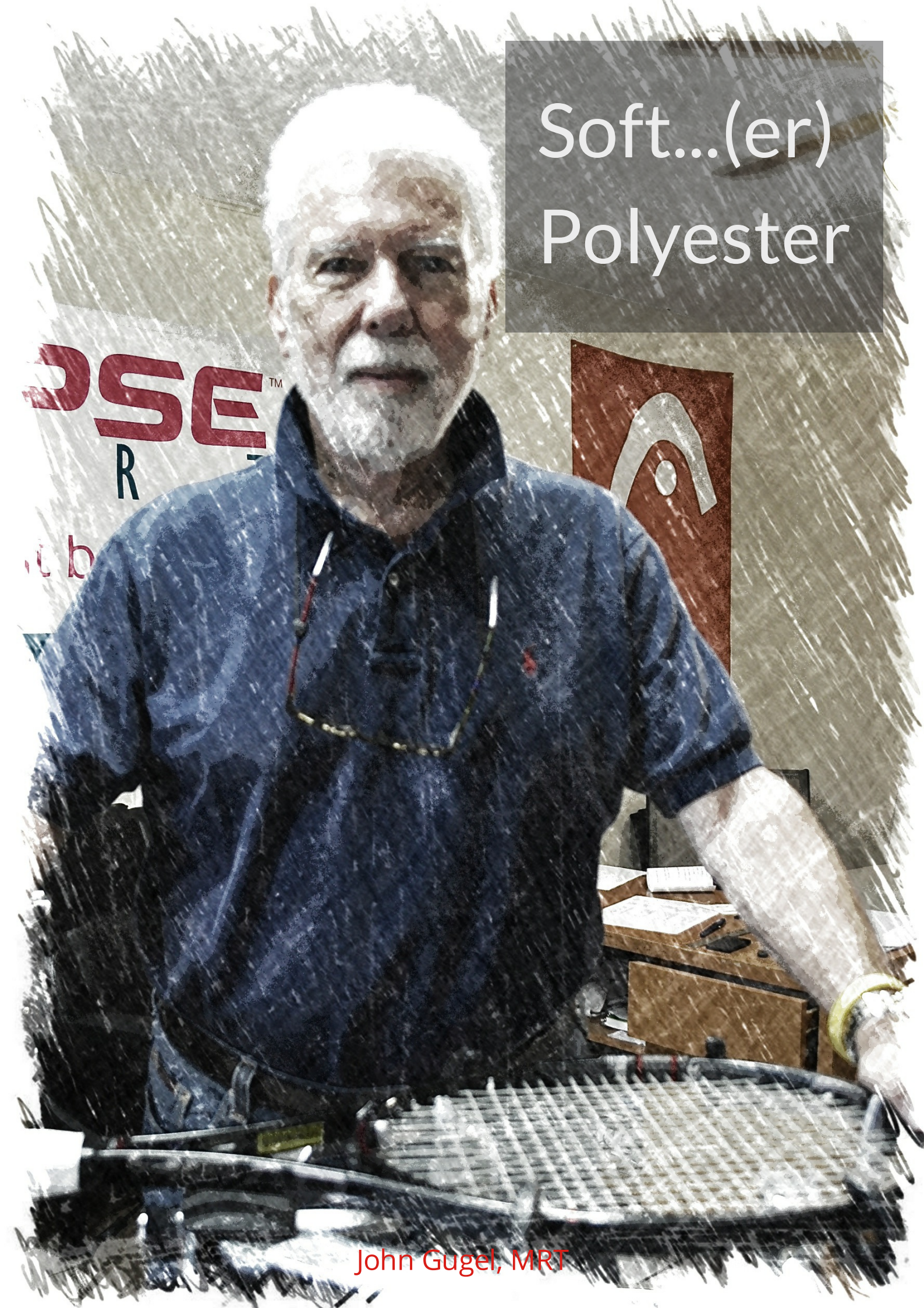
Soft...(er) Polyester



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Soft...(er) Polyester | RacquetQuest

Posted by RacquetQuest

What is “soft”?
In 1994 I did a presentation for the USRSA in Atlanta. What was the topic?

“Understanding String”.

It is now 2016 and we are still trying to understand string! Especially “soft” polyester based string.

In 1994 PolyStar was the only polyester based string I was familiar with. Since then there are dozens of offerings from anyone that can afford to purchase from manufacturers and market the string. If you have a desire to do it I applaud you!

In 1989 I started testing string and calculating “power potential”. Why “power potential”? Because “modulus”, “elongation” and “elasticity” didn’t get to the bottom line of string performance quickly enough! The steps to arrive at power potential are many.

For the testing, several calculations take place including “stretching” the string as in a ball impact. The difference between the first calculation and the “stretched” calculation is the power potential!

I have calculated hundreds of power potentials but have not until now quantified “soft”.

I think now is the time!

Dr. Rich Zarda has done a tremendous amount of work on this issue so we can now distill this work into the following explanation.

So, what is a “soft” tennis string?

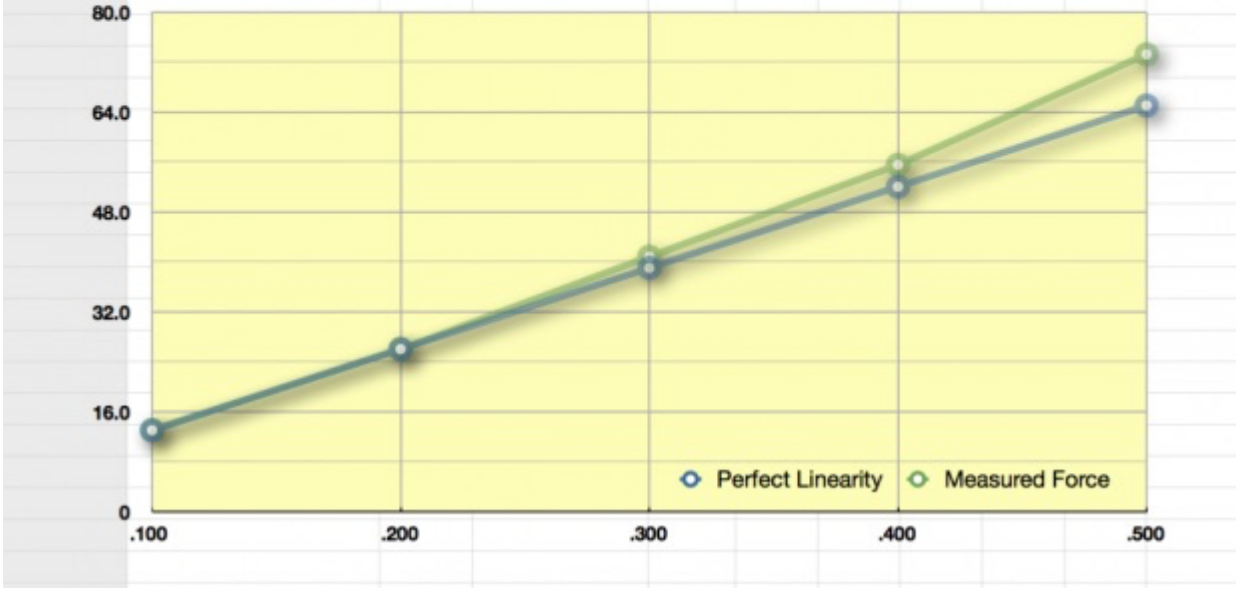
Strings in a tennis racquet carry the ball impact load in two ways:
1) Via the pre-load string tension placed in the strings caused by a stringing machine (and the racquet frame "holding" those tensions in place) and
2) Via additional tensions that develop in the same string caused by the elongation of the strings as they deflect with ball impact.

Both of these conditions occur simultaneously and contribute to the string bed stiffness (SBS, units of lbs./in). Racquet technicians measure SBS by applying a load to the center of a supported string bed and measuring the resulting deflection. Dividing the load by the deflection provides the SBS (lbs./in). The lower the SBS, the more power you have (power here is the ability of the ball to easily rebound from the string bed), but the less control (presumably); the higher the SBS, the less power you have but the more control you have (presumably).

One more point about SBS: the lower the SBS, the less the load your body will feel for a given swing. But for an SBS too low (less than 50-80 lbs./in), balls will be flying off your racquet going over the fence; and for an SBS too high (greater than 200-240 lbs./in), the racquet will hit like a board with significantly less ball rebound. So the most common SBSs are between 100-200 lbs./in: a balance between control and power.

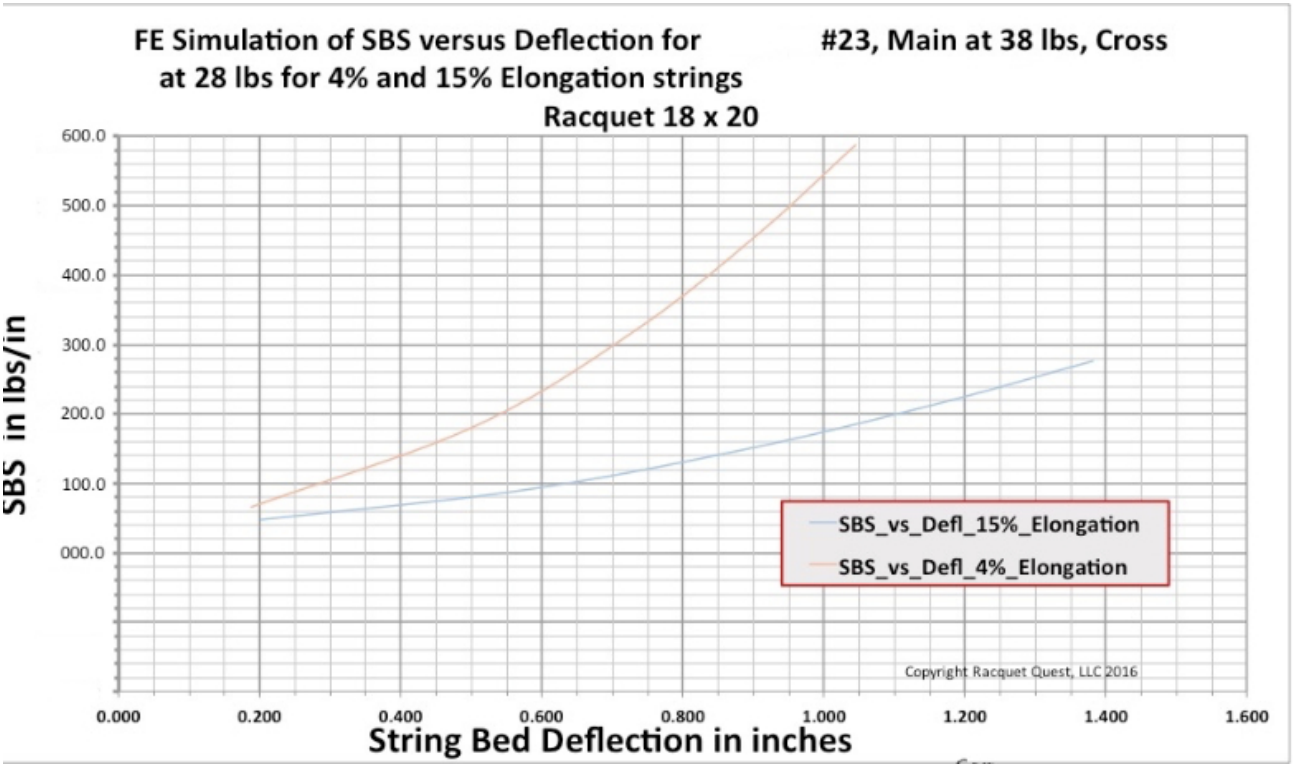
As already expressed, SBS is a function of the pulled string tension and the string elongation. Here is what is interesting: For large string elongations (for example, greater than 15%) and reasonably pulled string tensions (greater than 30-40 lbs.), SBS only depends on the pulled string tension and it does not depend on string elongation. Additionally, for this condition, SBS, for these high elongation strings, does not change as a ball is hit with more impact.

Racquet Model	Head Size	String Model	Pattern	String Bed Deflection				
				0.100	0.200	0.300	0.400	0.500
Babolat Pure Drive	100		16x19	2.54	5.08	7.62	10.16	12.70
Reference Tension: 38								
Machine: TT Professional			Perfect Linearity	13.0	26.0	39.0	52.0	65.0
			Measured Force	13.0	26.0	40.8	55.5	73.2
			Pounds/Inch	130.0	130.0	135.9	138.8	146.4
			Kg/cm	23.24	23.24	24.29	24.81	26.18
			Percent Linear	0	0.00%	-4.51%	-6.73%	-12.62%



But for a string bed with low elongation strings (less than 5%) under low pulled tensions (less than 20 lbs., or tensions that have been reduced due to racquet deformation and/or string tension relaxing with time), the SBS additionally depends on the string elongation and will significantly increase, in a nonlinear ever-increasing way, for harder ball impacts.

In order to achieve a repetitive feel for a player when hitting with a racquet, it is best to have a SBS that is independent of an increasing ball impact force. This will lead to a more consistent playability of the racquet, which includes a more repetitive feel. This desired “feel” implies using high elongation strings (greater than 10%). If low elongation strings are used (less than 4%), the SBS will significantly increase as the ball impact force increases, resulting in a racquet feeling “boardy” for higher impact loads. And low elongation strings will cause un-proportionally increasing load into the body.



As you can see by the graph, elongation contributes to SBS in a big way. The red line indicates a stiff string, about 4%, and the blue line indicates a "soft" string, about 15% elongation. You can see the loads increase dramatically as the impact increases. So the harder the hit the higher the loads on the body.

So to the question asked at the start "What is a soft tennis string?" In the context of the SBS discussed above, I would suggest that a soft tennis string is one whose elongation is 10-15%, and a stiff tennis string is 4-6%. And any string under 4% should be categorized as ultra-stiff.

String elongation (soft, stiff, ultra-stiff), stringing machine strung tension, and string pattern(s) all contribute to SBS and SBS is an important measure of how a racquet plays and ***should be adjusted for an individual player***, stiff and ultra-stiff strings can lead to less-repeatable racquet performance and player injury.

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Soft = 10 -15% Elongation Power Potential Range = 10.0 – 16.0
Stiff = 4 – 6% Elongation Power Potential Range = 4.0 – 7.0
Ultra Stiff = Less than 4% Power Potential Range = .65 – 3.96