Feasibility Verification of Portable Intelligent Gauge Calibrator

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Abstract. The current gauge calibrator has a series of problems, such as large volume, difficult to carry, low level of intelligence. As an improvement of the traditional gauge calibrator, a new portable intelligent gauge calibrator is designed. In this paper, based on the new type of gauge calibrator, it is compared with two traditional gauge calibrators to verify the feasibility of its application to the verification of grade 2 gauge.

Keywords: New gauge calibrator, comparison method verification.

1. Introduction

Gauge calibrator is used to test the gauge used in railway. Its structure is shown in Figure 1.

![Figure 1](link-to-image)

**Figure 1.** structure diagram of traditional railway gauge calibrator [1]

(1-movable superelevation edge; 2- superelevation measuring ruler; 3-inclination cushion block; 4-fixed measuring block; 5-measuring rod bracket; 6-longitudinal leveling bubble; 7-horizontal leveling bubble; 8-measuring plate screw; 9-measuring plate; 10-fixed superelevation edge; 11-inclination pad (2); 12-movable measuring block; 13-gauge reading device; 14-adjusting screw; 15-measuring rod)
This kind of calibrator has a low degree of intelligence, and it is easy to produce errors due to manual reading, which will affect the accuracy of the experimental results. At the same time, because the total length of the traditional gauge calibrator is generally more than 1.6 meters, and cannot be disassembled, it is difficult to carry out on-site detection. Therefore, the manufacturer can only send the gauge to the measuring institution, which will verify it and then return it. It's a waste of manpower and time costs.

The introduction of portable intelligent gauge can improve the above shortcomings, make the verification results more reliable and accurate, and make the field detection possible.

In this paper, the new portable gauge calibrator is compared with the traditional tangent gauge calibrator and the traditional sinusoidal gauge calibrator, so as to verify the feasibility of its verification of the track gauge.

2. Brief introduction of new gauge

The general structure of the portable intelligent gauge is shown in Figure 2 below [2], which can be divided into horizontal measurement platform and superelevation measurement platform.

![Figure 2. general structure of intelligent portable gauge calibrator](image)

The total weight of the device is about 14kg, which can be carried remotely in a suitcase. It can be used after assembling according to the standard on site. The overall operation process of the device is shown in Figure 3 below.
The whole detection process is basically similar to that of the traditional gauge calibrator, and the leveling link of the platform itself is added.

3. Comparison of test results
The actual device diagram of portable intelligent gauge calibrator is shown in Figure 4 below.
In this chapter, the portable intelligent gauge calibrator is compared with the traditional tangent principle gauge calibrator and sine principle gauge calibrator for the same digital display gauge verification data.[3] Among them, the comparison accuracy is grade 2 gauge (superelevation indication error ± 1.2mm, length indication error ± 0.25mm).[4]

Among them, the length verification indication error of three kinds of gauge calibrators for the same digital gauge is shown in Table 1.

Each verification point is verified for 5 times, and the arithmetic average value is taken as the effective data and added into the final uncertainty evaluation.

### Table 1. Horizontal indication error of gauge calibrator

| Point | Traditional tangent gauge calibrator (mm) | Traditional sine gauge calibrator (mm) | Portable intelligent gauge calibrator (mm) |
|-------|------------------------------------------|----------------------------------------|------------------------------------------|
| 1348  | -0.15                                    | -0.12                                  | -0.16                                    |
| 1391  | -0.17                                    | -0.18                                  | -0.15                                    |
| 1435  | -0.14                                    | -0.13                                  | -0.17                                    |

In the same way, for the same digital gauge, the error of superelevation inspection and setting is shown in Table 2.

### Table 2. Superelevation indication error of gauge calibrator

| Point | Traditional tangent gauge calibrator (mm) | Traditional sine gauge calibrator (mm) | Portable intelligent gauge calibrator (mm) |
|-------|------------------------------------------|----------------------------------------|------------------------------------------|
| 50    | +0.03                                    | +0.05                                  | +0.16                                    |
| 100   | +0.11                                    | +0.14                                  | +0.23                                    |
| 150   | +0.18                                    | +0.20                                  | +0.31                                    |

Since the three calibrators have the same accuracy level, the transfer comparison method cannot be used. Therefore, the comparison between multiple standard building units is used to evaluate whether the test results of portable intelligent gauge calibrator are credible, which should meet the following requirements [5]:

\[
|Y_{lab} - \bar{Y}| \leq \sqrt{\frac{n-1}{n} U_{lab}} \tag{1}
\]

Among them, \(Y_{lab}\) is the indication error of measuring points of intelligent gauge calibrator, \(\bar{Y}\) is the average indication error of three calibrators to measuring points, \(n\) is the number of equipment participating in verification comparison, \(U_{lab}\) is the expanded uncertainty of gauge indication error (length measurement: 0.06mm / superelevation measurement: 0.30mm) (k = 2).

### Table 3. Verification results of portable intelligent gauge calibrator

| Formula | 1348 | 1391 | 1435 | 50  | 100 | 150 |
|---------|------|------|------|-----|-----|-----|
| \(|Y_{lab} - \bar{Y}|\) | 0.049 | 0.049 | 0.049 | 0.245 | 0.245 | 0.245 |
| \(\sqrt{\frac{n-1}{n} U_{lab}}\) | 0.017 | 0.016 | 0.023 | 0.08 | 0.07 | 0.08 |
According to table 3 above, the verification results of portable intelligent gauge calibrator meet the evaluation requirements. The new type of calibrator can be used to verify the grade 2 gauge.

4. Summary
In this paper, the portable intelligent rail gauge calibrator is verified by comparison method. Compared with the traditional tangent gauge calibrator and the traditional sinusoidal gauge calibrator, it is proved that the portable intelligent gauge is feasible for the verification of grade 2 gauge.

References
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