



## Transactions of the American Society of Civil Engineers, vol. LXX, Dec. 1910

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1. Mathematical power (superscript) is rendered using a caret (^).
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## AMERICAN SOCIETY OF CIVIL ENGINEERS

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TRANSACTIONS

Paper No. 1168

TESTS OF CREOSOTED TIMBER.

BY W. B. GREGORY, M. AM. SOC. C. E.

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During the last few years a quantity of literature has appeared in which the treatment of timber by preservatives has been discussed. The properties of timber, both treated and untreated, have been determined by the Forest Service, United States Department of Agriculture, and through its researches valuable knowledge has come to engineers who have to deal with the design of wooden structures. There is very little information, however, regarding the effect of time on creosoted timber, and for this reason the results given herewith may prove of interest.

The material tested consisted of southern pine stringers having a cross-section approximately 6 by 16 in. and a length of 30 ft. For the purpose of testing, each beam was cut into two parts, each about 15 ft. long. This material had been in use in a trestle of a railroad near New Orleans for 26 years. The stringers were chosen at random to determine the general condition of the trestle. The timber had been exposed to the weather and subjected to heavy train service from the time it was treated until it was tested. The annual rainfall at New Orleans is about 60 in., and the humidity of the air is high. In spite of these conditions, there was no appearance of decay on any of the specimens tested. The specifications under which the timber was treated were as follows:

## TIMBER.

The timber for creosoting shall be long-leafed or southern pine. Sap surfaces on two or more sides are preferred.

*Piles.*--The piles shall be of long-leafed or southern pine, not less than 14 in. at the butt. They shall be free from defects impairing their strength, and shall be reasonably straight.

The piles shall be cleanly peeled, no inner skin being left on them. The oil used shall be so-called creosote oil, from London, England, and shall be of a heavy quality.

The treatment will vary according to the dimensions of the timbers and length of time they have been cut. Timbers of large and small dimensions shall not be treated in the same charge, neither shall timbers of differing stages of air seasoning, or the close-grained, be treated in the same charge with coarse or open-grained timbers.

The timbers shall be subjected first to live steam superheated to from 250 to 275° Fahr., and under a 30 to 40-lb. pressure. The live steam shall be admitted into the cylinders through perforated steam pipes, and the temperature shall be obtained by using superheated steam in closed pipes in the cylinders.

The length of time this steaming shall last will depend on the size of the timbers and the length of time they have been cut. In piles and large timbers freshly cut, as long a time as 12 hours may be required. After the steaming is accomplished, the live steam shall be shut off and the superheated steam shall be maintained at a temperature of 160° or more and a vacuum of from 20 to 25 in. shall be held for 4 hours or longer, if the discharge from the pumps indicates the necessity.

*Oil Treatment.*--The temperature being maintained at 160° Fahr., the cylinders shall be promptly filled with creosote oil at a temperature as high as practicable (about 100° Fahr.). The oil shall be maintained at a pressure ranging from 100 to 120 lb., as experience and measurements must determine the length of time the oil treatment shall continue, so that the required amount of oil may be injected.

After the required amount of oil is injected, the superheated steam shall be shut off, the oil let out, the cylinders promptly opened at each end, and the timber immediately removed from the cylinder.

In the erection of timbers the sap side must be turned up, and framing or cutting of timbers shall not be permitted, if avoidable. All cut surfaces of timbers shall be saturated with hot asphaltum, thinned with creosote oil. The heads of piles when cut shall be promptly coated with the hot asphaltum and oil, even though the cut-off be temporary.

METHOD OF TESTING.

The tests were made on a Riehlé 100,000-lb. machine in the Experimental Engineering Laboratory of Tulane University of Louisiana. The machine is provided with a cast-iron beam for cross-bending tests. The distance between supports was 12 ft. The method of support was as follows: Each end of the beam was provided with a steel roller which rested on the cast-iron beam of the testing machine, while above the roller, and, directly under the beam tested, there was a steel plate 6 by 8 in. in area and 1 in. thick. The area was sufficiently great to distribute the load and prevent the shearing of the fibers of the wood. The head of the Riehlé machine is 10 in. wide. A plate, 3/8 in. thick, 6 in. wide and 18 in. long, was placed between the head of the machine and the beam tested.

[Illustration: FIG. 1.--DEFLECTON CURVES BEAM I]

[Illustration: FIG. 2.--DEFLECTON CURVES BEAM II]

TABLE 1.--SUMMARY OF RESULTS OF TRANSVERSE TESTS OF BEAMS AT TULANE UNIVERSITY, FEBRUARY 10TH TO MARCH 2D, 1909.

Columns in table:

1. Number of beam. 2. Top or butt of log. 3. Width, in inches. 4. Height, in inches. 5.  $I = (bh^3)/12$  6. Actual at elastic limit. 7. Maximum. 8. At elastic limit. 9. Maximum. 10. At elastic limit. 11.  $E = (Pl^3)/(48dI)$  12. Weight, in pounds per cubic foot.

=====+															
b	h	I	LOADS: $IS = (Plc)/(4I)$	d,		INCHES.									
1	2	3	4	5	6	7	8	9	10	11	12				
45,900	2,975	6,200	0.41	I	T	6.00	15.69	1,934	20,000	38,000	2,915	5,540	0.465		
II[A]	T	6.37	15.81	2,098	20,000	43,450	2,722	5,918	0.380	II	B	6.41	16.41	2,360	16,000
25,040	1,999	3,130	0.430		III	T	5.88	15.68	1,871	24,000	45,130	3,608	6,785	0.535	
III	B	5.88	15.90	1,965	21,000	35,190	3,054	5,120	0.515		IV	T	6.00	15.43	1,835
22,000	38,425	3,320	5,810	0.465	IV	B	6.12	15.87	2,032	22,000	35,500	3,090	4,983	0.660	

||||| V | B | 6.00 | 16.00 | 2,048 | 22,000 | 47,000 | 3,090 | 6,610 | 0.400 | V[A] | T | 6.00 | 15.87 | 1,999 | 14,000 | 22,050 | 1,998 | 3,145 | 0.315 ||||| VI[A] | B | 5.50 | 15.75 | 1,790 | 22,000 | 51,330 | 3,484 | 8,925 | 0.450 | VI[A] | T | 5.87 | 15.62 | 1,865 | 20,000 | 44,000 | 3,013 | 6,627 | 0.410 ||||| VII | B | 6.56 | 15.62 | 2,083 | 34,000 | 51,900 | 4,580 | 6,985 | 0.620 | VII[A] | T | 6.22 | 15.62 | 1,975 | 20,000 | 49,000 | 2,845 | 6,970 | 0.380 |

[Footnote A: Failed in longitudinal shear.]

=====  
 ===== E ||| | -----+ | 11 | 12 | Remarks.  
 -----+-----+----- 1,575,000 | 50.2 | } Close-grained pine, 1,383,000 | 47.5 | } long-leaf. |  
 | 1,562,000 | 40.5 | } Coarse loblolly, 979,000 | 42.2 | } large knots. || 1,489,000 | 40.4 | } Close-grained,  
 long-leaf 1,288,000 | 44.2 | } no knots. || 1,601,000 | 40.8 | } Loblolly, with 1,017,000 | 41.5 | } knots. ||  
 1,670,000 | 47.2 | } Long-leaf yellow 1,382,000 | 42.1 | } pine. || 1,695,000 | 50.2 | } Long-leaf yellow  
 1,625,000 | 45.2 | } pine. || 1,637,000 | 43.7 | } Long-leaf yellow 1,658,000 | 40.2 | } pine.  
 =====

The deflection was measured on both sides of each beam by using silk threads stretched on each side from nails driven about 2 in. above the bottom of the beam and directly over the rollers which formed the supports. From a small piece of wood, tacked to the bottom of the beam at its center and projecting at the sides, the distance to these threads was measured. These measurements were taken to the nearest hundredth of an inch. The mean of the deflections was taken as the true deflection for any load.

[Illustration: FIG. 3.--DEFLECTON CURVES BEAM III]

[Illustration: FIG. 4.--DEFLECTON CURVES BEAM IV]

In computing the various quantities shown in Table 1, the summary of results, the load has been assumed as concentrated at the center of the beam. While it is true that the load was spread over a length of about 12 in., due to the width of the head of the machine and the plate between it and the beam tested, it is also true that there were irregularities, such as bolt-holes and, in some cases, abrasions due to wear, that could not well be taken into account. Hence, it was deemed sufficiently accurate to consider the load as concentrated. Besides the horizontal bolt-holes, shown in the photographs, there were vertical bolt-holes, at intervals in all the beams. The latter were 7/8 in. in diameter, and in every case they were sufficiently removed from the center of the length of the beam to allow the maximum moment at the reduced section to be relatively less than that at the center of the beam. For this reason, no correction was made for these holes. The broken beams often showed that rupture started at, or was influenced by, some of the holes, especially the horizontal ones.

While some of the heavy oils of a tarry consistency remained, they were only to be found in the sappy portions of the long-leaf pine and in the loblolly (Specimens II and IV). Exposure in a semi-tropical climate for 26 years had resulted in the removal of the more volatile portions of the creosote oil. The penetration of the oil into the sap wood seemed to be perfect, while in the loblolly it varied from a fraction of an inch to 1-1/2 in. In the heart wood there was very little penetration across the grain. The timber had been framed and the holes bored before treatment. The penetration of the creosote along the grain from the holes was often from 4 to 6 in.

Circular 39 of the Forest Service, U. S. Department of Agriculture, entitled "Experiments on the Strength of Treated Timber," gives the results of a great many tests of creosoted ties, principally loblolly pine, from which the following conclusions are quoted:

"(1) A high degree of steaming is injurious to wood. The degree of steaming at which pronounced harm results will depend upon the quality of the wood and its degree of seasoning, and upon the pressure

(temperature) of steam and the duration of its application. For loblolly pine the limit of safety is certainly 30 pounds for 4 hours, or 20 pounds for 6 hours." [Tables 3, 6, and 7.]

"(2) The presence of zinc chlorid will not weaken wood under static loading, although the indications are that the wood becomes brittle under impact." [Tables 3 and 4.]

[Illustration: FIG. 5.--DEFLECTON CURVES BEAM V]

[Illustration: FIG. 6.--DEFLECTON CURVES BEAM VI]

"(3) The presence of creosote will not weaken wood of itself. Since apparently it is present only in the openings of the cells, and does not get into the cell walls, its action can only be to retard the seasoning of the wood." [Tables 3, 4, 5, and 6.]

[Illustration: FIG. 7.--DEFLECTON CURVES BEAM VII]

COMPARISONS.

A comparison of the results obtained with tests made on untreated timber is interesting, and to this end Tables 2 and 3, from Circular 115, Forest Service, U. S. Department of Agriculture, by W. Kendrick Hatt, Assoc. M. Am. Soc. C. E., are quoted. The tests made by the writer were from timber raised in Louisiana and Mississippi, while the tests quoted were from timber raised farther north. The number of tests was not sufficient to settle questions of average strength or other qualities. It will be seen, however, that the treated timber 26 years old compares favorably with the new untreated timber.

[Illustration: PLATE I, FIG. 1.----SPECIMEN IN TESTING MACHINE, SHOWING METHOD OF SUPPORT.]

[Illustration: PLATE I, FIG. 2.--END VIEWS OF TESTED TIMBERS.]

TABLE 2.--BENDING STRENGTH OF LARGE STICKS.

Columns in table:

A: Reference number. B: Number of tests. C: Moisture, per cent. D: Rings per inch. E: Specific gravity, dry. F: WEIGHT PER CUBIC FOOT, IN POUNDS. G: As tested. H: Oven dry. I: Fiber stress at elastic limit, in pounds per square inch. J: Modulus of rupture, in pounds per square inch. K: Modulus of elasticity, in thousands of pounds per square inch. L: Elastic resilience, in inch pounds per cubic inch. M: Number failing by longitudinal shear.

LOBLOLLY PINE.

Locality	DIMENSIONS.	of	Grade.	Condition	A	Growth.	Section,	Span,
of	B   C   D	in   in	seasoning.	inches.	feet			
1   South	4 by 12	to	Square	Green	Average	48.0   5.7	Carolina.	6 by 16   15.5   edge   Maximum   42   92.   1.7   8 by 14   Minimum   30.2   2.3   8 by 16
2   South	6 by 10	to	Square	Partially	Average	27.7   5.0	Carolina.	6 by 16   16   edge   air dry.   Maximum   18   29.2   8.2   8 by 16   Minimum   25.5   2.5   10 by 16
								6 by 7   10   South   4 by 12



=====   A   B   C   D																
E	F	G	H	I	-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+----- Average											
13,580	15,480	1364	{4}	11,780	23.2	9.4	133.7	Air dry, Maximum   4	14,070	16,600	1440	11,987	124.3	11.5	134.5	3-1/2
months Minimum   13,090																
15,000	1327	11,530	121.5	8.0	132.5	in the open.										
-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+----- Average																
7.7	133.9	Kiln dry, Maximum   5	15,840	17,320	1488	11,790	122	110.2	138.0	6 days. Minimum   13,180	2,150	143				
11,410	118	4.7	127.7	-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+----- Average												
14,331	16,721	1493	{9}	11,688	--	7.7	--	Air dry, 21 Maximum   12	14,990	18,560	1620	12,002	--	9.5	--	1 months
under Minimum   13,110																
15,160	1380	11,398	--	5.5	--	shelter.										
=====																

NOTE.--Figures written as subscripts to the figures for longitudinal shear indicate the number of sticks failing in that manner.

[Illustration: PLATE II.--SIDE VIEWS OF TESTED TIMBERS.]

TABLE 4.--LOAD AND DEFLECTION LOG. BEAM I.

Columns in table:

A: Load, in pounds. B: Reading. C: Total deflection. D: Mean total deflection.

Date: February 26th, 1909. Date: February 24th, 1909. *l* = 12 ft.; *l* = 12 ft.; *b* (mean) = 6-9/32 in.; *b* (mean) = 6 in.; *h* (mean) = 15-15/16 in.; *h* (mean) = 15.69 in.; *c* = 7.97 in. *c* = 7.84 in. Time = 1 hour.

=====   P																				
DEFLECTION, IN INCHES.    P   DEFLECTION, IN INCHES.																				
No.	+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----   A   B   C   B   C   D    A   B   C   B   C																			
D	---+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+----- 1   0   1.86   0   1.88   0   0    0   1.83   0																			
11,860	0	0	2	2,000	1.92	0.05	1.90	0.02	0.03	2,000	1.87	0.04	1.90	0.04	0.04	3				
4,000	1.96	0.10	1.94	0.06	0.08	4,000	1.91	0.08	1.96	0.10	0.09	4	6,000	1.99	0.13	1.98	0.10	0.11	5	6,000
11,960	0.13	2.00	0.14	0.13	5	8,000	2.03	0.17	2.02	0.14	0.15	8,000	2.00	0.17	2.04	0.18	0.17	5	6	
110,000	2.05	0.19	2.06	0.18	0.18	10,000	2.04	0.21	2.08	0.22	0.21	7	12,000	2.10	0.24	2.09	0.21	0.22	7	12,000
12,090	0.26	2.13	0.27	0.26	8	14,000	2.13	0.27	2.13	0.25	0.26	14,000	2.14	0.31	2.18	0.32	0.31	5	9	
116,000	2.17	0.31	2.16	0.28	0.29	16,000	2.19	0.36	2.23	0.37	0.36	10								
118,000	2.20	0.34	2.20	0.32	0.33	18,000	2.24	0.41	2.28	0.42	0.41	11								
120,000	2.24	0.36	2.25	0.37	0.36	20,000	2.29	0.46	2.33	0.47	0.46	12								
122,000	2.28	0.42	2.28	0.40	0.41	22,000	2.34	0.51	2.39	0.53	0.52	13								
124,000	2.32	0.46	2.32	0.44	0.45	24,000	2.39	0.56	2.43	0.57	0.56	14								
126,000	2.36	0.50	2.36	0.48	0.49	26,000	2.44	0.61	2.48	0.62	0.61	15								
128,000	2.40	0.54	2.39	0.51	0.52	28,000	2.49	0.66	2.53	0.67	0.68	16								
130,000	2.43	0.57	2.44	0.56	0.56	30,000	2.55	0.72	2.58	0.72	0.72	17								
132,000	2.48	0.62	2.48	0.60	0.61	32,000	2.61	0.78	2.65	0.79	0.78	18								
134,000	2.52	0.68	2.53	0.65	0.65	34,000	2.68	0.85	2.70	0.84	0.84	19								
136,000	2.56	0.70	2.56	0.68	0.69	36,000	2.74	0.91	2.78	0.92	0.91	20								
138,000	2.61	0.75	2.62	0.74	0.74	38,000	Broke. 21					140,000	2.65	0.79	2.67	0.79	0.79	22		
142,000	2.70	0.84	2.73	0.85	0.84	23	144,000	2.75	0.89	2.77	0.89	0.89	23	37,500 lb., First Crack;    45,900 lb., Failed.       At Elastic Limit: Load, 22,000 lb.;   At Elastic Limit: Load, 20,000 lb.; deflection, 0.41 in.;    deflection, 0.465 in.; S, 2,975 lb.    S, 2,975 lb.    Maximum: Load, 45,900 lb.;   Maximum: Load, 38,000 lb.; deflection,.....;    deflection,.....; S, 6,209 lb.    S, 5,540 lb.    E = 1,575,000 lb.    E = 1,383,000 lb.						
=====																				

[Footnote B: First crack.]

TABLE 4.--(Continued.)--LOAD AND DEFLECTION LOG. BEAM II.

Columns in table:

A: Load, in pounds. B: Reading. C: Total deflection. D: Mean total deflection.

Date: February 20th, 1909. Date: --  $l = 12$  ft.;  $l = 12$  ft.;  $b$  (mean) = 6.38 in.;  $b$  (mean) = 6.41 in.;  $h$  (mean) = 15.81 in.;  $h$  (mean) = 16.41 in.;  $c = 7.91$  in.  $c = 8.20$  in. Time = 47.5 min.

===== | P |

DEFLECTION, IN INCHES. || P | DEFLECTION, IN INCHES.

No.	A	B	C	B	C	D	A	B	C	B	C	D
1	0	0	0	0	0	0	0	0	0	0	0	0
2	2,000	1.69	0.04	1.72	0.04	0.04	2,000	1.91	0.05	1.92	0.05	0.05
3	4,000	1.73	0.08	1.77	0.09	0.085	4,000	1.98	0.12	1.98	0.11	0.115
4	6,000	1.73	0.08	1.77	0.09	0.085	6,000	1.76	0.11	1.80	0.12	0.115
5	8,000	1.80	0.15	1.81	0.15	0.15	8,000	2.07	0.21	2.08	0.21	0.21
6	10,000	1.83	0.18	1.86	0.18	0.18	10,000	2.13	0.27	2.13	0.26	0.265
7	12,000	1.87	0.22	1.90	0.22	0.22	12,000	2.25	0.39	2.24	0.37	0.38
8	14,000	1.91	0.26	1.94	0.26	0.26	14,000	2.25	0.39	2.24	0.37	0.38
9	16,000	1.95	0.30	1.98	0.30	0.30	16,000	2.30	0.44	2.29	0.42	0.43
10	18,000	1.98	0.33	2.02	0.34	0.335	18,000	2.35	0.49	2.35	0.48	0.485
11	20,000	2.03	0.38	2.06	0.38	0.38	20,000	2.44	0.58	2.42	0.55	0.565
12	22,000	2.07	0.42	2.10	0.42	0.42	22,000	2.54	0.68	2.54	0.67	0.675
13	24,000	2.11	0.46	2.14	0.46	0.46	25,040	Failed	14	26,000	2.15	0.50
14	28,000	2.18	0.53	2.22	0.54	0.535	16	30,000	2.23	0.58	2.26	0.58
15	32,000	2.27	0.62	2.30	0.62	0.62	17	32,000	2.27	0.62	2.30	0.62
16	34,000	2.32	0.67	2.35	0.67	0.67	19	36,000	2.37	0.72	2.40	0.72
17	38,000	2.42	0.77	2.45	0.77	0.77	21	40,000	2.48	0.83	2.50	0.82
18	42,000	2.53	0.88	2.56	0.88	0.88	22	42,000	2.53	0.88	2.56	0.88
19	43,450	Fracture.					23	43,450	Fracture.			
20	45,710	Failed.					24	45,710	Failed.			

|| At Elastic Limit: Load, 20,000 lb.; || At Elastic Limit: Load, 16,000 lb.; deflection, 0.38 in.; || deflection, 0.43 in.; S, 2,722 lb. || S, 1,999 lb. || Maximum: Load, 43,450 lb.; || Maximum: Load, 25,040 lb.; deflection,.....; || deflection,.....; S, 5,918 lb. || S, 3,130 lb. || E = 1,562,000 lb. || E = 979,000 lb.

=====

[Footnote C: First crack.]

TABLE 4.--(Continued.)--LOAD AND DEFLECTION LOG. BEAM III.

Columns in table:

A: Load, in pounds. B: Reading. C: Total deflection. D: Mean total deflection.

Date: February 13th, 1909. Date: --  $l = 12$  ft.;  $l = 12$  ft.;  $b$  (mean) = 5.88 in.;  $b$  (mean) = 5.88 in.;  $h$  (mean) = 15.63 in.;  $h$  (mean) = 15.9 in.;  $c = 7.82$  in.  $c = 7.95$  in. Time = 45 min.

===== | P |

DEFLECTION, IN INCHES. || P | DEFLECTION, IN INCHES.

No.	A	B	C	B	C	D	A	B	C	B	C	D
1	0	0	0	0	0	0	0	0	0	0	0	0
2	2,000	1.27	0.04	1.10	0.04	0.04	2,000	1.70	0.03	1.68	0.05	0.04
3	4,000	1.32	0.09	1.13	0.07	0.08	4,000	1.72	0.05	1.72	0.09	0.07
4	6,000	1.37	0.14	1.17	0.11	0.125	6,000	1.86	0.19	1.82	0.19	0.19
5	8,000	1.42	0.19	1.22	0.16	0.175	8,000	1.86	0.19	1.82	0.19	0.19





TABLE 4.--(Continued.)--LOAD AND DEFLECTION LOG. BEAM V.

Columns in table:

A: Load, in pounds. B: Reading. C: Total deflection. D: Mean total deflection.

Date: -- Date: February 27th, 1909.  $l = 12$  ft.;  $l = 12$  ft.;  $b$  (mean) = 6 in.;  $b$  (mean) = 6 in.;  $h$  (mean) = 16 in.;  $h$  (mean) = 15.87 in.;  $c = 8$  in.  $c = 7.94$  in. Time = 40 min.

=====   P																							
DEFLECTION, IN INCHES.    P   DEFLECTION, IN INCHES.																							
No.	A	B	C	B	C	D	A	B	C	B	C	D											
D	1	0	11.97	0	11.37	0	10	11.31	0	11.31	0	0											
1	250	0	10	2	2,000	2.01	10.04	1.40	10.03	10.035	2,000	11.37	10.06	11.31	10.06	0.06	3						
4,000	2.06	10.09	1.43	10.06	10.075	4,000	11.41	10.10	10.36	10.11	10.105	4	6,000	2.08	10.11	11.47	10.10	10.105	6,000				
11.46	10.15	10.40	1.15	10.15	5	8,000	2.11	10.14	11.50	10.13	10.135	8,000	11.49	10.18	10.45	10.20	10.19	6					
10,000	2.16	10.19	11.54	10.17	10.18	10,000	11.54	10.23	11.49	10.24	10.235	7	12,000	2.19	10.22	11.57	10.20	10.21	12,000				
11.58	10.27	11.53	10.28	10.275	8	14,000	2.22	10.25	11.61	10.24	10.245	14,000	11.62	10.31	11.57	10.32	10.315	9					
16,000	2.25	10.28	11.65	10.28	10.28	16,000	11.68	10.37	11.65	10.40	10.385	10											
18,000	2.29	10.32	11.69	10.32	10.32	18,000	11.78	10.41	11.71	10.46	10.435	11											
20,000	2.32	10.35	11.73	10.36	10.35	20,000	11.99	10.68	11.97	10.72	10.70	12	22,000	2.36	10.39	11.78	10.41	10.40	13				
24,000	2.39	10.42	11.83	10.46	10.44	14	26,000	2.42	10.45	11.85	10.48	10.465	15	28,000	2.47	10.50	11.90	10.53	10.515	15			
16	30,000	2.50	10.53	11.95	10.58	10.565	17	32,000	2.54	10.57	11.99	10.62	10.595	18									
34,000	2.59	10.62	12.04	10.67	10.645	19	36,000	2.63	10.66	12.09	10.72	10.69	20	38,000	2.68	10.71	12.17	10.80	10.755	19			
21	40,000	2.73	10.76	12.21	10.84	10.80	22	42,000	2.80	10.83	12.30	10.93	10.88	23									
44,000	2.90	10.93	12.40	11.03	10.98	25,000	lb. Slight Crack; 20,000	lb. First Crack; 47,000	lb. Failed.	22,050	lb. Failed.    At Elastic Limit: Load, 22,000	lb.;   At Elastic Limit: Load, 14,000	lb.; deflection, 0.40	in.;    deflection, 0.315	in.; S, 3,090	lb.    S, 1,998	lb.    Maximum: Load, 47,000	lb.;   Maximum: Load, 22,050	lb.; deflection,.....;    deflection,.....; S, 6,610	lb.    S, 3,145	lb.    E = 1,670,000	lb.    E = 1,382,000	lb.
=====																							

TABLE 4.--(Continued.)--LOAD AND DEFLECTION LOG. BEAM VI.

Columns in table:

A: Load, in pounds. B: Reading. C: Total deflection. D: Mean total deflection.

Date: February 12th, 1909. Date: February 13th, 1909.  $l = 12$  ft.;  $l = 12$  ft.;  $b$  (mean) = 5.5 in.;  $b$  (mean) = 5.87 in.;  $h$  (mean) = 15.75 in.;  $h$  (mean) = 15.62 in.;  $c = 7.88$  in.  $c = 7.81$  in. Time = 40 min.

=====   P																			
DEFLECTION, IN INCHES.    P   DEFLECTION, IN INCHES.																			
No.	A	B	C	B	C	D	A	B	C	B	C	D							
D	1	0	11.22	0	11.30	0	10	11.28	0	11.28	0	0							
1	300	0	10	2	2,000	1.26	10.04	1.34	10.04	10.04	2,000	11.30	10.02	11.35	10.05	10.035	3		
4,000	1.29	10.07	1.38	10.08	10.075	4,000	11.36	10.08	11.39	10.09	10.085	4	6,000	1.33	10.11	11.42	10.12	10.115	6,000
11.40	10.12	11.44	10.14	10.13	5	8,000	1.37	10.15	11.47	10.17	10.16	8,000	11.43	10.15	11.47	10.17	10.16	6	
10,000	1.42	10.20	11.51	10.21	10.205	10,000	11.47	10.19	11.51	10.21	10.20	7	12,000	1.45	10.23	11.55	10.25	10.24	12,000
11.51	10.23	11.56	10.26	10.245	8	14,000	1.50	10.28	11.59	10.29	10.285	14,000	11.55	10.27	11.60	10.30	10.285	9	
16,000	1.54	10.32	11.63	10.33	10.325	16,000	11.59	10.31	11.64	10.34	10.325	10							
18,000	1.58	10.36	11.68	10.38	10.37	18,000	11.62	10.34	11.69	10.39	10.365	11							
20,000	1.61	10.39	11.72	10.42	10.405	20,000	11.66	10.38	11.74	10.44	10.41	12							

122,000|1.66|0.44|1.76|0.46|0.45||22,000 |1.71|0.43|1.80|0.50|0.465 13  
 124,000|1.81|0.59|1.81|0.51|0.55||24,000 |1.77|0.49|1.84|0.54|0.515 14  
 126,000|1.86|0.64|1.86|0.56|0.60||26,000 |1.83|0.55|1.90|0.60|0.575 15  
 128,000|1.91|0.69|1.91|0.61|0.65||28,000 |1.90|0.62|1.97|0.67|0.645 16  
 130,000|1.96|0.74|1.96|0.66|0.70||30,000 |1.97|0.69|2.02|0.72|0.705 17  
 132,000|2.00|0.78|2.02|0.72|0.75||32,000 |2.12|0.84|2.10|0.80|0.820 18  
 134,000|2.04|0.82|2.11|0.81|0.815||34,000 |2.20|0.92|2.16|0.86|0.885 19  
 136,000|2.10|0.88|2.20|0.90|0.89||36,000 |2.29|1.01|2.24|0.94|0.975 20  
 138,000|2.16|0.94|2.25|0.95|0.945||38,000 |2.39|1.11|2.32|1.02|1.065 21 |40,000|2.28|1.06|2.38|1.08|1.070|| 22  
 142,000|2.38|1.16|2.42|1.12|1.140|| 23 |44,000|2.44|1.22|2.52|1.22|1.220|| 24 |46,000|2.53|1.31|2.60|1.30|1.305||  
 25 |48,000|2.66|1.44|2.71|1.41|1.425|| 26 |50,000|2.78|1.56|2.87|1.57|1.565|| || 33,000 lb., First Crack; ||24,000  
 lb., First Crack; 51,330 lb., Failed. ||44,000 lb., Failed. || At Elastic Limit: Load, 22,000 lb.; ||At Elastic Limit:  
 Load, 20,000 lb.; deflection, 0.45 in.; || deflection, 0.41 in.; S, 3,484 lb. || S, 3,018 lb. || Maximum: Load,  
 51,330 lb.; ||Maximum: Load, 44,000 lb.; deflection,.....; || deflection,.....; S, 8,925 lb. || S, 6,627 lb. || E =  
 1,695,000 lb. || E = 1,625,000 lb.

TABLE 4.--(Continued.)--LOAD AND DEFLECTION LOG. BEAM VII.

Columns in table:

A: Load, in pounds. B: Reading. C: Total deflection. D: Mean total deflection.

Date: March 2d, 1909. Date: February 20th, 1909.  $l = 12$  ft.;  $l = 12$  ft.;  $b$  (mean) = 6.56 in.;  $b$  (mean) = 6.22 in.;  $h$  (mean) = 15.62 in.;  $h$  (mean) = 15.62 in.;  $c = 7.81$  in.  $c = 7.81$  in. Time = 1 hr. Time = 33 min.

===== | P |

DEFLECTION, IN INCHES. || P | DEFLECTION, IN INCHES.

No.	A	B	C	B	C	D	A	B	C	B	C
D	1	0	1.84	0	1.71	0	0	0	1.69	0	0
	1	73	0	0	2	2,000	1.88	0.04	1.74	0.03	0.035
	2,000	1.72	0.03	1.77	0.04	0.035	3	4,000	1.92	0.08	1.79
	4,000	1.76	0.07	1.80	0.07	0.070	4	6,000	1.96	0.12	1.81
	6,000	1.80	0.11	1.84	0.11	0.110	5	8,000	2.00	0.16	1.85
	8,000	1.84	0.15	1.87	0.14	0.145	6	10,000	2.03	0.19	1.89
	10,000	1.88	0.19	1.92	0.19	0.190	7	12,000	2.06	0.22	1.93
	12,000	1.91	0.22	1.95	0.22	0.220	8	14,000	2.11	0.27	1.95
	14,000	1.95	0.26	2.00	0.27	0.265	9	16,000	2.14	0.30	1.99
	16,000	1.99	0.30	2.03	0.30	0.300	10	18,000	2.18	0.34	2.03
	18,000	2.03	0.34	2.06	0.33	0.335	11	20,000	2.22	0.38	2.05
	20,000	2.07	0.38	2.11	0.38	0.380	12	22,000	2.25	0.41	2.10
	22,000	2.11	0.42	2.16	0.43	0.425	13	24,000	2.29	0.45	2.13
	24,000	2.15	0.46	2.20	0.47	0.465	14	26,000	2.32	0.48	2.17
	26,000	2.19	0.50	2.24	0.51	0.505	15	28,000	2.36	0.52	2.21
	28,000	2.23	0.54	2.28	0.55	0.545	16	30,000	2.40	0.56	2.25
	30,000	2.27	0.58	2.33	0.60	0.590	17	32,000	2.43	0.59	2.29
	32,000	2.32	0.63	2.37	0.64	0.635	18	34,000	2.47	0.63	2.32
	34,000	2.36	0.67	2.42	0.69	0.680	19	36,000	2.51	0.67	2.37
	36,000	2.56	0.72	2.41	0.70	0.710	20	38,000	2.56	0.72	2.41
	38,000	2.56	0.72	2.41	0.70	0.710	27,000 lb., First Crack;	28,000 lb., First Crack;	51,900 lb., Failed.   49,000 lb., Failed.    At Elastic Limit: Load, 34,000 lb.;   At	Elastic Limit: Load, 20,000 lb.; deflection, 0.62 in.;    deflection, 0.38 in.; S, 4,580 lb.    S, 2,845 lb.	
	49,000 lb., Failed.    At Elastic Limit: Load, 34,000 lb.;   At	Elastic Limit: Load, 20,000 lb.; deflection, 0.62 in.;    deflection, 0.38 in.; S, 4,580 lb.    S, 2,845 lb.	Maximum: Load, 51,900 lb.;   Maximum: Load, 49,000 lb.; deflection,.....;    deflection,.....; S, 6,985 lb.    S,	6,970 lb.    E = 1,637,000 lb.    E = 1,658,000 lb.							

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