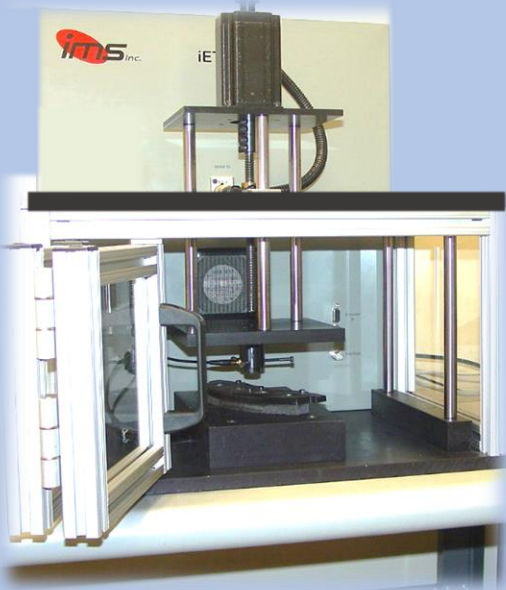


Dynamic Modulus Measurement in Friction Materials for Intact Pads using the iETEK



- No sample preparation required
- Fast Cycle Time
- Measures As-manufactured pads
- Automatic load and unload cycle
- Automatic measurement point detection
- Dynamic Modulus Measurements
- Accommodates most shapes and sizes pads
- QC applications

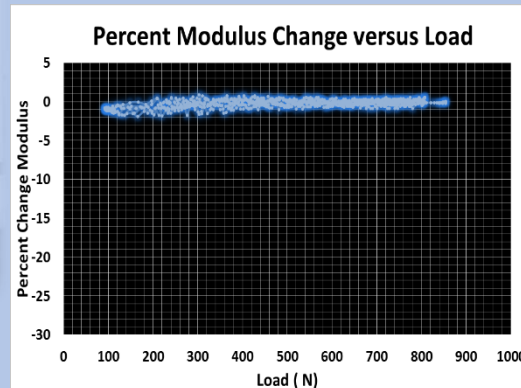


Figure 1. Acrylic

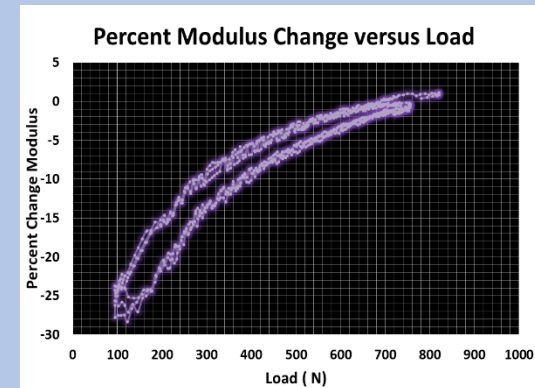
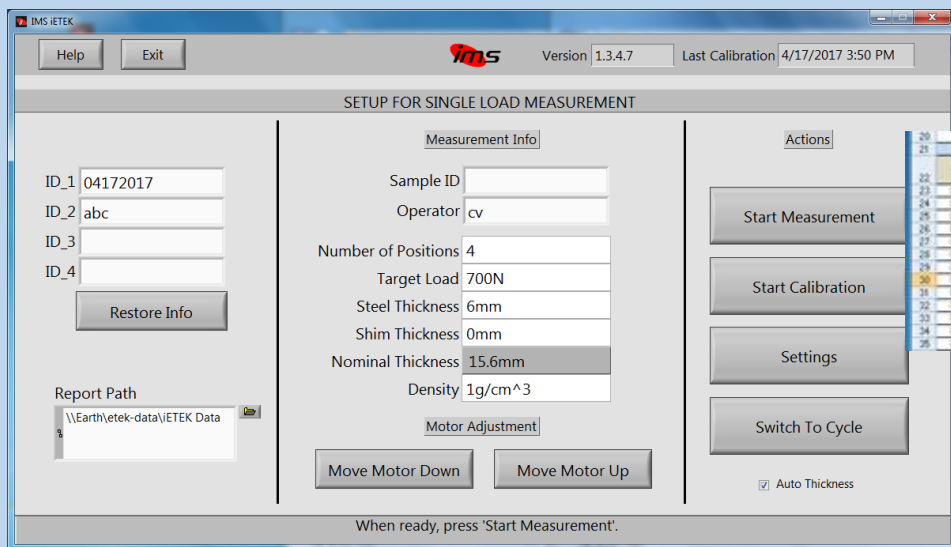


Figure 2. Friction Material

Introducing the iETEK for making QC measurements on as-manufactured brake pads using the same technology as the ETEK 3000 (SAE specification J2725). The iETEK is a non-destructive, ultrasonic system to measure uniformity and dynamic modulus in as-manufactured pads. The iETEK is a quality control tool for uniformity and batch-to-batch consistency. No sample preparation is required and most sizes and shapes of pads can be measured.

Two measurement modes are available on the iETEK. These include Single Load and Cycle Load. With Single load the operator selects a single preload (from 100N to 800N) and the number of positions to be measured on the intact brake pad. The density (or nominally 1g/cm³) is entered along with the steel backing thickness. The total thickness is measured automatically by position. An Excel multi-sample report is generated with one row per sample.

iETEK Single Load User Interface

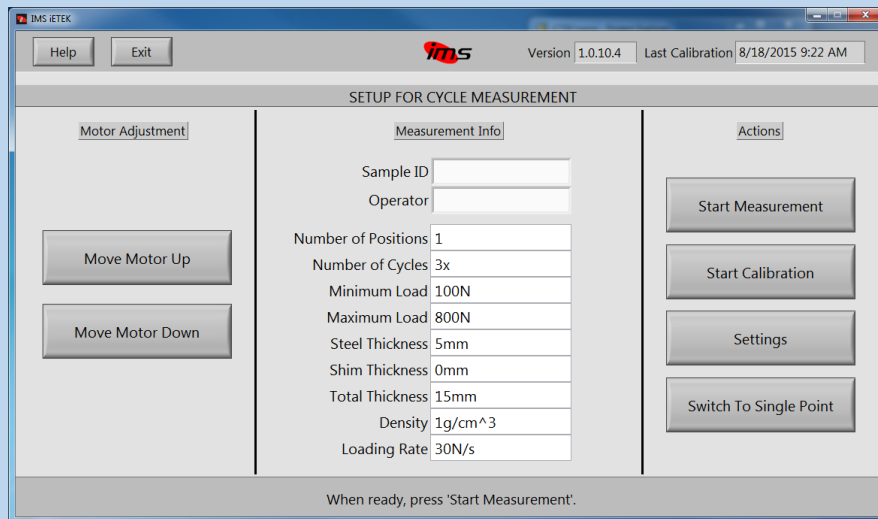


Excel data Report includes multiple sample information, one row for each pad measured. Date and time stamp, thickness, ultrasound time-of-flight and Modulus by position (up to 8 positions/pad) and Statistical information by pad. These reports can be tailored to customers' needs.

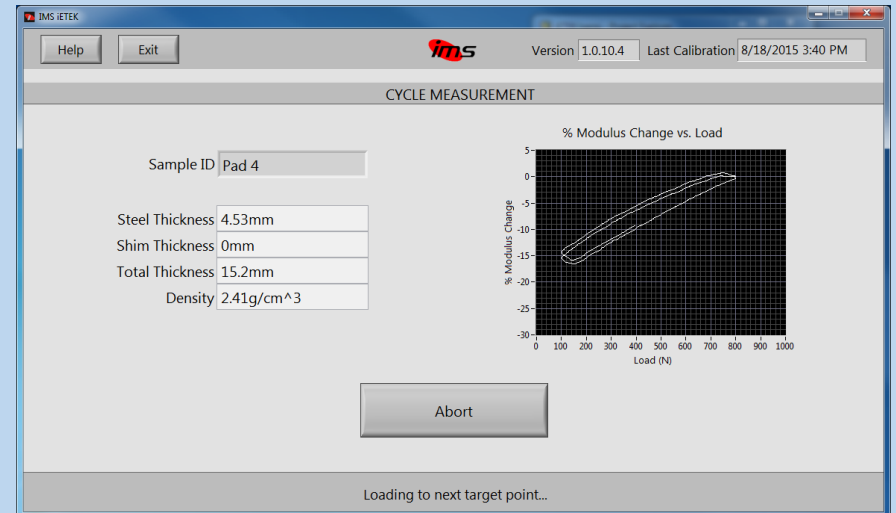
Sub	File	Sample ID	Operator	SPecifier	Target Load (N)	Steel Thickness (mm)	Shim Thickness (mm)	Result Thickness (mm)	Time of Flight (µs)	Modulus (GPa)	Position 1	Position 2	Position 3	Position 4	Position 5	Position 6	Position 7	Position 8
22	3/1/2017	4.15.21 PM																
24	3/1/2017	4.16.40 PM			700	5.50	0.00	2.620	96.31	1.2455E-05	2460	-1	96.30	0.00	2.62	2541	4.75	
25	3/1/2017	4.17.25 PM		cr	2	700	5.50	0.00	2.620	96.31	1.2455E-05	2460	-2	96.30	0.00	2.62	2555	3.95
26	3/1/2017	4.18.06 PM		cr	2	700	5.50	0.00	2.620	96.31	1.2455E-05	2460	-3	96.30	0.00	2.62	2569	3.15
27	3/1/2017	4.18.48 PM		cr	2	700	5.50	0.00	2.620	96.31	1.2455E-05	2460	-4	96.30	0.00	2.62	2583	2.35
28	3/1/2017	4.19.30 PM		cr	2	700	5.50	0.00	2.620	96.31	1.2455E-05	2460	-5	96.30	0.00	2.62	2597	1.55
29	3/1/2017	4.20.04 PM		cr	2	700	5.50	0.00	2.620	96.31	1.2455E-05	2460	-6	96.30	0.00	2.62	2611	0.75
30	3/1/2017	4.20.38 PM		cr	2	700	5.50	0.00	2.620	96.31	1.2455E-05	2460	-7	96.30	0.00	2.62	2625	-0.05
31	3/1/2017	4.21.11 PM		cr	2	700	5.50	0.00	2.620	96.31	1.2455E-05	2460	-8	96.30	0.00	2.62	2639	-0.85
32	3/1/2017	4.21.55 PM		cr	2	700	5.50	0.00	2.620	96.31	1.2455E-05	2460	-9	96.30	0.00	2.62	2653	-1.65
33	3/1/2017	4.22.45 PM		cr	2	700	5.50	0.00	2.620	96.31	1.2455E-05	2460	-10	96.30	0.00	2.62	2667	-2.45
34	3/1/2017	4.23.37 PM		cr	2	700	5.50	0.00	2.620	96.31	1.2455E-05	2460	-11	96.30	0.00	2.62	2681	-3.25
35	3/1/2017	4.24.32 PM		cr	2	700	5.50	0.00	2.620	96.31	1.2455E-05	2460	-12	96.30	0.00	2.62	2695	-4.05

With Cycle Load the operator selects the range of loads and the number of cycles in a given position as well as the number of positions to measure on the intact pad. Both real time display and automatic reports are generated.

iTEK Cycle Load User Interface

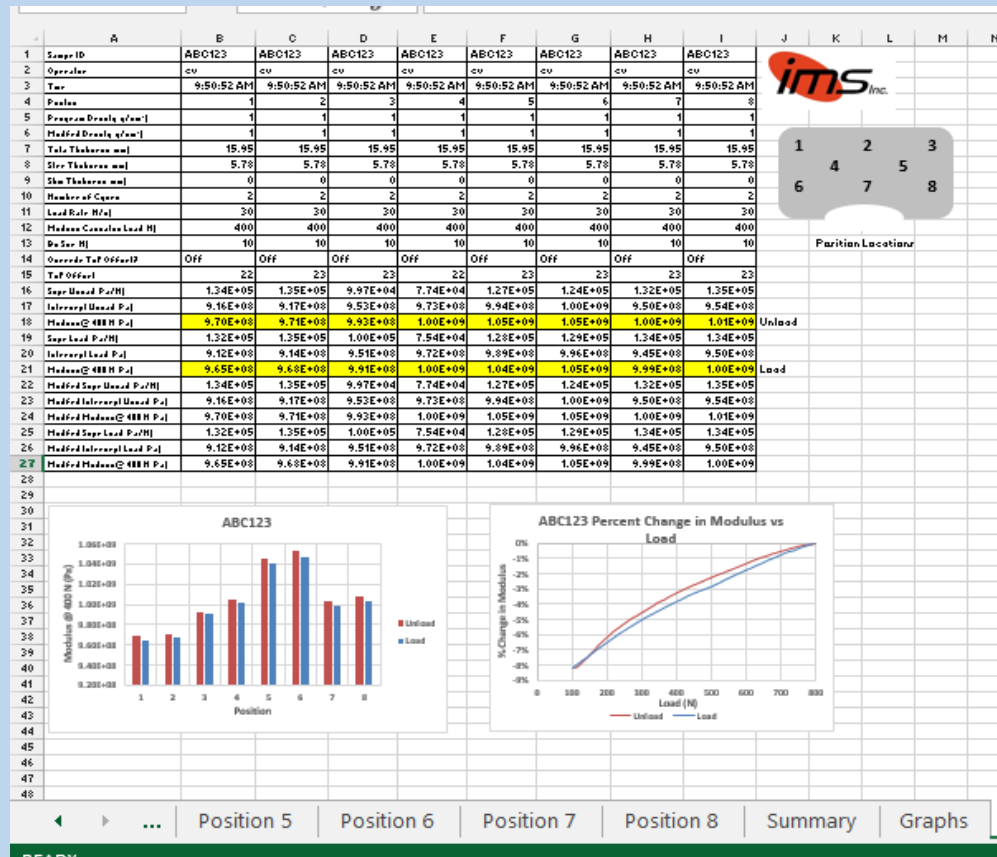


iTEK Cycle Load Real-Time Results Page



iTEK Cycle Load Report

Automatically Generated in Excel, the Load Cycle Report can be tailored to customers' needs. On the report summary page displayed here, tabularized numerical and graphical data show Young's Modulus for 8 positions measured on the intact pad which is then plotted as a function of position (preload of 400N, during load and unload cycle) as well as Percent Change in Modulus as a function of Load. The positional information provides spatial uniformity of the pad while the Percent Change in Modulus displays the overall change in stiffness with preload.



iETEK Application

The spatial uniformity of the out-of-plane dynamic modulus in brake pads is important for NVH performance and consistency in the manufacture of brake pads. The iETEK can measure modulus in multiple positions on a single brake pad in order to obtain a measure of intra-pad variability. In the example below fourteen intact, as-manufactured brake pads from various manufacturers were measured in 5 positions on the iETEK using a single pre-load of 700N (equivalent to 15 Bar). The average and standard deviations are plotted here on the left and % difference from average modulus is shown in the graph on the right.

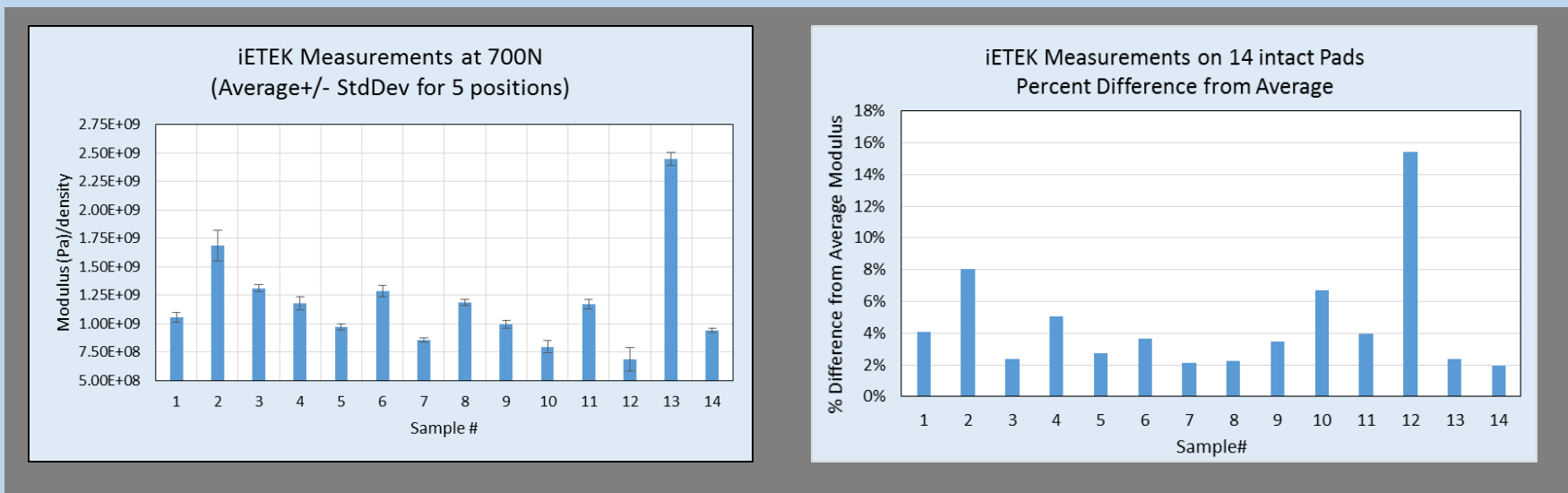
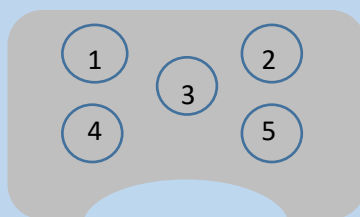


Diagram showing approximate location of 5 positions measured for each pad



iETEK Application

The spatial uniformity of the out-of-plane dynamic modulus in brake pads is important for NVH performance and consistency in the manufacture of brake pads. The iETEK can measure modulus in multiple positions on a single brake pad in order to obtain a measured of intra-pad variability. In many cases the spatial variation in modulus is random. However, in some cases there is a systematic variation in modulus as a function of position related to the manufacturing process. In the figure below, 12 positions were measured with the iETEK on each of three intact brake pads, six positions on the left side and six on the right. In this case there is a systematic variation in modulus with the right side positions exhibiting a significantly higher modulus relative to the left side positions.

