheet, tighten the part according to the information in the vehicle. If the steering knuckle is fitted with a different ball hinge pivot in the vehicle, a shorter pivot must be used in the test because of the higher load. Tensile force is Fzug, FG does not allow the presence of cracks or fracture. On the point of application of unloading, allowing plastic deformation is < 1 mm.

$$\mathbf{F1mm} \square \mathbf{Fz_{ug,FG}}$$

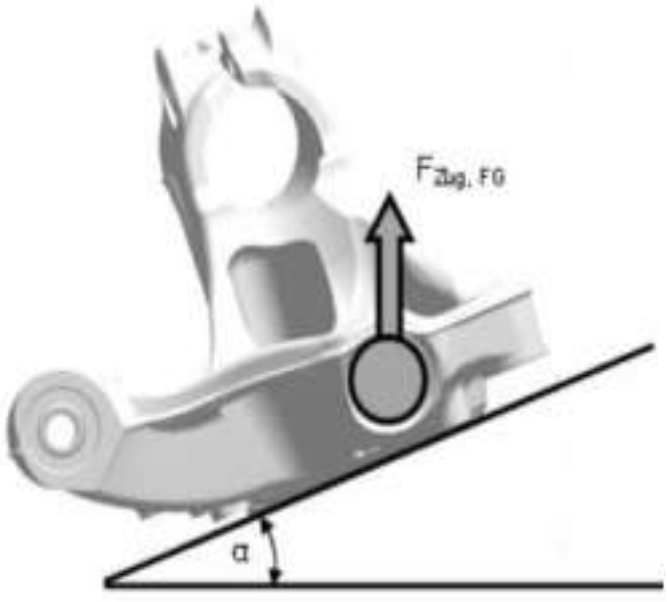


Fig.6 ball hinge tensile test device

Fzug, FGPull on pivot of ball hinge

αAngle of inclination with respect to the Z axis

When the force is greater than Fzug, FG, the failure performance must be consistent with the principle of fault safety". That is to say, there must be obvious plastic deformation on the pivot or steering knuckle before cracking or breaking.

The amount of deformation before cracking or breaking SB must be greater than the value required in the drawing Fzug, FG.

$$S_B \geq Szug,_{FG}$$

Which:

Fzug, $_{FG}$	When s< 1mm when the ball hinge pivot on the allowable pull (N)
Szug,$_{FG}$	Allowable deformation (mm) without crack or fracture

IV. ACCURACY ANALYSIS

In the test conditions of different batches and the coordinates of samples under different experimental measurement of heavy and light load of left and right side, draw weller curve as shown in figure 7.

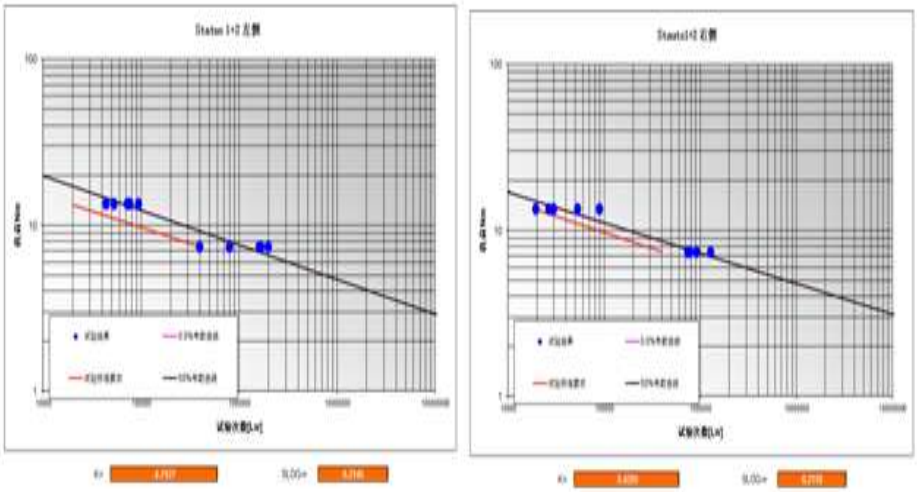


Fig.7 Weller curve

At the same time, according to figure 8 shows that the load bearing section steering capability increase with load frequency decreases, the measured results are in line, the steering knuckle measurements under different conditions and results to meet the requirements of the use of mechanical properties.

But under the conditions of use, if there are frequent over loading and wear, its performance will not be guaranteed. As long as the steering knuckle is required to achieve the specified minimum number of times of N under the specified test load, the plastic deformation of the crack can be avoided.

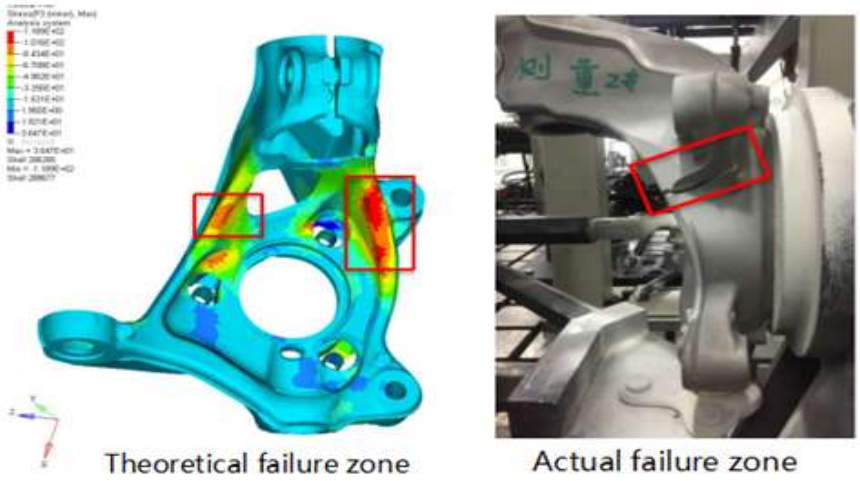


Fig.8 Failure mode of lateral force

V. CONCLUSION

Measured by the test results, to a higher precision section installed on the bench, and the location is not movable, the measured strength and stiffness to meet the use requirements, and bench test accuracy determines the measurement error, the accuracy of the measured data of the decision.

At the same time, based on the logarithmic standard deviation of Slog and K in the Weller curve slope test load and the number of tests, more conducive to the evaluation of the fatigue performance of science, to ensure the safety and reliability of the steering knuckle, and with the future development trend towards standardization and flexibility.

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