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WADC TECHNICAL REPORT 54-159

EVALUATION OF AN EXPERIMENTAL PLYWOOD-POLE LITTER

GEORGE W. HOGAN
AERO MEDICAL LABORATORY

MARCH 1954

WRIGHT AIR DEVELOPMENT CENTER

WADC TECHNICAL REPORT 54-159

EVALUATION OF AN EXPERIMENTAL PLYWOOD-POLE LITTER

George W. Hogan
Aero Medical Laboratory

March 1954

SEO No. 698-29

Wright Air Development Center
Air Research and Development Command
United States Air Force
Wright-Patterson Air Force Base, Ohio

FOREWORD

At the request of the Armed Services Medical Materiel Standardization Committee, 1/ the Aero Medical Laboratory, Directorate of Research, Wright Air Development Center undertook the testing of an experimental plywood pole litter. The test, accomplished under SEO-698-29, included a comparison with the standard (medical) straight aluminum pole litter, stock number 7-837-905.

The experimental litter was fabricated by the Lawrence Plycraft Incorporated, Lawrence, Massachusetts and submitted to this Laboratory for evaluation by the Engineering and Development Division, Armed Services Medical Procurement Agency, Fort Totten, New York. The latter organization has primary responsibility for the evaluation of substitute materials for litter poles. The same litter was tested by the Army Field Forces, Board No. 2, Fort Knox, Kentucky and results reported as Project No. 1740, dated 7 August 1953.

Due to previous commitments on high priority work, the test could not be undertaken at the Wright Air Development Center. After some delay the evaluation was finally conducted by the New York Testing Laboratories, Incorporated, New York 6, New York.

Mr. G. W. Hogan of the Aero Medical Laboratory served as Project Engineer on this evaluation.

1/ ASMWSC letter Serial No. 3514A, Subject: Service Test of Materials for Litter Poles (Project No. 6-98-03-001.010), dated 6 January 1953, to Commanding General, WADC, W-P AFB, Ohio (Attn: Chief, Aero Medical Laboratory)

WADC TR 54-159

ABSTRACT

Two experimental plywood pole litters were evaluated by this Center in comparison with four standard straight aluminum pole litters. All litters tested were of the medical field type. The experimental litters were fabricated to meet the requirements of Specification MIL-L-16462 and were proposed to substitute for the standard litter in the event of an emergency or a shortage of metal. The aluminum pole litters, stock no. 7-837-905, were obtained from supply.

The tests were designed to determine the following litter characteristics:

1. Dimensions
2. Weight
3. Flexibility
4. Durability and
5. Strength

Specification MIL-L-16462 was the basis for most of the tests. In addition some litters were tested for endurance and for ultimate strength.

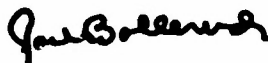
Both the plywood pole and the aluminum pole litters met the dimension and weight requirements for medical field litters as given in Specification MIL-L-16462. In the endurance test the plywood pole showed more flexibility than the aluminum pole. The plywood pole litters failed at an average of 1005 pounds while the aluminum pole litters at an average of 1660 pounds in the ultimate strength tests. Failure in both plywood pole litters was by rupture, while in all the aluminum pole litters it was by bending.

It is the conclusion of this Laboratory, from the few litters tested that the plywood pole litter, in its present form, is not a satisfactory substitute for the standard aluminum pole litter for aeromedical evacuation use.

PUBLICATION REVIEW

This report has been reviewed and is approved.

FOR THE COMMANDER:



JACK BOLLERUD
Colonel, USAF (MC)
Chief, Aero Medical Laboratory
Directorate of Research

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INTRODUCTION

The Engineering and Development Division, Armed Services Medical Procurement Agency, Fort Totten, New York, established Project No. 6-98-03-001 for the evaluation of commercial items purported to be superior to competitive items or to present standard medical supply items. These new items are subjected to engineering as well as service tests, where indicated. The evaluation of materials for litter poles falls under this project, one of which is the subject of this report.

A laminated plywood type litter pole was submitted by the Lawrence Plycraft Incorporated, Lawrence, Massachusetts, to Engineering and Development Division for evaluation. It was found by Engineering and Development Division to meet the basic requirements of the Military Medical Purchase Description for litter poles. Satisfied with the results of the preliminary tests, Engineering and Development Division had four litters assembled using the plywood poles and arranged for them to be field tested. The Army Field Forces, Board No. 2, Fort Knox, Kentucky tested two of the litters and reported the results as Project No. 1740, dated 7 August 1953. The other two were sent to the Aero Medical Laboratory, Directorate of Research, Wright Air Development Center. This report covers the test of these two litters.

The experimental plywood pole litters were tested in comparison with four standard (medical) straight aluminum pole litters, stock no. 7-837-905. The experimental litters were fabricated to meet the requirements of Specification MIL-L-16462. It is proposed that they be used as substitutes for the standard litters in the event of an emergency or shortage of metal. The standard aluminum pole litters tested were obtained from Base Medical Supply.

TEST PROCEDURE

A test plan based principally on the requirements of Specification MIL-L-16462 was prepared. The only additions were tests of endurance and ultimate strength. The test procedure is summarized below. Appendix I, the contractor's report, describes the tests in detail.

The tests included the determination of the following litter characteristics:

1. Dimensions
2. Weight
3. Flexibility
4. Durability and
5. Strength

All six litters tested were labeled, measured and weighed. To determine flexibility, one of each type of litter was loaded with 200 pounds and the deflection at the center measured. The same litter was loaded with 1600 pounds for 5 minutes and upon release of the load the deflection at the center, referred to as permanent deflection, was measured.

In the durability test, all litters were inspected in the "as received" condition to detect any signs of deterioration incident to handling and storage. One experimental and one standard litter were also subjected to an endurance test where 400 pounds was applied on and off the litter at $\frac{3}{4}$ cycles per minute and at an amplitude of 4 inches for a total of 10,000 cycles, or less in the event of failure.

All six litters, 2 experimental and 4 standard, were then subjected to ultimate strength tests. The load distribution pattern used in the endurance, flexibility and ultimate strength tests was prescribed in Specification MIL-L-16462.

TEST RESULTS

The dimensions and weights of the litters tested are given in Tables I and II of Appendix I, attached. As may be noted, all litters, standard as well as experimental, met all requirements of Specification MIL-L-16462 on dimensions and weights.

The results of the flexibility tests are given in Table III of Appendix I. Although, results showed both types of litters passed the requirements of the specification on temporary as well as on permanent deflection it is evident that the experimental plywood pole litter was more flexible than the standard aluminum pole litter.

The results of the endurance tests are shown in Table IV of the appendix. Both types of litters withstood the endurance tests, although these tests verified the results of the flexibility test given above that the plywood pole litter was more flexible than the aluminum pole litter.

Table V gives the results of the ultimate strength test of the litters. As may be seen, the experimental plywood pole litters failed at 920 and 1090 pounds or an average of 1005 pounds, while the standard aluminum pole litters failed at 1390, 1440, 1760 and 2050 pounds or an average of 1660 pounds. It must be noted that the two experimental and two of the standard litters had been previously subjected to deflection or endurance tests and that in 3 of these 4 litters failure took place at loads lower than those sustained during the deflection test. These results from the ultimate strength tests seem to indicate that the poles may have suffered structural injury from the deflection or endurance tests. The effect seemed to have been more pronounced in the plywood than in the metal pole.

DISCUSSION AND CONCLUSION

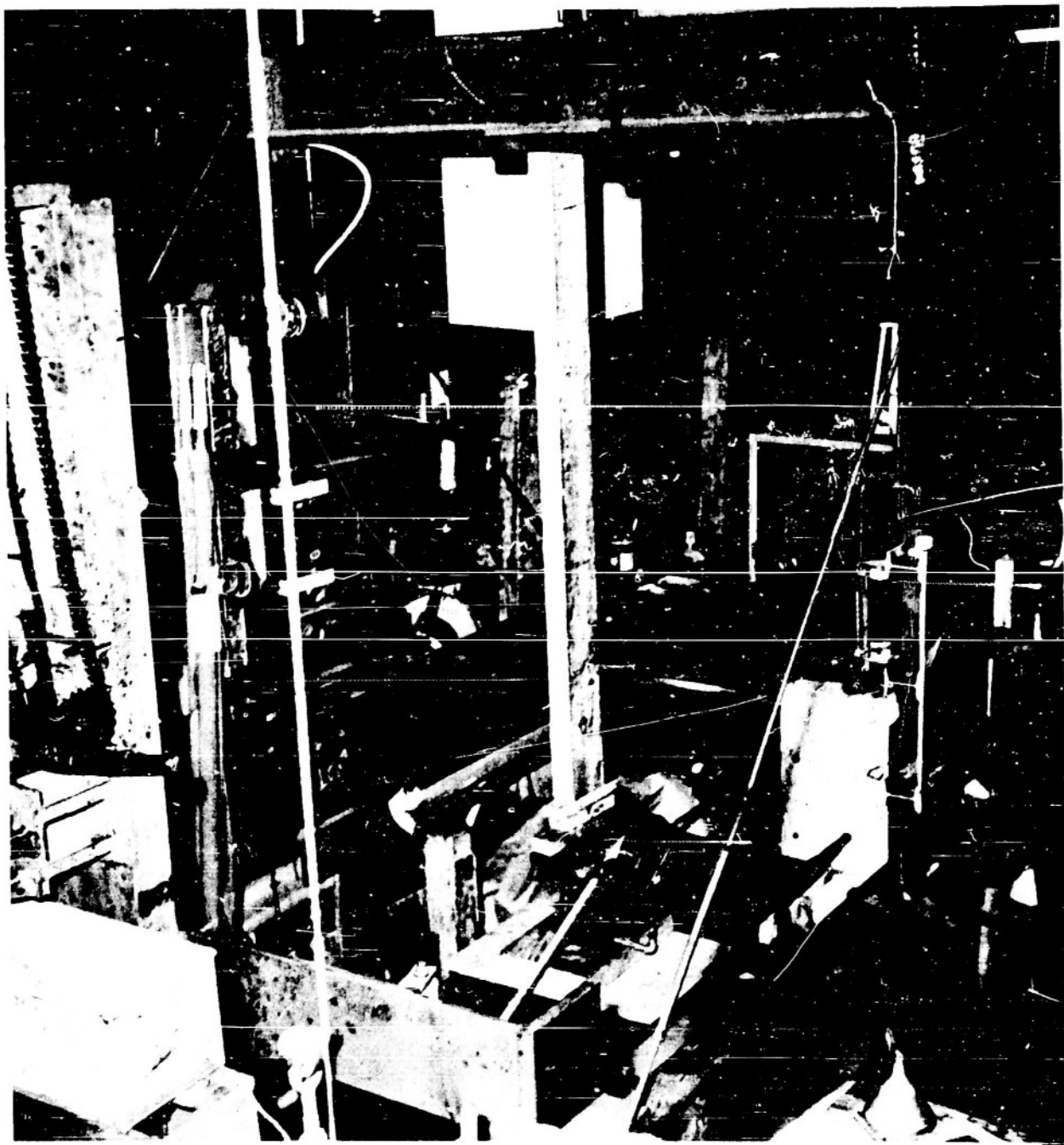
1. Test results showed the experimental pole litters met all dimension, weight and strength requirements of Specification MIL-L-16462. This specification is based, however, on field and not on aeromedical requirements.
2. The experimental plywood pole did not exhibit the same resiliency as the standard aluminum pole when subjected to the flexibility and endurance tests.
3. The experimental plywood pole litter failed at an average load of 1005 pounds as compared to 1660 pounds for the standard aluminum pole litter.
4. Based on the above findings and on the belief that plywood would be more vulnerable to rough handling and to deterioration on storage at extreme environmental conditions than would aluminum, it is the conclusion of the Aero Medical Laboratory, that the experimental plywood pole litter, in its present form, is not a satisfactory substitute for the standard straight aluminum pole litter in aeromedical evacuation.

Figure 1
METHOD & PATTERN OF LOADING, Par. 4.3.1. MIL-L-16462



Figure 2

METHOD OF LOADING. Par. 4.3.2. MIL-L-16462



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Figure 3

ENDURANCE TEST APPARATUS "UP POSITION"

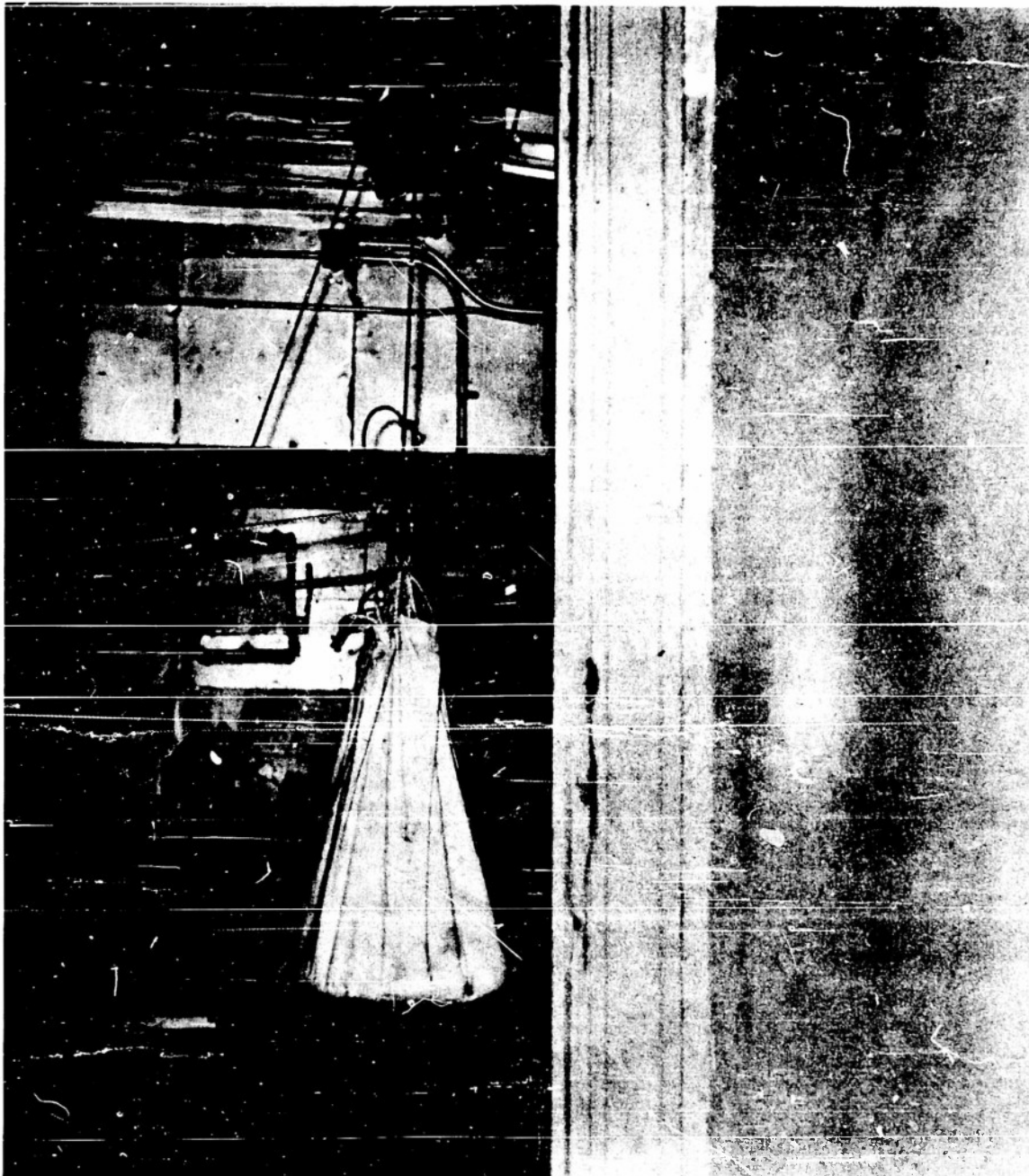


Figure 4

ENDURANCE TEST APPARATUS "DOWN POSITION"

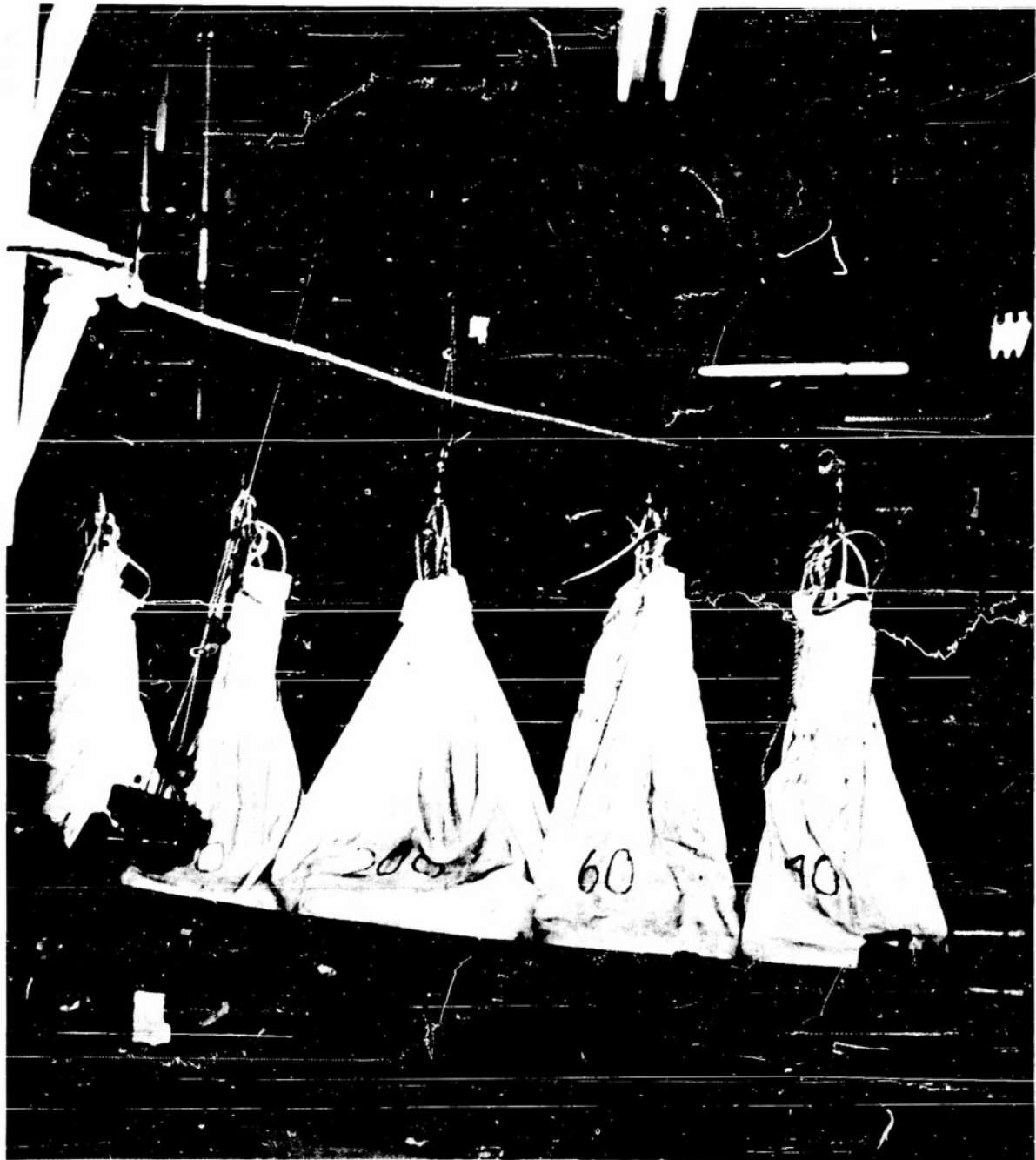


Figure 5

STIRRUP ASSEMBLY PLYWOOD POLE LITTER

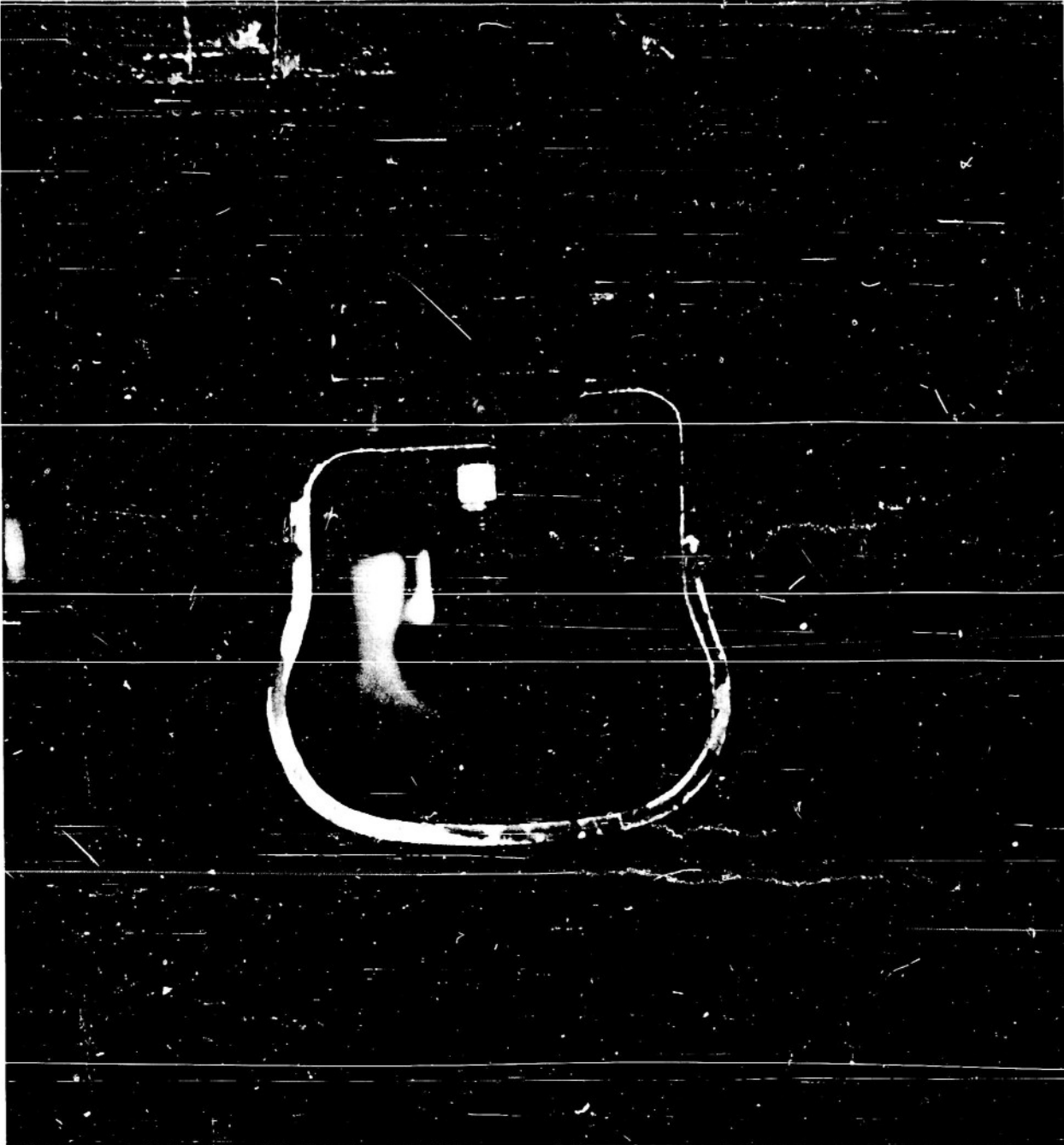


Figure 6

STIRRUP ASSEMBLY ALUMINUM POLE LITTER

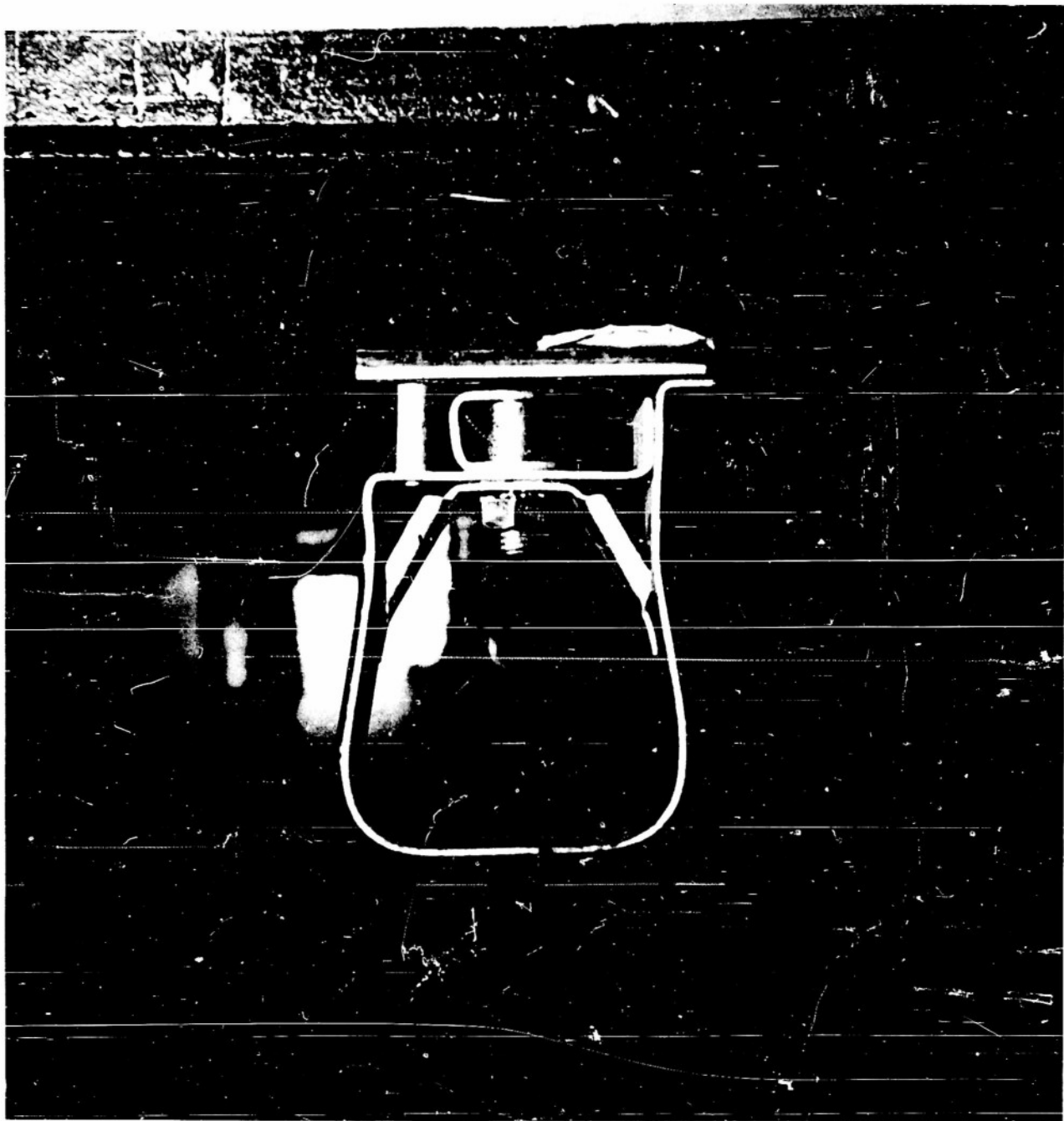


Figure 7

END ON VIEW PLYWOOD POLE LITTER

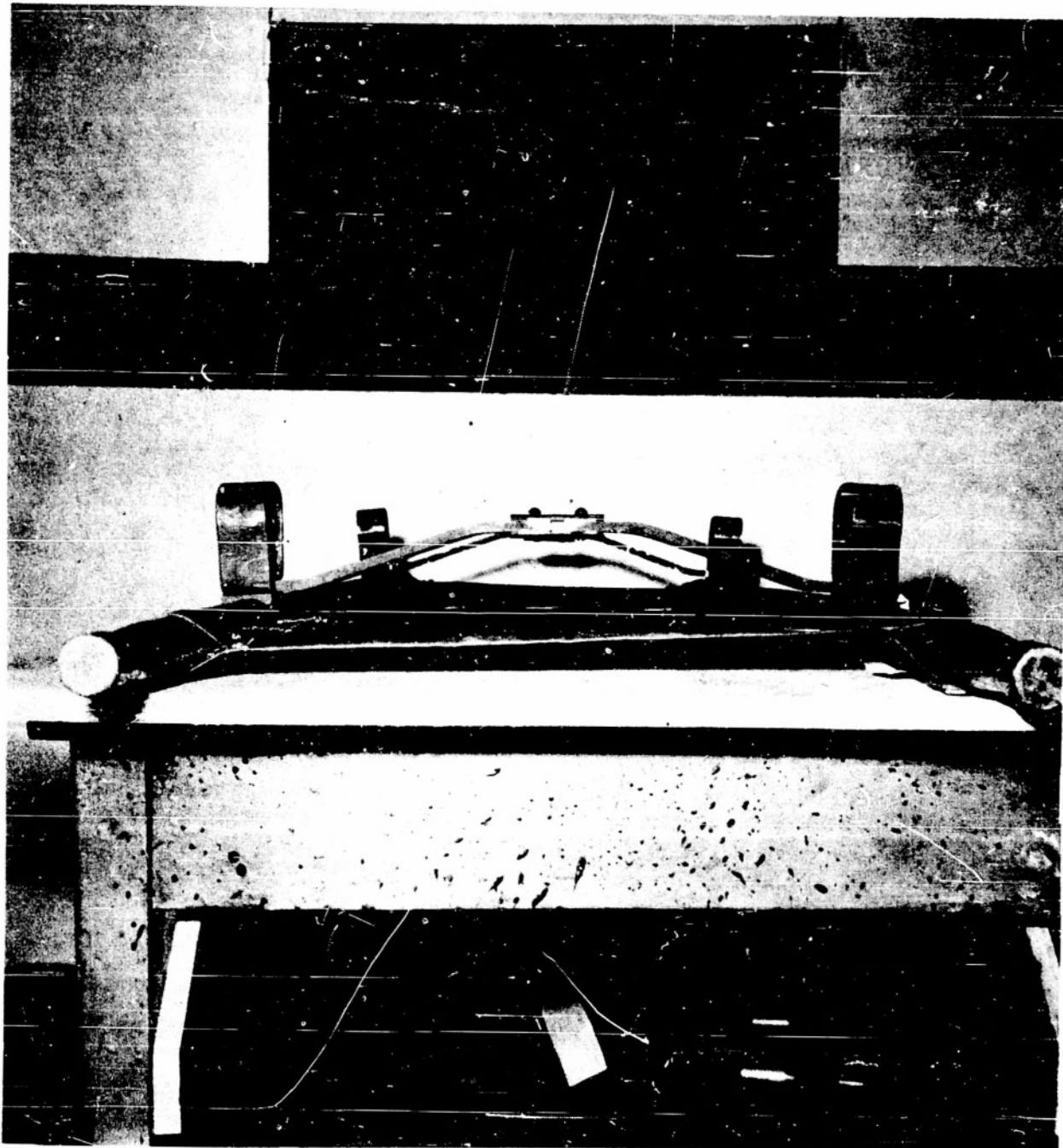
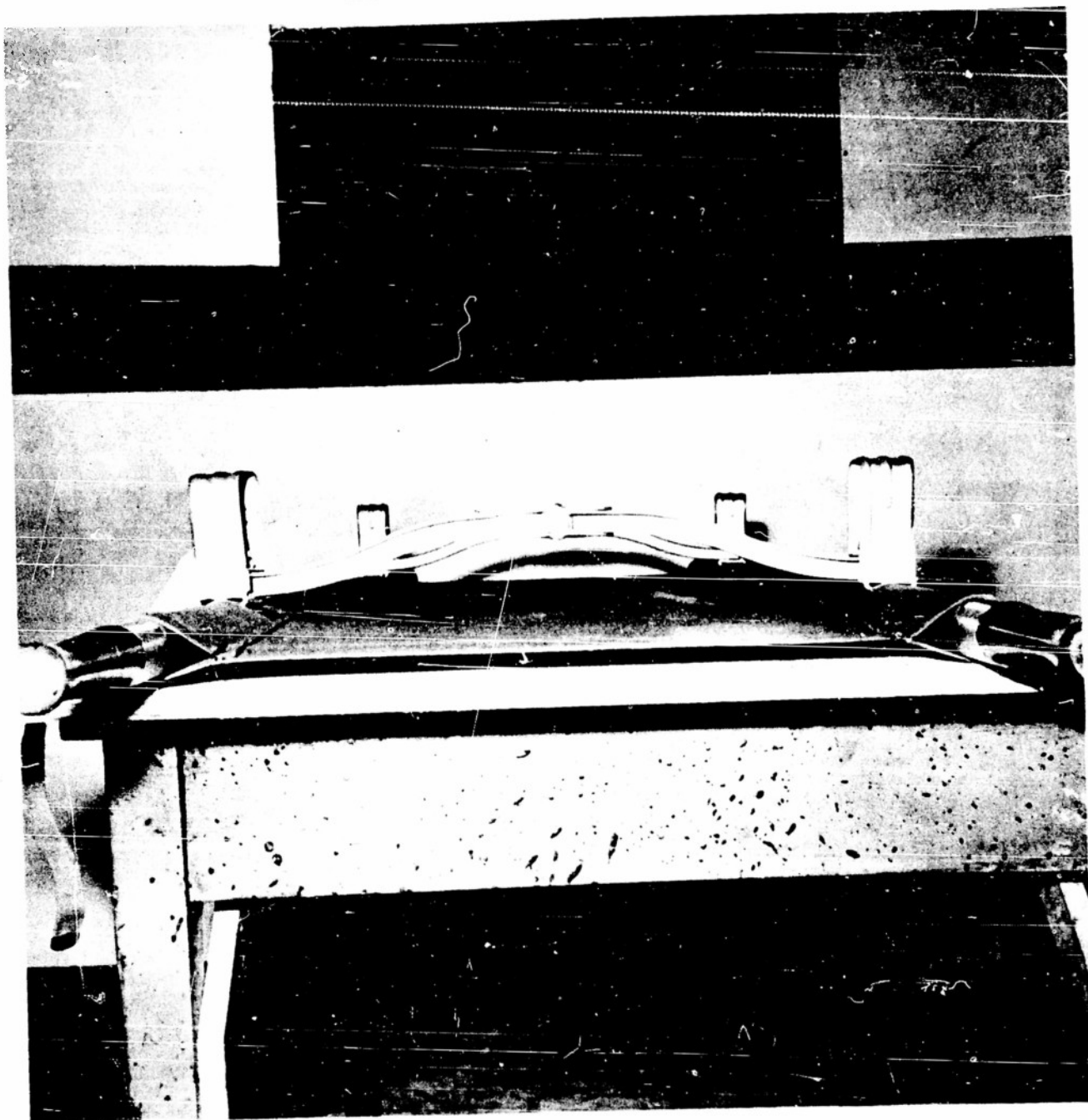


Figure 8

END ON VIEW ALUMINUM POLE LITTER



WADC TR 54-1-9

Figure 9
TOP VIEW LITTERS

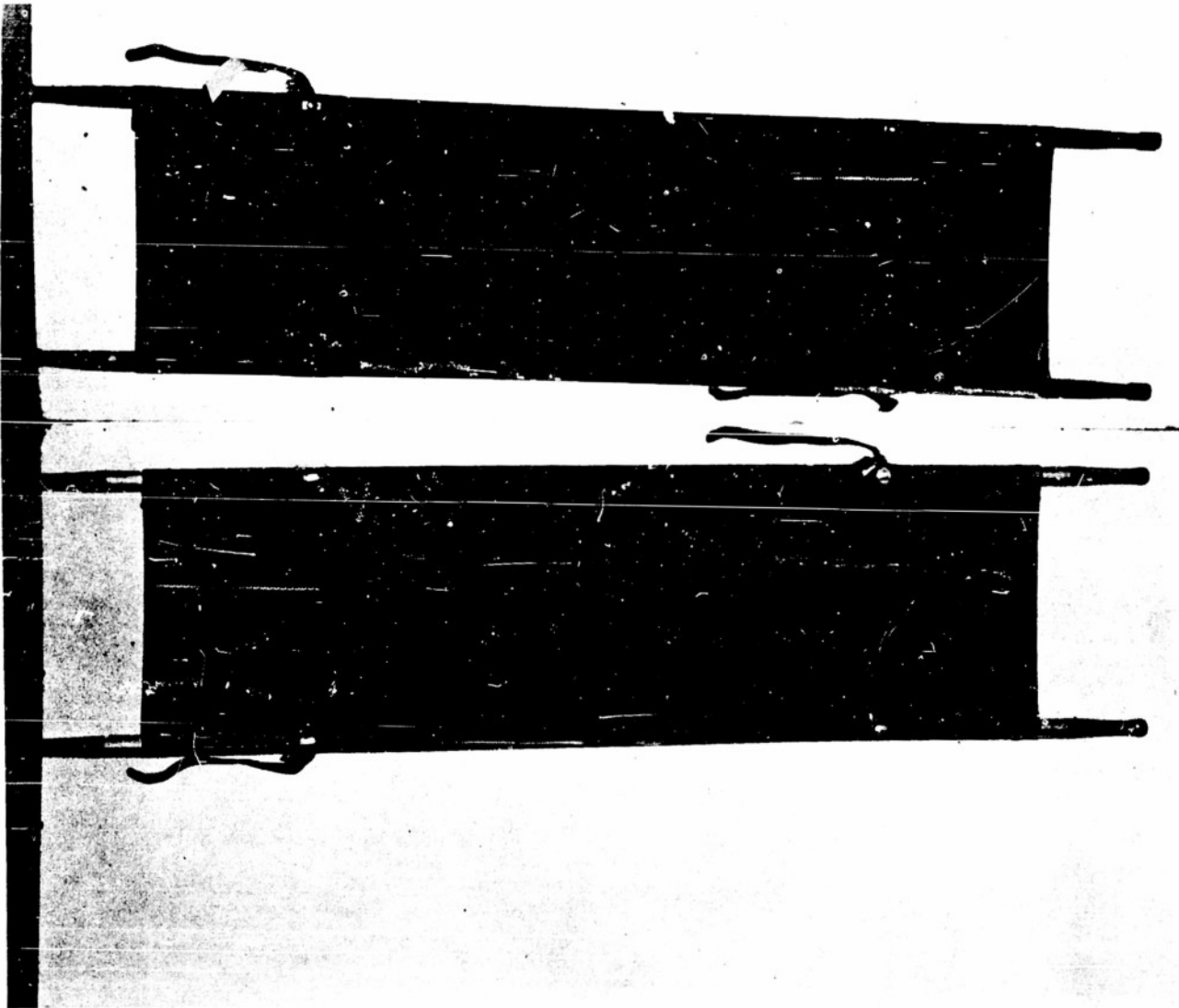


Figure 10

BOTTOM VIEW LITTERS

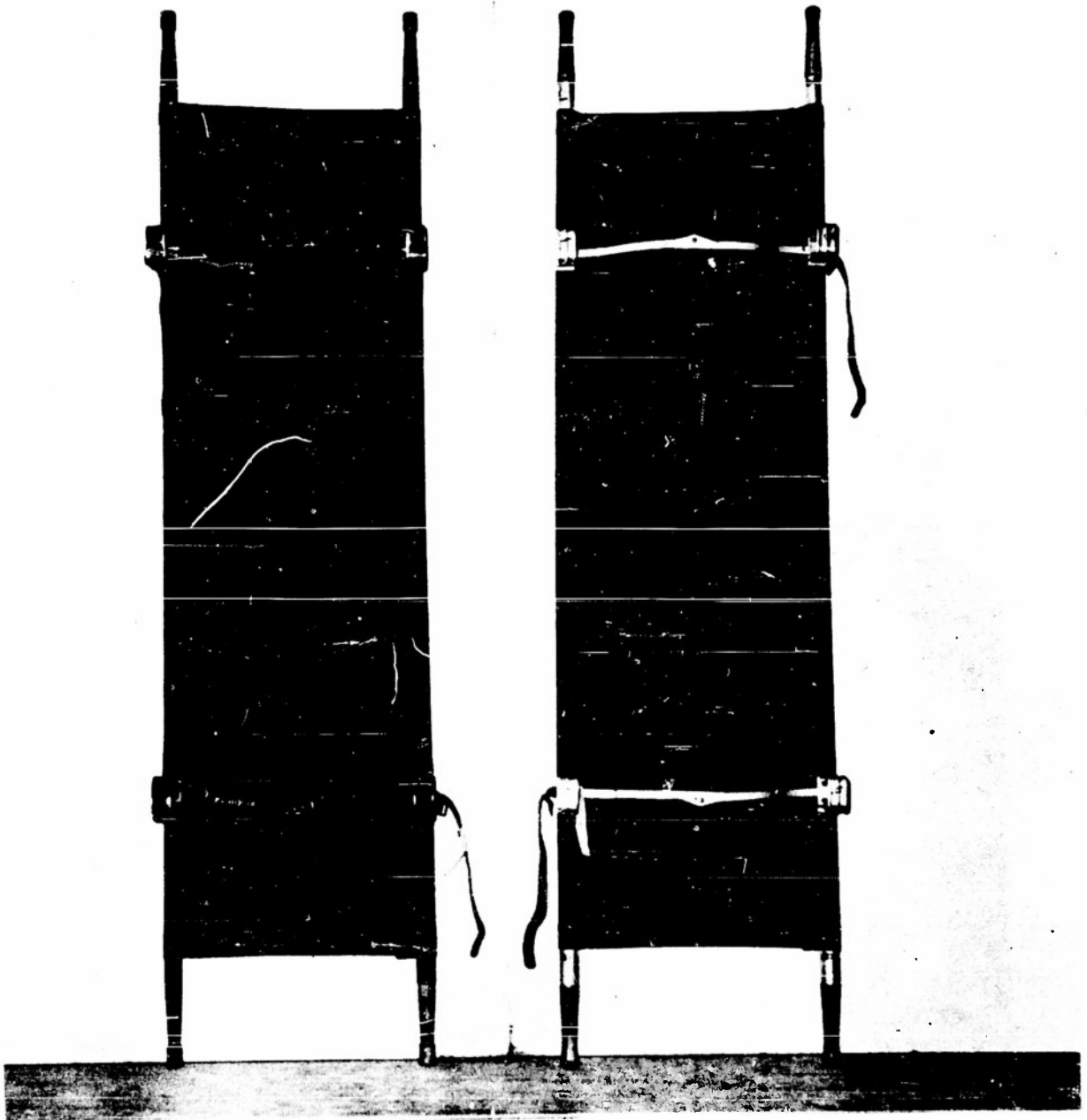


Figure 11

LITTERS No. 1 (ON THE LEFT) AND No. 2
AFTER "ULTIMATE STRENGTH" TEST

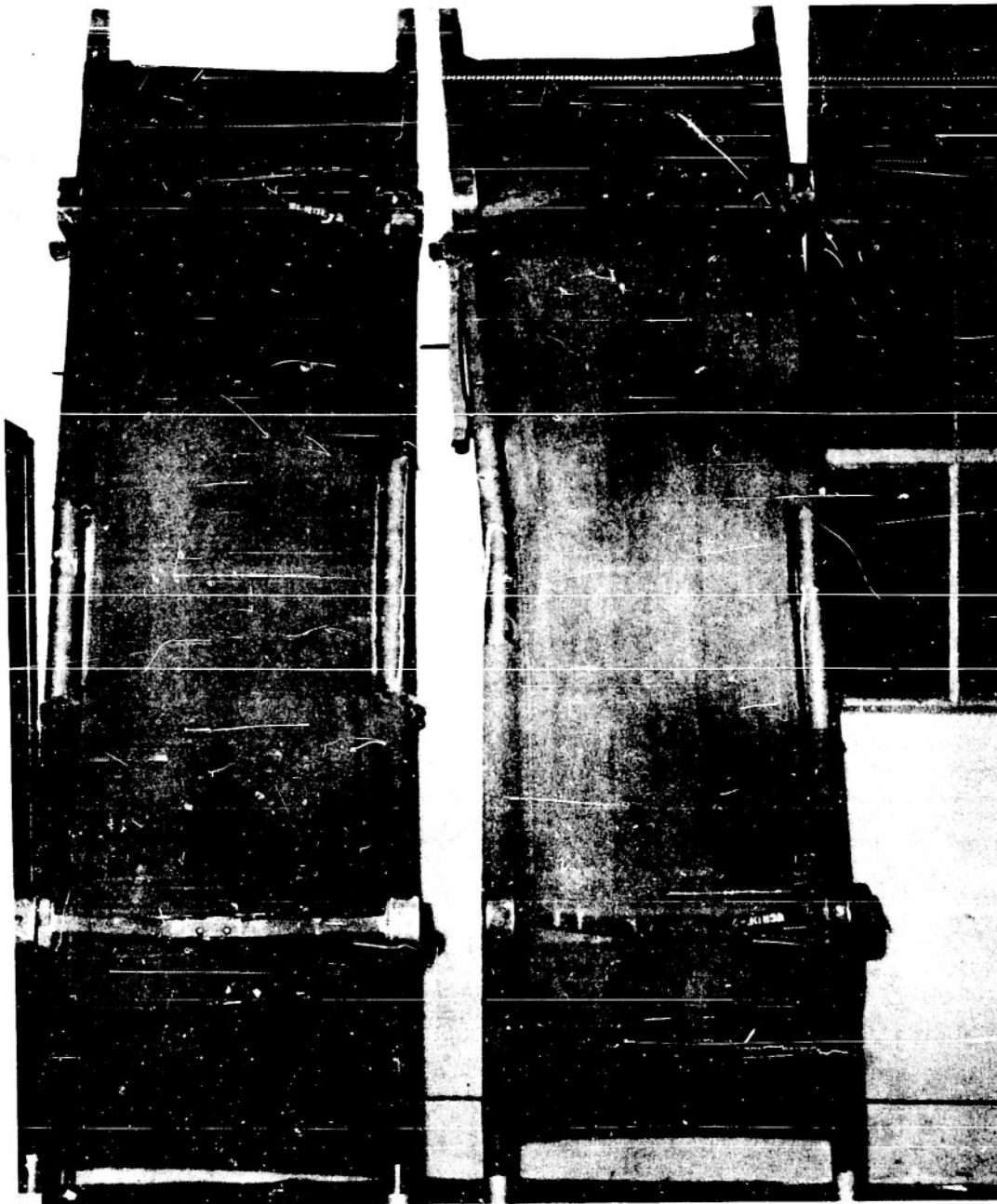


Figure 12

SIDE VIEW OF A TYPICAL PLYWOOD POLE BREAK

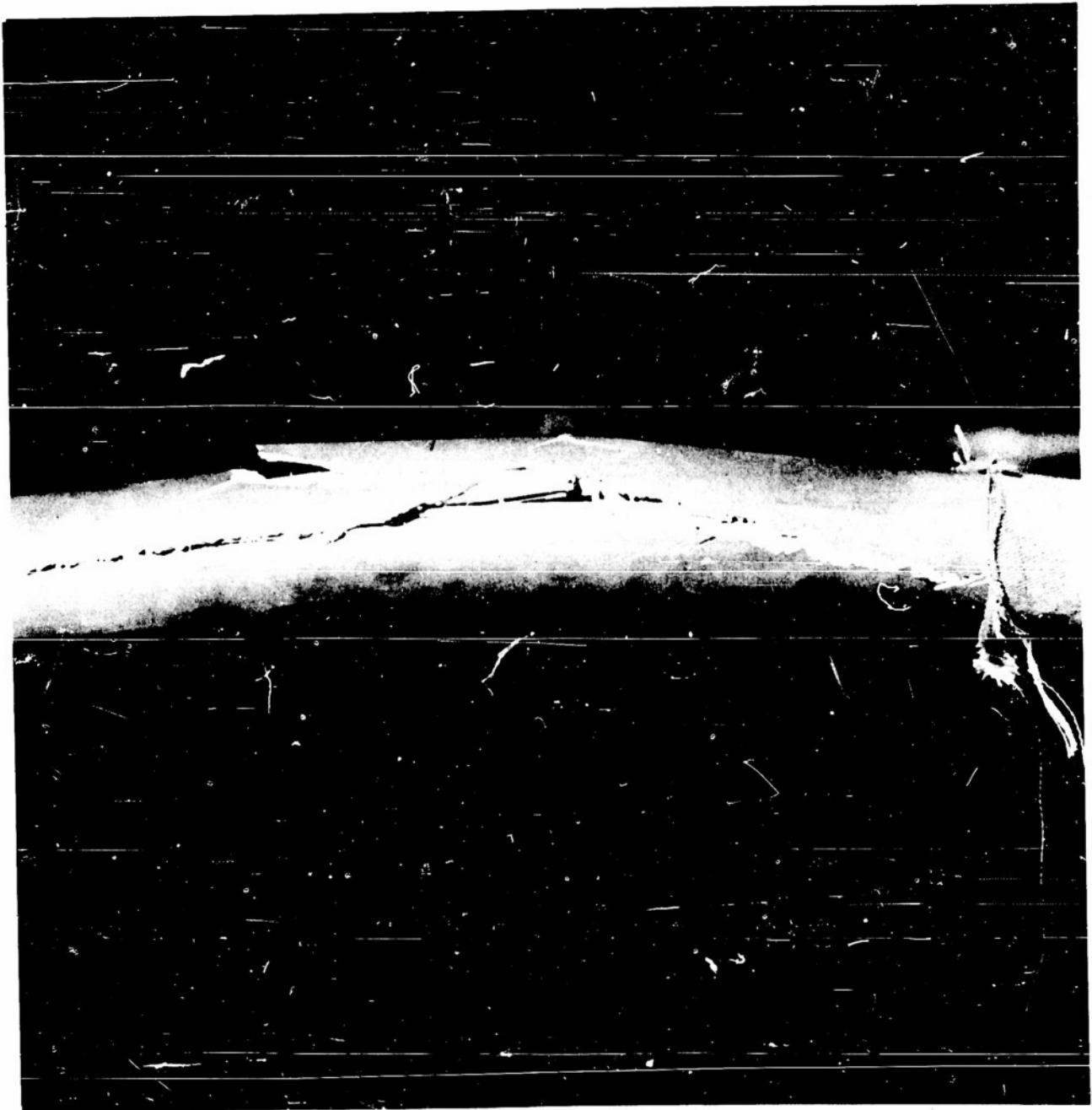


Figure 13

LITTER No. 3 AFTER "ULTIMATE STRENGTH" TEST

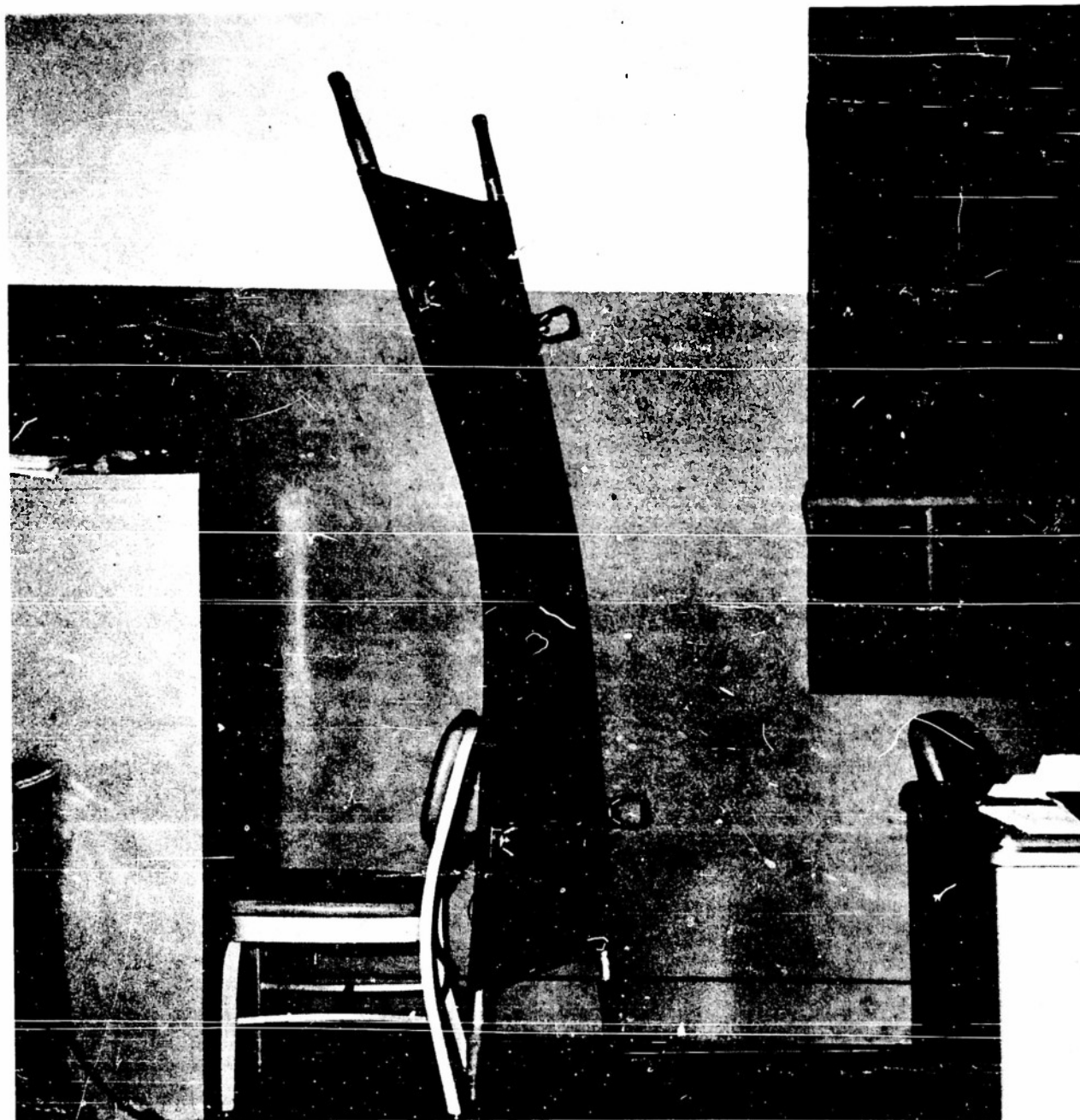


Figure 14

LITTER No. 4 AFTER "ULTIMATE STRENGTH" TEST

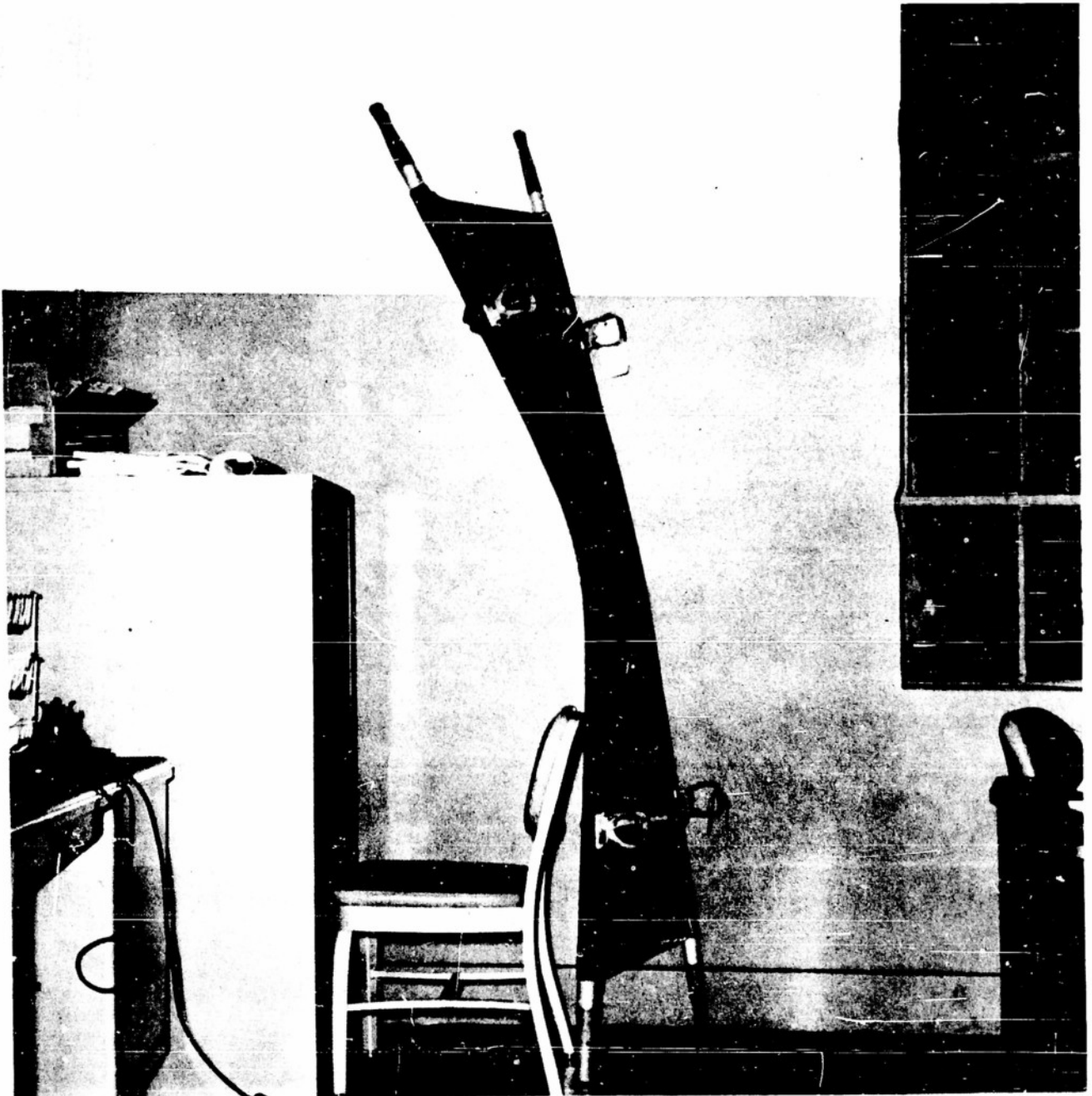


Figure 15

LITTER No. 5 AFTER "ULTIMATE STRENGTH" TEST



Figure 16

LITTER No. 6 AFTER "ULTIMATE STRENGTH" TEST



APPENDIX

New York Testing Laboratories, Inc.

80 WASHINGTON STREET, NEW YORK 6, N. Y.

Sheet No. 1Lab. No. X-276926Report No. B-5295REPORT OF TESTSMADE FORWRIGHT AIR DEVELOPMENT CENTERWRIGHT-PATTERSON AIR FORCE BASE, OHIO

Material: Six litters, Four aluminum pole type, Two plywood pole type

Marked: See below

Submitted for: Dimensional and Physical Tests

The six litters when received were numbered consecutively by the New York Testing Laboratories. All the litters bore "Accepted or Serviceable" tags, form 50B, with the following information.

<u>Litter No.</u> (New York Testing Laboratories No.)	<u>Tag Information</u>	<u>Manufacturer *</u>
1	Item Description-NS Class - Med Litter Straight Plywood Pole Exp. Date - 9/8/53	Mentone Manufacturing Co., Warsaw, Indiana
2	Same as Litter No. 1	" "
3	Item Description -7-837-905 Class - Med Litter Straight Aluminum Pole Date - 9/8/53	Name not found.
4	Same as Litter No. 3	Zimmer Thomson Corp.
5	Item Description -7-837-905 Class - Med Litter Straight Aluminum Pole Date - 11/5/53	Bebry Corporation
6	Same as Litter No. 5	Orthopedic Equipment Co., Bourbon, Ind.

* The manufacturer's name was found to be stamped on a part of the spreader assembly.

In addition, an insignia and "U.S. ARMY MEDICAL DEPARTMENT" were printed or stenciled upon the cover canvas of litters Nos. 1-5. An insignia and "U.S." were stenciled on the cover canvas of litter No. 6.

The New York Testing Laboratories' engineers affixed numbers 1,2,3 and 4 to the pole end and corresponding handles and stirrups. The poles of each litter are

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therefore identified as 1-2 or 3-4. The spreader assemblies were similarly marked 1 or 2.

Test Procedure

The following tests were performed upon the six litters submitted:

1. Various dimensions of each litter were measured.
2. Observations upon each litter in the "as received" condition were made.
3. Photographs were taken to indicate differences in the construction of the litters.
4. The overall weight of each litter was determined.
5. Various physical tests were conducted on one litter of each type as follows:
 - a) Two hundred pounds were placed on the litter cover canvas, with the litter suspended from four points located 37½ inches from the center of each pole. This weight was distributed as follows: 100 pounds over the center 18 inch length and full width of canvas; 30 pounds over each adjacent 15 inch length and full width of canvas; and 20 pounds over each end 12 inch length and full width of canvas. Measurements of the downward deflection of the pole centers were made. Figure 1 illustrates the method and pattern of loading.
 - b) With the litter resting on the stirrups, a load of 1600 pounds was applied by means of a Jenny Jack against a column, to a board 18 inches wide, resting crosswise on the poles at the center of the litter. The load was built up in a period of 5 minutes, allowed to remain 5 minutes, then removed. Measurements of the permanent set of the pole centers were made. Figure 2 shows the method of loading.
 - c) The static load, placed at the approximate center of the spreader bar, required to open one end of the litter was measured.

Procedures 5a, 5b and 5c are identical to paragraphs 4.3.1, 4.3.2 and 4.3.3 respectively of military specification MIL-L-16462. This specification covers construction, inspection, testing, etc. of folding, rigid pole litters.

6. One litter of each type not subjected to procedure No. 5 above was tested for endurance. The test consisted of loading and unloading the litters with weights totaling 400 pounds for 10,000 cycles. The points of suspension and pattern of loading were according to procedure No. 5a. The cycle frequency was ¾ cycles per minute with an amplitude of approximately 4 inches. The litters were examined for failures, permanent set, and deflection under load after each 1000 cycles and at the conclusion of the test. Figure 3 shows the endurance test system in the "up position" while Figure 4 illustrates the system in the "down" position.

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7. Each of the six litters was subjected to a test for "ultimate strength". This test consisted of applying an initial load (see results for initial loading) to the litters and increasing this load by 10 pounds every two minutes until failure occurred. The loading pattern was according to procedure No. 5a and the points of suspension were located 39-3/8 inches from the center of each pole. Refer to Figure 1 for method of testing.

All instruments used in the above tests were calibrated. Where loadings in distributed pattern were required, the weights consisted of sand in bags of proper dimension.

RESULTS

I. Dimensional Measurements

TABLE 1

		Measurement in inches					
		Litter No. 1	Litter No. 2	Litter No. 3	Litter No. 4	Litter No. 5	Litter No. 6
Length of pole 1-2		77 ¹ / ₂	77 ¹ / ₂	77.1 ¹ / ₂	77.1 ¹ / ₂	77 ¹ / ₂	77 ¹ / ₂
" " " 3-4		77	77	77.1	77.1	77.1	77
Diameter of pole near handle 1		1.47	1.50	1.54	1.55	1.53	1.50
" " " " " 2		1.46	1.44	1.54	1.55	1.53	1.50
" " " " " 3		1.46	1.46	1.55	1.54	1.54	1.51
" " " " " 4		1.52	1.49	1.54	1.55	1.53	1.51
Exposed length of handle 1		6.5	6.5	6.5	6.6	6.5	6.5
" " " " " 2		6.6	6.5	6.5	6.6	6.5	6.5
" " " " " 3		6.5	6.5	6.5	6.6	6.4	6.5
" " " " " 4		6.5	6.5	6.5	6.6	6.5	6.5
Overall pole length (pole + handles) 1-2		90.1	90.0	90.1	90.3	90.0	90.0
" " " " " 3-4		90.0	90.0	90.1	90.3	90.0	90.0
Distance between pole centers							
at pole ends 1 to 3		20.3	19.8	19.8	20.3	20.6	20.3
" " " 2 to 4		20.0	19.9	19.1	20.4	20.8	20.1
Total width of litters							
at pole ends 1 to 3		21.8	21.3	21.4	21.9	22.1	21.8
" " " 2 to 4		21.5	21.4	20.6	22.0	22.3	21.6
* Length of canvas		72.7	71.9	71.6	71.3	69.7	72.0
Thickness of stock - spreader 1		0.368	0.379	0.090	0.096	0.377	0.384
" " " spreader 2		0.378	0.377	0.092	0.097	0.380	0.393
Thickness of stock - stirrup 1		0.176	0.187	0.092	0.097	0.180	0.192
" " " stirrup 2		0.196	0.183	0.092	0.095	0.181	0.201
" " " stirrup 3		0.176	0.192	0.094	0.097	0.182	0.189
" " " stirrup 4		0.193	0.182	0.094	0.097	0.193	0.197

* These values are the average of three readings.

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2. The following defects of the litters in the "as received" condition were observed;

Litter No. 1 - Two pulls on underside of canvas cover.

Litter No. 2 - One tie belt slightly torn; canvas cover sewn loosely at one end.

Litter No. 3 - Canvas cover slightly damaged on pole 1-2 near bolt block No. 1.

Litter No. 4 - Canvas cover damaged under spreader No. 2 near pole 3-4; tear on canvas cover on pole 3-4 near bolt block 3.

Litter No. 5 - Small hole in canvas cover under spreader No. 2; numerous pulls and tears in canvas along pole 3-4; handles 1,2,3 loosely attached. This litter appeared to have been used prior to testing in that paint had been scraped from stirrups and handles and the canvas appeared worn and dirty.

Litter No. 6 - No defects observed.

3. Figures 5-10 illustrate the comparative construction of the litters. Litters Nos. 1,2 (plywood pole), 5 and 6 (aluminum pole) are similar in appearance to one another. Litters Nos. 3 and 4 (aluminum pole) are likewise similar to one another.

Figures 5 and 6 show the typical stirrup assemblies of litters Nos. 1 and 3 respectively. Note the thinner material used for the stirrup of litter No. 3 (see Table I - Thickness of Stirrup Stock)

Figures 7 and 8 are "end on" views of litters Nos. 1 and 3 respectively in the "upside down" position. Observe the corrugations on the stirrups and the channel-type construction of the spreader bars of litter No. 3. Also there is a coupler connecting the two spreader bars of litter No. 1 while a pin connects the spreader bars of litter No. 3. The "end on" view of litter No. 6 is similar to that of litter No. 1 excepting there is a taper to the stirrups of litter No. 6.

Figure 9 is the "top" view of litters No.1(on the left) and No. 3. Note that there are no transverse fold lines on the canvas cover of litter No. 3.

Figure 10 is the "bottom" view of litters No.1(on the left) and No. 3. This view illustrates the method of numbering parts of the litters.

4. Overall weight of each litter:

TABLE II

<u>Litter No.</u>	<u>Weight (lbs.)</u>
1 (plywood pole)	15.0
2 " "	14.5
3 (aluminum pole)	16.6
4 " "	17.4
5 " "	14.4
6 " "	15.1

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5. Physical Tests

TABLE III

Procedure No.	Requirement of Specification <u>MIL-L-16462</u>	Result for Litter No. 2 (plywood pole)	Comment	Result for Litter No. 4 (aluminum pole)	Comment
5a	Maximum downward deflection of $1\frac{1}{2}$ "	$1-1/8$ " (Average of two poles)	Conforms	$9/16$ " (average of two poles)	Conforms
5b	Maximum permanent set in pole - $5/8$ "	$3/16$ " (Average of two poles)	Conforms	None	Conforms
5c	50 - 60 pounds required to open one end	38 lbs. Spreader bar No. 1	Does not conform.	55 lbs. Spreader bar No. 1	Conforms
		22 lbs. Spreader bar No. 2	Does not conform.	26 lbs. Spreader bar No. 2	Does not conform.

Note: No damage in addition to that reported above occurred in either litter.

6. Endurance Test:

TABLE IV

(litters No. 1 and 3 tested for endurance)

No. of Cycles Completed	*Downward deflection of Litter No. 1 at center (plywood pole) -inches-	*Total permanent set of poles of Litter No. 1 -inches-	*Downward deflection of Litter No. 3 (aluminum pole) -inches-	*Total permanent set of Poles of Litter No. 3 -inches-
0	2-1/4	0	7/8	0
1000	2-1/4	1/16	7/8	0
2000	2-1/4	1/8	7/8	1/8
3000	2-5/16	1/4	7/8	1/8
4000	2-5/16	1/4	7/8	1/8
5000	2-5/16	1/4	1	1/8
6000	2-5/16	1/4	1	1/8
7000	2-5/16	5/16	1	1/8
8000	2-5/16	5/16	1	1/8
9000	2-5/16	3/8	1-1/16	1/8
10000	2-5/16	3/8	1-1/16	1/8

*Average of two poles.

Other damage to litters during the above test consisted only of burring of poles at points of support.

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Contract AF 33(616)-2064, job No. 1

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7. Ultimate Strength Test:

TABLE V

<u>Litter No.</u>	<u>Initial Load (lbs.)</u>	<u>Final Load (lbs.)</u>	<u>Failure</u>
1	920	920	Poles 1-2 and 3-4 broke. The fracture was characterized by longitudinal cracks and delamination.
2	1000	1090	Same as litter No. 1.
3 *	1440	1440	Pole 1-2 collapsed. Pole 3-4 showed a severe permanent set.
4	1000	1760	Pole 3-4 collapsed. Pole 1-2 showed a severe permanent set.
5	1000	1390	Failure similar to that of litter No. 4.
6	1000	2050	Failure similar to that of litter No. 4 but more severe. Also, wood handle No. 3 was abraded.

* Litter No. 3 was tested first. The initial load was planned to be 1500 pounds. Since failure occurred before 1500 pounds was reached, initial loading was reduced to 1000 pounds for subsequent tests.

Note: In each of the "ultimate strength" tests, the loading was started at the end sections of the canvas cover and completed at the center section. Initial loadings for litters Nos. 1 and 3 were discontinued after failure.

The validity of the "ultimate strength" test for litters Nos. 1-4 is questionable since these litters had been subjected to previous severe tests.

Also it is pointed out that litters No. 1 and No. 3, having failed at lower loads than the corresponding litters No. 2 and No. 4, had originally been tested for endurance.

Figure 11 shows failures of litters No. 1 (on the left) and No. 2 near the pole centers. (The canvas has been removed from near the failures so that the nature of the breaks can be observed). Note the long cracks on several of the failures.

Figure 12 shows a side view of a typical plywood pole break. Observe the long cracks and evidence of delamination.

Figures 13, 14, 15 and 16 show the collapsed poles of litters Nos. 3-6 respectively. Note the permanent sets in the other poles.

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Contract AF 33(616)-2064, job No. 1

New York Testing Laboratories, Inc.

80 WASHINGTON STREET, NEW YORK 6, N. Y.

Sheet No. 7

Lab. No. X-276926

Report No. B-5295

SUMMARY

The dimensional measurements and photographs indicate that the stirrup assemblies, spreader bar system, and canvas cover of aluminum pole litters Nos. 3 and 4 do not conform to specification MIL-L-16462 whereas the plywood pole litters and aluminum pole litters Nos. 5 and 6 appear to have been constructed largely to the specification. The litters tested under procedure Nos. 5a and 5b conform to the requirements of the corresponding MIL-L-16462 load tests. These litters tested under procedure 5c failed to meet the requirements of the corresponding specification test in three out of four cases. In addition, these litters suffered very slight apparent damage from the endurance test. From the results of the "ultimate strength" test, however, it appears that the endurance test may have a weakening effect upon the litters. "Ultimate strength" test results on the aluminum pole litters are varied, but it must be pointed out that aluminum litters of at least three different manufacturers were tested.

Based upon deflections, permanent sets, and "ultimate strength" results obtained during these tests, it appears that the aluminum pole litters are stronger than the plywood pole litters.

Subscribed and sworn to before me
this 1st day of July 1954.
City of New York
County of New York
Commissioner of the Court of Appeals July 1, 1955

We certify that this report is a true report
of results obtained from our tests of this
material.

Respectfully submitted,

NEW YORK TESTING LABORATORIES, INC.

G.J. Horvitz, P.E., Technical Director

G.J. Harvey, Asst. Technical Director

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Contract AF 33(616)-2064, job No. 1

Armed Services Technical Information Agency

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