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TRANSPORTABILITY TESTING OF COMMERCIAL CONTAINER IMPROVED DUNNAGE METHOD

Prepared for:
U.S. Army Defense Ammunition
Center and School
ATTN: SMCAC-DET
Savanna, IL 61074-9639

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The U.S. Army Defense Ammunition Center and School (USADACS), Validation Engineering Division (SMCAC-DEV), was tasked by USADACS, Transportation Engineering Division (SMCAC-DET), to conduct rail impact tests to verify the safety of the loading procedures mentioned within this report. This report contains the procedures, results, and recommendations from the tests conducted. As tested, the improved dunnage method of bracing in commercial containers successfully passed rail impact testing.

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U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL
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REPORT NO. 91-12

TRANSPORTABILITY TESTING OF
COMMERCIAL CONTAINER IMPROVED DUNNAGE METHOD

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PART 1

INTRODUCTION

A. BACKGROUND. The U.S. Army Defense Ammunition Center and School (USADACS), Validation Engineering Division (SMCAC-DEV), was tasked by USADACS, Transportation Engineering Division (SMCAC-DET), to test the commercial container improved dunnage method.

B. AUTHORITY. This test was conducted IAW mission responsibilities delegated by the U.S. Army Armament, Munitions and Chemical Command (AMCCOM), Rock Island, IL.

C. OBJECTIVE. The objective of this test was to assess the ability of the commercial container and the blocking and bracing to sustain rough handling and contain a load during a transportation cycle.

D. CONCLUSION. The method, as described in this report, passed rail impact and transportability testing. The doors bowed during all the rail impact tests, which suggests that the load is distributed along the width of the door including the hinges. The use of 1/4-inch-thick by 2-inch by 1 1/2-inch welded angle load retainer inside the doorway is preferable since this takes the load off the hinges, although the amount of bracing at the door could be increased to take the load off the door latches from the bracing flexing during impact. Note: Request for test identified 1 1/4-inch by 1 1/4-inch by 1/4-inch angle for test configuration, however 2-inch by 1 1/2-inch by 1/4-inch angle was substituted.

E. RECOMMENDATION. The bracing should be made symmetric from top to bottom to avoid the possibility of installing the bracing upside down, which occurred during the second rail impact test, resulting in failure.

PART 2

17 AND 24 APRIL 1991; 30 APRIL, 21 AND 30 MAY 1991; AND 3-4 JUNE 1991

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PART 3

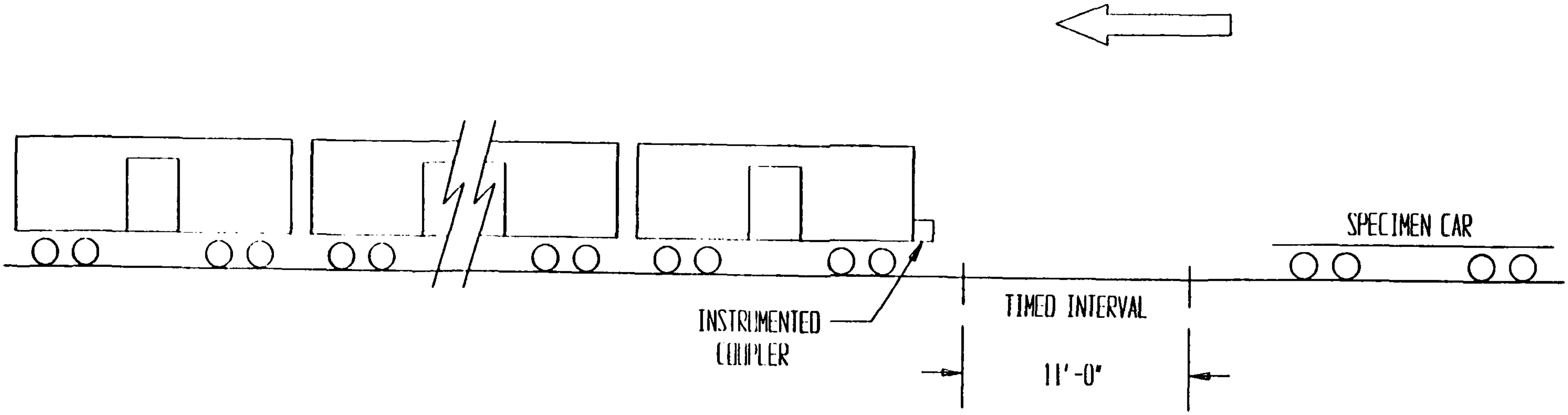
TEST PROCEDURES

TRANSPORTABILITY TESTS. The test procedures outlined in this section were extracted from TP-91-01, Transportability Testing Procedures, July 1991. This standard identifies six steps that a load must undergo if it is considered to be acceptable. The five tests that were conducted on the test specimen are synopsized below.

A. RAIL IMPACT TEST. Each container test load was positioned directly on the locking pedestals of the railcar. Equipment needed to perform the test included the specimen (hammer) car, five empty railroad cars connected together to serve as the anvil, and a railroad locomotive. These anvil cars were positioned on a level section of track with air and hand brakes set and with the draft gears compressed. The locomotive unit pulled the specimen car several hundred yards away from the anvil cars and, then, pushed the specimen car toward the anvil at a predetermined speed, disconnected from the specimen car approximately 50 yards away from the anvil cars and allowed the specimen car to roll freely along the track until it struck the anvil. This constituted an impact. Impacting was accomplished at speeds of 4, 6, and 8 mph in one direction and at a speed of 8 mph in the opposite direction. The 4 and 6 mph impact speeds are approximate; the 8 mph speed is a minimum. Impact speeds are determined by using an electronic counter to measure the time required for the specimen car to traverse an 11-foot distance immediately prior to contact with the anvil cars (see figure 1).

B. ROAD HAZARD COURSE. The specimen tested was subjected to the road hazard course. Using a suitable truck/tractor and chassis, the vehicle/specimen was towed/driven over a road hazard course two times at a speed of approximately 5 mph. The speed was increased or decreased, as appropriate, to produce the most violent load response.

ASSOCIATION OF AMERICAN RAILROADS (AAR)
STANDARD TEST PLAN



5 BUFFER CARS (ANVIL) WITH DRAFT GEAR COMPRESSED AND AIR BRAKES IN A SET POSITION

ANVIL CAR TOTAL WT 250,000 LBS (APPROX)

SPECIMEN CAR IS RELEASED BY SWITCH ENGINE TO

ATTAIN: IMPACT NO. 1 @ 4 MPH
IMPACT NO. 2 @ 6 MPH
IMPACT NO. 3 @ 8 MPH

THEN THE CAR IS REVERSED AND RELEASED BY SWITCH ENGINE TO

ATTAIN: IMPACT NO 4. @ 8 MPH

FIGURE 1

C. ROAD TRIP. Using a suitable truck/tractor and chassis, the container vehicle/specimen load was driven/towed for a total distance of at least 30 miles over a combination of roads surfaced with gravel, concrete, and asphalt. The test route included curves, corners, railroad crossings, cattle guards, stops and starts. The test vehicle traveled at the maximum speed suitable for the particular road being traversed, except as limited by legal restrictions. This step provided for the tactical vehicle/specimen load to be subjected to three full air brake stops while traveling in the forward direction and one in the reverse direction while traveling down a 7 degree grade. The first three stops were at 5, 10, and 15 mph, while the stop in the reverse direction was at approximately 5 mph.

D. WASHBOARD COURSE. Using a suitable truck/tractor, and chassis, the specimen was towed/driven over the washboard course at a speed which produced the most violent response in the particular test load.

E. SHIPBOARD TRANSPORTABILITY SIMULATOR (STS). The container test load was positioned onto the STS and securely locked in place using the cam lock at each corner. Using the procedure detailed in the operating instruction, the STS was started oscillating at an amplitude of 30 degrees +/- 2 degrees, either side of center and at a frequency of 2 cycles-per-minute. This frequency was observed for apparent defects that could cause a safety hazard. The frequency of oscillation was then increased to 4 cycles-per-minute and the apparatus operated for 2 hours. After inspection of the load, the frequency of oscillation was further increased to 5 cycles-per-minute, and the apparatus operated for 4 hours. No change or adjustments to the load or load restraints were permitted at any time during the test. After once being set in place, the test load was not removed from the apparatus until the test was completed or terminated.

PART 4

TEST EQUIPMENT

A. TEST LOAD.

a. Description:	PA37 Propelling Charge Containers
b. Drawing Number:	19-48-4154
c. Test Weight:	29,240 Pounds
d. Date:	17 April 1991

B. TEST LOAD.

a. Description:	C445 Wooden Boxes
b. Drawing Number:	19-48-4153
c. Test Weight:	48,200 Pounds
d. Date:	24 April 1991

C. TEST LOAD.

a. Description:	C445 Wooden Boxes (and side-opening container with 30mm rounds) (and MILVAN with M107 projectiles)
b. Drawing Number:	19-48-4153
c. Test Weight:	43,920 Pounds
d. Date:	30 April and 21 May 1991

D. TEST LOAD.

a. Description:	M107 Projectiles with 2" by 1-1/2" angle welded on door corner post (and MILVAN with C445 boxes) (and MILVAN with M107 projectiles)
b. Drawing Number:	DET-67
c. Test Weight:	41,350 Pounds
d. Date:	30 May 1991

E. TEST SPECIMEN.

a. Description:	Commercial Container:	ITEL 828119
b. Specifications:	Max Gross Weight:	44,800 lbs.
	Tare Weight:	4,960 lbs.
	Net Weight:	39,840 lbs.
	Internal Height:	7.85 ft.
	Internal Width:	7.71 ft.
	Internal Length:	19.35 ft.
	Internal Cube:	1,173 cu. ft.

F. TEST RAILCAR.

a. Car Number:	TTWX 992753
b. Car Length:	89 ft.
c. Load Limit:	150,000
d. Load Lt. Wt.:	69,000

PART 5

TEST RESULTS

A. RAIL IMPACT TESTING:

1. Rail impact testing was done at a nominal 4, 6, and 8 mph and 8 mph in reverse. The first test load consisted of PA37 propelling charge containers (see pages 6-2 thru 6-4). The exact speeds are shown below.

IMPACT NO.	SPEED (mph)
1	3.77
2	5.42
3	6.25
4	8.24
5	8.17 reverse

The first impacts were done with the door of the container facing the anvil cars. No damage was noted with this test load. During the second impact, approximately 1/8-inch bowing of one of the door supports resulted. The fourth impact showed slightly more bowing. Only 1-inch total void developed at door end after the fourth (reverse) impact.

2. Rail impact testing was done at a nominal 4, 6, and 8 mph and 8 mph in reverse. The second test load consisted of C445 wooden boxes (see page 6-5). The exact speeds are shown below.

IMPACT NO.	SPEED (mph)
1	3.85
2	5.21
3	6.41
4	7.58
5	8.43
6	8.52 reverse

The fourth impact caused the leftmost door latch to bow out 1/2-inch and the next latch to the right bowed 1/4-inch. Bowing increased slightly during the fifth impact. Upon disassembly, the front dunnage was noticed to have been crushed on one side which caused shifting of one row of pallets approximately two feet (see pages 6-6 and 6-7). The cause appeared to be offset struts; i.e., upside down dunnage (see recommendations). The longitudinal struts did not match up to the lateral beams because each set of struts was on a separate structure and one of the structures was installed upside down. This mistake would not have been possible had each structure been vertically symmetrical.

3. Rail impact testing was done at a nominal 4, 6, and 8.1 mph and 8.1 mph in reverse. The third test load, consisted of C445 wooden boxes with two additional containers on the flatcar to increase compression of the cushioned draft gear of the railcar (see pages 6-8). The exact speeds are shown below.

IMPACT NO.	SPEED (mph)
1	3.49
2	4.69
3	6.43
4	8.24
5	8.33 reverse

None of the impacts caused any significant deformation. The load seemed very tight, since, upon disassembly, there was very little gap in the front or rear of the cargo in the commercial container.

4. Rail impact testing was done at a nominal 4, 6, and 8 mph and 8 mph in reverse. The fourth test load consisted of M107 projectiles and two additional containers on the flatcar, to increase compression of the cushioned draft gear of the railcar. The test load was restrained

with 1/4-inch-thick by 2-inch by 1 1/2-inch steel welded angle load retainer on the door corner post of the container (see pages 6-9 thru 6-11). The exact speeds are shown below.

IMPACT NO.	SPEED (mph)
1	4.66
2	6.47
3	8.33
4	8.33 reverse

The first impact caused one door latch to bow 1/4 inch. The second impact caused the bowing to increase 3/4 inch. The third impact caused the bowing to increase to 1 inch, and the doors were opened to reveal that the load had rebounded 1 1/4 inch from the door.

B. ROAD TESTS. Two passes over the road hazard course, a 30-mile road trip, two additional passes over the road hazard course, and one pass over the washboard course was made per test procedures with the M107 test load. The times taken to traverse each are shown in order of sequence below. No damage was noticed during or after the transportability tests.

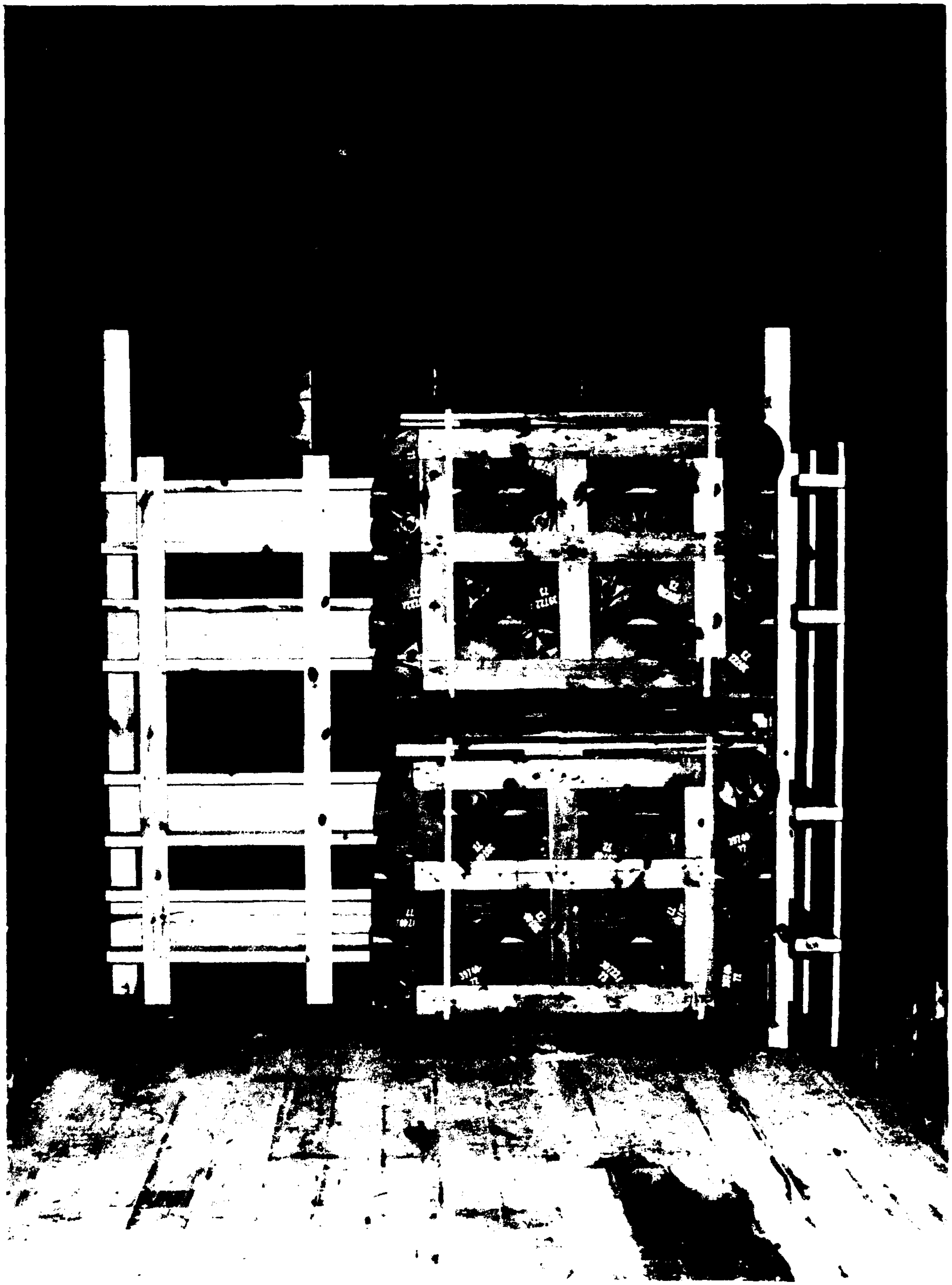
COURSE	TIME (min:sec)	AVG. SPEED (mph)
HAZARD COURSE NO. 1	00:42.00	3.2
HAZARD COURSE NO. 2	00:24.00	5.7
30-MILE ROAD TRIP	43:00	41.9
HAZARD COURSE NO. 3	00:24.30	5.6
HAZARD COURSE NO. 4	00:23.70	5.8
WASHBOARD COURSE	01:12.00	2.8

C. SHIPBOARD TRANSPORTATION SIMULATOR (STS). The commercial container loaded with M107 projectiles was tilted at the frequencies shown below for the time periods shown to simulate transportation on an ocean going vessel. No damage was noticed during or after STS testing.

FREQUENCY ON STS	
2 cycles/min	0845-0900
4 cycles/min	0900-1000, 1030-1130
5 cycles/min	1200-1530

PART6

PHOTOGRAPHS



	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
Photo No. AO317-SCN-91-200-3234. This photo shows the forward portion of the load for the first test load.		

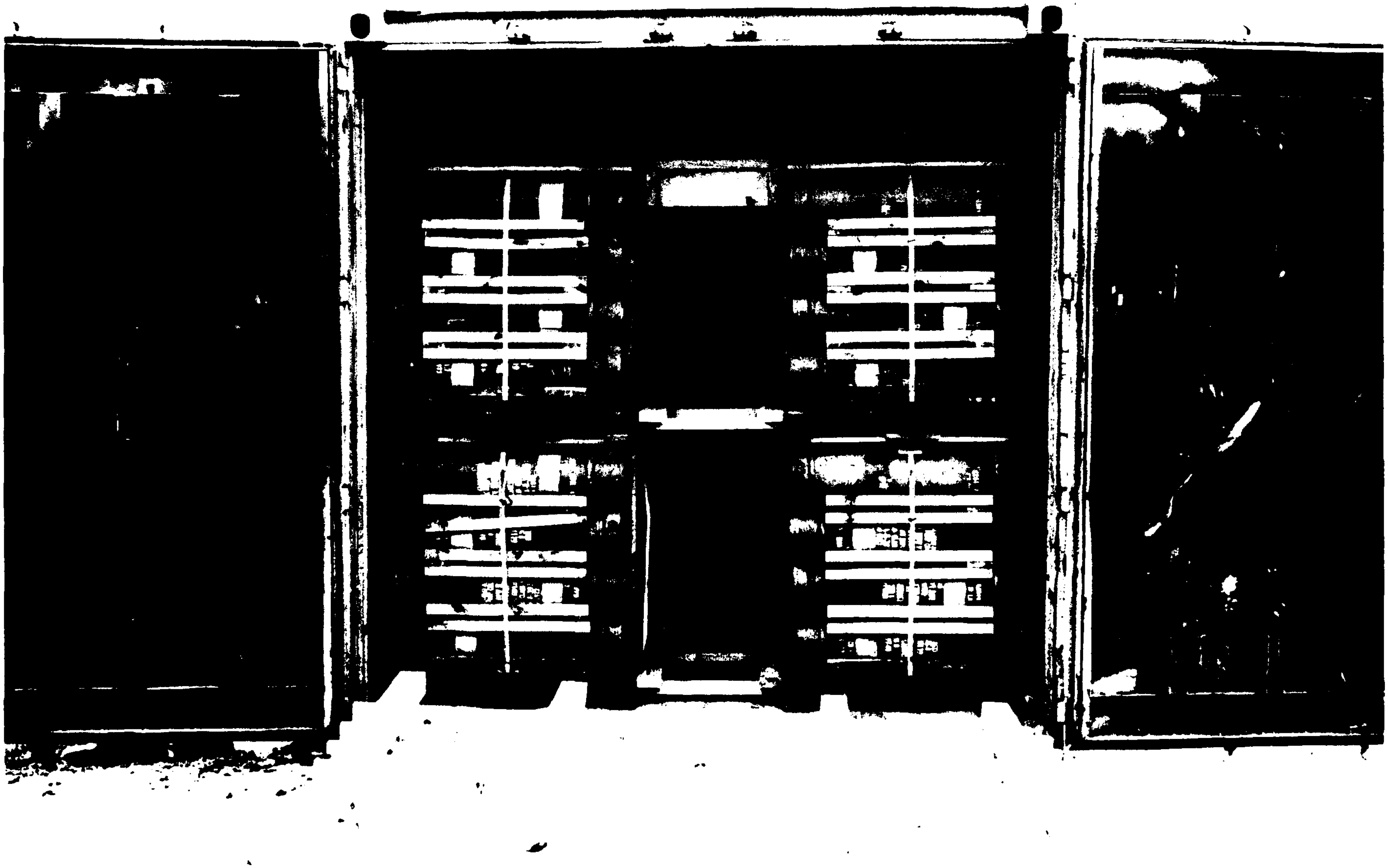


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Photo No. AO317-SPN-91-200-3228-91. This photo shows the completed load for the first test load.

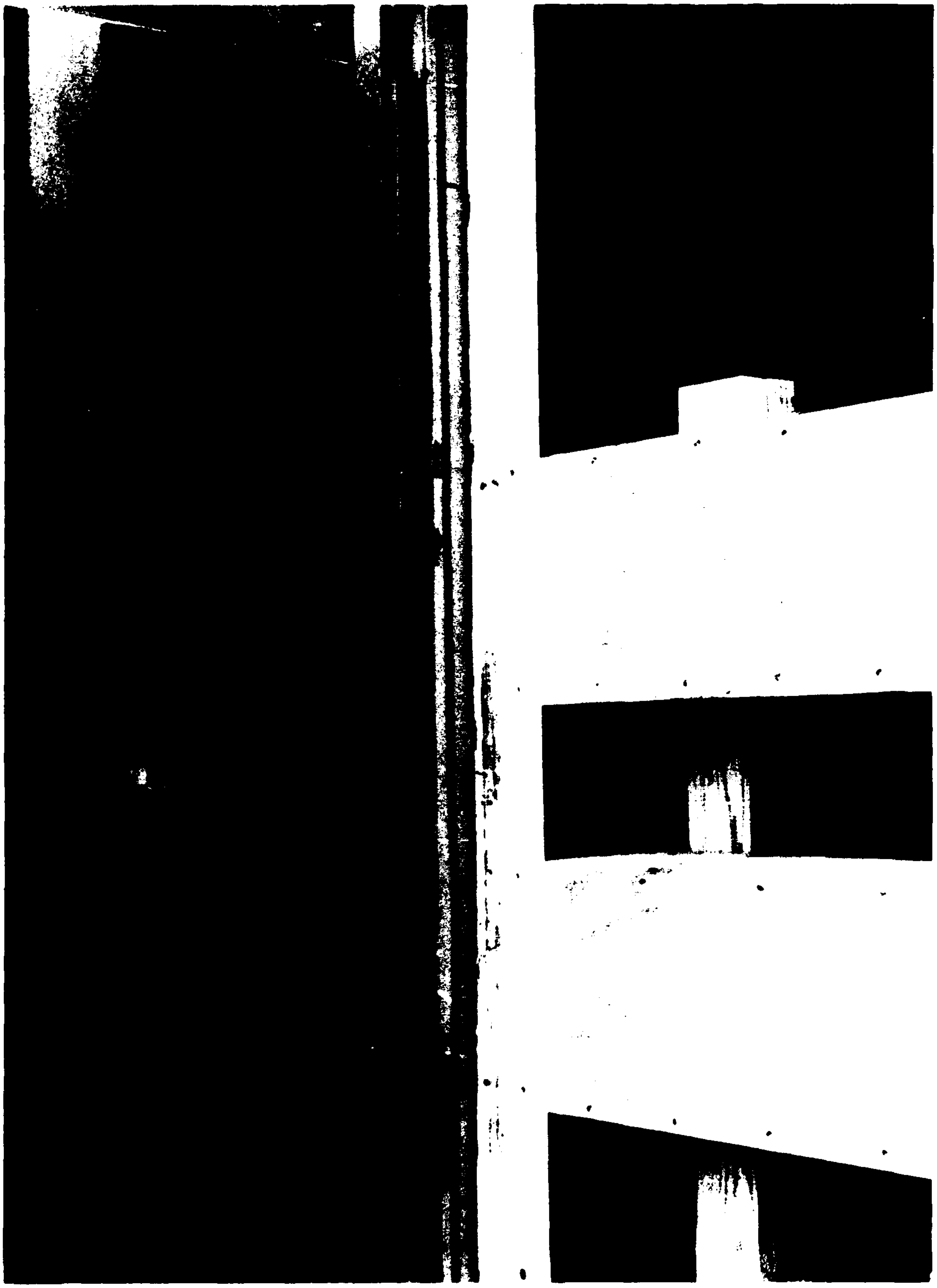

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Photo No. AO317-SCN-91-200-3238. This photo shows the orientation of the dunnage as it meets with the doors and hinges of the commercial container.

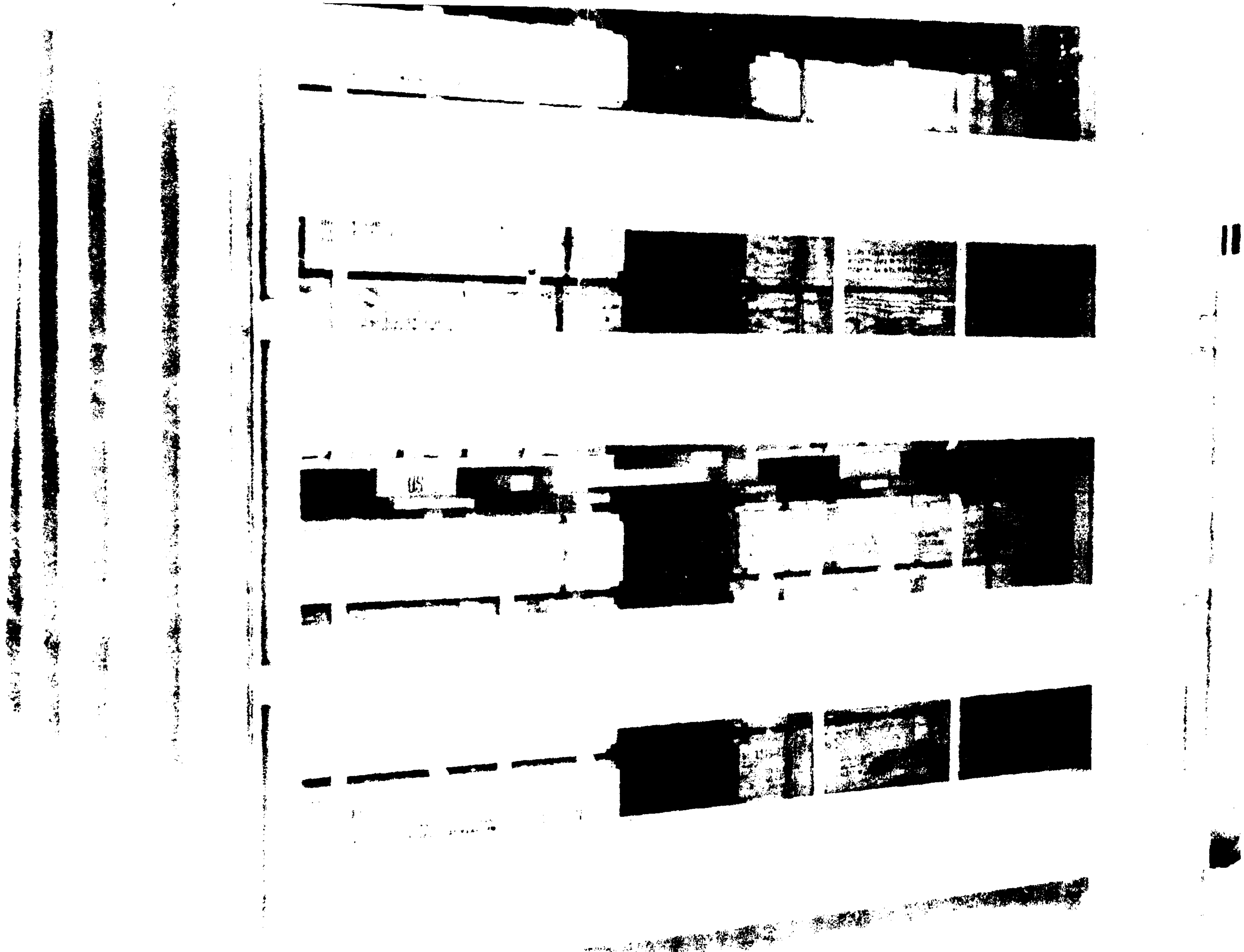

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Photo No. AO317-SCN-91-200-3219. This photo shows the completed load for the second and third test loads.

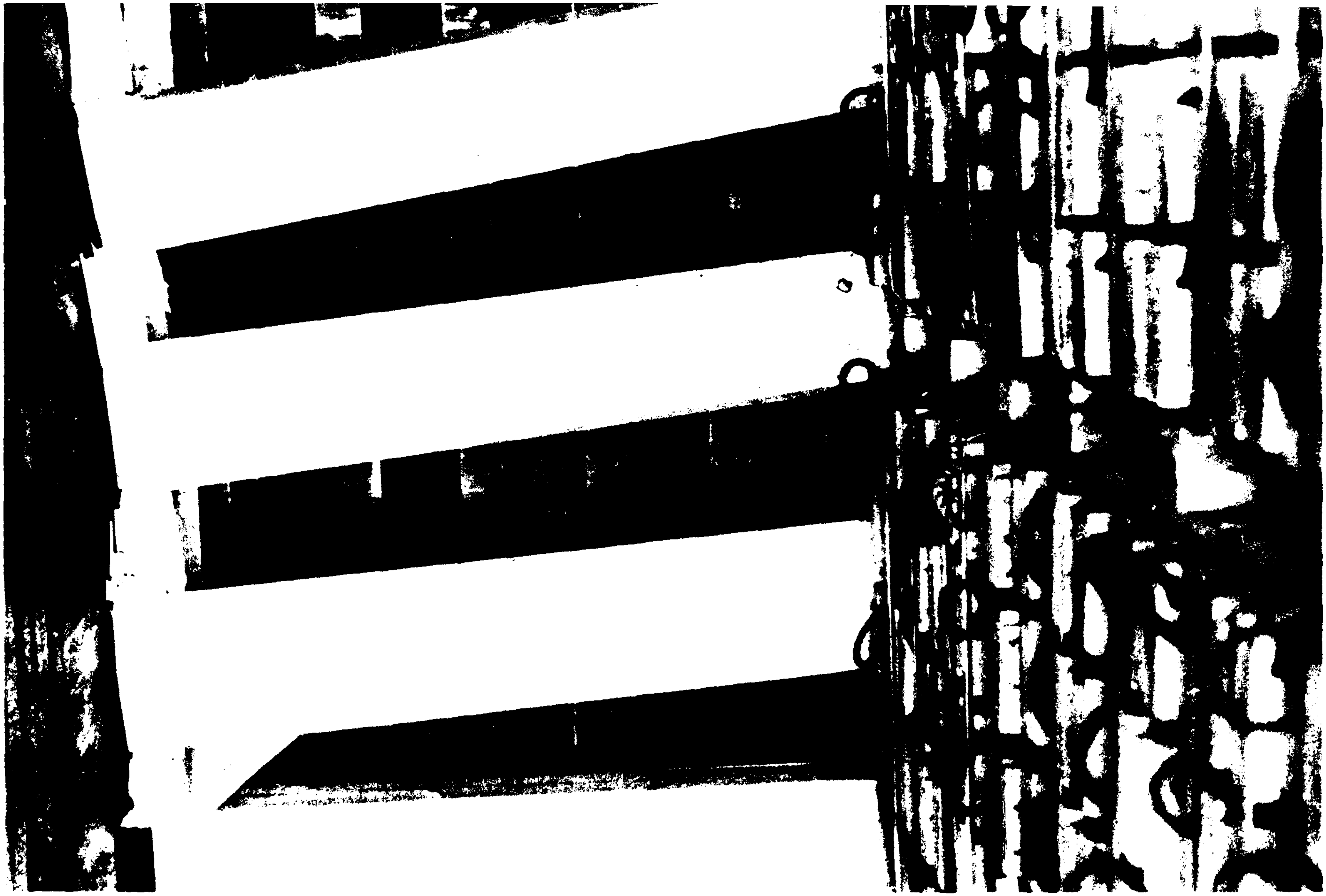

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Photo No. AO317-SCN-90-200-3222. This photo shows the results of the second test load when rail impact tested. The cause of failure was the longitudinal structural members (struts) did not match up to the lateral structural members (beams(.

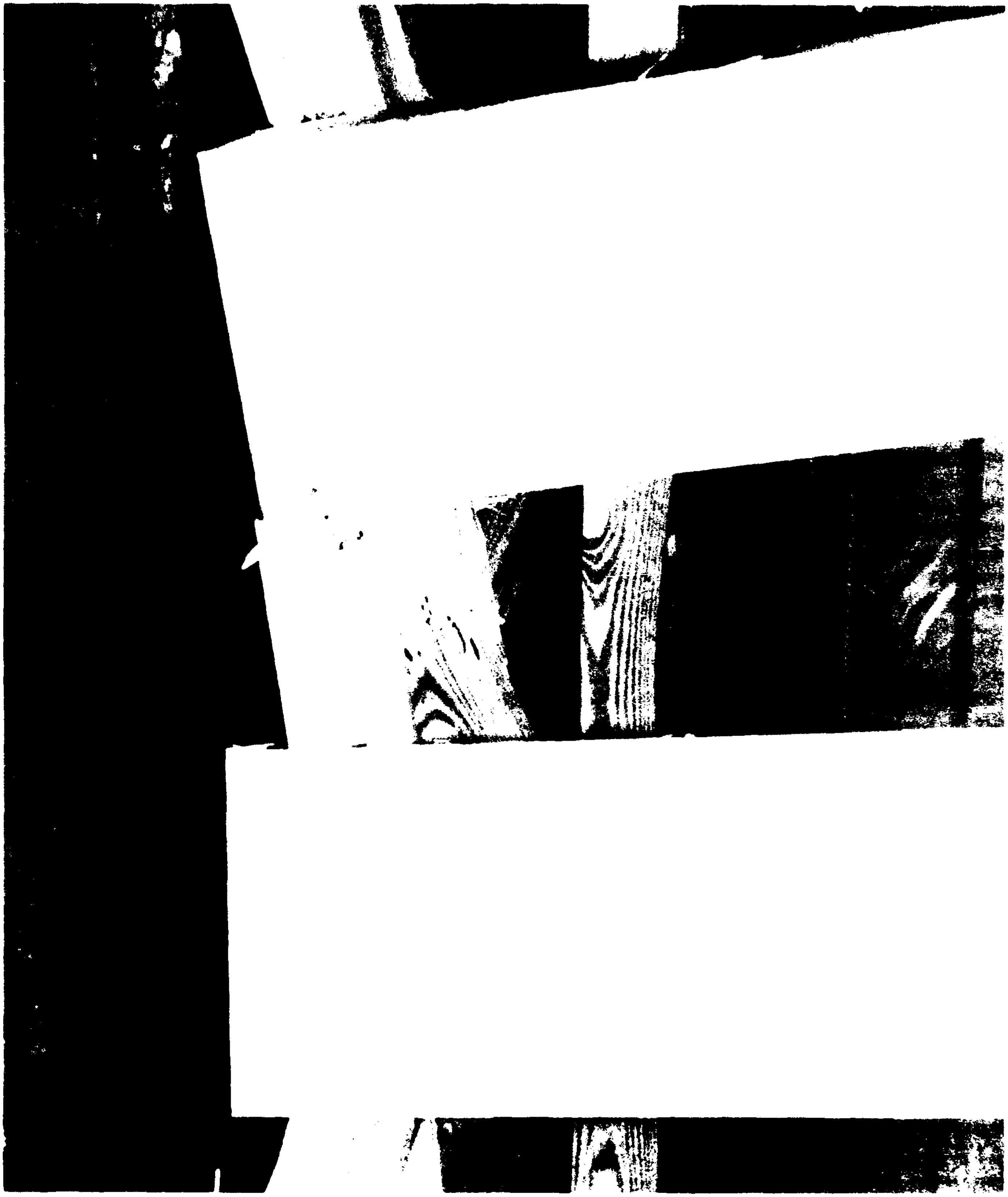

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Photo No. AO317-SCN-90-200-3224. This photo shows the results of the second test load when rail impact tested.		

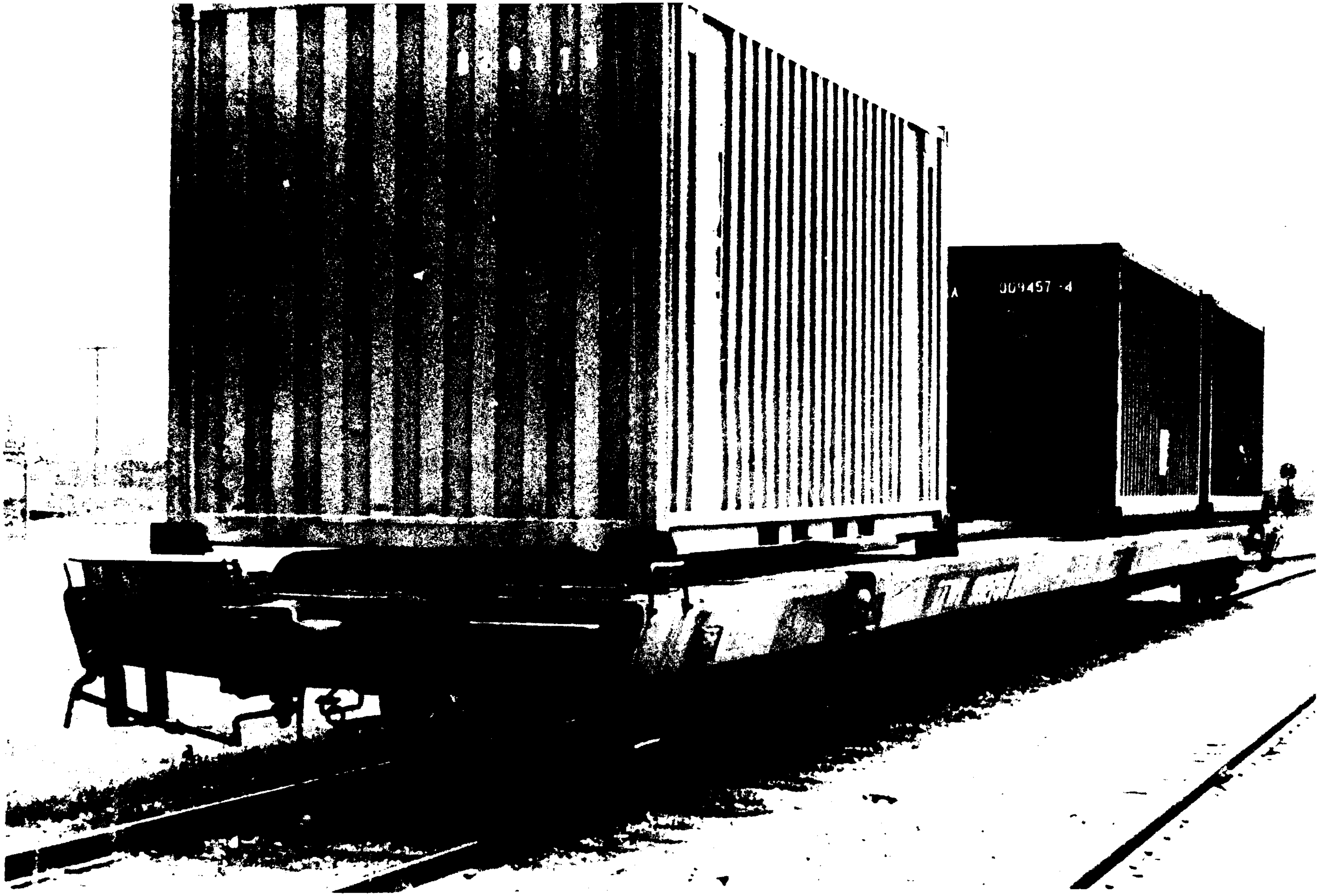

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Photo No. AO317-SCN-90-200-3206. This photo shows the rail car configuration used during rail impact tests.

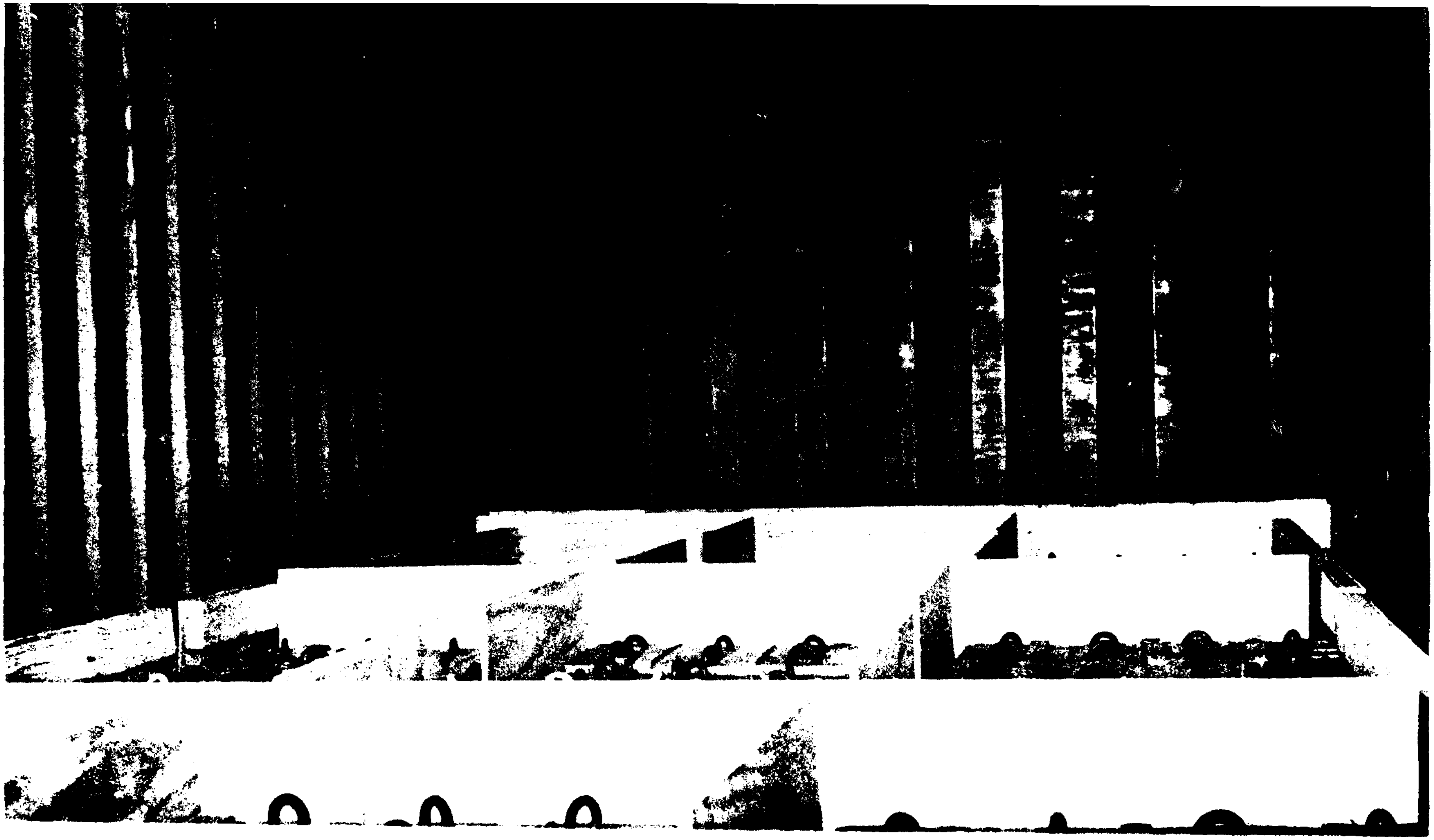

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Photo No. AO317-SCN-90-200-3212. This photo shows the completed load for the fourth rail impact test.

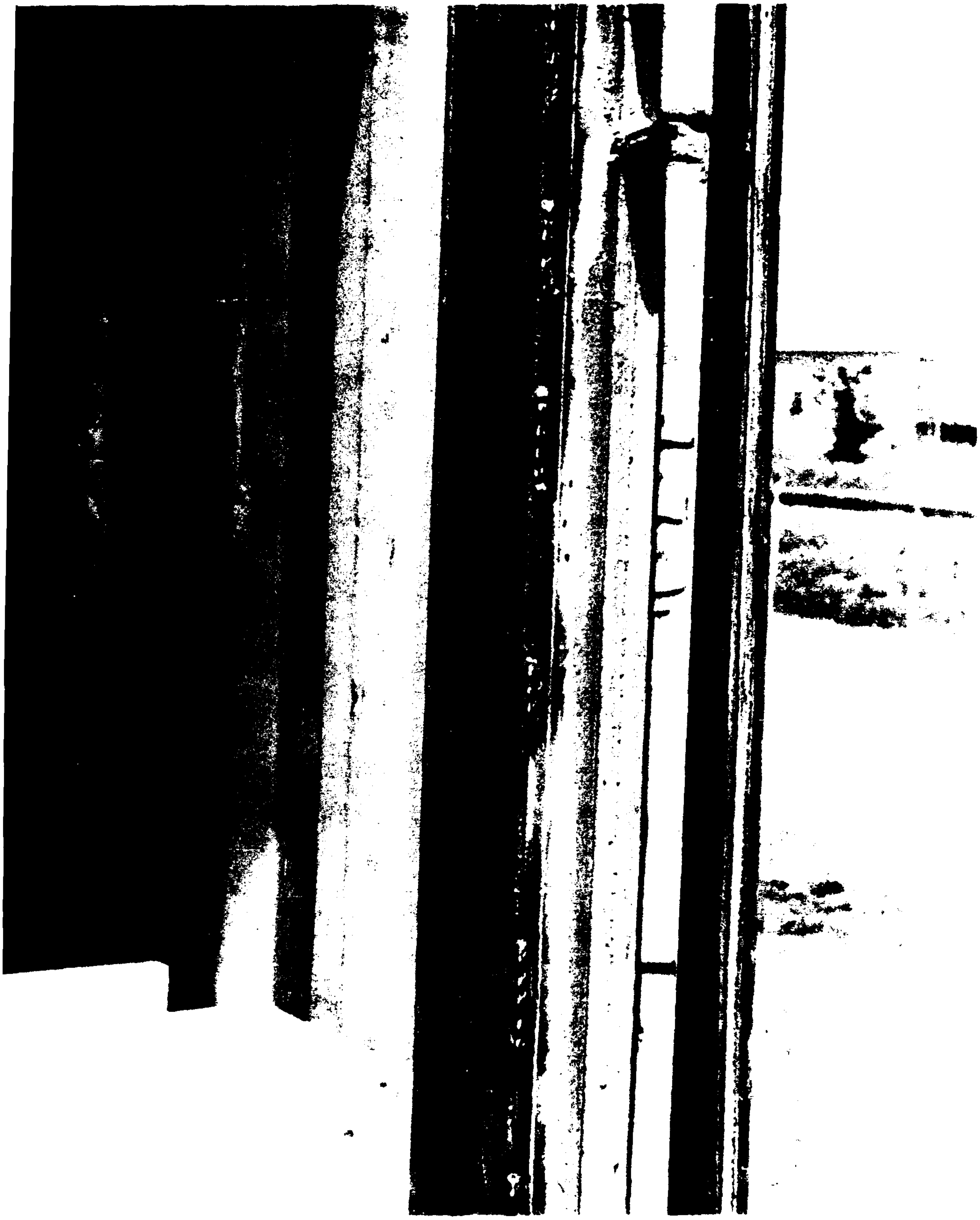

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Photo No. AO317-SCN-90-200-3209. This photo shows the welded angle load retainer in place for the fourth rail impact test.

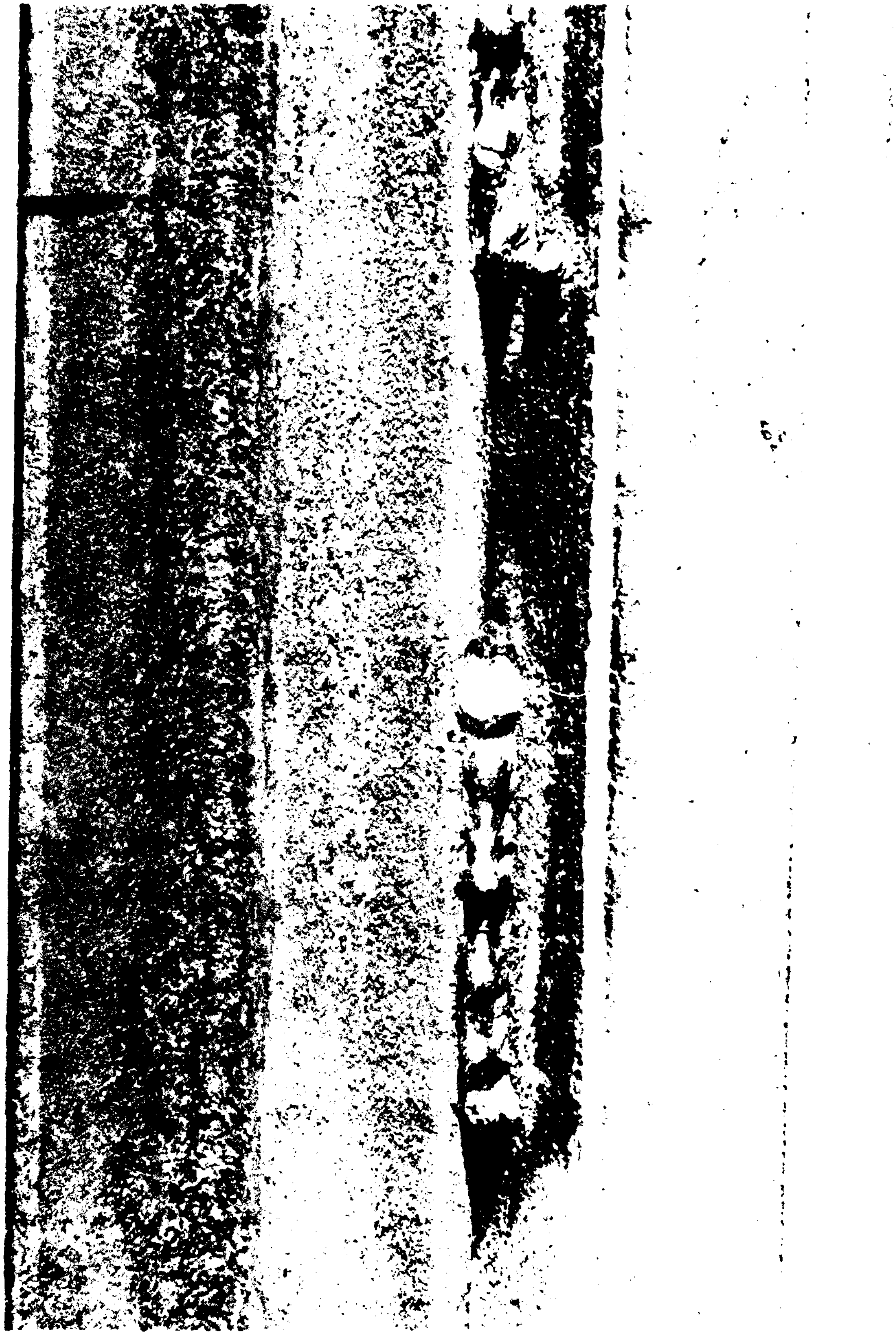

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Photo No. AO317-SCN-90-200-3210. This photo shows a closeup view of the welds on the welded angle load retainer.