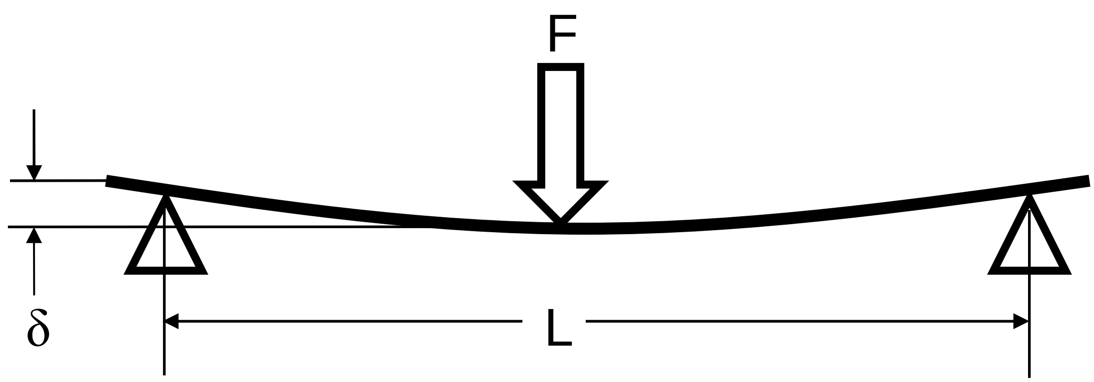
Translating Arrow Spine Test Methods

The conversion from the ATA (AMO) spine measurement method and the ASTM method is a very simple calculation based on beam deflection theory and is presented below.

The beam deflection equation is valid for beams in which the materials remain in their elastic state; this means that they recover their original shape when the force is removed.

An illustration of our spine tester is show below. The equation for stiffness of the shaft is:

$$k = \frac{F}{\delta} = \frac{48 \cdot E \cdot I}{L^3}$$



Where:
k is the shaft stiffness.
F is the force applied.
δ (delta) is the deflection of the arrow shaft.
E is the modulus of elasticity, the material's tendency to be deformed elastically.
I is the area moment of inertia, this property is used to predict the resistance to bending and is dependent on the cross-section of the beam.

For the two different spine measurement methods some of the elements of the equation are the same; k, E and I are properties of the particular arrow shaft and do not change. The differences in the two are; L and F are different and the result is that δ varies. So now we can write two equations, one for each method.

$$k = \frac{F_1}{\delta_1} = \frac{48 \cdot E \cdot I}{L_1^3}$$

$$k = \frac{F_2}{\delta_2} = \frac{48 \cdot E \cdot I}{L_2^3}$$

Let us call the ATA standard Method 1 and the ASTM standard Method 2. These equations can be manipulated to yield:

$$k = \frac{F_1 \cdot L_1^3}{\delta_1} = 48 \cdot E \cdot I$$

$$k = \frac{F_2 \cdot L_2^3}{\delta_2} = 48 \cdot E \cdot I$$

These two equations are equal to one another by observing that k is the same in both and 48EI is the same. Therefore they can be written:

$\frac{F_2 \cdot L_2^3}{\delta_2} = \frac{F_1 \cdot L_1^3}{\delta_1}$ The goal is to find the ratio of δ_1 to δ_2. So we manipulate the equations to give:

$$\frac{\delta_1}{\delta_2} = \frac{F_1 \cdot L_1^3}{F_2 \cdot L_2^3} = \frac{2lb. \cdot 26in.^3}{1.94lb. \cdot 28in.^3} = 0.825419$$

What does all of this mean? It is very simple: if you know the spine of a carbon shaft is 500, which means .500 inches deflection, multiply .500 by .825 and the result is .413 inches deflection in the ATA method. The ATA spine is simply 26 inches divided by .413 inches deflection to get 63 pounds spine.

Conversely, suppose we have a wooden arrow of 95 pounds spine and we want to determine what carbon or aluminum deflection is equivalent. Start by dividing 26 inches by 95 pounds to get an ATA deflection of .274 inches. Next divide this result by .825 to get .332; the closest carbon shaft is a 340. Three decimal places for these calculations is sufficient accuracy.

ATA Spine to Deflection

ATA Spine (pounds)	ATA Deflection	ASTM Deflection
20	1.300	1.575
21	1.238	1.500
22	1.182	1.432
23	1.130	1.370
24	1.083	1.312
25	1.040	1.260
26	1.000	1.212
27	0.963	1.167
28	0.929	1.125
29	0.897	1.086
30	0.867	1.050
31	0.839	1.016
32	0.813	0.984
33	0.788	0.955
34	0.765	0.926
35	0.743	0.900
36	0.722	0.875
37	0.703	0.851
38	0.684	0.829
39	0.667	0.808
40	0.650	0.787
41	0.634	0.768
42	0.619	0.750
43	0.605	0.733
44	0.591	0.716
45	0.578	0.700
46	0.565	0.685
47	0.553	0.670
48	0.542	0.656
49	0.531	0.643
50	0.520	0.630
51	0.510	0.618
52	0.500	0.606
53	0.491	0.594
54	0.481	0.583
55	0.473	0.573
56	0.464	0.562
57	0.456	0.553
58	0.448	0.543
59	0.441	0.534
60	0.433	0.525

ATA Spine to Deflection

ATA Spine (pounds)	ATA Deflection	ASTM Deflection
61	0.426	0.516
62	0.419	0.508
63	0.413	0.500
64	0.406	0.492
65	0.400	0.485
66	0.394	0.477
67	0.388	0.470
68	0.382	0.463
69	0.377	0.457
70	0.371	0.450
71	0.366	0.444
72	0.361	0.437
73	0.356	0.431
74	0.351	0.426
75	0.347	0.420
76	0.342	0.414
77	0.338	0.409
78	0.333	0.404
79	0.329	0.399
80	0.325	0.394
81	0.321	0.389
82	0.317	0.384
83	0.313	0.380
84	0.310	0.375
85	0.306	0.371
86	0.302	0.366
87	0.299	0.362
88	0.295	0.358
89	0.292	0.354
90	0.289	0.350
91	0.286	0.346
92	0.283	0.342
93	0.280	0.339
94	0.277	0.335
95	0.274	0.332
96	0.271	0.328
97	0.268	0.325
98	0.265	0.321
99	0.263	0.318
100	0.260	0.315
101	0.257	0.312

ATA Spine to Deflection

ATA Spine (pounds)	ATA Deflection	ASTM Deflection
102	0.255	0.309
103	0.252	0.306
104	0.250	0.303
105	0.248	0.300
106	0.245	0.297
107	0.243	0.294
108	0.241	0.292
109	0.239	0.289
110	0.236	0.286
111	0.234	0.284
112	0.232	0.281
113	0.230	0.279
114	0.228	0.276
115	0.226	0.274
120	0.217	0.262
125	0.208	0.252
130	0.200	0.242
135	0.193	0.233
140	0.186	0.225
145	0.179	0.217
150	0.173	0.210
155	0.168	0.203
160	0.163	0.197
165	0.158	0.191
170	0.153	0.185
175	0.149	0.180
180	0.144	0.175
185	0.141	0.170
190	0.137	0.166
195	0.133	0.162
200	0.130	0.157
205	0.127	0.154
210	0.124	0.150
215	0.121	0.147
220	0.118	0.143
225	0.116	0.140
230	0.113	0.137
235	0.111	0.134
240	0.108	0.131
245	0.106	0.129
250	0.104	0.126

ATA Def =	**0.825419**	**x ASTM Def**

ATA Spine = 26 / ATA Def.

Wt. ASTM =	1.94
Wt. ATA =	2
L. ASTM =	28
L. ATA =	26

Easton Aluminum Arrow Spine Chart

Shaft Size	ASTM Deflection	ATA Deflection	ATA Spine (pounds)
1214	2.501	2.064	12.6
1413	2.036	1.681	15.5
1416	1.684	1.390	18.7
1512	1.553	1.282	20.3
1514	1.379	1.138	22.8
1516	1.403	1.158	22.5
1612	1.298	1.071	24.3
1614	1.153	0.952	27.3
1616	1.079	0.891	29.2
1712	1.099	0.907	28.7
1713	1.044	0.862	30.2
1714	0.963	0.795	32.7
1716	0.880	0.726	35.8
1812	0.879	0.726	35.8
1813	0.874	0.721	36.0
1814	0.799	0.660	39.4
1816	0.756	0.624	41.7
1820	0.592	0.489	53.2
1912	0.778	0.642	40.5
1913	0.733	0.605	43.0
1914	0.658	0.543	47.9
1916	0.623	0.514	50.6
2012	0.680	0.561	46.3
2013	0.610	0.504	51.6
2014	0.579	0.478	54.4
2016	0.531	0.438	59.3
2018	0.464	0.383	67.9
2020	0.426	0.352	73.9
2112	0.590	0.487	53.4
2113	0.540	0.446	58.3
2114	0.510	0.421	61.8
2115	0.461	0.381	68.3
2117	0.407	0.336	77.4
2212	0.505	0.417	62.4
2213	0.458	0.378	68.8
2214	0.425	0.351	74.1
2215	0.419	0.346	75.2
2216	0.376	0.310	83.8
2219	0.337	0.278	93.5
2312	0.423	0.349	74.5
2314	0.391	0.323	80.6
2315	0.342	0.282	92.1
2317	0.297	0.245	106.1
2412	0.400	0.330	78.7
2413	0.365	0.301	86.3
2419	0.268	0.221	117.5
2512	0.321	0.265	98.1
2514	0.305	0.252	103.3
2613	0.265	0.219	118.9

ASTM Deflection to ATA Spine

ASTM Deflection	ATA Deflection	ATA Spine (pounds)
1.575	1.300	20.0
1.500	1.238	21.0
1.450	1.197	21.7
1.400	1.156	22.5
1.350	1.114	23.3
1.300	1.073	24.2
1.250	1.032	25.2
1.200	0.991	26.2
1.150	0.949	27.4
1.100	0.908	28.6
1.050	0.867	30.0
1.000	0.825	31.5
0.975	0.805	32.3
0.950	0.784	33.2
0.925	0.764	34.1
0.900	0.743	35.0
0.875	0.722	36.0
0.850	0.702	37.1
0.825	0.681	38.2
0.800	0.660	39.4
0.775	0.640	40.6
0.750	0.619	42.0
0.725	0.598	43.4
0.700	0.578	45.0
0.675	0.557	46.7
0.650	0.537	48.5
0.625	0.516	50.4
0.600	0.495	52.5
0.575	0.475	54.8
0.550	0.454	57.3
0.525	0.433	60.0
0.500	0.413	63.0
0.475	0.392	66.3
0.450	0.371	70.0
0.425	0.351	74.1
0.400	0.330	78.7
0.375	0.310	84.0
0.350	0.289	90.0
0.340	0.281	92.6
0.325	0.268	96.9
0.300	0.248	105.0
0.275	0.227	114.5
0.250	0.206	126.0
Wt. ASTM =	1.94	
Wt. ATA =	2	
L. ASTM =	28	
L. ATA =	26	
ATA Def =	**0.825419**	**x ASTM Def**
ATA Spine = 26 / ATA Def.		