Preparation of 50 kN Specialized Standard Force Device at CQMQ

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Abstract. The Specialized Standard Force Device (in short: SSFD) was designed to keep the metrology of the working dynamometers (300N~50kN). The push-pull gauge (digital display type and pointer type) (in short: PP) and tension-meter were the main measurement objects. The working principle of the SSFD was introduced in the paper. It was a build-up type system, innovative designs have been applied: the 1st, the precision angle changing mechanism has been developed to study the affection of the loading direction; the 2nd, the fixture system has been designed to assemble and disassemble working dynamometers conveniently and efficiently; the 3rd, the specified arrangement was adopted to control the movement of the movable beam. The machine was designed to apply the force up to 50kN in compression direction and pull direction respectively.

1. Introduction
Kinds of working dynamometers, such as PP gauge, were widely used in automobile and motorcycle industry. In recent year with upgrading of equipment manufacturing industry, there was a growing demand for calibration and measurement of the working dynamometers. The establishment of The Specialized Standard Force Device could provide reliable technical support for various industries. Force Laboratory of Chongqing Academy of Metrology and Quality Inspection (CQMQ) have responsible for studying the measurement and calibration of the specialized standard force machine, and providing calibration services for customers in various sectors of industry. In order to meet the requirement of the working dynamometers, a 50 kN build-up force machine had been developed at CQMQ since 2017, the range of the force machine was from 300 N to 50 kN. The machine will be accomplished at the end of 2019[1, 2].

2. MECHANICAL INTRODUCTION
The SSFD was mainly composed of the three parts: the based framework, the load frame system and control system. The system configuration was based on the build-up system. The system can apply compression direction and pull direction respectively. The fixture was selected according to range and fixture interface of the checked. The based framework was set up on the ground.
The coordinate system was defined: Z axis was upward, X axis was horizontal right, and Y axis was right hand. Fig1 was the schematic diagram of the SSFD: A1 was the centre line of the based
framework; A2 was the centre line of the adjustable angle framework, where A1 and A2 were coincided at 0°. Because some kind of the working dynamometers required the calibration of the effects of the load direction, the adjustable angle framework was designed and it could be rotated around the rotary centre at \( \alpha \) angle, the rotary mechanism had self-locking function. The range of the load direction was from \( (0^\circ \sim 90^\circ) \).

The working procedure of the SSFD was defined as following:

1. Set the angel \((\alpha)\) at 0°,
2. Install the standard device according to the checked,
3. Install the load fixture according to the checked,
4. Install the checked device;
5. Loading and recording the data;
6. End calibration or go to procedure(1) at the angel \((\alpha)\).

The schematic diagram of the SSFD was as following Fig.1.A and Fig.1.B was the definition of the load direction:

3. SYSTEM FUNCTION INTRODUCTION

According to the previous mechanical introduction, we define the function of the following mechanism.

3.1. The framework design

The based framework and the adjustable angle framework were made of steel plate, a welded frame. They were open design, the bottom of the based framework was the combination of universal wheel and lifting mechanism which was easy to install, service and use. The adjustable angle framework could bear the load up to 50kN.

3.2. The load system

In the specified angle, the self-locking mechanism made the adjustable angle framework fixe on the based framework. The guide was fixed on the adjustable angle framework and coincided with the A2. The load fixture was designed to install the checked device on the moveable crossbeam, so depending on range of the checked device and load direction, the load fixture was composed of following parts: the standard device connector components, the checked device connector components. The standard was fixed on the top the adjustable angle framework with connector A, the checked and the standard connected together by connector B. The connector sets could self-align. Fig2–Fig4 were the typical arrangement mode of the system.
The mode 1 (Fig2) was designed to calibrate the handheld devices, such as the PP. The checked device was set on the force reverse frame, and the checked fixture 1 was fixed on the movable crossbeam. Then the checked could move with the crossbeam, for example, crossbeam move downward was the pull load and the upward direction was the push load.

In the mode 2 (Fig3), the force reverse frame was designed to apply compressive load. The force reverse frame connected with the standard by connector B. The checked device was put on the force reverse frame, and the checked fixture 2 fixed on the movable crossbeam. Then if the crossbeam moves downward, the checked could take compressive load.

The mode 3 (Fig4) was designed to calibrate large size device, such as the tension-meter, and apply pull load. The top of the checked was connected with the standard by connector B and the bottom was connected with the movable crossbeam by the checked fixture 3. Then if the crossbeam move downward, the checked could apply pull load.

3.3. Drive system Construction.
Movable crossbeam could move along the guide precisely, which driven by the precision drive mechanism. To save space, double rail arranged symmetrically and could keep the stiffness of load system. The drive mechanism has two sets: Electric and manual. The Electro-Servo system was fixed on bottom of the adjustable angle framework and the manual system was fixed on top of the adjustable angle framework. The controller could move crossbeam by electro-servo system quickly and apply load manual.
3.4. The system Construction.

Based on the previous design, the construction of SSFD was designed as following: Fig.5.A was the components arrangement under mode 1, Fig.5.B was the components arrangement under mode 2 and Fig.5.C was the components arrangement under mode 2.

The calibration could be applied by recording and compare the dates of the standard and checked,

![Fig.5 components diagram of mode](image)

4. CONCLUSION AND FURTHER WORK

The Specialized Standard Force Device has been developed at CQMQ since 2017. The design of mechanical construction and electrical control system have been finished, the mechanical components have been put into manufacture. The SSFD has the following main features: the first, the machine can apply the compressive load or pull load respectively; the 2nd, Combination of universal wheel and lifting mechanism means ease of handling and installation, the 3rd, the adjustable angle framework was a welded frame structure, which was designed to overwhelm the load; the 4th, double-guide arrangement had been designed to stable the load of the crossbeam and the ball screw was driven by the servomotor mechanism. The SSFD was capable of apply force in range of (300N–50kN). The project of establishment of the machine will be finished in 2020.

5. References

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