Design and Simulate of ABS Dynamic Test-bed for Automobile

Fu Xiang Yang¹, An Yu Chen¹ and Fu Cai Wang¹

ABSTRACT

Aiming at the problems of ABS products tested on vehicle, a character test-bed of automobile ABS is studied. To provide an economic and efficient test method for vehicle anti-lock braking system (ABS) in laboratory, the idea of designing a dynamic test-bed is researched and developed, which can simulate actual working status of automobiles well and truly. The test-bed structure character, design principle and key techniques are discussed. It will provide a new method for testing ABS products of automobile and motorcycle.

INTRODUCTION

In the vehicle braking if the wheels are in the "locking" state, there will be the direction of decreasing stability, skidding, tail, sharp, tire braking distance lengthened, shorten the service life of the negative effects of high technology. The system of anti-lock braking system is the basic principle with the slip rate change based on the adhesion between tire and road and the development. It starts from the mechanism to prevent the braking process of wheel “lock”, automatic control brake force, the wheel is locked in a state of roll slide, to ensure that the wheels and the surface adhesion at the maximum value, avoid the rear wheel of the vehicle sideslip and front wheel steering capability in order to increase the loss. In order to enforce the car driving stability, handling and braking safety [1].

The author put forward a new ABS dynamic test bed design, which makes up for the shortage of the above scheme, and has a good economic performance.

Overall Scheme Design of ABS Dynamic Test Bed

Fig. 1 shows the test connection diagram. Fig. 2 shows the overall layout of the test bench.[2,3]

¹Dept. of Equipment Support, Bengbu Automobile NCO Academy, 233011, Bengbu, China
In this design scheme adopts magnetic clutch automatic control components. The magnetic powder clutch is with magnetic powder as the working medium, the excitation current as control means to control the brake or transfer torque. The output torque was a good linear relationship between the exciting current and rotate speed or slip, and response speed soon, the advantage of simple structure. The characteristics of magnetic powder device, transmission torque value and the magnetizing current size is approximately linear relationship. In general, in 5% to 95% of the rated torque, magnetizing current and torque is proportional to the linear relationship. When the excitation current is kept constant, the transmission torque will be stable. Not affected by slip. Therefore, as long as the current control, which can control the torque of the

**The Establishment of Mathematical Model**

Transfer analysis figure 1 joint torque, as shown in Fig. 3. The $\Sigma M=0$

\[
M_B = M_E + J_T \cdot \varepsilon, \quad (1) \\
M_B = F_\mu \cdot r, \quad (2)
\]

Among them, $M_B$ braking torque; $M_E$ electricity after magnetic powder clutch transfer torque; $J_T$ to the inertia of the flywheel moment of inertia; $\varepsilon$ epsilon wheel rotation angular acceleration; $F_\mu$ for the front wheel brake force; $r$ is the radius of the wheel.
In any attachment coefficient \( \psi \) of pavement on, front and rear wheel at the same time locking condition is: front and rear wheel brake force and equal to the adhesion, and front and rear wheel braking force are equal to their adhesion, i.e.

\[
\begin{align*}
F_{\mu 1} + F_{\mu 2} &= G \psi \\
F_{\mu 1} &= \psi F_{z1} \\
F_{\mu 2} &= \psi F_{z2}
\end{align*}
\]

(3)

\( F_{z1}, F_{z2} \) have respectively before the rear wheel load. Eq. 1 in Eq. 3 available

\[
M_E + J_T \ddot{\epsilon} = \psi F_{zt} \tau
\]

(4)

The force in the process of automobile braking is shown in Fig. 4, the drag force and the air resistance are ignored:

\[
\begin{align*}
F_{z1} &= \frac{G}{L} (b + \psi \cdot h_g) \\
F_{z2} &= \frac{G}{L} (a - \psi \cdot h_g)
\end{align*}
\]

When the vehicle is stationary, the force is only the G force, so.

\[
\begin{align*}
F_{z1s} &= \frac{b}{L} G \\
F_{z2s} &= \frac{a}{L} G
\end{align*}
\]

Thus, during braking, the rear axle load transfer, the transfer amount is:

\[
\Delta W = \delta \cdot m \cdot \frac{du}{dt} \cdot \frac{hg}{L} \leq G \cdot \psi \cdot \frac{hg}{L}
\]

During braking, the front axle load is a variable, the front axle load is a function of
the \( \frac{du}{dt} \) [6],

\[
F_{Z1} = F_{Z1s} + \Delta W = G\frac{b}{L} + \delta m \frac{du}{dt} \frac{h_z}{L} \leq \frac{G}{L} (b + \psi \cdot h_z)
\]

\[
F_{Z1} = F_{Z1s} - \Delta W = G\frac{b}{L} - \delta m \frac{du}{dt} \frac{h_z}{L} \leq \frac{G}{L} (a + \psi \cdot h_z)
\] (5)

The Eq. 5 into the Eq. 4 to

\[
M_e = \psi \cdot r (F_{z1s} + \Delta W) - J_T \cdot \varepsilon
\]

\[
M_e = \psi \cdot r G\frac{b}{L} + \psi \delta m \frac{du}{dt} \frac{h_z}{L} - J_T \cdot \varepsilon
\] (6)

Analysis of the rear wheel for the same

\[
M'_{e} = \psi \cdot r G\frac{b}{L} - \psi \delta m \frac{du}{dt} \frac{h_z}{L} - J_T \cdot \varepsilon
\] (7)

Eq. 6, Eq. 7 is a mathematical model for controlling the output torque of magnetic particle clutch.

Test Bench Working Principle

Before the start of the experiment, the car brake pedal is released, the computer prompts the user interface input attachment coefficient, namely through the computer first set the pavement type, through the control module, the constant excitation current of magnetic clutch, control motor through the coupling, magnetic powder clutch, flywheel, driven wheel, when the wheel speed reaches the specified value (initial braking velocity required), the brake pedal, the brake wheel speed decreased and began to work by wheel speed sensor speed changes after D / A conversion, computer read data through the data acquisition card, according to a certain algorithm to get the car to the police \( \frac{du}{dt} \) and the exercise of linear deceleration wheel rotation angle \( \varepsilon \), \( \psi \) values have been given in advance because of jealousy, according to already obtained the mathematical model police accounted for, can be obtained by magnetic Powder clutch to transmit torque and magnetic powder clutch is a kind of exciting current is controlled by means of automatic control element, the output torque and excitation current showed a good linear relationship and has nothing to do with the speed, combined by the torque sensor 1 acquisition of input of magnetic particle clutch torque value, by controlling the excitation of the magnetic particle clutch. Current control to achieve the purpose of magnetic powder clutch output torque M electric, accurately simulation car in the actual running process in a variety of attachment coefficient road on the work of the ABS.
CONCLUSION

It is consistent with the process ABS dynamic test rig can accurately simulate the working conditions of ABS on various kinds of adhesion coefficient of road surface during the actual motion of the vehicle.

The automatic control device of magnetic particle clutch is used to cancel the large mass flywheel, and only need a small mass flywheel to simulate the motion to improve the feasibility of the program.

Compared with the static test rig, the wheel on the test bench can generate rotation, which provides the parameters for the ABS control system. In contrast, the dynamic test bench can save a lot of cost, which can be used to replace the real vehicle road test.

REFERENCES

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