

Development of a Static Rollover Stability Test System for Trailer

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Abstract. The paper optimizes the original test system of the rollover test bench and demonstrates the design of each part in detail. The test system using the two-level hydraulic control can run stably and reliably with a large lifting capacity. It can be used flexibly. The successful development of this test system is of great reference significance for the upgrading and modification of China's rollover stability test bench, providing the necessary technical support for the safety performance design of the trailer.

Key words: Trailer; Roll; Stability; Test.

1. Introduction

At present, the test equipment for lateral turning stability is in 2004, according to the standard of GB7258-2004, according to the test method of GB/T 14172-1993 standard, it has the characteristics of convenient use, stable operation and big side turn angle for automobile products, but there are also problems such as insufficient rollover ability and inconvenient use of anti-slip device. With the popularization and application of trailers in recent years, the larger and heavier vehicles, and the wide application of computer and network technology in the engineering practice, it is necessary to improve the existing testing equipment to improve the ability of rollover and control, and to meet the needs of the trailer detection.

The aim of this paper is to design and produce a set of test system for static side rollover stability of trailer on the basis of the standard requirements of 4.7 and GB/T 14172-2009 "static side rollover stability bench test method" of GB7258-2017 "motor vehicle operation safety technical conditions".

2. Conceptual Design

The principles that should be followed in the overall design are as follows:

In terms of scheme selection, we should consider three aspects: accuracy, convenience and economy.

(1) Accuracy: the dimension accuracy, friction coefficient and speed of the table must meet the requirements of GB/T 14172-2009.



(2) Convenience: try to use the original rollover tester structure and components, reduce the upgrade time, and operate as simple and practical as possible.

(3) Economy: rational use of existing infrastructure (original rollover test rig, space arrangement, auxiliary facilities, etc.) to choose a suitable low cost scheme in the premise of meeting (1) (2).

The final design scheme is as follows:

Two rollover platforms are built and two foundations are built. The original side turn table does not move, a new side turn table is built, and two tables rise and fall at the same time when the long vehicle is tested, and the test is carried out on one of the rollover tables in the shorter Trailer Test.

Advantages: (1) the construction does not affect the original side rollover test, does not affect other vehicle tests, only the hydraulic control system and the revamp of the operating table will stop the use, the cost is low. 2. Flexible use and different test plans for different models.

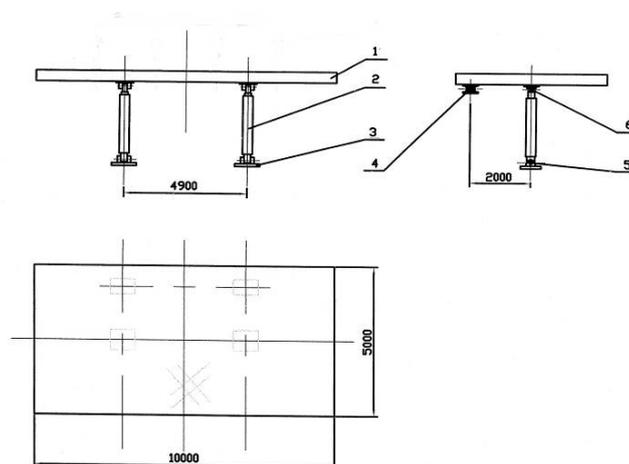
3. Composition of static side rollover stability test system for Trailer

The stability test system of trailer static side rollover mainly consists of the subside table and the foundation, the hydraulic control system, the anti-slip device and the tractor simulation device. The design of the key hydraulic control system is related to whether the two tipping tables can be synchronized to rise or descend after completion of the design.

3.1. The improved design scheme for hydraulic system

The main structure of the existing car rollover test rig is that the side turn table uses I-steel as the main beam, supplemented with reinforcement, the upper plate and the anti-slide plate make up the table, and the four nodes are connected with the foundation of two hydraulic cylinders respectively. The rollover device adopts two hydraulic cylinders and adopts hydraulic control. In order to synchronize the hydraulic cylinder, the two motors are connected hard to ensure the hydraulic cylinder to rise and fall at the same time. The two synchronous motors of the original test stand are connected by mechanical devices to control the rise and fall of two supporting cylinders respectively.

The main structure diagram is shown in figure 3.1



1) rollover platform, 2) supporting oil cylinder, 3) oil cylinder bearing, 4) rollover platform rotating shaft hinge point, 5) supporting oil cylinder lower hinge point, 6) supporting hinge on oil cylinder.

Fig. 3.1 The original rollover table

According to the design requirements, synchronous control of hydraulic synchronous motor is changed to synchronous valve control. It is also controlled by two stage synchronization mechanism, that is, two synchronous valves are located in the primary control loop, which control two support

cylinders of single test bench to rise and fall respectively. One synchronous valve is located in the two level control loop and controls four support cylinders in two test stations to rise and fall synchronously.

Analysis:

The principle of synchronizing the hydraulic synchronous motor is that there is a valve group composed of a hydraulic overflow valve and a one-way valve on every oil road inside the hydraulic synchronous motor. This valve group is designed to eliminate the position asynchrony error. A hydraulic synchronous motor usually controls several hydraulic actuators. Because of the unsynchronous error, there must be one of the hydraulic actuators (with hydraulic cylinder as an example) first to the end, if the position detection component signals, will notify the system's hydraulic control valve stop action, so that other hydraulic actuators will follow the stop action and cannot be in place. As a flow distribution device, the output flow of the pump is allocated according to the system requirements.

Because of the unique two level synchronous control after the transformation of the hydraulic system, that is:

The first level control loop controls the rise and fall of two supporting cylinders respectively. The two level control loop controls the synchronous lifting and lowering of the four supporting cylinders of the two test rig.

As a result, the flow of the hydraulic system is increased. From the practical application of the project, the synchronous motor cannot meet the control requirements. Therefore, the high precision shunt flow collector valve is used to realize the synchronous control demand.

The working principle of the distributary flow collector valve:

The diverging collector valve has two spool cores of the same size and structure, linked by hooks together, and fixed throttle holes 1 and 2 are opened on the spool. Common distributary flow valve structure is shown in Figure 3.2.

In the case of $P_0 > P_1$ (or $P_0 > P_2$), the pressure difference will push the two hooking valve core 1 and 2 open and be in the distributary operation. At this time the diverting runner is composed of the outer edge of the hook valve core 1, 2 and the outer edges of the valve sleeve 5 and 6, and the pressure difference will close the valve core 1 and 2 in the collection because of $P_0 < P_1$ (or $P_0 < P_2$). At this time, the flow collecting orifice is composed of the outer edge of the hook valve core 1, 2 and the inner edge of the valve sleeve 5 and 6.

The characteristics of the diverging collector valve are simple structure, low cost, high synchronous accuracy and good reliability. The split flow collecting valve is divided into fixed mode, self-regulating type, adjustable type, self-adjustable and adjustable combination mode according to the adjustment mode. Because the rollover stability test load is large and the distribution is uneven, the lifting and descending speed is constant, so the adjustable diverging collector valve is adopted.

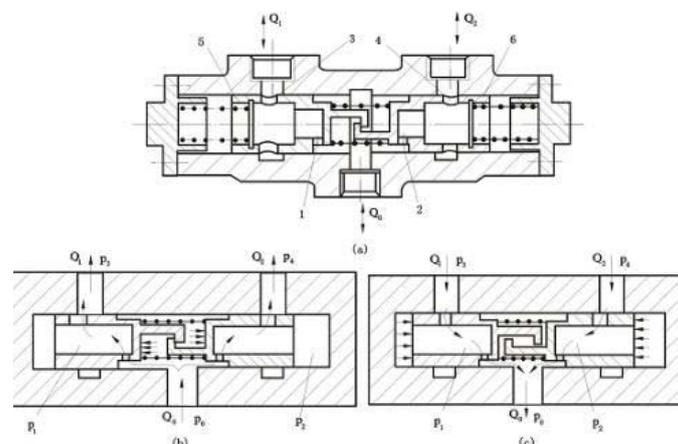


Figure 3.2 The work principle of the dividing-combining valve

Diagram of hydraulic principle is shown in figure 3.2.

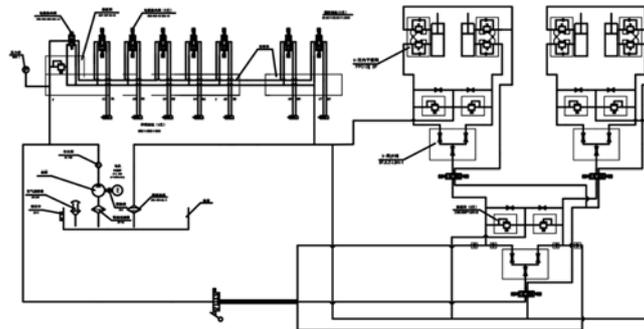


Fig. 3.3 Hydraulic synchronous control principle diagram

The manual three - position triple valve is in the middle. Through the operation button, three three - position four - pass solenoid valves are on the right, the two platforms support the hydraulic cylinder synchronous lifting, and the two platforms synchronously rise. Conversely, the three three bit four way solenoid valves are left through the operation button, while the small plate supports the hydraulic cylinder to shrink simultaneously, and the two platforms fall synchronously.

3.2. Verification Test

A full load semi-trailer is used to carry out the verification test to meet the design requirements. The test photos are shown in Figure 3.4:



Fig. 3.4 Semi-trailer with full load

4. Conclusion

In this paper, the static side rollover stability of the trailer is applied, based on the existing rollover test bench, according to the GB/T 14172-2009 "static side rollover stability bench test method", GB7258-2012 "motor vehicle operation safety technical conditions" and the GB 1589-2004 "road vehicle outline size, axle load and quality limit value" and other standards, A test system for the stability test of most trailers can be carried out. The maximum side turn angle of the test rig is 38 degrees, the maximum lift weight is 50t, and the parameters conform to the design goal, which solves the problem of the static side rollover stability test of the trailer.

Acknowledgments

The author has been engaged in the research work of automobile testing and related fields for many years. Since it has been employed, the author has carried out the work of the test of hundreds of vehicles and the development of more than 10 sets of related testing equipment.

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