Design of Vehicle ABS Rolling Drum Inert Testing Bench

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ABSTRACT

The status of domestic vehicle safety testing equipment and the working principle of ABS are simply reviewed in this paper. At present, the domestic vehicle safety testing equipment cannot evaluate the brake performance of ABS. Basing the object's kinetic energy can be expressed by the object's moment of inert, we designed a testing bench which can simulate the running state of vehicles. The testing bench not only can evaluate the brake performance of ABS, but also substitute the vehicle safety testing equipment, improving testing efficiency, and have a good market.

INTRODUCTION

The braking performance of the automobile plays an important role in the safety of the vehicle. It is particularly important to detect the braking performance of the car. The braking performance of the car is usually evaluated by the following three aspects: Braking efficiency, the stability of the braking efficiency, the direction of the braking stability [1,2]. Test methods of braking performance have two kinds of road test and bench test. In recent years, due to the application and development of the automobile safety testing equipment, the braking force is commonly used to evaluate the braking performance of the vehicle.

At present, the braking force detection device used in the automobile test line has the drum reverse force braking force detection platform and the flat plate type braking force detection platform. This article aims to design a kind of bench to evaluate ABS.

THE PRINCIPLE OF THE DRUM TYPE INERTIAL MERSURING BENCH

We can design a kind of drum type inertial measuring bench[3], the bench can simulation to be the running state of the vehicle inspection, and when the automobile
braking, simulation measurement of automotive wheel speed and vehicle speed, the problem is solved.

When the car is running, the car driver behind the drum rotation, and then through the sprocket drive in front of the roller rotation, which is equivalent to a rolling wheel of the road. In front of the drum with a flywheel group, drum and flywheel group of inertial mass and car seized inertial mass is [3,4]; due to different inspection car models, the quality varied, so to be matched by selecting a different combination of flywheel. So the roller system with equivalent inertia of traveling by car on the road. Brake tire for pavement rolling resistance, but due to the drum drive system with a certain inertia, and rolling road will be relative to the wheels to turn a certain distance, the distance is in the car in the road test of braking distance, in order to be able to simulate road brake when the testing conditions.

When the automobile runs on the road, the speed V (m/s) and the automobile kinetic energy W (ω) the relation is:

\[ W = \frac{1}{2} M v^2 + \frac{1}{2} (J_k + J_r) \omega^2 + W_0 \]

In the formula M is vehicle quality, \( \omega \) is wheel angular velocity, \( J_k \) and \( J_r \) is front and rear wheel moment of inertia, \( W_0 \) is rotational kinetic energy of vehicle drive system.

When the vehicle is running on the roller test bench, in the same speed, the motor and the roller, the flywheel system and the other main rotating parts have the kinetic energy \( W' (\omega) \):

\[ W' = \frac{1}{2} J_\omega r^2 + \frac{1}{2} J_0 \omega_0^2 + \frac{1}{2} (J_k + J_r) \omega^2 + \frac{1}{2} J_h \omega_h^2 + W_0 \]  

In the formula \( J \) is flywheel moment of inertia; \( r \) is the angular velocity of the flywheel, \( J_0 \) is cylinder rotary inertia, \( \omega_0 \) is the angular velocity of the roller, \( J_h \) the moment of inertia of the chain wheel and chain; \( \omega_h \) is angular velocity of the gear.

The car is equal to the translational rotational kinetic energy, i.e. \( W = W' \), there is

\[ \frac{1}{2} M v^2 + \frac{1}{2} (J_k + J_r) \omega^2 + W_0 = \frac{1}{2} J_\omega r^2 + \frac{1}{2} J_0 \omega_0^2 + \frac{1}{2} (J_k + J_r) \omega^2 + \frac{1}{2} J_h \omega_h^2 + W_0 \]

Finishing, get:

\[ Mv^2 = J_\omega r^2 + J_0 \omega_0^2 + J_h \omega_h^2 \]  

When the automobile is running on the roller test bench, the line speed of the outer edge of the tire is equal to the line speed of the roller edge.

\[ v = \omega r = \omega_0 r_0 \]  

In the design, the flywheel, the gear and the roller are rotated on the same root shaft. \( \omega_0 = \omega_r = \omega_h \)

Type (3), (4) into the equation (2) is:

\[ M(\omega_0 r_0)^2 = J_\omega r^2 + J_0 \omega_0^2 + J_h \omega_h^2 \]  

Finishing type (7), get:

\[ J = Mr_0^2 - J_0 - J_h \]
DETERMINATION OF FLYWHEEL ASSEMBLY [3]

Visible from the analysis, as long as the prior to determine the radius of the drum R0, rotary inertia J 0, gear moment of inertia h J, flywheel moment of inertia J, can be determined in accordance with the quality of the car. If limited to the test bench can simulate the quality of the car range $M_{\text{min}} \sim M_{\text{max}}$, you can determine the flywheel moment of inertia J range $J_{\text{min}} \sim J_{\text{max}}$. Then the flywheel is designed as a combination of a number of flywheel system, you can simulate different quality of the car.

The maximum error for the moment of inertia of the flywheel system for JM, if the flywheel moment of inertia according to the first item of 2J m, than for 2 geometric progression arrangement, the maximum error not greater than JM, number of flywheel and the least. That is

$$J_i = 2J m2^{i-1}$$  \hspace{1cm} (6)

$$\sum_{i=1}^{n} J_i = 2J m(2n -1)$$  \hspace{1cm} (7)

$$\sum_{i=1}^{n} J_i = J_{\text{max}} - (J_{\text{min}} + 2J m)$$  \hspace{1cm} (8)

Simultaneous formula (10), (11)

$$2J m(2n -1)=J_{\text{max}} - (J_{\text{min}} + 2J m)$$  \hspace{1cm} (9)

The least number of flywheel can be solved.

THE COMPOSITION AND FUNCTION OF THE DRUM TYPE INERTIAL TEST BENCH

The schematic diagram of the drum type inertia test bench is shown in Figure 1 and Figure 2.

Bench by five speed sensor (1, 2, 3, 4, 5), four supporting roller (a, b, e, f), four driving roller (c, d, g, h), four torque meter (A, B, C, D) and two chain wheels (E, F)
and flywheel group together to form, and the distance of the entire bench front and rear drum group, with automobile wheelbase is changed.

Because the inertia to support the roller is very small, when the automobile brake, the speed will soon tire of turns at the same speed. This can be seen as speed sensor 1, 2, 3, and 4 were measured is automobile front left, front right, left, right rear wheel speed, and speed sensor 5 is measured is the simulation of the automobile braking process of vehicle speed, so you can find various tire braking when the slip ratio. Also with the help of speed sensor 5 can also to carry on the adjustment to the automobile odometer.

In terms of torque measurement and torque meter a measured is vehicle braking torque, torque meter B measured is right front wheel, left rear wheel, right rear wheel braking torque, torque meter C measured is left rear brake torque, torque meter D measured is left rear wheel and a right rear wheel braking torque. Obviously, if the torque measured by the torque tester C minus torque measured by the torque tester D, you can get the right rear wheel brake torque, the same way to get the left front wheel, the right front wheel brake torque. If the braking torque is divided by the distance from the brake drum to the outer edge of the tire, the brake force can be obtained. In addition, let the car to be detected on the bench to run, and then disconnect the clutch, you can measure the block force of each tire and the total block force.

In addition, the speed sensor 5 in the test speed of the rotation of the drum also has a record of the number of the rotation of the vehicle to be detected in a certain speed under the braking of the braking distance.

CONCLUSION
This test bench can simulate the vehicle in the road to run the braking conditions, can be more objective reflection of the car at the time of the braking situation. Not only can replace anti force rolling test-bed and plate type detection platform, improve inspection efficiency and set various detection function and a body, but also to the car with ABS to brake performance testing and evaluation, and it must have a broad application prospect.

REFERENCES