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STRUCTURAL FEASIBILITY OF PARALLEL-LAMINATED VENEER CROSSARMS. (U)
1977 J YOUNGQUIST, F BREY, J JUNG

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STRUCTURAL FEASIBILITY OF PARALLEL-LAMINATED VENEER CROSSARMS

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ABSTRACT

Experimentally and commercially produced laminated M-19 crossarms were tested by standard Rural Electrification Administration (REA) crossarm tests. The laminated crossarms, produced by laminating veneer and by laminating solid-sawn dimension stock, generally performed satisfactorily according to REA specified standards. Materials tested are described and results on standarized tests are summarized. The objective of this work was to provide indications of performance trends. Statistically valid performance comparisons between the materials tested were not possible because of the limited number of samples tested.

LITERATURE CITED

1. American Society for Testing and Materials
   1976. Static tests of timbers in structural sizes. ASTM stand. Method D-198. Philadelphia, Pa.

2. Forest Products Laboratory
   1974. Wood handbook: Wood as an engineering material. USDA For. Serv. Agric. Handb. No. 72. U.S. Gov. Print. Off., Washington, D.C. 20402.

3. Moody, R. C., and C. C. Peters
   1972. Feasibility of producing a high-yield laminated structural product: strength properties of rotary knife-cut laminated southern pine. USDA For. Serv. Res. Pap. FPL 178. For. Prod. Lab., Madison, Wis.

4. Nelson, Sherman A.
   1972. Structural application of Micro-Lam. Civil Eng. 42(7):57.

5. Rural Electrification Administration
   1972. Rural Electrification Administration specification for wood crossarms (solid and laminated) transmission timbers and pole keys. Spec. No. DT-5B.

6. Schaffer, E. L., R. W. Jokerst, R. C. Moody, C. C. Peters, J. L. Tschernitz, and J. J. Zahn
   1972. Feasibility of producing a high-yield laminated structural product—general summary. USDA For. Serv. Res. Pap. FPL 175. For. Prod. Lab., Madison, Wis.

7. Schaffer, E. L., R. W. Jokerst, R. C. Moody, C. C. Peters, J. L. Tschernitz, and J. J. Zahn
   1976. Press-Lam progress in technical development of laminated veneer structural product. USDA For. Serv. Res. Pap. FPL 279. For. Prod. Lab., Madison, Wis.

STRUCTURAL FEASIBILITY OF PARALLEL-LAMINATED VENEER CROSSARMS[1/]

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INTRODUCTION

Within the last few years, researchers at the Forest Products Laboratory have developed a parallel-laminated veneer (LV) processing technique for the product Press-Lam (3,6,7)[3/], which has desirable product and process characteristics. Among advantages of the Press-Lam technique are (1) a greater yield than obtainable from conventional sawing, (2) an ability to efficiently utilize low-grade logs, (3) uniform strength properties, and (4) excellent penetration by a preservative. These advantages are desirable for certain end-use applications. Thus to encourage use of the process, research was extended to demonstrate the feasibility of parallel-laminated veneer in one end-use product — crossarms for electrical distribution.

One of the most frequently used electrical distribution crossarms measures 3-1/2 inches by 4-1/2 inches by 8 feet. This size range offers the possibility of manufacturing crossarms using parallel-laminated veneer technology in existing plywood manufacturing facilities.

In this investigation, crossarms of seven different types were subjected to four standard wood crossarm tests specified by the Rural Electrification Administration (REA). The objective of the work was to examine the feasibility of using various laminated materials as crossarm stock by comparing their strength properties with those of other crossarm stocks that have obtained REA approval. The test program was established to provide indications of performance rather than to establish statistically valid performance levels.

EXPERIMENTAL PROGRAM

Material

In this investigation, 136 electrical distribution crossarms made by seven processes termed "series" were tested. All of the crossarms used were M-19, type 03, as specified in REA Specification No. DT-5B (5). The dimensional details for series 1, 3 through 5, and series 7 of this investigation of crossarms

1/ Research was conducted in cooperation with American Crossarm and Conduit Co., Chehalis, Wash.; Sen-[illegible] Structures, Peshtigo, Wis.; Trus Joist Corp., [illegible] Idaho; and Rural Electrification Administration, Washington, D.C.

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

3/ Underlined numbers in parentheses refer to literature cited at end of report.

are presented in figure 1. REA allows glulam crossarms of the M-19, 03 type to be shorter by 1.5 inches than solid-sawn crossarms arms and have the outer holes 0.75 inch closer to the center of the crossarm. The glulam crossarms of series 2 and 6 of this study were of this configuration. The crossarm types are described in table 1 and shown in figure 2.

Series 1 crossarms were solid-sawn Douglas-fir, treated with pentachlorophenol preservative. This type of crossarm is REA accepted and serves as the standard for the crossarm industry.

Series 2 crossarms were commercially purchased six-ply, horizontally laminated, untreated Douglas-fir glulam beams with 0.75-inch laminations. These crossarms also have REA acceptance.

An experimental commercial product was used for the series 3 crossarms. The crossarms were constructed of untreated red pine boards. The process consisted of press drying the boards to a moisture content of approximately 12 percent; reheating half of the boards to serve as heat sources in the gluing process while phenolresorcinol adhesive was

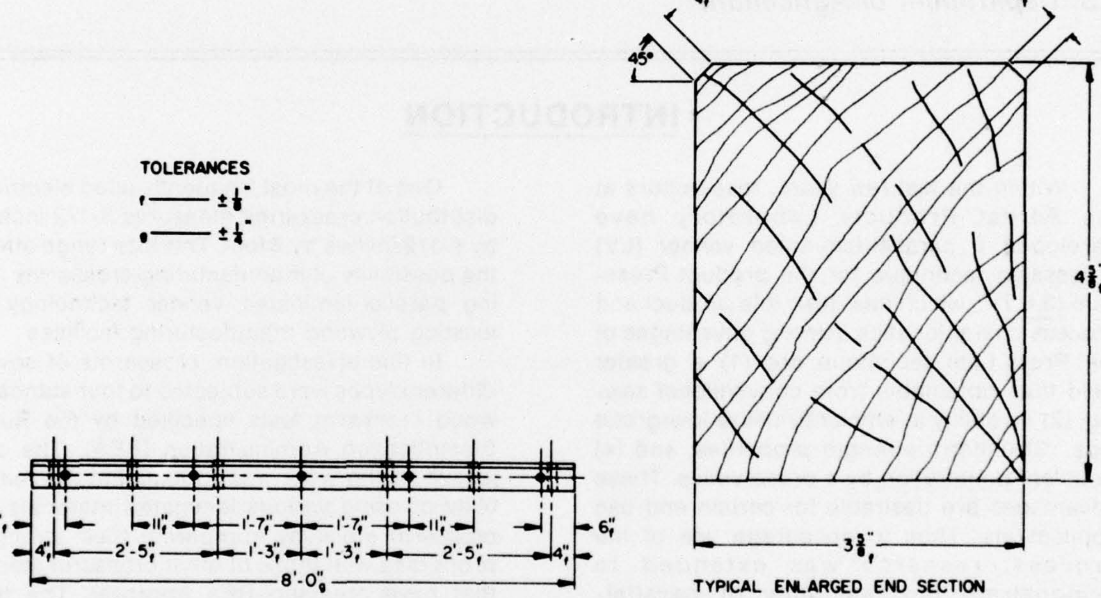


Figure 1.—Schematic of M-19, type 03 crossarms, Rural Electrification Administration.
(M 145 623)

Table 1.—Crossarm types, by series number and species

Series number	Crossarm type	Species
1	Solid sawn	Douglas-fir
2	Six-ply glulam	Douglas-fir
3	Glulam	Red pine
4	Press-Lam with butt joints	Douglas-fir
5	Press-Lam without butt joints	Douglas-fir
6	Four-ply glulam	Douglas-fir, white fir, hemlock
7	Micro-Lam	Douglas-fir

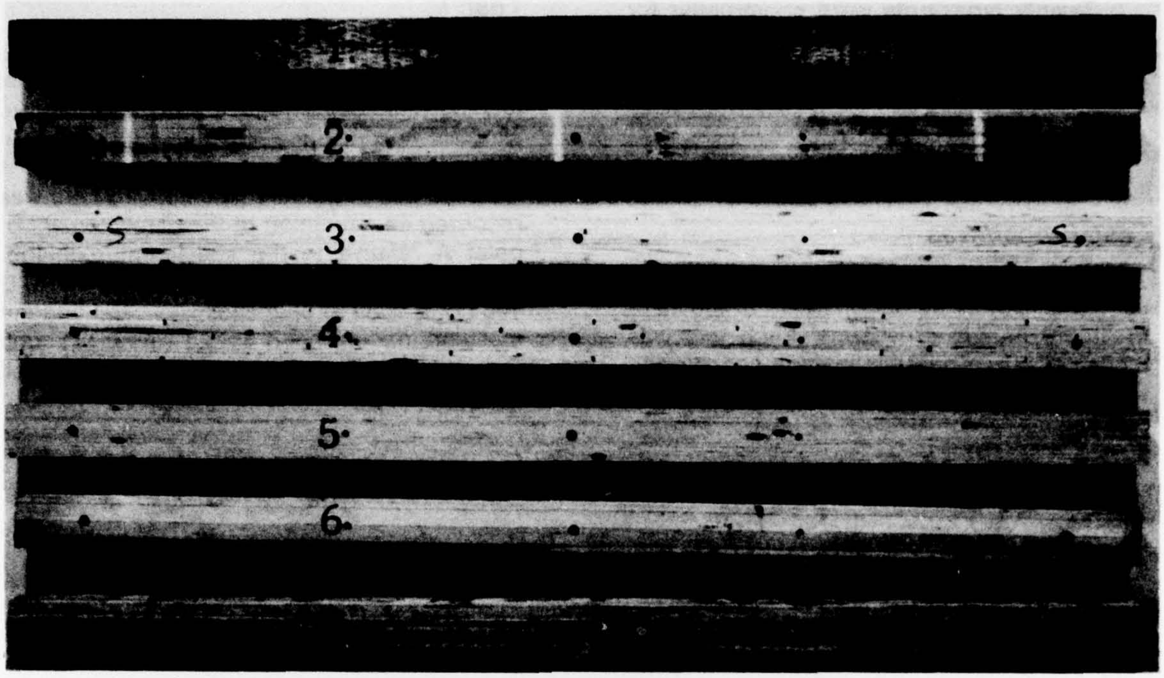


Figure 2.—Crossarms tested, from top to bottom: 1, solid-sawn Douglas-fir; 2, six-ply glulam; 3, red pine glulam; 4, Press-Lam with butt joints; 5, Press-Lam without butt joints; 6, four-ply glulam; and 7, Micro-Lam.
(M 144 477)

applied to both sides of the colder boards. The hot and the cold boards were then assembled alternately until the desired thickness was reached (between 9 and 11 plies), at which time the entire assembly was placed under hydraulic pressure of approximately 150 pounds per square inch.

Series 4 crossarms were of untreated Douglas-fir Press-Lam beams with butt joints. Veneer thickness was 0.4 inch and butt-joint spacing in adjacent laminae was 1 foot. The veneer was prepared at FPL on a 4-foot lathe.

Series 5 was a laminated veneer lumber product of untreated Douglas-fir veneer of 0.35-inch thicknesses. The logs were obtained from the same location as those used for series 4, but the veneer was peeled by a commercial veneer mill on a standard 8-foot veneer lathe. The crossarms were manufactured by the same process as used for the series 3 crossarms; thus the material was essentially identical to the series 4 Press-Lam crossarms but without butt joints.

Series 6 crossarms were commercially purchased four-ply untreated glulam beams. The laminae were of a variety of western species (Douglas-fir, hemlock, white fir). Each of the inner two laminae were 1.5 inches thick; the outer two laminae, 0.75 inch thick. These crossarms were laminated in a random fashion — the wood species used for any given laminae was not used consistently. These crossarms have REA approval.

For series 7, the untreated crossarms were constructed from a commercial product, Micro-Lam (4) made by laminating thin veneers (0.1 in.) and using overlap joints. The material for this series was from 1.5- by 24- by 100-inch laminated billets. The billets were cold-glued together with room-temperature-setting phenolresorcinol adhesive to form the crossarms.

Typically, conventional glulam crossarms are horizontally laminated; therefore, the experimental LV crossarms were used in the same orientation.

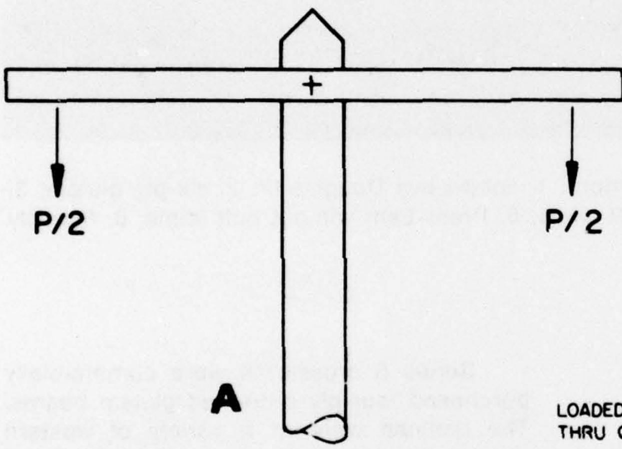
Twenty crossarms were constructed for each series except for series 7 with 16 crossarms because available material was limited.

Test Procedures

Four tests, specified by the REA, were used to evaluate the performance of the electrical distribution crossarms. Each test was modeled after a possible loading condition to which crossarms could be subjected.

Test 1

The objective of test 1 was to evaluate the crossarms' ability to withstand static vertical loading (fig. 3,A). The laboratory test used to simulate this loading condition is shown in figure 3,B. The load was applied through a 5/8-inch rod at point A. The applied load was recorded as a function of the displacement of point A relative to the specimen midheight over the supports, in accordance with ASTM D 198 (1). A span of 88 inches was used and the machine-loading head speed was 0.175 inch per minute. The test was continued until failure.



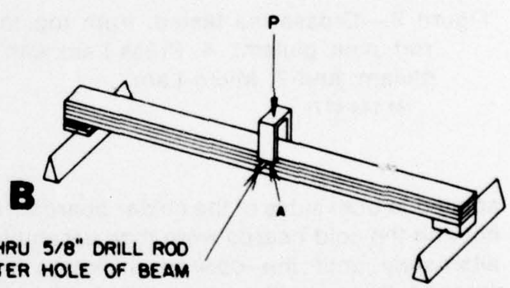


Figure 3.—A, test 1, field loading configuration; B, laboratory test configuration. (P/2, 1/2 applied load; P, applied load.)
(M 145 619; M 145 620)

Test 2

Test 2 was designed to emulate loading in the horizontal plane, perpendicular to the axis of the crossarms (fig. 4,A). The laboratory test procedure (fig. 4,B) required a 9-1/2- by 3-inch steel-simulated insulator with a 1/4- by 3-1/2-inch washer at the base. The crossarms were bolted at their centers to an 8-inch diameter round head support. At their far ends, the crossarms were firmly supported on two 3- by 12-inch wood members spaced 6 inches apart and were bolted to the loading bed through the insulator hole. A machine-loading head speed of 0.6 inch per minute was used and the test was continued until a crossarm failed.

An abitrary acceptable level of performance, ability to withstand 700 pounds of loading, has been set by REA. This value, although arbitrary, provides a designer of an electrical distribution line an indication of minimum expected strength of any REA-approved crossarm subjected to this loading configuration.

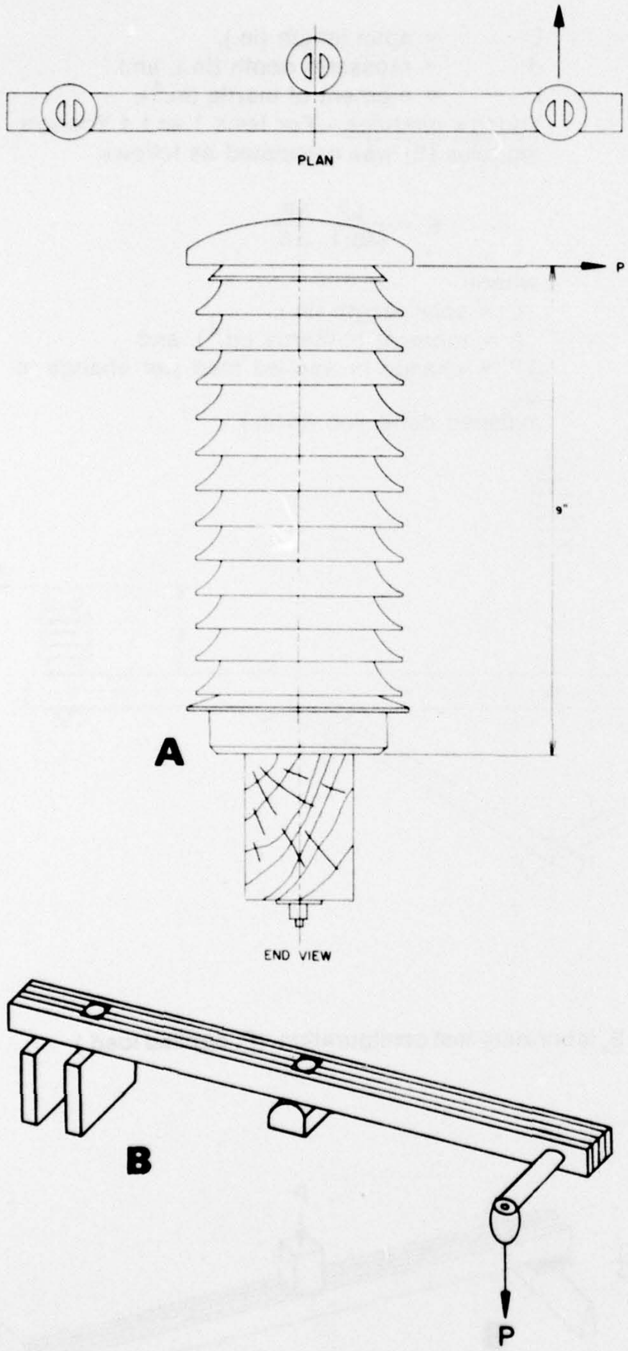


Figure 4.—A, test 2, loading configuration; B, laboratory test configuration. (P, applied load.)
(M 145 626; M 145 627)

Test 3

Test 3 was designed to determine the effects of loads parallel to the axis of the crossarms (fig. 5,A). The test configuration (fig. 5,B) consisted of bolting the crossarm to two steel plates through the two end holes. A 6-inch-wide support was also placed under the center of the crossarm. Load was applied through a 9-1/2- by 3-inch steel simulated insulator. A machine-loading head speed of 0.3 inch per minute was used. The majority of the tests were continued until failure or a load of 1,500 pounds was reached. A few of the initial tests were stopped at lower load levels because REA has set the acceptable level of performance at capability of withstanding 1,000 pounds of load. During testing, most of the crossarms could carry much more load than this; thus, the 1,500-pound load was used.

Test 4

In test 4 (figs. 6,A and B), crossarms were subjected to bending about the minor axis in accordance with ASTM D 198 specifications (1). An unsupported span of 88 inches was used. The load was applied through a 6-inch radius woodblock and a loading head speed of 0.175 inch per minute was used. The applied load versus the midspan deflection relative to the specimen midheight over the supports was recorded and the test was continued until failure.

Calculations

Determinations of moisture content and specific gravity.—Two, 1-inch-thick cross-sectional slices were taken from each side of the tested crossarms at distances of approximately 1 foot from the center.

The moisture content was calculated as:

$$\text{Moisture content (pct)} = 100[(I-F)/F] \quad (1)$$

where

I = initial weight and

F = final ovendry weight.

The specific gravity (sp. gr.) was calculated as:

$$\text{Sp. gr.} = \frac{(0.061)W}{[1 + (M/100)]Lwt} \quad (2)$$

where

W = initial weight of the specimen (g),

M = moisture content of sample (pct),

L = length of specimen (in.),

w = width of specimen (in.), and

t = thickness of specimen (in.).

Modulus of rupture.—For tests 1 and 4 the modulus of rupture (MOR) was calculated as follows:

$$MOR = \frac{M_{max} d}{I2} = \frac{P_{max} Ld}{8I} \quad (3)$$

where

M_{max} = maximum bending moment (lb-in.),

P_{max} = maximum applied load (lb),

L = span length (in.),

d = crossarm depth (in.), and

I = moment of inertia (in.^{4}).

Young's modulus.—For tests 1 and 4 Young's modulus (E) was calculated as follows:

$$E = \frac{L^3}{(48)I} \frac{\Delta P}{\Delta \delta}$$

where

L = span length (in.),

I = moment of inertia (in.^{4}), and

$\frac{\Delta P}{\Delta \delta}$ = change in applied load per change in midspan deflection (lb/in.).

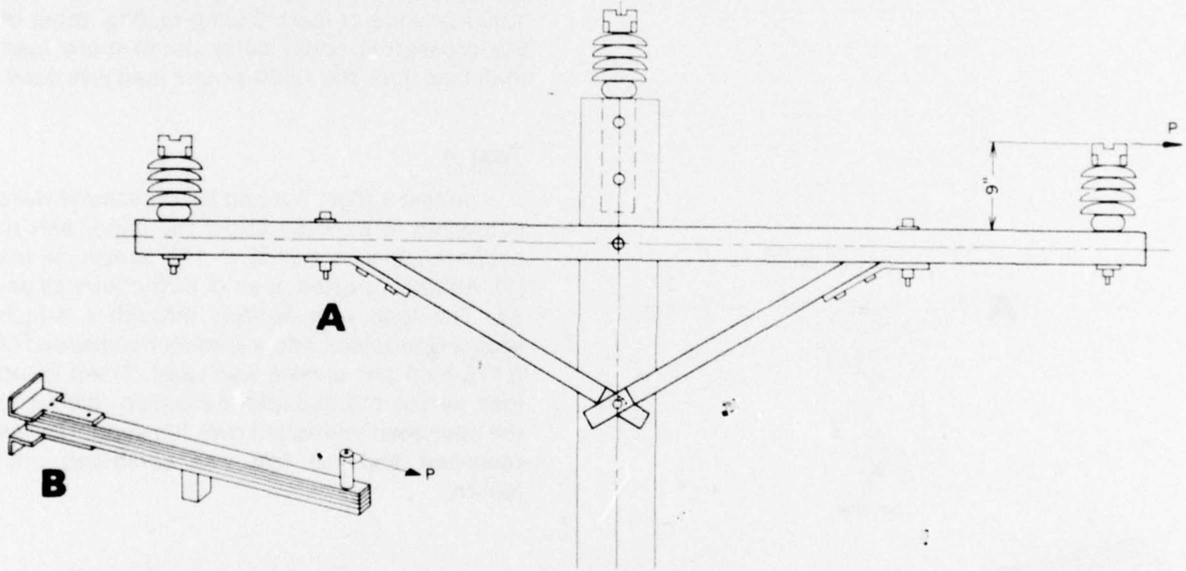


Figure 5.—A, test 3, loading configuration; B, laboratory test configuration. (P, applied load.)
(M 145 622; M 145 621)

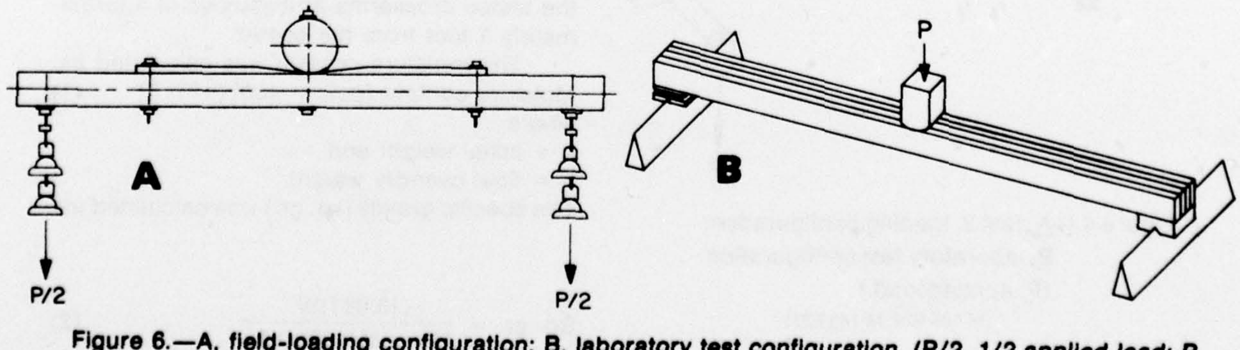


Figure 6.—A, field-loading configuration; B, laboratory test configuration. (P/2, 1/2 applied load; P, applied load.)

RESULTS AND DISCUSSION

The scope of this work precluded testing a sufficent number of samples to provide statistically significant results. Therefore, the results are indicative of performance trends only.

Test 1

The capability of the crossarms of test 1 to withstand static vertical loading is summarized in table 2.

Modulus of Rupture.—Using the solid-sawn Douglas-fir crossarms, series 1, as a basis for comparison, it is seen that the series 3 red pine and series 4 Press-Lam with butt joints possessed the lowest moduli of rupture (MOR) with means at 74 and 61 percent of the solid-sawn MOR, respectively. Both of these values can be expected since red pine possesses a lower clear wood strength in bending than does Douglas-fir (2) and lower bending strengths for Press-Lam material with butt joints could be due to: (1) Reduced section moduli at butt-jointed sections and (2) stress concentrations in the gluelines at the butt joints.

Compared to the solid-sawn Douglas-fir crossarms, all of the remaining crossarms types performed efficiently. Series 5 performed the most efficiently, with a mean MOR 10 percent higher than that of the solid-sawn members. This figure may not be statistically significant; however, it indicates strengths at least comparable to those of the solid-sawn member tested.

The results also indicate that the series 5 Press-Lam without butt joints yielded the highest estimated fifth percentile value of MOR, 8,270 pounds per square inch, with the series 1 solid-sawn crossarms following at 7,410 pounds per square inch. The series 4 Press-Lam with butt joints results possessed the lowest fifth percentile value at 3,640 pounds per square inch.

The principal mode of failure for all of the crossarm types was splitting around the rod through which the load was applied.

Modulus of Elasticity.—The moduli of elasticity (MOE) values obtained from test 1 are summarized in table 2. Only the series 5 laminated veneer lumber was substantially

Table 2.—Capability of crossarms to withstand static vertical loading, test 1

					Modulus of rupture				Modulus of elasticity		
Series number	Crossarm type	Number of tests	Mean specific gravity	Mean moisture content	Mean	Coefficient of variation	Percent [1/] of solid sawn	Estimated [2/] fifth percentile value	Mean	Coefficient of variation	Percent [1/] of solid sawn
				Pct	Lb/in.^{2}	Pct		Lb/in.^{2}	10^6 Lb/in.^{2}	Pct	
1	Solid sawn	5	0.52	13	9,030	10.9	100	7,410	1.27	16.0	100
2	Six-ply glulam	5	.50	11	8,140	13.1	90	7,070	1.99	15.1	112
3	Red pine glulam	5	.41	12	6,680	6.51	74	5,960	1.20	2.95	68
4	Press-Lam with butt joints	5	.50	10	5,480	20.4	61	3,640	1.93	6.27	109
5	Press-Lam without butt joints	5	.53	9.7	9,910	10.1	110	8,270	2.20	10.2	124
6	Four-ply glulam	5	.45	13	8,580	17.6	95	6,100	1.86	14.5	105
7	Micro-Lam	4	.54	7.7	7,510	8.22	83	6,500	1.87	10.2	106

1/ Comparison based on means.
2/ Calculated as $\bar{x} - 1.645\ (s)$.

stiffer, a 24-percent higher MOE, than that of the series 1 solid-sawn crossarms. But all of the crossarm types tested, with the exception of the red pine glulam members of series 3, were at least as stiff as the solid-sawn crossarms. The values for series 3 red pine glulam were much lower than any of the others; this could be expected since red pine, on the average, is less stiff than Douglas-fir (2).

Test 2

The REA considers capability to withstand a load of 700 pounds acceptable performance for a crossarm, in this test. This basis was used to interpret the results shown in table 3. It is interesting that only three of five of the standard solid-sawn Douglas-fir crossarms passed the acceptability criteria.

Of the LV crossarms in series 4, 5, and 7, only those of series 7 performed exceptionally efficiently. All of the crossarms in series 7 were able to withstand a 700-pound applied load; the mean strength of this series was the highest of all of the crossarm types tested.

Comparison of values for series 4 and 5 yields conclusions counter to those expected. The results indicate that the Press-Lam material with butt joints performed more satisfactorily than did the Press-Lam material without butt joints. No explanation for this discrepancy was noted when the failed specimens were examined in detail, but the high variability in the results may preclude any discussion of the relative merits of series 4 and 5.

End splitting was the commonest type of failure for all of the crossarms. Undoubtedly, lathe checks in the Press-Lam members decrease torsional strength. These members can possibly be reinforced with metal bands wrapped around the insulator holes to restrain the wood from splitting.

Test 3

For the load configuration of test 3, REA has set acceptable performance as capability of withstanding 1,000 pounds of load.

The test 3 values, table 4, indicate that only the series 1 solid-sawn crossarm had difficulty in withstanding a 1,000-pound load. Two of these crossarms failed to meet the acceptance criteria. Most of the failures for these crossarms were end splitting under loads between 950 and 1,200 pounds. The remainder of the crossarm types did not end split; in fact, all of the laminated veneer crossarms were able to sustain a load of 1,500 pounds without failure.

Test 4

Modulus of rupture.—The values for MOR, table 5, indicate that all of the LV crossarms performed relatively satisfactorily as vertically laminated members. The series 5 Press-Lam crossarms performed remarkably efficiently with a MOR 36 percent higher than that of the solid-sawn crossarms.

In general, the different crossarms types had higher MOR's in test 4 than in test 1. Most likely this resulted because the test 4 loading configuration does not induce tensile stresses that attempt to split the laminations apart; thus the crossarms in test 4 were better able to develop their full bending strengths.

The crossarms exhibited higher fifth percentile values in this test than they did in test 2. Again, the series 5 Press-Lam without butt joints performed the most satisfactorily with a fifth percentile value for MOR of 8,920 pounds per square inch, but in this test the solid-sawn crossarms possessed the lowest fifth percentile value, 5,700 pounds per square inch.

Modulus of elasticity.—The MOE values for the crossarms tested are summarized in table 5. From the results apparently all of the Douglas-fir crossarm types had similar MOE's with the exception of the series 5 LV's, which were 23 percent higher than that of the solid-sawn members. In general, the crossarms had higher MOE's from test 4 than from test 1. This can probably be attributed to the difference in loading configurations between the two tests.

Performance of LV Crossarm Types

Series 5, Press-Lam without butt joints.—From the results of tests 1 and 4, with strength the principal factor of interest, relative comparisons indicate that the Press-Lam crossarms without butt joints of series 5 apparently are adequate in these types of loadings if compared to the results of the crossarms of series 1, 2, and 6, which are REA accepted and have been proven reliable by use. Not only does the series 5 crossarm

Table 3.—Effects of loading in horizontal plane perpendicular to axis of seven types of crossarms, test 2

Series number	Crossarm type	Mean specific gravity	Mean moisture content	Number[1/] passed / number tested	Maximum load	Mean failure load	Coefficient of variation
			Pct		Lb	Pct of 700 lbs	Pct
1	Solid sawn	0.56	12.	3/5	788	99.2	20.5
					788		
					674		
					760		
					457		
2	Six-ply glulam	.51	11.	5/5	786	120.	12.9
					705		
					1,000		
					870		
					837		
3	Red pine glulam	.43	9.3	5/5	844	116.	13.0
					800		
					743		
					975		
					700		
4	Press-Lam with butt joints	.52	10.	3/5	700	100.	3.80
					667		
					698		
					740		
					700		
5	Press-Lam without butt joints	.55	8.	2/5	1,300	120.	41.5
					685		
					593		
					1,104		
					496		
6	Four-ply glulam	.43	12.	2/5	830	96.	16.9
					756		
					568		
					640		
					586		
7	Micro-Lam	.57	7.6	4/4	806	157.	37.1
					1,343		
					706		
					1,538		

1/ REA considers withstanding 700 lbs of load as passing.

Table 4.—Effects of loads parallel to axis of seven types of crossarms, test 3

Series number	Crossarm type	Mean specific gravity	Mean moisture content	Maximum applied load 1/
			Pct	Lbs
1	Solid sawn	0.56	8.4	1,000
				954*
				1,000*
				963*
				1,183*
2	Six-ply glulam	.51	12.	1,500
				1,500
				1,500
				1,280
				1,500
3	Red pine glulam	.44	10.	1,000
				1,000
				1,270
				1,000
				1,330
4	Press-Lam with butt joints	.52	10.	1,500
				1,500
				1,500
				1,500
				1,500
5	Press-Lam without butt joints	.54	10.	1,500
				1,500
				1,500
				1,500
				1,500
6	Four-ply glulam	.44	12.	1,500
				1,500
				1,500
				1,500
				1,500
7	Micro-Lam	.57	8.3	1,500
				1,500
				1,500
				1,500
				1,500

1/ *Crossarm failure.

Table 5.—Effect of subjecting seven types of crossarms to bending about minor axis, test 4

Series number	Crossarm type	Number of tests	Mean specific gravity	Mean moisture content	Modulus of rupture: Mean	Modulus of rupture: Coefficient of variation	Modulus of rupture: Percent [1] of solid sawn	Modulus of rupture: Estimated [2] fifth percentile value	Modulus of elasticity: Mean	Modulus of elasticity: Coefficient of variation	Modulus of elasticity: Percent [1] of solid sawn
				Pct	Lb/in.²	Pct		Lb/in.²	10⁶ Lb/in.²	Pct	
1	Solid sawn	5	0.53	14	8,010	17.5	100	5,700	1.87	17.9	100
2	Six-ply glulam	5	.50	11	9,190	5.27	115	8,390	2.01	4.52	108
3	Red pine glulam		.44	8.7	6,690	7.71	84	5,840	1.49	3.29	79
4	Press-Lam with butt joints	5	.52	11	7,100	6.05	89	6,400	1.95	3.02	103
5	Press-Lam without butt joints	5	.53	7.8	10,930	11.2	136	8,920	2.32	6.09	123
6	Four-ply glulam	5	.44	12	8,600	10.7	107	7,090	1.83	16.4	97
7	Micro-Lam	4	.56	7.5	9,050	13.2	113	7,080	2.04	9.80	108

[1] Comparison based on means.
[2] Calculated as $\bar{x} - 1.645\ (s)$.

possess the highest mean strength, but it also possesses the highest estimated fifth percentile value of MOR, indicative of not only its high mean strength but also its low variability.

In the test 3 configuration, the series 5 crossarms had no difficulty meeting the performance requirements.

A potential problem with the Press-Lam crossarms can be noted in the test 2 results. These results show that the crossarms' ability to carry torsional type loads is extremely variable. This is most probably attributed to lathe checks. Should lathe checks prove a limiting factor in the uses of series 5 type crossarms, undoubtedly reinforcement could be added to the crossarms to help them carry the torsional load.

Series 4, Press-Lam with butt joints.—The bending strengths of this material is significantly lower than that of solid-sawn crossarms (61 pct and 89 pct of solid sawn in tests 1 and 4, respectively). This will require a designer of an electrical distribution line to space powerline poles closer together; thus additional cost beyond that expected for conventional crossarms will be incurred. It may be possible, however, to use these crossarms in the vertically laminated configuration; thus effects of the butt joints will be be minimized. Further work, however, must investigate the possibility of end splitting problems if this type of orientation is used.

The series 4 crossarms performed, in general, similarly to series 5 crossarms in tests 2 and 3.

Series 7, Micro-Lam.—The series 7 material performed relatively satisfactorily in all of the tests. Although the average strength of the Micro-Lam crossarms in test 1 was lower than that of the solid sawn (83 pct of solid sawn), the crossarms performed satisfactorily in tests 2 and 3.

Performance of Series 3 Red Pine Glulam Crossarms

In tests 1 and 4, crossarms of series 3 were significantly lower in strength than were those of solid-sawn Douglas-fir, but in tests 2 and 3 they performed satisfactorily.

A possible method to produce red pine crossarms competitive with conventional glulam and solid-sawn Douglas-fir crossarms would be to produce these crossarms with a larger cross-sectional area. To be compatible with existing crossarm hardware such as bracing, REA allows these M-19, type 03 crossarms dimensions of 4-5/8 ± 1/8 inches in depth and 3-5/8 ± 1/8 inches in width (fig. 1). Most crossarms are now manufactured near the lower tolerance levels. Assuming outermost fiber bending stresses govern failure, manufacturing these crossarms at the maximum allowable cross-sectional dimensions will increase load-carrying capacity of red pine crossarms to the 89 percent of load that conventional solid-sawn Douglas-fir crossarms, series 1, will carry in the test 1 configuration.

SUMMARY

Experimentally and commercially produced laminated crossarms were tested by Rural Electrification Administration crossarms standards. The objective here was to provide indications of trends and relative performance of the experimentally produced crossarms rather than to provide statistically valid performance comparisons. Therefore, based on the work reported here, the following general conclusions can be made:

1. Laminated Douglas-fir veneer crossarms without butt-jointed veneer have lower coefficients of variation then do solid-sawn Douglas-fir crossarms.

2. Douglas-fir laminated veneer crossarms without butt-jointed veneer have bending strengths comparable to that of REA-accepted solid-sawn and glulam crossarms.

3. Butt joints in Douglas-fir Press-Lam crossarms reduce bending strengths significantly and may not be suitable for use as crossarms.

4. Adequacy of a torsional strength test of Press-Lam members needs further investigation.

5. Low demand, inexpensive wood species can possibly be used for crossarms if they are manufactured with the maximum allowable cross-sectional dimensions.

U.S. Forest Products Laboratory.

Structural feasibility of parallel-laminated veneer crossarms, by John Youngquist, Frank Brey, and Joseph Jung. Madison, Wis., For. Prod. Lab. 1977.
13 p. (USDA For. Serv. Res. Pap. FPL 303).

Strength properties of crossarms of various laminated materials are compared with those of crossarms that have obtained approval by the Rural Electrification Administration.

KEYWORDS: Laminated M-19 crossarms, REA standards, performance, strength, yield, low-grade logs.

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