Mechanical system

The HAUSSERMANN Spring Load Tester:

Thickness of test platens: 80 mm
Traversing test platen guided by 4 pillars with extra long sleeves in order to guarantee parallelism in spite of non-axial forces.

Load test system
3 load cells arranged in a triangle to compensate for non-axial forces.
Capacity: 0.2 kN to 100 kN.

Length measuring system
Non-contact transducer that takes its signals from the revolution of the spindle on the traversing platen. For all - or for typical - spring fixture configurations, the distortion curves of the whole system including the machine are taken for the compression and release movements, and are transferred to straight vertical lines by the on-board computer. This individual correction curve is stored for each spring and used for the correction of each measurement. (Please see the length measuring curves.)

Load deflection testing method
Pass-through technique. Up to 12 preset spring heights in either loading or unloading mode will be captured. Hysterisis as the difference between the load measured at a preset height during loading and unloading can be calculated and displayed, as can other correlations between different readings, such as spring rate. For diaphragm springs beyond the ho/t - relation of 1.44, the peak and valley loads can be ascertained and displayed.
For batch testing all statistical evaluations of the data are possible, including histograms. A conversion of test results from Newtons and mm into lbs. and in. can also be displayed and documented.

Accuracy of Spring Load Tester

The following is an abbreviated translation of the official certificate of approval for our load testing machine.

Characteristics of the test platens:

Hardness:	*60 to 63 HRc*
Surface roughness:	*Ra 0.15 to 0.30*
micro mm	
Flatness:	*less than 0.01/450 mm (0.0004/17.7 in.)*

Parallelism:

- *Unloaded: 0.023/450 mm (0.0009/17.7 in.)*
- *Loaded in the center to 100 kN (10 tons) with a steel ball between the platens: less than 0.04 mm (0.0016 in.)*
- *Loaded 150 mm (5.9 in.) off-center to 12 kN (1.2 tons) by a steel ball: 0.17/450 mm (0.0067/17.7 in.)*

Uncertainty of load measurement:
Definitions:
UF = Uncertainty of load measurement
q = error of ourtput in relation to true value
b = repeatability, calculated as deviation from the mean
a = resolution of reading
s = hysterisis error, calculated as deviation from the mean measured during loading cycle tests

The load range of the machine to 100 kN (3 load cells with 50 kN each) has been calibrated and tested with a 10 kN Master and a 200 kN Master at a calibrating speed of 0.025 mm/min (0.001 in./min.) and 0.04 mm/min. (0.0015 in./min.).

10 test cycles during loading and 6 during unloading were taken.

Specifications:

Load range	*UF less than*
100 kN - 1 kN	*0,5 %*
1 kN - 200 N	*1 %*
< 200 N	*- 0.0017*

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Test results:

The resolution of reading a has been taken into account at 0.25 % for all the measurements

Slew error

Slew error can occur during the time delay between measurement of the preset length and capture of the corresponding load data.

Test conditions:

Test specimen: Load ring (70 kN - range) with a spring rate of 45.1 kN/mm (255,000 lbs/in.)

Test speeds:

0.25 mm/min	*(0.01 in./min.)* *= calibrating speed*
6 mm/min	*(0.24 in./min.)*
12 mm/min	*(0.47 in./min.)*
18 mm/min	*(0.70 in./min.)*

The max. speed of load increase was 11.4 kN/s (2.560 lbs/s).

Results:

There was no significant offset to be seen from the basic test at calibrating speed. This could be verified by zooming sections out of the plotted load-deflection curves.

Load (kN)	q (%)	b (%)	s (%)	UF (%)	UF (%)
0.20	-0.41	0.60	-0.52	0.93	1.86
0.40	-0.07	0.54	0.56	0.82	3.28
0.80	-0.01	0.07	-0.09	0.27	
1.20	-0.06	0.09	0.15	0.31	
1.60	-0.03	0.18	0.03	0.31	
2.00	0.00	0.08	0.08	0.27	
4.00	0.04	0.06	...	0.26	
8.00	0.18	0.13	0.16	0.37	
10.00	0.16	0.19	0.02	0.35	
20.00	0.16	0.09	0.00	0.31	
30.00	0.13	0.05	0.03	0.29	
40.00	0.18	0.08	0.02	0.31	
50.00	0.18	0.04	0.00	0.31	
60.00	0.17	0.05	0.06	0.31	
70.00	0.18	0.04	0.05	0.31	
80.00	0.24	0.06	-0.02	0.35	
90.00	0.25	0.07	-0.01	0.36	
00.00	0.25	0.05	...		

Uncertainty of measurement of the length measuring system under load

Definitions:

UH = Uncertainty of length measurement

q, b, a, s ... see above.

Correction of distortion of frame and load cells: The correction curves (see Annex 1 for the load range up to 50 kN) fall within the specified range of 5 microns (0.0002 in.).

Test conditions:

Specimen: Centrically located load ring (70 kN-range) with a spring rate of 45.1 kN/mm (255,000 lbs/in.)

Test speed: 1mm/min (0.04 in./min.) 10 test cycles during loading and unloading were taken for evaluation. The master was an incremental feeler with an uncertainty of less than 1 micron (0.00004 in.).

Load range: Up to 66.3 kN at the height of 184.4 mm

Specification: UH <0.005 mm (0.0002 in.)

Test results: The resolution of reading a has been taken into account with 1 micron (0.00004 in.) for each measurement.

Height (mm)	Q (mm)	b (mm)	s (mm)	a (mm)	UH (microns)	UH (micro in.)
185.80	-0.0011	0.0020	0.0026	0.001	3.04	0.120
185.30	-0.0023	0.0020	0.0036	0.001	4.33	0.170
184.80	-0.0017	0.0030	0.0024	0.001	3.34	0.131
184.40	-0.0012	0.0020	0.0038	0.001	4.14	0.163

Total uncertainty of measurement

The uncertainty of load to length measurement of our new load tester has been determined as two figures for load measurement and height measurement. The total uncertainty of measurement can be expressed as one figure for an individual specimen at an individual point on its spring curve as

U_{Total} (N) = UF (%) x load (N)/100 +
UH (mm) x C (N/mm)

C = Spring rate of the measured spot on the spring curve

So the second position of U_{Total} shows the influence of the individual spring rate and explains why there is no U_{Total} in general.

Example:

Specimen: P/N 2.0026.0024 (R84429) of the inter-laboratory test

OD 254 mm
ID 213 mm
Thick 4.57 mm

Spring rate at test height of 7.25 mm 8.2 kN/mm
Load at test height 13.200 N

Uncertainty of measurement:

UF (%) = 0.35 (%), taken from the above table
UF (N) = 0.35 x 13.200/100 = 46.2 (N)

UH(mm) = 4.33 . 10 (mm), taken from the above table
UH(N) = 4.33 . 10 x 8.2 . 10 = 35.5 (N)

UTotal(N) = 46.2 (N) + 35.5 (N) = 81.7 (N)

This means that repeated measurements fall within a band of 81.7 N with the true value as a mean. In other words, the specified tolerances of the spring to be measured should be shortened at both ends by 87.1 N in order to be sure that the true value is within the specified tolerances.