II.—*A Series of Experiments on different kinds of American Timber.* By W. DENISON, Lieut. Royal Engineers, F.R.S., A.Inst.C.E.

THE following Tables contain the results of experiments on different kinds of American timber; they are not so complete as I could wish, such, however, as they are, I submit them to the Institution. Some of them corroborate in a remarkable degree the experiments made by Mr. Barlow upon wood of the same nature, but of very different scantling, and under different circumstances. My object in commencing these experiments was twofold; I wished, in the first place, to establish some proportion between the strength of different kinds of American timber, and then, by reference to Mr. Barlow's experiments, between these and European timber; so as to enable me to supply the place of the constant factors which enter into the rules or formulæ by which the dimensions of timber for different purposes may be calculated with some degree of correctness; and, in the second place, to ascertain the difference, both in dimension and strength, made by seasoning, or by difference of age, or position in the tree. For this purpose I had trees felled as nearly as possible of the same size; from these I sawed a plank through the heart of the block, and this plank was afterwards divided into pieces for experiment one inch square and three or four feet in length, which were numbered according to their position in the tree from the sap inwards.

I commenced experimenting at once upon some of these specimens in their green state, intending to reserve the others until they were seasoned, having noted upon each its dimensions when green, for the purpose of ascertaining the amount of shrinkage in seasoning. My return to England, which was unexpected, unluckily put a stop, not only to these experiments, but also to some on a much larger scale for which I had the timber already prepared. Having said thus much in explanation of the motives which induced me to make these experiments, I shall proceed shortly to describe the apparatus I employed, in order that the Institution may judge of the degree of confidence to be placed in the results.

Description of the
apparatus employed.
Plate IV. Figs. 1, 2, 3.

Two blocks of oak, about 6 inches square and 4 feet high, were morticed firmly into a 3 inch plank, and further supported by struts, as shewn in the drawing. They were tied together at the top by a cross bar, which by the way in which it was notched into the uprights acted

both as a tie and a strut ; this cross bar served at the same time to support a graduated circle which indicated the amount of deflection : (the radius of the divided circle being ten times that of the barrel which communicated motion to the index, as ascertained by frequent comparisons, the smallest deflection was easily measured.) A groove was cut in the top of each of the uprights to receive the specimens ; it was lined with iron, as shewn in the sketch, and in order that it might be possible, if wished, to fix the ends of the timber subjected to experiment, two screws were riveted to this lining, and a cap constructed which might be screwed fast on the specimen.

The specimen being carefully measured, was placed upon the supports ; the first weight it had to sustain was that of the scale and ropes, and weights to make up 20 lbs.*; the deflection was then noted, and after that weights added by 20 lbs. at a time, noting carefully the deflection after each addition. When it was thought likely that the limit of elasticity was nearly attained, the weights were added more gradually and allowed to remain longer, the changes of deflection were closely watched, and the weights often removed to ascertain whether or no the specimen would return to its original state. After the limit of elasticity was once passed, the weights were added quickly till the specimen gave way ; the flexure at the time of fracture was noted as near as possible, but upon this, of course, much reliance cannot be placed. As soon as the experiment was concluded, a piece of the specimen was cut off and the specific gravity determined.

I cannot conclude without expressing my hopes that officers and others employed in the colonies will be induced to turn their attention to this subject. In America especially, for many years, timber from its cheapness will be employed in preference to iron, and should Mr. Kyan succeed in his attempts to secure it from the attacks of insects, and from natural decay, we may look forward in that country, at all events, to its employment in a variety of situations where its destructibility is now a complete bar to its use.

* This applies to the later experiments ; at first I was obliged to make use of the weights I could procure on the spot, but I afterwards had others cast on purpose.

EXPERIMENTS on the STRENGTH of TIMBER when exposed to a Transverse Strain, carried on in Canada in the Years 1830 and 1831, and the Results of the Experiments calculated according to Formulæ given by Barlow.

No. of Experiment.	Names of Woods.	Length in inches = l .	Breadth = a .	Depth = d .	Specific gravity.	Weight applied.	Deflection in inches = Δd .	REMARKS.	Value of S from formula $S = \frac{IW}{4ad^2}$.	Value of S' from formula $S' = \frac{IW \sec^2 \Delta}{4ad^2}$.	Columns of Differences.	
											Weights.	Deflection.
1	Canadian White Oak, seasoned.	24	.99	.99	786.4	71	.1	Ends loose on supports.	1824	1902	56	.1
						127	.2				28	.06
						155	.26	In 5' = .28, weight taken off. Set = 0			28	.12
						183	.38	In 10' = .40			28	.12
						211	.50	In 10' = .56, weight taken off. Set = .05			28	.23
						239	.73	In 5' = .76			14	.12
						253	.85				14	.16
						267	1.01				14	.14
						281	1.15	In 30' = 1.73, weight taken off. Set = .53			7	.65
						288	1.80	In 10' = 1.90, began to crack.			7	Broke
						295		Broke in 5', deflection = 2.43				
2	Do. seasoned.	24	.975	.97	763.6	71	.15	Ends loose in support.	2388	2456	28	.06
						99	.21				..	.06
						127	.27				..	.06
						155	.33	Weight taken off. Set = 0			..	.06
						183	.40	In 20' = .45, weight taken off. Set = .05			..	.07
						211	.52				..	.12
						239	.60	In 10' = .62			..	.08
						253	.67	In 20' = .70			14	.07
						267	.75				..	.08
						281	.80				..	.05
						295	.85				..	.08
						309	.93				..	.07
						323	1.00	In 10' = 1.05			7	.1
						330	1.10				..	.05
						337	1.15	All weights taken off. Set = .3			..	.1
						344	1.25				..	.15
						351	1.40				..	.1
						358	1.50	Began to crack, and broke in about 10 minutes, deflection at instant of fracture 1.85			..	.05
						365	1.55					
3	Do. White Oak, green.	24	1.01	1.0	918	20	.04		1544	1576	20	.05
						40	.09				..	.05
						60	.14				..	.05
						80	.19				..	.06
						100	.25				..	.06
						120	.31	Weight taken off. No set.			..	.06
						140	.37				..	.06
						160	.45	Set = .03			..	.08
						180	.57	In 5' = .60			..	.12
						200	.70	In 5' = .75			..	.13
						220	.85	In 10' = .95			..	.15
						240	1.05	In 5' = 1.15			..	.2
						260	1.40	Broke, deflection at instant of fracture = 1.75			..	.35
4	Do. green.	24	.985	1.0	1034	20	.04	Heart of tree.	1340	1370	20	.06
						40	.10	A faulty specimen, though cut from the same block as the former, the upper surface was weakened by a knot.			..	.06
						60	.16				..	.06
						80	.22				..	.06
						100	.28				..	.09
						120	.37	Weights taken off. Set = .02			..	.11
						140	.48				..	.11
						160	.59	In 5' = .63			..	.24
						180	.83				..	.15
						200	.98	In 5' = 1.08			..	.27
						220	1.25	Broke, deflection at instant = 1.83			..	
5	Do. heart of tree.	24	1.0	1.0	951	20	.05	This and the two following specimens were cut from the same tree.	1500	1652	20	.05
						40	.10				..	.05
						60	.15				..	.05
						80	.20				..	.05
						100	.25				..	.05
						120	.30	No set.			..	.05

EXPERIMENTS CONTINUED.

No. of Experiment.	Names of Woods.	Length in inches = l .	Breadth = a .	Depth = d .	Specific gravity.	Weight applied.	Deflection in inches = Δd .	REMARKS.	Value of S from formula $S = \frac{lW}{4ad^3}$.	Value of S' from formula $S' = \frac{lW \sec^2 \Delta}{4ad^3}$.	Columns of Differences.	
											Weights.	Deflection.
5	Canadian White Oak, heart of tree.	24	1.0	1.0	951	140 .40 160 .50 180 .65 200 .82 220 1.10 240 1.60 250 3.83	In 3' = .55 .. = .72 .. = .95 .. = 1.40 In 5' = 2.45 Broke gradually, being equally strained throughout.	1500	1652	20	.1 .1 .15 .17 .28 .5 .23	
6		24	1.01	1.0	939	20 .06 40 .12 60 .18 80 .25 100 .33 120 .45 140 .55 160 .65 180 .83 200 1.05	Set hardly perceptible. Set = .05 In 3' = .72 .. = .94 Gave way at a knot 5 inches from the centre.	1188		20	.06 .06 .07 .08 .12 .1 .1 .18 .22	
7	Do.	24	1.02	1.0	798	20 .04 40 .08 60 .12 80 .16 100 .21 120 .27 140 .33 160 .40 180 .51 200 .62 220 .75 240 .89 260 1.09 280 1.62 300 1.92	No set. In 3' = .44 Set = .02 .. = .55 .. = .68 .. = .82 .. = 1.02 .. = 1.32 .. = 1.80 Broke gradually, deflection = 2.72	1764	1854	20	.04 .04 .04 .05 .06 .06 .07 .11 .06 .13 .14 .2 .53 .3	
8	White Oak.	24	1.0	1.0	788.9	20 .05 40 .10 60 .15 80 .20 100 .25 120 .30 140 .35 160 .42 180 .49 200 .58 220 .72 240 .82 260 1.13 280 1.32	These specimens were pretty dry. Set = .05 In 3' = .62 In 3' = .92 Broke suddenly. I had not time to observe the ultimate deflection.	1680	1700	20	.05 .05 .05 .05 .05 .05 .05 .07 .07 .09 .14 .1 .31 .19	
9	Do.	24	1.01	1.01	789.6	20 .047 40 .095 60 .142 80 .189 100 .236 120 .283 140 .33 160 .39 180 .47 200 .57 220 .68 240 .82 260 1.02 280 1.35	In this and the former specimen the wood was cut in some measure across the grain, and they both broke with a long splinter in the direction of the fibres. They cannot, therefore, give a fair estimate of the absolute strength. In 2' = .34 .. = .40 Set = .05 .. = .49 .. = .66 .. = .75 .. = .93 .. = 1.20 .. = 1.50 Broke suddenly.	1630	1654	20	.048 .047 .047 .047 .047 .047 .047 .06 .08 .1 .11 .14 .2 .33	

EXPERIMENTS CONTINUED.

No. of Experiment.	Names of Woods.	Length in inches = l .	Breadth = a .	Depth = d .	Specific gravity.	Weight applied.	Deflection in inches = Δd .	REMARKS.	Value of S from formula $\frac{lw}{4ad^3}$.	Value of S' from formula $\frac{lw \sec^2 \Delta}{4ad^3}$.	Columns of Differences.	
											Weights.	Deflection.
10	White Oak.	24	1.0	1.0	790	20	.045				20	.045
						40	.09				..	.045
						60	.135				..	.045
						80	.18				..	.045
						100	.225				..	.045
						120	.27				..	.045
						140	.33				..	.06
						160	.39	Set = .04			..	.06
						180	.44	In 2' = .46	2040	2111	..	.05
						200	.52	.. = .535			..	.08
						220	.59	.. = .63			..	.07
						240	.685	.. = .745			..	.095
						260	.80	.. = .87			..	.115
						280	.89	.. = 1.01			..	.09
						300	1.08	.. = 1.37			..	.19
						320	1.46	.. = 1.80			..	.38
						340		Broke, deflection at instant = 2.25			..	Broke
11	Do.	24	.99	.98	760.4	20	.045				20	.05
						40	.095				..	.055
						60	.15				..	.055
						80	.205				..	.05
						100	.255				..	.065
						120	.32	Set = .03	1514	1527	..	.055
						140	.375	In 2' = .41			..	.09
						160	.465	.. = .51			..	.1
						180	.565	.. = .625			..	.12
						200	.685	.. = .785			..	.17
						220	.855	.. = .955			..	.07
						240	.925	.. = 1.12			..	
								Broke suddenly.				
12	Do. pretty dry.	24	.98	.98	738.5	20	.055				20	.055
						40	.11				..	.055
						60	.165				..	.055
						80	.22				..	.055
						100	.275				..	.075
						120	.35	Set = .02	1530	1551	..	.06
						140	.41	In 2' = .455			..	.10
						160	.51	.. = .575			..	.13
						180	.64	.. = .710			..	.14
						200	.78	.. = .800			..	.17
						220	.95	.. = 1.15			..	.3
						240	1.25	Broke, deflection = 1.43			..	
13	Do.	24	.98	.98	736	20	.06				20	.04
						40	.10				..	.05
						60	.15				..	.04
						80	.19				..	.05
						100	.23				..	.05
						120	.28				..	.05
						140	.33	Set = .02	1912	1962	..	.05
						160	.38	In 2' = .41			..	.08
						180	.46	.. = .49			..	.09
						200	.55	.. = .60			..	.12
						220	.67	.. = .72			..	.12
						240	.79	.. = .91			..	.19
						260	.98	.. = 1.13			..	.26
						280	1.24				..	.7
						300	1.94	Broke.			..	
14	Rock Elm, seasoned	24	.985	1.005	748.7	71	.13				28	.04
						99	.17				..	.05
						127	.22	Same in 10'	2623.4	2666.8	..	.05
						155	.27	In 10' = .28, weights taken off set = .0			..	.05
						183	.32	No set.			..	.05
						211	.37	No set.			..	.05
						239	.45	No set.			..	.08

EXPERIMENTS CONTINUED.

No. of Experiment.	Names of Woods.	Length in inches = l .	Breadth = a .	Depth = d .	Specific gravity.	Weight applied.	Deflection in inches = Δ d.	REMARKS.	Value of S' from formula $S = \frac{lW}{4ad^3}$.	Value of S from formula $S' = \frac{lW \sec^2 \Delta}{4ad^3}$.	Columns of Differences.	
											Weights.	Deflection.
14	Rock Elm, seasoned.	24	.985	1.005	748.7	267 .51 281 .60 295 .64 302 .67 309 .70 316 .75 323 .78 330 .80 337 .82 344 .84 349 .88 351 .92 358 .96 365 1.01 372 1.06 379 1.1 386 1.15 393 1.2 400 1.25 407 1.32 414 1.40 421 1.47 428 1.55 435 1.85	In half an hour = .55. Set = .03 In 10' = .68 In 6' = .71 					

EXPERIMENTS CONTINUED.

[illegible]

LIEUTENANT DENISON'S EXPERIMENTS

EXPERIMENTS CONTINUED.

[illegible]

EXPERIMENTS CONTINUED.

No. of Experiment.	Names of Woods.	Length in inches = l .	Breadth = a .	Depth = d .	Specific gravity.	Weight applied.	Deflection in inches = Δd .	REMARKS.	Value of S from formula $S = \frac{lW}{4ad^2}$.	Value of S' from formula $S' = \frac{lW \sec^2 \Delta}{4ad^2}$.	Columns of Differences.	
											Weights.	Deflection.
25	Rock Elm, Green.	24	.97	.98	755	240 .62 60 .72 80 .86 300 .97 20 1.16 40 1.37 360 1.75		$\left. \begin{array}{l} = .67 \\ = .80 \\ = .91 \\ = 1.09 \\ = 1.30 \\ = 1.62 \\ = 2.20 \text{ cracked.} \end{array} \right\} \text{in } 2'$	2318	2399	20	.08 .1 .14 .11 .19 .21 .38
26	Swamp Ash, Green.	24	.96	.98	931.7	20 .06 40 .13 60 .20 80 .27 100 .43 40 1.00 160		In 5' = 1.18 Broke, deflection = 1.68	1141		20 40	.07 .07 .07 .16 .57 Broke
27	Do.	24	1.0	.98	919.6	20 .03 40 .09 60 .15 80 .21 100 .30 20 .51 40 .63 60 1.03 70 1.30 80 2.00 190		Broke, deflection = 2.33	1189		20 10	.06 .06 .06 .09 .21 .12 .4 .27 .7 Broke
28	Black Ash, green.	24	.98	1.0	608	71 .40 99 .97 113 1.40 120		In 5' = 1.50 Gave way suddenly.	735		28 .. 14 .. 7 ..	.57 .43 Broke
29	Do.	24	.98	.98	.458	71 .28 127 .75 155		Broke in 3 minutes.	988		56 .. 28 ..	.47 Broke
30	White Hickory. Specimen pretty dry.	24	.97	.97	839	20 .047 40 .095 60 .142 80 .189 100 .236 20 .28 40 .33 60 .39 80 .46 200 .54 20 .66 40 .76 60 .92 80 1.10 90 1.40 300 1.62 10 1.79 330		In 3' = .35 Set = .04 .. = .41 .. = .46 .. = .58 .. = .69 .. = .83 .. = 1.00 .. = 1.32 .. = 1.53 .. = 1.73 .. = 1.90 The specimen cracked, and I released the Index, 330, however, made no fracture, and it would probably have stood a good deal more as the next specimen bent 4.6 before it gave a symptom of fracture.	2170		20 10	.048 .047 .047 .047 .044 .05 .06 .07 .08 .12 .1 .16 .18 .3 .22 .17
31	White Hickory. Pretty dry.	24	.94	.94	834	20 .05 40 .10 60 .16 80 .21 100 .26 20 .32 40 .40			2240	2569	20	.05 .06 .05 .05 .06 .08

EXPERIMENTS CONTINUED.

No. of Experiment.	Names of Woods.	Length in inches = l .	Breadth = a .	Depth = d .	Specific gravity.	Weight applied.	Deflection in inches = Δd .	REMARKS.	Value of S from formula $\frac{W}{S} = \frac{4ad^3}{48}$.	Value of S' from formula $\frac{W \sec^2 \Delta}{S'} = \frac{4ad^3}{48}$.	Columns of Differences.	
											Weights.	Deflection.
31	White Hickory. Pretty dry.	24	.94	.94	834	160 80 200 20 40 60 80 300 310	.48 .55 .67 .80 .95 1.18 1.50 1.90 4.60	Began to crack; this piece was fairly strained, and a slight increase in the flexure would have commenced the rupture.	2240	2569	 10	.08 .07 .12 .13 .15 .23 .32 .4 2.7
32	Black Birch, Green.	24	1.02	1.0	781	20 40 60 80 100 20 40 60 80 200 20 240	.05 .10 .15 .20 .26 .32 .39 .49 .60 .80 1.00 1.00	No set. In 3' = .50 .. = .65 In 5' = 1.10. Broke suddenly without warning.	1387		20	.05 .05 .05 .06 .06 .07 .1 .11 .1 .2
33	Do.	24	1.02	1.0	762.8	20 40 60 80 100 20 40 60 80 200 20 240	.04 .08 .12 .17 .22 .27 .32 .40 .48 .62 .75 1.00	No set. In 5' = .80 Broke like the former.	1387		20	.04 .04 .05 .05 .05 .05 .05 .08 .08 .14 .13
34	Yellow Birch, Green.	24	.99	1.0	767.7	20 40 60 80 100 20 40 60 80 200	.023 .046 .07 .11 .15 .20 .28 .36 .48 .60	This specimen had a slight set originally, and was placed with the concavity downwards. No set. In 5' = .39 .. = .51 Broke; deflection = 1.10	1212	1222	20	.023 .024 .04 .04 .05 .08 .08 .12 .12
35	Do.	24	.99	.99	745.4	20 40 60 80 100 20 40 60 80 200 20 240	.04 .08 .14 .20 .26 .32 .38 .48 .60 .72 .85 1.10	No set. = .75 } in 5' = .95 } Broke; deflection = 1.20	1458	1472	20	.04 .06 .06 .06 .06 .10 .12 .12 .13 .25
36	White Cedar, or Arbor Vitæ.	24	.99		357	20 40 60 80 100 120	.10 .20 .32 .47 .70 1.20	No set. Broke.	805	813	20	.1 .12 .15 .23 .5

EXPERIMENTS CONTINUED. ENDS LOOSE.

No. of Experiment.	Names of Woods.	Length in inches = l .	Breadth = a .	Depth = d .	Specific gravity.	Weight applied.	Deflection in inches = Δd .	REMARKS.	Value of S from formula $S = \frac{l W}{4 a d^3}$.	Value of S' from formula $S' = \frac{l W \sec^2 \Delta}{4 a d^3}$.	Columns of Differences.	
											Weights.	Deflection.
37	White Cedar.	24	.99	1.0	352	20 .11 40 .22 60 .35 80 .50 100 .75 120 1.36		In 5' = .80 Broke.	727	730	20 .11 .. .13 .. .15 .. .25 .. .61	
38	White Beech, Green.	24	.99	.99	718	20 .04 40 .09 60 .14 80 .19 100 .24 20 .29 40 .34 60 .45 80 .60 200 .75 220 1.00		No set. In 5' set = .48 .48 in 5' Broke.	1360	1369	20 .05 .. .05 .. .05 .. .05 .. .05 .. .05 .. .11 .. .15 .. .15 .. .25	
39	Do.	24	.97	.99	704	20 .04 40 .093 60 .146 80 .199 100 .25 20 .34 40 .43 60 .58 80 .75 200 1.05 210 1.30		No set. In 5' = 1.15 Broke suddenly.	1400	1416	20 .053 .. .053 .. .053 .. .051 .. .09 .. .09 .. .15 .. .17 .. .30 10 .25	
40	Red Beech, Green.	24	1.0	1.0	821	20 .02 40 .06 60 .10 80 .14 100 .18 20 .22 40 .26 60 .31 80 .40 200 .50 20 .65 40 .85 60 1.20 265		No set. In 5' = .55 In 10' = .75 .. = 1.0 In 20' = 1.65 Broke, deflection = 2.00	1590	1634	20 .04 .. .04 .. .04 .. .04 .. .04 .. .05 .. .09 .. .1 .. .15 .. .2 .. .35 .. Broke	
41	Red Beech, Green.	24	.995	.995	786.8	20 .02 40 .06 60 .10 80 .14 100 .18 20 .22 40 .26 60 .33 80 .40 200 .50 20 1.48 40 1.55 60 1.62 70 1.72 75 1.82 80 1.92 285 2.30		In 5' = .28 No set. .. = .35 In 20' = .45 In 36 hours = 1.42 Broke in half an hour gradually; neither this nor the last specimen broke exactly in the middle.	1736	1787	20 .04 .. .04 .. .04 .. .04 .. .04 .. .04 .. .07 .. .07 .. .1 .. .98 .. .07 .. .07 .. .1 .. .1 .. .1 .. .38	
42	Black Oak, Green.	24	.99	.99	956.8	20 .05 40 .10 60 .15			1608	1643	20 .05 .. .05	

EXPERIMENTS CONTINUED. ENDS LOOSE.

No. of Experiment.	Names of Woods.	Length in inches = l .	Breadth = a .	Depth = d .	Specific gravity.	Weight applied.	Deflection in inches = Δd .	REMARKS.	Value of S from formula $S = \frac{lW}{4ad^3}$.	Value of S' from formula $S' = \frac{lW \sec^2 \Delta}{4ad^3}$.	Columns of Differences.	
											Weights.	Deflection.
42	Black Oak, Green.	24	.99	.99	956.8	80 100 20 40 60 80 200 20 40 260	.20 .26 .32 .40 .50 .65 .80 .95 1.15	Set = .03 In 5' = .43 .. = .55 In 20' = .75 In 5' = .85 .. = 1.03 .. = 1.4 Broke, deflection = 1.75	1608	1643		.05 .06 .06 .08 .1 .15 .15 .15 .2 Broke
43	Do.	24	.975	1.0	972	20 40 60 80 100 20 40 60 80 200 20 40 60 280	.05 .10 .15 .20 .25 .30 .35 .45 .50 .60 .70 .85 1.15	This oak is principally used for staves, it is so porous longitudinally that a small quantity of water placed on the top of a long rod, will in a few minutes, make its way through the pores and appear at the bottom. Set = .01 In 20' = .75 In 5' = .75 .. = .95 Broke, deflection = 1.95	1723	1768	20	.05 .05 .05 .05 .05 .05 .1 .05 .1 .1 .15 .30 Broke
44	Tamarack, or Larch, Green.	24	1.025	1.0	430.9	20 40 60 80 100 20 40 160	.05 .10 .15 .22 .29 .40 .50 .90	Set = .05 Broke, deflection = 1.2	936	945	20	.05 .05 .07 .07 .11 .1 .4
45	Do.	24	1.02	1.03	435	20 40 60 80 100 20 40 160	.03 .09 .15 .21 .27 .38 .52	In 5'. Set = .05 Broke, deflection = 1.15	886	894	20	.06 .06 .06 .06 .11 .14 Broke
46	White Pine, Green.	24	1.015	1.02	465	20 40 60 80 100 20 40 60 80 200 220	.05 .09 .13 .17 .21 .25 .32 .39 .47 .63	Weight taken off. Set = .05. Weight re- [placed, deflection same as before. In 10' = .41 .. = .50 .. = .70 Broke, deflection = .65	1250	1256	26	.04 .04 .04 .04 .04 .07 .07 .08 .16 Broke
47	Ditto, Seasoned.	24	.985	.99	397	71 99 127 155 183	.17 .25 .35 .55 1.00	In 5' = .38 No set. In 10' = .59 Set .07 Broke suddenly.	1137	1144	28 28 28 ..	.08 .1 .2 .45
48	Do.	24	.965	.98	467	71 99 127 155 183	.22 .30 .42 .53	Same in 10' In 30' = .32 In 5' = .55 Set = .04, same weights re- placed, deflection = .58. Broke in 5'. Deflection = 1.4	1184	1199	28	.08 .12 .11 Broke

EXPERIMENTS CONTINUED. ENDS LOOSE.

No. of Experiment.	Names of Woods.	Length in inches = l .	Breadth = a .	Depth = d .	Specific gravity.	Weight applied.	Deflection in inches = Δd .	REMARKS.	Value of S from formula $\frac{lW}{S} = \frac{1}{4}ad^3$.	Value of S' from formula $\frac{lW \sec^2 \Delta}{S'} = \frac{1}{4}ad^3$.	Columns of Differences.	
											Weights.	Deflection.
49	Canada Balsam, Green.	24	1.01	1.0	556	20 40 60 80 100 20 40 60 80 200	.04 .08 .12 .16 .20 .27 .34 .42 .57 .87	Set = 0 In 5' = 45 In 10' = 64 Broke, deflection = 1.07	1188	1197	20	.04 .04 .04 .04 .07 .07 .08 .15 .3
50	Do.	24	1.02	1.0	541	20 40 60 80 100 20 40 60 180	.04 .08 .12 .17 .22 .29 .40 .55 .75	No set. No set. In 30' = 44 In 5' = 57 Broke, deflection = 1.07	1058	1068	20	.04 .04 .05 .05 .07 .11 .15 .20
51	Hemlock, Green.	24	1.01	1.02	876	20 40 60 80 100 20 40 60 80 200	.04 .09 .14 .19 .25 .33 .41 .53 .73 1.00	No set. In 5' = 43 .. = 58 .. = 85 Broke, deflection = 1.25	1142	1153	20	.05 .05 .05 .06 .08 .08 .12 .2 .27
52	Do.	24	1.01	1.02	946	20 40 60 80 100 20 40 60 80 200	.03 .08 .13 .18 .23 .29 .37 .51 .65 .85	No set. In 10' = 39 .. = 54 In 5' = 75 Broke, deflection = 1.35	1122	1156	20	.05 .05 .05 .05 .06 .08 .14 .14 .2
53	Red Pine, Seasoned.	24	.965	.99	534	71 99 127 155 183 197 211	.25 .32 .37 .45 .55 .62 ..	Specimen a little warped upwards. The curve was reduced, but specimen had no set. Set in 10' = .05 Broke short in 5'	1338		28 14 ..	.07 .05 .08 .1 .07 Broke.
54	Do.	24	.976	.975	477.8	71 99 127 155 183	.15 .27 .37 .52 .85	Set = .03 Broke in 5', deflection = 1.85	1184	1212	28	.12 .1 .15 .33
55	Beech, Seasoned.	24	1.0	1.0	710	71 99 127 155 183 197 211 225 239	.15 .20 .25 .33 .44 .83 .86 .89 .92	In 2 hours = .38 In 4 hours = .66, in 18 hours = .80	1950		28 14 14 14	.05 .05 .08 .11 .39 .03 .03 .03

EXPERIMENTS CONTINUED. ENDS LOOSE.

No. of Experiment.	Names of Woods.	Length in inches = l .	Breadth = a .	Depth = d .	Specific gravity.	Weight applied.	Deflection in inches = Δ .	REMARKS.	Value of S from formula $S = \frac{W}{4ad^3}$.	Value of S' from formula $S' = \frac{W \sec^2 \Delta}{4ad^3}$.	Columns of Differences.	
											Weights.	Deflection.
55	Beech, Seasoned.	24	1.0	1.0	710	253 267 281 295 309 319 325	.97 1.15 1.20 1.25 1.35 1.50	In 20' = 1.10 Broke in 2 hours.	1950		14 10 6	.05 .18 .05 .05 .10 .15 Broke.
56	Black Spruce, Green.	24	.99	1.0	670	91 127 155 183	.20 .35 .48 1.25	In 10' = .37 In 10' = .58. Set = .05 Broke in 3	1109		36 28 ..	.15 .13 .77
57	Do.	24	.975	.995	874.8	71 99 127 155	.23 .35 .53	In 10' = .37. No set. In 10' = .60. Gave way directly, deflection = .85	963	967.8	28 ..	.12 .18 Broke.
58	Soft Maple, Green.	24	1.01	1.02	718	71 99 127 155 183 211 239 253 267	.17 .22 .30 .37 .50 .75 1.13 1.30 1.65	In 10' = .40' Set = .05 .. = .60 In 10' In 5' = 1.45 Gave way suddenly.	1524		28 14 ..	.05 .08 .07 .13 .25 .38 .17 .35
59	Do.	24	1.01	1.0	649	71 127 155 183 211 239 253 267 274 281 288 295	.10 .22 .75 .82 .92 1.05 1.20 1.30 1.35 1.45 1.55 1.80	After remaining suspended 48 hours. Set = .4 In 10' = 1.50 In 5' gave way suddenly, deflection = 1.82	1752	1792.3	28 14 .. 7	.12 .53 .07 .1 .13 .15 .1 .05 .1 .1 .25
60	Do.	24	.95	1.0	659	71 127 155 183 211 239 253 267 281 286	.20 .30 .40 .55 .67 .84 .98 1.28 1.55 1.70	In 10' In 10' = 1.60 cracked. Broke in 3 minutes.	1807		56 28 14 7 .. 5	.1 .1 .15 .12 .17 .14 .3 .27 .15
61	Bitter Nut Hickory, Green.	24	1.035	1.01	926	71 127 155 183 211 225 239	.15 .33 .40 .59 .80 .95	Gave way suddenly.	1358		56 28 14 ..	.18 .07 .19 .21 .15 Broke.
62	Do.	24	1.02	1.0	807	71 127 155 183 211 239	.13 .25 .30 .38 .50 .75	Specimen a little warped, placed convexity upwards. Gave way suddenly in 5'	1406		56 28 28	.12 .05 .08 .12 .25

EXPERIMENTS CONTINUED. ENDS LOOSE.

No. of Experiment.	Names of Woods.	Length in inches = l .	Breadth = a .	Depth = d .	Specific gravity.	Weight applied.	Deflection in inches = Δd .	REMARKS.	Value of S from formula $\frac{lW}{S} = \frac{4ad^2}{3}$.	Value of S' from formula $\frac{lW \sec^2 \Delta}{S'} = \frac{4ad^2}{3}$.	Columns of Differences.	
											Weights.	Deflection.
63	Bitter Nut Hickory, Green.	24	.975	.98	880	71 127 155 183 197 211 225 239 253 260	.10 .23 .32 .45 .65 .90 .96 1.03 1.15 1.25	= .38 in 5' = .53 in 10' Gave way in 10', deflection = 2.0	1632	1677	56 28 14 7	.13 .09 .13 .20 .25 .06 .07 .12 .1
64	Iron Wood, Green.	24	1.0	1.0	897	71 127 155 183 211 239 267 281 295 309 316	.15 .23 .28 .35 .43 .60 .84 1.00 1.15 1.45 1.75	Cracked in 10' = 1.60 Gave way in about 10'	1896	1934.9	56 28 14 7	.08 .05 .07 .08 .17 .24 .16 .15 .3 .3 Broke.
65	Do.	24	1.01	1.0	883	71 127 155 183 211 239 253 267 281 295 309 316 323 330 335 340	.10 .21 .28 .34 .45 .60 .70 .80 .90 1.25 1.50 1.70 1.85 1.95 2.15 2.4	In 10', began to give. In 15' = 2.05 Cracked, and slipped on support.	2019	2099.6	56 28 14 7 5 5	.11 .07 .06 .11 .15 .1 .1 .35 .25 .2 .15 .1 .2 .35
66	Iron Wood.	24	1.01	1.0	858	71 127 155 183 211 225 239 249 254 258 265	.20 .35 .45 .60 .70 .85 .95 1.25 1.68 1.72	In 5' = .90 In 20' = 1.20, and began to give. In 30' Broke gradually. Deflection = 2.05	1485	1528.3	56 28 14 .. 10 5 4 7	.15 .1 .15 .1 .15 .1 .3 .43 .04 Broke.
67	Birch, Pretty Dry.	24	.94	.965	679	71 99 127 155 183 211 239 267 295 323 351 365	.1 .14 .18 .22 .26 .33 .39 .47 .55 .67 .85	Permanent set = .1 Gave way gradually.	2525		28 14	.04 .04 .04 .04 .07 .06 .08 .08 .12 .18 Broke.

EXPERIMENTS CONTINUED. ENDS FIXED.

No. of Experiment.	Names of Woods.	Length in inches = l .	Breadth = a .	Depth = d .	Specific gravity.	Weight applied.	Deflection in inches = Δd .	REMARKS.	Value of S from formula $S = \frac{W}{4ad^3}$.	Columns of Differences.	
										Weights.	Deflection.
1	Red Cedar, Pretty Dry.	24	.985	.96	546	64	.15	In these 3 experiments one end only of the Specimen was firmly secured, the other end in the support. Slipped. Taking off weights. Set = .1 Gave way very suddenly at a knot.	2336		
						92	.20			28	.05
						120	.27			..	.07
						148	.33			..	.06
						176	.38			..	.05
						204	.50			..	.12
						232	.55			..	.05
						260	.60			..	.05
						274	.65			14	.05
						288	.70			..	.05
						302	.75			..	.05
						316	.80			..	.05
						330	.83			..	.03
						347	.87			17	.04
						357	.90			10	.03
						2	Do.			24	1.005

EXPERIMENTS CONTINUED. ENDS FIXED.

No. of Experiment.	Names of Woods.	Length in inches = l .	Breadth = a .	Depth = d .	Specific gravity.	Weight applied.	Deflection in inches = Δd .	REMARKS.	Value of S from formula $\frac{1}{W} S = \frac{4}{3} a d^2$.	Columns of Differences.	
										Weights.	Deflection.
5	Beech, Pretty dry.	24	.98	.96	787	295	.65	Gave way suddenly about 1' after weight was applied.	2684		
						323	.75			..	.1
						351	.85			..	.1
						379	.92			..	.1
						407	1.00			..	.07
6	Black Cherry, Pretty dry.	24	1.0	1.0	640	71	.07	Began to give way. But it required a weight of 520 to break it, which remained on some hours.	3650		
						127	.17			56	.1
						183	.25			..	.08
						211	.30			28	.05
						239	.36			..	.06
						267	.42			..	.06
						295	.48			..	.06
						323	.53			..	.05
						351	.60			..	.05
						379	.65			..	.07
						393	.70			..	.05
						407	.73			14	.05
						421	.80			..	.03
						435	.85			..	.07
						449	.90			..	.05
						463	.95			..	.05
						477	1.00			..	.05
						491				43	Broke
						520					
7	Curly Maple, Dry.	24	.97	.97	748.1	71	.10	Weights taken off. Set = .03	3125		
						127	.18			56	.08
						183	.23			..	.05
						239	.29			..	.06
						295	.37			..	.08
						323	.41			28	.04
						379	.52			56	.11
						435	.63			..	.11
						463	.70			28	.07
						477				14	Broke
8	Rock Elm, Pretty dry.	24	.92	.94	819.5	71	.10	Set = .15	3835		
						127	.25			56	.15
						183	.35			..	.1
						239	.55			..	.2
						267	.65			28	.1
						323	.82			56	.17
						379	1.03			..	.21
						435	1.14			..	.11
						463	1.25			28	.11
						491	1.39			..	.14
9	White Oak, Dry.	24	.975	.975	660.5	71	.10	Set = .02	3362		
						127	.20			56	.1
						183	.30			..	.1
						239	.40			..	.1
						295	.50			..	.1
						351	.60			..	.1
						407	.80			..	.2
						463	1.04			..	.24
						491	1.10			28	.06
						521				30	
10	Ditto, Green.	24	.98	.98	685	100	.15	Set = .06	3943		
						200	.33			100	.18
						300	.58			..	.25
						400	.98			..	.4
						500	1.37			..	.39

EXPERIMENTS CONTINUED. ENDS FIXED.

No. of Experiment.	Names of Woods.	Length in inches = l .	Breadth = a .	Depth = d .	Specific gravity.	Weight applied.	Deflection in inches = Δd .	REMARKS.	Value of S from formula $\frac{lW}{S} = \frac{4ad^3}{3}$.	Columns of Differences.	
										Weights.	Deflection.
10	White Oak, Green.	24	.98	.98	.685	600 620	2.90	Broke.	3943	.. 20	
11	Black Ash, Green.	24	.99	.975	531	71 127 155 183 211 239 267 295 309	.18 .37 .48 .60 .80 .90 1.05 1.25 1.3	The wood soft, and drew a little from supports. In $\frac{3}{4}$ set = 1.18 Began to give, but it took 28 lbs. more to break it.	1965	56 28 14	.19 .11 .12 .2 .1 .15 .2 .05
12	Iron Wood, Green.	24	.995	.98	768.7	71 127 183 239 295 351 407 463 491 521	.05 .13 .20 .27 .35 .47 .67 1.00 1.08 1.20	Weight taken off. No set. Cracked at bottom. After remaining 24 hours deflection became 1.6 and set 1.2	3172	56 28 30	.08 .07 .07 .08 .12 .2 .33 .08 .12
13	Do.	24	.985	.98	807.7	71 127 183 239 295 351 407 463 491 521	.06 .11 .22 .35 .47 .58 .72 .90 1.03 1.15	In 24 hours, deflection 1.40. Set = .9	3172	56 28 30	.05 .11 .13 .12 .11 .14 .18 .13 .12
14	Bitter Nut Hickory, Green.	24	.985	.98	779.5	71 127 183 239 295 351 407	.08 .17 .25 .32 .42 .55 .75	No set. Broke in about 5'.	2478	56	.09 .08 .07 .1 .13 .2

Fig. 1.

Fig. 2

Fig. 3

a. Weight to keep the thread stretched.

b. Hook for scale.

W. Derisgn R.E. } del.
W. J. Herwood.... }