element™

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CALIBRATION CERTIFICATE

INTERFACE FORCE MEASUREMENTS LTD
GROUND FLOOR, UNIT 19
WELLINGTON BUSINESS PARK
DUKES RIDE
CROWTHORNE
BERKSHIRE
RG45 6LS

Certificate No: 2202038
Issue Date: 22 February 2022

Calibration Date: 21 February 2022
Technician: L Shenton

End User: Mecmesin Ltd

Description: A 5000 N compression and tension strain gauged load cell, used with an associated digital indicator, both manufactured by Interface.

Identification: 1203804 on load cell. TM0457
J92180 on indicator. TM0458
CT-177-10 on cable.

Basis of Calibration: BS EN ISO 376:2011
Increasing Forces Only

Calibration Location: Element Sheffield (address shown in header)

Classification: The force proving instrument satisfies the requirement of BS EN ISO 376:2011 for the following classification range:-

Compression	**Class 0.5 ,**	**5000 N down to 100 N**
Tension,	**Class 0.5 ,**	**5000 N down to 100 N**

Issued by:
R Moore
Force Calibration Technician

UKAS CALIBRATION
0157

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.
The certificate and results within, relates only to the item calibrated as shown on the first page of the certificate.

When Element is making statements of conformity a simple acceptance rule has been applied.
Uncertainty budgets have been determined and are available on request.

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Method:

The calibration was made in the laboratory's No. 4 and No. 5 Force Standard Machines in terms of the SI unit of force, the newton (N). The uncertainty of the forces applied during the calibration is ± 1 part in 5 000 (±0.02%).

An overload test as specified in Clause B.1 of Annex B of BS EN ISO 376:2011 was carried out prior to the calibration.

A creep test as specified in Clause 7.4.4 of BS EN ISO 376:2011 was performed for between 30 and 300 seconds at maximum load after the final pre-load, the results of which were within the classification parameters stated in Clause 8.2.5 table 2 of BS EN ISO 376:2011.

Two tests were made in compression followed by two tests in tension. Two further tests were then made in compression followed by two further tests in tension. The forces were applied to the device in compression through a soft pad, provided by Element, placed centrally on the domed upper loading boss. In tension the forces were applied to the device through adaptors, also provided by Element.

Measurements:

1. The bearing pad test, Clause B.2 of Annex B of BS EN ISO 376:2011, was carried out during this calibration. The force proving instrument satisfies the requirements of the bearing pad test for the following classification range(s):-

   Class 0.5   5000 N down to 100 N

2. The temperature during the calibration tests varied between 21.0°C and 21.4°C.

3. Before calibration commenced the device was zeroed using the Tare button. The no-load reading for compression and tension are shown in the table below. The results on the following pages have been adjusted using a linear progression between the initial and final zero values based on these zero readings.

	Compression				Tension			
	Run 1	Run 2	Run 3	Run 4	Run 1	Run 2	Run 3	Run 4
Initial Zero	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Final Zero	0.05	-0.08	0.06	-0.11	0.08	0.18	0.03	0.04

4. The forces applied and the resulting deflections are given in Tables 1 and 2: no correction for temperature has been applied to the results.

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5. For calibration in the compression mode in increasing forces, the estimate of the mean deflection was calculated as the mean of the tests 1, 3 and 4.

6. The procedure above was repeated for the calibration in the tension mode.

   For each mode of application of force, the coefficients of a third degree equation relating the estimate of the mean deflection as a function of the applied calibration force were calculated by the method of least squares. The differences between the mean value of deflection with rotation for each force and the computed value of deflection given by the equation were used to determine the relative interpolation error. The coefficients of a third degree equation relating a given applied force to the estimate of the mean deflection were also calculated.

Notes:

1. Clause 8.3.2 of BS EN ISO 376:2011 states that the maximum period of validity of the calibration of a force proving instrument shall not exceed 26 months. The force proving instrument shall be recalibrated if it sustains an overload which exceeds the maximum force by 12%.
2. Clause 9 of BS EN ISO 376:2011 states that the force proving instrument shall be loaded in accordance with the conditions under which it was calibrated. Precautions shall be taken to prevent it from being subject to forces greater than the maximum force to which it is classified.
3. If given or calculated forces are required to be in terms of one of the technical units of force, then the following conversion factors may be used:

Required unit of force	Factor by which the force in newtons must be multiplied
kilogram-force (kgf)	101.972×10^{-3}
pound-force (lbf)	224.809×10^{-3}
ton-force (tonf)	100.361×10^{-6}

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Results Table 1 : Compression

Test Number	1	2	3	5	Unbiased	Expanded
Orientation	0°	0°	120°	240°	estimate	Uncertainty
Force (N)	Deflection (N)				of mean	N
						±
100	-99.95	-99.98	-100.04	-100.03	-100.01	0.10434
200	-199.92	-199.94	-200.08	-200.04	-200.01	0.10777
500	-500.06	-500.05	-500.19	-499.96	-500.07	0.17612
1000	-1000.04	-1000.08	-1000.10	-1000.02	-1000.05	0.34560
1500	-1500.21	-1500.29	-1500.22	-1500.30	-1500.24	0.35197
2000	-2000.28	-2000.52	-2000.31	-2000.51	-2000.37	0.57846
2500	-2500.31	-2500.44	-2500.17	-2500.38	-2500.29	0.59113
3000	-3000.18	-3000.27	-3000.25	-3000.30	-3000.24	0.68028
3500	-3500.08	-3500.17	-3500.17	-3500.12	-3500.12	0.79078
4000	-3999.92	-3999.91	-4000.07	-4000.03	-4000.01	0.90083
4500	-4499.89	-4499.82	-4499.98	-4499.93	-4499.93	1.00643
5000	-4999.83	-4999.75	-4999.86	-4999.84	-4999.84	1.11847

Maximum Relative Uncertainty = 0.10%

Coefficients

For a given applied force F (in N), the expected deflection D (in N) OR For a given deflection D (in N), the applied force F (in N) is calculated from the following:

$$D=B_0+B_1F+B_2F^2+B_3F^3 \qquad F=A_0+A_1D+A_2D^2+A_3D^3$$

where:

B_0 = 6.41514E-02 A_0 = 6.41414E-02

B_1 = -1.00033E+00 A_1 = -9.99666E-01

B_2 = 9.17132E-08 A_2 = 9.16617E-08

B_3 = -3.99292E-12 A_3 = 3.98528E-12

If the expanded uncertainty is required for forces other than above it can be calculated from the following:

$$U_{exp}=(C_0+C_1F+C_2F^2)\times 2$$

where:

C_0 = 0.00000E+00

C_1 = 1.07000E-04

C_2 = -9.89889E-10

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Results Table 2 : Tension

Test Number	1	2	3	5	Unbiased estimate of mean	Expanded Uncertainty N
Orientation	0°	0°	120°	240°		
Force (N)	Deflection (N)					±
100	99.94	99.95	99.95	99.93	99.94	0.09753
200	199.99	199.98	200.04	200.02	200.02	0.05235
500	500.37	500.29	500.35	500.35	500.36	0.14867
1000	1000.84	1000.34	1000.94	1000.97	1000.92	0.62724
1500	1501.30	1500.91	1501.31	1501.35	1501.32	0.67749
2000	2002.14	2001.60	2002.11	2002.12	2002.12	0.80482
2500	2502.63	2501.75	2502.66	2502.73	2502.67	1.21188
3000	3003.05	3002.11	3002.90	3003.04	3003.00	1.30224
3500	3503.11	3502.27	3503.10	3503.20	3503.14	1.30092
4000	4003.51	4002.51	4003.46	4003.69	4003.55	1.48720
4500	4503.72	4502.56	4503.62	4503.82	4503.72	1.70257
5000	5003.97	5002.61	5003.79	5004.02	5003.93	1.95729

Maximum Relative Uncertainty = 0.10%

Coefficients

For a given applied force F (in N), the expected deflection D (in N) OR For a given deflection D (in N), the applied force F (in N) is calculated from the following:

$D=B_0+B_1F+B_2F^2+B_3F^3$ $F=A_0+A_1D+A_2D^2+A_3D^3$

where:

$B_0 =$ -2.26220E-01 $A_0 =$ 2.25890E-01
$B_1 =$ 1.00120E+00 $A_1 =$ 9.98805E-01
$B_2 =$ -8.13192E-09 $A_2 =$ 7.88986E-09
$B_3 =$ -1.34671E-11 $A_3 =$ 1.34524E-11

If the expanded uncertainty is required for forces other than above it can be calculated from the following:

$U_{exp}=(C_0+C_1F+C_2F^2)x2$

where:

$C_0 =$ 0.00000E+00
$C_1 =$ 2.38028E-04
$C_2 =$ -1.06147E-08

End of Certificate