Supplement to

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

Buckling of Flat Plywood Plates in Uniform Shear With Face Grain at Angles of 0°, +45°, and 90°

Revised July 1950

No. 1316-H

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FOREST SERVICE
FOREST PRODUCTS LABORATORY
Madison 5, Wisconsin
In Cooperation with the University of Wisconsin

BUCKLING OF FLAT PLYWOOD PLATES IN UNIFORM SHEAR WITH FACE GRAIN AT ANGLES OF 0°, ±45°, AND 90°

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Introduction

Forest Products Laboratory Report No. 1316-H, issued in February 1945, presented preliminary results of an experimental study of a mathematical analysis for the buckling of flat plywood plates subjected to shear. The formula that had been previously developed in Forest Products Laboratory Report No. 1316 was found satisfactory for the plates tested. Curves were drawn to show the correlation between the tests and computations made with constants for both clamped and simply supported edges. From the limited number of tests reported, an effective ultimate-stress curve was obtained for design purposes.

The Army-Navy-Civil Subcommittee, after reviewing Report No. 1316-H, requested that results of additional tests, including square plates with face grain at angles of +45° and -45°, together with whatever check tests might be required to examine the effect of the stiffness of the loading frames on observed stresses, be included in this revised report.

Summary

This report supersedes Report No. 1316-H and presents a more extensive experimental study of the mathematical analysis presented in Forest Products Laboratory Report No. 1316 for the buckling of flat plywood plates under shear load. Included in it are results of tests made on plywood plates of several proportions and with their face grain at various angles, as follows:

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[1]Formerly an engineer at the Forest Products Laboratory. The other authors assume responsibility for the present revision.

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

With the face grain at 0° (parallel to short dimensions)

Plates 10 by 20 inches
Plates 10 by 30 inches

With the face grain at 90° (perpendicular to short dimensions)

Plates 10 by 20 inches
Plates 10 by 30 inches

With the face grain at +45° (parallel to tension diagonal)

Plates square (size varied)
Plates 10 by 20 inches
Plates 10 by 30 inches

With the face grain at -45° (perpendicular to tension diagonal)

Plates square (size varied)
Plates 10 by 20 inches
Plates 10 by 30 inches

In each of these conditions the thickness of the plate and the stiffness of the loading frame were varied.

The formula developed in Report No. 1316 was found satisfactory. A group of curves for applying the buckling coefficient, $k_{s\infty}$, for infinitely long plates to finite plates is presented. Curves showing the relationship between observed stresses and computed stresses with edges of the plates simply supported and with edges clamped are included. Adjustment factors required to bring theoretical and observed stresses into agreement are presented.

Analysis of the data on frame stiffness showed no consistent effect of this stiffness on buckling stresses.

The effective ultimate-shear stresses were obtained and plotted against a nondimensional parameter of panel width to establish a curve for the design of plates subjected to shear.

Purpose

Because of the pressing need for design criteria necessary to the building of wood aircraft during the war, formulas and constants were developed by mathematical analyses. One such analysis was presented in Forest Products Laboratory Report No. 1316 on the buckling of flat plywood plates in compression, shear, or combined compression and shear. The formula for compression was subsequently substantiated experimentally, and the results were published in Forest Products Laboratory Report No. 1316-D. The work presented herein was an experimental investigation of formula 21, $q_{cr} = k_s E_L h^2/a^2$ (energy method), of Forest Products Laboratory Report No. 1316 for the critical buckling stress of plywood plates under uniform shear, together with an empirical study of the maximum shear stress that plywood panels will sustain after buckling.

Description of Material

The plywood for this series of tests was made from Sitka spruce logs obtained as part of a shipment from the state of Washington[3] and from yellow-poplar logs obtained from Tennessee. The Sitka spruce was cut into flitches and shipped to a plywood manufacturer to be quarter-sliced to the specified thicknesses. The sliced veneer was returned to the Forest Products Laboratory to be dried, edge-glued, and pressed into 2- by 6-foot plywood panels. The yellow-poplar was rotary cut, dried, and pressed into panels at the Laboratory. The face grain of the finished plywood was at angles of 0°, 90°, and 45° with reference to the short side of the panels.

Marking and Matching

Panels were numbered according to construction and species, as shown in table 16.[4] Constructions 4 to 21, inclusive, were of the usual plywood construction; that is, the grain direction of each ply was perpendicular to the grain direction of the adjacent plies. Constructions 40 to 45, inclusive, were different only in that the grain direction of the center two plies was parallel. In addition to the construction number, small letters (a, b, c, etc.) were used to distinguish panels of like species and construction from one another.

A typical layout of specimens is shown in figure 108.[5] The 45° material was used both in negative and positive shear, so that the face grain was parallel and perpendicular, respectively, to the compression diagonal. The designations for individual specimens suffixed to the panel designations and the tests thereby indicated were as follows:

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[3]Shipment 1580.

[4]The tables and figures in this supplement are numbered consecutively with those of Report No. 1316 and its supplements B, C, D, E, F, and G. Figures 134 through 138 have been deleted, however, in the revision of Report No. 1316-H.

[5]Because the plywood panels were manufactured to meet specification AN-NN-P-511a and were thought equal to commercial aircraft grade, no attempt was made to avoid minor defects in the face plies, since there was probably as much variation in the inner plies as in the face plies.

Designation	Test
1, 2, etc.	Plate buckling
s1, s2, etc.	Shear strength (panel)
C	Plate shear test for modulus of rigidity in shear
D and E	Static bending with the face grain parallel to span
F and G	Static bending with the face grain perpendicular to span

Each frame member was assigned the same identification as the plate from which it was cut, after the buckling test was completed, plus an additional number to identify each member of the frame.

All specimens and coupons were conditioned to produce a moisture content between 3-1/2 and 5-1/2 percent at time of test so as to avoid results that would require correction for moisture content.

Method of Test

Preparation of Specimens

All test specimens were cut on fine-cutting, sharp, circular saws after the panels marked as indicated in figure 108 had been cut on a band saw into sections.

Buckling test specimens were prepared as shown in figure 109. First the corners were cut by drilling 1-inch-diameter holes centered 1/2 inch from the corner of the test area and 1/2 inch away from the corner on a line at 45° to the edges. The plate was then cut to size on a circular saw. The specimen was then glued into a frame of white pine, hard maple, or yellow birch. White pine frames were used on a few of the very thin specimens (three 1/48-inch plies), since the heavy hardwood frames caused some breakage at the corners of the fragile plates during handling before test. On these thin plates frames were made of 3/4- by 2-inch members glued to each side of the plywood, while on the thickest plates the frame members were 1-3/8 by 2-3/4 inches. For the bulk of the specimens between these two extremes, the frame members were 3/4 by 2-3/4 inches. A gap of approximately 1/16 inch was maintained at the corners between the ends of the frame members to prevent their bearing on one another. Holes to receive the loading pins were located according to the table of dimensions given on figure 109 and were drilled sufficiently large to provide the necessary bearing area on the frame.

Frame members were prepared for static bending tests after the plate buckling test was completed. Each member, made up of two blocks with the plywood glued between them, was removed from the test plate by means of a band-saw cut along the edge of the area tested for shear buckling. This sawed surface of the frame members was then joinered to a flat, smooth surface for about 2 inches from each end to bear on the supports during the static bending test.

Test Procedures

The procedures for the static bending test of frame members and for the shear strength test of plywood (coupons s1 and s2)are given in the appendix. Static bending tests made on coupons D, E, F, and G are described in the appendix to Forest Products Laboratory Report No. 1316-D. The plate shear test on coupon C is discussed and described in Forest Products Laboratory Report No. 1301, "Method of Measuring the Shearing Moduli of Wood."

The procedure for the buckling test of plywood plates in shear was established only after much time and effort had been devoted to experimentation with methods of supporting and loading plates and with methods of observing the critical buckling load.

The method of obtaining the critical buckling stress of plywood plates in shear is illustrated in figure 110, which shows a specimen under load. Load was applied to the frame of the specimen through wood loading blocks fitted with 1-inch-square steel bars. Hardened-steel rollers and loading pins transmitted the load to the frame, and the frame transmitted the load to the plywood panel by glue shear.

The test procedure was as follows: The loading pins and rollers were assembled into the drilled holes. When necessary, the holes were reamed with a hand reamer to provide a snug fit for the pins. A dial gage graduated to 0.0001 inch was then adjusted to one member of the frame of the specimen to measure the flexure of the member in the plane of the plywood. This frame gage was adjusted so that its spindle contacted the edge of the plywood at the center of the frame member.

Diagonal deformation (when recorded) was measured on the compression diagonal across the center of the panel. To obtain this measurement two dial gages (not shown in fig. 110) graduated to 0.0001 inch were mounted opposite one another on opposite sides of one of the longer frame members. The spindles of the dials were connected to the opposite frame member by fine wires that passed over the center of the panel, one on each side, and made angles of 45° with the edges of the panel. The readings of the two dials were averaged to minimize the effects of any slight twisting of the frame caused by warping and of any slight eccentric drilling of the holes for the loading pins.

The specimen was then placed in the testing machine. To prevent the panel from twisting and to keep the frame properly alined, guide rails were clamped to the frame at the two corners not loaded. These rails were clamped tightly to one frame member, but were shimmed to allow approximately 0.002-inch clearance for the adjacent frame member. A small load was then applied to hold the specimen between the heads of the machine while plumbing and centering the set-up on the loading blocks. Dial gages were then brought into position to measure lateral deflection (buckling) at the center and approximately at the quarter points of the longitudinal center line of the specimen. The points of contact between the spindles of the gages and the panel were marked with a pencil, thumb tacks to which silver contact points had been soldered were forced into the plywood, and the necessary electrical connections were made to a couple of dry-cell batteries and a buzzer.

Since the exact positions of the crests of the buckles were unpredictable, especially in very thin plywood, a small prebuckling load was applied, and the contacts were spotted on the panel at the points of maximum lateral movement as shown by a straightedge. This procedure usually resulted in a good set of curves from which the buckling load was easily read.

The question as to whether this procedure weakened the panel and caused it to sustain less load before buckling was answered by making several test runs, consecutively, on each of several panels. No weakening was evident, and buckling took place at about the same load on all runs. This repeated loading procedure applied to only a few of the thin specimens that had a low ratio of buckling stress to estimated proportional-limit stress.

Although on some of the thick panels the electrical contact was eliminated for the gages measuring lateral deflection, it was felt that the pressure of the dial spindles on thin specimens would influence the buckling. The system of electrical contact was therefore used. During test the spindles were kept free of the specimens except at time of reading, when contact was made with only enough pressure to complete the circuit and to energize the buzzer. To take the readings of the frame and diagonal gages was no problem, but the lateral-deflection gages had to be read one at a time and with considerable care to prevent lateral pressure on the panel by the spindle. While the readings were being taken, the load on the specimen was held constant. Under this arrangement some scatter of points could always be expected, partly because of the difficulty of holding an even load (especially at the higher loads) and partly because of the factor of human error in the technique of measuring the lateral deflections.

The load was applied in increments so estimated as to give at least 10 readings before buckling occurred. The speed of the head of the testing machine during the application of load was approximately 0.018 inch per minute. Readings were taken as rapidly as possible in order to prevent unnecessary creep of the specimen and were continued past buckling. The gages for measuring lateral deflection were then removed, and the buckles were marked on the specimen as it was being loaded to failure. Failure usually occurred in one of two ways -- by compression and bending at one of the corners not loaded, or by shear along the frame. Failure by shear along the frame was typical for the 0° and 90° face-grain panels.

Method of Choosing the Observed Buckling Load

To determine the critical buckling load, the following measurements were taken at each increment of load and were plotted against the load.

1. Lateral deflections of the plywood plate.
2. Diagonal compression across the plate at 45° to the edges.
3. Deflection of the frames in the plane of the plate.

Of these measurements the lateral deflections were the most consistent and were therefore considered the best indicators of buckling. Of secondary importance were the readings of the diagonal compression. The chief difficulty in using these diagonal measurements to determine the critical load was that usually several changes of slope of the plotted curve were obtained before buckling, as evidenced by lateral deflections, occurred. However, the determination of the critical load by use of these diagonal measurements appeared fairly reliable for the thicker panels. The frame deflections were too inconsistent to be used as indicators of buckling. While the curves plotted from these measurements generally followed a given pattern for panels having a certain face-grain direction, the changes in slope of the curve were too irregular to be of value. Whenever the lateral deflections gave a sharp definition of a critical buckling load, the plots of the other measurements indicated the same critical load.

The load, lateral-deflection curve seldom changed direction with a sharp and precise break at the critical buckling load (Forest Products Laboratory Report No. 1316-D), probably on account of an initial curvature in the plate. The curve usually assumed a new slope in a gradual manner. The buckling load was chosen just above the knee of the curve. Figure 76 of Forest Products Laboratory Report No. 1316-D illustrates the manner of selecting the load, as follows: By extrapolating the curve of run No. 4, the buckling load chosen on run No. 5 would have been read at a point where the curve begins to level off. A similar situation is shown again in figure 92 of Forest Products Laboratory Report No. 1316-G, in which the buckling deflection curve is compared to strains measured with metalectric gages set at the center and edges of the panel. These examples are taken from the buckling of plywood plates under compression.

The following examples show that this same method is applicable to plates under uniform shear. Specimens 6xc-1 and 6xc-2 were cut from the same 2- by 6-foot plywood panel. It so happened that specimen 6xc-1 (fig.111) behaved under test in an ideal manner; the lateral movement was slight until the buckling load was reached, and then rapid movement was recorded. There is no question but that the critical buckling load on this specimen was 2,450 pounds. Specimen 6xc-2 (fig. 112) behaved in a contrary fashion. If the method of choosing buckling loads were applied, 2,100 pounds would be chosen because at this load two of the curves become straight lines. No buckling load was chosen for this specimen because of its noncritical behavior, but it is desired to point out that, even in such an extreme case, the critical buckling load can be approximated.

Specimen 44xn-2 (fig. 113) further shows this method of choosing the buckling load to be correct. Strain gages of the electric-resistance type were glued to both faces of the plate opposite each other, and strains were recorded in addition to measurements of lateral deflection and of frame deflections. The buckling load chosen from the strains recorded by the metalectric gages was approximately 3,200 pounds. This load was also indicated by all dial gages. Metalectric gages numbered 3 and 8 increased in strain under compression until buckling was reached, when compressive strain was relieved, and a slight increase in tension was noted with gages numbered 1 and 6. Gages number 2 and 7 should theoretically have remained at zero strain while tension and compression equalized each other, but at buckling, a new relationship developed. The buckling load picked from the lateral-deflection curves agreed with that indicated by the electric-resistance strain gages. Matched to this specimen was specimen 44xn-1, curves for which are shown in figure 114. This is a typical set of curves that again indicates the correctness of the method of choosing buckling load.

A different type of behavior is shown in the curves of figure 115. These curves are representative of specimens that begin to bow in one direction on the application of load and that at buckling change into a wave pattern of a quite different form. The buckling load is then relatively simple to read from the curves and is usually at a point where one of the lateral gages reverses. The curves for specimen 17xh-1 (fig. 115) illustrate this. The curves for the matched specimen 17xh-2 (fig. 116) are also shown in order to compare the methods of reading buckling loads.

The selection of a critical buckling load frequently required personal judgment in the interpretation of the load-deformation curves. To eliminate any possibility of the results being influenced by this judgment, all of the observed critical loads were established, and the observed critical stress was determined, before the critical stresses were computed by use of the theory.

Presentation of Data and Computations

The data obtained from the plywood tests and the results of computations are presented in tables 17 to 26 and in figures 117 through 126, 117 (with figure 127, 128, and 129 being used in computations) and 130 through 133.

In tables 17 through 26, column 1 gives the panel designation, and column 2 identifies the buckling test plates. Data pertaining to the buckling test are given in columns 3 through 7 and include width (a), length (b), and thickness (h) dimensions in columns 3, 4, and 5. The observed critical buckling stress given in column 6 and the effective ultimate stress tabulated in column 7 were computed from loads observed in test by the formula:

$$q = \frac{P}{h\sqrt{a^2 + b^2}} \qquad (1)$$

When P is the critical buckling load, q is the critical buckling stress; and when P is the maximum load, q is the effective ultimate stress, labeled F_s in this report.

Data from the shear strength test specimens (s1 and s2) matched with the buckling test plate are given in columns 8, 9, and 10. The thickness (t) is given in column 8, and the length of the sides (w) of the square test area is given in column 9. The maximum load (W_{ult}) attained during the test was used to compute the ultimate stress ($F_{s\theta}$) by the following formula:

$$F_{s\theta} = \frac{W_{ult}}{Wt\sqrt{2}} \qquad (2)$$

This ultimate stress is given in column 10.

The moduli of elasticity E_1 and E_2 were computed from bending tests of specimens D, E, F, and G by the formula:

$$E_1 \text{ or } E_2 = \frac{1}{48}\frac{PL^3}{DI} \qquad (3)$$

where P = load upon the centrally loaded coupon in pounds
L = length of span over which the coupon was tested in inches
D = deflection of the coupon at load P in inches
I = moment of inertia of the cross section of the coupon in inches.

The modulus E_1 results when the face grain of the coupon is parallel to the span, and the modulus E_2 when the face grain is perpendicular to the span. The load was kept sufficiently low so that the proportional limit would not be exceeded. The values obtained are tabulated in columns 11 and 12 of the tables. The ratio E_1 ($E_1 + E_2$) is given in column 13 of the tables.

The modulus of elasticity E_L in the direction of the grain of the wood used in making the plywood was computed from the formula:

$$E_L = \frac{20}{21}(E_1 + E_2) \qquad (4)$$

which results from the formula:

$$E_L + E_T = E_1 + E_2 \qquad (5)$$

if it be assumed that $E_T = \frac{1}{20} E_L$, and where E_T = modulus of elasticity of wood in the tangential direction. (See Forest Products Laboratory Report No. 1316-B, page 3.) This assumption is not greatly in error for this use.

The critical buckling stresses given in column 14 for simply supported edges and in column 15 for clamped edges were computed by formula (27) of Forest Products Laboratory Report No. 1316, which is:

$$q_{cr} = k_s E_L \frac{h^2}{a^2}$$

where E_L = the modulus of elasticity of the wood

h = the thickness of the plywood plate (col. 5)

a = the width of the plywood plate (col. 3)

k_s = a coefficient that depends on the plate and that was determined as follows:

From the data on static bending tests the ratio $\frac{E_1}{E_1 + E_2}$, which is given in column 13, was obtained. This ratio was used to enter the curves in figure 127 for clamped edges and in figure 129 for simply supported edges and to obtain the proper values of $k_{s\infty}$ - the coefficient for infinitely long plates subjected to shear. These coefficients then were corrected for the finite plate, as follows:

Again the ratio $\frac{E_1}{E_1 + E_2}$ was used -- this time to enter the curves in figure 128 for clamped edges and in figure 130 for simply supported edges and to obtain the corresponding value of $\frac{b'}{a}$, i.e., the ratio of the theoretical buckle length in an infinitely long plate to the width of the plate.

The length-width ratio $\frac{b}{a}$ for each plate tested was then divided by the two values of $\frac{b'}{a}$ to obtain the ratio of $\frac{b}{b'}$ for each edge condition. These ratios of $\frac{b}{b'}$ were then used to obtain the ratio of $\frac{k_{s\infty}}{k_s}$ for each edge condition by application of the proper curve from figure 131 when the face grain was at 0° or 90°, or from figure 132 when the face grain was at ±45°. By taking the reciprocals and multiplying by the $k_{s\infty}$ for each edge condition a value of k_s for simply supported edges and a value of k_s for clamped edges were determined. The two values of q_{cr}, one for simply supported edges and one for clamped edges, were then easily computed by the formula.

Ratios of the critical buckling stresses to the shear strength (col.10) were computed by using the observed stress (col. 6), the stress for simply supported edges (col. 14), and the stress for clamped edges (col. 15), and were tabulated in columns 16, 17, and 18, respectively.

The ratio $\frac{a}{a_o}$ given in column 19 is a nondimensional parameter of panel width obtained by the formula:

$$\frac{a}{a_o} = \sqrt{\frac{F_{s\theta}}{q_{cr\ obs}}}$$ (Eq. (3) of Forest Products Laboratory Report No. 1316-I.)

The values tabulated in column 19 were obtained by taking the square root of the reciprocal of the values of $\frac{q_{cr\ obs}}{F_{s\theta}}$ given in column 16.

The ratio of the effective ultimate stress of the plates tested for buckling to the ultimate stress of the matched coupons tested in shear is given in column 20.

For comparison of the stresses computed for simply supported edges and the observed stresses figures 117A through 126A were prepared, with the values of $\frac{q_{cr}}{F_{s\theta}}$ (simply supported) from column 17 of the tables plotted as abscissas and the values of $\frac{q_{cr\ (observed)}}{F_{s\theta}}$ from column 16 as ordinates.

For comparison of the stresses computed for fixed edges and the observed stresses figures 117B through 126B were prepared in a similar manner.

An empirical curve obtained from a composite plotting of all tests with $\frac{a}{a_o}$ from column 19 for the abscissas and $\frac{F_s}{F_{s\theta}}$ from column 20 for the ordinates is given in figure 133. From this curve the effective ultimate shearing stress of flat plywood plates can be estimated for design purposes.

The data obtained from tests of frame members are presented in tables 17a through 26a.

The plate specimen from which the frame members were cut is identified in column 1 of these tables, and the number of the frame members tested for each plate is shown in column 2. Columns 3, 4, and 5 show, respectively, the span, width, and depth of the member at test. Width includes the thickness of the plywood and two thicknesses of the material forming the frame. The value of EI computed for each member is given in column 6, and the average value of EI for the two long sides of the frame, or all sides tested in the case of square plates, is given in column 7. In column 8 is the ratio of the critical stress observed during the test of the plate to the critical stress computed for simply supported edges obtained from tables 17 through 26 by dividing column 6 by column 14.

Discussion of Results

Critical Buckling Stresses

The critical buckling stresses obtained by test are compared with those computed by means of the theory presented in Forest Products Laboratory Reports Nos. 1316 and 1316-B and with additional theoretical results. The following equation, number (21) of report 1316, was used:

$$q_{cr} = k_s E_L \frac{h^2}{a^2}$$

in which E_L = modulus of elasticity in the direction of the grain of the wood of which the plywood is made

h = thickness of the plywood

a = smaller dimension of the plywood plate

b = larger dimension of the plywood plate

k_s = a coefficient, the value of which depends upon the construction of the plywood and the ratio $\frac{b}{a}$

The procedure was to find that value of k_s, that is $k_{s\infty}$, that applies to infinitely long panels and then to adjust this value to apply to panels of finite length by means of curves obtained from various mathematical analyses. The values of $k_{s\infty}$ were obtained from the curves plotted in figures 127 to 129, inclusive, as previously described. These figures were plotted from the original mathematical data obtained in connection with Report No. 1316-B. The adjustment of $k_{s\infty}$ to k_s was made by means of the curves of figures 131 and 132, which were obtained from various mathematical investigations. For plywood having its face grain parallel to one of the edges and the edges simply supported, the work of E. Seydel was used, from which the curve of figure 12 of Report No. 1316 was obtained and replotted in figure 132 of the present report. When the edges of these panels were clamped, the work of R. C. T. Smith[6] was used. A curve obtained from Smith's report was also plotted in figure 132. The cusp in the curve was used in the computations in the present report, although the smooth dashed curve, which is only slightly in error, could have been used. For panels having their face grain directions at 45° to their edges, formulas derived by Green and Hearmon[7] were used. The determinants in these formulas were expanded and solved to obtain the group of curves drawn in figure 131. The use of these curves has been previously described.

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[6] R. C. T. Smith. "Buckling of Plywood Plates in Shear." Australian Council for Scientific and Industrial Research - Division of Aeronautics. Report SM51.

[7] A. E. Green and R. F. S. Hearmon. "The Buckling of Flat Rectangular Plywood Plates." Philosophical Magazine. 1945 Ser. 7, vol. xxxvi, pp. 659-688.

In figures 117A to 126A and 117B to 126B, inclusive, values of the observed critical stresses are plotted against computed values, with both values divided by the appropriate strength of the plywood. In general, the observed values of critical stress are greater than the computed values for plates with simply supported edges, and are less than those computed for plates with clamped edges when the computed stresses are less than the proportional-limit stress. The straight line shown in each figure is extended from 0 over the range in which the computed critical buckling stress is less than the approximate proportional-limit stress in shear. If the computed critical buckling stresses are corrected by factors equal to the slopes of these lines, the observed stresses are approximately obtained. For each grain direction two such factors were obtained; one to apply to computed stresses when assuming edges are simply supported, and the other to computed stresses when assuming the edges are clamped. An average factor was obtained for each grain direction and for each of the two methods of computation. These factors are as follows:

θ	Simply supported edges	Clamped edges
0°	1.06	0.64
90°	1.14	.74
-45°	1.00	.66
+45°	1.30	.84

The factors applying to computations based on simply supported edges are substantially unity, with the exception of the one applying to a face-grain direction of +45°. It is indicated, therefore, that the plates tested were more nearly simply supported than clamped.

The data showing the effect of the supporting frames on the critical buckling stresses are presented in tables 17a through 26a. Analysis of these data indicated that the stiffness of the frames, over the limited range studied, had no consistent effect on the observed critical buckling stresses.

Effective Ultimate Stresses

The effective ultimate stress of plywood plates and the shear strength of the plywood were both obtained in this study. When buckling occurs in a plate subjected to shear before it fails, the average or effective ultimate stress (F_s) is lower than the ultimate stress ($F_{s\theta}$) attained when the plate fails without buckling.

From the formula for the critical buckling stress it is obvious that from a given material a plate can be made sufficiently narrow to buckle at the same stress at which failure occurs. This particular width, labeled a_o, is obtained by using the strength for the critical stress and solving for a_o. Thus:

$$a_o^2 = \frac{k_s E_L h^2}{F_{s\theta}}$$

Similarly, the width of a particular plate may be expressed in terms of the observed critical load. Thus:

$$a^2 = \frac{k_s E_L h^2}{q_{cr\ obs}}$$

The ratio of the width of a finite plate of a given material to the width that will cause buckling to occur at failure is:

$\frac{a}{a_o}$ which, from the above equations, equals $\sqrt{\frac{F_{s\theta}}{q_{cr\ obs}}}$

The ratio $\frac{a}{a_o}$ obtained by taking the above square root of observed stresses is therefore a nondimensional parameter of panel width that does not depend on the edge or end conditions of the plate except as they enter the shear-test data.

The general curve in figure 133 with $\frac{a}{a_o}$ for abscissas and $\frac{F_s}{F_{s\infty}}$ for ordinates fitted separate plots of the data for each panel size and grain direction. The lightweight lines indicate the area in which the plots of individual tests were scattered. Of course, most of the plots were bunched along the curve. The broken line shows, for comparison, the curve resulting when the abscissas are the reciprocals of the ordinates.

The general curve shown in figure 133 may be used as follows to obtain the effective ultimate stress that a plate will carry if the strength and elastic properties of the material in the plate are known. First solve for (a_o) in the formula for the critical buckling stress by using the shear strength as the critical buckling stress. Then with the dimension (a) of the plate, obtain the ratio $(\frac{a}{a_o})$. Enter the curve at this value of $(\frac{a}{a_o})$ and read the corresponding value of $\frac{F_s}{F_{s\theta}}$. Multiply this ratio by the shear strength of the material $(F_{s\theta})$, and the result will be the effective ultimate stress for the plate.

If (a_o) is computed by assuming simply supported edges, the value will be smaller than for any other edge condition because the ratio $\frac{a}{a_o}$ is larger than for any other edge condition and the reading of $\frac{F_s}{F_{s\theta}}$ from the curve is a minimum for the plate.

Conclusions

The mathematical analysis given in Forest Products Laboratory Report No. 1316 gives buckling stresses due to shear that are in reasonable agreement with experimental results if the edge fixities of the plates are taken into account. The use of computations based on plates with simply supported edges leads to slightly conservative results.

The ultimate effective stress can be obtained from figure 133 with sufficient accuracy for design purposes if the edge fixity of the plate is estimated. This curve will give conservative values if the edges of the plates are assumed to be simply supported.

Appendix

Method of Test for Ultimate Shear Stress of Plywood Plates

A standard test for determining the ultimate shear stress of plywood had not been established when this series of tests was performed. A tentative method that had given consistent results at the Forest Products Laboratory was followed.

The coupon for test was shaped as shown in figure 108, coupons S1 and S2. The detail at the corner of the coupon was the same as that shown for the buckling test specimen in figure 109. The diameter of the pin was 1/4 inch, "A" was 1/4 inch, "B" was 5/16 inch, and the diameter of the roller was 3/4 inch for all the coupons.

Dimensions of the coupons were such that the square area would not buckle before failure occurred and that the area glued to the blocks would be sufficient to transmit the forces between the blocks and the plywood without failure. Thickness of the plywood ranged from about 1/16 inch to 1/4 inch, and the side of the square ranged from 1-1/4 inches to 4-1/2 inches, depending on the direction of stress and the thickness of the plywood.

Hardwood blocks 1/16 inch shorter than the sides of the square were located on the plywood coupons by the use of a jig and were glued to the plywood with a cold-setting urea-resin glue. Pressure was applied to the glued parts by wood clamps for at least 15 hours. After the glue was set, the coupon was completed for test by drilling 1/4-inch-diameter holes with the specimen held in a jig.

In setting up the apparatus for test, 1/4-inch-diameter pins and 3/4-inch-diameter rollers were assembled on the coupon, and two steel wedge-shaped heads with surfaces at 45° to the vertical were centered in a hydraulic testing machine. The specimen was then placed between the heads as shown in figure 139. A load of 10 pounds was maintained on the specimen while the alinement and bearing between the parts in the set-up were checked.

The load was then increased until the specimen failed, and a maximum load was obtained. Failures occurred either in shear parallel to the sides of the square or in compression or tension along the diagonals of the square, depending upon the construction of the plywood and the relative strengths in shear, compression, and tension.

The ultimate shear stress was computed from the maximum load by formula (2) as follows:

$$F_{s\theta} = \frac{W_{ult}}{Wt\sqrt{2}}$$

where $F_{s\theta}$ = ultimate shear stress

W_{ult} = ultimate load, regardless of type of failure

t = thickness of plywood

w = length of one side of square.

This method assumes that the effect of the loading pins located 1/4 inch outside the edge of the square is the same as if the pins were centered at the edge of the square.

Two coupons were tested for each 2- by 6-foot panel, and the average ultimate stress was used for the computation of the effective widths of buckled plates. The data on these tests of coupons are given in tables 17 through 26 in columns 8, 9, and 10.

Test of Frame Members

Frame members were tested in static bending, as illustrated in figure 140, to determine the stiffness of the frames in the plane of the plywood. Ends were supported on 1-inch roller plates centered 1 inch from each end on the smoothed surfaces. The distance between the laterally adjustable knife-edge supports was recorded as the span. Load was applied at the center through a curved wooden loading block. Deformation in inches was obtained from a dial reading to 0.001 inch that was mounted on the supporting base and bore on the plywood between the solid-wood components of the frame. Load-deflection curves were plotted, and the slope was used to compute the value of EI by the formula:

$$EI = \frac{1}{48}\frac{PL^3}{D}$$

where P = load in pounds

L = span in inches

D = deflection in inches

Table 16.--Plywood constructions and species

Construction No.	Construction Type	Ply thickness	Species
4	1:1:1	1/48	Yellow-poplar
5		1/20	Do.
6		1/16	Do.
7	1:1:1	1/48	Sitka spruce
8		1/20	Do.
9		1/16	Do.
16	1:1:1:1:1	1/48	Yellow-poplar
17		1/20	Do.
18		1/16	Do.
19	1:1:1:1:1	1/48	Sitka spruce
20		1/20	Do.
21		1/16	Do.
40	1:2:1	1/48	Yellow-poplar
41		1/20	Do.
42		1/16	Do.
43	1:2:1	1/48	Sitka spruce
44		1/20	Do.
45		1/16	Do.

Table 17.--Test data and computed values for shear buckling test specimens and coupons. Test specimens 10 by 20 inches with face grain at 0° (parallel to width of panel)

Panel No.	Buckling test specimens: Specimen No.	Width a	Length b	Thickness h	Buckling stress observed q_{cr} obs.	Ultimate stress F_s	Shear coupons: Thickness	Length of side	Ultimate stress $F_{s\theta}$	Bending coupons: Modulus of elasticity E_1	E_2	Factors and results of computations: Ratio $\frac{E_1}{E_1 + E_2}$	Edge conditions: Simply supported q_{cr} ss	Clamped q_{cr} cl	As tested $\frac{q_{cr} \text{ obs.}}{F_{s\theta}}$	Simply supported $\frac{q_{cr} \text{ ss}}{F_{s\theta}}$	Clamped $\frac{q_{cr} \text{ cl}}{F_{s\theta}}$	Parameter of width $\frac{a}{a_o}$	Effective stress $\frac{F_s}{F_{s\theta}}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
		In.	In.	In.	Lb. per sq. in.	Lb. per sq. in.	In.	In.	Lb. per sq. in.	1,000 lb. per sq. in.	1,000 lb. per sq. in.		Lb. per sq. in.	Lb. per sq. in.					
4xf	1	10.00	20.00	0.06358	316.5	791	0.127	2.99	1,876	1,506.6	115.0	0.9291	129.9	231.1	0.1687	0.0692	0.123	2.435	0.4216
	2	10.00	20.00	.06358	211.0	712	.128	2.98	1,876	1,506.6	115.0	.9291	129.9	230.8	.1125	.0692	.123	2.982	.2795
5xd	1	10.02	20.04	.134	999.2	1,299	.135	2.98	1,627	1,834.0	129.6	.9340	692.0	1,227.1	.6141	.4253	.754	1.276	.7984
	2	10.03	20.08	.138	937.0	1,199	.133	3.02	1,627	1,834.0	129.6	.9340	731.7	1,298.9	.5759	.4497	.798	1.318	.7369
6xg	1	10.03	20.04	.177	1,309.9	1,452	.168	3.01	1,193	1,516.8	108.0	.9335	997.5	1,769.0	1.0980	.8361	1.483	.954	1.2171
7xf	1	10.00	20.00	.04833	277.6	601	.097	2.99	2,472	1,870.5	198.6	.9040	98.5	176.8	.1123	.0398	.072	2.983	.2431
	2	10.00	20.00	.04833	231.3	569	.095	2.98	2,472	1,870.5	198.6	.9040	98.5	176.8	.0936	.0398	.072	3.269	.2302
9xg	1	10.04	20.06	.177	805.3	862	.168	3.00	1,256	1,417.7	150.1	.9043	993.1	1,779.2	.6412	.7907	1.416	1.249	.6863
16xg	1	10.04	20.07	.104	685.3	1,358	.208	4.49	2,110	1,701.8	455.6	.7888	501.1	917.1	.3248	.2375	.435	1.755	.6436
	2	10.04	20.06	.104	642.4	1,349	.204	4.48	2,110	1,701.8	455.6	.7888	501.1	917.1	.3045	.2375	.435	1.811	.6393
19xd	1	10.02	20.05	.082	408.2	1,265	.167	4.50	2,244	1,544.4	607.6	.7177	310.8	574.4	.1819	.1385	.256	2.345	.5637
	2	10.02	20.03	.081	385.7	1,314	.173	4.51	2,244	1,544.4	607.6	.7177	303.2	560.5	.1719	.1351	.250	2.412	.5856
40xf	1	10.00	20.00	.07592	382.9	1,069	.153	4.51	2,310	1,546.4	291.8	.8413	226.3	411.9	.1658	.0980	.178	2.456	.4628
	2	10.00	20.00	.07592	530.2	998	.164	4.50	2,310	1,546.4	291.8	.8413	226.3	411.9	.2295	.0980	.178	2.088	.4320
43xf	1	10.00	20.00	.06192	252.8	888	.123	2.99	2,292	1,875.2	293.5	.8647	175.1	317.4	.1103	.0764	.138	3.012	.3874
	2	10.00	20.00	.06192	325.0	809	.130	2.99	2,292	1,875.2	293.5	.8647	175.1	317.4	.1418	.0764	.138	2.655	.3530
44xf	2	10.02	20.03	.181	1,282.2	1,436	.183	4.50	1,456	1,658.7	359.0	.8221	1,414.6	2,578.6	.8806	.9716	1.771	1.066	.9863
5xf	1	10.01	20.03	.135	926.6	1,301	.137	2.98	1,268	1,682.6	137.2	.9246	659.1	1,174.4	.7308	.5198	.926	1.170	1.0260
	2	10.01	20.02	.135	893.5	1,291	.136	3.00	1,268	1,682.6	137.2	.9246	659.1	1,175.5	.7047	.5198	.926	1.191	1.0181
8xg	2	10.01	20.02	.133	806.2	1,414	.132	3.00	1,784	1,719.8	178.5	.9060	682.4	1,220.6	.4519	.3825	.684	1.487	.7926
9xf	1	10.00	20.00	.168	1,118.0	1,139	.166	2.99	1,401	1,587.8	132.6	.9229	969.3	1,727.1	.7980	.6919	1.233	1.120	.8130
16xf	1	10.01	19.99	.102	744.6	1,358	.094	4.50	2,290	1,738.8	615.2	.7387	528.9	974.1	.3252	.2310	.425	1.752	.5930
	2	10.02	20.01	.095	563.8	1,327	.097	4.50	2,290	1,738.8	615.2	.7387	457.9	843.2	.2462	.2000	.368	2.015	.5795
19xg	1	9.99	20.02	.081	525.0	1,161	.158	4.48	2,432	1,690.2	701.8	.7066	338.2	625.9	.2159	.1391	.257	2.152	.4774
	2	10.01	20.01	.079	480.7	1,227	.161	4.48	2,432	1,690.2	701.8	.7066	320.7	593.5	.1977	.1319	.244	2.249	.5045
5xe	2	10.00	20.02	.137	914.0	1,172	.133	2.98	1,662	1,832.6	136.8	.9305	731.5	1,299.2	.5499	.4401	.7817	1.349	.7052
8xe	2	10.01	20.03	.138	841.7	1,405	.134	3.00	1,712	1,867.2	183.3	.9106	789.5	1,407.9	.4916	.4612	.8224	1.426	.8207
16xd	2	10.00	20.01	.098	570.4	1,314	.105	2.99	1,901	1,548.3	441.0	.7783	414.1	758.3	.3001	.2178	.3989	1.825	.6912
19xe	2	10.01	20.02	.085	473.0	1,080	.168	4.47	2,444	1,795.2	644.0	.7360	380.4	700.4	.1935	.1556	.2866	2.274	.4419

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Table 18.--Test data and computed values for shear buckling test specimens and coupons. Test specimens 10 by 30 inches with face grain at 0° (parallel to width of panel)

Panel No.	Buckling test specimens						Shear coupons			Bending coupons		Factors and results of computations							
	Speci-men No.	Width	Length	Thick-ness	Buckling stress observed	Ultimate stress	Thick-ness	Length of side	Ultimate stress	Modulus of elasticity		Ratio	Edge conditions					Parameter of width	Effective stress
													Simply supported	Clamped	As tested	Simply sup-ported	Clamped		
		a	b	h	$q_{cr\ obs.}$	F_s			$F_{s\theta}$	E_1	E_2	$\frac{E_1}{E_1+E_2}$	$q_{cr\ ss}$	$q_{cr\ cl}$	$\frac{q_{cr\ obs.}}{F_{s\theta}}$	$\frac{q_{cr\ ss}}{F_{s\theta}}$	$\frac{q_{cr\ cl}}{F_{s\theta}}$	$\frac{a}{a_o}$	$\frac{F_s}{F_{s\theta}}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
		In.	In.	In.	Lb. per sq. in.	Lb. per sq. in.	In.	In.	Lb. per sq. in.	1,000 lb. per sq. in.	1,000 lb. per sq. in.		Lb. per sq. in.	Lb. per sq. in.					
4xg	1	10.00	30.00	0.06192	229.8	631	0.126	2.99	1,902	1,665.4	96.7	0.9451	131.3	226.5	0.1208	0.0690	0.1191	2.878	0.3318
	2	10.00	30.00	.06192	178.7	592	.125	2.98	1,902	1,665.4	96.7	.9451	131.3	226.5	.0940	.0690	.1191	3.262	.3113
20xg	1	10.02	30.07	.22150	1,496.0	1,713	.218	4.52	1,788	1,632.2	474.8	.7747	2,148.5	3,860.9	.8367	1.2016	2.1594	1.095	.9581
40xg	2	10.00	30.00	.07442	297.4	970	.148	4.49	2,136	1,794.0	189.1	.9046	221.8	389.8	.1392	.1038	.1824	2.680	.4541
43xg	1	10.00	30.00	.0550	241.5	791	.112	2.98	2,708	1,741.6	331.2	.8402	130.4	232.5	.0892	.0482	.0859	3.349	.2921
	2	10.00	30.00	.0550	230.0	819	.114	2.98	2,708	1,741.6	331 2	.8402	130.4	232.5	.0849	.0482	.0859	3.430	.3024
8xg	1	10.02	30.01	.132	717.3	1,320	.131	3.00	1,784	1,719.8	178.5	.9060	664.5	1,167.1	.4021	.3725	.6542	1.575	.7399
9xf	2	10.01	30.01	.167	1,002.6	1,135	.164	3.01	1,401	1,587.8	132.6	.9229	951.3	1,662.8	.7156	.6790	1.1869	1.183	.8101
41xf	1	10.02	30.03	.183	1,241.7	1,368	.182	4.52	1,649	1,503.0	321.2	.8239	1,270.2	2,264.6	.7530	.7703	1.3733	1.153	.8296
	2	10.03	30.02	.183	1,102.6	1,309	.180	4.49	1,649	1,503.0	321.2	.8239	1,267.7	2,264.5	.6686	.7688	1.3733	1.225	.7938
44xd	1	10.02	30.01	.178	1,276.6	1,330	.178	4.51	1,698	1,756.6	360.1	.8299	1,392.6	2,484.2	.7518	.8201	1.4630	1.153	.7833
	2	9.99	30.02	.180	1,266.2	1,407	.178	4.52	1,698	1,756.6	360.1	.8299	1,432.6	2,555.7	.7457	.8437	1.5051	1.158	.8286
4xe	1	9.98	30.00	.063	150.9	619	.128	2.98	1,996	1,827.6	153.4	.9226	156.9	274.5	.0756	.0786	.1376	3.640	.3101
5xe	1	10.005	30.03	.136	557.8	1,069	.133	3.00	1,662	1,832.6	136.8	.9305	718.1	1,250.0	.3356	.4321	.7521	1.726	.6432
8xe	1	10.00	30.03	.138	641.6	1,331	.132	2.99	1,712	1,867.2	183.3	.9106	784.7	1,377.3	.3748	.4584	.8045	1.633	.7775
16xd	1	10.01	30.03	.106	447.0	1,311	.100	2.99	1,901	1,548.3	441.0	.7783	465.7	836.4	.2351	.2450	.4400	2.061	.6896
19xe	1	9.97	30.02	.087	328.1	1,187	.165	4.47	2,444	1,795.2	644.0	.7360	384.4	694.5	.1342	.1573	.2842	2.728	.4857
40xd	1	9.99	29.99	.077	349.4	1,176	.148	3.02	2,402	1,882.4	300.2	.8625	267.9	476.1	.1455	.1115	.1982	2.620	.4896
40xe	1	9.98	30.01	.076	312.7	1,099	.148	3.03	2,514	1,948.0	321.0	.8585	272.2	484.1	.1244	.1083	.1926	2.833	.4372
	2	10.02	30.02	.075	315.6	1,037	.154	3.02	2,514	1,948.0	321.0	.8585	263.0	467.8	.1255	.1046	.1861	2.823	.4125
41be	1	9.95	29.98	.198	963.1	1,252	.196	4.48	1,408	1,651.5	309.0	.8424	1,614.0	2,873.9	.6840	1.1463	2.0411	1.209	.8892
41xd	1	9.99	29.99	.181	1,049.3	....	.178	4.53	1,661	1,529.7	290.0	.8406	1,241.9	2,215.8	.6317	.7477	1.3340	1.257	....
	2	10.03	30.00	.178	1,417.0	1,594	.179	4.52	1,661	1,529.7	290.0	.8406	1,191.5	2,125.9	.8531	.7173	1.2799	1.082	.9597
41xe	1	10.00	30.00	.182	1,320.5	1,498	.177	4.52	1,546	1,643.0	337.4	.8296	1,367.6	2,439.6	.8541	.8846	1.5780	1.082	.9690
43xd	1	9.98	30.06	.062	153.3	1,099	.123	3.00	2,729	1,878.2	464.5	.8017	188.9	338.2	.0562	.0692	.1239	4.225	.4027
	2	10.03	30.02	.061	283.7	851	.119	3.02	2,729	1,878.2	464.5	.8017	180.3	322.8	.1040	.0661	.1183	3.100	.3118
43xe	1	9.99	30.04	.064	222.6	989	.124	3.02	2,615	1,892.8	464.6	.8029	202.2	361.8	.0851	.0773	.1384	3.430	.3782
	2	10.01	30.03	.061	233.0	839	.121	3.02	2,615	1,892.8	464.6	.8029	182.9	327.4	.0891	.0699	.1252	3.351	.3208
44xe	2	10.04	30.02	.176	1,431.7	1,555	.176	4.53	1,698	1,674.0	372.4	.8180	1,313.4	2,343.8	.8432	.7735	1.3803	1.089	.9146

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Table 19.--Test data and computed values for shear buckling test specimens and coupons. Test specimens 10 by 20 inches with face grain at 90° (parallel to length of panel)

Panel No.	Buckling test specimens: Specimen No.	Buckling test specimens: Width a	Buckling test specimens: Length b	Buckling test specimens: Thickness h	Buckling test specimens: Buckling stress observed q_{cr} obs.	Buckling test specimens: Ultimate stress F_s	Shear coupons: Thickness	Shear coupons: Length of side	Shear coupons: Ultimate stress $F_{s\theta}$	Bending coupons: Modulus of elasticity E_1	Bending coupons: Modulus of elasticity E_2	Factors and results of computations: Ratio $\frac{E_1}{E_1 + E_2}$	Edge conditions: Simply supported $q_{cr\ ss}$	Edge conditions: Clamped $q_{cr\ cl}$	Edge conditions: As tested $\frac{q_{cr\ obs.}}{F_{s\theta}}$	Edge conditions: Simply supported $\frac{q_{cr\ ss}}{F_{s\theta}}$	Edge conditions: Clamped $\frac{q_{cr\ cl}}{F_{s\theta}}$	Parameter of width $\frac{a}{a_o}$	Effective stress $\frac{F_s}{F_{s\theta}}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
		In.	In.	In.	Lb. per sq. in.	Lb. per sq. in.	In.	In.	Lb. per sq. in.	1,000 lb. per sq. in.	1,000 lb. per sq. in.		Lb. per sq. in.	Lb. per sq. in.					
4xb	1	10.00	20.00	0.060	93.2	524	0.121	2.99	1,940	1,646.4	125.7	0.9291	52.1	94.7	0.0480	0.0269	0.0488	4.563	0.2701
	2	10.00	20.00	.061	73.3	574	.120	2.99	1,940	1,646.4	125.7	.9291	53.8	97.9	.0378	.0277	.0504	5.145	.2959
6xc	1	10.05	20.07	.169	645.1	1,033	.170	2.99	1,298	1,843.6	130.0	.9341	444.3	813.2	.4970	.3423	.6265	1.417	.7958
7xb	1	10.00	20.00	.048	139.8	475	.096	2.99	2,104	1,782.7	172.4	.9118	40.4	72.9	.0664	.0192	.0347	3.881	.2258
	2	10.00	20.00	.050	67.1	411	.099	2.99	2,104	1,782.7	172.4	.9118	43.8	79.1	.0319	.0208	.0376	5.599	.1953
43xb	2	10.00	20.00	.065	137.6	798	.130	2.98	2,240	1,596.6	325.8	.8305	96.0	177.6	.0614	.0429	.0793	4.035	.3562
5xa	1	10.00	20.01	.136	361.7	977	.137	2.99	1,572	1,603.8	137.6	.9210	275.2	501.4	.2301	.1751	.3190	2.083	.6215
6xb	1	10.01	20.01	.172	623.4	961	.174	2.99	1,265	1,785.8	125.2	.9345	448.2	820.8	.4928	.3543	.6489	1.425	.7597
	2	10.01	20.02	.170	683.3	1,025	.175	2.98	1,265	1,785.8	125.2	.9345	437.8	801.8	.5402	.3461	.6338	1.360	.8103
9xb	1	9.99	19.99	.170	579.3	974	.170	2.99	1,252	1,617.6	162.4	.9088	463.9	843.3	.4627	.3705	.6736	1.464	.7780
	2	10.03	20.00	.169	580.4	889	.170	3.00	1,252	1,617.6	162.4	.9088	455.8	829.0	.4636	.3641	.6621	1.466	.7101
44xc	1	9.99	20.01	.185	1,064.7	1,534	.183	4.51	1,674	1,683.9	375.0	.8179	862.8	1,594.9	.6360	.5154	.9527	1.253	.9164
	2	10.03	20.01	.183	1,072.1	1,523	.184	4.50	1,674	1,683.9	375.0	.8179	839.5	1,550.5	.6404	.5015	.9262	1.249	.9098
6oa	1	....	....	....	....	....	.179	4.49	2,307	2,035.3	139.8	.9357	....	....	....	....	....	....	....
	2	9.97	19.99	.181	619.6	1,105	.180	2.50	2,307	2,035.3	139.8	.9357	563.3	1,032.9	.2686	.2442	.4477	1.929	.4790
7xv	1	....	....	....	....	....	.102	2.98	2,098	2,207.8	202.9	.9158	....	....	....	....	....	....	....
	2	9.97	20.03	.057	157.4	425	.113	2.96	2,098	2,207.8	202.9	.9158	68.8	124.6	.0750	.0328	.0594	3.654	.2026
9xc	1	....	....	....	....	....	.172	2.98	1,254	1,494.6	111.0	.9309	....	....	....	....	....	....	....
	2	9.93	20.00	.173	468.6	846	.171	2.98	1,254	1,494.6	111.0	.9309	393.1	716.7	.3737	.3135	.5715	1.635	.6746
16xc	1	....	....	....	....	....	.104	2.98	2,174	1,550.7	557.6	.7355	....	....	....	....	....	....	....
	2	10.00	20.02	.106	464.1	1,141	.103	2.99	2,174	1,550.7	557.6	.7355	346.5	657.1	.2135	.1594	.3022	2.162	.5248

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Table 20.--Test data and computed values for shear buckling test specimens and coupons. Test specimens 10 by 30 inches with face grain at 90° (parallel to length of panel)

Panel No.	Buckling test specimens: Specimen No.	Width	Length	Thickness	Buckling stress observed	Ultimate stress	Shear coupons: Thickness	Length of side	Ultimate stress	Bending coupons: Modulus of elasticity		Ratio $\frac{E_1}{E_1 + E_2}$	Factors and results of computations: Edge conditions: Simply supported	Clamped	As tested	Simply supported	Clamped	Parameter of width	Effective stress
		a	b	h	$q_{cr\ obs.}$	F_s			$F_{s\theta}$	E_1	E_2		$q_{cr\ ss}$	$q_{cr\ cl}$	$\frac{q_{cr\ obs.}}{F_{s\theta}}$	$\frac{q_{cr\ ss}}{F_{s\theta}}$	$\frac{q_{cr\ cl}}{F_{s\theta}}$	$\frac{a}{a_o}$	$\frac{F_s}{F_{s\theta}}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
		In.	In.	In.	Lb. per sq. in.	Lb. per sq. in.	In.	In.	Lb. per sq. in.	1,000 lb. per sq. in.	1,000 lb. per sq. in.		Lb. per sq. in.	Lb. per sq. in.					
4xa	1	10.02	30.01	0.060	184.1	479	0.126	2.98	1,880	1,631.4	113.1	0.9352	38.8	71.2	0.0979	0.0206	0.0379	3.198	0.2548
	2	9.99	30.00	.061	238.7	437	.127	2.98	1,880	1,631.4	113.1	.9352	40.4	74.1	.1270	.0215	.0394	2.808	.2324
4xc	1	10.00	30.00	.063	75.3	402	.127	2.98	1,902	1,604.3	115.3	.9329	43.0	79.3	.0396	.0226	.0417	5.025	.2114
	2	10.00	30.00	.062	63.8	290	.124	2.99	1,902	1,604.3	115.3	.9329	41.6	76.8	.0335	.0219	.0404	5.450	.1525
5xb	2	10.01	30.00	.133	427.5	836	.135	2.98	1,515	1,737.2	108.3	.9413	193.3	350.0	.2822	.1276	.2310	1.883	.5518
6xe	1	9.99	30.01	.171	647.9	973	.178	2.98	1,308	1,643.9	117.6	.9332	323.9	594.5	.4953	.2476	.4545	1.422	.7439
	2	9.96	30.01	.177	681.6	942	.174	2.98	1,308	1,643.9	117.6	.9332	349.1	640.4	.5211	.2669	.4896	1.385	.7202
7xa	1	10.01	29.99	.049	103.2	383	.094	2.99	2,198	2,141.4	156.0	.9321	35.0	64.5	.0470	.0159	.0293	4.621	.1742
	2	10.00	29.99	.050	151.8	376	.098	2.98	2,198	2,141.4	156.0	.9321	36.5	67.1	.0691	.0166	.0305	3.802	.1711
7xc	1	10.00	30.00	.050	79.1	412	.101	2.97	1,974	1,754.6	167.0	.9131	34.4	65.0	.0401	.0174	.0329	4.997	.2087
	2	10.00	30.00	.051	93.0	372	.101	2.97	1,974	1,754.6	167.0	.9131	35.7	67.6	.0471	.0181	.0342	4.615	.1884
8xa	1	9.99	30.00	.135	515.8	1,077	.135	2.98	1,582	1,528.3	168.8	.9005	238.5	451.3	.3260	.1508	.2853	1.732	.6808
	2	10.00	30.00	.137	507.8	956	.135	2.98	1,582	1,528.3	168.8	.9005	245.4	463.8	.3210	.1551	.2932	1.765	.6043
9xa	1	10.01	30.00	.175	577.7	930	.173	2.98	1,055	1,223.9	135.6	.9003	320.2	607.5	.5476	.3035	.5759	1.351	.8815
	2	10.00	30.01	.176	575.0	948	.174	2.97	1,055	1,223.9	135.6	.9003	324.1	615.7	.5450	.3072	.5836	1.354	.8986
16xa	1	9.98	30.01	.100	538.7	1,209	.205	4.50	2,212	1,540.0	500.2	.7548	258.9	480.5	.2435	.1170	.2172	2.026	.5466
	2	9.98	30.01	.102	621.3	1,171	.103	2.99	2,212	1,540.0	500.2	.7548	269.3	500.0	.2809	.1217	.2260	1.886	.5294
19xa	1	9.99	30.00	.083	400.4	994	.151	4.51	2,484	1,837.8	530.6	.7760	197.0	365.1	.1612	.0793	.1470	2.492	.4002
	2	9.99	30.01	.083	419.5	927	.156	4.48	2,484	1,837.8	530.6	.7760	197.0	365.1	.1689	.0793	.1470	2.432	.3732
40xa	1	10.00	30.00	.080	336.0	763	.162	4.48	2,202	1,331.0	333.2	.7998	120.2	225.0	.1526	.0546	.1022	2.560	.3465
	2	10.01	30.01	.082	366.0	813	.155	4.48	2,202	1,331.0	333.2	.7998	126.0	236.0	.1662	.0572	.1072	2.452	.3692
40xc	1	10.00	30.00	.086	193.0	590	.172	2.98	2,008	1,325.8	228.0	.8533	109.1	205.8	.0961	.0543	.1025	3.229	.2938
	2	10.00	30.00	.087	218.1	676	.174	4.48	2,008	1,325.8	228.0	.8533	111.7	210.5	.1086	.0556	.1048	3.035	.3367
43xa	1	10.01	30.01	.068	371.7	790	.129	2.99	2,304	2,039.8	307.2	.8691	96.7	182.2	.1613	.0420	.0791	2.490	.3429
	2	10.00	30.00	.067	283.2	743	.129	2.98	2,304	2,039.8	307.2	.8691	93.9	177.3	.1229	.0408	.0769	2.852	.3225
43xc	1	10.00	30.00	.072	109.8	549	.145	2.98	1,976	1,756.8	263.0	.8698	93.3	175.6	.0556	.0472	.0889	4.240	.2778
	2	10.00	30.00	.070	135.5	548	.139	2.98	1,976	1,756.8	263.0	.8698	88.2	166.0	.0686	.0446	.0840	3.815	.2773
44xa	1	10.00	30.01	.185	1,128.2	1,451	.181	4.48	1,668	1,276.4	339.1	.7901	641.9	1,196.5	.6764	.3848	.7173	1.213	.8699
	2	10.02	30.01	.185	1,160.0	1,460	.180	4.48	1,668	1,276.4	339.1	.7901	639.3	1,191.7	.6954	.3833	.7144	1.198	.8753
5xa	2	10.01	30.01	.133	261.3	898	.137	2.99	1,572	1,603.8	137.6	.9210	210.5	393.6	.1662	.1339	.2504	2.453	.5712
17xc	2	10.00	30.02	.224	1,270.6	1,299	.223	4.49	1,637	1,594.0	450.1	.7798	1,222.0	2,272.0	.7762	.7465	1.3879	1.133	.7935
20xc	1	10.01	30.01	.228	1,086.3	1,171	.231	4.51	1,624	1,447.3	544.2	.7267	1,388.4	2,571.2	.6689	.8549	1.5832	1.223	.7211
	2	10.00	30.02	.231	1,040.4	1,244	.228	4.50	1,624	1,447.3	544.2	.7267	1,427.1	2,644.5	.6406	.8788	1.6284	1.249	.7660
42xc	1	9.99	30.01	.242	837.1	1,150	.245	4.50	1,308	1,734.2	290.7	.8564	1,114.7	2,097.5	.6400	.8522	1.6036	1.250	.8792
	2	10.01	30.01	.242	887.7	1,110	.244	4.50	1,308	1,734.2	290.7	.8564	1,111.4	2,090.1	.6787	.8497	1.5980	1.214	.8486
5xs	1	10.01	30.02	.139	215.9	697	.137	4.53	1,366	1,249.4	113.0	.9171	184.1	345.6	.1581	.1348	.2530	2.515	.5102
	2	10.04	30.06	.138	296.7	813	.139	4.53	1,366	1,249.4	113.0	.9171	180.4	339.6	.2172	.1321	.2486	2.147	.5952
5xt	1	9.97	30.01	.140	249.2	720	.135	4.53	1,492	1,195.5	114.4	.9127	185.2	350.0	.1670	.1241	.2346	2.447	.4826
	2	10.00	30.00	.138	309.4	779	.143	4.52	1,492	1,195.5	114.4	.9127	179.1	338.1	.2074	.1200	.2266	2.196	.5221
6ca	1	9.98	29.98	.191	530.9	969	.179	4.49	2,307	2,035.3	139.8	.9357	490.9	897.3	.2301	.2128	.3889	2.085	.4200
7xv	1	9.98	29.98	.054	80.4	364	.102	2.98	2,098	2,207.8	202.9	.9158	49.7	93.4	.0383	.0237	.0445	5.120	.1735
8aa	1	9.95	30.00	.135	282.5	904	.136	3.01	1,575	1,889.8	190.7	.9083	281.6	531.9	.1794	.1788	.3377	2.360	.5740
	2	10.01	30.04	.135	514.8	1,041	.135	3.02	1,575	1,889.8	190.7	.9083	278.2	525.5	.3269	.1766	.3337	1.749	.6610
8xb	1	9.98	30.01	.138	344.4	886	.142	3.01	1,476	1,706.2	167.4	.9107	260.3	490.4	.2333	.1764	.3322	2.071	.6003
	2	10.05	30.02	.138	456.0	993	.140	3.02	1,476	1,706.2	167.4	.9107	257.4	483.9	.3089	.1744	.3278	1.800	.6728
9xc	1	9.97	30.00	.189	369.2	668	.172	2.98	1,254	1,494.6	111.0	.9509	369.3	679.2	.2944	.2945	.5417	1.843	.5327
16xc	1	9.98	29.97	.105	362.1	1,022	.104	2.98	2,174	1,550.7	557.6	.7355	308.1	569.6	.1666	.1417	.2620	2.452	.4701
19xc	1	9.96	30.02	.084	226.8	852	.168	4.48	2,316	1,792.7	517.6	.7760	197.5	366.7	.0979	.0853	.1583	3.198	.3679
43bb	1	9.96	30.01	.069	92.0	791	.143	3.03	2,176	1,869.8	401.1	.8234	114.7	214.9	.0423	.0527	.0988	4.863	.3635
	2	9.98	30.05	.065	292.5	692	.135	3.03	2,176	1,869.8	401.1	.8234	101.4	190.0	.1344	.0466	.0873	2.728	.3180
43v	1	9.97	30.01	.081	215.4	940	.161	3.03	2,560	1,844.4	481.0	.7932	176.6	329.2	.0841	.0690	.1286	3.442	.3672
	2	10.03	30.02	.081	194.6	930	.159	3.03	2,560	1,844.4	481.0	.7932	174.6	325.6	.0760	.0682	.1272	3.628	.3633
44aa	1	9.98	30.02	.178	818.9	1,353	.176	4.53	1,698	1,631.2	367.0	.8163	684.1	1,278.3	.4823	.4029	.7528	1.440	.7968
	2	10.03	30.02	.176	1,074.8	1,408	.177	4.53	1,698	1,631.2	367.0	.8163	662.7	1,237.3	.6330	.3903	.7585	1.257	.8292
44xb	1	9.99	30.00	.181	909.4	1,324	.185	4.53	1,673	1,555.8	385.5	.8014	715.6	1,337.2	.5436	.4277	.7993	1.358	.7914
	2	10.02	30.03	.180	1,157.2	1,490	.185	4.52	1,673	1,555.8	385.5	.8014	704.1	1,315.6	.6917	.4209	.7864	1.203	.8906
45xb	1	9.945	30.015	.241	897.2	1,069	.227	4.51	1,301	1,362.7	273.5	.8328	980.1	1,834.9	.6896	.7533	1.4104	1.204	.8217

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Table 21.--Test data and computed values for shear buckling test specimens and coupons. Test specimens 10 by 20 inches with face grain at 45° (parallel to compression diagonal)

Panel No.	Buckling test specimens: Specimen No.	Width a	Length b	Thickness h	Buckling stress observed q_{cr} obs.	Ultimate stress F_s	Shear coupons: Thickness	Length of side	Ultimate stress $F_{s\theta}$	Bending coupons: Modulus of elasticity E_1	E_2	Factors and results of computations: Ratio $\frac{E_1}{E_1+E_2}$	Edge conditions: Simply supported q_{cr} ss	Clamped q_{cr} cl	As tested $\frac{q_{cr} \text{ obs.}}{F_{s\theta}}$	Simply supported $\frac{q_{cr} \text{ ss}}{F_{s\theta}}$	Clamped $\frac{q_{cr} \text{ cl}}{F_{s\theta}}$	Parameter of width $\frac{a}{a_o}$	Effective stress $\frac{F_s}{F_{s\theta}}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
		In.	In.	In.	Lb. per sq. in.	Lb. per sq. in.	In.	In.	Lb. per sq. in.	1,000 lb. per sq. in.	1,000 lb. per sq. in.		Lb. per sq. in.	Lb. per sq. in.					
4xh	1	10.00	20.00	0.063	390.4	1,036	0.126	2.00	2,930	1,937.2	140.0	0.9326	351.3	546.4	0.1332	0.1199	0.1865	2.740	0.3536
	2	10.00	20.00	.063	390.4	1,075	.126	1.99	2,930	1,937.2	140.0	.9326	351.3	546.4	.1332	.1199	.1865	2.740	.3669
7xh	1	10.00	20.00	.050	357.8	1,068	.103	1.98	3,400	2,356.4	164.7	.9347	269.1	419.2	.1052	.0791	.1233	3.083	.3141
	2	10.00	20.00	.051	306.9	949	.098	1.99	3,400	2,356.4	164.7	.9347	280.0	436.2	.0903	.0824	.1283	3.328	.2791
8xk	1	10.01	20.04	.133	940.6	2,257	.130	2.02	3,440	2,011.9	175.3	.9199	1,621.7	2,530.4	.2734	.4714	.7356	1.912	.6561
	2	10.03	20.04	.136	1,049.1	2,242	.129	2.01	3,440	2,011.9	175.3	.9199	1,691.6	2,635.3	.3050	.4917	.7661	1.811	.6517
9xn	1	10.05	20.06	.178	1,600.0	2,360	.171	2.49	2,938	1,453.5	142.4	.9108	2,085.5	3,256.5	.5446	.7098	1.1084	1.356	.8033
16xk	2	10.02	20.06	.102	809.5	1,816	.101	2.01	3,838	1,335.4	549.8	.7084	646.4	1,024.4	.2109	.1684	.2669	2.177	.4732
19xj	1	10.05	20.05	.084	529.7	1,473	.168	2.48	3,669	1,646.3	616.8	.7275	536.5	848.9	.1444	.1462	.2314	2.632	.4015
40xh	1	10.00	20.00	.081	690.1	1,264	.163	2.48	3,160	1,707.4	298.6	.8511	515.1	807.1	.2184	.1630	.2554	2.140	.4000
43xh	1	10.00	20.00	.070	383.3	926	.139	2.00	2,756	1,753.9	344.5	.8358	395.8	620.3	.1391	.1436	.2251	2.681	.3360
	2	10.00	20.00	.070	383.3	1,054	.136	2.00	2,756	1,753.9	344.5	.8358	395.8	620.3	.1391	.1436	.2251	2.681	.3824
8xl	1	10.05	20.04	.135	1,384.4	2,284	.134	1.98	3,356	2,074.6	238.4	.8969	1,716.0	2,682.7	.4125	.5113	.7994	1.556	.6806
	2	10.02	20.04	.133	1,342.3	2,366	.134	1.99	3,356	2,074.6	238.4	.8969	1,675.5	2,615.1	.4000	.4993	.7792	1.581	.7050
9xl	1	10.04	20.01	.169	1,686.8	2,355	.165	2.48	3,060	1,610.2	171.3	.9038	2,089.8	3,265.2	.5512	.6829	1.0671	1.346	.7696
	2	10.03	20.00	.166	1,611.6	2,227	.167	2.50	3,060	1,610.2	171.3	.9038	2,020.2	3,156.5	.5267	.6602	1.0315	1.378	.7278
16xn	1	10.03	20.03	.104	900.3	2,036	.102	1.98	4,568	1,561.4	504.8	.7557	779.6	1,231.3	.1971	.1707	.2695	2.252	.4457
	2	10.02	20.00	.102	875.1	1,987	.103	1.99	4,568	1,561.4	504.8	.7557	751.4	1,186.8	.1916	.1645	.2598	2.285	.4350
4da	2	10.00	20.02	.068	164.4	796	.130	1.98	2,600	1,191.8	123.8	.9059	252.2	393.2	.0632	.0970	.1512	3.978	.3062
5xm	2	9.97	19.99	.135	1,462.0	2,027	.135	1.97	3,652	2,056.4	140.8	.9359	1,719.7	2,678.1	.4003	.4709	.7333	1.581	.5550
6da	2	9.97	20.02	.183	2,255.1	2,356	.183	2.49	2,604	1,945.0	145.3	.9305	2,985.4	4,656.1	.866	1.1465	1.7881	1.075	.9048
9xk	2	10.01	19.99	.169	1,479.7	1,897	.173	2.48	2,248	1,488.4	132.8	.9181	1,941.7	3,023.5	.6582	.8637	1.3450	1.232	.8439
16da	2	9.98	19.97	.105	597.5	1,263	.106	1.97	2,244	1,032.0	378.8	.7315	532.0	841.8	.2663	.2371	.3751	1.936	.5628
20xk	2	9.99	20.00	.227	2,444.2	2,602	.226	2.46	2,404	1,427.8	443.4	.7630	3,417.4	5,393.8	1.0167	1.4215	2.2437	.992	1.0824
40da	2	9.98	19.99	.084	266.7	824	.166	2.52	2,015	1,121.7	240.0	.8237	366.2	574.6	.1324	.1817	.2852	2.748	.4089
44xj	2	9.99	20.00	.176	1,831.3	2,193	.178	2.47	2,402	1,764.0	377.6	.8237	2,523.3	3,959.7	.7624	1.0505	1.6485	1.145	.9130

Z M 85279 F

Table 22.--Test data and computed values for shear buckling test specimens and coupons. Test specimens 10 by 30 inches with face grain at 45° (parallel to compression diagonal)

Panel No.	Buckling test specimens: Speci-men No.	Width	Length	Thick-ness	Buckling stress observed	Ultimate stress	Shear coupons: Thick-ness	Length of side	Ultimate stress	Bending coupons: Modulus of elasticity		Factors and results of computations: Ratio	Edge conditions: Simply supported	Clamped	As tested	Simply sup-ported	Clamped	Parameter of width	Effective stress
		a	b	h	$q_{cr\ obs.}$	F_s			$F_{s\theta}$	E_1	E_2	$\frac{E_1}{E_1+E_2}$	$q_{cr\ ss}$	$q_{cr\ cl}$	$\frac{q_{cr\ obs.}}{F_{s\theta}}$	$\frac{q_{cr\ ss}}{F_{s\theta}}$	$\frac{q_{cr\ cl}}{F_{s\theta}}$	$\frac{a}{a_o}$	$\frac{F_s}{F_{s\theta}}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
		In.	In.	In.	Lb. per sq. in	Lb. per sq. in.	In.	In.	Lb. per sq. in.	1,000 lb. per sq. in.	1,000 lb. per sq. in.		Lb. per sq. in.	Lb. per sq. in.					
4xj	1	10.00	30.00	0.063	376.5	721	0.124	1.99	3,734	1,703.1	127.6	0.9303	272.2	432.1	0.1008	0.0720	0.1157	3.150	0.1931
	2	10.00	30.00	.061	414.7	1,004	.121	1.99	3,734	1,703.1	127.6	.9303	255.2	405.1	.1111	.0685	.1085	3.000	.2689
4xk	1	10.00	30.00	.064	321.1	972	.128	2.00	3,496	1,716.2	122.4	.9334	283.0	449.8	.0918	.0809	.1287	3.300	.2780
	2	10.00	30.00	.064	333.5	956	.127	2.00	3,496	1,716.2	122.4	.9334	283.0	449.8	.0954	.0809	.1287	3.238	.2735
7xj	1	10.00	30.00	.049	258.1	797	.095	1.99	3,914	2,0698	186.9	.9172	200.5	318.7	.0659	.0512	.0814	3.895	.2036
	2	10.00	30.00	.051	248.0	785	.098	1.98	3,914	2,0698	186.9	.9172	217.2	345.2	.0634	.0555	.0882	3.972	.2006
7xk	1	10.00	30.00	.049	364.6	794	.096	1.99	3,974	1,818.8	167.4	.9157	176.4	280.0	.0917	.0444	.0705	3.301	.1998
	2	10.00	30.00	.049	354.9	703	.095	1.99	3,974	1,818.8	167.4	.9157	176.4	280.0	.0893	.0444	.0705	3.346	.1769
20xj	1	....	....	....	....	....	.211	2.50	2,968	1,494.0	475.3	.7586	....	....	....	....	....	....	....
	2	10.03	30.07	.214	2,475.1	2,908	.211	2.49	2,968	1,494.0	475.3	.7586	2,814.9	4,523.3	.8339	.9484	1.5240	1.095	.9798
40xj	1	10.00	30.00	.083	571.5	1,056	.166	2.50	3,490	1,337.4	272.8	.8306	376.3	601.7	.1638	.1078	.1724	2.470	.2968
40xk	1	10.00	30.00	.084	489.4	1,095	.168	2.53	2,580	1,374.8	314.4	.8139	397.4	636.4	.1897	.1540	.2467	2.296	.4244
	2	10.00	30.00	.084	527.0	1,062	.167	2.52	2,580	1,374.8	314.4	.8139	397.4	636.4	.2043	.1540	.2467	2.212	.4116
41xj	1	10.03	30.07	.18125	2,174.3	2,505	.181	2.48	3,489	1,697.4	298.8	.8503	2,257.8	3,604.4	.6232	.6471	1.0331	1.267	.7180
	2	10.03	30.05	.182	1,940.2	2,425	.181	2.48	3,489	1,697.4	298.8	.8503	2,276.6	3,634.3	.5561	.6525	1.0416	1.341	.6950
43xj	1	10.00	30.00	.066	431.2	882	.134	2.50	2,868	1,702.4	364.4	.8237	303.3	485.5	.1503	.1058	.1693	2.579	.3075
	2	10.00	30.00	.066	431.2	871	.133	2.52	2,868	1,702.4	364.4	.8237	303.3	485.5	.1503	.1058	.1693	2.579	.3037
43xk	1	10.00	30.00	.064	370.6	875	.138	2.51	2,934	1,747.4	387.8	.8184	292.9	468.9	.1263	.0998	.1598	2.814	.2982
	2	10.00	30.00	.064	395.3	850	.127	2.52	2,934	1,747.4	387.8	.8184	292.9	468.9	.1347	.0998	.1598	2.724	.2897
44xk	1	10.03	30.05	.1795	1,844.3	2,094	.178	2.48	3,104	1,623.3	365.0	.8164	2,127.5	3,405.4	.5942	.6854	1.0971	1.297	.6746
	2	10.03	30.06	.1780	1,859.8	2,216	.175	2.49	3,104	1,623.3	365.0	.8164	2,092.1	3,348.7	.5992	.6740	1.0788	1.292	.7139
45xk	1	10.03	30.04	.226	2,232.1	2,436	.224	2.48	2,824	1,397.9	302.6	.8221	2,902.5	4,644.8	.7904	1.0278	1.6448	1.124	.8626
6xl	1	10.00	30.04	.180	1,721.7	2,108	.178	2.50	2,954	1,714.8	136.0	.9265	2,238.8	3,556.3	.5828	.7579	1.2039	1.311	.7136
	2	10.06	30.00	.180	2,095.6	2,165	.178	2.50	2,954	1,714.8	136.0	.9265	2,214.4	3,514.1	.7094	.7496	1.1896	1.187	.7329
9xm	1	10.01	30.01	.168	1,730.0	2,076	.166	2.49	3,172	1,706.4	139.6	.9244	1,938.3	3,078.3	.5454	.6111	.9705	1.354	.6545
	2	10.03	30.01	.170	1,854.6	2,070	.167	2.52	3,172	1,706.4	139.6	.9244	1,976.8	3,139.4	.5847	.6232	.9897	1.307	.6526
16xh	1	10.00	30.00	.106	855.3	1,689	.106	1.98	3,697	1,650.6	493.3	.7699	766.0	1,229.9	.2259	.2072	.3327	2.103	.4569
	2	10.01	30.00	.108	877.5	1,676	.104	1.98	3,697	1,650.6	493.3	.7699	793.6	1,274.3	.2374	.2147	.3447	2.052	.4533
41xm	1	10.04	30.06	.181	2,436.2	2,732	.177	2.50	3,565	1,706.0	299.9	.8505	2,259.4	3,613.5	.6834	.6338	1.0136	1.210	.7663
	2	10.02	30.02	.183	2,483.4	2,621	.178	2.49	3,565	1,706.0	299.9	.8505	2,318.8	3,702.2	.6966	.6504	1.0385	1.198	.7352
44xl	1	10.01	30.03	.180	1,965.7	2,447	.178	2.47	2,792	1,676.9	380.4	.8151	2,219.3	3,554.8	.7040	.7949	1.2732	1.192	.8764
4da	1	9.98	30.01	.062	204.4	680	.131	1.98	2,600	1,191.8	123.8	.9059	185.9	295.3	.0786	.0715	.1136	3.567	.2615
5xm	1	9.96	30.01	.137	1,436.9	1,789	.136	1.97	3,652	2,056.4	140.8	.9359	1,564.7	2,484.0	.3935	.4285	.6802	1.594	.4899
6da	1	10.00	30.03	.183	2,211.9	2,367	.182	2.51	2,604	1,945.0	145.3	.9305	2,623.5	4,163.5	.8494	1.0075	1.5989	1.085	.9090
8xh	1	9.98	30.00	.139	1,094.2	1,509	.134	1.98	3,491	1,971.0	171.4	.9200	1,542.1	2,448.1	.3134	.4417	.7013	1.786	.4323
9xk	1	9.94	30.00	.178	1,357.7	1,565	.168	2.47	2,248	1,488.4	132.8	.9181	1,924.6	3,057.4	.6040	.8561	1.3601	1.286	.6962
16da	1	10.01	30.02	.106	655.7	1,143	.105	1.97	2,244	1,032.0	378.8	.7315	480.8	773.2	.2922	.2143	.3446	1.850	.5094
20xk	1	9.94	30.02	.230	2,214.2	2,317	.225	2.49	2,404	1,427.8	443.4	.7630	3,153.5	5,064.6	.9210	1.3118	2.1067	1.042	.9638
40da	1	10.00	30.01	.085	372.0	830	.169	2.51	2,015	1,121.7	240.0	.8257	331.5	530.0	.1846	.1645	.2630	2.327	.4119
41xk	1	10.00	30.00	.180	1,669.0	2,020	.179	2.51	2,418	1,548.1	283.6	.8452	2,045.0	3,267.5	.6902	.8457	1.3513	1.204	.8354
	2	10.02	30.01	.178	2,056.7	2,184	.178	2.52	2,418	1,548.1	283.6	.8452	1,991.8	3,188.1	.8506	.8237	1.3185	1.084	.9032
41xl	1	9.98	29.99	.179	1,699.4	1,919	.182	2.52	2,708	1,560.0	271.5	.8518	2,043.7	3,260.2	.6275	.7547	1.2039	1.261	.7086
	2	10.00	30.02	.179	2,332.0	2,438	.180	2.53	2,708	1,560.0	271.5	.8518	2,035.5	3,252.7	.8612	.7517	1.2011	1.077	.9005
44xj	1	9.96	30.02	.182	1,675.6	1,833	.177	2.47	2,402	1,764.0	377.6	.8237	2,407.5	3,852.0	.6976	1.0023	1.6037	1.197	.7631

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Table 23.--Test data and computed values for shear buckling test specimens and coupons. Test specimens square with face grain at -45° (parallel to compression diagonal)

Panel No.	Specimen No.	Buckling test specimens: Width	Length	Thickness	Buckling stress observed	Ultimate stress	Shear coupons: Thickness	Length of side	Ultimate stress	Bending coupons: Modulus of elasticity		Ratio	Factors and results of computations: Edge conditions: Simply supported	Clamped	As tested	Simply supported	Clamped	Parameter of width	Effective stress
		a	b	h	q_{cr} obs.	F_s			$F_{s\theta}$	E_1	E_2	$\frac{E_1}{E_1 + E_2}$	$q_{cr\ ss}$	$q_{cr\ cl}$	$\frac{q_{cr\ obs.}}{F_{s\theta}}$	$\frac{q_{cr\ ss}}{F_{s\theta}}$	$\frac{q_{cr\ cl}}{F_{s\theta}}$	$\frac{a}{a_o}$	$\frac{F_s}{F_{s\theta}}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
		In.	In.	In.	Lb. per sq. in.	Lb. per sq. in.	In.	In.	Lb. per sq. in.	1,000 lb. per sq. in.	1,000 lb. per sq. in.		Lb. per sq. in.	Lb. per sq. in.					
5ka	v1	18.76	18.77	0.144	732.9	1,732	0.149	2.00	2,728	1,978.4	138.5	0.9346	856.8	1,289.0	0.2687	0.3141	0.4725	1.929	0.6347
	v2	18.76	18.76	.146	671.2	1,669	.149	2.00					880.9	1,327.9	.2460	.3229	.4868	2.016	.6118
4ka	v1	18.29	18.25	.063	104.3	340	.121	2.00	1,753	1,304.0	135.4	.9059	113.6	171.5	.0595	.0648	.0978	4.100	.1940
4kd	v1	18.29	18.29	.062	112.2	683	.128	1.98	1,535	1,353.0	123.7	.9162	114.0	172.0	.0731	.0743	.1121	3.700	.4452
	v2	18.27	18.27	.062	156.1	687							114.3	172.4	.1017	.0745	.1123	3.136	.4474
4ke	v1	18.28	18.28	.061	158.5	687	.126	1.98	1,638	1,334.4	122.3	.9160	109.0	164.4	.0968	.0665	.1004	3.217	.4197
	v2	18.28	18.28	.062	163.5	704							112.5	169.7	.1029	.0687	.1036	3.116	.4297
5kc	v1	18.80	18.80	.147	639.7	1,791	.147	1.98	3,148	1,741.0	111.6	.9398	782.8	1,179.9	.2032	.2487	.3748	2.218	.5690
	v2	18.78	18.78	.146	618.9	1,857	.146	2.00					773.8	1,166.3	.1966	.2458	.3705	2.256	.5898
4a	v1	6.97	6.98	.063	732.2	1,471	.128	2.00	1,712	1,063.5	110.7	.9057	634.4	959.4	.4277	.3706	.5604	1.528	.8592
	v2	7.98	7.99	.063	583.3	1,162	.128	1.98	1,897	1,277.2	83.0	.9390	584.5	879.3	.3075	.3081	.4635	1.803	.6125
	v3	8.98	8.99	.064	405.8	1,103	.130	2.00	1,591	1,200.7	95.5	.9263	447.1	674.3	.2551	.2810	.4238	1.980	.6933
	v4	9.97	9.98	.063	436.6	979	.121	2.00	1,870	1,064.3	106.3	.9092	310.6	470.0	.2335	.1661	.2513	2.069	.5235
	v5	11.01	11.00	.062	342.0	976	.125	2.00	1,739	1,137.9	112.3	.9102	264.8	399.9	.1967	.1523	.2300	2.255	.5612
4b	v1	10.02	10.02	.062	295.9	990	.123	1.98	1,684	1,230.7	106.1	.9206	346.0	521.5	.1757	.2055	.3097	2.387	.5879
	v2	10.02	10.04	.062	318.4	1,055	.128	1.99	1,624	1,272.7	79.9	.9409	357.5	538.0	.1961	.2201	.3313	2.258	.6496
	v3	10.00	9.99	.062	479.2	1,170	.126	1.99	1,776	1,390.1	127.9	.9157	392.8	591.3	.2698	.2212	.3329	1.925	.6588
	v4	10.00	10.00	.062	593.1	992	.124	1.99	1,948	1,207.3	86.2	.9334	341.2	513.5	.3045	.1752	.2636	1.812	.5092
	v5	10.03	10.01	.063	492.9	1,104	.128	1.99	1,985	1,588.8	99.6	.9410	461.7	694.6	.2483	.2326	.3499	2.006	.5562
40a	v1	7.99	7.98	.084	1,180.7	1,471	.083	1.99	1,669	1,260.4	220.2	.8513	1,016.4	1,537.7	.7074	.6090	.9213	1.188	.8814
	v2	8.98	8.99	.084	1,011.8	1,383	.080	1.99	2,176	1,193.7	236.7	.8345	758.4	1,149.7	.4650	.3485	.5284	1.466	.6356
	v3	9.99	10.00	.089	744.0	1,318	.083	1.99	1,926	1,338.5	218.8	.8595	775.2	1,167.1	.3863	.4025	.6060	1.608	.6843
	v4	11.00	10.98	.086	628.4	1,115	.080	1.99	2,176	1,262.0	217.5	.8530	563.7	852.0	.2888	.2591	.3915	1.860	.5124
	v5	12.01	11.98	.083	426.1	1,121	.184	2.00	1,969	1,347.9	258.5	.8391	470.0	711.7	.2164	.2387	.3615	2.149	.5693
40b	v1	9.99	10.01	.084	538.7	1,197	.083	1.99	1,969	1,782.9	269.8	.8686	918.1	1,390.2	.2736	.4663	.7060	1.912	.6079
	v2	10.01	10.00	.084	599.1	1,267	.082	1.98	2,243	1,875.3	247.3	.8835	966.6	1,461.8	.2671	.4309	.6517	1.934	.5649
	v3	10.02	9.99	.085	756.6	1,347	.085	1.98	1,722	1,956.7	270.0	.8787	1,031.6	1,560.4	.4394	.5991	.9062	1.509	.7822
	v4	9.97	9.98	.084	768.0	1,134	.080	1.98	1,964	2,011.2	273.9	.8801	1,041.5	1,575.7	.3910	.5303	.8023	1.598	.5774
	v5	10.01	10.01	.084	1,042.8	1,266	.083	2.00	2,151	1,897.1	275.9	.8730	976.0	1,477.0	.4848	.4537	.6867	1.436	.5886
16a	v1	9.01	8.99	.103	1,026.0	1,716	.106	1.98	1,381	1,017.2	360.9	.7381	960.7	1,464.1	.7429	.6957	1.0602	1.160	1.2426
	v2	9.98	9.97	.106	909.5	1,592	.106	1.99	2,095	1,109.0	337.4	.7667	905.0	1,375.1	.4341	.4320	.6564	1.516	.7599
	v4	12.00	12.01	.103	600.4	1,401	.102	2.00	1,819	1,129.3	375.5	.7505	599.9	914.7	.3301	.3298	.5029	1.738	.7702
	v5	13.00	12.99	.103	348.7	1,175	.105	1.99	2,115	956.5	308.0	.7564	434.9	660.2	.1649	.2056	.3122	2.461	.5556
16b	v2	10.02	10.00	.105	854.4	1,514	.106	2.00	1,534	1,276.7	379.1	.7710	1,017.4	1,544.0	.5570	.6632	1.0065	1.339	.9870
	v3	9.99	9.98	.103	1,168.8	1,602	.107	1.98	1,902	989.6	340.5	.7440	759.2	1,158.5	.6145	.3992	.6091	1.275	.8423
	v4	9.98	10.00	.104	966.4	1,395	.102	2.00	2,218	977.2	327.0	.7493	763.8	1,164.8	.4357	.3444	.5252	1.515	.6289
	v5	10.00	9.99	.102	936.3	1,509	.103	2.00	1,768	1,387.0	322.9	.8112	1,050.6	1,593.8	.5296	.5942	.9015	1.373	.8535

Z M 85283 F

Table 24.--Test data and computed values for shear buckling test specimens and coupons. Test specimens 10 by 20 inches with face grain at +45° (parallel to tension diagonal)

Panel No.	Buckling test specimens						Shear coupons			Bending coupons		Factors and results of computations							
	Specimen No.	Width	Length	Thickness	Buckling stress observed	Ultimate stress	Thickness	Length of side	Ultimate stress	Modulus of elasticity		Ratio	Edge conditions					Parameter of width	Effective stress
													Simply supported	Clamped	As tested	Simply supported	Clamped		
		a	b	h	q_{cr} obs.	F_s			$F_{s\theta}$	E_1	E_2	$\frac{E_1}{E_1 + E_2}$	$q_{cr\ ss}$	$q_{cr\ cl}$	$\frac{q_{cr}\ obs.}{F_{s\theta}}$	$\frac{q_{cr\ ss}}{F_{s\theta}}$	$\frac{q_{cr\ cl}}{F_{s\theta}}$	$\frac{a}{a_o}$	$\frac{F_s}{F_{s\theta}}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
		In.	In.	In.	Lb. per sq. in.	Lb. per sq. in.	In.	In.	Lb. per sq. in.	1,000 lb. per sq. in.	1,000 lb. per sq. in.		Lb. per sq. in.	Lb. per sq. in.					
20xh	1	10.08	20.05	0.226	1,727.5	2,083	0.223	2.49	2,446	1,423.7	540.7	0.7248	1,643.0	2,657.7	0.7063	0.6717	1.0865	1.190	0.8516
41xh	1	10.01	20.01	.180	943.2	1,584	.178	2.00	3,012	1,671.2	268.3	.8617	603.2	1,024.3	.3131	.2003	.3401	1.786	.5259
	2	9.99	20.01	.183	978.5	1,624	.181	1.99	3,012	1,671.2	268.3	.8617	625.4	1,063.0	.3249	.2076	.3529	1.754	.5392
44xh	1	10.05	20.01	.174	920.7	1,803	.171	2.00	3,238	2,031.6	383.6	.8412	772.9	1,303.8	.2843	.2387	.4027	1.874	.5568
	2	10.04	20.01	.169	843.4	1,819	.178	2.00	3,238	2,031.6	383.6	.8412	730.6	1,230.5	.2605	.2256	.3800	1.959	.5618
44xn	1	10.01	20.02	.172	831.2	1,631	.169	2.00	3,246	1,855.7	370.4	.8336	727.4	1,220.6	.2561	.2241	.3760	1.975	.5025
	2	10.05	20.04	.171	832.7	1,562	.169	2.01	3,246	1,855.7	370.4	.8336	713.8	1,197.5	.2565	.2199	.3689	1.973	.4812
45xl	1	10.01	20.02	.219	1,142.4	1,829	.229	2.50	2,158	1,465.8	333.2	.8148	1,034.1	1,724.6	.5294	.4792	.7992	1.374	.8475
5wd	2	9.94	20.01	.144	312.4	694	.137	1.49	2,094	1,485.8	109.0	.9317	202.4	350.6	.1492	.0967	.1674	2.713	.3314
8xj	2	9.94	19.97	.151	357.5	810	.136	1.48	2,234	1,980.1	169.8	.9210	326.0	565.6	.1600	.1459	.2532	2.500	.3626
17xj	2	10.00	20.00	.227	1,418.5	1,621	.225	2.48	2,485	1,402.6	398.0	.7790	1,281.3	2,115.5	.5708	.5156	.8513	1.323	.6523
40db	2	9.98	20.00	.087	154.5	603	.165	1.98	2,452	1,118.4	232.6	.8278	116.3	194.8	.0630	.0474	.0794	3.985	.2459
41da	2	9.98	20.02	.210	853.5	1,364	.198	1.97	2,889	1,543.8	214.5	.8780	681.4	1,163.4	.2954	.2359	.4027	1.840	.4721

Z M 85285 F

Table 25.--Test data and computed values for shear buckling test specimens and coupons. Test specimens 10 by 30 inches with face grain at +45° (parallel to tension diagonal)

Panel No.	Buckling test specimens						Shear coupons			Bending coupons		Factors and results of computations							
	Specimen No.	Width a	Length b	Thickness h	Buckling stress observed $q_{cr\ obs.}$	Ultimate stress F_s	Thickness	Length of side	Ultimate stress $F_{s\theta}$	Modulus of elasticity E_1	Modulus of elasticity E_2	Ratio $\frac{E_1}{E_1 + E_2}$	Edge conditions: Simply supported $q_{cr\ ss}$	Edge conditions: Clamped $q_{cr\ cl}$	Edge conditions: As tested $\frac{q_{cr\ obs.}}{F_{s\theta}}$	Edge conditions: Simply supported $\frac{q_{cr\ ss}}{F_{s\theta}}$	Edge conditions: Clamped $\frac{q_{cr\ cl}}{F_{s\theta}}$	Parameter of width $\frac{a}{a_o}$	Effective stress $\frac{F_s}{F_{s\theta}}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
		In.	In.	In.	Lb. per sq. in.	Lb. per sq. in.	In.	In.	Lb. per sq. in.	1,000 lb. per sq. in.	1,000 lb. per sq. in.		Lb. per sq. in.	Lb. per sq. in.					
4xl	2	10.00	30.05	0.065	133.8	427	0.125	1.50	2,752	1,803.4	135.4	0.9302	46.6	81.8	0.0486	0.0169	0.0297	4.535	0.1552
4xm	1	10.02	30.00	.061	77.6	383	.181	1.98	3,388	1,695.9	120.4	.9337	37.1	65.5	.0229	.0110	.0193	6.615	.1130
	2	10.00	30.01	.062	127.5	423	.187	1.98	3,388	1,695.9	120.4	.9337	38.4	67.9	.0376	.0113	.0200	5.160	.1249
5xl	1	10.00	30.01	.136	348.8	774	.132	1.48	2,446	1,713.4	124.0	.9325	189.7	333.4	.1426	.0776	.1363	2.649	.3164
	2	10.01	30.01	.135	374.4	790	.132	1.48	2,446	1,713.4	124.0	.9325	186.5	327.8	.1531	.0762	.1340	2.555	.3230
6xm	2	10.03	30.03	.1815	416.9	754	.179	1.99	2,623	1,626.6	121.5	.9305	324.9	570.8	.1589	.1239	.2176	2.508	.2875
7xl	1	10.00	30.01	.053	74.6	319	.095	1.47	2,471	1,974.6	166.2	.9224	36.3	63.7	.0302	.0147	.0258	5.760	.1291
	2	10.00	30.07	.051	124.0	388	.102	1.49	2,471	1,974.6	166.2	.9224	33.6	59.0	.0502	.0136	.0239	4.465	.1570
7xm	1	9.99	30.00	.049	161.5	375	.150	1.99	2,592	1,854.3	173.9	.9143	31.3	55.2	.0623	.0121	.0213	4.010	.1447
	2	10.00	29.99	.051	124.0	337	.154	2.00	2,592	1,854.3	173.9	.9143	33.9	59.8	.0478	.0131	.0231	4.572	.1300
8xm	1	10.00	30.01	.130	389.2	788	.130	1.51	2,616	1,687.8	163.0	.9119	205.3	358.7	.1488	.0785	.1371	2.592	.3012
	2	10.00	30.00	.135	374.8	837	.130	1.51	2,616	1,687.8	163.0	.9119	221.3	386.8	.1433	.0846	.1479	2.642	.3200
16xl	1	10.00	30.03	.101	501.0	1,099	.101	1.49	3,384	1,388.4	394.4	.7788	225.5	380.0	.1480	.0666	.1123	2.599	.3248
	2	10.00	30.05	.102	496.0	1,053	.103	1.48	3,384	1,388.4	394.4	.7788	230.0	387.6	.1466	.0680	.1145	2.612	.3112
16xm	1	9.96	29.99	.106	509.2	1,144	.105	1.49	3,191	1,393.4	515.0	.7301	313.5	520.0	.1596	.0982	.1630	2.503	.3585
	2	10.00	30.00	.106	537.0	1,171	.103	1.48	3,191	1,393.4	515.0	.7301	311.6	516.4	.1683	.0976	.1618	2.437	.3670
19xl	1	9.99	30.01	.082	[illegible]	826	.157	1.97	2,764	1,770.2	574.4	.7550	212.9	354.3	.1362	.0770	.1282	2.709	.2988
	2	10.00	30.01	.081	351.4	947	.159	1.98	2,764	1,770.2	574.4	.7550	207.3	345.0	.1271	.0750	.1248	2.805	.3426
20xj	1	10.06	30.05	.222	1,132.8	1,504	.213	2.47	3,038	1,494.0	475.3	.7586	1,276.8	2,128.1	.3729	.4203	.7005	1.637	.4951
40xm	1	10.02	30.08	.082	202.1	761	.165	1.99	3,218	1,533.6	164.9	.9029	78.9	138.2	.0628	.0245	.0429	3.995	.2365
	2	10.00	30.07	.082	192.8	777	.166	2.00	3,218	1,533.6	164.9	.9029	79.2	138.7	.0599	.0246	.0431	4.089	.2415
43xl	1	10.00	30.07	.062	191.3	636	.123	1.49	3,060	1,935.2	360.0	.8432	84.7	145.5	.0625	.0277	.0475	4.000	.2078
	2	10.04	30.00	.064	233.8	....	.126	1.50	3,060	1,935.2	360.0	.8432	89.5	153.9	.0764	.0292	.0503	3.620	....
43xm	1	10.02	30.00	.068	208.9	664	.131	1.48	2,912	1,791.0	297.5	.8576	85.9	148.6	.0717	.0295	.0510	3.733	.2280
	2	10.01	30.00	.069	228.9	659	.136	1.49	2,912	1,791.0	297.5	.8576	88.6	153.3	.0786	.0304	.0526	3.568	.2263
44xm	1	9.99	30.00	.175	904.4	1,606	.173	2.00	3,154	1,471.9	364.0	.8017	642.2	1,088.1	.2867	.2036	.3450	1.867	.5092
	2	10.00	30.02	.180	913.5	1,514	.174	2.00	3,154	1,471.9	364.0	.8017	678.1	1,148.9	.2896	.2150	.3643	1.857	.4800
17xh	1	10.06	30.02	.230	1,585.4	1,730	.223	2.49	3,463	1,271.9	446.7	.7401	1,268.8	2,108.1	.4578	.3664	.6087	1.477	.4996
	2	10.03	30.05	.226	1,618.3	1,888	.224	2.48	3,463	1,271.9	446.7	.7401	1,231.6	2,046.0	.4673	.3556	.5908	1.463	.5452
20xm	1	10.06	30.07	.223	1,691.5	1,787	.222	2.51	2,688	1,471.1	519.3	.7391	1,384.1	2,300.7	.6293	.5149	.8559	1.261	.6648
	2	10.01	30.02	.225	1,516.4	....	....	....	2,688	1,471.1	519.3	.7391	1,423.2	2,363.7	.5641	.5295	.8794	1.330	....
21xl	1	10.04	30.00	.281	1,614.1	1,825	.282	2.51	1,970	1,348.0	438.5	.7545	1,887.2	3,145.3	.8193	.9580	1.5966	1.105	.9264
42xm	1	10.02	30.09	.243	1,246.8	1,727	.243	2.48	2,422	1,544.6	281.7	.8458	1,020.9	1,751.3	.5148	.4215	.7231	1.395	.7130
	2	10.05	30.03	.244	1,289.6	1,829	.242	2.48	2,422	1,544.6	281.7	.8458	1,023.2	1,757.2	.5325	.4225	.7255	1.370	.7552
5wd	1	9.94	30.00	.142	224.0	614	.141	1.49	2,094	1,485.8	109.0	.9317	183.5	321.4	.1070	.0876	.1535	3.054	.2932
6xj	1	9.99	30.02	.184	447.3	1,001	.185	2.00	2,642	1,436.4	119.8	.9230	316.3	558.1	.1693	.1197	.2112	2.428	.3789
	2	10.08	30.04	.178	458.2	883	.188	2.02	2,642	1,436.4	119.8	.9230	290.7	513.5	.1734	.1100	.1944	2.400	.3342
6xk	1	9.99	30.01	.176	431.7	1,052	.178	2.00	2,688	1,693.2	130.6	.9284	327.3	573.1	.1606	.1218	.2132	2.492	.3914
	2	10.04	30.01	.176	501.1	921	.177	2.02	2,688	1,693.2	130.6	.9284	324.0	567.4	.1864	.1205	.2111	2.312	.3426
8xj	1	9.93	29.98	.154	310.2	761	.136	1.48	2,234	1,980.1	169.8	.9210	315.7	554.0	.1389	.1413	.2480	2.682	.3406
9xh	1	10.03	30.01	.167	377.6	952	.170	2.01	2,184	1,496.8	158.8	.9041	316.5	556.0	.1729	.1449	.2546	2.404	.4359
	2	10.01	30.00	.167	472.9	885	.172	2.00	2,184	1,496.8	158.8	.9041	317.7	557.8	.2165	.1455	.2554	2.148	.4052
9xj	1	9.98	30.01	.170	447.3	986	.173	2.01	2,298	1,391.0	167.6	.8925	335.5	584.5	.1946	.1460	.2544	2.265	.4291
	2	10.02	30.01	.168	526.0	977	.169	2.02	2,298	1,391.0	167.6	.8925	325.1	566.7	.2289	.1415	.2466	2.090	.4252
16db	1	10.03	30.02	.109	347.1	791	.107	1.49	2,266	1,078.0	318.6	.7719	210.2	353.1	.1532	.0928	.1558	2.553	.3491
17xj	1	11.095	30.015	.232	1,130.2	1,396	.228	2.48	2,485	1,402.6	398.0	.7790	996.5	1,671.3	.4548	.4010	.6726	1.483	.5618
19xk	1	9.97	30.00	.080	228.0	971	....	....	....	1,703.7	574.4	.7479	201.6	336.1	.0734	.0811	.1353	3.640	.3212
	2	10.02	30.03	.080	315.6	903	.160	2.01	3,023	1,703.7	574.4	.7479	199.8	333.0	.1044	.0661	.1102	3.091	.2987
19xm	1	9.98	30.03	.078	243.7	1,040	.167	2.02	3,051	1,859.4	547.8	.7724	186.4	313.8	.0799	.0611	.1029	3.539	.3409
	2	10.02	30.05	.079	279.6	883	.160	2.01	3,051	1,859.4	547.8	.7724	189.7	319.9	.0916	.0622	.1049	3.303	.2894
20xl	1	10.00	30.01	.227	1,448.8	1,867	.228	2.53	2,475	1,506.8	465.5	.7640	1,325.1	2,225.2	.5854	.5354	.8991	1.306	.7543
	2	10.00	30.04	.225	1,405.5	1,498	.228	2.52	2,475	1,506.8	465.5	.7640	1,301.8	2,183.4	.5679	.5260	.8822	1.327	.6053
20xm	1	10.01	29.99	.225	1,460.2	1,865	.224	2.53	2,327	1,598.6	504.8	.7600	1,407.8	2,354.1	.6275	.6050	1.0116	1.261	.8015
	2	10.00	30.01	.223	1,588.2	1,702	.224	2.53	2,327	1,598.6	504.8	.7600	1,384.7	2,315.1	.6825	.5951	.9949	1.209	.7314
40db	1	10.00	30.01	.090	149.3	534	.170	1.98	2,452	1,118.4	232.6	.8278	112.5	191.6	.0609	.0459	.0781	4.051	.2178
41da	1	9.98	29.96	.198	800.2	1,349	.197	1.97	2,889	1,543.8	214.5	.8780	556.3	965.0	.2770	.1926	.3340	1.899	.4669

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Table 26.--Test data and computed values for shear buckling test specimens and coupons. Test specimens square with face grain at +45° (parallel to tension diagonal)

Panel No.	Buckling test specimens: Specimen No.	Width	Length	Thickness	Buckling stress observed	Ultimate stress	Shear coupons: Thickness	Length of side	Ultimate stress	Bending coupons: Modulus of elasticity		Factors and results of computations: Ratio	Edge conditions: Simply supported	Clamped	As tested	Simply supported	Clamped	Parameter of width	Effective stress
		a	b	h	$q_{cr\ obs.}$	F_s			$F_{s\theta}$	E_1	E_2	$\frac{E_1}{E_1 + E_2}$	$q_{cr\ ss}$	$q_{cr\ cl}$	$\frac{q_{cr\ obs.}}{F_{s\theta}}$	$\frac{q_{cr\ ss}}{F_{s\theta}}$	$\frac{q_{cr\ cl}}{F_{s\theta}}$	$\frac{a}{a_o}$	$\frac{F_s}{F_{s\theta}}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
		In.	In.	In.	Lb. per sq. in.	Lb. per sq. in.	In.	In.	Lb. per sq. in.	1,000 lb. per sq. in.	1,000 lb. per sq. in.		Lb. per sq. in.	Lb. per sq. in.					
6ka	s1	8.38	8.36	0.177	953.4	1,573							614.1	1,024.8	0.3544	0.2283	0.3810	1.680	0.5848
	s2	8.37	8.37	.177	1,264.8	1,613							614.1	1,026.5	.4702	.2283	.3816	1.457	.5997
	s3	8.37	8.36	.177	1,288.7	1,728	0.179	2.00	2,690	1,614.6	120.6	0.9305	614.9	1,026.5	.4791	.2286	.3816	1.444	.6423
	s4	8.38	8.37	.179	1,131.4	1,758							627.4	1,047.3	.4206	.2332	.3893	1.542	.6536
	s5	18.43	18.42	.178	226.3	804							128.3	214.1	.0841	.0477	.0796	3.451	.2989
6kb	s1	18.41	18.42	.180	256.1	774	.182	2.01	2,154	1,581.2	118.4	.9303	129.1	215.6	.1189	.0599	.1001	2.900	.3591
	s3	8.36	8.34	.179	1,134.1	1,585							618.9	1,036.0	.5265	.2873	.4810	1.379	.7360
6kc	s2	18.44	18.42	.180	266.3	967	.180	2.00	2,344	1,485.2	149.9	.9083	149.1	250.6	.1136	.0636	.1069	2.966	.4126
	s3	8.37	8.36	.175	1,496.5	1,786							684.1	1,149.7	.6384	.2919	.4905	1.250	.7620
4ka	s2	12.77	12.76	.061	54.5	209	.122	2.01	2,336	1,304.0	135.4	.9059	32.1	54.1	.0233	.0137	.0232	6.544	.0894
4kd	s1	12.76	12.76	.063	140.7	369	.124	1.99	2,189	1,353.0	123.7	.9162	32.3	54.3	.0643	.0148	.0248	3.940	.1688
4ke	s1	12.74	12.74	.062	94.0	376	.126	1.98	2,097	1,334.4	122.3	.9160	31.0	52.2	.0448	.0148	.0249	4.725	.1793
40c	v1	6.98	6.97	.086	386.6	1,020	.086	2.00	1,747	1,172.8	331.6	.7796	457.2	736.9	.2213	.2617	.4218	2.122	.5839
	v2	7.97	7.98	.084	439.0	1,045	.086	2.00	1,726	1,262.8	277.8	.8197	284.1	465.0	.2543	.1646	.2694	1.982	.6054
	v3	9.02	8.98	.085	429.8	939	.085	2.00	1,788	897.5	304.0	.7470	245.1	392.4	.2404	.1371	.2195	2.039	.5252
	v4	9.98	10.00	.084	411.2	829	.081	2.00	1,680	1,020.7	242.0	.8083	156.7	254.6	.2448	.0933	.1515	2.020	.4935
	v5	11.01	11.00	.084	275.4	766	.084	1.99	1,607	1,214.8	342.6	.7800	180.9	292.2	.1714	.1126	.1818	2.414	.4767
40d	v1	10.00	10.00	.086	361.7	714	.084	2.00	2,294	1,286.6	214.8	.8569	151.2	250.1	.1577	.0659	.1090	2.518	.3112
	v2	10.01	10.00	.085	284.3	763	.086	1.98	1,453	1,347.1	228.3	.8551	156.3	257.5	.1957	.1076	.1772	2.259	.5251
	v3	10.01	9.98	.084	269.5	844	.085	2.00	1,456	1,207.1	231.9	.8388	153.3	251.1	.1851	.1053	.1725	2.322	.5797
	v4	9.98	9.98	.083	437.1	855	.085	2.00	2,287	1,133.0	256.8	.8152	163.5	265.7	.1911	.0715	.1162	2.287	.3739
	v5	9.99	10.00	.083	477.3	951	.083	1.99	1,841	1,264.3	281.8	.8177	179.2	292.0	.2593	.0973	.1586	1.964	.5166
5a	v1	7.98	7.97	.148	838.7	1,429	.148	2.00	2,209	1,642.0	223.8	.8801	757.3	1,252.4	.3797	.3428	.5670	1.623	.6469
	v2	9.00	8.97	.144	833.4	1,487	.147	1.98	2,757	2,011.4	194.0	.9120	529.1	884.5	.3023	.1919	.3208	1.817	.5394
	v3	10.00	10.00	.146	745.9	1,174	.147	1.99	2,671	1,593.5	176.2	.9004	385.8	642.0	.2793	.1444	.2404	1.892	.4395
	v4	10.99	11.00	.144	457.8	1,117	.147	1.99	1,994	1,898.0	194.9	.9069	349.0	585.5	.2296	.1750	.2936	2.088	.5602
	v5	11.99	12.00	.146	403.8	856	.146	1.99	2,616	1,365.7	164.1	.8927	244.8	408.7	.1544	.0936	.1562	2.542	.3272
5b	v1	10.01	10.01	.145	613.8	940	.146	2.00	2,349	1,943.6	133.1	.9359	328.3	547.0	.2613	.1398	.2329	1.955	.4002
	v2	10.01	10.00	.150	593.4	826	.148	2.00	2,412	1,695.9	123.1	.9323	318.2	533.3	.2460	.1319	.2211	2.013	.3425
	v3	9.99	10.00	.146	649.3	1,153	.150	1.98	1,714	1,746.9	217.1	.8895	463.4	773.1	.3788	.2704	.4511	1.625	.6727
	v4	9.99	9.99	.146	785.4	1,273	.147	1.98	2,478	1,749.1	179.7	.9068	400.2	670.5	.3169	.1615	.2706	1.776	.5137
	v5	10.00	9.99	.149	717.0	997	.151	1.98	1,951	1,049.5	145.8	.8780	316.2	524.7	.3675	.1621	.2689	1.648	.5110
17a	v1	9.01	9.00	.230	1,853.8	2,267	.234	2.00	2,500	1,587.3	392.8	.8016	2,344.7	3,798.4	.7415	.9379	1.5194	1.161	.9068
	v2	10.00	9.99	.226	1,878.2	2,129	.234	1.98	2,518	1,463.1	414.0	.7794	1,919.3	3,096.3	.7459	.7622	1.2297	1.157	.8455
	v3	11.00	10.99	.225	1,829.3	2,127	.236	2.00	2,464	1,378.1	442.3	.7570	1,673.4	2,684.6	.7424	.6791	1.0895	1.160	.8632
17c	v2	12.01	12.00	.235	1,353.5	1,692	.233	2.00	1,896	1,030.5	382.3	.7294	1,315.7	2,108.5	.7139	.6939	1.1121	1.183	.8924
	v3	12.98	13.03	.239	1,274.0	1,392	.242	2.00	1,833	1,042.1	358.9	.7438	1,095.7	1,750.3	.6950	.5978	.9549	1.200	.7594
17b	v2	10.02	10.01	.224	2,206.4	2,332	.227	1.99	2,684	1,595.4	412.1	.7947	883.3	3,039.4	.8221	.7017	1.1324	1.102	.8689
	v3	9.99	10.01	.225	2,187.3	2,250	.227	1.98	2,847	1,557.6	415.3	.7895	1,914.9	3,092.9	.7683	.6726	1.0864	1.141	.7903
17c	v1	10.00	9.97	.234	1,694.8	1,928	.234	2.00	1,851	939.3	404.2	.6991	1,996.7	3,174.4	.9156	1.0787	1.7150	1.045	1.0416

Z M 85289 F

Table 17a.--Results of tests for stiffness of frame members matching buckling panels, 10 by 20 inches, face grain at 0°

Buckling test Specimen No.	Frame No.	Span	Width	Depth	EI	Average EI	Ratio of buckling stresses Observed / Computed ss
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		In.	In.	In.	1,000 lb. per sq. in.	1,000 lb. per sq. in.	
4xf-1	1	18	1.832	2.744	3,003.7	2,927.9	2.44
	2	18	1.837	2.747	2,852.1		
4xf-2	1	18	1.824	2.005	1,227.3	1,316.0	1.62
	2	18	1.831	2.004	1,404.6		
5xd-1	1	18	1.871	2.733	4,516.7	4,467.4	1.44
	2	18	1.874	2.731	4,418.2		
5xd-2	1	18	1.879	2.742	3,532.0	3,311.8	1.28
	2	18	1.864	2.720	3,091.6		
6xg-1	1	18	1.919	2.731	3,857.1	4,023.4	1.31
	2	18	1.918	2.735	4,189.7		
7xf-1	1	18	1.835	2.748	3,147.7	3,073.8	2.82
	2	18	1.820	2.754	3,000.0		
7xf-2	1	18	1.810	1.996	1,396.6	1,299.8	2.35
	2	18	1.816	1.997	1,203.0		
9xg-1	1	18	2.898	2.731	7,476.9	7,170.6	.81
	2	18	2.898	2.721	6,864.4		
16xg-1	1	18	1.847	2.733	4,248.3	4,554.2	1.37
	2	18	1.841	2.737	4,860.0		
16xg-2	1	18	1.845	2.737	4,105.6	3,861.2	1.28
	2	18	1.846	2.737	3,616.7		
19xd-1	1	18	1.826	2.737	4,542.1	4,554.9	1.31
	2	18	1.826	2.734	4,567.7		
19xd-2	1	18	1.829	2.745	2,886.0	3,402.7	1.27
	2	18	1.823	2.732	3,919.4		
40xf-1	1	18	1.835	2.734	2,761.4	2,544.5	1.69
	2	18	1.850	2.757	2,327.6		
40xf-2	1	18	1.850	2.010	1,289.8	1,301.6	2.34
	2	18	1.852	2.001	1,313.5		
43xf-1	1	18	1.824	2.740	2,382.4	2,624.0	1.44
	2	18	1.823	2.734	2,865.6		
43xf-2	1	18	1.820	1.994	1,357.5	1,373.0	1.86
	2	18	1.828	1.996	1,388.6		
44xf-2	1	18	2.924	2.737	7,074.2	7,553.6	.91
	2	18	2.923	2.736	8,033.1		
5xf-1	1	18	1.891	2.750	3,944.8	4,503.6	1.41
	2	18	1.895	2.751	5,062.5		
5xf-2	1	18	1.890	2.746	4,860.0	4,790.8	1.36
	2	18	1.902	2.756	4,721.5		
8xg-2	1	18	1.888	2.746	4,077.2	4,387.2	1.18
	2	18	1.889	2.749	4,697.2		
9xf-1	1	18	1.934	2.753	4,533.6	4,352.0	1.15
	2	18	1.936	2.753	4,1705		
16xf-1	1	18	1.853	2.748	4,697.2	4,544.4	1.41
	2	18	1.867	2.757	4,391.6		
16xf-2	1	18	1.853	2.742	4,050.0	4,115.0	1.23
	2	18	1.863	2.745	4,180.0		
19xg-1	1	18	1.848	2.750	4,697.2	4,785.1	1.55
	2	18	1.848	2.749	4,873.0		
19xg-2	1	18	1.834	2.754	5,207.1	4,864.7	1.50
	2	18	1.850	2.760	4,522.3		
5xe-2	1	17	2.147	.985	360.4	366.3	1.25
	2	17	2.140	.995	372.2		
8xe-2	1	17	2.141	.981	368.2	361.8	1.07
	2	17	2.143	.994	355.4		
16xd-2	1	17	2.112	.991	343.5	352.8	1.38
	2	17	2.110	.991	362.1		
19xe-2	1	17	2.096	.994	383.3	398.0	1.24
	2	17	2.094	1.004	412.7		

Z M 85272 F

Table 18a.--Results of tests for stiffness of frame members matching buckling panels, 10 by 30 inches, face grain at 0°

Buckling test Specimen No.	Frame test data: Frame No.	Span	Width	Depth	EI	Average EI	Ratio of buckling stresses (Observed / Computed ss)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		In.	In.	In.	1,000 lb. per sq. in.	1,000 lb. per sq. in.	
4xg-1	1	28	1.834	2.742	3,942.5	3,568.1	1.75
	2	28	1.834	2.745	3,193.7		
4xg-2	1	28	1.834	2.736	3,517.9	3,534.3	1.36
	2	28	1.835	2.744	3,550.7		
20xg-1	1	28	1.954	2.730	5,380.4	5,380.4	.70
	2	28	1.957	2.734	5,380.4		
40xg-2	1	28	1.835	2.734	3,962.5	3,831.6	1.34
	2	28	1.837	2.729	3,700.6		
43xg-1	1	28	1.818	2.742	3,266.7	3,507.6	1.85
	2	28	1.801	2.725	3,748.6		
43xg-2	1	28	1.809	2.745	3,827.1	4,011.4	1.76
	2	28	1.815	2.741	4,195.7		
8xg-1	1	28	1.888	2.741	5,822.8	5,943.4	1.08
	2	28	1.889	2.744	6,064.1		
9xf-2	1	28	1.932	2.753	5,333.3	6,013.0	1.05
	2	28	1.922	2.748	6,692.7		
41xf-1	1	28	1.941	2.748	5,832.7	6,021.7	.98
	2	28	1.941	2.748	6,210.7		
41xf-2	1	28	1.940	2.750	5,761.7	6,099.6	.87
	2	28	1.941	2.753	6,437.5		
44xd-1	1	28	1.937	2.752	5,672.4	5,570.2	.92
	2	28	1.932	2.745	5,468.1		
44xd-2	1	28	1.944	2.753	5,394.8	5,648.0	.88
	2	28	1.938	2.748	5,901.1		
4xe-1	1	27	2.082	.766	203.4	191.6	.96
	2	27	2.083	.752	179.9		
5xe-1	1	27	2.140	1.001	322.4	356.8	.78
	2	27	2.159	.996	391.3		
8xe-1	1	27	2.154	.998	374.1	336.5	.82
	2	27	2.145	1.005	298.9		

Buckling test Specimen No.	Frame test data: Frame No.	Span	Width	Depth	EI	Average EI	Ratio of buckling stresses (Observed / Computed ss)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		In.	In.	In.	1,000 lb. per sq. in.	1,000 lb. per sq. in.	
16xd-1	1	27	2.120	0.996	320.4	349.4	0.96
	2	27	2.121	1.000	378.3		
19xe-1	1	27	2.096	.998	324.4	314.8	.85
	2	27	2.099	.995	305.1		
40xd-1	1	28	2.087	1.003	406.5	382.6	1.30
	2	28	2.090	.996	358.7		
40xc-1	1	28	2.090	.993	423.3	422.2	1.15
	2	28	2.088	.998	421.2		
40xe-2	1	28	2.081	3.740	14,889.9	15,022.0	1.20
	2	28	2.080	3.750	15,154.2		
41ba-1	1	27	2.967	1.134	788.6	731.5	.60
	2	27	2.964	1.130	674.4		
41xd-1	1	28	2.188	.994	397.7	410.5	.84
	2	28	2.188	1.005	423.3		
41xd-2	1	28	2.184	3.720	15,009.9	14,507.2	1.19
	2	28	2.184	3.720	14,004.5		
41xe-1	1	28	2.184	.999	466.3	450.2	.97
	2	28	2.190	1.003	434.0		
43xd-1	1	28	2.071	1.003	385.7	370.8	.81
	2	28	2.073	.997	355.9		
43xd-2	1	28	2.064	3.740	14,469.3	14,232.1	1.57
	2	28	2.065	3.730	13,994.9		
43xe-1	1	28	2.072	1.001	382.4	409.8	1.10
	2	28	2.073	1.000	437.3		
43xe-2	1	28	2.064	3.740	15,104.6	14,968.5	1.27
	2	28	2.067	3.740	14,832.4		
44xe-2	1	28	2.184	3.730	14,388.0	14,469.8	1.09
	2	28	2.184	3.720	14,551.5		

Z M 85274 F

Table 19a.--Results of tests for stiffness of frame members matching buckling panels, 10 by 20 inches, face grain at 90°

Buckling test Specimen No.	Frame No.	Span	Width	Depth	EI	Average EI	Ratio of buckling stresses (Observed / Computed ss)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		In.	In.	In.	1,000 lb. per sq. in.	1,000 lb. per sq. in.	
4xb-1	1	18	1.831	2.747	2,641.3	2,793.4	1.79
	2	18	1.834	2.755	2,945.5		
4xb-2	1	18	1.828	1.994	1,342.5	1,347.8	1.36
	2	18	1.828	1.999	1,353.0		
6xc-1	1	18	1.910	2.742	3,375.0	3,316.2	1.45
	2	18	1.910	2.737	3,257.4		
7xb-1	1	18	1.809	2.748	2,449.6	2,482.6	3.46
	2	18	1.811	2.743	2,515.5		
7xb-2	1	18	1.806	2.002	1,289.8	1,281.0	1.53
	2	18	1.811	2.002	1,272.3		
40xb-1	1	18	1.837	2.737	2,793.1	2,662.2	
	2	18	1.851	2.745	2,531.2		
40xb-2	1	18	1.846	1.998	1,335.2	1,284.4	
	2	18	1.845	1.996	1,233.5		
43xb-1	1	18	1.847	2.752	2,858.8	3,210.9	
	2	18	1.855	2.754	3,563.0		
43xb-2	1	18	1.828	2.004	1,265.6	1,282.6	1.43
	2	18	1.826	1.996	1,299.5		
5xa-1	1	18	1.891	2.744	4,925.7	4,854.6	1.31
	2	18	1.889	2.742	4,783.5		
6xb-1	1	18	1.930	2.744	4,613.9	4,776.4	1.39
	2	18	1.932	2.752	4,939.0		
6xb-2	1	18	1.937	2.745	4,602.3	4,596.5	1.56
	2	18	1.934	2.750	4,590.7		
9xb-1	1	18	1.931	2.752	5,360.3	4,844.6	1.25
	2	18	1.927	2.748	4,329.0		
9xb-2	1	18	1.928	2.743	4,993.2	5,137.9	1.27
	2	18	1.937	2.750	5,282.6		
44xc-1	1	18	1.949	2.754	4,423.5	4,512.9	1.23
	2	18	1.945	2.750	4,602.3		
44xc-2	1	18	1.935	2.736	5,222.1	4,894.9	1.28
	2	18	1.941	2.748	4,567.7		
6ca-2	1	17	2.973	1.134	682.4	734.8	1.10
	2	17	2.954	1.131	787.3		
7v-2	1	17	2.058	.757	173.5	175.9	2.29
	2	17	2.066	.759	178.3		
9xc-2	1	17	2.178	.997	381.9	385.6	1.19
	2	17	2.170	.997	389.2		
16xc-2	1	17	2.117	.991	396.7	393.0	1.34
	2	17	2.108	.995	389.2		
19xc-2	1	17	2.092	.993	377.7	377.0	
	2	17	2.088	1.002	376.3		
45xb-2	1	18	2.985	1.121	913.5	870.0	
	2	18	2.988	1.127	826.5		

Z M 85276 F

Table 20a.--Results of tests for stiffness of frame members matching buckling panels, 10 by 30 inches, face grain at 90°

Buckling test Specimen No. (1)	Frame No. (2)	Span (3)	Width (4)	Depth (5)	EI (6)	Average EI (7)	Ratio of buckling stresses (Observed / Computed as) (8)
		In.	In.	In.	1,000 lb. per sq. in.	1,000 lb. per sq. in.	
4xa-1	1	28	1.610	2.776	3,959.6	4,157.6	4.74
	2	28	1.609	2.770	4,355.6	....	....
4xa-2	1	28	1.601	2.776	5,543.4	4,953.6	5.91
	2	28	1.624	2.780	4,363.9	....	....
4xc-1	1	28	1.813	2.727	4,004.7	4,123.6	1.75
	2	28	1.830	2.749	4,242.4	....	....
4xc-2	1	28	1.812	2.742	3,552.1	3,581.3	1.53
	2	28	1.812	2.730	3,610.5	....	....
5xb-1	1	28	1.669	2.762	5,025.6	5,031.2	....
	2	28	1.672	2.773	5,036.7	....	....
5xb-2	1	28	1.685	2.777	4,739.2	5,098.3	2.21
	2	28	1.672	2.768	5,457.4	....	....
6xe-1	1	28	1.736	2.783	5,510.0	4,922.4	2.00
	2	28	1.740	2.780	4,334.9	....	....
6xe-2	1	28	1.729	2.775	5,138.6	5,001.9	1.95
	2	28	1.740	2.786	4,865.2	....	....
7xa-1	1	28	1.589	2.776	5,034.9	4,739.3	2.95
	2	28	1.591	2.776	4,443.7	....	....
7xa-2	1	28	1.590	2.783	4,573.3	4,632.0	4.16
	2	28	1.592	2.782	4,690.6	....	....
7xc-1	1	28	1.819	2.716	3,523.4	3,686.5	2.30
	2	28	1.818	2.736	3,849.6	....	....
7xc-2	1	28	1.791	1.995	1,829.3	1,679.4	2.60
	2	28	1.807	1.996	1,529.5	....	....
8xa-1	1	28	1.675	2.772	4,690.6	4,622.5	2.16
	2	28	1.688	2.779	4,554.4	....	....
8xa-2	1	28	1.679	2.782	5,201.9	4,887.6	2.07
	2	28	1.677	2.777	4,573.3	....	....
9xa-1	1	28	1.716	2.774	4,372.9	4,640.0	1.80
	2	28	1.717	2.779	4,907.0	....	....
9xa-2	1	28	1.720	2.776	4,944.1	4,615.8	1.77
	2	28	1.722	2.784	4,287.5	....	....
16xa-1	1	28	1.662	2.772	4,763.9	4,801.7	2.08
	2	28	1.643	2.758	4,839.5	....	....
16xa-2	1	28	1.646	2.778	4,814.0	4,534.2	2.31
	2	28	1.655	2.768	4,254.3	....	....
19xa-1	1	28	1.621	2.775	4,423.0	4,724.3	2.03
	2	28	1.621	2.778	5,025.6	....	....
19xa-2	1	28	1.622	2.778	4,714.8	4,829.4	2.13
	2	28	1.623	2.775	4,944.1	....	....
40xa-1	1	28	1.646	2.784	3,908.8	4,709.4	2.80
	2	28	1.739	2.769	5,510.0	....	....
40xa-2	1	28	1.622	2.774	4,592.5	4,611.8	2.90
	2	28	1.619	2.769	4,631.2	....	....
40xc-1	1	28	1.831	2.729	4,035.3	3,984.6	1.77
	2	28	1.842	2.731	3,934.0	....	....
40xc-2	1	28	1.834	2.723	3,962.5	3,867.2	1.95
	2	28	1.847	2.734	3,771.8	....	....
43xa-1	1	28	1.608	2.767	4,917.6	4,482.4	3.84
	2	28	1.609	2.776	4,047.2	....	....
43xa-2	1	28	1.636	2.788	4,619.5	4,716.8	3.02
	2	28	1.641	2.794	4,814.0	....	....
43xc-1	1	28	1.832	2.741	3,703.1	3,781.2	1.18
	2	28	1.821	2.723	3,859.4	....	....
43xc-2	1	28	1.813	2.722	3,942.5	3,951.0	1.54
	2	28	1.802	2.743	3,959.6	....	....
44xa-1	1	28	1.720	2.779	4,596.3	4,619.6	1.76
	2	28	1.726	2.779	4,643.0	....	....
44xa-2	1	28	1.725	2.779	4,372.9	4,257.4	1.81
	2	28	1.722	2.778	4,141.9	....	....
5xa-2	1	28	1.894	2.748	6,946.8	6,020.6	1.24
	2	28	1.899	2.757	5,094.3	....	....
17xc-1	1	28	1.988	2.748	6,308.0	6,250.6	....
	2	28	1.987	2.751	6,193.1	....	....
17xc-2	1	28	1.986	2.750	5,838.3	6,109.8	1.04
	2	28	1.978	2.746	6,381.4	....	....
20xc-1	1	28	1.993	2.756	5,394.8	5,409.4	.78
	2	28	1.988	2.749	5,423.9	....	....
20xc-2	1	28	1.983	2.742	7,035.9	6,887.8	.73
	2	28	1.990	2.749	6,739.6	....	....
42xc-1	1	28	2.005	2.754	5,687.0	5,315.6	.73
	2	28	2.000	2.747	4,944.1	....	....
42xc-2	1	28	1.993	2.742	6,114.8	6,418.4	.80
	2	28	2.001	2.745	6,722.0	....	....
45xc-1	1	28	1.998	2.753	5,095.6	4,875.2	....
	2	28	1.995	2.752	4,654.8	....	....
45xc-2	1	28	1.992	2.753	5,628.7	5,813.2	....
	2	28	1.986	2.743	5,997.8	....	....
5xe-1	1	28	2.146	.995	385.1	404.3	1.17
	2	28	2.150	.996	423.5	....	....
5xe-2	1	28	2.145	3.720	15,335.7	15,572.4	1.64
	2	28	2.147	3.730	15,809.1	....	....
5xt-1	1	28	2.145	1.002	363.2	399.4	1.35
	2	28	2.142	.996	435.6	....	....
5xt-2	1	28	2.137	3.760	14,149.5	13,886.1	1.73
	2	28	2.142	3.740	13,622.7	....	....
6oa-1	1	27	2.948	1.131	551.2	682.4	1.08
	2	27	2.947	1.133	813.6	....	....
7v-1	1	27	2.074	.765	188.4	184.8	1.62
	2	27	2.074	.762	181.1	....	....
8aa-1	1	28	2.142	1.004	451.1	458.6	1.00
	2	28	2.143	1.003	466.1	....	....
8aa-2	1	28	2.140	3.720	16,107.3	15,675.8	1.05
	2	28	2.141	3.730	15,244.4	....	....
8xb-1	1	28	2.149	.997	408.0	405.8	1.32
	2	28	2.145	.994	403.5	....	....
8xb-2	1	28	2.145	3.730	13,918.8	14,815.4	1.77
	2	28	2.146	3.730	15,712.1	....	....
9xc-1	1	27	2.186	1.012	349.9	315.0	1.00
	2	27	2.161	.999	280.1	....	....
16xc-1	1	27	2.118	.997	271.9	288.0	1.18
	2	27	2.121	.990	304.2	....	....
19xc-1	1	27	2.101	.988	292.1	310.0	1.15
	2	27	2.098	1.000	328.0	....	....
43bb-1	1	28	2.071	.998	408.6	402.5	.80
	2	28	2.075	.991	396.4	....	....
43bb-2	1	28	2.076	3.740	13,338.9	14,383.5	2.88
	2	28	2.070	3.750	15,428.1	....	....
43v-1	1	28	2.087	.999	374.5	414.2	1.22
	2	28	2.086	.996	453.8	....	....
43v-2	1	28	2.088	3.740	14,071.8	14,395.3	1.12
	2	28	2.084	3.740	14,718.8	....	....
44aa-1	1	28	2.188	.992	418.9	422.2	1.20
	2	28	2.188	1.000	425.4	....	....
44aa-2	1	28	2.088	3.730	14,977.0	15,047.8	1.62
	2	28	2.183	3.730	15,118.5	....	....
44xb-1	1	28	2.196	1.000	415.8	422.3	1.27
	2	28	2.195	.997	428.8	....	....
44xb-2	1	28	2.186	3.730	16,523.0	15,455.5	1.64
	2	28	2.186	3.730	14,388.0	....	....
45xb-1	1	27	3.023	1.126	861.5	854.4	.92
	2	27	3.016	1.140	847.2	....	....

Table 21a.--Results of tests for stiffness of frame members matching buckling panels, 10 by 20 inches, face grain at 45°

Buckling test Specimen No.	Frame test data: Frame No.	Span	Width	Depth	EI	Average EI	Ratio of buckling stresses (Observed / Computed ss)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		In.	In.	In.	1,000 lb. per sq. in.	1,000 lb. per sq. in.	
4xh-1	1	18	1.814	2.721	3,000.0	2,978.1	1.11
	2	18	1.816	2.717	2,956.2		
4xh-2	1	18	1.803	2.719	3,351.7	2,817.8	1.11
	2	18	1.825	2.737	2,283.8		
7xh-1	1	18	1.810	2.732	3,029.9	3,174.8	1.33
	2	18	1.810	2.721	3,319.7		
7xh-2	1	18	1.801	2.723	3,000.0	2,752.6	1.10
	2	18	1.806	2.734	2,505.2		
8xk-1	1	18	1.876	2.733	3,727.0	3,835.9	.58
	2	18	1.866	2.725	3,944.8		
8xk-2	1	18	1.875	2.736	3,301.6	3,366.9	.62
	2	18	1.871	2.730	3,432.2		
9xn-1	1	18	2.913	2.727	8,168.1	7,121.6	.77
	2	18	2.900	2.729	6,075.0		
16xk-2	1	18	1.840	2.738	4,139.7	4,295.8	1.25
	2	18	1.839	2.734	4,451.9		
19xj-1	1	18	1.807	2.733	4,218.8	4,401.8	.99
	2	18	1.820	2.733	4,584.9		
40xh-1	1	18	1.831	2.710	2,700.0	2,656.4	1.34
	2	18	1.831	2.710	2,612.9		
43xh-1	1	18	1.815	2.710	2,694.0	2,759.8	.97
	2	18	1.813	2.723	2,825.6		
43xh-2	1	18	1.813	2.705	2,842.1	3,156.8	.97
	2	18	1.807	2.725	3,471.4		
8xl-1	1	18	2.887	2.720	7,269.2	6,702.8	.81
	2	18	2.874	2.730	6,136.4		

Buckling test Specimen No.	Frame test data: Frame No.	Span	Width	Depth	EI	Average EI	Ratio of buckling stresses (Observed / Computed ss)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		In.	In.	In.	1,000 lb. per sq. in.	1,000 lb. per sq. in.	
8xl-2	1	18	2.892	2.740	6,776.9	6,666.4	0.80
	2	18	2.880	2.709	6,555.8		
9xl-1	1	18	2.905	2.711	6,462.8	6,683.1	.81
	2	18	2.904	2.702	6,903.4		
9xl-2	1	18	2.831	2.695	6,394.7	6,511.0	.80
	2	18	2.817	2.705	6,627.3		
16xn-1	1	18	1.856	2.742	5,237.1	4,825.0	1.16
	2	18	1.868	2.755	4,412.8		
16xn-2	1	18	1.870	2.759	4,118.6	4,716.0	1.16
	2	18	1.857	2.742	5,313.4		
4da-2	1	17	2.070	.750	159.9	160.8	.65
	2	17	2.062	.753	161.6		
5xm-2	1	18	2.895	1.116	920.5	862.6	.85
	2	18	2.899	1.117	804.6		
6da-2	1	17	2.954	1.134	614.1	677.0	.76
	2	17	2.950	1.133	739.9		
9xk-2	1	18	2.923	1.126	867.9	897.7	.76
	2	18	2.924	1.123	927.5		
16da-2	1	17	2.120	1.007	404.0	397.6	1.12
	2	17	2.120	1.002	391.2		
20xk-2	1	18	2.985	1.126	820.9	863.8	.72
	2	18	2.990	1.123	906.7		
40da-2	1	17	2.096	.760	145.5	137.8	.73
	2	17	2.084	.750	130.1		
44xj-2	1	18	2.936	1.117	799.3	789.0	.73
	2	18	2.939	1.124	778.8		

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Table 22a.--Results of tests for stiffness of frame members matching buckling panels, 10 by 30 inches, face grain at -45°

Buckling test Specimen No.	Frame test data Frame No.	Span	Width	Depth	EI	Average EI	Ratio of buckling stresses Observed / Computed as
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		In.	In.	In.	1,000 lb. per sq. in.	1,000 lb. per sq. in.	
4xj-1	1	28	1.775	2.008	1,772.6	1,730.1	1.38
	2	28	1.768	2.004	1,687.6		
4xj-2	1	28	1.774	1.991	1,693.8	1,687.6	1.62
	2	28	1.778	1.988	1,681.4		
4xk-1	1	28	1.780	1.977	1,829.3	1,725.5	1.13
	2	28	1.794	1.977	1,621.7		
4xk-2	1	28	1.804	1.986	1,836.7	1,925.7	1.18
	2	28	1.782	1.986	2,014.7		
7xj-1	1	28	1.772	1.993	1,633.3	1,706.4	1.29
	2	28	1.769	1.989	1,779.5		
7xj-2	1	28	1.778	2.011	1,577.0	1,623.0	1.14
	2	28	1.775	2.004	1,669.1		
7xk-1	1	28	1.785	1.975	1,719.3	1,709.7	2.07
	2	28	1.782	1.978	1,700.1		
7xk-2	1	28	1.783	1.981	1,566.2	1,781.6	2.01
	2	28	1.770	1.989	1,997.1		
20xj-2	1	28	2.955	2.740	9,074.1	8,657.2	.88
	2	28	2.941	2.734	8,240.2		
40xj-1	1	28	1.810	2.774	4,763.9	4,515.0	1.52
	2	28	1.808	2.770	4,266.2		
40xk-1	1	28	1.817	2.734	4,461.8	4,461.8	1.23
	2	28	1.813	2.730	4,461.8		
40xk-2	1	28	1.813	2.739	4,397.4	4,605.7	1.33
	2	28	1.811	2.729	4,814.0		
41xj-1	2	28	1.912	2.734	5,468.1	5,468.1	.96
41xj-2	1	28	2.900	2.733	8,240.2	8,131.8	.85
	2	28	2.902	2.727	8,023.4		
43xj-1	1	28	1.798	2.779	4,564.2	4,740.9	1.42
	2	28	1.786	2.771	4,917.6		
43xj-2	1	28	1.785	2.768	5,825.9	5,439.6	1.42
	2	28	1.780	2.771	5,053.4		
43xk-1	1	28	1.801	2.742	4,981.3	4,711.0	1.27
	2	28	1.793	2.727	4,440.1		
43xk-2	1	28	1.790	2.730	4,389.0	4,685.4	1.35
	2	28	1.795	2.733	4,981.8		
44xk-1	1	28	1.916	2.725	4,917.6	5,181.0	.87
	2	28	1.923	2.736	5,444.4		
44xk-2	2	28	1.914	2.734	5,444.4	5,444.4	.89
45xk-1	1	28	2.945	2.732	8,694.6	8,653.6	.77
	2	28	2.950	2.731	8,612.7		
6xl-1	1	28	2.935	2.753	8,770.8	7,932.6	.77
	2	28	2.902	2.705	7,094.4		
6xl-2	1	28	2.919	2.708	8,130.4	8,250.0	.95
	2	28	2.916	2.717	8,369.5		
9xm-1	1	28	2.910	2.720	7,714.1	8,479.9	.89
	2	28	2.898	2.711	9,245.7		
9xm-2	1	28	2.913	2.739	7,784.4	8,189.3	.94
	2	28	2.903	2.699	8,594.2		
16xh-1	1	28	1.868	2.757	5,444.4	5,306.0	1.09
	2	28	1.866	2.757	5,167.6		
16xh-2	1	28	1.867	2.751	4,535.5	5,163.8	1.11
	2	28	1.862	2.749	5,792.1		
41xm-1	1	28	2.921	2.739	7,885.1	6,951.3	1.08
	2	28	2.943	2.740	6,017.5		
41xm-2	1	28	2.902	2.693	8,452.4	8,071.6	1.07
	2	28	2.908	2.722	7,690.9		
44xl-1	1	28	2.931	2.729	8,208.5	7,996.4	.89
	2	28	2.925	2.702	7,784.4		
4da-1	1	27	2.060	.740	135.6	136.9	1.10
	2	27	2.071	.744	138.2		
5xm-1	1	27	2.923	1.138	737.5	766.1	.92
	2	27	2.912	1.139	794.7		
6da-1	1	27	2.951	1.143	661.4	720.5	.84
	2	27	2.947	1.134	779.6		
8xh-1	1	27	2.156	.987	364.8	340.1	.71
	2	27	2.149	.996	315.4		
9xk-1	1	27	2.964	1.139	732.3	774.6	.71
	2	27	2.963	1.129	816.9		
16da-1	1	27	2.118	.994	438.1	440.4	1.36
	2	27	2.113	1.016	442.8		
20xk-1	1	27	3.001	1.134	776.6	720.0	.70
	2	27	3.010	1.130	663.5		
40da-1	1	27	2.088	.750	163.8	162.4	1.12
	2	27	2.080	.754	160.9		
41xk-1	1	28	2.926	1.127	819.5	794.6	.82
	2	28	2.930	1.130	769.6		
41xk-2	1	28	3.660	3.730	25,108.5	25,232.8	1.03
	2	28	3.680	3.740	25,357.1		
41xl-1	1	28	2.938	1.126	659.2	686.6	.83
	2	28	2.934	1.125	713.9		
41xl-2	1	28	3.660	3.750	27,538.4	27,108.1	1.15
	2	28	3.675	3.752	26,677.8		
44xj-1	1	27	2.965	1.135	843.8	762.5	.70
	2	27	2.958	1.131	681.2		

Table 23a.--Results of tests for stiffness of frame members matching square buckling panels with face grain at -45°

Buckling test Specimen No.	Frame test data: Frame No.	Span	Width	Depth	EI	Average EI	Ratio of buckling stresses Observed/Computed as
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		In.	In.	In.	1,000 lb. per sq. in.	1,000 lb. per sq. in.	
5ka-v1	1	16	1.677	2.775	4,666.7	4,333.2	0.86
	2	16	1.675	2.765	4,685.0		
	3	16	1.675	2.778	3,647.8		
5ka-v2	1	16	1.672	2.782	4,169.9	4,276.6	.76
	2	16	1.677	2.770	4,482.8		
	3	16	1.674	2.773	4,177.2		
4ka-v1	1	16	1.592	2.761	4,228.9	4,051.4	.92
	2	16	1.592	2.772	3,929.8		
	3	16	1.587	2.762	3,995.5		
4kd-v1	1	16	1.585	2.732	2,949.8	2,885.6	.98
	2	16	1.580	2.725	2,771.8		
	3	16	1.590	2.723	2,935.3		
4kd-v2	1	16	1.582	2.735	2,746.4	2,831.9	1.37
	2	16	1.584	2.724	2,817.6		
	3	16	1.581	2.781	2,931.7		
4ke-v1	1	16	1.588	2.722	2,844.4	2,862.7	1.45
	2	16	1.597	2.740	2,864.9		
	3	16	1.585	2.725	2,878.7		
4ke-v2	1	16	1.588	2.730	2,765.4	2,715.0	1.50
	2	16	1.581	2.742	2,837.7		
	3	16	1.585	2.758	2,541.8		
5kc-v1	1	16	1.687	2.764	4,191.8	4,651.8	.82
	2	16	1.681	2.772	4,936.6		
	3	16	1.684	2.758	4,826.9		
5kc-v2	1	16	1.682	2.748	4,282.0	4,407.0	.80
	2	16	1.678	2.748	4,344.2		
	3	16	1.682	2.765	4,594.9		
4a-v1	1	5	1.558	2.486	718.4	704.2	1.15
	2	5	1.570	2.552	699.1		
	3	5	1.575	2.514	680.8		
	4	5	1.572	2.518	718.4		
4a-v2	1	5	1.574	2.508	644.6	711.4	1.00
	2	5	1.558	2.505	744.0		
	3	5	1.570	2.503	733.6		
	4	5	1.561	2.508	723.4		
4a-v3	1	7	1.582	2.522	1,361.1	1,211.8	.91
	2	7	1.575	2.512	1,082.7		
	3	7	1.573	2.524	1,171.4		
	4	7	1.579	2.518	1,232.0		
4a-v4	1	8	1.569	2.503	1,497.1	1,496.6	1.41
	2	8	1.580	2.522	1,513.0		
	3	8	1.559	2.514	1,534.8		
	4	8	1.571	2.514	1,441.4		
4a-v5	1	10	1.569	2.503	1,911.3	1,862.6	1.29
	2	10	1.566	2.500	1,680.1		
	3	10	1.566	2.496	1,902.6		
	4	10	1.570	2.501	1,956.2		
4b-v1	1	8	1.560	1.997	1,169.0	1,139.2	.86
	2	8	1.560	1.998	1,153.2		
	3	8	1.559	1.988	1,094.0		
	4	8	1.554	1.996	1,140.8		
4b-v2	1	8	1.553	2.249	1,491.8	1,474.6	.89
	2	8	1.554	2.246	1,471.3		
	3	8	1.560	2.254	1,610.1		
	4	8	1.558	2.249	1,325.1		
4b-v3	1	8	1.572	2.518	1,568.6	1,586.5	1.22
	2	8	1.565	2.510	1,628.5		
	3	8	1.569	2.506	1,580.2		
	4	8	1.567	2.506	1,568.6		
4b-v4	1	8	1.572	2.768	1,777.8	1,681.1	1.74
	2	8	1.576	2.771	1,673.2		
	3	8	1.570	2.768	1,580.2		
	4	8	1.578	2.760	1,693.1		
4b-v5	1	8	1.579	3.017	1,984.5	1,922.0	1.07
	2	8	1.575	3.020	1,823.4		
	3	8	1.575	3.023	1,904.8		
	4	8	1.577	3.022	1,975.3		
40a-v1	1	5	1.588	2.506	703.8	742.4	1.16
	2	5	1.584	2.504	728.4		
	3	5	1.585	2.508	723.4		
	4	5	1.605	2.521	813.8		
40a-v2	1	7	1.597	2.528	1,387.5	1,340.2	1.33
	2	7	1.598	2.529	1,348.3		
	3	7	1.560	2.518	1,354.7		
	4	7	1.593	2.507	1,270.4		
40a-v3	1	8	1.592	2.508	1,502.3	1,593.0	.96
	2	8	1.580	2.507	1,580.2		
	3	8	1.594	2.522	1,616.2		
	4	8	1.590	2.514	1,673.2		
40a-v4	1	10	1.601	2.521	2,052.5	1,872.7	1.12
	2	10	1.606	2.526	1,765.5		
	3	10	1.615	2.538	1,640.4		
	4	10	1.608	2.526	2,032.5		
40a-v5	1	10	1.586	2.502	2,083.3	2,084.8	.91
	2	10	1.587	2.506	2,012.9		
	3	10	1.586	2.502	2,170.1		
	4	10	1.585	2.510	2,073.0		
40b-v1	1	8	1.577	2.005	1,082.9	1,105.0	.59
	2	8	1.583	1.998	1,072.0		
	3	8	1.585	2.000	1,066.7		
	4	8	1.579	2.002	1,198.5		
40b-v2	1	8	1.581	2.254	1,412.8	1,445.2	.62
	2	8	1.581	2.242	1,422.2		
	3	8	1.583	2.242	1,422.2		
	4	8	1.580	2.240	1,523.8		
40b-v3	1	8	1.596	2.512	1,471.3	1,460.3	.73
	2	8	1.585	2.498	1,491.8		
	3	8	1.593	2.519	1,431.8		
	4	8	1.590	2.506	1,446.3		
40b-v4	1	8	1.594	2.762	1,887.9	1,772.4	.74
	2	8	1.596	2.777	1,693.1		
	3	8	1.600	2.774	1,855.1		
	4	8	1.596	2.771	1,653.7		
40b-v5	1	8	1.595	3.012	2,031.7	2,160.5	1.07
	2	8	1.594	3.014	2,269.5		
	3	8	1.594	3.023	2,071.2		
	4	8	1.602	3.015	2,269.5		
16a-v1	1	7	1.623	2.518	1,387.5	1,315.7	1.07
	2	7	1.608	2.506	1,380.8		
	3	7	1.620	2.521	1,341.9		
	4	7	1.608	2.520	1,152.6		
16a-v2	1	8	1.607	2.496	1,108.2	1,470.4	1.00
	2	8	1.618	2.520	1,610.1		
	3	8	1.619	2.512	1,385.3		
	4	8	1.624	2.520	1,777.8		
16a-v4	1	10	1.607	2.505	2,228.2	2,165.6	1.00
	2	10	1.608	2.500	2,193.0		
	3	10	1.606	2.504	2,136.8		
	4	10	1.610	2.502	2,104.4		
16a-v5	1	11	1.609	2.502	2,092.8	2,277.4	.80
	2	11	1.608	2.502	2,390.4		
	3	11	1.610	2.506	2,443.1		
	4	11	1.603	2.506	2,183.4		
16b-v2	1	8	1.603	2.248	1,422.2	1,421.0	.84
	2	8	1.593	2.244	1,513.0		
	3	8	1.593	2.250	1,316.9		
	4	8	1.603	2.253	1,431.8		
16b-v3	1	8	1.616	2.512	1,693.1	1,632.7	1.54
	2	8	1.615	2.512	1,534.8		
	3	8	1.620	2.518	1,568.6		
	4	8	1.615	2.512	1,734.4		
16b-v4	1	8	1.620	2.762	1,957.2	1,896.7	1.27
	2	8	1.613	2.763	1,777.8		
	3	8	1.604	2.764	1,839.1		
	4	8	1.612	2.758	2,012.6		
16b-v5	1	8	1.620	3.018	2,031.7	2,127.6	.89
	2	8	1.612	3.014	2,293.9		
	3	8	1.617	3.014	2,051.3		
	4	8	1.611	3.017	2,133.3		

Table 24a.--Results of tests for stiffness of frame members matching buckling panels, 10 by 20 inches, face grain at +45°

Buckling test Specimen No.	Frame No.	Span	Width	Depth	EI	Average EI	Ratio of buckling stresses (Observed / Computed ss)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		In.	In.	In.	1,000 lb. per sq. in.	1,000 lb. per sq. in.	
20hx-1	1	18	2.941	2.698	6,417.3	6,318.7	1.05
	2	18	2.942	2.696	6,220.1		
41xh-1	1	18	1.941	2.751	5,177.6	4,650.4	1.56
	2	18	1.950	2.757	4,123.3		
41xh-2	1	18	1.948	2.757	4,821.4	4,666.2	1.56
	2	18	1.952	2.754	4,511.1		
44xh-1	1	18	1.927	2.738	5,027.6	4,806.2	1.19
	2	18	1.935	2.744	4,584.9		
44xh-2	1	18	1.936	2.755	5,192.3	4,981.6	1.15
	2	18	1.926	2.746	4,770.9		
44xn-1	1	18	1.909	2.726	7,275.4	6,107.2	1.14
	2	18	1.918	2.731	4,939.0		
44xn-2	1	18	2.901	2.718	7,500.0	7,721.8	1.17
	2	18	2.909	2.737	7,943.5		
45xl-1	1	18	2.978	2.729	7,036.7	6,796.2	1.10
	2	18	2.970	2.729	6,555.8		
5wd-2	1	17	2.147	1.001	350.5	348.2	1.54
	2	17	2.150	.991	345.8		
8xg-2	1	17	2.147	.992	355.4	390.8	1.10
	2	18	2.138	.999	426.3		
17xj-2	1	18	2.983	1.133	979.8	892.2	1.11
	2	18	2.985	1.121	804.6		
40db-2	1	17	2.093	.752	162.5	140.6	1.33
	2	17	2.085	.748	118.6		
41da-2	1	17	2.964	1.134	708.9	701.4	1.25
	2	17	2.974	1.131	693.9		

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Table 25a.--Results of tests for stiffness of frame members matching buckling panels, 10 by 30 inches, face grain at +45°

Buckling test Specimen No.	Frame test data: Frame No.	Span	Width	Depth	EI	Average EI	Ratio of buckling stresses Observed / Computed ss
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		In.	In.	In.	1,000 lb. per sq. in.	1,000 lb. per sq. in.	
4xl-2	1	28	1.758	2.002	1,461.1	1,417.2	2.87
	2	28	1.774	1.989	1,373.4		
4xm-1	1	28	1.618	2.771	4,670.6	4,622.0	2.09
	2	28	1.653	2.770	4,573.3		
4xm-2	1	28	1.617	2.780	4,596.3	4,730.8	3.32
	2	28	1.605	2.774	4,865.2		
5xl-1	1	28	1.797	2.783	4,878.2	4,846.1	1.84
	2	28	1.779	2.777	4,814.0		
5xl-2	1	28	1.674	2.777	5,034.9	4,883.0	2.01
	2	28	1.674	2.773	4,731.0		
6xm-2	1	28	1.911	2.732	3,658.7	4,223.8	1.28
	2	28	1.916	2.730	4,788.8		
7xl-1	1	28	1.731	2.744	2,998.9	2,984.3	2.06
	2	28	1.731	2.746	2,969.7		
7xl-2	1	28	1.745	1.981	1,104.7	1,149.4	3.69
	2	28	1.744	1.992	1,194.1		
7xm-1	1	28	1.605	2.783	4,083.3	4,198.9	5.16
	2	28	1.601	2.781	4,314.5		
7xm-2	1	28	1.604	2.780	4,363.9	4,539.4	3.66
	2	28	1.609	2.765	4,714.8		
8xm-1	1	28	1.680	2.774	4,751.5	4,711.0	1.90
	2	28	1.673	2.773	4,670.6		
8xm-2	1	28	1.676	2.783	4,718.8	4,665.3	1.69
	2	28	1.675	2.780	4,611.8		
16xl-1	1	28	1.801	2.748	2,730.3	2,942.2	2.22
	2	28	1.794	2.746	3,154.0		
16xl-2	1	28	1.795	1.995	1,377.5	1,499.6	2.16
	2	28	1.813	2.000	1,621.7		
16xm-1	1	28	1.645	2.780	5,287.1	5,333.8	1.62
	2	28	1.650	2.781	5,380.4		
16xm-2	1	28	1.647	2.778	5,510.0	5,129.5	1.72
	2	28	1.644	2.778	4,749.0		
19xl-1	1	28	1.615	2.771	4,054.4	4,341.6	1.77
	2	28	1.624	2.781	4,628.9		
19xl-2	1	28	1.635	2.781	4,355.6	4,385.4	1.70
	2	28	1.619	2.773	4,415.1		
20xj-1	1	28	[illegible].955	2.728	6,222.2	7,401.3	.89
	2	28	2.935	2.727	8,580.4		
40xm-1	1	28	1.853	2.756	4,314.5	4,152.9	2.56
	2	28	1.846	2.745	3,991.3		
40xm-2	1	28	1.840	1.999	1,559.1	1,608.0	2.43
	2	28	1.845	1.995	1,657.0		
43xl-1	1	28	1.742	1.986	1,129.2	1,208.8	2.26
	2	28	1.748	1.988	1,288.3		
43xl-2	1	28	1.755	2.749	2,849.4	2,845.0	2.61
	2	28	1.739	2.741	2,840.6		
43xm-1	1	28	1.610	2.764	4,611.8	4,641.2	2.43
	2	28	1.617	2.780	4,670.6		
43xm-2	1	28	1.609	2.781	4,418.7	4,429.4	2.58
	2	28	1.613	2.777	4,440.1		
44xm-1	1	28	1.722	2.777	4,440.1	4,469.2	1.41
	2	28	1.718	2.779	4,498.4		
44xm-2	1	28	1.714	2.776	4,564.2	4,409.2	1.35
	2	28	1.727	2.778	4,254.3		
17xh-1	1	28	2.961	2.730	7,690.9	7,622.8	1.25
	2	28	2.935	2.680	7,554.8		
17xh-2	1	28	2.965	2.734	8,108.7	8,119.6	1.31
	2	28	2.957	2.722	8,130.4		
20xm-1	1	28	2.706	2.687	8,028.4	7,331.6	1.22
	2	28	2.702	2.686	6,634.9		
20xm-2	1	28	2.984	2.740	7,622.2	6,366.0	1.07
	2	28	3.003	2.754	5,109.9		
21xl-1	1	28	3.030	2.726	5,716.7	5,350.6	.86
	2	28	3.000	2.740	4,984.6		
42xm-1	1	28	2.972	2.712	9,017.8	8,503.1	1.22
	2	28	2.963	2.695	7,988.4		
42xm-2	1	28	3.013	2.728	6,628.0	6,958.1	1.26
	2	28	3.010	2.737	7,288.2		
5wd-1	1	27	2.156	.998	266.3	296.4	1.22
	2	27	2.163	.992	326.5		
6xj-1	1	28	2.191	.997	354.1	362.4	1.41
	2	28	2.201	.996	370.8		
6xj-2	1	28	2.186	3.720	15,907.2	15,575.8	1.58
	2	28	2.183	3.720	15,244.4		
6xk-1	1	28	2.188	.992	358.7	362.3	1.32
	2	28	2.190	1.004	365.9		
6xk-2	1	28	2.182	3.730	13,331.2	13,701.5	1.55
	2	28	2.182	3.730	14,071.8		
8xj-1	1	27	2.149	.997	283.2	285.2	.98
	2	27	2.156	1.000	287.2		
9xh-1	1	28	2.176	.997	390.6	368.2	1.19
	2	28	2.178	.997	345.7		
9xh-2	1	28	2.173	3.752	13,871.7	14,638.3	1.49
	2	28	2.177	3.740	15,404.9		
9xj-1	1	28	2.181	.999	390.4	373.8	1.33
	2	28	2.177	.994	357.1		
9xj-2	1	28	2.175	3.730	15,521.6	14,572.2	1.62
	2	28	2.176	3.730	13,622.7		
16db-1	1	27	2.114	1.003	410.7	422.3	1.65
	2	27	2.115	.999	433.9		
17xj-1	1	27	3.012	1.106	516.5	658.7	1.13
	2	27	3.020	1.138	800.9		
19xk-1	1	28	2.093	1.001	361.1	397.9	1.13
	2	28	2.092	.997	434.7		
19xk-2	1	28	2.086	3.740	16,630.3	15,442.4	1.58
	2	28	2.090	3.740	14,254.5		
19xm-1	1	28	2.086	.998	406.5	394.4	1.31
	2	28	2.085	1.001	382.4		
19xm-2	1	28	2.084	3.750	15,616.3	15,522.2	1.47
	2	28	2.082	3.750	15,428.1		
20xl-1	1	28	2.983	1.112	680.0	697.5	1.09
	2	28	2.991	1.126	715.0		
20xl-2	1	28	3.730	3.750	28,615.3	27,242.4	1.08
	2	28	3.730	3.740	25,869.4		
20xm-1	1	28	2.985	1.124	677.5	733.3	1.04
	2	28	2.979	1.125	789.1		
20xm-2	1	28	3.730	3.740	26,000.7	26,623.0	1.15
	2	28	3.730	3.750	27,245.4		
40db-1	1	27	2.088	.743	106.0	129.8	1.33
	2	27	2.086	.741	153.6		
41da-1	1	27	2.958	1.144	550.4	569.5	1.44
	2	27	2.966	1.135	588.6		

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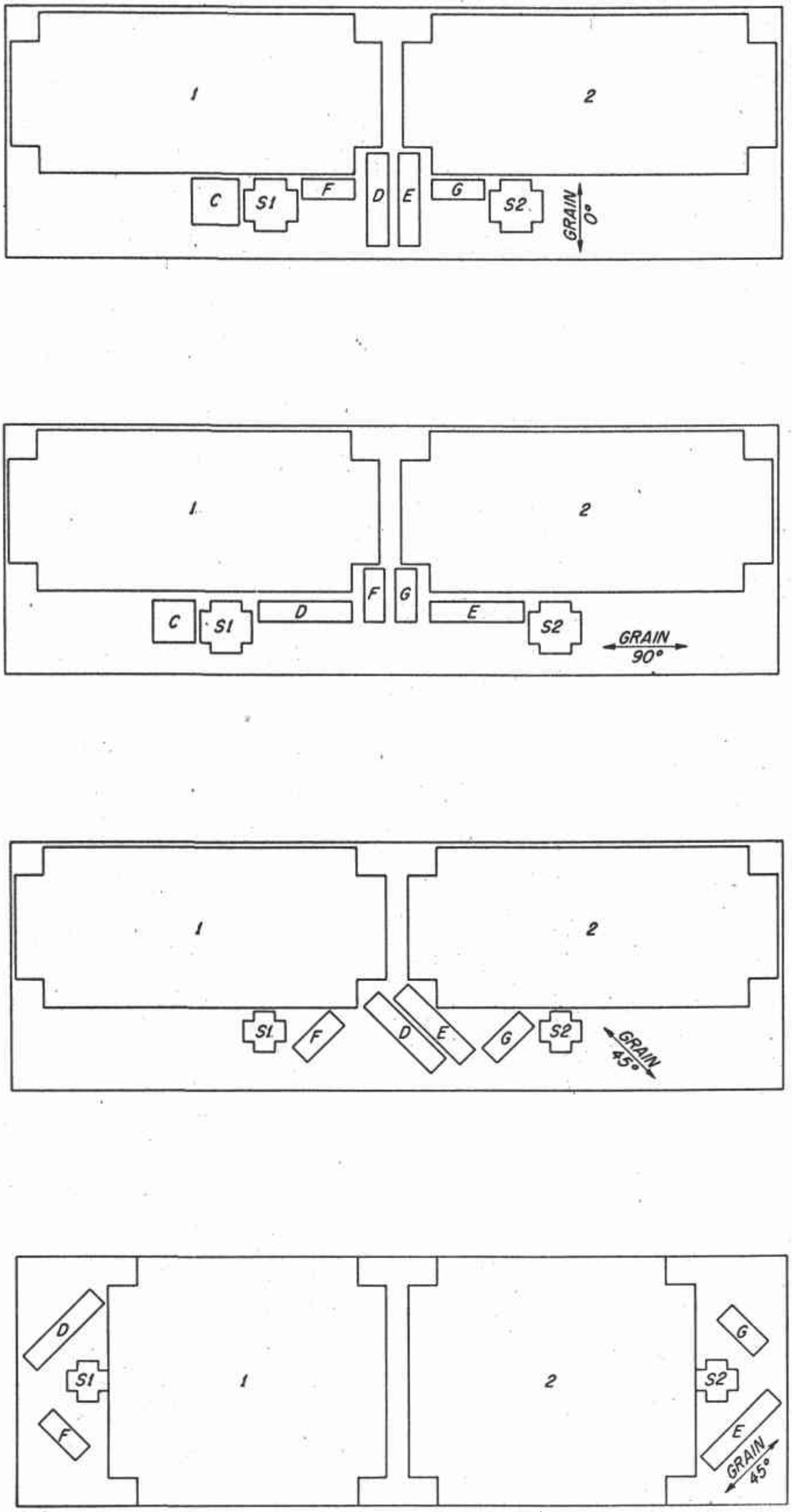
Table 26a.--Results of tests for stiffness of frame members matching square buckling panels with face grain at +45°

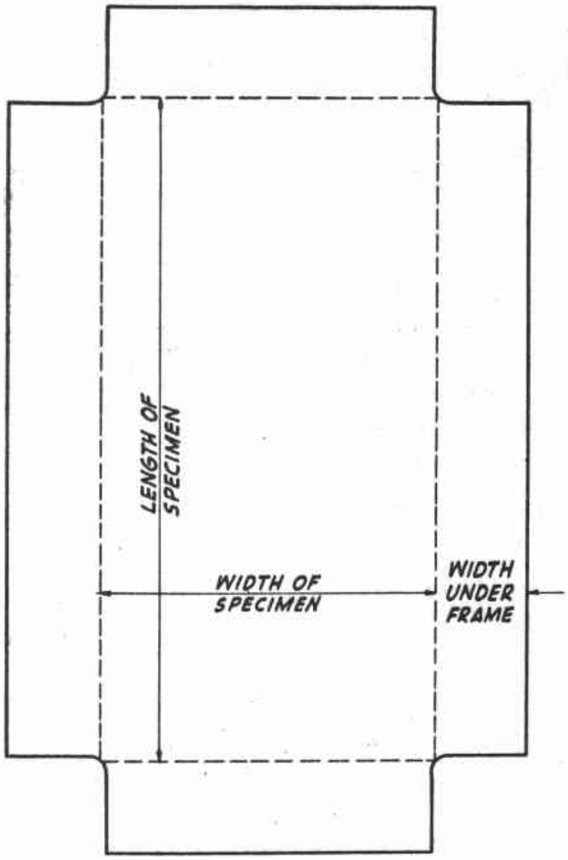
Buckling test Specimen No.	Frame test data: Frame No.	Span	Width	Depth	EI	Average EI	Ratio of buckling stresses Observed / Computed as
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		In.	In.	In.	1,000 lb. per sq. in.	1,000 lb. per sq. in.	
6ka-s1	1	6	1.707	2.520	1,350.0	1,390.2	1.55
	2	6	1.709	2.526	1,430.5		
6ka-s2	1	6	1.710	2.528	1,161.3	1,216.0	2.06
	2	6	1.709	2.521	1,270.6		
6ka-s3	1	6	1.713	2.521	1,193.4	1,228.3	2.10
	2	6	1.710	2.520	1,263.2		
6ka-s4	1	6	1.709	2.530	1,241.4	1,198.2	1.80
	2	6	1.709	2.520	1,155.1		
6ka-s5	1	16	1.706	2.768	4,384.1	4,128.0	1.76
	2	16	1.715	2.768	4,266.7		
	3	16	1.702	2.770	3,733.3		
6kb-s1	1	16	1.703	2.775	4,474.4	4,247.2	1.98
	2	16	1.712	2.769	4,251.5		
	3	16	1.710	2.771	4,015.7		
6kc-s3	1	6	1.707	2.529	1,297.3	1,378.4	2.19
	2	6	1.705	2.532	1,459.5		
4ka-s2	1	11	1.586	2.528	2,298.8	2,313.9	1.70
	2	11	1.590	2.532	2,164.2		
	3	11	1.589	2.532	2,478.6		
4kd-s1	1	11	1.587	2.501	1,120.4	1,329.4	4.36
	2	11	1.584	2.501	1,348.5		
	3	11	1.590	2.502	1,519.4		
4ke-s1	1	11	1.588	2.490	1,386.5	1,401.4	3.03
	2	11	1.584	2.491	1,386.5		
	3	11	1.582	2.492	1,431.2		
40c-v1	1	5	1.595	2.520	699.1	780.9	.85
	2	5	1.585	2.508	826.7		
	3	5	1.601	2.526	744.0		
	4	5	1.585	2.508	853.8		
40c-v2	1	5	1.594	2.507	643.0	672.1	1.55
	2	5	1.596	2.508	694.4		
	3	5	1.600	2.524	676.4		
	4	5	1.600	2.506	674.7		
40c-v3	1	7	1.589	2.510	1,221.5	1,310.0	1.75
	2	7	1.494	2.506	1,367.6		
	3	7	1.498	2.512	1,429.2		
	4	7	1.484	2.516	1,221.5		
40c-v4	1	8	1.581	2.496	1,481.5	1,531.0	2.62
	2	8	1.583	2.518	1,741.5		
	3	8	1.581	2.506	1,398.9		
	4	8	1.590	2.516	1,502.3		
40c-v5	1	10	1.589	2.509	1,902.6	1,809.8	1.52
	2	10	1.591	2.508	1,876.9		
	3	10	1.586	2.508	1,640.4		
	4	10	1.588	2.506	1,819.5		
40d-v1	1	8	1.581	1.996	1,300.8	1,176.6	2.39
	2	8	1.588	1.998	1,172.2		
	3	8	1.589	2.005	1,153.2		
	4	8	1.581	1.995	1,080.2		
40d-v2	1	8	1.587	2.244	1,376.3	1,431.0	1.82
	2	8	1.579	2.240	1,398.9		
	3	8	1.585	2.250	1,502.3		
	4	8	1.582	2.252	1,446.3		
40d-v3	1	8	1.586	2.504	1,580.2	1,576.6	1.76
	2	8	1.582	2.511	1,481.5		
	3	8	1.573	2.508	1,616.2		
	4	8	1.582	2.500	1,628.5		
40d-v4	1	8	1.593	2.757	1,169.0	1,492.6	2.67
	2	8	1.585	2.750	1,673.2		
	3	8	1.595	2.770	1,815.6		
	4	8	1.601	2.772	1,312.8		
40d-v5	1	8	1.590	3.024	1,855.1	1,897.4	2.66
	2	8	1.598	3.018	2,081.3		
	3	8	1.602	3.018	1,748.6		
	4	8	1.595	3.016	1,904.8		
5a-v1	1	6	1.659	2.514	1,168.8	1,093.2	1.11
	2	6	1.658	2.515	967.7		
	3	6	1.656	2.511	1,111.1		
	4	6	1.658	2.517	1,125.0		
5a-v2	1	7	1.653	2.506	1,408.0	1,344.6	1.58
	2	7	1.653	2.514	1,311.2		
	3	7	1.660	2.517	1,335.7		
	4	7	1.656	2.510	1,323.3		
5a-v3	1	8	1.651	2.512	1,534.8	1,673.7	1.93
	2	8	1.651	2.509	1,616.2		
	3	8	1.655	2.510	1,823.4		
	4	8	1.663	2.517	1,720.4		
5a-v4	1	9	1.650	2.500	2,146.6	1,976.6	1.31
	2	9	1.649	2.504	1,797.3		
	3	9	1.653	2.507	2,154.3		
	4	9	1.654	2.500	1,808.0		
5a-v5	1	10	1.653	2.506	2,136.8	2,053.9	1.65
	2	10	1.646	2.504	2,052.5		
	3	10	1.648	2.500	2,115.1		
	4	10	1.652	2.502	1,911.3		
5b-v1	1	8	1.645	1.994	1,354.5	1,221.8	1.87
	2	8	1.648	1.998	1,169.0		
	3	8	1.643	2.004	1,185.2		
	4	8	1.647	1.997	1,178.6		
5b-v2	1	8	1.649	2.241	1,523.8	1,485.2	1.86
	2	8	1.646	2.252	1,523.8		
	3	8	1.649	2.241	1,461.2		
	4	8	1.647	2.248	1,431.8		
5b-v3	1	8	1.658	2.502	1,628.5	1,666.5	1.40
	2	8	1.651	2.512	1,693.1		
	3	8	1.654	2.516	1,610.1		
	4	8	1.654	2.506	2,734.4		
5b-v4	1	8	1.655	2.755	1,706.7	1,916.8	1.96
	2	8	1.658	2.756	2,133.3		
	3	8	1.657	2.769	1,887.9		
	4	8	1.653	2.753	1,939.4		
5b-v5	1	8	1.655	3.014	2,012.6	1,988.9	2.27
	2	8	1.659	3.010	1,887.9		
	3	8	1.660	3.022	2,133.3		
	4	8	1.662	3.012	1,921.9		
17a-v1	1	7	1.751	2.509	1,387.5	1,343.0	.79
	2	7	1.740	2.514	1,287.5		
	3	7	1.744	2.503	1,361.1		
	4	7	1.742	2.510	1,335.7		
17a-v2	1	8	1.733	2.502	1,693.1	1,722.5	.98
	2	8	1.748	2.508	1,706.7		
	3	8	1.741	2.520	1,823.4		
	4	8	1.739	2.507	1,666.7		
17a-v3	1	10	1.731	2.502	2,222.2	2,211.7	1.09
	2	10	1.730	2.506	2,052.5		
	3	10	1.730	2.505	2,204.6		
	4	10	1.727	2.505	2,367.4		
17c-v2	1	10	1.740	2.504	2,276.9	2,191.6	1.33
	2	10	1.733	2.502	2,022.7		
	3	10	1.732	2.504	2,340.8		
	4	10	1.739	2.499	2,125.8		
17c-v3	1	11	1.742	2.500	2,579.5	2,475.2	1.16
	2	11	1.753	2.517	2,437.7		
	3	11	1.742	2.498	2,385.3		
	4	11	1.749	2.511	2,498.1		
17b-v2	1	8	1.722	2.250	1,616.2	1,530.2	1.17
	2	8	1.725	2.249	1,610.1		
	3	8	1.724	2.250	1,481.5		
	4	8	1.723	2.238	1,412.8		
17b-v3	1	8	1.730	2.504	1,823.4	1,819.4	1.14
	2	8	1.727	2.498	1,896.3		
	3	8	1.741	2.520	1,734.4		
	4	8	1.749	2.511	1,823.4		
17c-v1	1	8	1.746	3.012	2,480.6	2,255.6	.85
	2	8	1.735	3.014	1,984.5		
	3	8	1.750	3.017	2,133.3		
	4	8	1.750	3.015	2,424.2		

Z M 85290 F

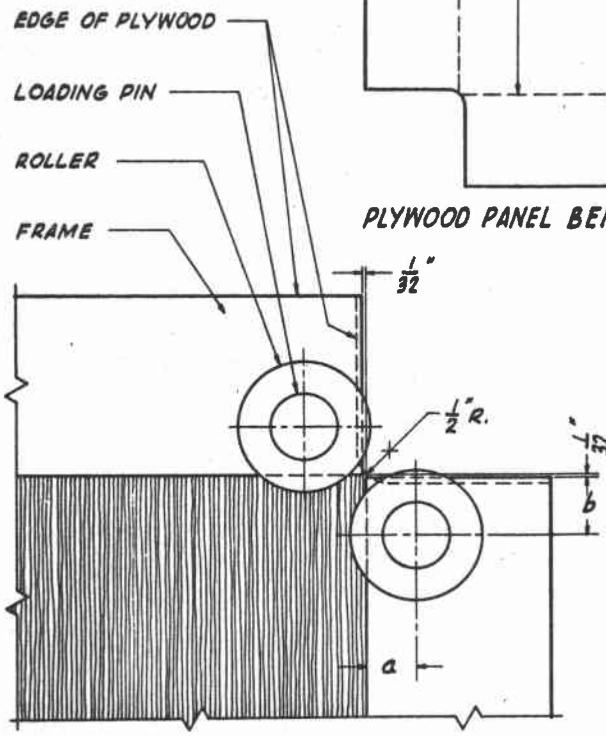


Z M 56941 F

Figure 108.--Typical layouts of specimens on sheets of plywood 2 by 6 feet.



PLYWOOD PANEL BEFORE FRAME ASSEMBLY



DETAIL OF CORNER SHOWING FRAME AND ROLLER ASSEMBLY

TABLE OF DIMENSIONS			
DIAMETER OF HOLE	a	b	DIAMETER OF ROLLER
1/4"	1/4"	5/16"	3/4"
1/2"	7/16"	5/8"	1 1/2"
3/4"	9/16"	3/4"	1 3/4"
1"	3/4"	7/8"	2"

M 54366 F

Figure 109.--Method of preparing buckling specimens.

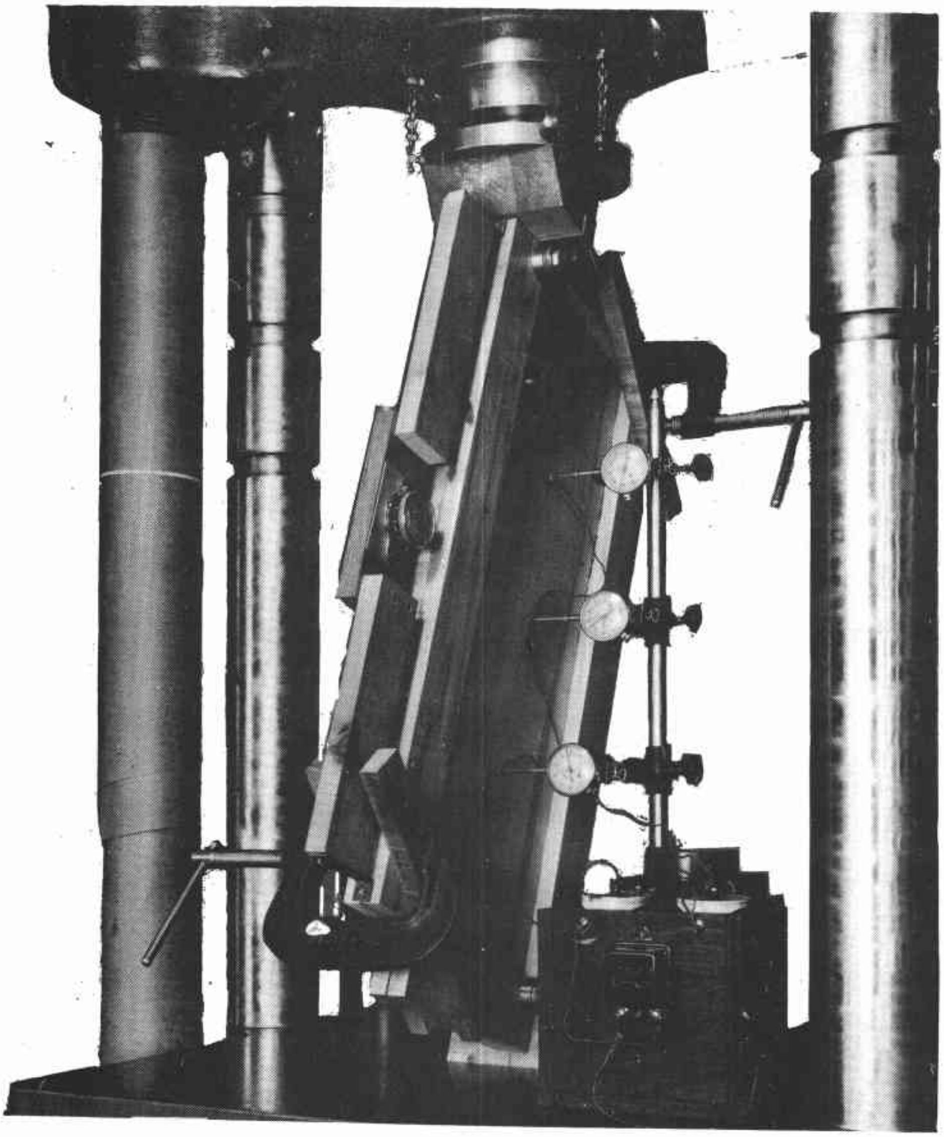


Figure 110.--Method used for making shear buckling test, showing lateral and frame gages in place. Diagonal gages not shown.

Z M 58943 F

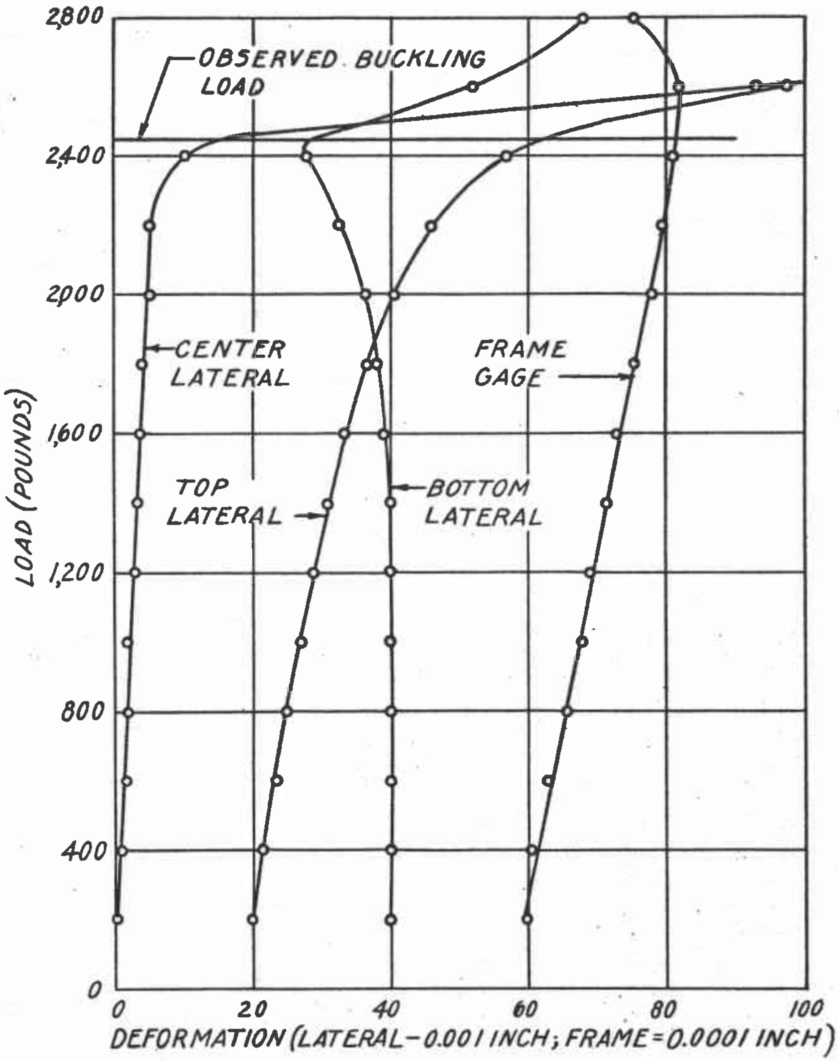


Figure 111.--Flexure of frame and lateral deflections of specimen 6 x c-1 during test.

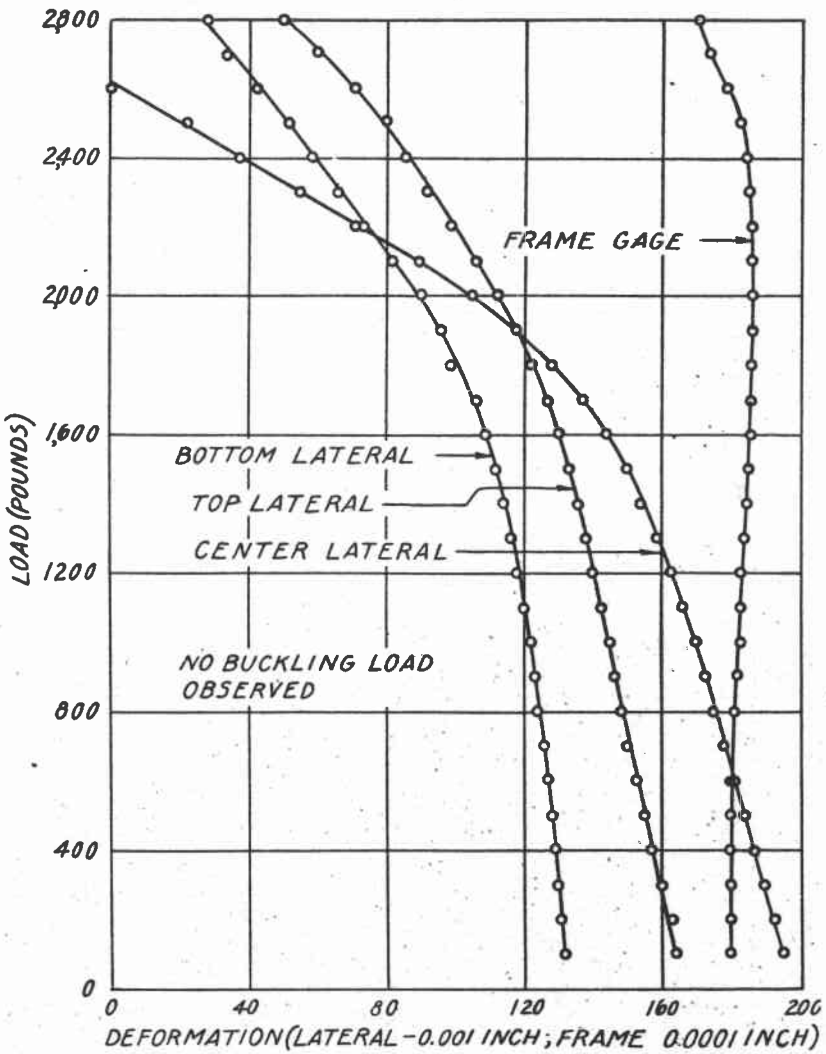


Figure 112.--Flexure of frame and lateral deflections of specimen 6 x c-2 during test.

Z M 58944 F

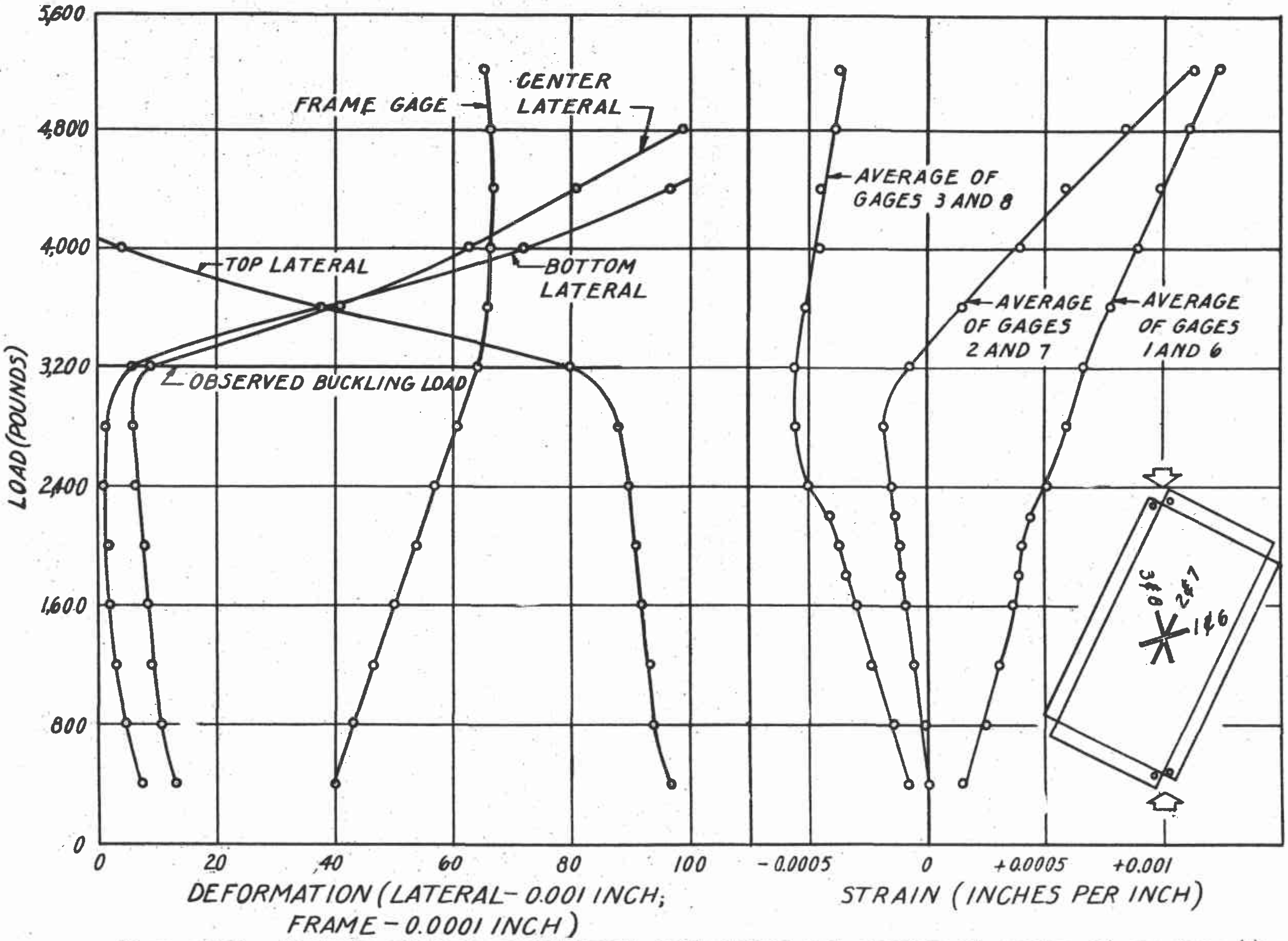


Figure 113.--Flexure of frame and lateral deflections and strains at center of specimen 44 x n-2 during test.

Z M 58945 F

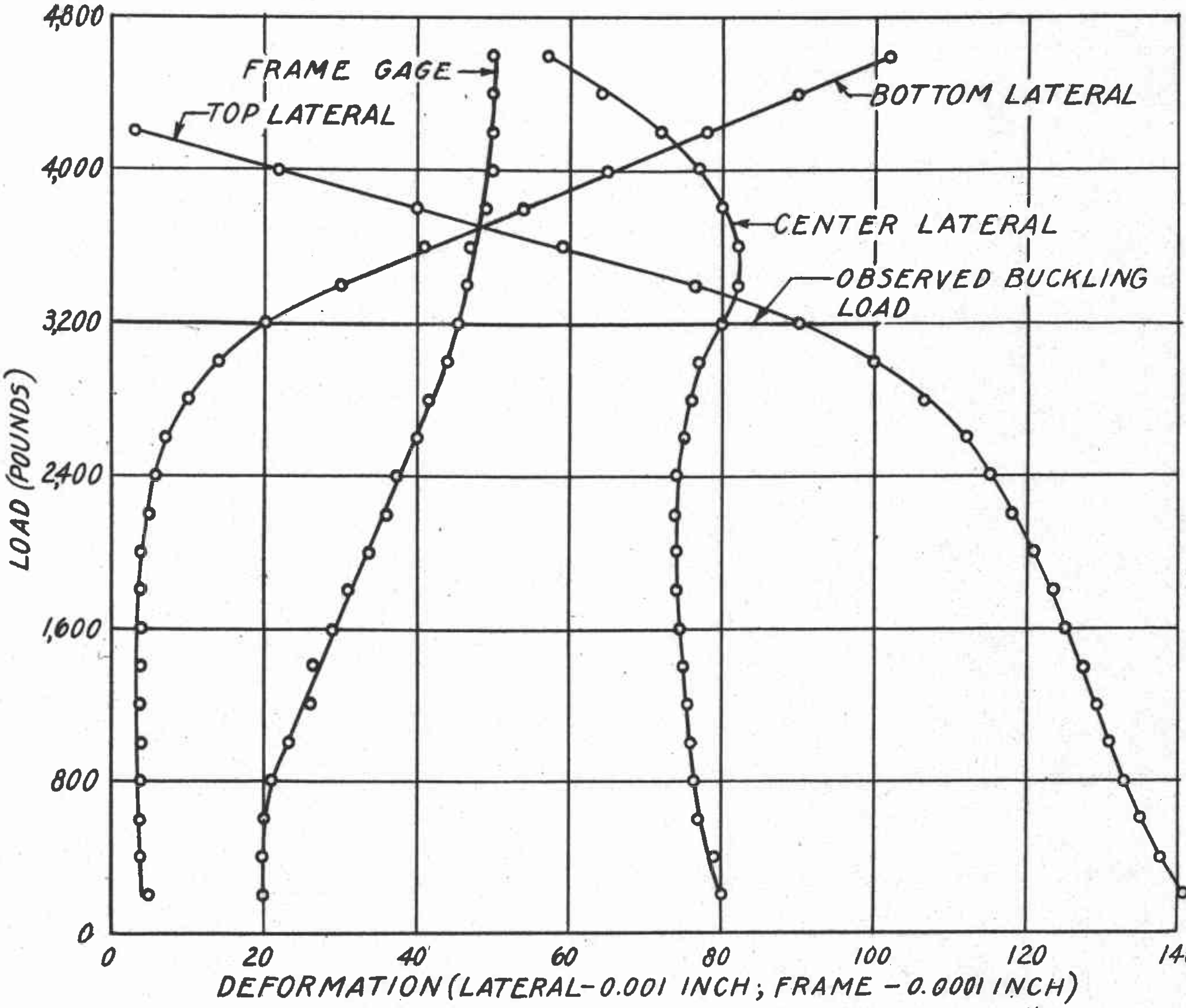


Figure 114.--Flexure of frame and lateral deflection of specimen 44 x n-1 during test.

Z M 58946 F

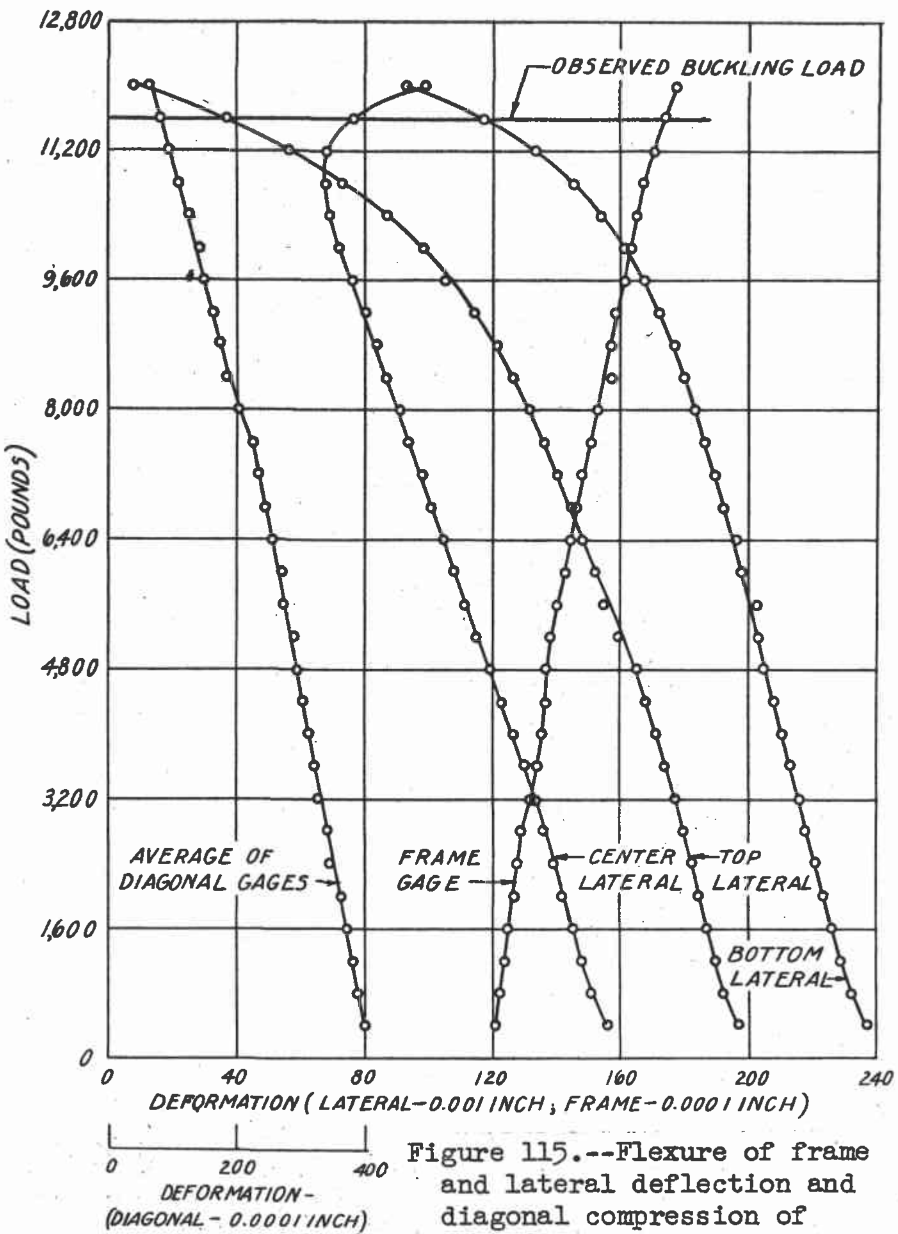


Figure 115.--Flexure of frame and lateral deflection and diagonal compression of specimen 17 x h-1 during test.

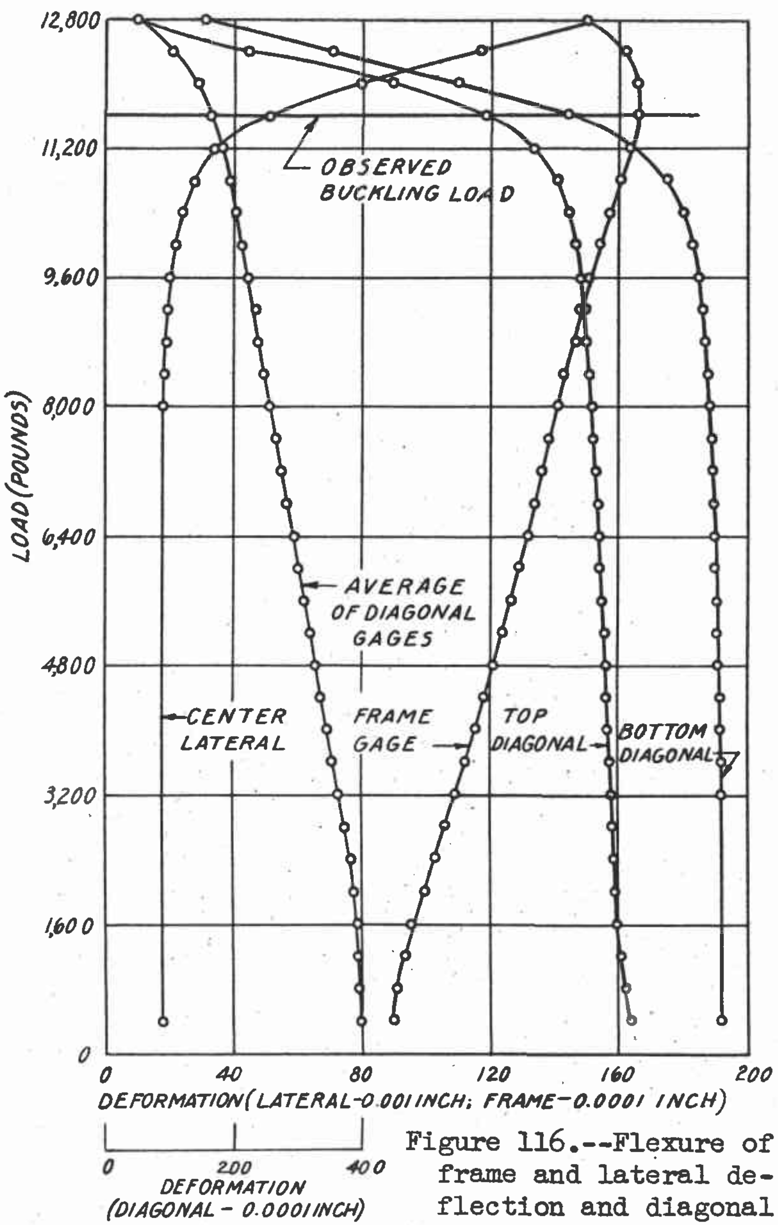


Figure 116.--Flexure of frame and lateral deflection and diagonal compression of specimen 17 x h-2 during test.

Z M 58947 F

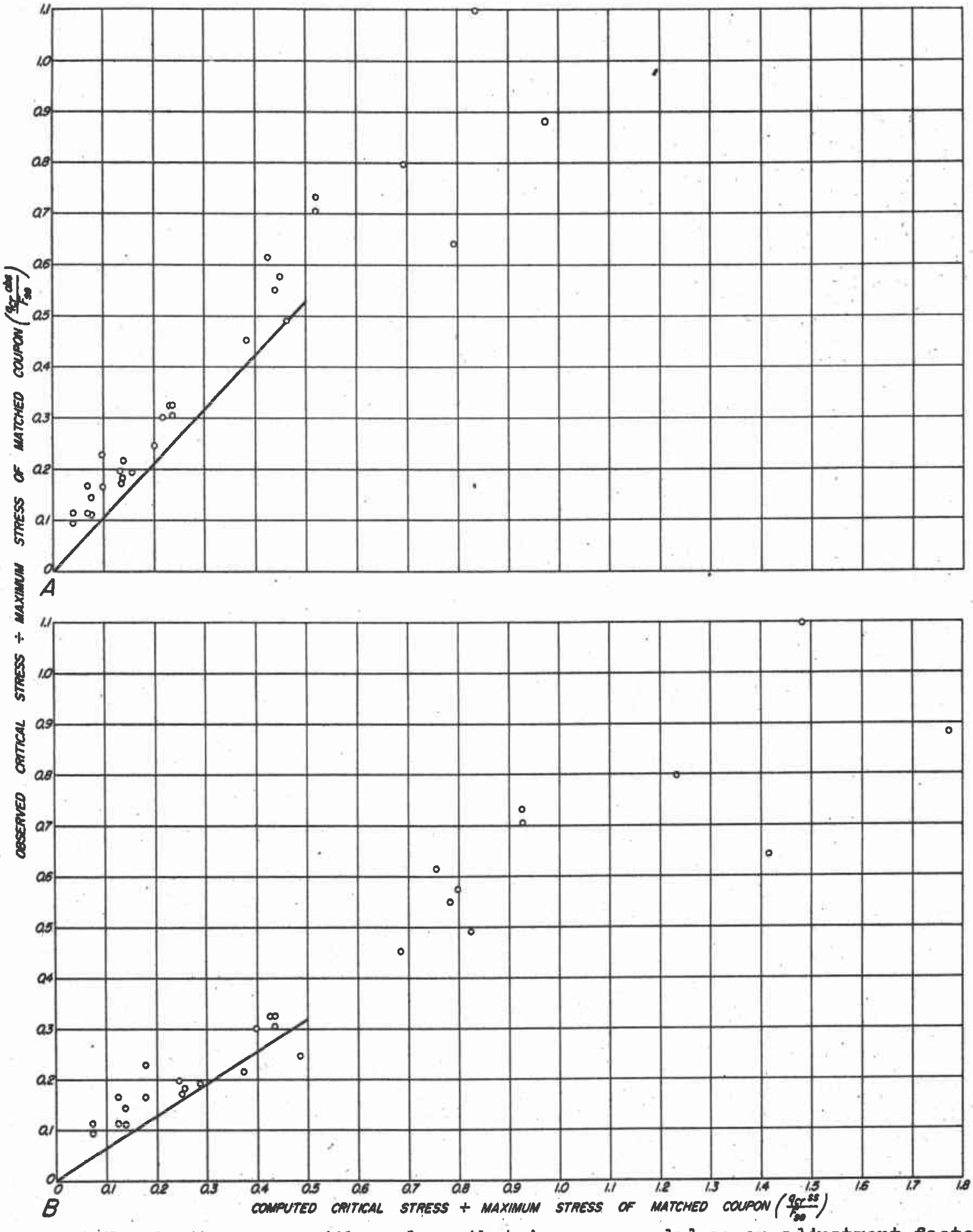


Figure 117.--A, the curve with a slope that is recommended as an adjustment factor for the computed stresses together with data plotted for the comparison of observed stresses with stresses computed by assuming simply supported edges. B, the same except that clamped edges were assumed instead of simply supported edges. Test specimens were 10 x 20 inches. Face grain was 0°. ZM85068F

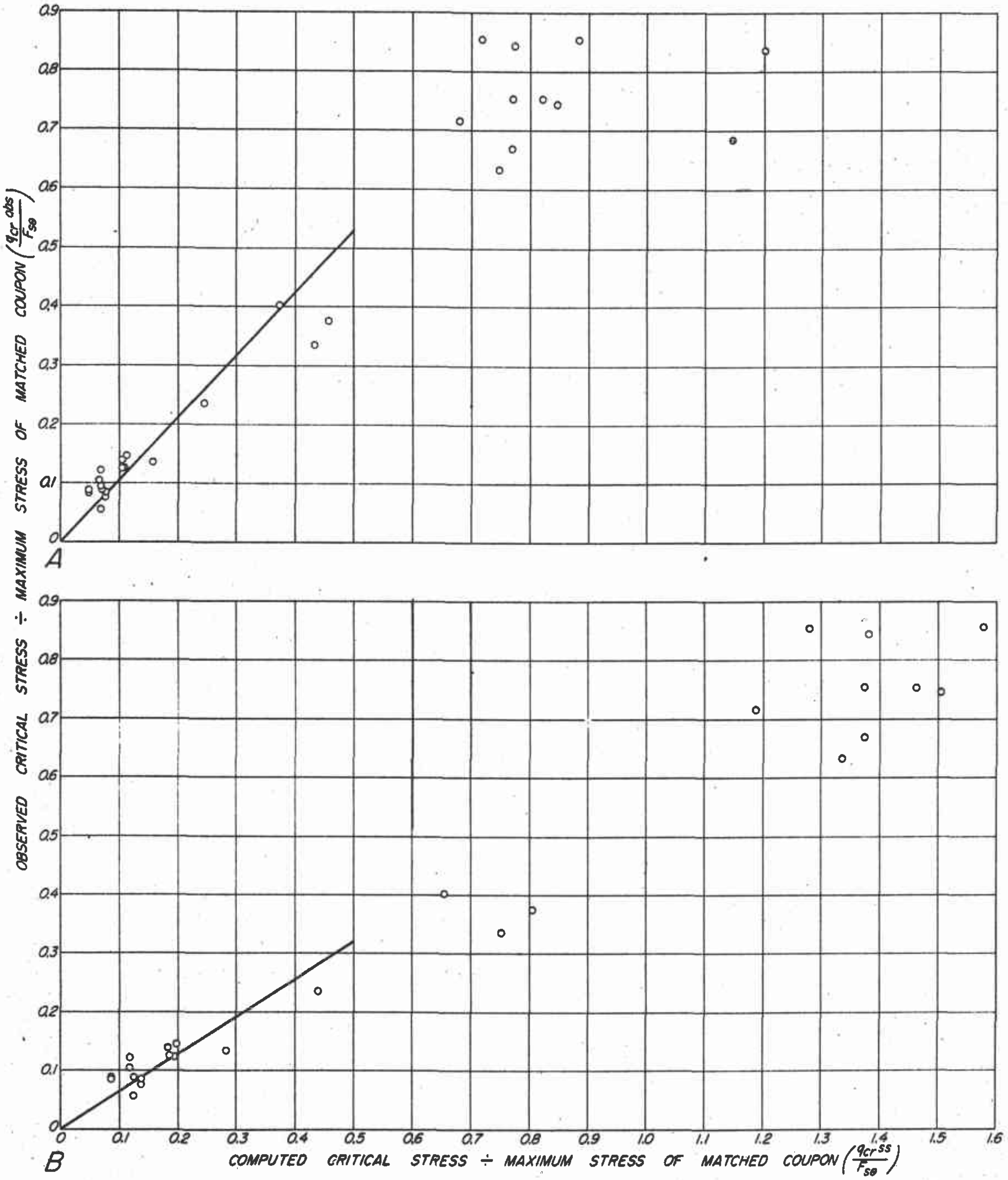
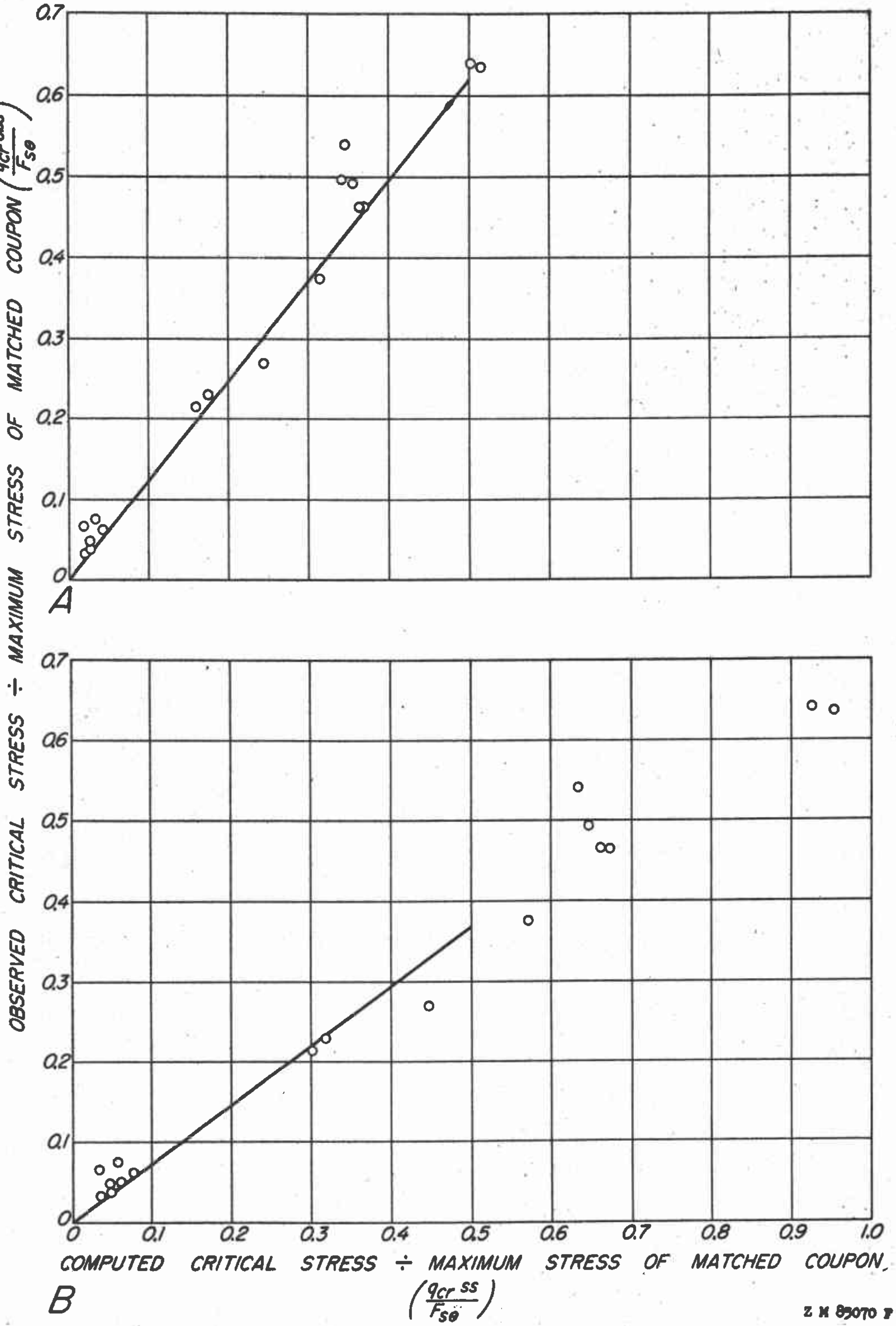


Figure 118.--A, the curve with a slope that is recommended as an adjustment factor for the computed stresses together with data plotted for the comparison of observed stresses with stresses computed by assuming simply supported edges. B, the same except that clamped edges were assumed instead of simply supported edges. Test specimens were 10 x 30 inches. Face grain was 0°.

Z M 85069 F



Z M 85070 F

Figure 119.--A, the curve with a slope that is recommended as an adjustment factor for the computed stresses together with data plotted for the comparison of observed stresses with stresses computed by assuming simply supported edges. B, the same except that clamped edges were assumed instead of simply supported edges. Test specimens were 10 x 20 inches. Face grain was 90°.

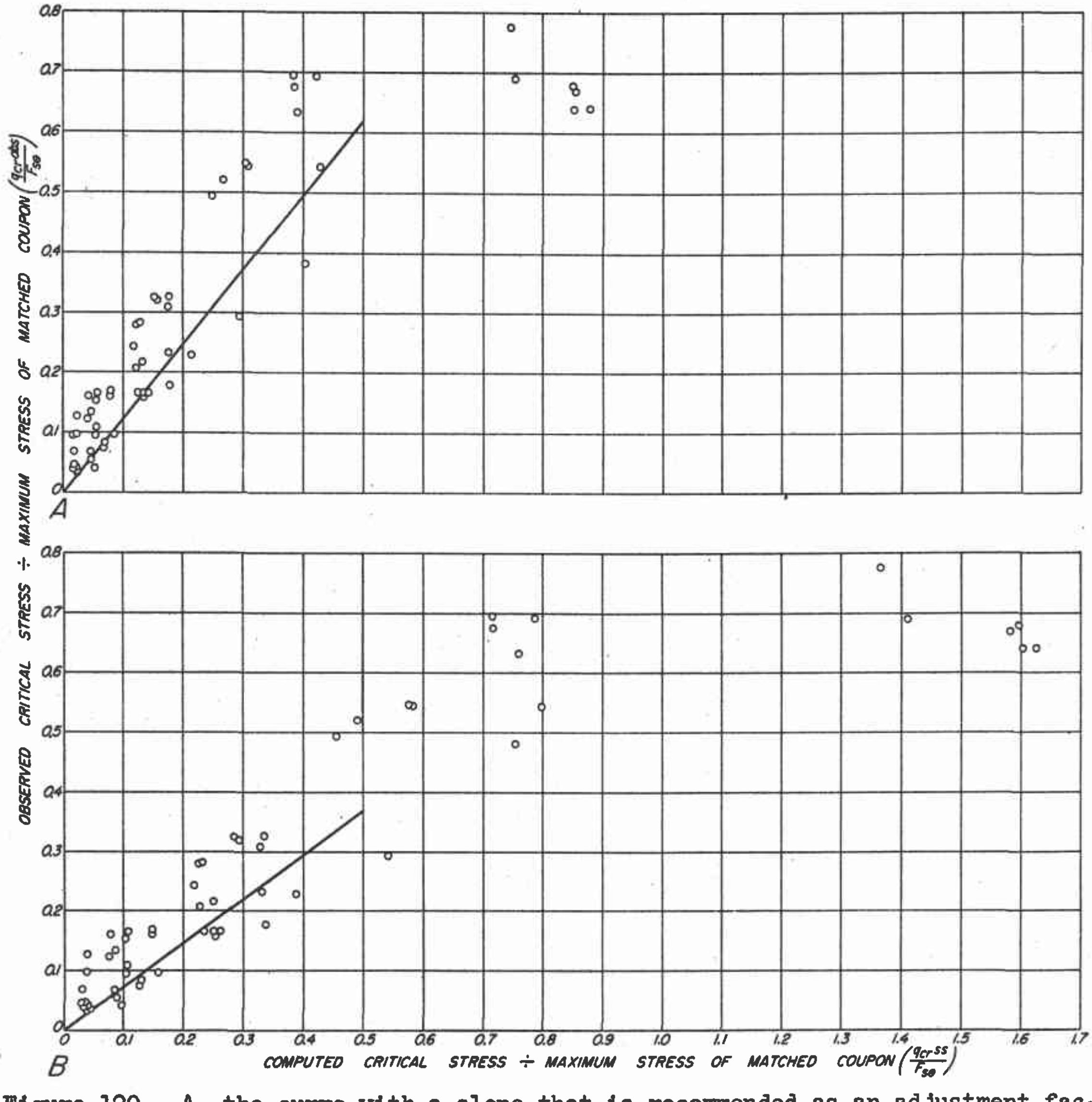


Figure 120.--A, the curve with a slope that is recommended as an adjustment factor for the computed stresses together with data plotted for the comparison of observed stresses with stresses computed by assuming simply supported edges. B, the same except that clamped edges were assumed instead of simply supported edges.

Test specimens were 10 x 30 inches. Face grain was 90°.

Z M 85071 F

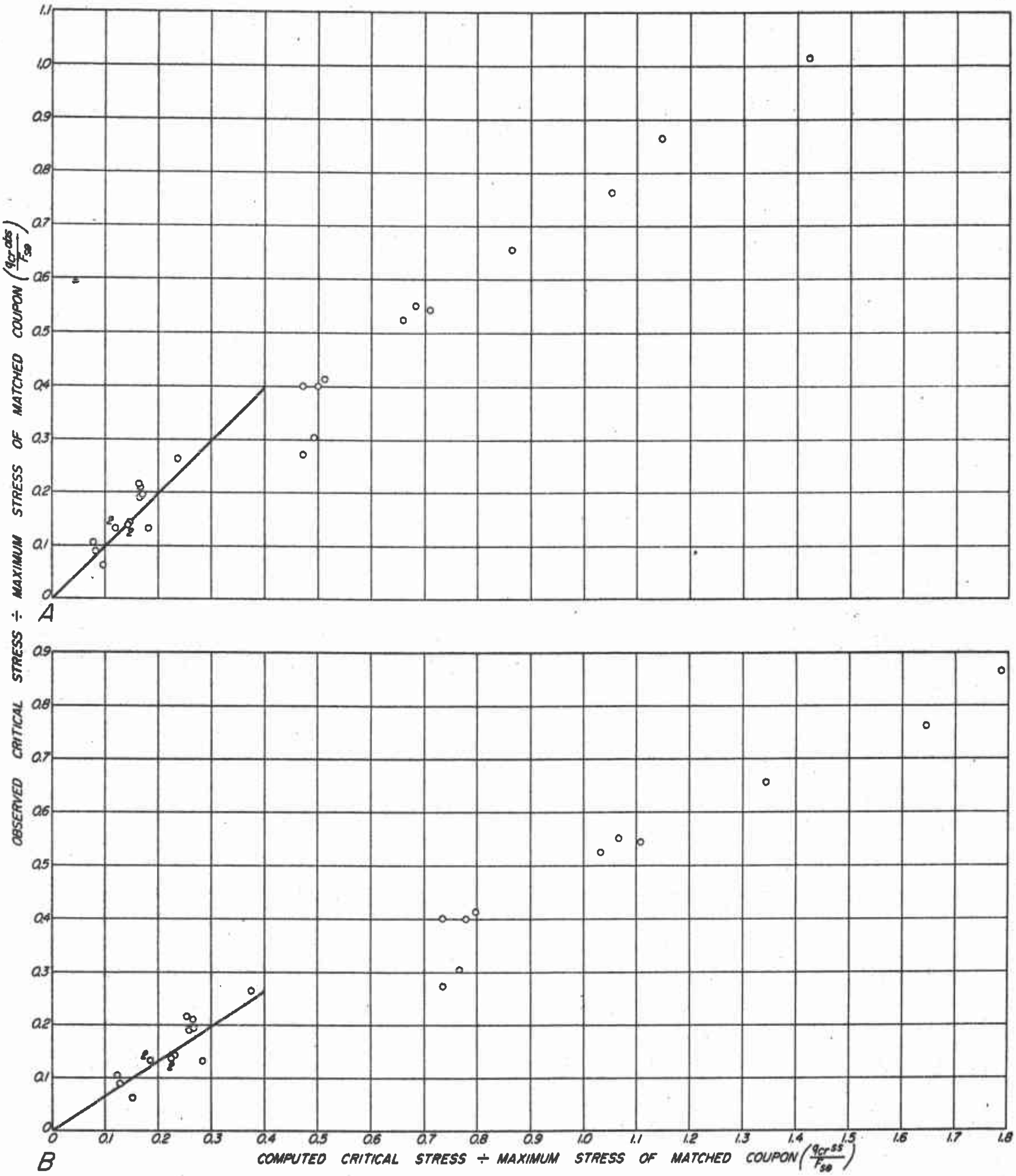


Figure 121.--A, the curve with a slope that is recommended as an adjustment factor for the computed stresses together with data plotted for the comparison of observed stresses with stresses computed by assuming simply supported edges. B, the same except that clamped edges were assumed instead of simply supported edges. Test specimens were 10 x 20 inches. Face grain was -45°.

Z M 85072 F

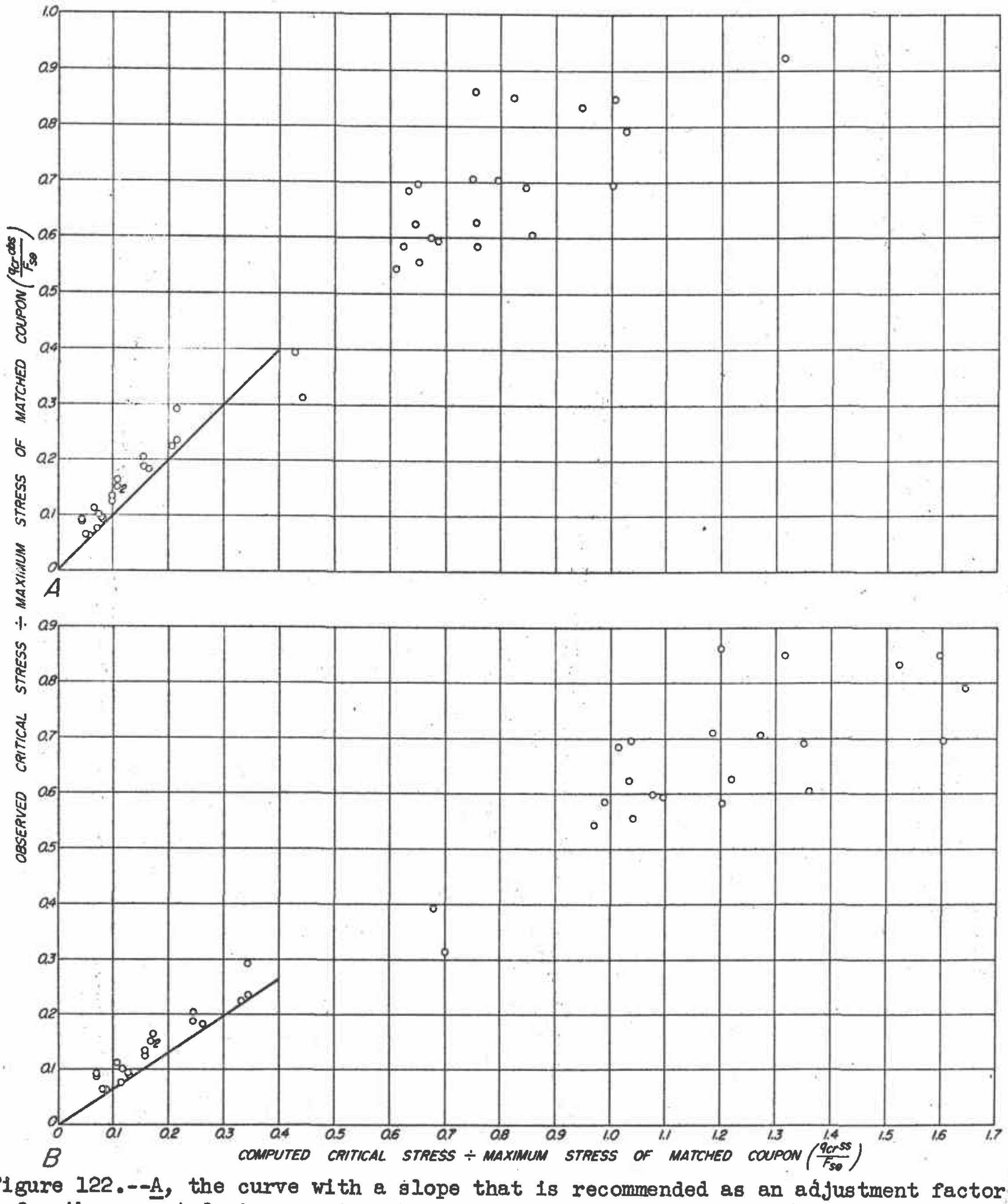


Figure 122.--A, the curve with a slope that is recommended as an adjustment factor for the computed stresses together with data plotted for the comparison of observed stresses with stresses computed by assuming simply supported edges. B, the same except that clamped edges were assumed instead of simply supported edges. Test specimens were 10 x 30 inches. Face grain was -45°.

Z M 85073 F

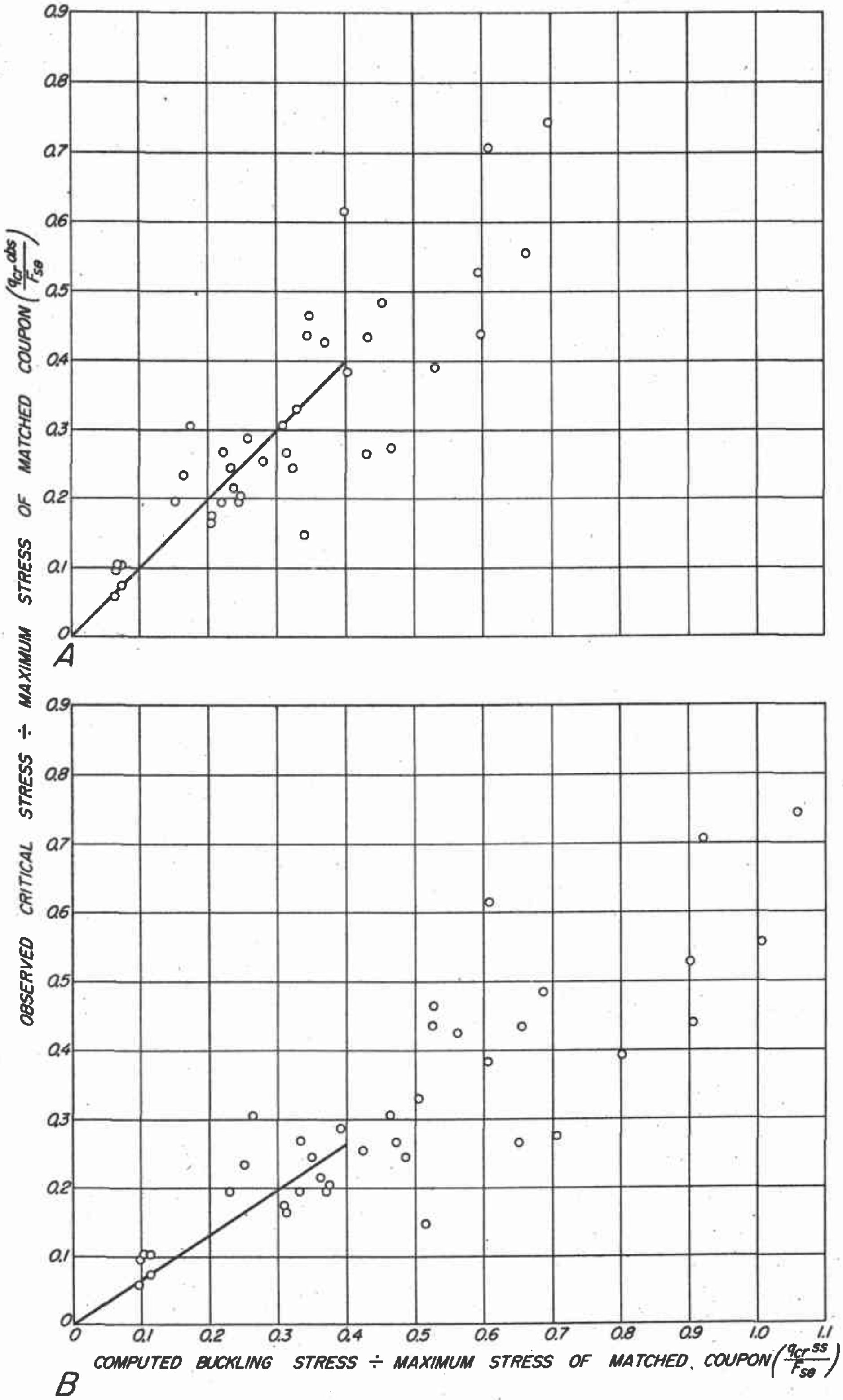


Figure 123.--A, the curve with a slope that is recommended as an adjustment factor for the computed stresses together with data plotted for the comparison of observed stresses with stresses computed by assuming simply supported edges. B, the same except that clamped edges were assumed instead of simply supported edges. Test specimens were square. Face grain was -45°.

ZM85074F

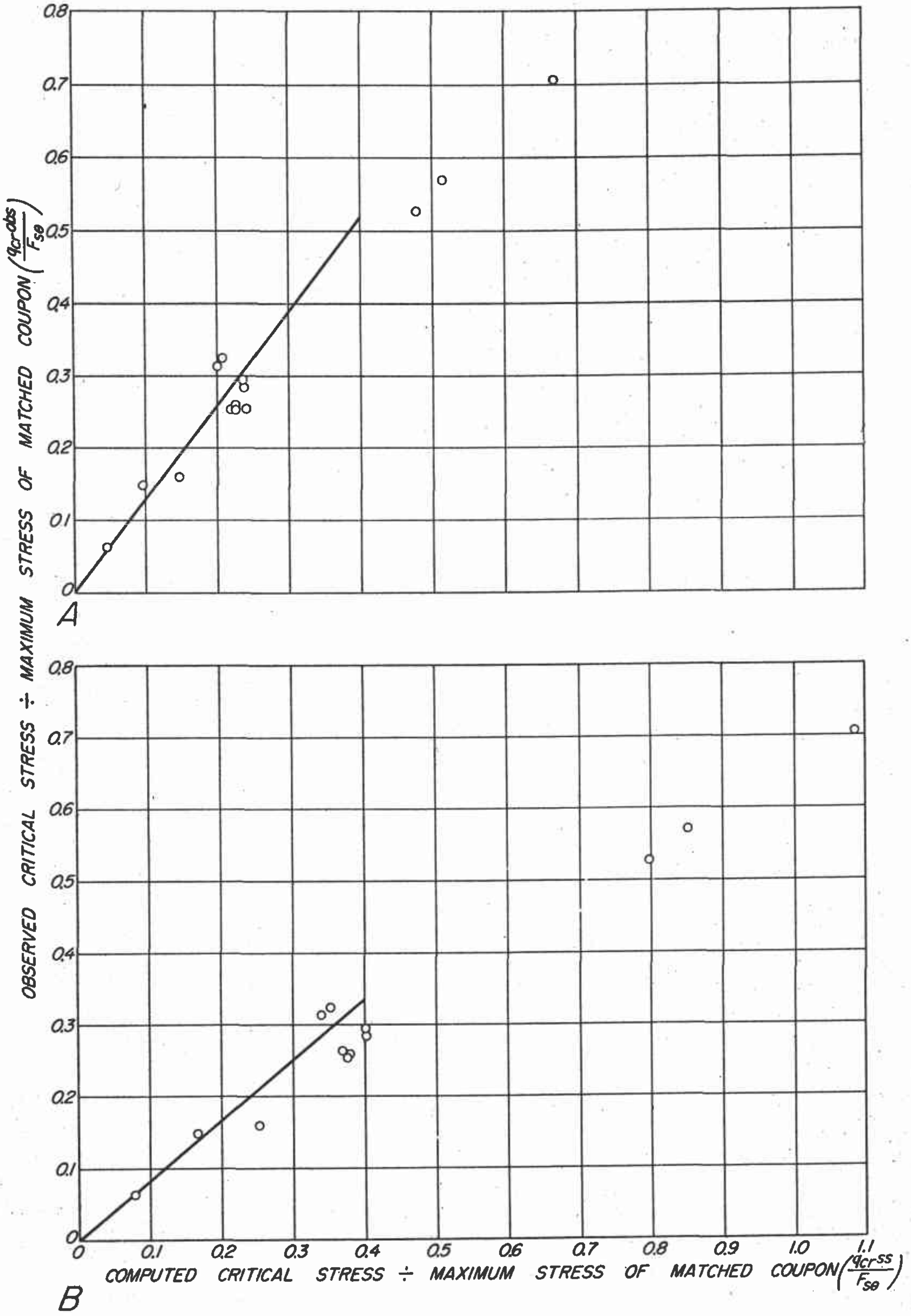


Figure 124.--A, the curve with a slope that is recommended as an adjustment factor for the computed stresses together with data plotted for the comparison of observed stresses with stresses computed by assuming simply supported edges. B, the same except that clamped edges were assumed instead of simply supported edges. Test specimens were 10 x 20 inches. Face grain was +45°.

ZM85075F

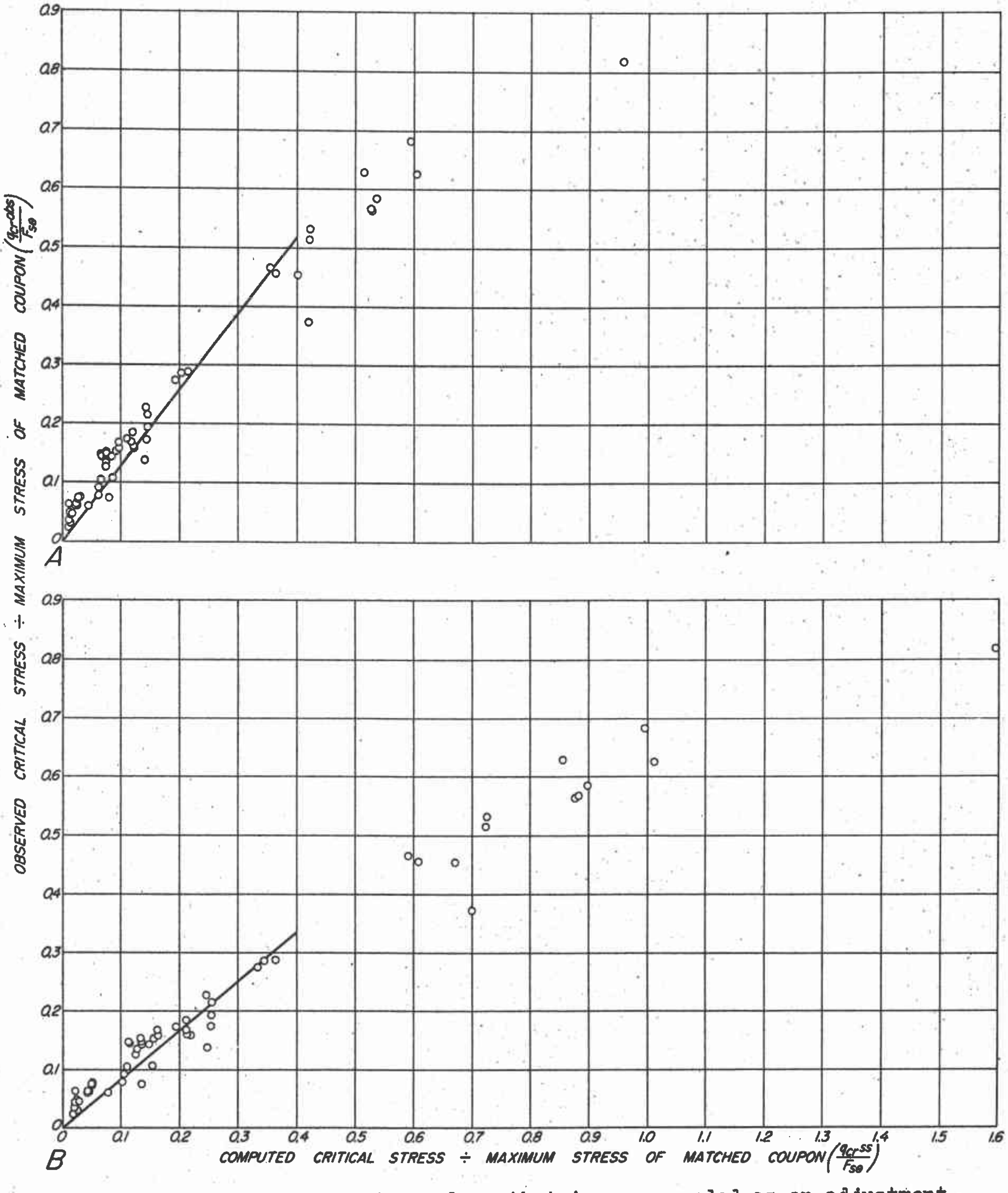


Figure 125.--A, the curve with a slope that is recommended as an adjustment factor for the computed stresses together with data plotted for the comparison of observed stresses with stresses computed by assuming simply supported edges. B, the same except that clamped edges were assumed instead of simply supported edges. Test specimens were 10 x 30 inches. Face grain was +45°. ZM85076F

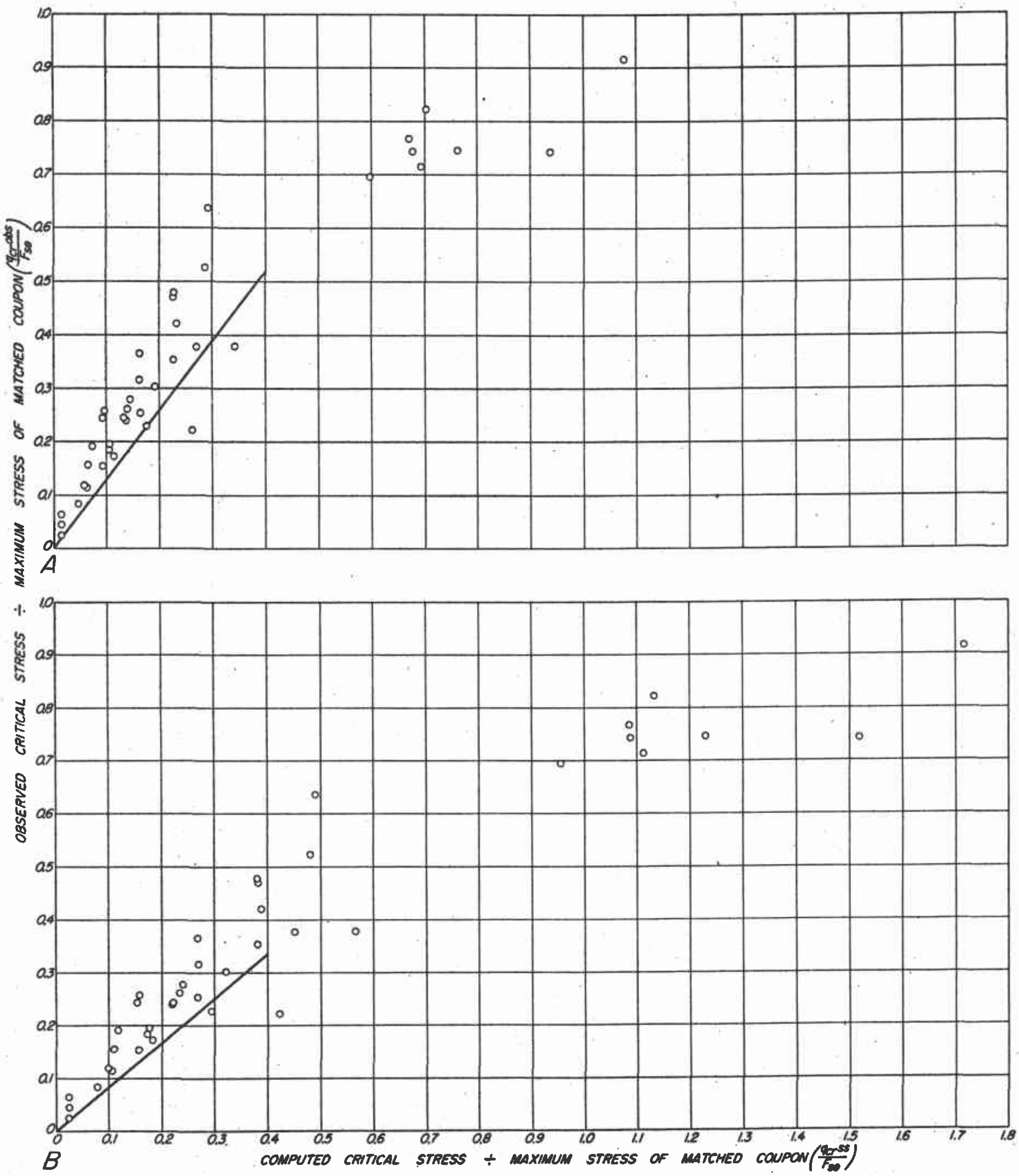


Figure 126.--A, the curve with a slope that is recommended as an adjustment factor for the computed stresses together with data plotted for the comparison of observed stresses with stresses computed by assuming simply supported edges. B, the same except that clamped edges were assumed instead of simply supported edges. Test specimens were square. Face grain was +45°. ZM85077F

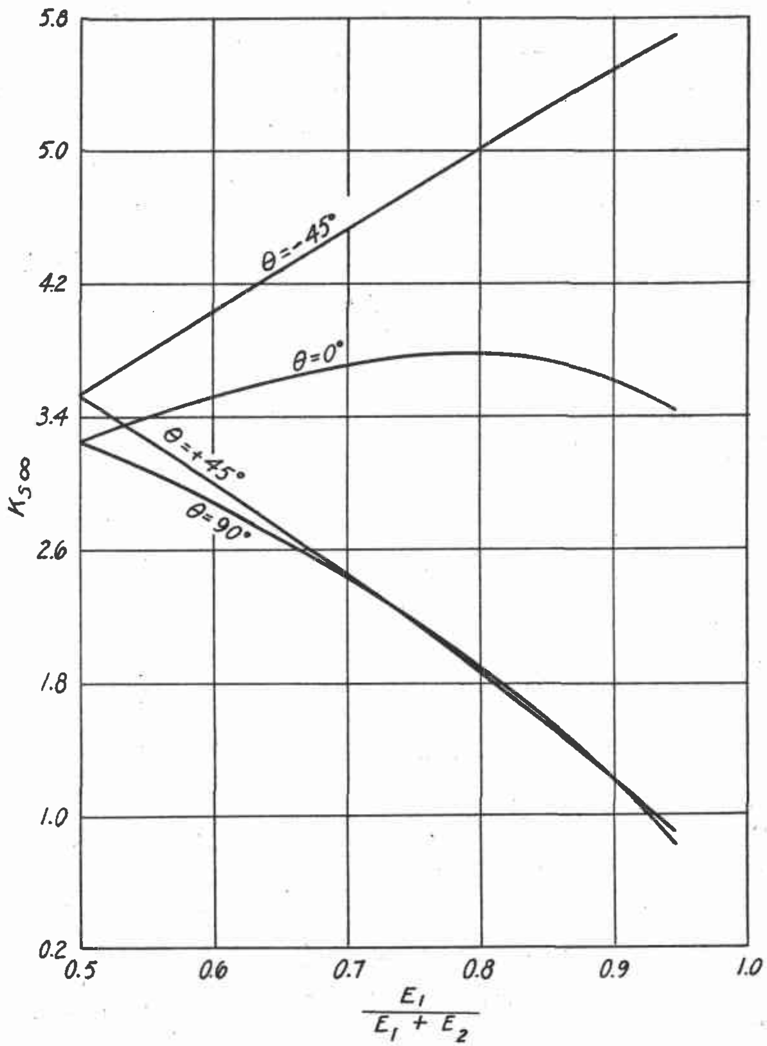


Figure 127.--Buckling under uniform shear of infinitely long plates of symmetrical construction, edges clamped. The constant k_s plotted as a function of the ratio $\frac{E_1}{E_1 + E_2}$

ZM58952F

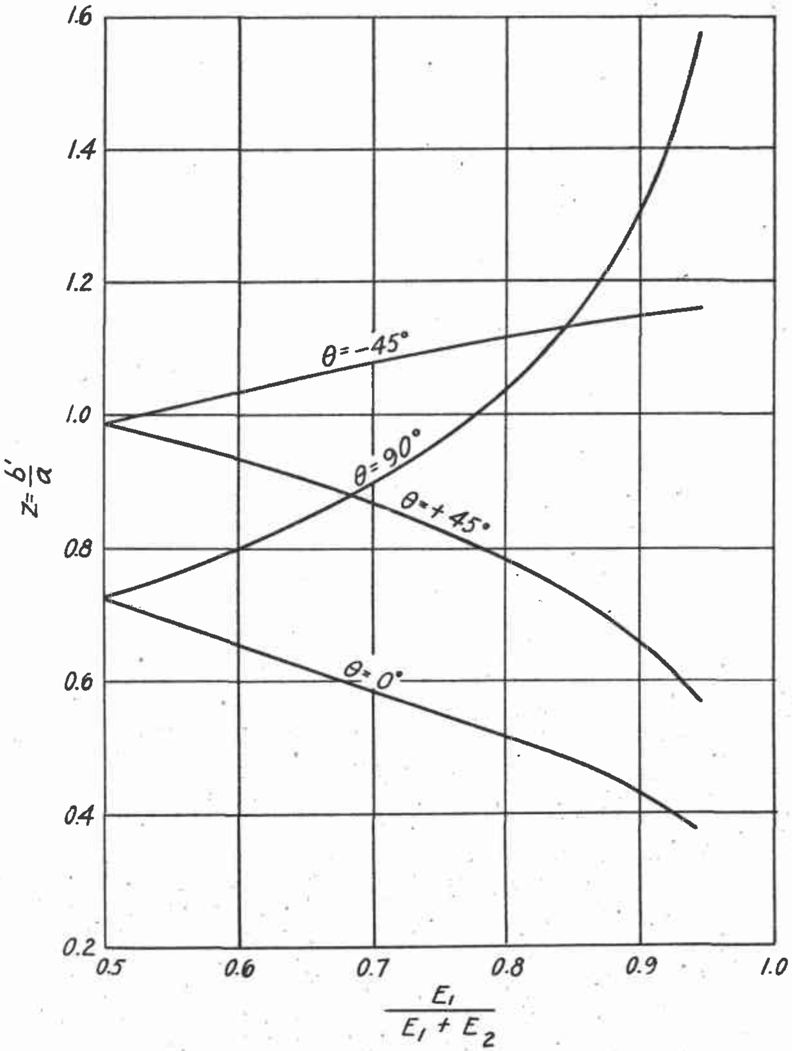


Figure 128.--Buckling under uniform shear of infinitely long plates of symmetrical construction, edges clamped. The constant Z plotted as a function of the ratio $\frac{E_1}{E_1 + E_2}$

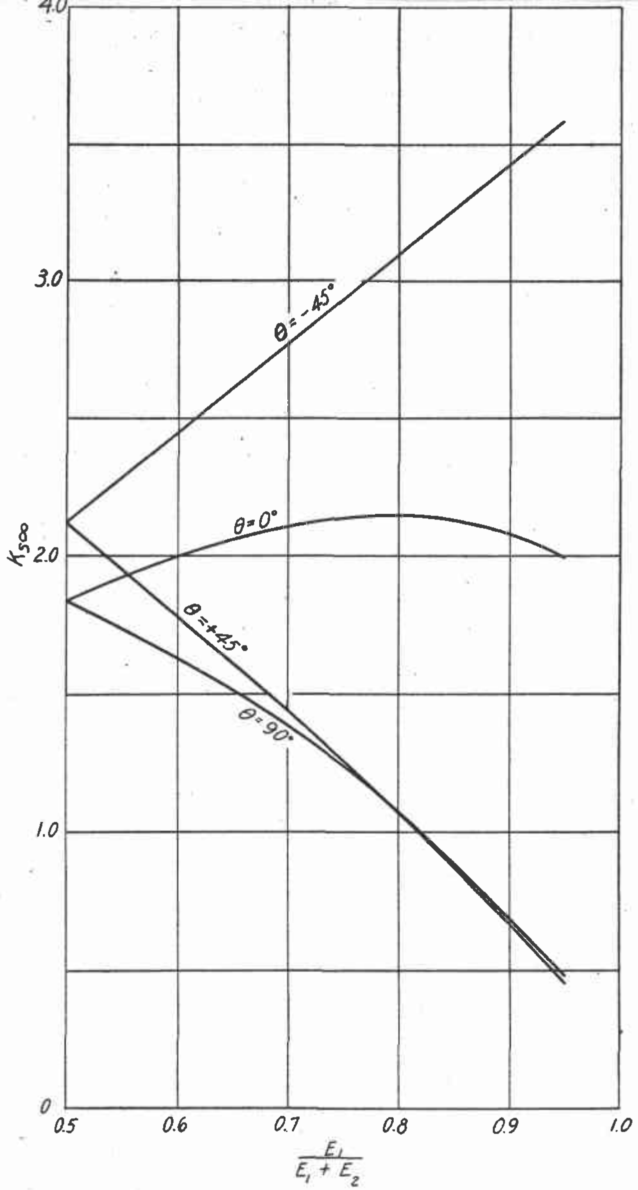


Figure 129.--Buckling under uniform shear of infinitely long plates of symmetrical construction. Edges simply supported. The constant k_s plotted as a function of the ratio $\frac{E_1}{E_1 + E_2}$.

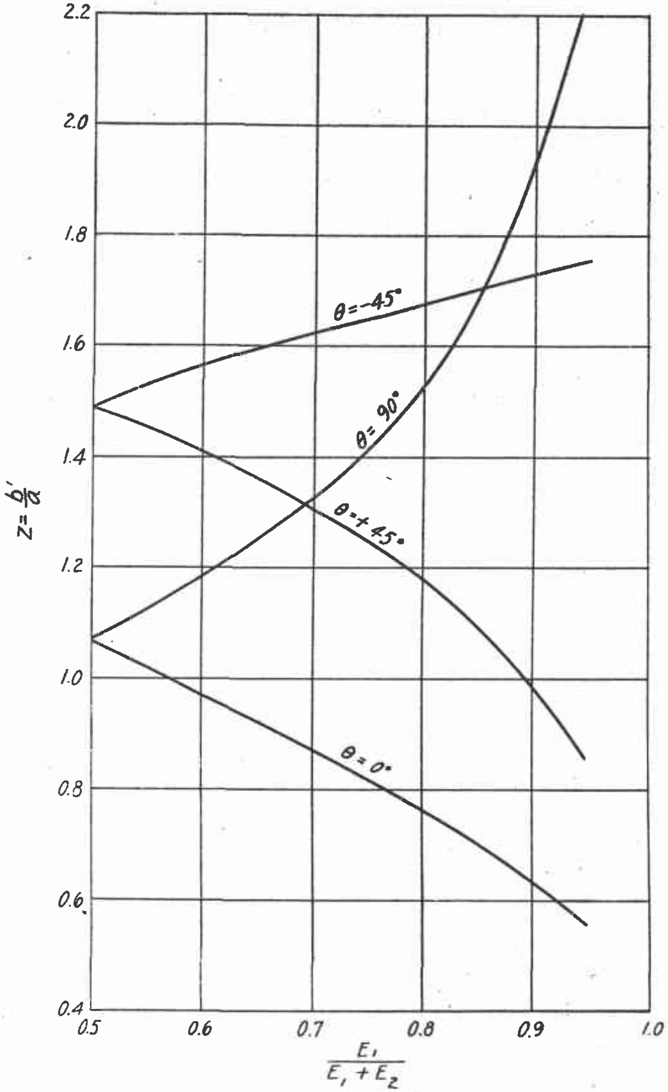
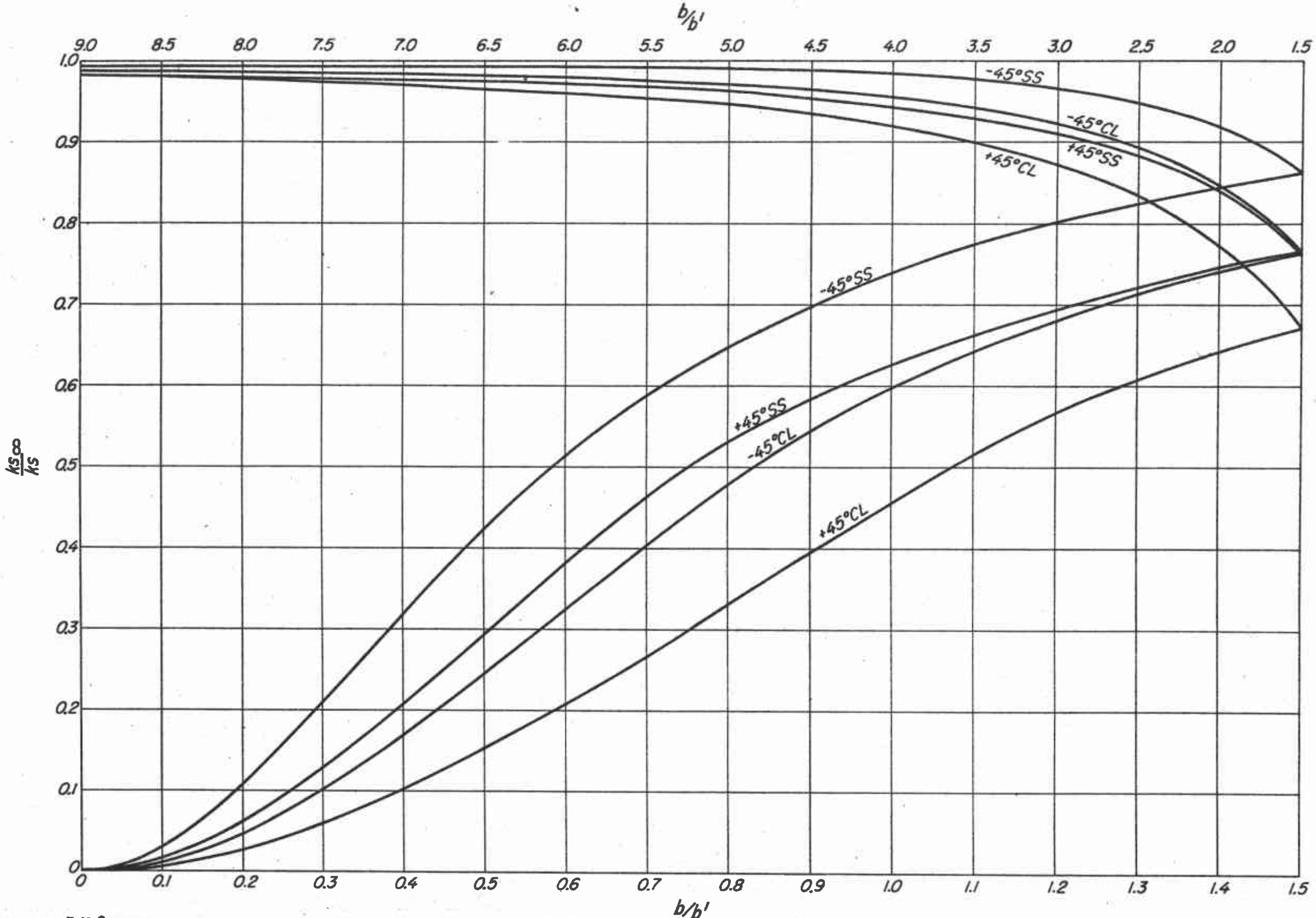


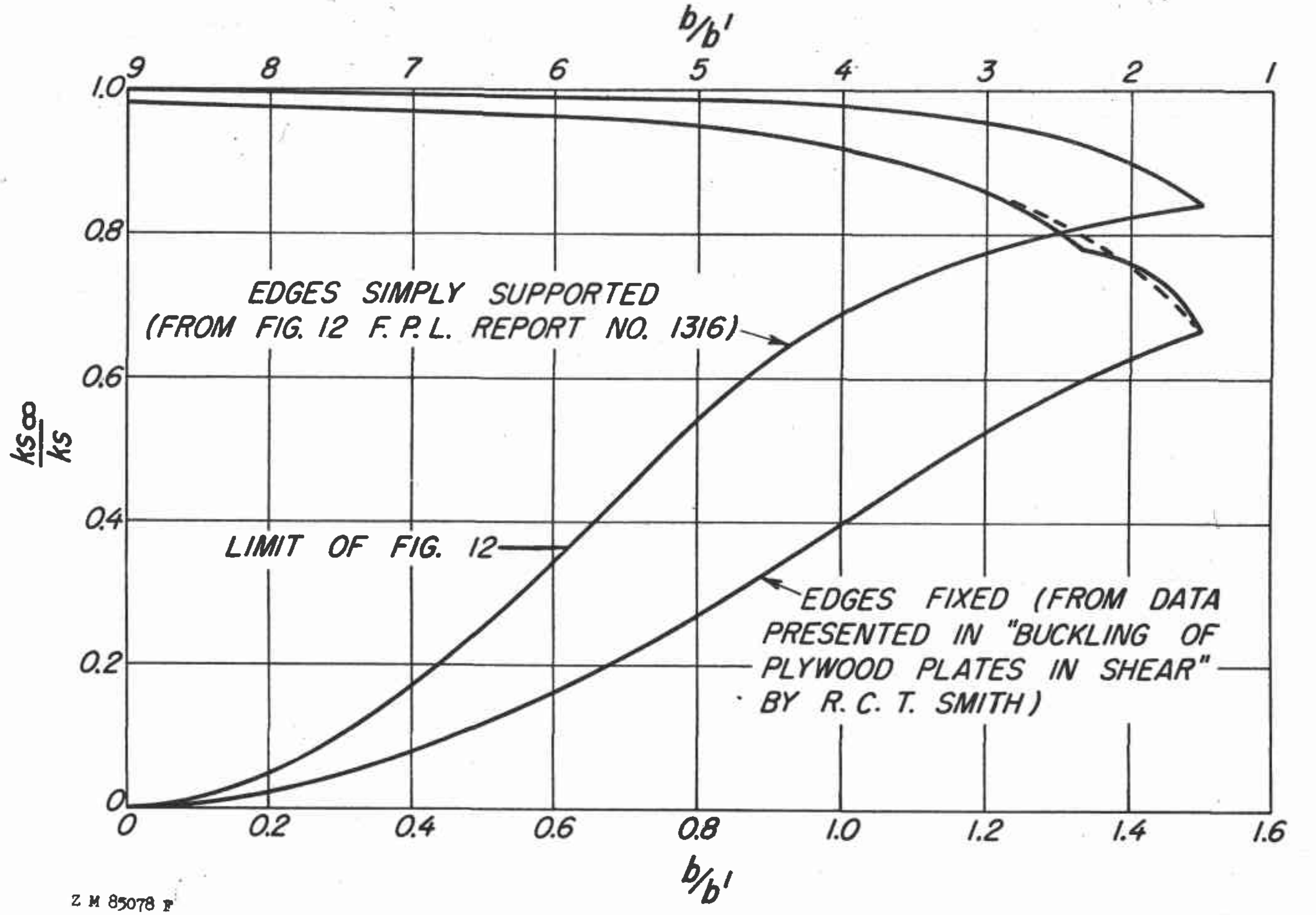
Figure 130.--Buckling under uniform shear of infinitely long plates of symmetrical construction. Edges simply supported. The constant Z plotted as a function of the ratio $\frac{E_1}{E_1 + E_2}$.

Z M 58953 F



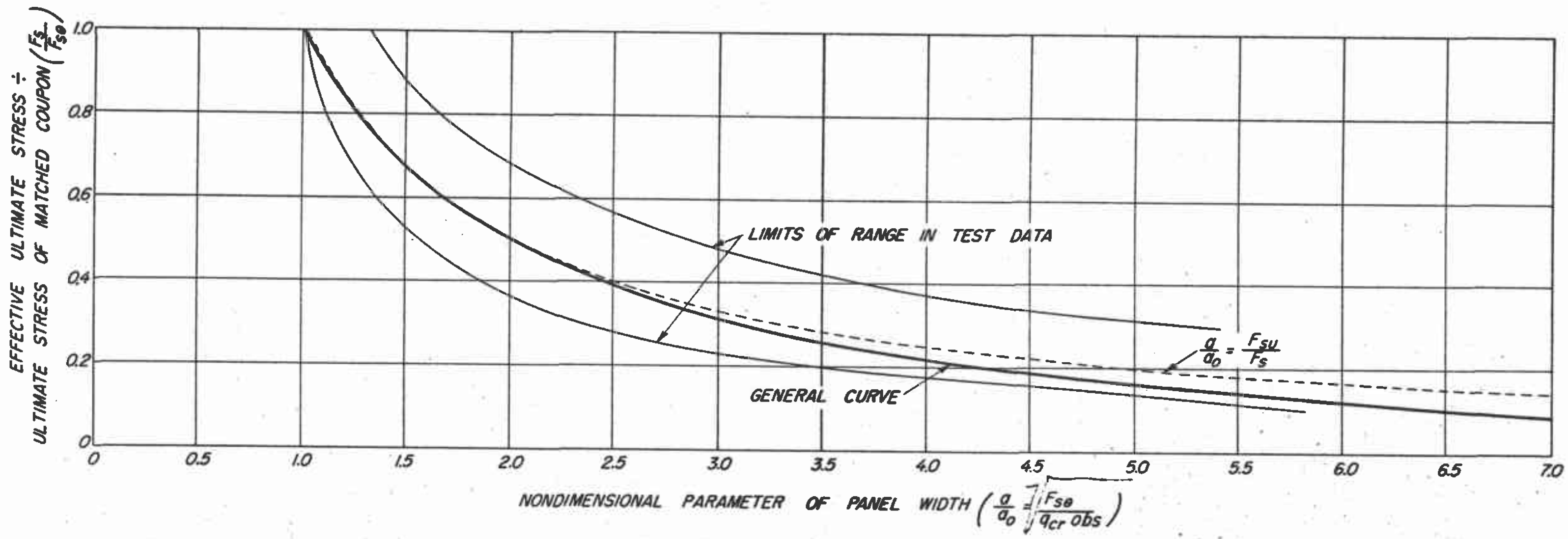
Z M 85079 F.

Figure 131.--Ratio $k_{s\infty}/k_s$ plotted with b/b' for plywood plates in shear with the face grain at ±45° and the edges either fixed or simply supported.



Z M 85078 F

Figure 132.--Ratio k_s /k_s plotted with b/b' for plywood plates in shear with the face grain at 0° and 90° and the edges either fixed or simply supported.



Z M 85080 F

Figure 133.--Curve showing relationship between effective ultimate stresses and nondimensional parameter of panel width a/a_o.

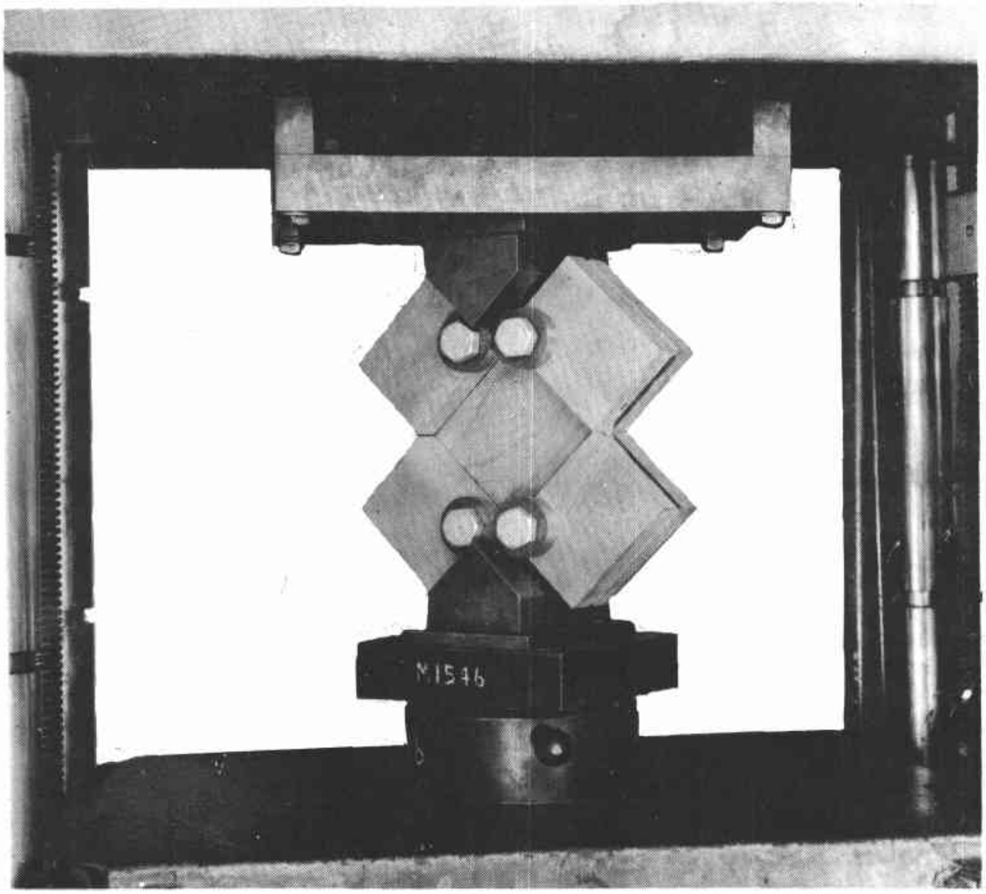


Figure 139.--Method of making panel shear test.

Z M 58961 F

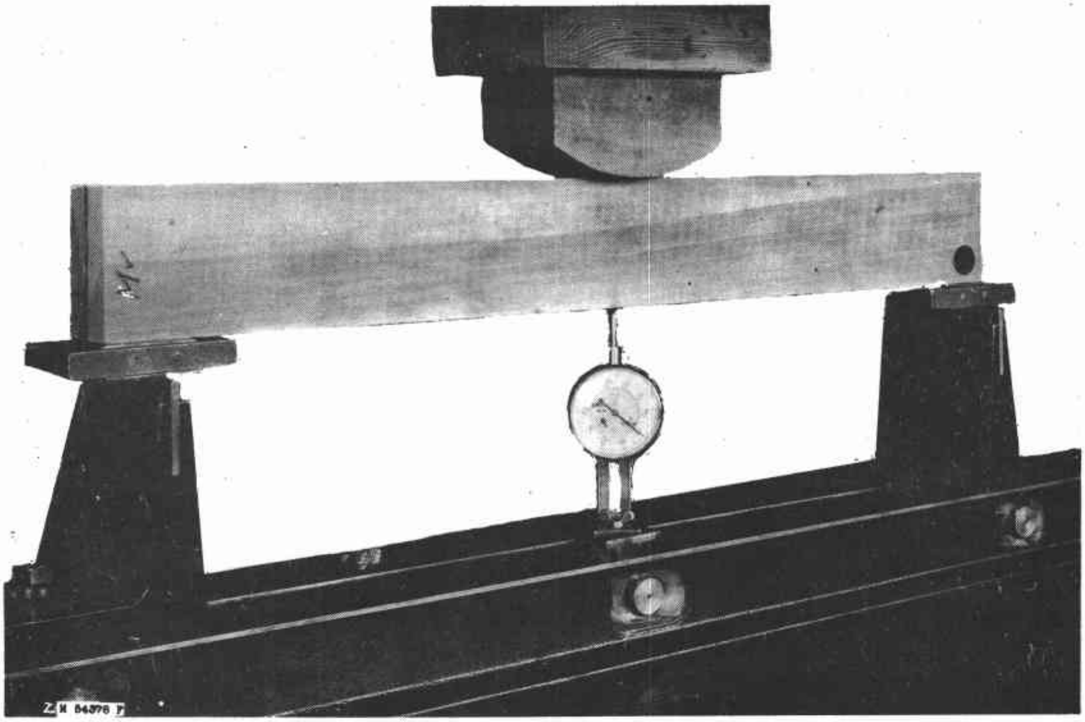


Figure 140.--Static bending test for stiffness of frame member.