EFFECT OF 5,000 CYCLES OF REPEATED BENDING STRESSES ON 5-PLY SITKA SPRUCE PLYWOOD

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In Cooperation with the University of Wisconsin

EFFECT OF 5,000 CYCLES OF REPEATED BENDING STRESSES ON 5-PLY SITKA SPRUCE PLYWOOD[1,2]

By

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Introduction

Little information has been available regarding the ability of various forest products, such as solid wood, plywood, compreg, and the paper plastics, to resist repeated and reversed stresses. It is desirable to know, for purposes of aircraft design, the endurance limit of a material, or the stress to which that material may be subjected an infinite number of times without failure. It also aids the designer to know what effect a specific number of repeated or reversed stress cycles may have on a material.

The purpose of this report is to present the results of a series of tests made at the Forest Products Laboratory to determine the effect of 5,000 cycles of repeated cantilever bending stresses on the strength of 5-ply plywood of one species -- Sitka spruce. The program originally contemplated determinations of the effect of various numbers of cycles on different species and plywood constructions, but because of other pressing war work the program was suspended after this limited series of tests was made.

Material Tested

All test specimens were cut from a 2- by 6-foot panel of Sitka spruce plywood consisting of five 1/16-inch plies. Each face ply of this panel was a single piece of veneer. The number of pieces in cross-bands and core was not determined. The nominal width of specimen was 1-1/4 inches; actual

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[1] Original report published in 1943.

[2] This is one of a series of progress reports prepared by the Forest Products Laboratory relating to the use of wood in aircraft. Results here reported are preliminary and may be revised as additional data become available.

[3] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

specimen dimensions are given in table 1. The thicknesses of the various plies were measured with a micrometer comparator, and the total thickness checked against the sum of the thicknesses of the 5 plies. The thickness of the glue line and the weight of the glue are assumed to be negligible throughout the calculations in this report. The specimens were rectangular in shape, 9 inches long, with the grain of the outside plies parallel to the length. The panel was received in a shipment of Tego-bonded aircraft plywood conforming to Army-Navy Specification AN-NN-P-511. The specimens were marked and numbered on one face of the panel before being cut, as shown in figure 1. Of the 128 specimens cut from the panel, 117 were used in this series of tests, with the remaining 11 used for preliminary trial tests. Their average specific gravity, based on weight when oven dry and volume at test, was 0.374. Their average moisture content at the time of test was 7.4 percent.

Each odd-numbered specimen from 1 through 117 was statically tested to failure as a cantilever beam without previous stressing to determine the average modulus of rupture for the material in the panel (table 1). The even-numbered specimens were subjected to repeated bending stresses, followed by static bending to failure, to determine the effect on strength resulting from the repeated stresses (tables 2 and 3).

Methods of Tests

Repeated Stress Tests

Krouse plate fatigue machines, shown in figure 2, were used to apply the repeated stresses to the specimens on a 6-inch span. In this machine, an electric motor rotates an adjustable eccentric, which transmits vertical action through a connecting rod and load pin to one end of the specimen. These machines can be adjusted to produce either repeated stress cycles from the unstressed position to a maximum deflection in one direction, or completely reversed stress cycles. The maximum deflection is limited to 2 inches. The machine is of the fixed deflection type, which uses the specimen as its own dynamometer, necessitating the calibration of each specimen in its testing position.

This calibration is accomplished, after the specimen is clamped in place, by hanging weights from the load pin (with the connecting rod disconnected) which will produce the required stress in the specimen over a 6-inch span from the edges of the grips to the center of the applied load. The deflection of the specimen under this load is measured with the lower dial gage, reading to 0.001 inch, and the machine is then adjusted so that the specimen will oscillate between this downward deflection and its neutral or unstressed position (fig. 2). Tapered wood strips one-eighth inch thick were placed between the specimen and the steel grips at the fixed end of the cantilever to prevent crushing of the specimen and to reduce the concentration of stress at the edges of the grips.

The error introduced by the additional weight of the bearing attached at the free end of the cantilever was partially offset during the calibration loading and during the static tests by the upward force of the dial spindle spring. The remainder of the effect of this weight has been disregarded. The speed of the machine was 1,790 r.p.m. and the cycles were recorded on a revolution counter with a 1000 to 1 ratio. The machine was started and stopped by a motor switch, allowance being made for coast after the power was shut off, and it is estimated that the actual number of cycles was within 2 percent + or - 100 of the intended value of 5,000. The upper dial and the two rectangular switch boxes above and below the specimen have no relation to this series of tests.

Static Tests

After removal from the fatigue machine, each specimen was immediately tested in static cantilever bending in a hydraulic testing machine of 100-pound capacity. Control specimens were tested in the same way. Figure 3 shows this apparatus. The load was applied to the specimen by means of the loading rocker, rod, and notched plate to assure the application of vertical loads only. The span from the center of the applied load to the edges of the steel grips was 6 inches.

Even-numbered specimens 2 through 72, after removal from the fatigue machine, were placed in "normal" position in the static testing machine, in order that stress would occur in the same direction as in the repeated stress machine. Even-numbered specimens 74 through 116 were placed in the static machine in "reversed" position, so that stress would occur in the reverse direction from that in the repeated stress machine. In all static tests the moving head of the testing machine descended at a rate of 0.15 inch per minute until the proportional limit was passed, after which the speed was approximately doubled. The rate of deflection corresponding to the standard rate of fiber strain of 0.0015 inch per inch per minute would be 0.096 inch per minute. The data from individual tests are given in tables 1 to 3.

Orientation of Specimens

The numbered faces of the specimens were upward in all tests except the final static tests on even-numbered specimens 74 to 116, inclusive.

Analyses of Results

Figure 4 presents the results of the repeated tests. In this figure the final modulus of rupture, expressed as a percentage of the modulus of rupture of the control specimens, is plotted against the magnitude of the repeated stress, expressed as a percentage of the same control value. Except as mentioned later, the average modulus of rupture of odd-numbered specimens 1 to 117, inclusive, is the base for all percentages. The repeated stresses applied to the specimens ranged from about 40 to 85 percent of the modulus of rupture of the controls for reversed final tests and from about 15 to 85 percent for the nonreversed, or "normal," tests. The abscissas are at varying percentages of stress because the repetitive tests were made with predetermined loads and the resulting stresses were calculated from the dimensions of the individual specimens.

Effect of Repetition of Stress on Modulus of Rupture

The specimens tested to failure in the normal position showed no reduction in strength even when subjected to repeated stress as high as 85 percent of the control value. In fact, it is evident from figure 4 and from tables 1 and 2 that the average is above that for the controls and that in only a few instances (8 out of 36) was the final strength of the repeated stress specimen below the average control value. It may be that the specimen, in acting as its own dynamometer and absorbing the energy of the bending, is raised in temperature at the maximum stress cross section, this increase causing a slight reduction in the moisture content of the wood at the cross section. These sections of lower moisture content would then support higher loads in static bending than does the average control specimen. It was not possible to check this possibility in this series of tests because the disc used for moisture content determinations was cut from the unbroken portion of the specimen and hence does not accurately represent the moisture content at the cross-section of failure.

The specimens which were tested to failure in the reversed position showed definite reductions in strength. This reduction was evident at the lowest value of repeated stress used, about 42 percent of the static modulus of rupture. Since repeated tests were not made at lower values, the stress that could be repeated 5,000 times without lowering the static modulus under the reversed direction is not known, but extrapolation from the trend of the plotted points suggests that it is not higher than 30 percent of the static value, and may be even lower. In some specimens, at the higher percentages of stress, visible compression failures were noticeable after removal from the fatigue machine, and, in these, failures resembling those which occur in brash wood resulted when the specimens were tested statically in the opposite direction.

Table 1 shows that the control specimens exhibited considerable variation in strength properties; for example, the average modulus of rupture was 8,827 pounds per square inch, the maximum 10,480 pounds, and the minimum 7,127 pounds. The vertical scatter of the points in figure 4 is consequently to be considered as largely due to variations in the specimens rather than to variations in the effect of repetition of stress. Except for those values designated by squares, figure 4 represents the ratio of the final modulus of rupture of a specimen to the average for all control specimens. Thus, the average of all controls is assumed to represent the original strength of each specimen that was repetitively tested. Since the controls were so variable, checks were made to determine whether the data shown in figure 4 would be affected if the control value for each repetitively tested specimen was assumed to be the average value of only the specimens that were adjacent to it in the original plywood panel. Results of such computations for the "reversed" specimens are shown by the squares plotted in figure 4. (These squares represent the same specimens as do the triangles.) It is evident from inspection of figure 4 that, in this instance, the conclusion is the same whether the triangles or the squares are considered. Although the use of the average value for adjacent specimens as the control value for each individual specimen is probably the more accurate procedure, it is extremely improbable that a change to this basis would affect the conclusion with respect to the specimens tested in the "normal" position; hence, such computations have not been made.

For points above line a-b in figure 4, the final modulus of rupture was higher than the repeated stress to which the specimen had been subjected. For points below this line, the reverse is true; i.e., the final modulus of rupture was less than the repeated stress. As is evident from the figure, this latter relation is true only of some of the specimens that were finally broken by stress in the direction opposite to that of the repeated stress.

Effect of Repetition of Stress on Modulus of Elasticity

The principal object of this series of tests was to find the effect of repeated stress on the strength of the material. From load and deflection readings taken in the static tests, values of modulus of elasticity were computed. These are listed with other data in tables 1, 2, and 3. In figure 5, values for repetitively stressed specimens are plotted as against the value of the reversed stress. Both coordinates are on a percentage basis; the base for the ordinates is the average modulus of elasticity for all control specimens (odd-numbered specimens) and that for the abscissas is the average modulus of rupture for the controls. Figure 5 indicates that repetitions of stress below about 65 percent of the modulus of rupture have no effect on E, but beyond this value there is a rapid decrease whether the tests were in the reversed or the normal position.

The results presented do not include data on the effect of 5,000 repetitions of a stress greater than 85 percent of the static modulus of rupture nor on the effect of completely reversed stress cycles.

Conclusions

The data show that the modulus of rupture of 5-ply, 5/16-inch Sitka spruce plywood was not affected adversely when specimens were subjected to 5,000 repetitions of stress in the Krouse plate fatigue machine, provided that the final breaking load was applied in the direction of the repeated stress. This conclusion holds for repeated stresses over the range of intensities of repeated stress concerned in the study -- 20 to 85 percent of the static modulus of rupture. Considerable weakening was evident, however, when the breaking load was applied in the direction opposite to that of the repeated stress if the repeated stress exceeded about 40 percent of the static modulus of rupture of the material. Extrapolation from the data indicated that the weakening effect from 5,000 repetitions when the load was opposite the direction of the repeated stress may begin at a value of repeated stress as low as 30 percent of the modulus of rupture.

The results here discussed are for one species (Sitka spruce) and one plywood construction over a limited range of repeated stress values. Hence, it should not be assumed that all species and plywood constructions will react in the same manner after 5,000 cycles of repeated stress. The tests, however, give some indication of what may be expected in future investigations of the effect of any given number of cycles of repeated stress on wood members.

Table 1.--Results of static bending tests on individual control specimens. Five-ply Sitka spruce plywood tested as a cantilever beam

Spec. No.	Width	Total thick-ness	Thick-ness top-ply	Thick-ness second-ply	Thick-ness third-ply	Thick-ness fourth-ply	Thick-ness bottom-ply	Modulus of elas-ticity	Maximum load	Modulus of rupture	Moisture content
	In.	In.	In.	In.	In.	In.	In.	1000 lb. per sq. in.	Lb.	Lb. per sq. in.	Percent
1	1.254	0.3087	0.0623	0.0635	0.0624	0.0642	0.0563	802	22.40	8,383	7.5
3	1.252	.3069	.0644	.0615	.0579	.0648	.0583	810	26.15	9,917	6.8
5	1.251	.3075	.0602	.0630	.0600	.0648	.0595	788	27.40	10,359	7.1
7	1.253	.3063	.0603	.0630	.0578	.0648	.0606	640	24.05	9,149	7.0
9	1.258	.3112	.0599	.0659	.0620	.0682	.0572	734	22.15	8,130	6.8
11	1.253	.3114	.0703	.0592	.0619	.0624	.0576	742	25.25	9,293	7.1
13	1.250	.3106	.0638	.0606	.0602	.0658	.0602	686	23.25	8,622	7.0
15	1.249	.3085	.0619	.0629	.0607	.0625	.0605	660	21.30	8,013	7.2
17	1.256	.3140	.0614	.0655	.0623	.0640	.0608	618	23.35	8,432	7.4
19	1.251	.3084	.0618	.0615	.0618	.0597	.0636	708	25.30	9,509	7.1
21	1.250	.3082	.0627	.0600	.0584	.0654	.0617	780	22.30	8,399	7.1
23	1.251	.3071	.0613	.0583	.0615	.0640	.0620	786	27.65	10,480	7.1
25	1.257	.3110	.0611	.0655	.0603	.0636	.0605	735	20.60	7,577	7.4
27	1.250	.3069	.0610	.0624	.0600	.0626	.0609	793	23.30	8,850	6.9
29	1.251	.3120	.0645	.0613	.0584	.0677	.0601	647	22.60	8,299	7.1
31	1.251	.3114	.0648	.0623	.0630	.0609	.0604	670	27.70	10,211	7.5
33	1.258	.3136	.0634	.0643	.0613	.0644	.0602	782	23.90	8,639	7.6
35	1.255	.3097	.0616	.0627	.0620	.0613	.0621	804	23.95	8,898	7.2
37	1.253	.3133	.0633	.0614	.0620	.0660	.0606	623	19.60	7,127	7.2
39	1.248	.3091	.0625	.0636	.0615	.0631	.0584	805	25.80	9,676	7.3
41	1.255	.3142	.0626	.0684	.0596	.0638	.0598	824	25.90	9,349	7.7
43	1.250	.3081	.0622	.0620	.0590	.0645	.0604	916	25.20	9,497	7.1
45	1.246	.3110	.0604	.0616	.0617	.0664	.0609	714	22.00	8,164	7.1
47	1.247	.3110	.0624	.0637	.0617	.0615	.0617	936	23.20	8,602	7.3
49	1.257	.3152	.0632	.0685	.0583	.0649	.0603	804	26.00	9,310	7.6
51	1.252	.3094	.0634	.0637	.0591	.0631	.0601	862	25.65	9,571	7.4
53	1.248	.3117	.0621	.0620	.0596	.0693	.0587	836	22.40	8,262	7.0
55	1.248	.3114	.0650	.0625	.0627	.0615	.0577	792	24.10	8,897	7.4
57	1.254	.3121	.0624	.0655	.0600	.0644	.0598	848	26.10	9,556	7.5
59	1.251	.3122	.0626	.0634	.0609	.0649	.0604	830	25.50	9,352	7.1
61	1.248	.3137	.0615	.0634	.0594	.0681	.0613	744	23.55	8,575	7.2
63	1.245	.3114	.0600	.0655	.0608	.0678	.0573	716	24.80	9,186	7.4
65	1.253	.3119	.0621	.0667	.0598	.0625	.0608	868	24.35	8,933	7.7
67	1.245	.3088	.0517	.0634	.0598	.0649	.0590	772	24.70	9,304	7.5
69	1.248	.3125	.0629	.0606	.0613	.0673	.0604	774	23.85	8,751	7.5
71	1.249	.3141	.0626	.0647	.0597	.0671	.0600	792	23.60	8,565	7.1
73	1.253	.3147	.0588	.0674	.0608	.0656	.0621	858	23.95	8,631	7.7
75	1.247	.3094	.0602	.0628	.0610	.0638	.0616	848	23.65	8,860	7.5
77	1.249	.3135	.0578	.0679	.0597	.0681	.0600	772	23.50	8,561	7.6
79	1.245	.3156	.0600	.0649	.0623	.0652	.0632	770	22.70	8,186	8.0
81	1.252	.3174	.0624	.0666	.0618	.0644	.0622	920	26.10	9,254	7.9
83	1.248	.312	.0607	.0635	.0628	.0629	.0621	828	24.30	8,246	7.6
85	1.246	.3147	.0619	.0640	.0606	.0667	.0615	822	22.40	8,118	7.4
87	1.245	.3136	.0626	.0632	.0617	.0636	.0625	770	23.60	8,620	7.7
89	1.254	.3122	.0601	.0672	.0604	.0641	.0604	838	22.90	8,379	7.8
91	1.249	.3075	.0602	.0661	.0600	.0615	.0597	824	26.30	9,959	7.1
93	1.248	.3123	.0615	.0650	.0592	.0649	.0617	752	24.10	8,854	7.1
95	1.247	.3119	.0629	.0626	.0694	.0646	.0614	706	23.60	8,700	7.3
97	1.251	.3110	.0552	.0693	.0618	.0649	.0598	857	23.80	8,796	7.7
99	1.251	.3100	.0603	.0630	.0616	.0627	.0624	824	20.30	7,551	7.2
101	1.248	.3104	.0677	.0566	.0610	.0660	.0591	810	22.10	8,219	7.6
103	1.253	.3097	.0617	.0626	.0603	.0632	.0619	696	21.40	7,963	7.8
105	1.254	.3029	.0551	.0647	.0655	.0590	.0586	742	22.10	8,590	7.8
107	1.249	.3121	.0649	.0607	.0625	.0639	.0601	677	25.40	9,337	7.5
109	1.248	.3094	.0594	.0620	.0601	.0657	.0622	788	23.55	8,815	7.7
111	1.248	.3079	.0602	.0628	.0602	.0629	.0618	795	24.50	9,260	7.7
113	1.252	.3011	.0557	.0636	.0598	.0642	.0588	718	22.50	8,865	8.0
115	1.249	.3126	.0650	.0620	.0617	.0627	.0612	827	25.95	9,508	7.6
117	1.248	.3136	.0640	.0633	.0607	.0662	.0594	768	21.10	7,688	7.4
Averages								777	23.88	8,827	7.4

Table 2.--Results of static bending tests on individual specimens after being subjected to 5000 stress repetitions. Specimens in static test stressed in same direction as in repeated loading. Five-ply Sitka spruce plywood tested as a cantilever beam

Spec. No.	Width	Total thick-ness	Thick-ness top-ply	Thick-ness second-ply	Thick-ness third-ply	Thick-ness fourth-ply	Thick-ness bottom-ply	Repeated stress	Static modulus of elas-ticity	Static maximum load	Modulus of rupture	Percent of control modulus of rupture	Repeated stress percent of control modulus of rupture	Moisture content
	In.	In.	In.	In.	In.	In.	In.	Lb. per sq. in.	1000 lb. per sq. in.	Lb.	Lb. per sq. in.			Percent
2	1.254	0.3098	0.0618	0.0633	0.0603	0.0639	0.0605	1,486	840	25.05	9,306	105.2	16.8	7.0
4	1.248	.3092	.0656	.0617	.0597	.0628	.0594	1,499	774	26.00	9,744	110.2	16.9	6.9
6	1.253	.3074	.0619	.0631	.0589	.0628	.0597	1,700	778	27.55	10,408	117.7	19.2	7.0
8	1.256	.3114	.0616	.0640	.0595	.0628	.0635	1,652	694	24.10	8,847	100.0	18.7	7.2
10	1.255	.3115	.0652	.0520	.0618	.0650	.0575	1,836	752	23.95	8,794	99.4	20.8	6.9
12	1.251	.3083	.0636	.0611	.0641	.0620	.0575	1.880	690	25.15	9,456	106.9	21.3	6.9
14	1.249	.3081	.0626	.0626	.0609	.0634	.0596	2,263	724	24.80	9,354	105.8	25.6	7.0
16	1.249	.3103	.0685	.0544	.0622	.0625	.0627	2,231	726	23.30	8,664	98.0	25.2	7.1
18	1.253	.3085	.0623	.0616	.0631	.0609	.0616	2,625	681	25.85	9,694	109.6	29.7	7.0
20	1.250	.3084	.0623	.0631	.0611	.0621	.0598	2,633	798	26.20	9,855	111.4	29.8	7.3
22	1.248	.3082	.0625	.0611	.0601	.0627	.0618	3,018	782	22.35	8,432	95.3	34.1	7.0
24	1.252	.3099	.0611	.0639	.0584	.0630	.0635	2,975	786	26.75	9,948	112.5	33.6	7.0
26	1.255	.3114	.0630	.0627	.0606	.0631	.0620	3,307	714	23.50	8,635	97.6	37.4	7.2
28	1.251	.3100	.0620	.0638	.0606	.0626	.0610	3,348	817	25.05	9,319	105.4	37.9	6.8
30	1.245	.3000	.0633	.0631	.0612	.0616	.0508	3,991	672	25.10	10,017	113.3	45.1	7.6
32	1.251	.3086	.0655	.0619	.0596	.0637	.0579	3,754	678	25.55	9,591	108.4	42.4	7.6
34	1.255	.3152	.0641	.0627	.0596	.0616	.0672	3,945	690	21.80	7,818	88.4	44.6	7.4
36	1.252	.3129	.0640	.0626	.0610	.0638	.0615	4,013	773	24.50	8,938	101.1	45.4	7.3
38	1.248	.3121	.0651	.0624	.0615	.0627	.0604	4,414	862	22.80	8,387	94.8	49.9	7.2
40	1.250	.3105	.0627	.0644	.0612	.0628	.0594	4,453	917	27.10	10,056	113.7	50.4	7.6
42	1.252	.3118	.0638	.0610	.0638	.0611	.0621	4,776	672	21.40	7,862	88.9	54.0	7.9
44	1.250	.3130	.0624	.0640	.0626	.0610	.0630	4,747	904	25.10	9,165	103.6	53.7	7.5
46	1.246	.3110	.0631	.0640	.0599	.0632	.0608	5,195	826	22.60	8,386	94.8	58.7	6.6
48	1.250	.3108	.0641	.0623	.0613	.0639	.0592	5,185	1,024	27.85	10,314	116.6	58.6	7.1
50	1.253	.3117	.0635	.0633	.0618	.0621	.0610	5,510	811	25.00	9,183	103.8	62.3	7.4
52	1.250	.3123	.0641	.0633	.0604	.0628	.0617	5,502	810	26.00	9,537	107.8	62.2	6.6
54	1.249	.3114	.0627	.0643	.0615	.0628	.0601	5,908	893	27.20	10,043	113.6	66.8	7.5
56	1.249	.3120	.0620	.0646	.0624	.0628	.0602	5,885	932	24.30	8,938	101.1	66.5	8.1
58	1.251	.3122	.0627	.0643	.0614	.0631	.0607	6,235	852	25.70	9,426	106.6	70.5	7.6
60	1.249	.3111	.0618	.0668	.0603	.0633	.0609	6,289	823	25.00	9,249	104.6	71.1	7.4
62	1.248	.3132	.0612	.0671	.0603	.0645	.0601	6,575	890	26.20	9,570	108.2	74.3	7.3
64	1.250	.3100	.0622	.0651	.0588	.0626	.0603	6,701	843	27.50	10,237	115.8	75.8	7.8
66	1.250	.3121	.0639	.0640	.0610	.0623	.0609	6,978	618	26.20	9,622	108.8	78.9	7.5
68	1.245	.3106	.0622	.0637	.0620	.0622	.0605	7,074	418	22.80	8,489	96.0	80.0	7.8
70	1.248	.3097	.0615	.0645	.0597	.0639	.0601	7,472	822	26.40	9,863	111.5	84.5	8.1
72	1.253	.3122	.0621	.0652	.0598	.0631	.0620	7,323	571	24.70	9,044	102.3	82.8	8.3
Averages										25.10	9,283	105.0		7.8

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Table 3.--Results of static bending tests on individual specimens after being subjected to 5000 stress repetitions. Specimens in static test stressed in the opposite direction to that in repeated loading. Five-ply Sitka spruce plywood tested as a cantilever beam

Spec. No.	Width	Total thickness	Thickness top-ply	Thickness second-ply	Thickness third-ply	Thickness fourth-ply	Thickness bottom-ply	Repeated stress	Static modulus of elasticity	Static maximum load	Modulus of rupture	Percent of control modulus of rupture	Repeated stress percent of control modulus of rupture	Moisture content
	In.	In.	In.	In.	In.	In.	In.	Lb. per sq. in.	1000 lb. per sq. in.	Lb.	Lb. per sq. in.			Percent
74	1.248	0.3111	0.0592	0.0643	0.0627	0.0640	0.0609	3,702	804	21.7	8,033	90.8	41.9	7.8
76	1.244	.3101	.0585	.0648	.0611	.0644	.0613	3,738	840	20.8	7,775	87.9	42.3	7.8
78	1.245	.3158	.0608	.0657	.0605	.0648	.0640	3,962	851	24.0	8,644	97.7	44.8	8.0
80	1.245	.3142	.0598	.0657	.0608	.0642	.0637	4,002	897	22.2	8,077	91.3	45.3	8.5
82	1.248	.3166	.0636	.0630	.0605	.0647	.0648	4,290	860	24.05	8,598	97.2	48.5	7.8
84	1.249	.3118	.0608	.0644	.0608	.0632	.0626	4,419	762	23.25	8,562	96.8	50.0	7.7
86	1.247	.3148	.0612	.0660	.0601	.0637	.0638	4,704	891	23.95	8,666	98.0	53.2	7.7
88	1.248	.3132	.0629	.0645	.0584	.0652	.0622	4,749	855	20.25	7,397	83.6	53.7	8.1
90	1.250	.3106	.0622	.0647	.0604	.0641	.0592	5,192	842	20.50	6,954	78.6	58.7	7.5
92	1.248	.3126	.0604	.0644	.0622	.0632	.0624	5,134	756	16.30	5,977	67.6	58.1	7.0
94	1.245	.3113	.0640	.0630	.0619	.0619	.0605	5,560	785	14.50	5,375	60.8	62.9	7.3
96	1.251	.3138	.0633	.0629	.0592	.0651	.0633	5,445	802	18.70	6,788	76.8	61.6	7.8
98	1.250	.3104	.0616	.0649	0607	.0640	.0592	5,941	847	17.15	6,368	72.0	67.2	7.6
100	1.247	.3156	.0652	.0636	.0600	.0619	.0649	5,761	691	12.10	4,357	49.3	65.1	7.4
102	1.246	.3127	.0639	.0635	.0623	.0603	.0627	6,240	728	8.65	3,175	35.9	70.6	7.6
104	1.254	.3115	.0620	.0623	.0624	.0653	.0595	6,248	709	8.35	3,069	34.7	70.6	7.7
106	1.248	.3100	.0629	.0631	.0609	.0617	.0614	6,712	469	8.85	3,300	37.3	75.9	7.9
108	1.246	.3119	.0646	.0614	.0625	.0625	.0609	6,641	707	9.75	3,597	40.7	75.1	7.7
110	1.244	.3130	.0622	.0660	.0593	.0648	.0607	6,972	684	8.55	3,137	35.5	78.8	8.1
112	1.248	.3112	.0610	.0622	.0623	.0636	.0621	7,030	709	8.80	3,256	36.8	79.5	8.3
114	1.249	.3112	.0639	.0634	.0624	.0601	.0614	7,394	426	7.75	2,865	32.4	83.6	8.0
116	1.247	.3150	.0663	.0611	.0632	.0630	.0614	7,228	374	8.45	3,054	34.5	81.7	7.4
Average														7.8

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