Wood properties

Six values describing the wood properties can be put into the spread sheet. Four of these are absolutely necessary, and two are optional, and provide better accuracy or extra information. MOE, Mp, Ssr, and either MOR, or Sar are necessary. If MOR is input an approximate Sar can be calculated; use this if you do not have Sar from a bend test, and set the switch in cell xxxx to 0 to use the approximate Sar value. If an actual Sar value has been measured, put this in cell xxxxx, and set the switch in cell xxx to 1 to use the more accurate value.

	A	B	C	D
1		wood properties		
2		stress		% strain
3	(elastic modulus) MOE	1,560,000	Sp	0.40%
4	(proportional limit) Mp	6,200	set strain @ rupture (Srs)	0.13%
5	(rupture modulus) MOR	13,800	active strain @ rupture (Sra)	0.88%
6	density (g/cc)	0.72	set /(deflection above Mp)	0.2668421
7				

MOE, or elastic modulus.
* This is a measure of the stiffness of the wood. larger numbers indicate wood that bends less for a given amount of force. It is the average slope of the stress-strain curve for the range of strain that the bow will see from unstrung to full draw.

Mp proportional limit.
* This is the maximum stress for which the wood behaves in a perfectly elastic manner. That is, up to this stress level, the wood takes essentially no set. At stress levels above the proportional limit, some inelastic bending, called set in a bow, occurs. In practice this is an approximation of the region where set is negligible.

MOR, modulus of rupture.
* This is the stress level where the wood fails. This is either a catastrophic tension break, or severe crysal (compression fracture).

density.
* This is the mass of the wood divided by the volume. It includes the moisture content (MC). 1 gram of mass divided by 1 cc of volume has a density of 1. This is similar to specific gravity (SG) from the wood tables except the wood table value is oven dry weight divided by 12%MC volume. This is to allow density to be estimated at any MC by the following formula; density = SG*(1+MC). For example: if:SG= .67, and MC=14%, then, density = .67*(1+.14) = .67*1.14 = .7638.

Sp.
* This is the % strain at the wood surface at the proportional limit of the wood. It is computed from the formula: Sp = Mp / MOR. At strain levels below Sp, the wood takes no set. At levels above Sp some permanent deformation (or set) occurs.

set strain at rupture (Ssr).
*This is the amount of permanent deformation of the wood just before loading to the point of failure, expressed as a % strain. That is after releasing a load just less than that required to cause wood failure, there will be this amount of permanent deformation. The next higher loading causes failure.

active strain at rupture (Sar)
*This is the amount of reversible deformation of the wood at the loading just prior to or exactly at the point of failure, expressed as a % strain.

String properties

	A	B	C	D
1		**wood properties**		
2		**stress**		**% strain**
3	**(elastic modulus) MOE**	**1,560,000**	**Sp**	0.40%
4	**(proportional limit) Mp**	**6,200**	**set strain @ rupture (Srs)**	**0.13%**
5	**(rupture modulus) MOR**	**13,800**	**active strain @ rupture (Sra)**	0.88%
6	**density (g/cc)**	**0.72**	set /(deflection above Mp)	0.266842105
7				
8				
9		**string properties**		
10	**% stretch per kg.**	**0**	string weight (g)	9.65
11	**weight per mm (g/mm)**	**0.0054**	string weight (grains)	149
12				
13		**bow specifications**		
14	**weight (Lb)**	**50**	weight (g)	22,700
15	**length(in.)**	**72**	length(mm)	1,829
16	**brace %**	**40.00%**	est. brace(in.)	6.42
17	**draw target (in.)**	**30**	draw(Dt)(in.)	30.08
18	**thickness scale (Ts)**	**19.6**	est / linear ratio (%)	101.9%
19	linear energy (Ft-Lb)	49.30132106	est draw energy (Ft-Lb)	50.22219537
20	Bow mass (g)	428	Bow mass (Oz)	15.07
21				

% stretch per kg.

* The percentage that the bow string will elongate under 1kg of force. For example; if a 1meter string with no load, measures 1,001mm with a 10kg load applied the % stretch per kg is ((1,001-1,000)/1,000)/10kg = 0.0001/kg or 0.01% per kg. ....This value is not currently used, and all string is assumed to be un-stretchable.

Weight per mm

* This is the weight of a 1mm long piece of the bow string. It is used to determine the total string weight in grams, and grains. There is no added weight for serving at the center or for the loops. ...... This value is currently only used to get these weights and nothing further is done with the string weight values. Theoretically the string should contribute 1/3 of it's mass to the value of the total bow virtual mass. When a workable virtual mass formula is discovered & implemented this value should be of use as a contributor to total bow virtual mass.

Bow specifications

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weight
* This is the full draw weight of the bow. The sheet will set the dimensions of the bow to achieve this weight, at the draw listed in the draw(Dt)(in.) field.

length
* This is the nock to nock length of the bow along the neutral bending axis. This sets the length of the bow in the calculations.

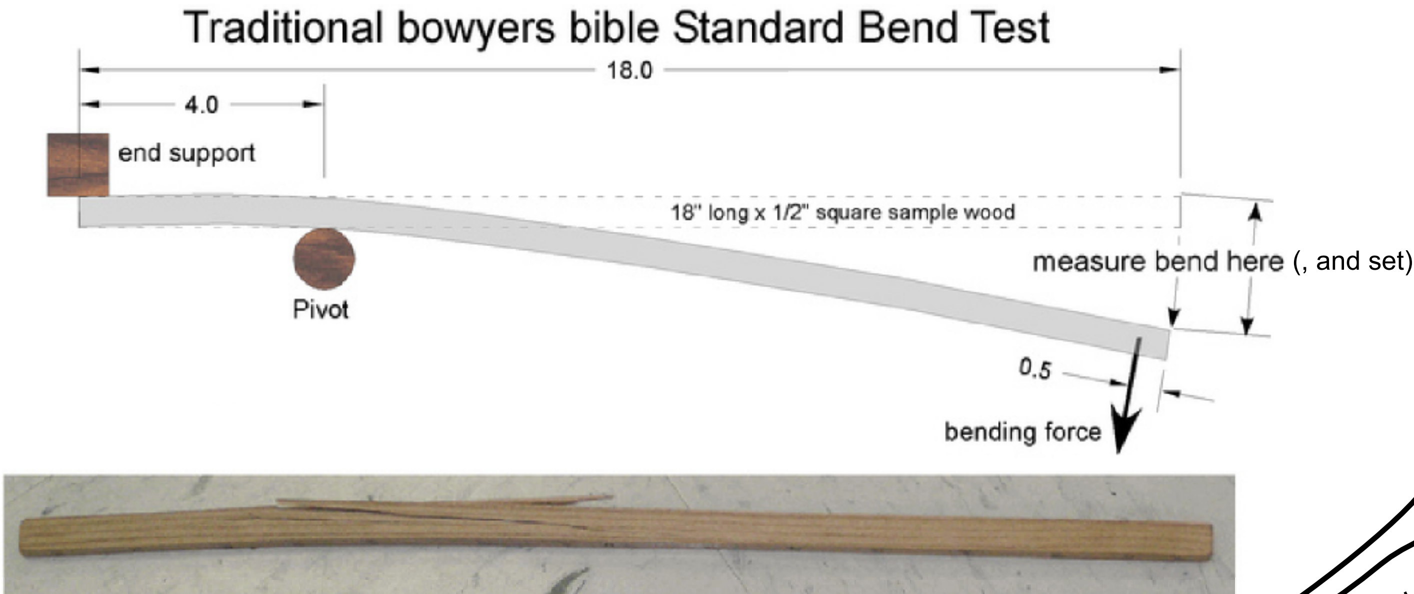
brace %
* This is the percentage of full draw curvature of the bow that will be used to compute the string length and brace height. For example; if a straight stave bow is designed with a 30 in. draw, and has a 15 inch deflection of the bow tips at full draw, the tip deflection at brace will be computed as 40% of 15inch, or 6 inches. The bow curvature is scaled back to 40% of the full draw curvature at all points, and this shape is used to compute the straight line distance between the nocks. This nock to nock distance is then used as the string length for the calculation of the draw length of the bow.

draw target
* This is the intended draw length of the bow. It does NOT set the bow dimensions and only sets the color of the actual draw (draw(Dt)) cell to the right of it. The thickness scale factor below it is used to adjust the draw length of the bow until the actual draw cell turns green. The actual draw cell turns green when the actual draw is within 1/2 inch of the target draw. This is not a limit as to how finely to adjust the thickness scale factor. The factor can be adjusted more and more finely until the actual draw is as close as you want it to the target.

Thiskness scalle (Ts)
* This is a scale factor that adjusts the thickness of all parts of the bow. Once the relative scale factors in the table to the right are set.

Wood properties

When a bend test is done for bow making purposes, the sample must be loaded and released a number of times (5 or more) at each load level. After each loading is released for loads above the proportional limit, there sill be some permanent bend of the sample, called set. The set % strain is proportional to this permanent bend. There will also be a reversible bend for each load level. The wood bends by this amount when under load, and returns to the "set" bend level when the load is released. The reversible bend is called the "active" bend, and the active strain is proportional to this active bend. The loads in a bend test are usually increased until the sample fails.



There are sheets in the workbook that provide templates for two types of bend test for wood samples.

One is taken from the traditional bowyers bible, and has the advantage of being directly applicable to the rules of thumb from Tim Baker's chapter on bow design in that book. This version of the TBB bend test has been adapted to allow any thickness of test sample to be used, and the geometry has been solved to convert the data to stress, strain, and elastic modulus.

The other bend test is a conventional test of the type commonly tabulated in the wood handbook. The data can not be directly used in the TBB rules of thumb for bow dimensions, but the formulas are easier for deriving the data for input to the selfbow design sheet. Any rectangular sample size can be used for this test.

In both tests it is important to do the test in a way that simulates the way a bow is used. That is the load must be applied and released a number of times (5 or more) at each tested load level prior to recording the deflection and set for that load level.