



To participants

Final Report on an interlaboratory comparison (ILC) of the calibration in the force area part 3 speed of the beam

There are more separate parts:

Part 1 force tension and compression

Part 2 position of the beam

Part 4 Extensometer

Material testing machine



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Abstract

This interlaboratory comparison was conducted to verify the measurement results obtained by participating calibration laboratories and to demonstrate their technical competence in accordance with ISO/IEC 17025:2017 (SS-EN ISO/IEC 17025:2018), clause 7.7.2. The comparison also serves as a technical basis for accreditation purposes.

The intercomparison was primarily organized by the organizer with the evaluator assigned to assess and analyze the submitted calibration results. The evaluation and reporting were performed in accordance with the principles of ISO/IEC 17043:2023.

The object of calibration was a universal testing machine equipped for tension and compression measurements up to 10 kN. The comparison focused on the calibration of the crosshead displacement speed at selected evaluation points of 1 mm/min, 10 mm/min, 100 mm/min, and 500 mm/min. Participants applied their own calibration procedures, but only the agreed calibration points were included in the evaluation.

The reference calibration of the machine speed was performed using a laser tracker system. Measurement results from the participants were compared against the reference values using the En criterion, which accounts for both participant-reported and reference uncertainties.

All reported En values were within the acceptance criterion $|En| < 1$, demonstrating that all participants achieved measurement results consistent with their stated uncertainties. The intercomparison therefore confirms that the participating laboratories possess adequate technical capability for the calibration of crosshead displacement speed.

Purpose and implementation of the comparison

This interlaboratory comparison serves as a tool to verify results from the measurement carried out by calibration laboratories. It is an effective method to demonstrate technical capacity of the participant and serves as a technical base for accreditation as required by ISO/IEC 17025:2017 (SS-EN ISO/IEC 17025:2018) as specified in point 7.7.2.

The participants asked the evaluator to evaluate results of an intercomparison that was primarily organised by themselves.

Information about the testing machine that was calibrated

Tinius Olsen, model DBBSTOL-10kN-08-1035, serial no. AP46115.

Universal testing machine, model 5ST Series, serial no. ST-AFR-02589GB.

PC with Horizon Software, version 10.3.0.7. –

Cable belonging to the object and system.

Measuring range 10 kN compression and tension

Participants in the intercomparison

Details are given in part 1 of the report

Calibration instructions

Details are given in part 1 of the report

Agreed calibration points

The participants calibrated according to their own methods but only the following points were evaluated as a part of this project.

Measurement of speed of the beam

Evaluated calibration points

| |
|------------|
| 1 mm/min |
| 10 mm/min |
| 100 mm/min |
| 500 mm/min |

Planning and instruction details

The participants were asked to send calibration certificates to the organiser after finishing the calibration.

The evaluator uses the principles of the ISO/IEC 17043:2023 in the reporting.

Administrative information

| |
|--|
| Address to send the required documents: |
| Swedish Metrology and Quality AB Håkan Källgren Dragspelsgatan 21 SE-504 72 Borås, Sweden e-mail: hakan.kallgren@smquality.se Phone: +46 705 774 931 |

Reference calibrations

The testing machine's speed was calibrated using a laser tracker as a reference. A reflector was mounted on the machine's moving beam, and the measurement system recorded measurement points at a sampling rate of 100 Hz. All speed measurements were carried out for approximately 60 seconds during upward movement, starting when the machine's fixed scale was at position 230 mm. The machine was calibrated at 4 different speeds according to the results table. Three measurement series were performed at each speed. The temperature of the testing machine was measured with two temperature sensors placed on the machine's lower foundation and on the back of the left column. The environmental parameters of room temperature, relative humidity, and air pressure were used to calculate the refractive index of air. The results have not been corrected for the temperature of the object.

Reference calibration certificate

105101-1337162-K03

Analysis of the calibration results

The main information compared is the found deviation at the evaluated measurement points

The quality of each individual measurement result is reviewed using the E_n criteria. For each measurement point it is the distance of respective laboratory result to the corresponding reference value normalised with respect to the uncertainty in determine this difference.

$$E_n = \frac{x_i - x_{ref}}{\sqrt{U_i^2 + U_{ref}^2}}$$

x_i : Single measurement result (error of indication); index i counts the various participants.

x_{ref} : Provided inter-comparison reference value.

U_i : The estimated expanded uncertainty ($k=2$) stated by each laboratory for each calibration point.

U_{ref} : The estimated expanded uncertainty ($k=2$) of the reference value for the same calibration point.

The principle of the intercomparison

An absolute value of E_n of less than $|1|$ is often used as a criterion for an acceptable measurement quality, according to ISO/IEC 17043:2010, B.4.1.1. It means a reported deviation x_i from the nominal mass value by a participant does not deviate more from the assigned reference comparison value x_{ref} than what can be expected from the calculated uncertainty in this difference.

$$E_n < 1: \quad |x_i - x_{ref}| < \sqrt{U_i^2 + U_{ref}^2}$$

However, to make this measure a reliable one for an inter-comparison the reference U_{ref} must be small enough not to contribute significantly to the right side of equation 4. Due to the quadratic combination ideally U_{ref} should be in the range of $1/3$ of U_i . That was not possible on all points in this case

Measuring results on calibration in comparison for the different calibrations

The following tables and diagrams present the deviation of indication along with the stated measurement uncertainty for each calibration point and the related reference values.

Crosshead displacement speed of the beam

| Speed of beam | Table 1 | 1 mm/min | |
|-----------------------|---------------------|---------------------------|-----------------|
| Identification | Error mm/min | Uncertainty mm/min | En value |
| 1 | 0,002 | 0,004 | 0,10 |
| 5 | -0,002 | 0,060 | 0,03 |
| 6 | 0,0024 | 0,0013 | 0,12 |
| 7 | 0,00 | 0,004 | 0,00 |
| | Ref error | Ref Uncertainty | |
| | 0,00 | 0,02 | |

| Speed of beam | Table 2 | 10 mm/min | |
|-----------------------|---------------------|---------------------------|-----------------|
| Identification | Error mm/min | Uncertainty mm/min | En value |
| 1 | 0,022 | 0,040 | 0,50 |
| 5 | 0,007 | 0,13 | 0,12 |
| 6 | 0,0027 | 0,013 | 0,25 |
| 7 | 0,003 | 0,04 | 0,20 |
| | Ref error | Ref Uncertainty | |
| | -0,01 | 0,05 | |

| Speed of beam | Table 3 | 100 mm/min | |
|-----------------------|---------------------|---------------------------|-----------------|
| Identification | Error mm/min | Uncertainty mm/min | En value |
| 1 | 0,107 | 0,400 | 0,33 |
| 5 | -0,012 | 0,5 | 0,04 |
| 6 | 0,0076 | 0,130 | 0,23 |
| 7 | 0,030 | 0,4 | 0,15 |
| | Ref error | Ref Uncertainty | |
| | -0,03 | 0,10 | |

| Speed of beam | Table 4 | 500 mm/min | |
|-----------------------|---------------------|---------------------------|-----------------|
| Identification | Error mm/min | Uncertainty mm/min | En value |
| 1 | 0,519 | 2,0 | 0,32 |
| 5 | 0,940 | 2,5 | 0,43 |
| 6 | 0,0052 | 0,650 | 0,20 |
| 7 | 0,167 | 2,0 | 0,15 |
| | Ref error | Ref Uncertainty | |
| | -0,13 | 0,20 | |

Additions and changes to the DRAFT report

Some input values that were implemented in a wrong way and redactional changes were done.

Final conclusions

In this inter comparison all participants could demonstrate a convincing capacity to calibrate and give relevant values in relationship to their uncertainties.

The intercomparison documents include 16 calibration values, where all En values below 1.

Acknowledgement

Elastocon AB that allowed us to use the machine on their site during the process

Primary laboratory RISE, National Reference laboratory of Sweden

References:

- ISO/IEC 17043:2023 Conformity assessment – General requirements for proficiency testing
- ISO/IEC 17025:2017 General requirements for the competence of testing and calibration laboratories
- [ISO 13528](#) Statistical methods for use in proficiency testing by interlaboratory comparison
- Evaluation of measurement data – Guide to the expression of uncertainty in measurement, GUM (JCGM 100:2008)
- EA-4/02 M:2013 Evaluation of Uncertainty of Measurement in Calibration
- International Vocabulary of Metrology – Basic and General Concepts and Associated Terms (VIM)
- ISO 7500-1:2018 calibration of force machines
- ISO 9513:2012 calibration of extensometers