



Cotton fibres – Comparison of single fibre strength and fibre bundle strength to each other

■ made
■ in
■ Germany

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1. INTRODUCTION

- For determination of strength/elongation properties at cotton fibers the fiber-bundle strength test method is applied.
- To test fiber-bundle strength the High Volume Testing instruments according to ASTM D 5867-05 are used.
- HVI-STR and HVI-ELO cannot be used for evaluation of spin-ability: This requires an absolute measurement of the STR and ELO, especially for OE spinning, where the fiber strength is the most important parameter.
- Measured ELO values on single cotton fibers are showing a clear correlation with the measured strength values. Surprisingly in case of HVI-ELO a negative correlation, i.e. shorter elongation in case of higher strength, is observed.



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- Therefore the relation between single-fiber strength/elongation test data and fiber-bundle strength test data should be studied within this paper.
- To perform these tests the TEXTECHNO testing devices FIBROTEST (for bundle strength test) and FAVIGRAPH (tensile test at single fibers) have been used.
- The advantage of the FIBROTEST is, that this testing device is able to perform two different testing modes : HVI-Mode and direct (absolute) test mode.



2. Strength tests on cotton samples

- How are the strength values of STR(HVI1000), STR(HVI900), STR(FIBROTEST- direct mode) and STR(single fiber tests) in relation to each other ?
- The tests have been made on 10 cotton samples from Texas.
- On following testers the STR values have been measured:
 - a) FIBROTEST direct mode (absolute STR measured),
 - b) HVI 900, calibrated with IC-calibration cotton,
 - c) HVI 1000, calibrated with HVI-calibration cotton,
 - d) FAVIGRAPH, tensile test on single fibers,
 - e) FAVIGRAPH_B, tensile test on fibre bundles, by using STELOMETER clamps and manual weighing of the sample mass after the tests,



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No	Absolute Strength STR (g/tex)		Relative Strength STR (g/tex)		STR (g/tex)
	FIBROTEST direct mode (a)	FAVIGRAPH fiber bundle test (e)	HVI-900 IC Cal.Co. (b)	HVI-1000 HVI-Cal.Cot. (c)	FAVIGRAPH single fiber test (d)
1	12,19	14,62	19,89	24,50	23,63
2	13,00	14,12	20,30	26,60	24,78
3	19,94	20,28	25,00	34,20	39,66
4	16,87	19,00	25,19	33,20	33,92
5	19,37	19,68	22,34	30,90	33,05
6	20,02	19,50	25,19	33,90	37,59
7	16,70	18,71	22,75	27,10	28,47
8	20,49	20,89	25,70	34,20	36,13
9	16,11	18,67	23,77	30,60	30,91
10	17,18	18,60	22,34	29,70	28,61
Average	17,19	18,41	23,25	30,49	31,68
Coeff.Corr.	R(STRabs) =	0,95		R(STRrel)=	0,96

■ Tab.1 : Comparison test results for 10 different cotton samples

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- 1) STR (HVI 1000) shows nearly the same test results like the single fiber STR (FAVIGRAPH).
- 2) STR (FIBROTEST – absolute value) is equal to the measured STR(FAVIGRAPH_B with the STELOMETER clamps.
- 3) Fiber bundle strength STR (HVI-900) is in between HVI1000 strength and absolute measured strength at FIBROTEST.



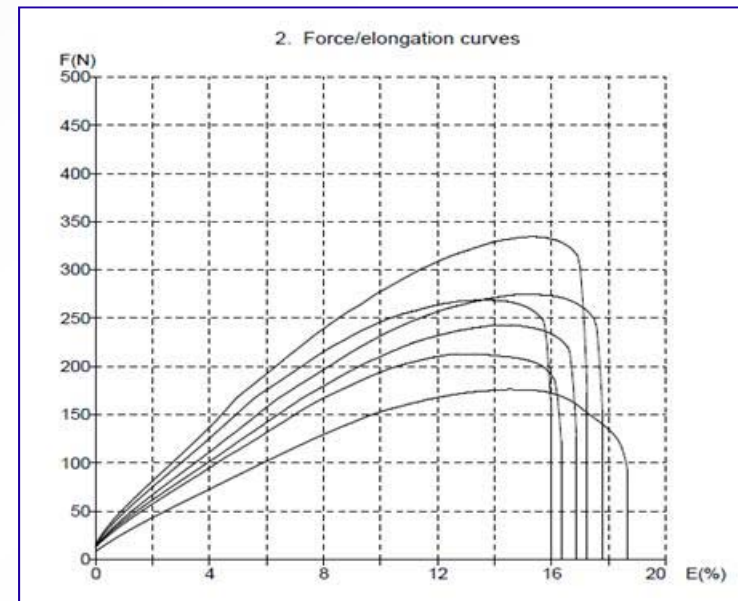
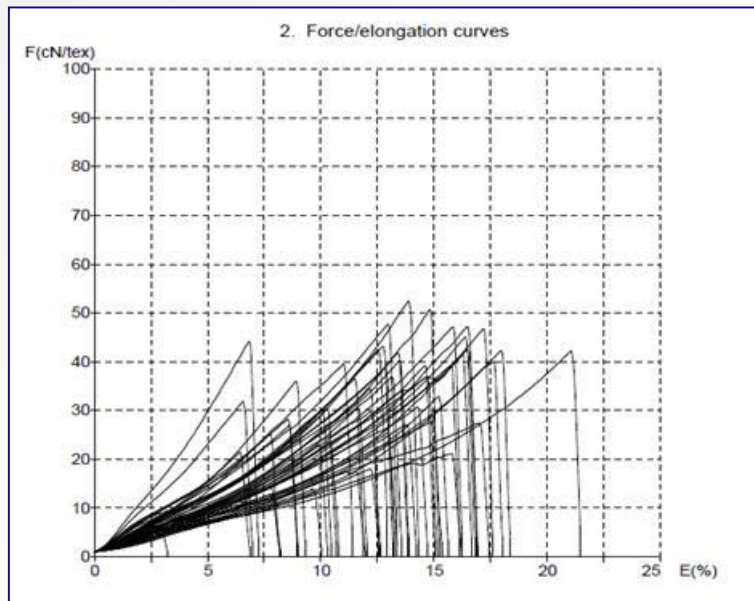
Discussion of the test results:

- 2) has been expected : in booth cases the strength is measured absolutely !
- 1) this is a surprising result and can not be possible from the physical point of view ! That would mean, that all single fibers do have the same strength and same elongation, i.e.

$$\text{Bundle strength} = N * \text{Single fiber strength} \quad (1)$$

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■ Practice is different !!!!



- Fig 1 : Left: Single fibers F-E Diagram for cotton GIZA 90 LS (STR (FAVIGRAPH) single fiber test = 33,46 g/tex)
Right: Fiber bundle F-E Diagram for cotton GIZA 90 LS (STR (FIBROTEST) direct mode = 20,04 g/tex
STR (HVI 1000) HVI mode = 34,82 g/tex)

Conclusion – Strength test :

- F-E-Diagram for single fiber tests shows:
The individual fibers do have different STR and ELO values ! Equation (1) is not correct !
- F-E-Diagram of the fiber bundle can be calculated : At equidistant elongation steps the force values for all individual fibers needs to be summarized in order to get F-E Diagram of the bundle !
- Result : Absolute Fiber bundle strength is much smaller then the average strength of the single fibers, what is equal to HVI-STR !
- This is a plausible result : a standard cotton has an absolute fiber bundle STR value of around 12 ... 15 g/tex on a sliver/roving.
Giving twist on the roving, the tension on the yarn is increased up to 17... 19 g/tex due to the friction between the fibers !



3. Elongation tests on cotton samples

- How are the Elongation values of ELO(HVI1000) and ELO(FIBROTEST) in relation to each other ?
- The tests have been made on 8 cotton samples from Texas. These samples have been tested continuously over 5 days, what means 40 tests have been made totally. The tests have been performed at TEXAS TECH University Lubbock.
- On following testers the samples have been measured:
 - a) FIBROTEST in HVI-mode (calibrated with HVI calibration cotton),
 - b) HVI 1000, calibrated with HVI-calibration cotton,



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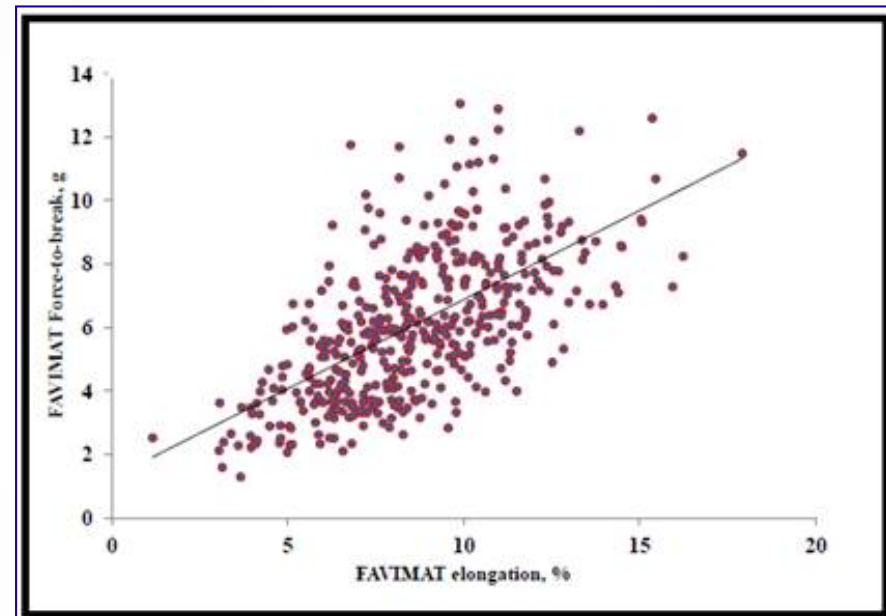
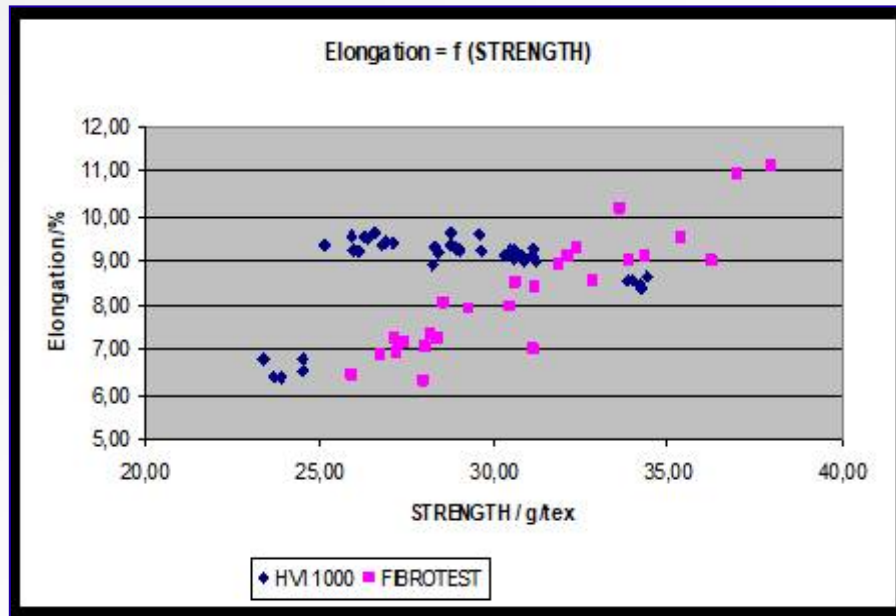
Sample No.	HVI 1000	FIBROTEST	HVI 1000	FIBROTEST	HVI 1000	FIBROTEST	HVI 1000	FIBROTEST	HVI 1000	FIBROTEST
	UHM/mm	UHM/mm	UI	UI	SFI	SFI	Emax	Emax	HVI STR	HVI STR
1	28,88	29,09	82,98	82,30	7,97	8,36	9,12	9,27	30,64	34,03
2	31,50	31,97	83,89	85,86	6,23	5,23	8,51	10,48	34,14	37,87
3	28,40	28,45	80,27	78,30	11,71	9,79	9,45	6,88	26,04	28,43
4	28,91	29,05	81,41	78,91	10,35	9,24	9,36	7,12	26,65	27,18
5	29,78	30,49	82,62	82,78	8,22	7,27	9,13	8,55	30,73	31,71
6	26,02	26,61	76,63	77,28	16,46	11,44	6,58	4,68	24,03	25,15
7	28,83	29,37	80,50	79,28	10,88	8,92	9,39	7,64	28,93	28,86
8	29,30	29,56	81,13	79,80	10,02	8,68	9,20	7,56	28,66	28,59
Corr.Co.		0,99		0,86		0,93		0,49		0,95

- Tab.2 : Comparison test results for 8 different cotton samples

NOTE: Denkendorf Fiber Table :

ELO of Cotton is between 6 % 10 %

■ Correlation between STR and ELO :



- Fig 2 : Left : $ELO = f(STR)$ for HVI 1000 and FIBROTEST for the 8 cotton samples from Texas
Right: $STR = f(ELO)$ for single fiber test results of Cotton samples (example : E. Hequet).

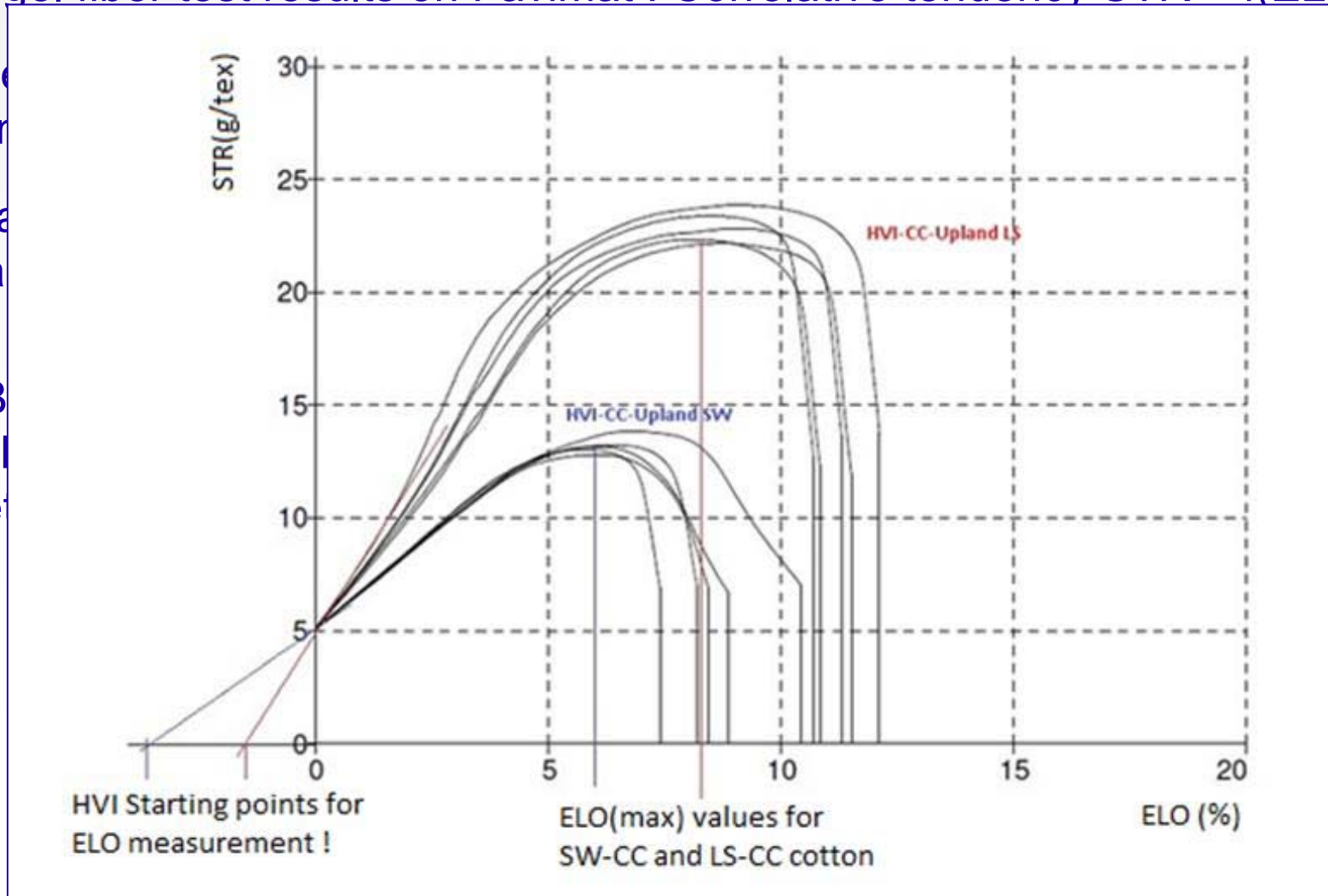
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- Singel fiber test results on Favimat : Correlative tendency $STR = f(ELO)$!

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THANKS FOR YOUR ATTENTION !



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