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Research on bench test method for reliability and durability of commercial vehiclesr

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Abstract

The relationship among reliability, durability and quality, and the importance of durability verification are expounded. The difference between the bench test and the traditional road test is compared, and the feasibility of the bench test is verified by a brand commercial vehicle, which provides theoretical reference for the future commercial vehicle bench test..

Keywords

Reliability; Durability; Bench Test; Road Test.

1. Introduction

1.1. What is Automobile Reliability and Durability

1.1.1. Automotive reliability

Automobile reliability refers to the ability of the automobile to complete the specified functions within the specified time and under the specified conditions of use. In a broad sense, it includes the trouble-free (durability), maintainability and preservation of automobiles. Trouble-free is an important aspect of it. Its main evaluation indicators are failure-free probability (reliability), cumulative failure probability and failure rate, etc. The durability of automobiles is evaluated by a series of life indicators. These indicators mainly include average life (or average trouble-free working mileage or time), rated life, characteristic life, reliable life, effective life, etc. In addition to indicators such as maintainability, maintenance rate, and average maintenance time, the evaluation of maintainability can also use a series of indicators that can indicate that the car is easy to maintain and easy to inspect, diagnose, disassemble, and repair after a breakdown, such as maintenance cycle, Maintenance workload, maintenance cost (yuan/1000km), etc. [1] .

1.1.2. Automotive Durability

The durability of automobile use refers to the working period of the whole vehicle and assembly of the automobile before reaching the limit wear value or being unusable. Simply put, it is the service life of the car. It has a direct impact on the technical integrity factor, depreciation cost and overhaul cost of the car. The durability of a car depends on the wear resistance of parts and the ability to resist fatigue and corrosion.

1.1.3. Relationship among reliability, durability and quality of automobiles

Simply put, car quality is the ability of a car to meet customer expectations. Reliability refers to the ability of the vehicle to complete the function within the specified time and under the specified conditions. It is equivalent to adding a time condition or scale to the quality of the car, which can better control the quality of the car. In the process of automobile development, how to make the vehicle structure strong and durable, and the maintenance rate is small is the focus of reliability. Automobile durability refers to the working period of the whole vehicle and assembly of the automobile before reaching the limit wear value or becoming unusable. That is,

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the ultimate life of the vehicle or parts is the focus of durability. However, reliability and durability must be distinguished. Reliability refers to the performance and structural strength of parts or vehicles within a specified period of time, while durability does not have an exact time, and is entirely determined by the limit life of parts or vehicles. . Therefore, we can draw a brief conclusion that the quality of a car depends on the strength of the reliability of the car, and the strength of the reliability of a car depends on the durability of the vehicle or parts. [2]

1.1.4. Endurance reliability test

According to the conclusions drawn in the previous chapter, a car with good durability has high reliability, but good durability means that the materials or processing methods selected in the design of its vehicle parts are all highly demanding. During the forward development process of the vehicle The design state may appear in the process, which will increase the cost of the enterprise; so when we verify whether the design is reasonable, we use the durability reliability test to verify the durability of the component design on the basis of the vehicle reliability.

1.1.5. Basic method of durability reliability test

There are roughly three types of test methods currently used by car companies in durability development: CAE simulation analysis, bench test and road test.

For CAE simulation analysis, CAE technology almost runs through the whole process of automobile design. However, most virtual simulations assume that the system is linear. If the nonlinear system is not specially analyzed HYPERLINK "http:// www.so.com /s?q= %E9% 9D%9E%E7%BA%BF%E6%80%A7%E7%B3%BB%E7%BB%9F&ie=utf-8&src=internal_wenda_recommend_textn" \t "https://wenda.so.com/q/_blank" , then the problems caused by the nonlinear characteristics cannot be seen in the results of the linear system simulation. However, there are many nonlinearities in the vehicle system, so the virtual simulation at the vehicle level is often not very accurate and has its limitations. Most of the virtual simulations are to analyze the results of normal conditions . Furthermore, compared with the road test, the bench test can be tested continuously for 24 hours and does not require a driver during the whole test process, which ensures the repeatability of each test condition and is not affected by weather and traffic conditions.

Three ways to compare			
Test items Test Methods	CAE simulation analysis	bench test	road test
completely broken	able	able	able
crack (fatigue)	able	able	able
obvious permanent deformation	able	able	able
loose connection	Partially able	able	able
weld cracking	Partially able	able	able
Unacceptable noise/vibration	cannot	Partially able	able
Surface Degradation/Corrosion	cannot	cannot	able
stone bruise	cannot	cannot	able
Performance degradation due to	Partially able	Partially able	able

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thermal effects/acid/ice etc.			
unacceptable suspension deflection	cannot	able	able
Unacceptable four-wheel alignment error	able	able	able
unacceptable damping degradation	cannot	able	able
Leakage	cannot	able	able
unacceptable wear and tear	cannot	able	able
Reduced efficiency	Partially able	able	able

According to the table above, the bench test can basically simulate the factors that affect the vehicle in the road test, and according to the characteristics of the bench, the repeatability and timeliness of the test are higher than that of the road test.

2. Commercial Vehicle Reliability and Durability Bench Test

2.1. Test introduction

For commercial vehicles, the best way to evaluate a commercial vehicle is the benefit and profit brought by the user level after it is put into use. The benefits and profits generated by vehicles are nothing more than the ability to load goods and the maintenance and repair of vehicles in the later period. This has caused major vehicle manufacturers to continuously develop and manufacture a durable commercial vehicle. Since automobile production is a mass flow method, the production volume is large, the manpower and capital investment are large, and the social ownership of the product is also large. Once the product development is unsuccessful, it will cause heavy losses to the enterprise and sometimes even cause the enterprise to go bankrupt. At the same time, automobiles are means of transportation. Once safety and quality problems occur, the impact on life, property and society will be huge. Therefore, experimental verification in vehicle development is essential and throughout development. It is also relying on these experiments that automobile technology has made great progress in recent years. This puts forward more and higher requirements for automobile manufacturers: continuously reduce costs, shorten development cycles, improve vehicle quality, detect engineering quality problems as early as possible and provide solutions in time [3].

We take the research and development of vehicle structure as an example, which is divided into vehicle level, system level and component level at a macro level. The wheel-coupled road simulation test bench and the shaft-coupled road simulation test bench are common vehicle-level test benches. This paper takes the wheel-coupled road simulation test as an example to introduce the commercial vehicle bench test verification process.

First, load spectrum acquisition is required. Load spectrum acquisition refers to installing different types of sensors on the target parts of the vehicle, collecting sensor signals through the data acquisition system, and obtaining the excitation information of the target parts through data processing [4,5,6]. The durability test needs to collect the strengthened roads of the test site, including Belgian roads, cobblestone roads, concrete roads, straight washboard roads, rope roads, square pit roads, concrete patch roads, etc..

ISSN: 1813-4890

2.2. Test validation

The collected signals mainly include the acceleration of the axle head, the vehicle body and different positions of the suspension, the displacement signal of the suspension, the strain of the structural risk point, and so on. An example of sensor installation and location is shown in the figure below:

Fig.1 Frame acceleration sensor

Fig.2 Beam strain sensor

This load spectrum collection has a total of 123 channels, including signals such as acceleration, pull wire and strain. The load spectrum collection results of the test vehicle are shown in the figure below. Due to space limitations, only one channel is shown as an example:

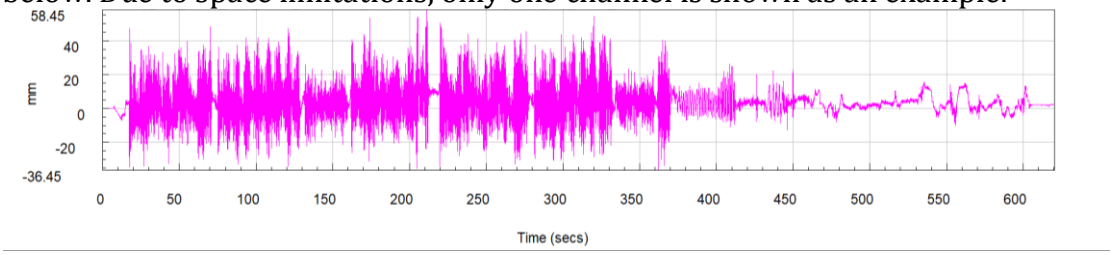

Figure 3 Signal of the cable displacement sensor

This paper mainly compares the damage of the non-participating iterative channel before and after the commercial vehicle iteration, so the iterative process will not be described in detail. The iterative pass of the verification project mainly includes four axle head accelerations and four suspension displacements. The iterative results of the Belgian road are shown in the figure below, where the root mean square error of the acceleration is below 10%, and the root mean square error of the displacement is about 15%, which is the optimal result of this iteration:

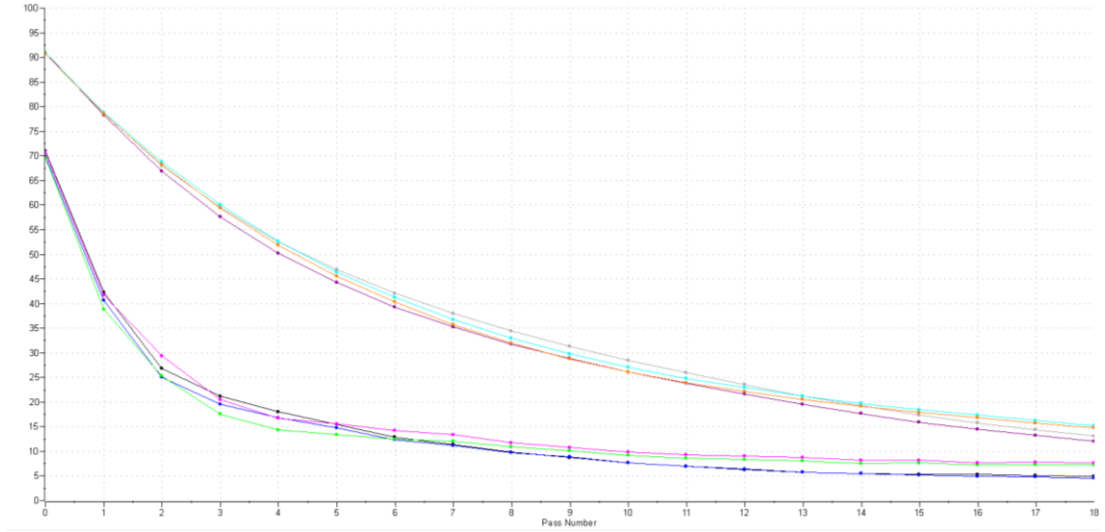

Fig. 4 Iterative result of Belgian road

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Four acceleration signals are selected as the comparison channel between the iteration result and the actual road spectrum signal. They are the left front frame acceleration-Z, the left front cab shock absorber frame end acceleration-Z, the left front cab shock absorber cab end acceleration-Z, and the battery bracket battery end acceleration-Z. Carry out damage calculation on the corresponding signal, and obtain the following results.

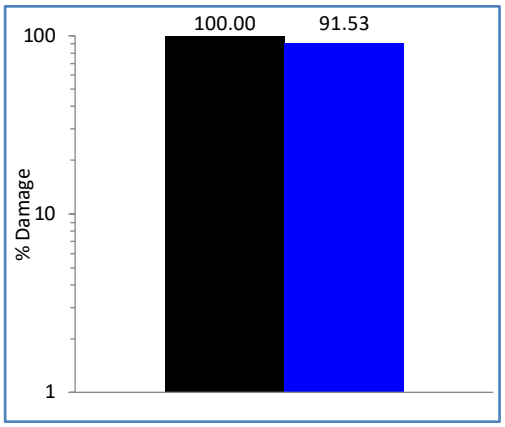

Fig.5 Acceleration of left front frame

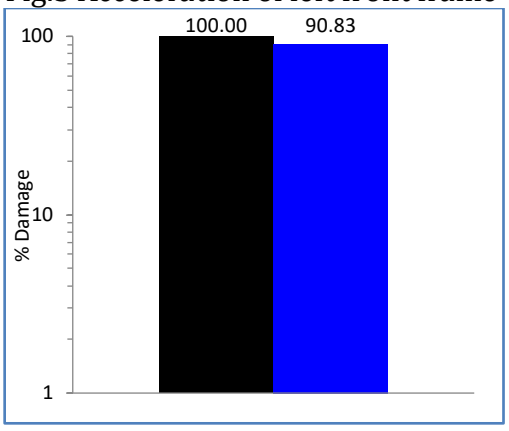

Fig.6 Acceleration of frame end of left front cab shock absorber

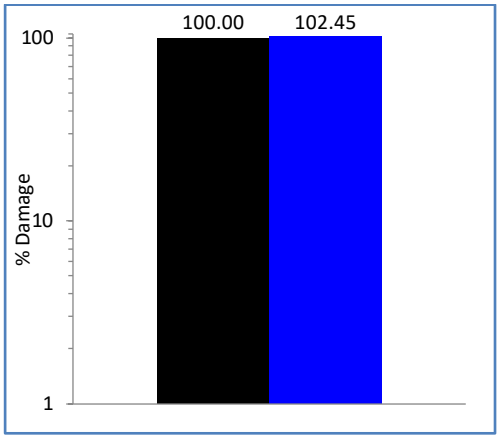

Fig.7 Acceleration at the cab end of the left front cab shock absorber

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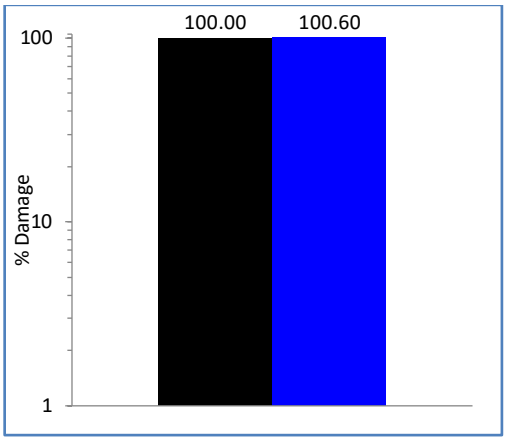

Fig.8 Acceleration at the battery end of the battery bracket

3. Conclusion

From the above analysis, it can be seen that iterating the acceleration of the axle head and the displacement of the suspension of the vehicle body as the target signal can relatively accurately reproduce the motion state of the vehicle on the actual road. Furthermore, it can be seen that the durability test of the commercial vehicle through the wheel coupling test bench is a relatively accurate verification method, especially for the verification of the frame, cab, shock absorber, and battery bracket.

References

[1] Lang JF , Kjell G . Comparing vibration measurements in an electric vehicle with standard vibration requirements for Li-ion batteries using power spectral density analysis[J]. International Journal of Electric & Hybrid Vehicles, 2015, 7(3):272-286.C. Li, W.Q. Yin, X.B. Feng, et al. Brushless DC motor stepless speed regulation system based on fuzzy adaptive PI controller, Journal of Mechanical & Electrical Engineering, vol. 29 (2012), 49-52.

[2] Wu Jiangsheng. Application research on road simulation test method based on pseudo-damage equivalent of automobile. 2016.J. Liu, E.L. Chen and Z.T. He: Journal of Shi Jia Zhuang Railway Institute (Natural Science), Vol. 22 (2009) No. 4, p.40-42.

[3] Wang Shixiong, Zhang Bensong. Research on road simulation test method of battery pack based on four columns [J]. Journal of Jiamusi University: Natural Science Edition, 2020, 38(5):4.

[4] Wang Linglong, Liu Wei, Li Wei. Research on Fatigue Test of Auto Parts Based on Vehicle Indoor Road Simulation[J]. Automotive Practical Technology, 2019(24):4.

[5] Chen Yousong, Qiu Rongying, Luo Miao, et al. Research on Improvement of Body Fatigue Life Based on Road Load Spectrum[C]// Academic Annual Meeting of Shanghai Society of Automotive Engineers. CNKI; WanFang, 2011:29-33.

[6] Zhou Hung, Yu Xiaohui. Research on multi-channel road simulation test of the whole vehicle[J]. Automobile and Parts, 2015(50):3.