EXPERIENCE OF THE FIBROTEST FOR MEASURING COTTON FIBER LENGTH AND STRENGTH PROPERTIES

Xiaoliang Cui
Chris Delhom
James Rodgers
USDA ARS, SRRC
New Orleans, LA
Yiyun Cai
Louisiana State University
Baton Rouge, LA
Vikki Martin
Mike Watson
Cotton Incorporated
Cary, NC

Abstract

The Fibrotest is a device developed by Textechno for measuring cotton fiber length and strength properties. A series experiments were conducted to compare its results with those of other devices such as the HVI and with standard USDA values. The characteristics of the Fibrotest's operations and experimental results are discussed.

Introduction

The Fibrotest is a device developed by Textechno for measuring cotton length and strength properties. It applies the fibrograph theory for length measurement. It measures the fiber strength (tenacity) after conducting a tensile test on the fiber beard and obtaining the linear density. The Fibrotest has relatively compact size: about 0.7m×0.41m×0.55m; it weighs approximately 55 kg. The measurements of cotton fiber length and strength are mostly automated.

The Fibrotest reports two "modes" of parameters: absolute mode and relative mode. The length calibration is by use of a template, and the load cell calibration is by use of a 10 kg weight. If no further calibration is performed, the test results are referred as "absolute mode" values. In the relative mode, the reported parameters are computed by matching the results against a set of "calibration" data, which can be individually generated by different operators by matching standard calibration cottons, which can be at HVI level, ICC level or any customer level depending on the calibration material used.

The Fibrotest reports more than 20 length and strength parameters. It reports length parameters such as Mean Length (ML), Upper Half Mean Length (UHM), Span Lengths (SL), Short Fiber Content (SFC), Uniformity Index (UI), etc. The strength parameters include Strength (Tenacity), breaking elongation (Emax), breaking force (Fmax), etc. In addition, the Fibrotest can generate fiber length histograms, staple diagrams, fibrograms, and force/elongation curves. It also provides a black and white image of the scanned fiber bundle.

In order to understand the performance and characteristics of the Fibrotest, we conducted a series of comparative studies.

Experimental

A selection of cottons, including two sets of United States Department of Agriculture, Agriculture Marketing Service (USDA AMS) 8x8 strength and length cottons and two sets of 6x8 micronaire cottons, as well as three international calibration cottons that have Stelometer strength values, was tested by the Fibrotest, HVI, and AFIS. All samples were kept in standard conditions for at least 24 hours. Each sample was separately tested by two technicians who received trainings from the distributor of the Fibrotest. For each sample, each technician tested at least eight reps. Tests were performed to investigate:

1) Possible operator effects on measurement results;

2) Comparisons between the "relative mode" results of the Fibrotest and those of other devices such as HVI or "standard" values from USDA;
3) Micronaire's impacts on strength measurements; and
4) Comparisons between Fibrotest strength results and Stelometer values.

Results and Discussion

Operator Effects on Fibrotest Length and Strength

A total of 248 pairs of results from two technicians were used to study operator effects. Operator effects were found. On length measurements, Technician 1 consistently obtained longer UHM and ML. The overall average difference is 0.016 inch for ML and 0.022 inch for UHM. However UI did not show an operator effect. Since UI=ML/UHM, any possible operator effect might have been counteracted. On strength measurements, Technician 1 obtained lower strength and the average difference is 0.3 g/tex. The correlation coefficient between the results of the Technicians was 0.97 for UHM and 0.92 for Strength, respectively. The testing beards are prepared by operators manually; therefore, the way an operator prepares the beards (such as forming a beard using the comb, brushing a beard to remove loose fibers and fiber crimps) may influence the test results. We also found that Technician 1 prepared larger beards.

Comparisons between the "Relative Mode" Results of the Fibrotest and Those of Other Devices Such as HVI or "Standard" Values from USDA

Two sets of USDA AMS 8x8 cottons with "standard" HVI values were used for the comparisons. Each sample was measured by two technicians, and each sample had eight reps. The observed differences between the relative mode values and the "standard" values were small. Relative UHM values were 0.004 inch shorter on average than the "standard" UHM. Relative Strength values were 1.3 g/tex higher on average than the "standard" Strength values. The correlation coefficient between the Relative UHM values and "standard" UHM values is 0.99; the correlation is 0.95 for strength. Tables 1 and 2 show the comparisons between Fibrotest measurement relative UHM and strength and the "standard" values respectively.

Table 1 Fibrotest relative UHM means and standard deviations and "standard" values

ID	Reps	Mean	Std Dev	"Standard" Value	Difference
31-1	16	0.974	0.021	0.961	0.013
31-2	16	0.939	0.021	0.943	-0.004
32-1	16	0.974	0.023	0.990	-0.016
32-2	16	1.009	0.016	1.002	0.007
33-1	16	1.009	0.017	1.022	-0.013
33-2	16	1.050	0.012	1.040	0.010
34-1	16	1.068	0.019	1.053	0.015
34-2	16	1.048	0.017	1.046	0.002
35-1	16	1.082	0.021	1.085	-0.003
35-2	16	1.095	0.023	1.104	-0.009
36-1	16	1.138	0.020	1.133	0.004
36-2	16	1.119	0.028	1.129	-0.010
37-1	16	1.138	0.029	1.162	-0.024
37-2	16	1.159	0.025	1.169	-0.010
38-1	16	1.169	0.027	1.182	-0.013
38-2	16	1.181	0.025	1.188	-0.007

Impacts of Micronaire on Strength Measurements

The HVI corrects the measured strength by micronaire values since the micronaire affects the optical measurement of the linear density of the beard between the clamps. The Fibrotest does not correct strength by micronaire values since the linear density of the beard between the clamps is determined gravimetrically. To check if micronaire significant affects the strength difference between Fibrotest and HVI, 12 cottons with micronaire values ranging from 2.52 to 5.48 were tested on both instruments. Based on the results, the micronaire value did not show statistically significant influence on the strength difference between Fibrotest and HVI. Figures 1 and 2 show the strength values measured by Fibrotest and HVI respectively.

Comparisons between Fibrotest Strength Results and Stelometer Values

We selected three international calibration cottons, which had standard Stelometer strength values. Two operators tested the cottons, each with 8 reps (overall 48 reps) for the comparisons. Based on the strength results of these 48 observations, the Fibrotest absolute strength is lower than Stelometer strength; the Fibrotest elongation is higher than Stelometer elongation (Table 3). This may be mainly caused by the fiber crimps since Fibrotest does not have a mechanism to keep fibers straight for testing. Since the Fibrotest has a "relative" calibration mode, it can be calibrated to Stelometer level, which may be useful for people interested in Stelometer values. If we had set the relative mode to Stelometer level, the difference would have been much smaller.

Table 2 Fibrotest relative strength means and standard deviations and "standard" values

ID	Reps	Mean	Std Dev	"Standard" Value	Difference
31-1	16	28.4	1.4	27.9	0.5
31-2	16	26.9	2.3	23.7	3.2
32-1	16	23.7	1.5	23.7	0.0
32-2	16	24.5	1.9	23.4	1.1
33-1	16	29.6	2.2	28.1	1.5
33-2	16	29.3	1.6	29.0	0.3
34-1	16	29.5	2.0	27.9	1.6
34-2	16	31.3	2.4	29.5	1.8
35-1	16	33.5	2.2	30.7	2.8
35-2	16	29.2	1.3	27.5	1.7
36-1	16	29.0	1.4	27.4	1.6
36-2	16	28.1	2.0	27.6	0.5
37-1	16	36.9	1.6	33.3	3.6
37-2	16	32.4	1.8	31.7	0.7
38-1	16	33.8	2.8	33.8	0.0
38-2	16	33.5	1.8	33.4	0.1

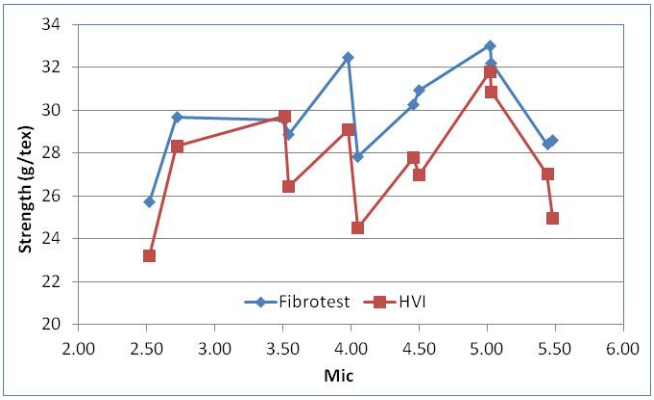

Figure 1 Fibrotest and HVI strength of different micronaire samples

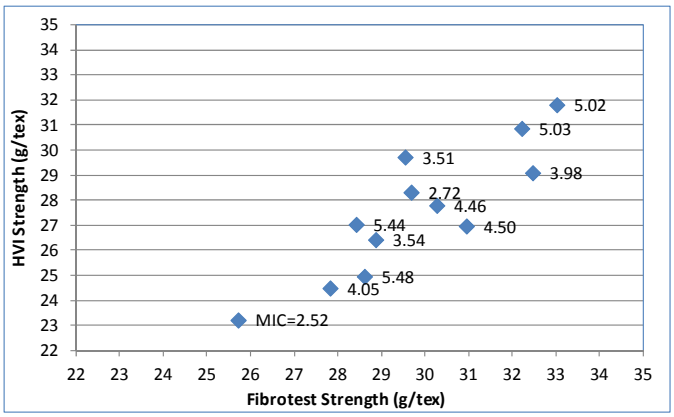

Figure 2 Relationship between Fibrotest and HVI measured strengths with different micronaire samples

Table 3 Fibrotest measured strengths and standard Stelometer values

ID	Fibrotest			Stelometer	
	Strength (g/tex)	Rel.Strength (g/tex)	Elongation (%)	Strength (g/tex)	Elongation (%)
G-18	12.7	26.5	16.4%	17.0	8.5%
G-12	11.6	25.0	15.5%	18.0	8.1%
C-39	18.4	34.7	15.9%	25.1	7.1%

Summary

The Fibrotest is a device developed by Textechno for measuring cotton fiber length and strength properties. The Fibrotest provides abundant information, including more than 20 length and strength parameters in absolute and relative modes, and displays fibrogram, load-elongation curve, and fiber beard image. Its calibration method has several advantages, such as individual operators can have different calibration files, or it can be calibrated to different relative levels. The observed differences between the relative mode UHM and Strength values and "standard" HVI values were small. The micronaire value did not show a statistically significant impact on strength difference between Fibrotest and HVI. The Fibrotest produced a higher breaking elongation and a lower strength in absolute mode than Stelometer, which can be reduced by the use of Stelometer values in relative mode (calibration to Stelometer level). Small operator effects on length and strength measurements were observed. The Fibrotest does not have a mechanism to keep fibers straight for testing, which may contribute to the differences in testing results from other devices.

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