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BUCKLING OF FLAT PLYWOOD PLATES IN COMPRESSION, SHEAR, OR COMBINED COMPRESSION AND SHEAR

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In Cooperation with the University of Wisconsin

EFFECTIVE WIDTH OF THIN PLYWOOD PLATES IN COMPRESSION

WITH THE FACE GRAIN AT 0° AND 90° TO LOAD[1]

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Summary

This report presents the results of compression tests of thin plywood plates at 0° and 90° to the face grain direction to determine the stress distribution under load and the compressive strength after buckling. Presented also are curves for determining from the properties of the material, the "effective width ratio" of plywood plates in compression when the edges are simply supported in a plane, the "effective width ratio" being defined as the ratio of the maximum load sustained by a buckled plate to the maximum load it would carry had it been restrained from buckling.

Purpose

Formulas for the calculation of critical buckling stresses of plywood plates subjected to compression, shear, and combined compression and shear are presented in Forest Products Laboratory Report No. 1316, "Buckling of Flat Plywood Plates in Compression, Shear, or Combined Compression and Shear." The compression formula was checked experimentally for stresses at 0° and 90° to the face grain and the data are presented in Forest Products Laboratory Report No. 1316-D, "Buckling of Flat Plywood Plates in Compression with Face Grain at 0° and 90° to Load." At stresses below the critical buckling stress, the usual formula[3] may be used to compute the stress from the load on any

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[1] This report is one of a series of progress reports prepared by the Forest Products Laboratory to further the Nation's war effort. Results here reported are preliminary and may be revised as additional data become available. Original report dated October 1943.

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

[3] Forest Products Laboratory Report No. 1315.

given plate. After buckling occurs, these formulas are not applicable because the stresses vary over the cross sections of the plate. It was the purpose of this study to determine the stress distribution in plywood plates subjected to compression and to determine empirical effective width ratio curves for computing the compressive load that a plywood plate will carry after buckling. The effective width ratio is defined as the ratio of the maximum load the plate sustained in test to the maximum load the plate would have withstood had it been restrained from buckling.

Description of Material

The specimens used to determine the effective width ratio curves were the same specimens used to check the critical buckling formula. For a description of the material, marking, matching, and conditioning of the specimens, the buckling test method and the coordination of tests, see Forest Products Laboratory Report No. 1316-D.

Method of Test

The evaluation of the effective width ratio for thin flat plywood plates was based on compression tests of plates supported in a special frame and on compression tests of coupons cut from the panels, using the so-called pack test apparatus. The plywood panel compression tests were made on the same specimens used for the plywood buckling study and without removing the plate from the test frame (Report No. 1316-D). The special frame for plate tests is shown in figures 83 and 84.[4] The method of conducting the compression tests of plywood coupons is illustrated in figure 81 of Report No. 1316-D.

In the plate compression tests, the exact procedure varied somewhat in relation to the buckling tests on the same plates, and depended on the ratio of the critical buckling stress to the proportional limit stress.

For thin plywood having a critical buckling stress less than 75 percent of the proportional limit stress, the plate compression test was made immediately after the test for critical buckling load. After removal of the load in the buckling test, the specimen was again lined up with the edges straight and parallel. Compression gages were attached 3/8 inch from the edges of the specimen on both faces and a gage was mounted with the spindle in contact with the center of the plate to measure lateral deflections. Figures 83 and 84 show the two faces of a specimen ready for test.

[4] The figures and tables in this supplement are numbered consecutively with those of Forest Products Laboratory Report No. 1316 and supplements A, B, C, and D.

For thicker plywood, having a buckling stress greater than 75 percent of the proportional limit stress, each plate was tested simultaneously for plate compressive strength and for critical buckling load. The load was applied intermittently in equal increments until failure occurred. All gages were read after each increment until failure was approached, at which time the gages were removed. Another series of tests was made on nine plates to determine the strain distribution before and after buckling occurred, using the same loading conditions as for the plate compression tests made to evaluate effective width. Strains in the same direction as the load were measured, using 1-inch metalectric strain gages on both faces of the plates at points 1/2, 1-1/2, 3, 4-1/2, and 6 inches from the edges on the transverse centerline. Also, 4-inch compression gages were mounted on gage lines 3/8 inch from the edges and a dial gage was mounted with its spindle in contact with the center of the plate to measure lateral deflections.

Data Presentation

Strain Distribution Across Plate

Typical data from the strain distribution study on plywood plates in compression are presented in table 12. Readings of the six metalectric gages on the north face of the plate are listed in columns 3 to 8. In columns 9 to 14, the readings of the corresponding gages on the south face are given. The 4-inch gage length compression gage readings are tabulated in columns 15 to 18 and are designated by the number of the nearest metalectric gage. The lateral or buckling deflection at the center is presented in column 2.

The metalectric gages read strain directly, but the readings of the 4-inch gage length compression gages should be divided by four to convert to strain.

These data are plotted in figure 85 with the compressive strains as ordinates and the gage numbers along the horizontal axis. The sketch above the curves shows the gage positions along the transverse center line of the plate. Each plotted point was determined by averaging the readings of the two metalectric strain gages mounted upon the same gage line but upon opposite faces of the plate. The curve of average strains across the width of the plate is given for each load at which the gages were read. Numbers on the curves represent loads in hundreds of pounds.

These data are replotted in figure 86 with the load as an ordinate and the average compressive strain of each group of four gages the same distance from either edge as an abscissa. Curves for gages 1/2 inch from the edges are labeled (IN-IS-6N-6S); those 1-1/2 inches from the edges (2N-2S-5N-5S); and those 3 inches from the edges, (3N-3S-4N-4S). The curve for the 4-inch gage length compression gages at 3/8 inch from the edges is also shown in this figure.

Figure 87 shows how the lateral deflection at the center of the plate varied with the load.

Effective Width Ratios

Effective width ratios obtained in this series of tests are presented in table 13 together with test data and computed loads. To determine the effective width ratios at proportional limit, column 2 or 4, the data obtained during the plate compression test were plotted as a load-strain curve as shown in figure 88. The strains used were those measured at 3/8 inch from the edges of the plates. Entering the curve at the strain at proportional limit determined by the compression tests of the coupons (point A, fig. 88), column 13 or 16, the load on the specimen at this strain was obtained (point B, fig. 88) column 6 or 8. The stress at proportional limit determined by tests of coupons, column 12 or 15, was used to compute the load at proportional limit that the specimen would have carried if buckling had not occurred (point C, fig. 88). This load is entered in column 10 or 11. The ratio of the load on the plate at this strain (B) to the load at this strain that the specimen would carry if it were restrained from buckling (C) is the effective width ratio at proportional limit and is entered in column 2 or 4. If the plate failed before the proportional limit strain indicated by the coupon tests was reached, the maximum load was used in computating the effective width ratio.

The effective width ratio at maximum stress, column 3 or 5, is the ratio of the maximum average compressive stress across the plate, column 7 or 9, to the maximum stress that the plate would carry if it was restrained from buckling, column 14 or 17. The latter maximum stress was computed from the tests on coupons.

In columns 18 and 19 are entered the square roots of the ratios of the computed proportional limit stresses to the computed critical buckling stresses taken from column 2 or 8 of table 11 of the report on buckling tests of these same specimens (Report No. 1316-D).

The effective width ratios at proportional limit are plotted as ordinates in figure 89 with the square roots of the ratios of computed proportional limit stresses to computed critical buckling stresses plotted as abscissas. The effective width ratios at maximum load are plotted in a similar manner in figure 90.

Analysis of Results

The study of strain distribution across the width of the plates indicated that the strain is uniformly distributed until the computed critical buckling load is attained. Figure 85 shows that the compressive strain remained practically uniform across the width of the plate for loads up to 400 pounds. At 400 pounds one edge was strained a greater amount than the center or the other edge. At 500 pounds the strain at the edges was at least twice the strain at the center. The buckling, or lateral, deflection of the center of the plate started at about 75 pounds and increased to 0.1 inch at a load of 470 pounds with no indication of a critical buckling load. The computed critical buckling load for this specimen was 350 pounds. This agreement, between the computed critical buckling load and the load at which the strain becomes concentrated at the edges and relieved at the center of a plate, was observed in all nine specimens studied.

As the load was increased above the critical buckling load, the strain became concentrated at the edges as shown by figures 85 and 86. The average compressive strain at the center practically vanished as failure was approached.

Figure 86 shows that, after buckling occurs, the average strains computed from the readings of the 4-inch gages mounted 3/8 inch from the edges of the plate are greater than the strains measured by the 1-inch gages mounted 1/2 inch from the edges of the plate on the same transverse centerline. Much of the difference can be attributed to the rapid increase in strain as the edge of the plate is approached. Extrapolation on figure 85 to the 3/8-inch gageline accounts for 40 to 60 percent of the difference.

As the plate deflects, its vertical edges pull in more at the center than at the top and bottom and therefore the 4-inch gages measured the change in length of the chord rather than that of the arc. The 1-inch gages were of the metalectric type and therefore measured the change in length of the arc. The difference, however, is negligible. Computations show that it accounts for only 5-1/2 percent of the difference between the two gages.

It is evident, therefore, that the strain distribution in a vertical direction near the edge of the plate is not uniform but is maximum at the top and bottom corners of the plate and minimum at the center.

During the tests, it was noted that the greatest curvature occurred near the corners of the plates. The deflected surface in these areas approximated a portion of a cone with the apex at the corner. This same concentration of bending was observed in tests of longer plates not reported here. In the longer plates, similar conelike deflections were noted in the corners formed by nodes and the guided edges of the plates.

The plates generally failed near the corners where the compressive and bending stresses were concentrated. Since this occurred outside of the range of the 4-inch gage length, the measured strains were less than the maximum strains in the plate. Occasionally failures occurred before these gages indicated that the proportional limit strain, calculated from the compression tests of the coupons, had been reached. This premature failure was observed in 8 percent of the tests in which the load was applied parallel to the face grain, and in 30 percent of the tests in which the load was applied perpendicular to the face grain. When the specimen failed before the elastic limit strain was observed, the maximum load was used as the load at the elastic limit strain in the computation of the effective width ratio at the proportional limit.

The strains measured by the 4-inch gages were, then, less than the maximum strains in the plywood plates when the critical buckling stresses were exceeded. The observed load at the elastic limit strain (point B of fig. 88) is, therefore, greater than the load at the true proportional limit strain.

It follows that the method of computing effective width ratios at the proportional limit gives values which are too great.

The effective width ratio at maximum stress was obtained as previously explained on page 3. This ratio was based on accurate measurements of load and area without introducing the strain readings. The effective width ratio curve is given in figure 9.

The effective width ratios were plotted as ordinates in figure 89 and 90 with the square roots of the ratios of proportional limit stresses to critical computed buckling stresses as abscissas. The abscissas are, therefore, ratios of the widths of the plates to the widths of plates, identical except for width, which would buckle at the proportional limit stress. These abscissas were chosen because it seemed logical that they would lead to an effective width ratio curve which would apply equally well to plywood plates of all constructions. There are probably, other factors which influence the value of the effective width ratio. The existence of such factors is indicated by the divergence of the points for tests with compression parallel to face grain from the points for tests with compression perpendicular to face grain as the abscissas increased. The effective width ratios may not be exact due to variations between the minor test specimen and the buckling test specimen. Also, the buckling test specimens were of such proportions as would give a minimum critical buckling load. However, the curves are believed dependable for the range covered; and the effective width ratio may be determined for plates from the properties of the material and the plate dimensions.

Conclusions

The strain distribution in a plywood plate simply supported at the four edges and subjected to compression parallel to the face grain or to compression perpendicular to the face grain remains relatively unchanged until the computed critical buckling load is exceeded. After buckling occurs the strain distribution changes rapidly with strains becoming concentrated at the edges of the plate.

The common compression formulas are applicable for computing loads, stresses, or strains before buckling occurs. After buckling occurs, a portion of the plate may be considered to carry the load. The width of this portion (effective width) at maximum load can be determined, if the stresses are at 0° or 90° to the face grain, by the use of figure 90 in connection with the elastic and strength properties and the dimensions of the particular plate considered.

From the nature of the evaluation, it is evident that the effective width ratios for maximum loads are inherently more accurate than for the proportional limit loads, which are indicated as being somewhat high. Further study is necessary to establish more accurately the effective width ratios at the proportional limit, and to determine the ratios at other loads between the critical buckling loads and the maximum loads.

Such determinations are involved because of the complicated stress distribution in the plate after the critical buckling load has been exceeded. Further study would involve also the mathematical analysis of the elastic behavior of the plate in this range and the development of new and more complicated testing techniques.

Table 12.--Results of compression test on plate 19r-A to determine the strain distribution.

Load	Buckling deflection	Metalectric gage readings in 0.0001 inch per inch compression												Compression gage readings in 0.001 inch per 4-inch gage length			
		North face						South face									
		1N	2N	3N	4N	5N	6N	1S	2S	3S	4S	5S	6S	1N	6N	1S	6S
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Pounds	Inches																
0	0.707	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
100	.708	1.0	1.0	1.5	1.0	1.0	0.0	0.5	0.0	0.5	1.0	0.5	1.5	0.30	0.40	0.40	0.35
200	.718	1.0	1.7	2.7	3.0	2.2	1.5	1.0	1.0	1.0	0.7	1.0	2.5	0.65	0.75	0.70	0.60
300	.743	1.5	3.0	4.5	4.7	3.5	2.2	1.5	1.0	-0.7	-1.0	1.0	3.0	1.00	1.30	0.90	0.80
400	.776	2.0	4.5	6.5	6.8	5.0	3.5	2.5	0.5	-2.2	-2.5	1.0	4.0	1.35	1.85	1.30	1.20
500	.821	3.0	5.0	8.0	8.0	6.0	5.5	5.0	0.0	-4.5	-4.5	0.0	5.5	1.80	2.65	1.80	2.10
600	.860	4.0	7.0	9.0	9.0	7.5	7.0	6.0	0.0	-5.5	-6.0	0.0	7.0	2.40	3.60	2.50	3.30
700	.894	5.0	7.0	11.0	10.0	8.5	9.5	8.0	1.0	-7.0	-7.0	0.0	9.5	3.20	4.55	3.35	4.40
800	.924	6.5	7.0	11.5	12.0	8.5	11.0	9.5	2.5	-7.0	-7.5	2.0	12.0	3.95	5.45	4.10	5.70
800	.700	(Readjusted buckling gage)															
900	.725	7.0	7.0	12.0	10.5	8.0	12.0	12.0	4.0	-8.0	-8.0	3.0	14.0	4.90	6.35	5.00	7.00
1000	.755	8.0	7.0	12.0	11.0	8.0	14.0	14.5	4.5	-8.0	-8.5	5.0	17.0	5.80	7.20	5.95	8.05
1100	.793	9.0	7.0	11.5	10.5	8.0	15.5	18.0	7.0	-8.5	-9.0	7.5	21.0	7.10	8.25	7.30	9.40
1200	.833	10.0	6.0	10.5	9.0	7.0	17.5	21.0	10.0	-9.0	-9.5	10.0	24.0	8.60	9.15	8.75	10.55
1300	.894	11.0	5.0	9.5	7.5	5.0	18.5	24.0	12.0	-8.0	-9.0	12.5	27.5	10.00	10.15	10.30	11.75
1315	.938	Maximum load															

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Table 13.—Summary of effective width ratios for plywood plates in compression including test data and computed loads.

Panel number	Effective width ratio: Parallel to face grain: At proportional limit	Effective width ratio: Parallel to face grain: At maximum stress	Effective width ratio: Perpendicular to face grain: At proportional limit	Effective width ratio: Perpendicular to face grain: At maximum stress	Panel compression tests: Parallel to face grain "A" specimens: Load at proportional limit	Panel compression tests: Parallel to face grain "A" specimens: Maximum stress	Panel compression tests: Perpendicular to face grain "B" specimens: Load at proportional limit	Panel compression tests: Perpendicular to face grain "B" specimens: Maximum stress	Computed panel loads at proportional limit, based on coupon tests: Parallel to face grain	Computed panel loads at proportional limit, based on coupon tests: Perpendicular to face grain	Coupon compression tests: Parallel to face grain H and J coupons and average value in order: Proportional limit: Stress	Coupon compression tests: Parallel to face grain H and J coupons and average value in order: Proportional limit: Average strain	Coupon compression tests: Parallel to face grain H and J coupons and average value in order: Maximum stress	Coupon compression tests: Perpendicular to face grain K and L coupons and average value in order: Proportional limit: Stress	Coupon compression tests: Perpendicular to face grain K and L coupons and average value in order: Proportional limit: Average strain	Coupon compression tests: Perpendicular to face grain K and L coupons and average value in order: Maximum stress	$\sqrt{\frac{\text{Proportional limit stress}}{\text{Critical buckling stress}}}$ In compression: Parallel to face grain	$\sqrt{\frac{\text{Proportional limit stress}}{\text{Critical buckling stress}}}$ In compression: Perpendicular to face grain
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
					Lb.	Lb. per sq. in.	Lb.	Lb. per sq. in.	Lb.	Lb.	Lb. per sq. in.	In. per in.	Lb. per sq. in.	Lb. per sq. in.	In. per in.	Lb. per sq. in.		
1a	0.512	0.289	....	....	568	1,310	....	....	1,110	....	2,220 2,040 2,130	0.00233	4,890 4,190 4,540	1,756 1,250 1,503	0.00193	3,460 2,420 2,940	4.23	....
1b	.461	.286	....	....	645	1,470	....	....	1,400	....	2,980 2,730 2,855	.00246	5,120 5,150 5,140	1,594 1,304 1,449	.00202	2,700 3,350 3,020	5.40	....
1c	.461	.309	....	....	618	1,470	....	....	1,340	....	2,620 2,770 2,695	.00222	4,980 4,550 4,760	1,642 1,618 1,730	.00229	3,340 3,170 3,260	4.98	....
2a	.527	.340	0.546	0.351	1,730	1,940	1,595	1,040	3,320	2,920	3,110 2,890 3,000	.00206	5,720 5,700 5,710	1,712 1,644 1,678	.00246	2,930 3,000 2,960	2.18	2.66
2b	.587	.384	.632	.348	2,000	2,220	1,650	1,150	3,410	2,610	3,470 2,780 3,125	.00206	5,650 5,900 5,780	.... 1,518 1,518	.00196	3,330 3,280 3,300	2.23	2.52
2c	.594	.400	.496	.305	2,240	2,230	1,655	1,120	3,770	3,340	3,450 3,470 3,460	.00235	5,330 5,830 5,580	1,644 2,192 1,918	.00211	3,710 3,630 3,670	2.35	2.81
3a	.816	.406	.641	.339	2,840	2,040	2,115	1,090	3,480	3,300	2,380 2,620 2,500	.00234	5,170 4,890 5,030	1,202 1,762 1,482	.00249	3,040 3,400 3,220	1.75	2.17
3b	.668	.472	.454	.291	2,490	2,470	1,845	1,040	3,730	4,060	3,020 2,370 2,695	.00231	5,480 4,980 5,230	1,625 2,028 1,826	.00229	3,590 3,580 3,580	1.70	2.21
3c	.654	.422	.551	.361	2,055	2,110	1,853	1,050	3,140	3,360	2,410 2,160 2,285	.00205	5,120 4,890 5,000	.... 1,500 1,500	.00258	.... 2,910 2,910	1.62	2.06
4a	.453	.271	....	....	575	1,200	....	....	1,270	....	2,820 2,440 2,630	.00208	4,280 4,550 4,420	930 1,086 1,008	.00258	2,200 1,770 1,980	5.63	....
4b	.363	.279	....	....	624	1,290	....	....	1,720	....	3,480 3,560 3,520	.00232	5,570 3,680 4,620	.... 1,166 1,166	.00244	.... 2,100 2,100	6.18	....
4c	.335	.246	....	....	580	1,190	....	....	1,730	....	3,660 3,410 3,535	.00249	5,110 4,570 4,840	1,392 1,068 1,230	.00229	1,970 2,140 2,060	6.34	....
5a	.519	.320	.531	.319	1,600	1,700	1,115	800	3,080	2,100	3,070 2,780 2,925	.00245	5,300 5,330 5,320	1,224 1,248 1,236	.00222	2,670 2,350 2,510	2.52	2.61
5b	.583	.342	.663	.338	2,138	1,940	1,605	940	3,670	2,420	3,600 3,070 3,335	.00260	5,930 5,440 5,680	1,522 1,087 1,304	.00193	3,060 2,500 2,780	2.42	2.31
5c	.602	.400	.521	.319	2,070	2,040	1,215	835	3,440	2,330	3,300 2,800 3,050	.00245	5,210 5,000 5,100	1,108 1,582 1,345	.00238	2,240 3,000 2,620	2.42	2.68
6a	.619	.382	.525	.326	2,285	1,840	1,890	913	3,690	3,600	2,340 2,930 2,635	.00274	4,940 4,710 4,820	1,381 1,804 1,592	.00241	2,630 2,960 2,800	1.94	2.39
6b	.587	.440	.577	.344	1,950	1,720	1,725	771	2,840	2,990	1,690 2,390 2,040	.00212	3,690 4,130 3,910	1,690 980 1,335	.00259	2,750 1,720 2,240	1.80	2.35
6c	.649	.394	.661	.413	2,195	1,640	1,255	707	3,380	1,900	2,410 2,410	.00276	4,160 4,160	965 739 852	.00216	1,980 1,440 1,710	2.01	1.90

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Table 13.—Summary of effective width ratios for plywood plates in compression including test data and computed loads (cont.)

Panel number	Effective width ratio				Panel compression tests				Computed panel loads at proportional limit, based on coupon tests		Coupon compression tests						$\sqrt{\frac{\text{Proportional limit stress}}{\text{Critical buckling stress}}}$	
	Parallel to face grain		Perpendicular to face grain		Parallel to face grain "A" specimens		Perpendicular to face grain "B" specimens				Parallel to face grain H and J coupons and average value in order			Perpendicular to face grain K and L coupons and average value in order			In compression	
	At proportional limit	At maximum stress	At proportional limit	At maximum stress	Load at proportional limit	Maximum stress	Load at proportional limit	Maximum stress	Parallel to face grain	Perpendicular to face grain	Proportional limit: Stress	Proportional limit: Average strain	Maximum stress	Proportional limit: Stress	Proportional limit: Average strain	Maximum stress	Parallel to face grain	Perpendicular to face grain
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
					Lb.	Lb. per sq. in.	Lb.	Lb. per sq. in.	Lb.	Lb.	Lb. per sq. in.	In. per in.	Lb. per sq. in.	Lb. per sq. in.	In. per in.	Lb. per sq. in.		
7a	0.408	0.343			580	1,200			1,420		2,790 3,100 2,945	0.00226	3,400 3,590 3,500	1,022 1,658 1,340	0.00189	2,160 2,100 2,130	5.75	
7b	.303	.230			478	1,090			1,580		3,110 3,250 3,180	.00222	3,750 5,730 4,740	1,770 1,770	.00267	2,490 2,250 2,370	5.80	
7c	.349	.259			565	1,120			1,620		3,160 3,260 3,210	.00253	4,350 4,310 4,330	1,310 1,375 1,342	.00183	2,550 2,280 2,420	5.69	
8a	.526	.370	0.420	0.274	2,120	1,980	1,519	859	4,030	3,620	3,600 3,890 3,745	.00262	5,320 5,380 5,350	1,895 2,196 2,046	.00258	3,070 3,210 3,140	2.58	2.97
8b	.507	.386	.411	.284	2,174	1,990	1,575	898	4,290	3,830	3,720 4,140 3,930	.00276	5,160 5,140 5,150	2,170 2,195 2,182	.00273	3,190 3,140 3,160	2.57	3.05
8c	.550	.373	.437	.279	2,056	1,910	1,407	848	3,740	3,220	2,900 4,060 3,480	.00247	5,130 5,100 5,120	1,908 1,760 1,834	.00227	3,030 3,050 3,040	2.47	2.81
9a	.606	.382	.514	.329	1,690	1,360	1,568	690	2,790	3,050	2,260 1,710 1,985	.00210	3,540 3,580 3,560	1,342 1,339 1,340	.00262	2,130 2,060 2,100	1.82	2.42
9b	.550	.362	.528	.320	1,830	1,380	1,425	631	3,330	2,700	2,320 2,370 2,345	.00238	3,450 4,170 3,810	1,046 1,344 1,195	.00268	1,940 2,000 1,970	1.99	2.34
9c	.632	.418	.474	.359	1,920	1,530	1,730	798	3,040	3,650	2,330 1,960 2,145	.00219	3,650 3,670 3,660	1,572 1,676 1,624	.00275	2,200 2,240 2,220	1.87	2.63
10a	.427	.258			610	1,320			1,430		2,280 3,500 2,890	.00233	4,520 5,720 5,120	1,288 1,086 1,187	.00258	2,200 2,110 2,160	5.46	
10b	.450	.243			630	1,330			1,400		2,950 2,950	.00231	4,920 6,050 5,480	1,552 1,392 1,472	.00238	2,920 2,150 2,540	5.58	
10c	.412	.240			680	1,410			1,650		3,640 3,200 3,420	.00259	5,820 5,940 5,880	931 1,222 1,076	.00254	2,540 2,380 2,460	5.99	
11a	.511	.337	.428	.331	2,010	2,130	1,550	1,010	3,930	3,620	3,710 3,350 3,530	.00231	6,360 6,280 6,320	2,257 1,885 2,071	.00284	2,990 3,110 3,050	2.41	3.02
11b	.491	.327	.494	.303	2,140	2,120	1,708	990	4,360	3,460	3,600 4,280 3,940	.00240	6,490 6,460 6,480	1,716 2,302 2,009	.00258	3,040 3,500 3,270	2.58	3.03
11c	.559	.345	.456	.340	2,075	2,090	1,528	1,000	3,710	3,350	3,520 3,190 3,355	.00218	6,360 5,740 6,050	1,700 2,110 1,905	.00249	2,750 3,120 2,940	2.34	2.89
12a	.609	.385	.488	.326	2,350	1,960	2,215	1,030	3,860	4,540	2,980 2,630 2,805	.00236	5,340 4,840 5,090	1,999 2,120 2,060	.00295	3,100 3,220 3,160	1.84	2.52
12b	.657	.410	.540	.350	2,530	2,130	2,150	1,050	3,850	3,980	2,950 2,640 2,795	.00247	5,210 5,190 5,200	2,144 1,466 1,805	.00263	3,120 2,870 3,000	1.72	2.22
12c	.677	.419	.513	.310	2,600	2,180	2,150	970	3,840	4,190	2,650 2,950 2,800	.00265	5,040 5,360 5,200	1,744 2,032 1,888	.00280	2,990 3,270 3,130	1.83	2.38

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