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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: 2001036
Issue Date: 20 January 2020

Calibration Date: 15 January 2020

Description: A 25 kN compression and tension strain gauged load cell, used with an associated digital indicator, both manufactured by Interface.

Identification: 1106254 on load cell and cable.(TM0419)
J92167 on indicator. (TM0418)

Basis of Calibration: BS EN ISO 376:2011

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

Compression, Class 0.5 , 25 kN down to 0.5 kN

Tension, Class 0.5 , 25 kN down to 0.5 kN

Issued by:
R Moore
Force Calibration Technician
Force Laboratory

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Method:

The calibration was made in the laboratory's No. 4 Force Standard Machine in terms of the SI unit of force, the kilonewton (kN). 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 25 kN down to 0.5 kN

2. The temperature during the calibration tests varied between 19.8°C and 20.1°C.

3. During the tests, the no-load reading varied between 0.0 and 1.1 N for compression and between -0.6 and 0.0 N for tension.

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 estimate of mean	Expanded Uncertainty N
Orientation	0°	0°	120°	240°		
Force (N)	Deflection (N)					
						±
500	-499.8	-499.7	-499.8	-499.8	-499.8	0.27931
1000	-999.3	-999.5	-999.4	-999.4	-999.4	0.94021
2500	-2497.4	-2497.4	-2496.4	-2496.5	-2496.8	1.23142
5000	-4992.4	-4991.7	-4991.9	-4991.7	-4992.0	3.19653
7500	-7492.4	-7490.7	-7491.4	-7490.1	-7491.3	3.11548
10000	-9992.8	-9992.7	-9992.2	-9992.6	-9992.5	3.15391
12500	-12491.9	-12493.9	-12492.6	-12493.9	-12492.8	4.17756
15000	-14992.8	-14994.6	-14993.1	-14994.4	-14993.4	4.18507
17500	-17494.9	-17496.2	-17494.9	-17496.1	-17495.3	4.44652
20000	-19996.4	-19997.5	-19996.5	-19997.6	-19996.8	5.10588
22500	-22498.4	-22500.0	-22498.6	-22500.8	-22499.3	5.88277
25000	-25001.8	-25003.1	-25001.5	-25003.1	-25002.1	6.21920

Maximum Relative Uncertainty = 0.09%

Coefficients

For a given applied force F (in N), the expected deflection D (in N) OR For a given delection 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 = -9.71298E-01
B_1 = -9.97793E-01
B_2 = -1.50231E-07
B_3 = 2.43354E-12

A_0 = -9.69483E-01
A_1 = -1.00221E+00
A_2 = -1.50401E-07
A_3 = -2.43868E-12

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

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

where:

C_0 = 0.00000E+00
C_1 = 1.59911E-04
C_2 = -2.14010E-09

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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)					±
500	501.6	501.4	501.4	501.5	501.5	0.52174
1000	1002.0	1002.4	1002.2	1002.1	1002.1	0.63939
2500	2502.4	2502.6	2502.1	2502.2	2502.3	0.64429
5000	5002.1	5002.2	5002.9	5002.9	5002.6	1.25953
7500	7502.0	7502.2	7503.2	7503.4	7502.8	2.03906
10000	10001.1	10000.9	10001.9	10003.0	10002.0	2.51440
12500	12499.6	12500.1	12501.2	12502.6	12501.1	3.37578
15000	14998.7	14999.3	15000.6	15002.1	15000.5	3.95290
17500	17498.4	17499.1	17500.3	17501.2	17500.0	4.30307
20000	19998.0	19999.0	19999.9	20000.9	19999.6	4.94892
22500	22497.7	22498.3	22499.4	22500.7	22499.2	5.38103
25000	24997.0	24998.3	24999.1	25000.6	24998.9	6.15826

Maximum Relative Uncertainty = 0.10%

Coefficients

For a given applied force F (in N), the expected deflection D (in N) OR For a given delection 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:

$B_0 =$ 1.50445E+00 $A_0 =$ -1.50345E+00

$B_1 =$ 1.00045E+00 $A_1 =$ 9.99548E-01

$B_2 =$ -5.16176E-08 $A_2 =$ 5.16417E-08

$B_3 =$ 1.18614E-12 $A_3 =$ -1.18665E-12

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

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

where:

$C_0 =$ 0.00000E+00

$C_1 =$ 1.17567E-04

$C_2 =$ -3.66701E-11

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