Research on Key Technologies of Fatigue Testing Machine Calibration Device
Fatigue Testing Machine Calibration Device

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Abstract: Fatigue testing machine is a kind of equipment commonly used in the field of machinery manufacturing, the application of high-end equipment materials research and structural design is particularly important, its technical parameters include static force, dynamic force, strain, coaxially, etc., the accurate calibration is a guarantee of the reliability and comparability of the test data. As the application of dynamic force calibration technology is becoming more widespread, the study of dynamic force calibration technology is of great significance. In this paper the application and demand of dynamic force calibration technology of fatigue testing machine is briefly introduced, a fatigue testing machine calibration device is designed and constructed. the importance of the research on dynamic force calibration technology is pointed out, and the main system and main characteristics of dynamic force calibration is summarized.

CCS CONCEPTS • Applied computing • Physical sciences and engineering • Physics

Additional Keywords and Phrases: Fatigue Testing Machine, Calibration device, Dynamic Force, Standards

1 Introduction

Fatigue damage phenomenon refers to the material or structure subjected to repeated changes in many times after the action of the load, although the stress value always does not exceed the strength limit of the material, or even lower than the elastic limit, the destruction also may occur, this alternating load under the repeated action of the material or structural damage phenomenon is called fatigue damage.

Fatigue damage is one of the main forms of mechanical failure. With the development of modern machinery in the direction of high-speed and large-scale, a large number of mechanical parts are often at high temperatures, heavy loads and other poor operating conditions, fatigue damage accidents are more likely to occur[1]. According to statistics, about 80% mechanical parts of the overall fracture failure belong to the fatigue fracture, several examples of fatigue damage are shown in figure 1. Therefore, it is of great significance to study the fracture mechanism of mechanical parts and promote fatigue design to improve the

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reliability and service life of mechanical products. Over the past decades, a lot of theoretical and experimental research work has been carried out on fatigue problems, and some laws of fatigue problems have been gradually mastered. However, it is still not possible to use the theoretical method to analyze the fatigue problems of materials or components, which makes the fatigue test method particularly important in the study of material properties and engineering applications.

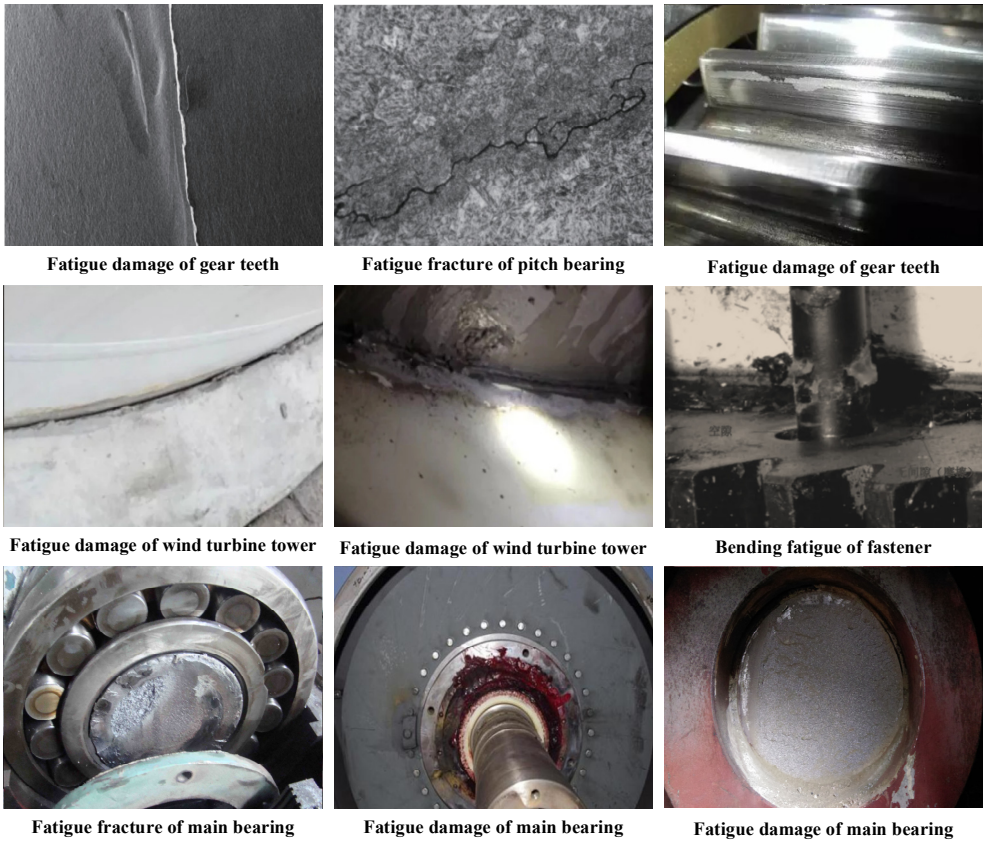


Figure 1: Examples of fatigue damage.

2 Comparison of fatigue tester calibration methods

Regarding the calibration specification of fatigue testing machine, it is mainly categorized into domestic standard and international standard in China. In the international standard classification, the calibration of fatigue testing machine involves mechanical test and metal material test, and in the Chinese standard classification, the calibration of fatigue testing machine involves metal material testing machine and non-metal material test[2]. The main domestic and international calibration standards for fatigue testing machines are shown in Table 1.

Table 1: Main domestic and international calibration standards for fatigue testing machines

Standard Issuing Unit	Standard Name	Standard Scope
General Administration of Quality Supervision, Inspection and Quarantine of P.R.China	Axia force-applied fatigue testing machines dynamic force calibration	Applicable to GB/T 3075 for axial force control fatigue test with fatigue testing machine dynamic force calibration, not applicable to special testing machines and test equipment calibration
General Administration of Quality Supervision, Inspection and Quarantine of P.R.China	Calibration Specification for Rubber Transmission Belt (Torque) Fatigue Testing Machine	Applicable to the calibration of torque fatigue testers for rubber transmission belts such as V-belts for automotive industry, general-purpose ordinary V-belts, general-purpose narrow V-belts, flame-retardant V-belts
	Calibration Specification for Rotary Fatigue Testing Machine	Applicable to the calibration of rotational fatigue testing machine with two-way reciprocating rotation and one-way continuous rotation function, other forms of rotational fatigue testing machine can refer to use
International Organization for Standardization	ISO 23788-2012[1]	Applicable to dynamic uniaxial tensile/compression, pure torsion and combined tensile/compression plus torsion fatigue testing machines for metallic materials, also for static testing machines and non-metallic material testing
	ISO 4965-2:2012[2]	This part of ISO 4965 defines the calibration procedure for the DCD's instrumentation. The method for the analysis of the result is also described, leading to range of testing frequencies over which instrumentation is valid for use with DCDs in accordance with ISO 4965-1
	ISO 4965:1979[3]	These guidelines lay down calibration of fatigue testing machine including special attachments, for example grips, which may affect the calibration. ISO 4965 deals exclusively with axial load machines in which symmetrical test pieces are subjected to fluctuating and reversed forces. Applies both to the calibration of new testing machines by the manufacturer and to the verification of machines in service

3 Principle of fatigue testing machine dynamic force calibration

After decades of development, dynamic force calibration has emerged as a relatively complete calibration system[4]. From the practical application of the main can be divided into absolute method calibration (laser interference), comparison method calibration, on-site calibration.

3.1 Absolute method calibration (laser interference)

Absolute method is through the laser Doppler system to directly measure the upper surface of the mass block mounted on the calibrated sensor, when the mass block is subjected to vibration or shock effect, through the laser interferometer to determine the change of speed of

the moving body over time, its reproduced acceleration value is directly traceable to the basic quantities of metrology(time and length), and then use the mass as a reliable intermediate quantities to complete the absolute reproducibility of the dynamic force[5]. The motion quantity concerned in this process is completely independent of the output of the calibrated transducer, and the measurement process conforms to the metrological definition and requirements of the absolute method. After completing the force value reproduction, the force value is transferred to the calibrated sensor through comparison, which can make a complete and objective evaluation of the metrological performance and dynamic characteristics of the calibrated sensor. The block diagram of force sensor calibration by absolute method is shown in figure 2.

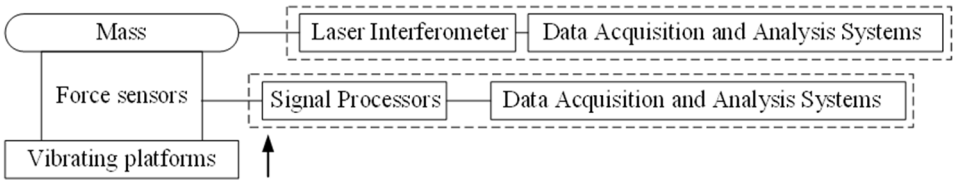


Figure 2: The block diagram of force sensor calibration by absolute method.

3.2 Comparison method calibration

Comparison method calibration is to measure the acceleration of the mass block by a standard accelerometer, use the mass as a reliable intermediate quantity, realize the reproduction of the dynamic force value, and then compare the reproduced force value with the measurement result of the calibrated force transducer to obtain the calibration result. When calibrating with this method, the mass acts on the calibrated force transducer to generate a dynamic signal, at which time the standard acceleration measurement system and the calibrated force transducer measurement system simultaneously respond and record the dynamic force value[6]. This method is susceptible to the influence of the standard accelerometer's own error, so its calibration uncertainty is not easy to meet the requirements. This method is mainly suitable for calibration accuracy requirements are not too high or the field calibration conditions are more complex. The block diagram of force sensor comparison method calibration shown in Figure 3.

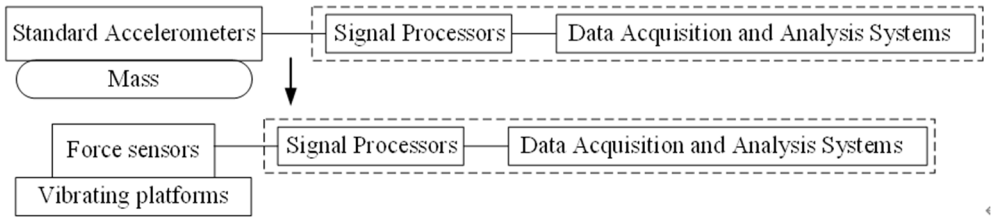


Figure 3: The block diagram of force sensor comparison method calibration.

3.3 On-site calibration

On-site calibration is to utilize on-site conditions to connect the force part of the instrument or equipment to be measured to a standard force sensor for measurement and compare the measurement results with those of the force sensor that comes with the instrument or

equipment in order to obtain the calibration results[7]. On-site calibration is mainly applicable to the situation where the instrument is large or precise and not easy to move. The main reason for the force value error is that the specimen and the test machine with the sensor between the unit also has a certain mass, the mass of the dynamic load will produce additional inertial force on the test machine with the sensor. The block diagram of field calibration is shown in Figure 4.

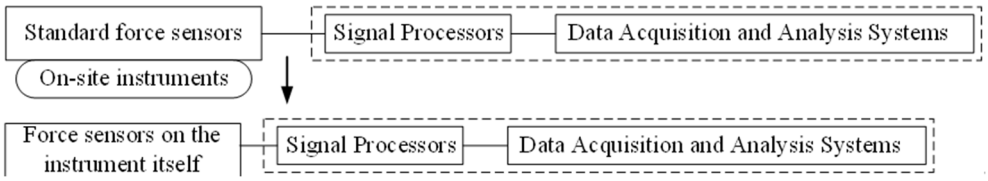


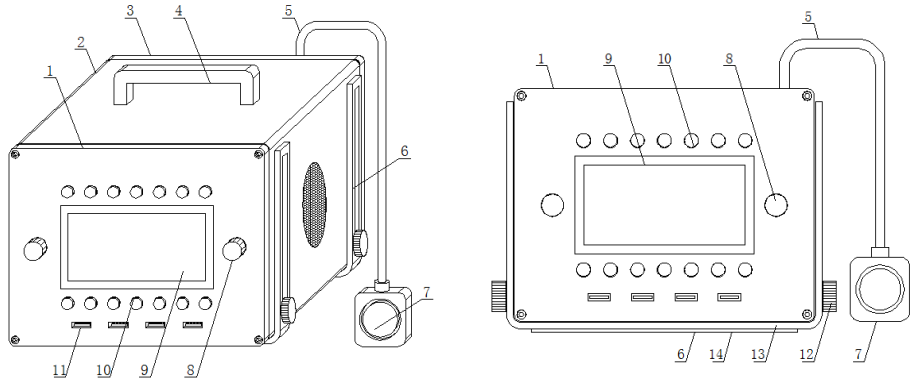
Figure 4: The block diagram of field calibration.

4 Fatigue testing machine calibration device development

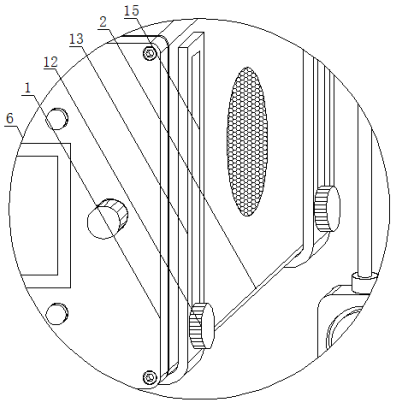
The Calibration Unit for Fatigue Testers is a device used to calibrate keystroke fatigue testers. Keystroke fatigue testers are typically used to test the longevity and stability of a product's keystroke performance after prolonged use. The main purpose of the calibrator is to ensure the accuracy and reliability of the test machine's measurements. In short, a calibrator for fatigue testing machines is a device used to ensure the accuracy and reliability of the test machine's measurements. Calibration of force transducer, displacement transducer and frequency control system by calibration device can improve the testing accuracy of fatigue testing machine and ensure the accuracy of test results. It plays an important role in product development, quality control and performance evaluation.

However, the calibration device for fatigue testing machine is used to calibrate the key type fatigue testing machine, it is necessary to place the calibration host on the ground or desktop, but the space of the key type fatigue testing machine is limited, so most of the time, the calibration host is placed on the ground, or you need to move the table separately to place the calibration host on the table, and when placed on the ground, because the control panel is facing the direction of the front, so the user also needs to bend down to control, so that the user needs to bend down to control, so the user needs to bend down to control. When placed on the floor, because the control panel is facing forward, the user needs to bend down to control it, which is very inconvenient for the user to operate the calibration mainframe, and it is also inconvenient for the user to watch the calibration content shown on the data display, and it is time-consuming and labour-intensive.

Based on the current research, a calibration device for fatigue testing machine is designed, as shown in the figure 5, the calibration device for fatigue testing machine is moved to the side of the key type fatigue testing machine, and the calibration device for fatigue testing machine is placed on the desktop or on the ground, and then it is necessary to connect a good power supply to the calibration main unit through the power interface on the rear panel, and the calibration test head is placed between the testing mechanism of the key type fatigue testing machine to carry out calibration.



(a) (b)



(c)

1 front panel, 2 calibration host, 3 back panel, 4 handle, 5 data cable, 6 adjustable device, 7 calibration probe, 8 adjustment knob, 9 data display screen, 10 button, 11 data interface, 12 knob screw, 13 U-shaped adjustable bracket, 14 anti-slip pad, 15 lifting slot, 16 fixing hole, 17 square block.

Figure 5: Structure of fatigue testing machine calibration device

The adjustable device includes a U-shaped adjustable bracket, a lifting slot, a fixing hole and a square block. The U-shaped adjustable bracket is sleeved on the bottom and both ends of the calibration host with the opening facing up. The U-shaped adjustable bracket has a lifting slot vertically arranged on the inner sides of both ends, and both ends of the lifting slot have a square block inside. The two square blocks are fixed on the outer walls of both ends of the calibration host, and the inner sides of the two square blocks have fixing holes facing outward. The U-shaped adjustable bracket is made of aluminum alloy, and the corners of both ends of the bottom of the U-shaped adjustable bracket are processed with arc surfaces. The lifting slot can move up and down on the outside of the square block, but the lifting slot cannot rotate on the outside of the square block.

5 Conclusion

In this paper, the main fatigue testing machine calibration methods is summarized through the overview of the dynamic force measurement technology in the actual engineering, and the method and process of dynamic force calibration are explained. On this basis, according to the problems existing in the current development of dynamic force calibration technology of fatigue testing machine, attention should be paid to the research of the following aspects: the size and shape of the mass block and the distribution of acceleration, the consistency of the sensor sensitivity, the calibration of the range of force value and the expansion of the frequency response range.

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