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IMPACT REDUCTION METHOD FOR SIDE LAUNCHING
PONTOON STRUCTURES - INFLATABLE CUSHION

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IMPACT REDUCTION METHOD FOR SIDE LAUNCHING PONTOON STRUCTURES - INFLATABLE CUSHION

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Type C

by

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ABSTRACT

When pontoon structures are side-launched from LST's, the high impacts cause damage to the structures that results in excessive maintenance and replacement costs. In previous efforts an expendable fibre board cushion was designed; procedures for assembling and attaching it were developed. Impacts and apparent damage to the pontoon structure were reduced to acceptable levels with the fibre board cushions.

For reasons of economy the investigation was continued into the use of reusable inflatable cushion materials. These were found to be less effective, and are also undesirable and impractical for reasons of handling. Use of the inflatable units for impact reduction is not recommended.

INTRODUCTION

Pontoon structures such as barges and causeway sections are vital equipment to an amphibious operation. These pontoon structures are transported to the action area on the sides of LST's (Landing Ship Tanks) and free dropped or side launched into the water (Figure 1). It was evident from the cumulative damage sustained by the pontoon structures after repeated side launchings in training exercises, (Figure 2), that the large impact forces associated with this method of launching would have to be reduced to prolong the life of the pontoon.

Two methods for effectively reducing impact damage have been used. One method, used on the latest class LST's, was controlled launching; i. e., lowering the structures into water through rigging. This procedure eliminates impacting the structure into the water, but requires expensive and complex equipment. In the other method, reduction of impact forces are accomplished by placing expendable fibre board boxes on the under side of the structures to act as cushions.

BuDocks concluded that further cost reductions could be realized if a reusable inflatable cushioning method were developed. This report describes the evaluation of selected materials on a 3 x 1 pontoon unit and on a 3 x 3 pontoon barge.

TEST PROGRAM

Deceleration Limits

The following ranges of impact deceleration in g's (number of times the force due to gravity) applicable to the launching of NL pontoon structures were established for studying the fibre board cushions,[1] and were used as a guide for evaluating the results of this task:

0-30	Negligible damage
30-50	Minor damage
50 & above	Moderate to heavy damage

Impact reductions to 30 g's or less were desirable.

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1. NCEL Technical Report R-215, Impact-Reduction Method for Side-Launching Pontoon Structures, by J. E. Smith, 4 October 1962.

Selection of Material

Criteria for selecting materials for testing and possible development into a cushioning design were established. It was determined that the material should be:

1. Deflatable (for minimum storage space prior to launching).

2. Reusable (to keep cost within practical limits).

3. Lightweight (to facilitate handling).

4. Presently in production (to prevent costly design and development).

5. Adaptable for use considering the external construction features of the pontoon structures.

6. Adaptable for use considering the operational procedures and requirements of the amphibious construction battalions.

Various sizes of heavy duty inner tubes were selected for limited testing and a commercial product (4' x 6' x 2' dunnage bag) was used for full-scale tests. The dunnage bag is an inflatable cell used for the protection of cargo in transporting.

Test Equipment

A dock-mounted platform, fabricated from pontoons and I-beams, was used to simulate the side launching of the structure from an LST side carry position. Two pontoon structures, short sections of normal barges, were used in the launchings to test the inflatable units. One was a frame 3 pontoons wide by 1 pontoon long (Figure 3), and the other, 3 pontoons wide by 3 pontoons long (Figure 4). The launchings were conducted in a harbor in calm water; therefore, the effect of ocean swells was not determined.

Two accelerometers (120 volt, 100-g range) were mounted on the topside of the outboard single angle, as shown in Figure 5, to measure the deceleration in g's at the time of impact with the water. The accelerometers were connected to a Consolidated Electronic Corporation System "D" amplifier and a PR Massa osillograph recorder. Two pressure transducers, as shown in Figure 5, were also mounted on the topside of the outboard angle with an air pressure hose connected to the valves on the bags to record the pressure change in the bags.

Test Procedure and Results

To determine the effectiveness of inflatable units for reducing impact and to achieve a suitable design for a reusable inflatable cushion, two basic types of construction were tested. Type I construction consisted of test units A, B, and C (Figures 6, 7, and 8). These were made up with various sizes of inner tubes, arranged in a cone shape and wrapped with a strong adhesive tape to provide strength to withstand the pressure of high impacts. Table I lists the inner tubes used and the approximate size of their configuration when inflated to about 0.5 psig. The inner tubes were solely used to determine effectiveness of inflatable units to reduce impacts. The selection of a suitable cushioning configuration, its securing and handling, was to be determined on subsequent tests. This led to the type II construction.

Type II construction consisted of test units D and E (Figures 9 and 10) and was a commercial dunnage bag 4-feet wide, 6-feet long, and 2-feet deep when inflated to 1.5 psig. The only difference between test unit D and E was the orientation on the structure. Each unit weighed 32 pounds and consisted of a bladder and outer casing. The bladder was made of butyl rubber, approximately 0.035 inches thick, of the same type material as used in automotive tire tubes; thus, it can be repaired just as easily. The outer casing is made of neoprene coated nylon. The nylon provides strength while the neoprene coating provides the resistance to abrasion and puncture. A large diaphram valve was located on one of the broad sides of the unit for easy inflation. This valve also acts as an automatic check to keep the air in the unit after the air supply has been shutoff.

The tests consisted of side-launching the pontoon structures with the test units from the simulated LST side-carry position. The launching height and location of the cushioning units on the pontoon structures remained essentially fixed throughout the tests. The inflatable cushion units were centered on the outboard pontoons of the structure, (outboard refers to the position most remotely removed from the launch rail) where the impacts and the damage are the greatest. For one test cushion units were located at the bilge openings between the outboard pontoons of the 3 x 3 structure. Also, both structures were test launched without cushioning to establish a basis for comparing deceleration forces.

<u>Tests with 3 x 1 Structure</u>. Six tests were conducted using the 3 x 1 pontoon structure, four with inflatable cushion test units A, B, and C, utilizing various sizes of inner tubes inflated to a working pressure of 0.5 psig, and two without cushioning devices. The units were lashed to the underneath side of the structure with light manila lines.

Data obtained during the launching tests consisted of continuous recordings of decelerations on launches from rail heights of 4-feet 10-inches to 7-feet 0-inches. Deceleration ranged from 50 to 70 g's for the structure with cushion units and from 71 to 125 g's without cushions. Figure 11 is a typical trace of the decelerations. A slight identation on the pontoon structure occurred as the result of launchings without cushions. No pontoon damage was noted resulting from tests with cushions. The summary of results for these tests is given in Table II.

Tests with 3 x 3 Structure. ~~Nine~~ Thirteen tests were made with a 3 x 3 pontoon structure; 8 with dunnage bags, one with an inner tube configuration, and four without cushioning devices. The tests were made at rail heights of 5 to 7 feet. The dunnage bag test units D and E were oriented on the outer string of the 3 x 3 pontoon structure as shown in Figures 4 and 5, and inflated to a working pressure of 1.0 or 1.5 psig. A light rope harness of 1/2-inch manilla line was used to secure the units.

Data obtained during the launching tests consisted of continuous recordings of decelerations and pressure changes in the inflatable bags. The latter were for establishing performance criteria for future procurements. Figure 12 is a typical trace of the pressure changes in the bags, while decelerations are typified in Figure 11. Deceleration readings ranged from 46 to 67 g's for test unit D and from 41 to 87 g's for test unit E. A close inspection of a pontoon structure launched with the inflatable cushions revealed no damage; whereas, the pontoon barge without the cushion showed slight identation on the pontoon bottoms of the outboard string. The summary of results for these tests is given in Table III.

DISCUSSION

The primary action in reducing impacts is the breaking of the water surface; thus, setting the water into motion and providing a less abrupt entry of the pontoon structure into the water. The inflatable units achieved this, but perhaps with less effectiveness than the fiberboard cushions. Similar impact reductions were attained with both the inner tubes and the dunnage bags, although the desired or acceptable levels were never attained with either type. Of these, test unit D appeared to be slightly better with impact reduction readings averaging as low as 45.6 g. This, however, was somewhat higher than the 32 g's recorded for the fiberboard cushions on a 3 x 12 structure. It was judged that the impact forces could be reduced further and even possibly to acceptable limits by further design refinements, through the use of more units and/or a change in placement procedure. However, for the reasons discussed below, further investigations into reducing impacts with inflatable units did not appear to be feasible. Designs for suitably attaching the inflatable units were not completed.

Inflating, deflating, recovery, stowage, and placement are the prime factors in the operational procedure. Inflation requires an air source that may not always be readily available, while deflation, recovery, and stowage of the inflatable bags after the launching creates a major problem. Deflating the bags may be simplified through the use of a pop-off valve set for certain pressures. But recovering and storing the bags without removing a harness or other attaching device cannot be satisfactorily accomplished, except when the bags are positioned at the open area between the pontoons. For this positioning a bag orientation on edge, as in test unit E, is required. An on-edge orientation, however, did not produce satisfactory results, as the decelerations were higher for this condition and at least one cushion unit ruptured on each test. No bag damage occurred in the flat oriented test D. Also, providing a suitable storage space during operations at sea may be cumbersome. An expendable impact reduction device as the fiberboard cushions appears to be the most desirous. Because of the handling problems, the inflatable units are considered unsatisfactory.

CONCLUSIONS AND RECOMMENDATION

The inflatable units will reduce impact forces on launched pontoon structures, but not as effectively as the fiberboard cushions. In addition, the inflatable units are undesirable and impractical for reasons of handling. Their use is not recommended.

Table I. Test Units

Unit	Description	Dimensions (feet - inches)					Weight (lbs)
		Base Dia.	Top Dia.	Depth	Length	Width	
A	Two inner tubes, 1400 x 24 and 1300 x 24 wrapped together with cloth tape.	4 - 4	4 - 2	2 - 3	---	---	24
B	Three inner tubes 1400 x 24, 1300 x 20, and 1050 x 18 wrapped together with cloth tape.	4 - 4	2 - 5	3 - 1	---	---	34
C	Three inner tubes, 1300 x 24, 1050 x 18 and 750 x 15 wrapped together with cloth tape.	4 - 0	2 - 4	2 - 3	---	---	26
D	Dunnage bag oriented flat.	---	---	2 - 2	6 - 0	4 - 0	32
E	Dunnage bag oriented on edge.	---	---	4 - 0	6 - 0	2 - 2	32

Table II. Launching Test Results on 3 x 1 Pontoon Structure

Test no. and unit	Launch rail height	Impact Deceleration (g's)		Initial inflation pressure (psig)	Remarks
	ft - in	A	B		
1-A	5 - 6		70	0.5	1400 x 24 base tube ruptured.
2-B	5 - 0	52	58	0.5	1400 x 24 base tube ruptured.
3-C	5 - 0	58	60	0.5	No damage to tubes.
4-C	4 - 6	53	66	0.5	No damage to tubes.
5	5 - 0	86	71		No impact reduction units.
6	5 - 10	91	125		No impact reduction units.

Table III. Launching Test Results on 3 x 3 Pontoon Structure

Test no. and unit	Launch rail height	Impact Deceleration (g's)		Pressure increase in bags (psig)		Initial inflation pressure (psig)	Remarks
	ft - in	A	B	C	D		
1-C	6 - 6	59	--			0.5	Test units on all three pontoons. 760 x 15 top tube on no. 1 pontoon and 1300 x 24 base tube on no. 3 pontoon ruptured.
2-D	5 - 6	48.5	46.2	12.0	12.6	1.5	Test units mounted on all three pontoons. Tie down straps on no 1 and no. 3 broke.
3-D	7 - 0	45.0	46.2	10.8	12.0	1.5	Test units mounted on no. 1 and no. 3 pontoon. No damage occured.
4-D	5 - 0	49.5	56.2	12.0	11.4	1.5	Test units mounted on no. 1 and no. 3 pontoon. Tie down straps broke on both units.
5-D	6 - 0	58.8	55.3	--	--	1.5	Test units mounted on no. 1 and no. 3 pontoon. No damage occured.
6-D	5 - 0	67.0	--	13.8	--	1.5	Test units mounted on no. 1 and no. 3 pontoon. Wire on accelerometer broke loose.
7-D	6 - 0	49.9	59.8	--	14.4	1.0	Test units mounted on all three pontoons. No damage occured.
8-E	5 - 0	83.3	41.5	--	12.0	1.0	Test units placed edge ways on all pontoons. Test unit on no. 1 pontoon ruptured.
9-E	6 - 0	83.3	78.5	--	13.2	1.5	Test units placed edge ways between all three pontoons. Test unit between no. 1 and no. 2 pontoon ruptured.
10	5 - 0	108.0	106.0	--	--	--	No impact reduction units used.
11	6 - 0	117.5	119.8	--	--	--	No impact reduction units used.
12	5 - 6	117.5	117.5	--	--	--	No impact reduction units used.
13	7 - 0	83.5	87.5	--	--	--	No impact reduction units used.

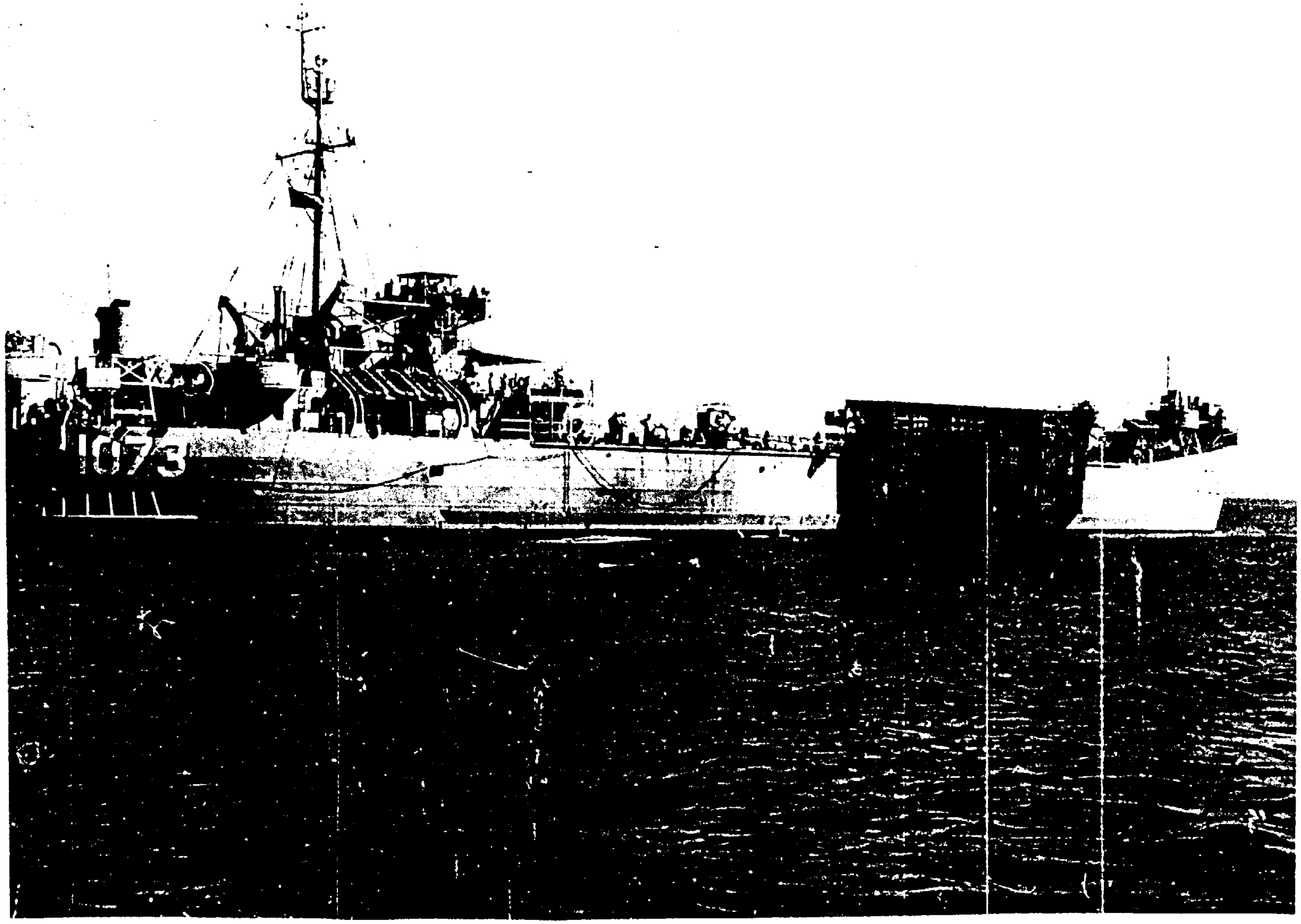


Figure 1. (a) Launching pontoon structure from side of LST.

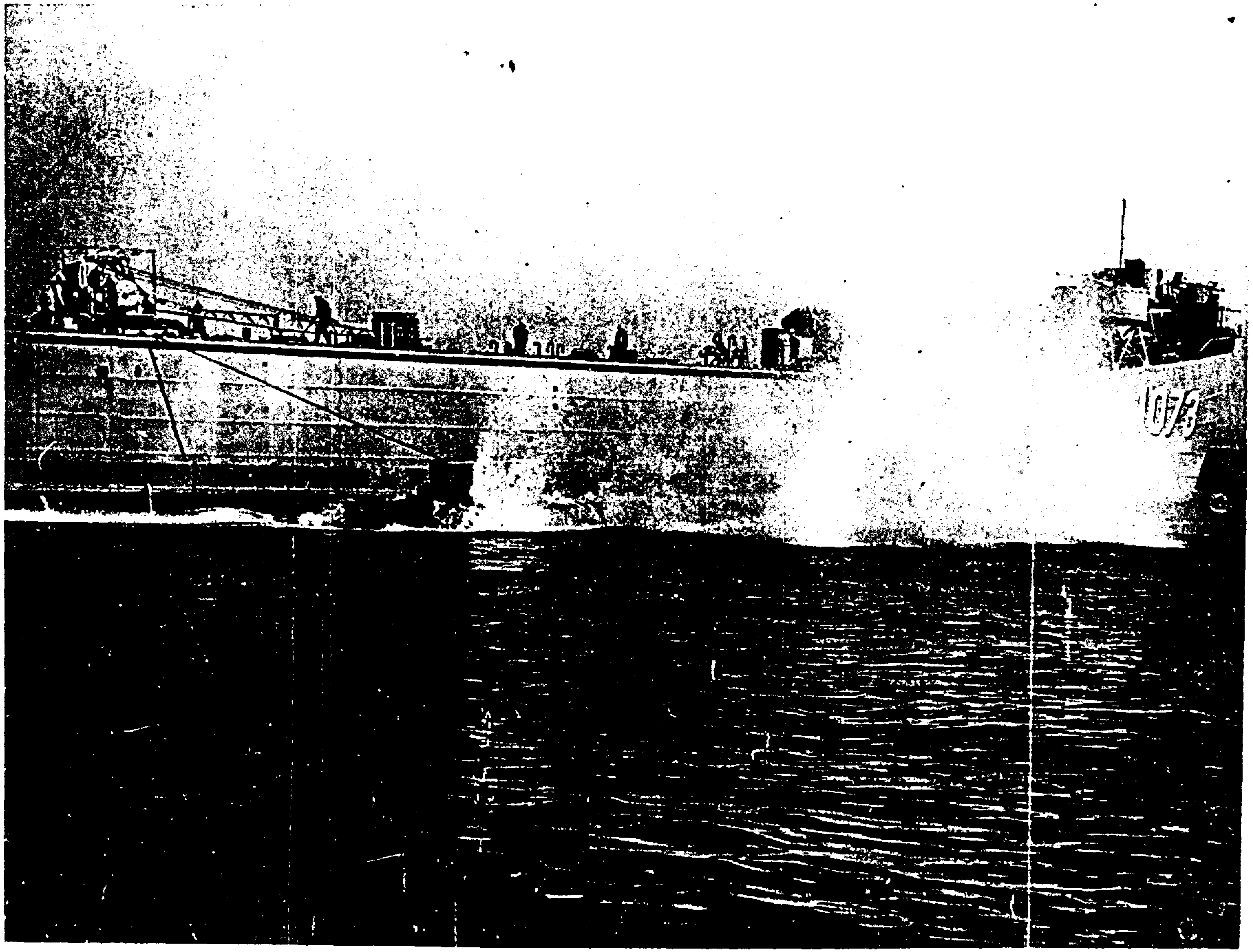


Figure 1. (b) Launching pontoon structure from side of LST.

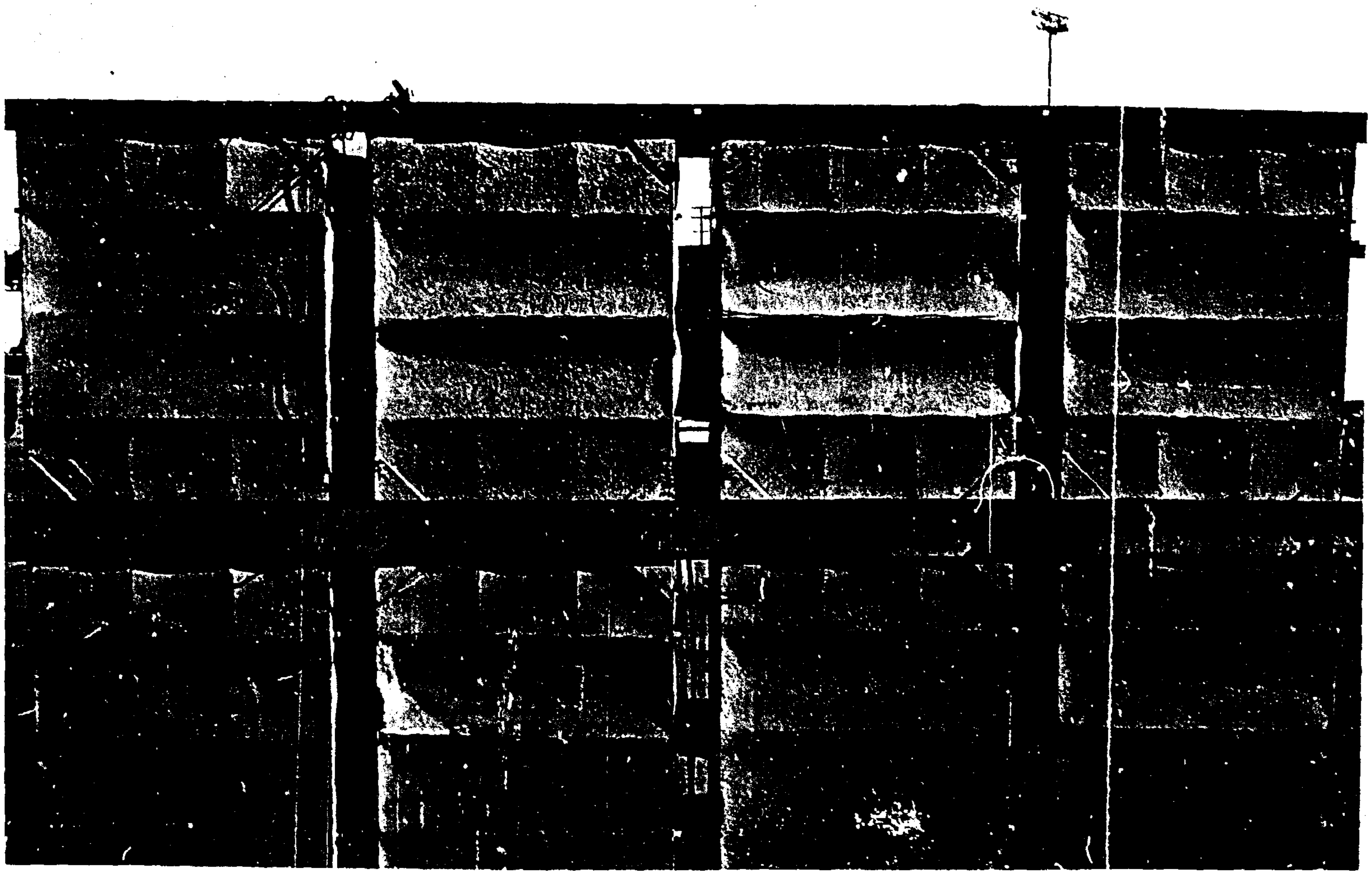


Figure 2. Cumulative damage to side-launched pontoon structures.

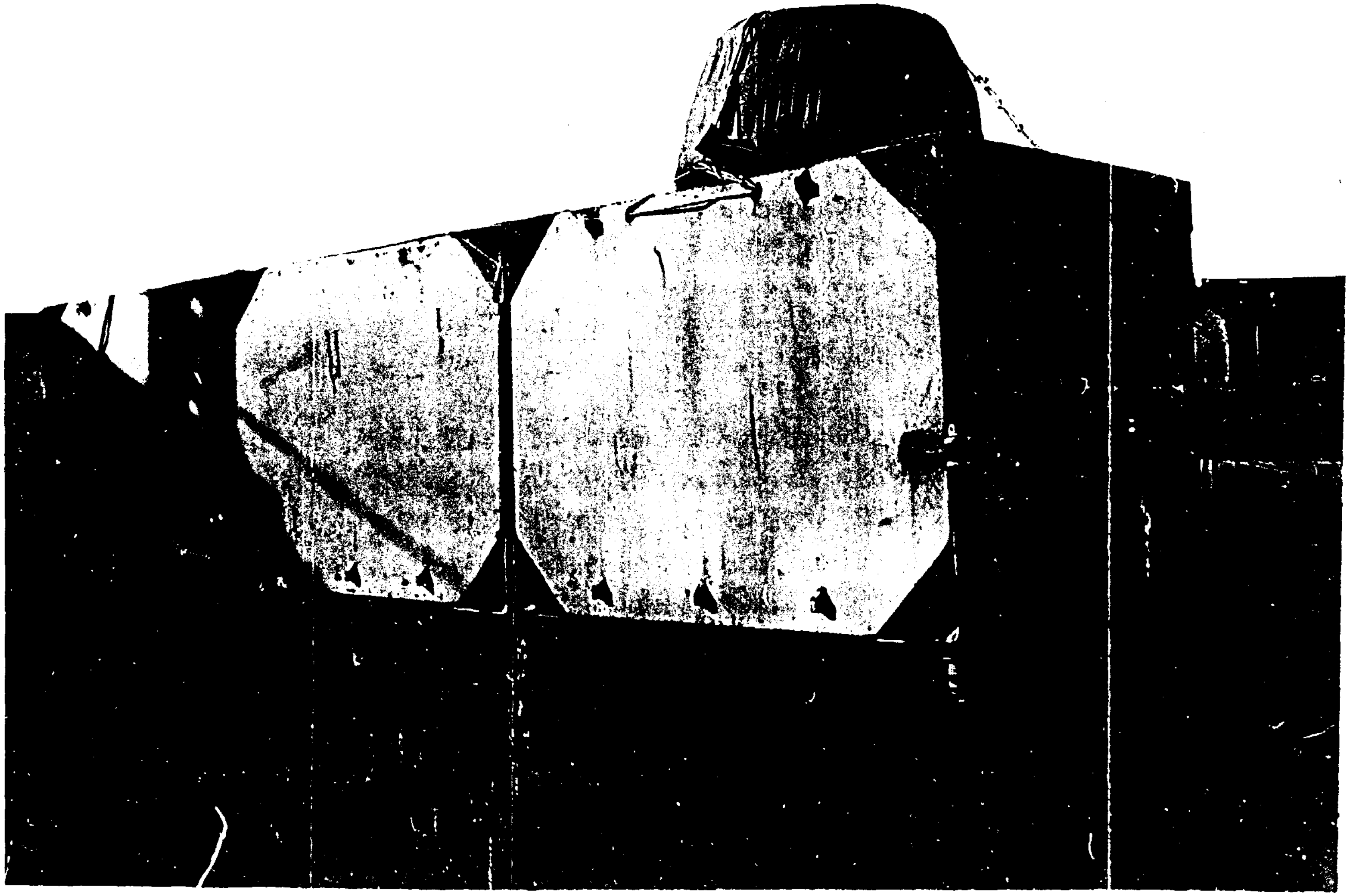


Figure 3. Pontoon test structure 3 wide by 1 long.

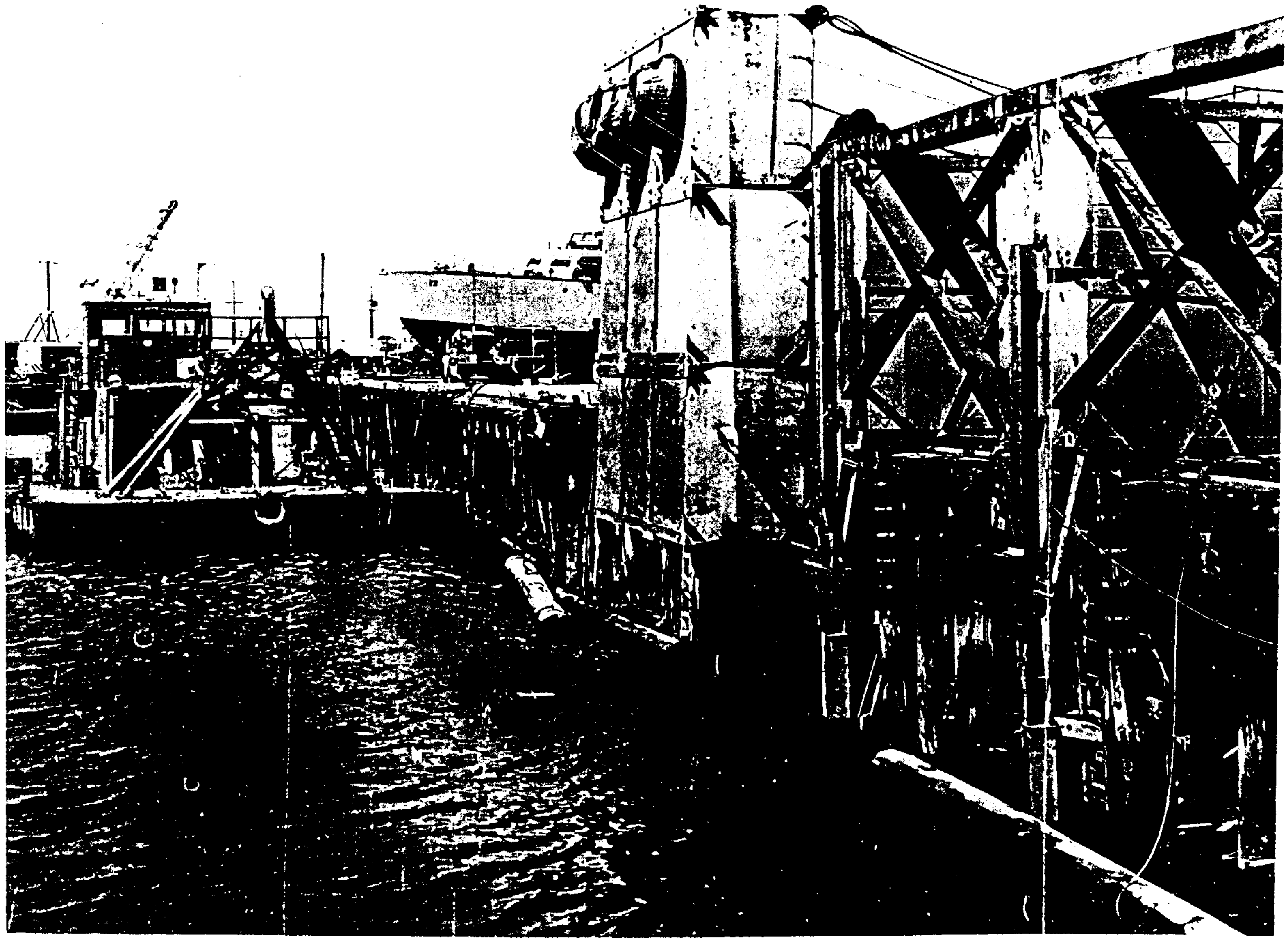
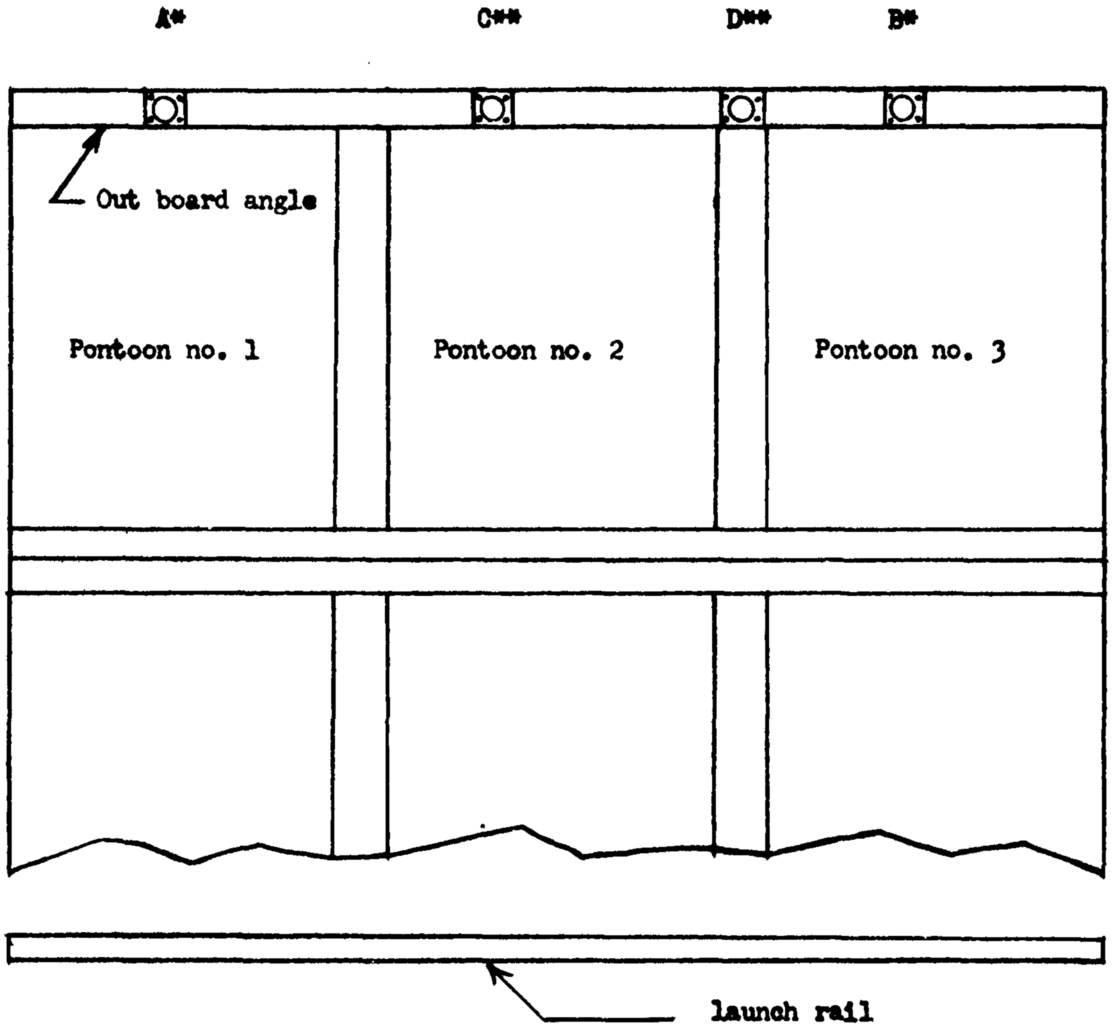


Figure 4. Pontoon test structure 3 wide by 3 long, ready for launching.



* Accelerometers

** Pressure transducers - connected to inflatable bag on pontoon no. 1 and no. 3

Figure 5. Location of accelerometers and pressure transducers on 3 x 3 pontoon structure.

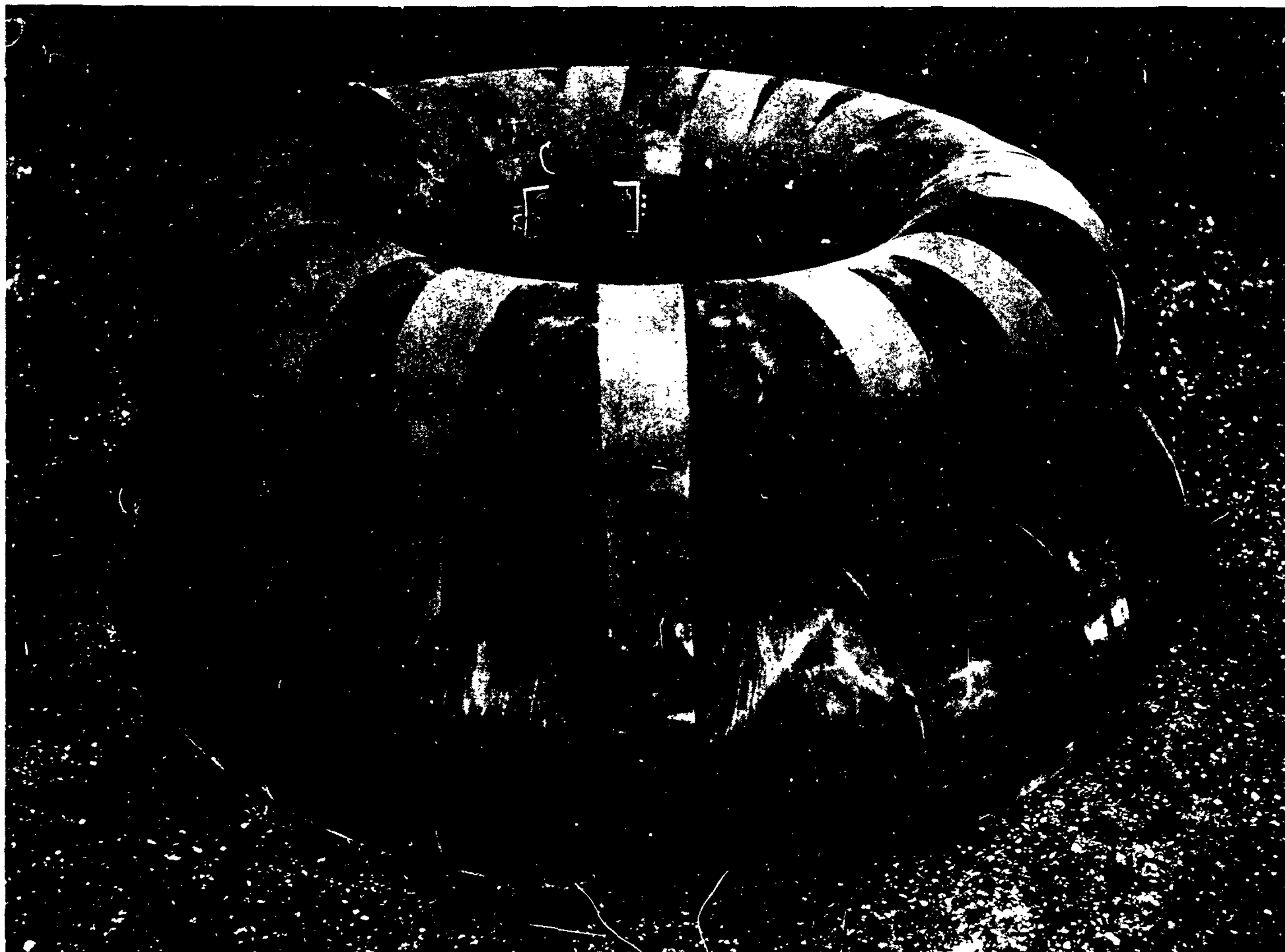


Figure [illegible]. Test [illegible] 1.

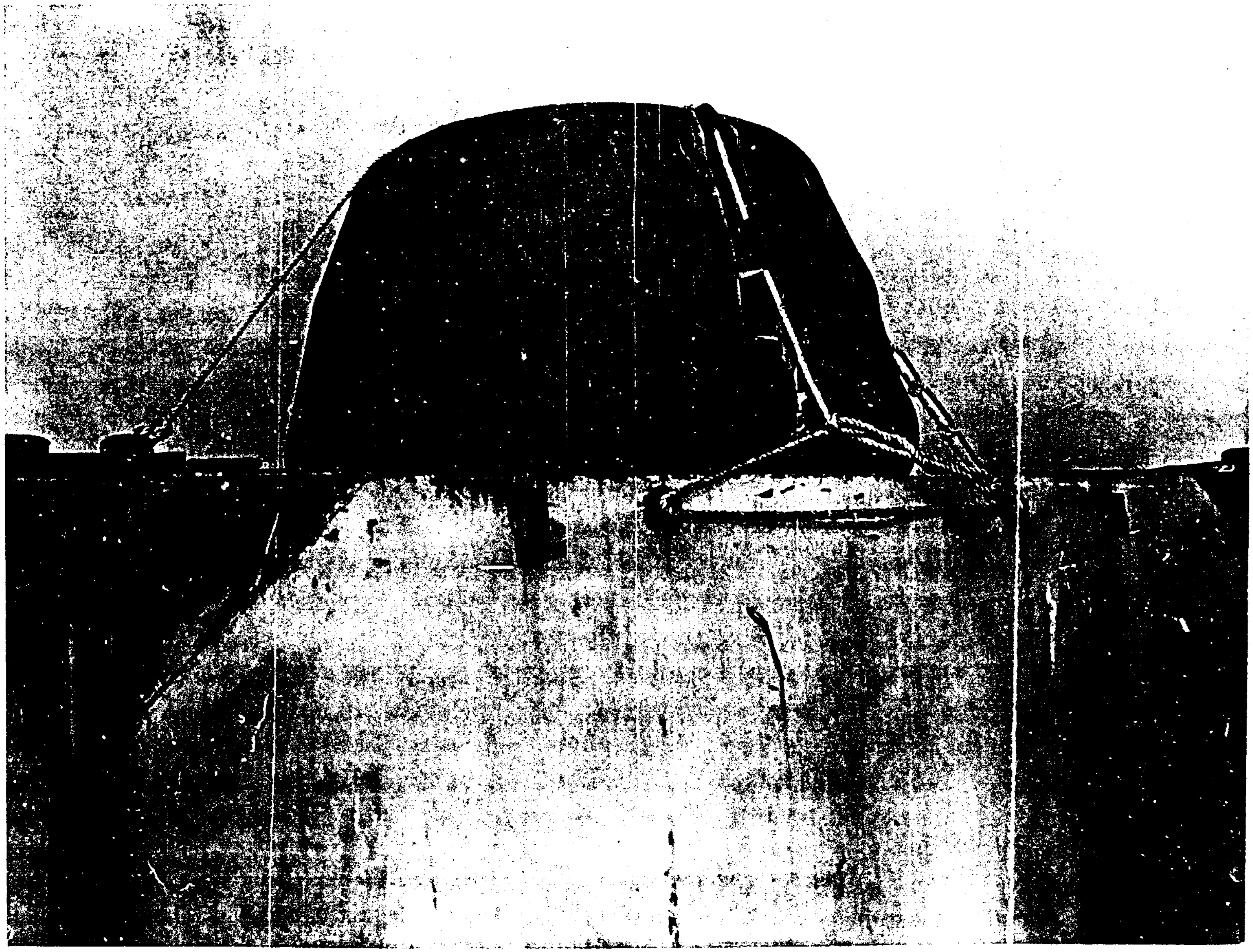


Figure 7. Test Unit B.

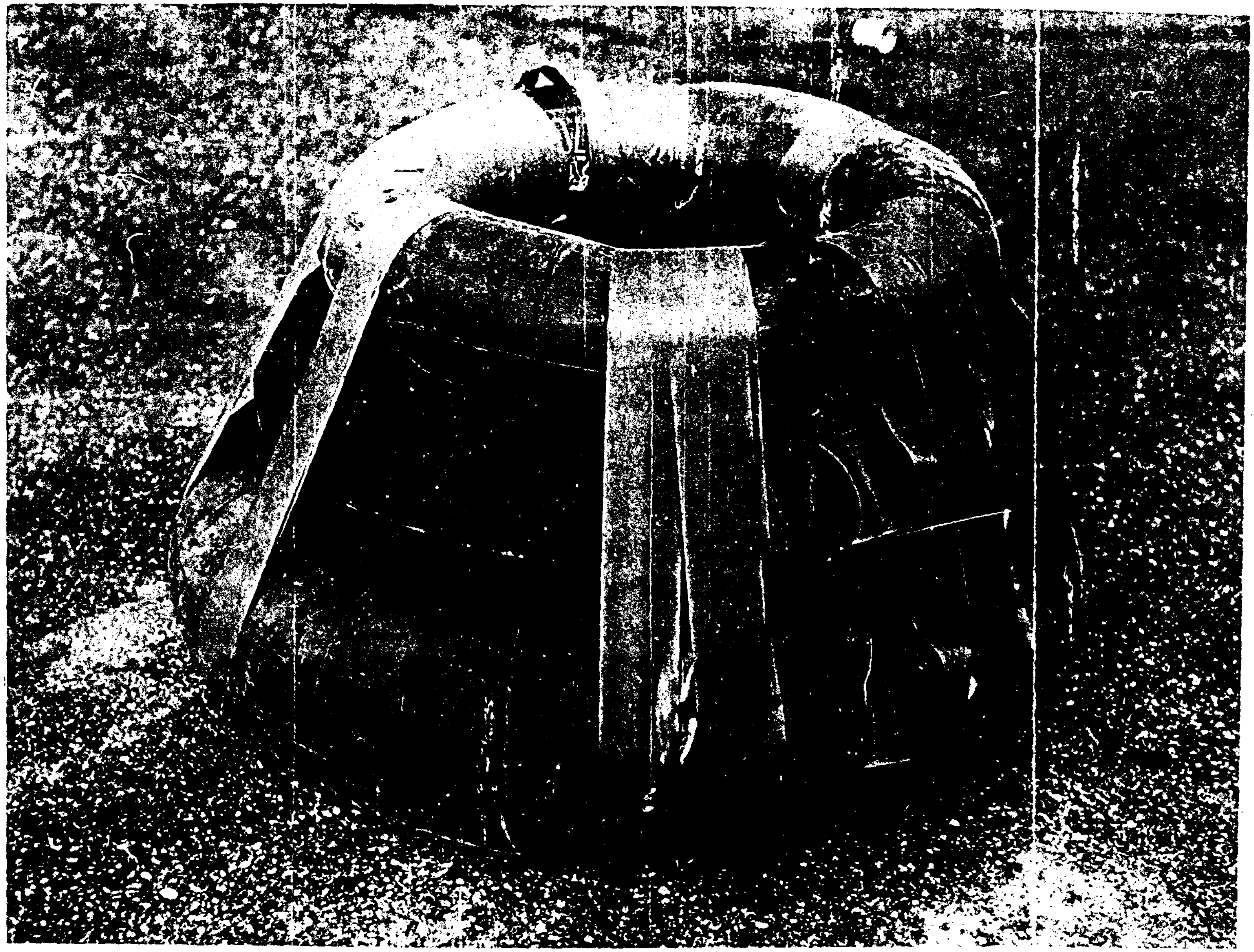


Figure 8. Test Unit C.

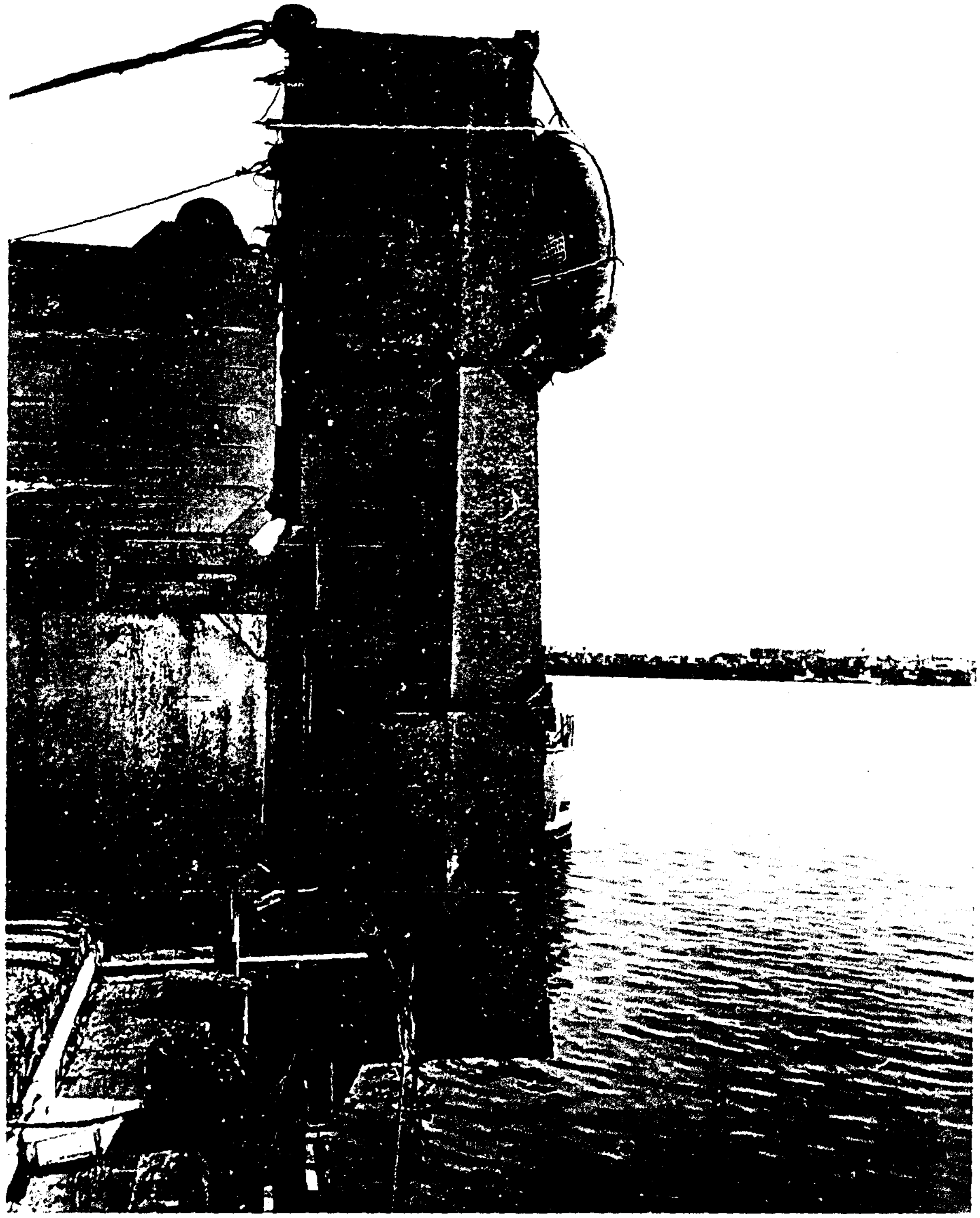


Figure 9. Test Unit D.

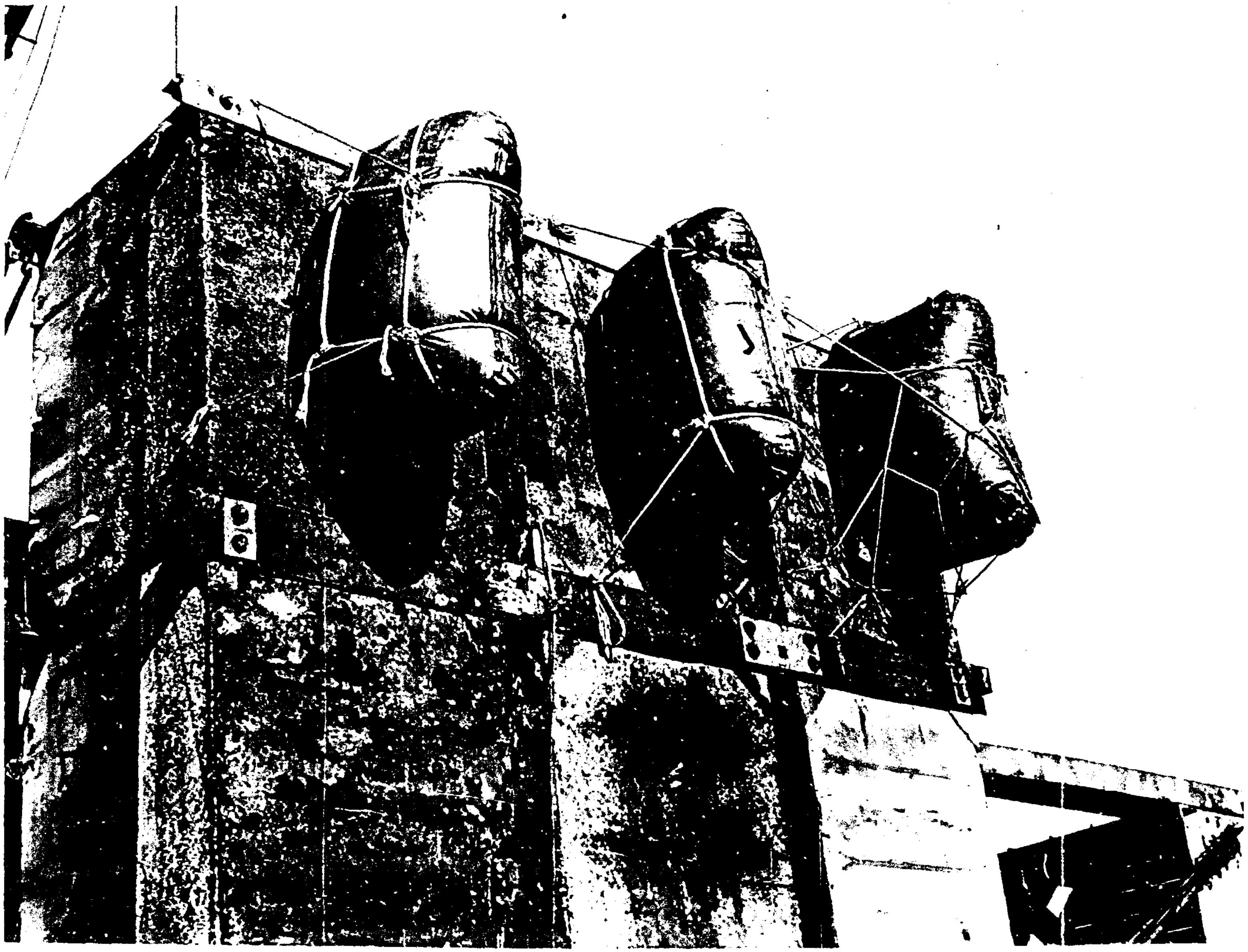


Figure 10. Test Unit E.

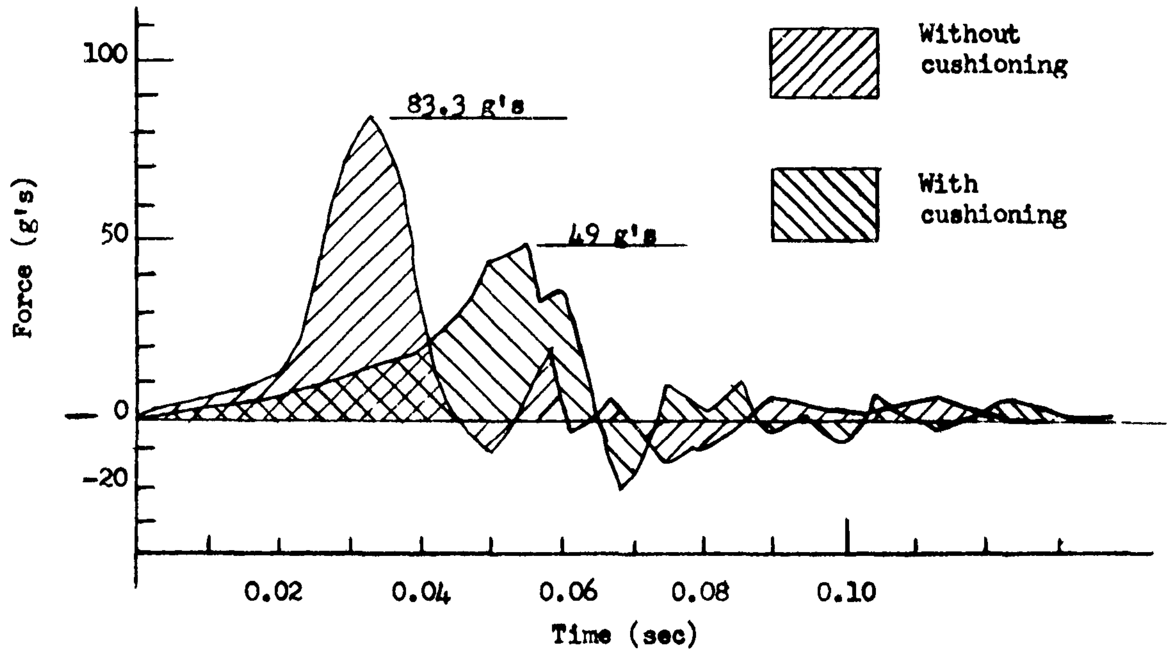


Figure 11. Decelerations without inflatable cushioning and with inflatable cushioning, reconstructed to comparable scales.

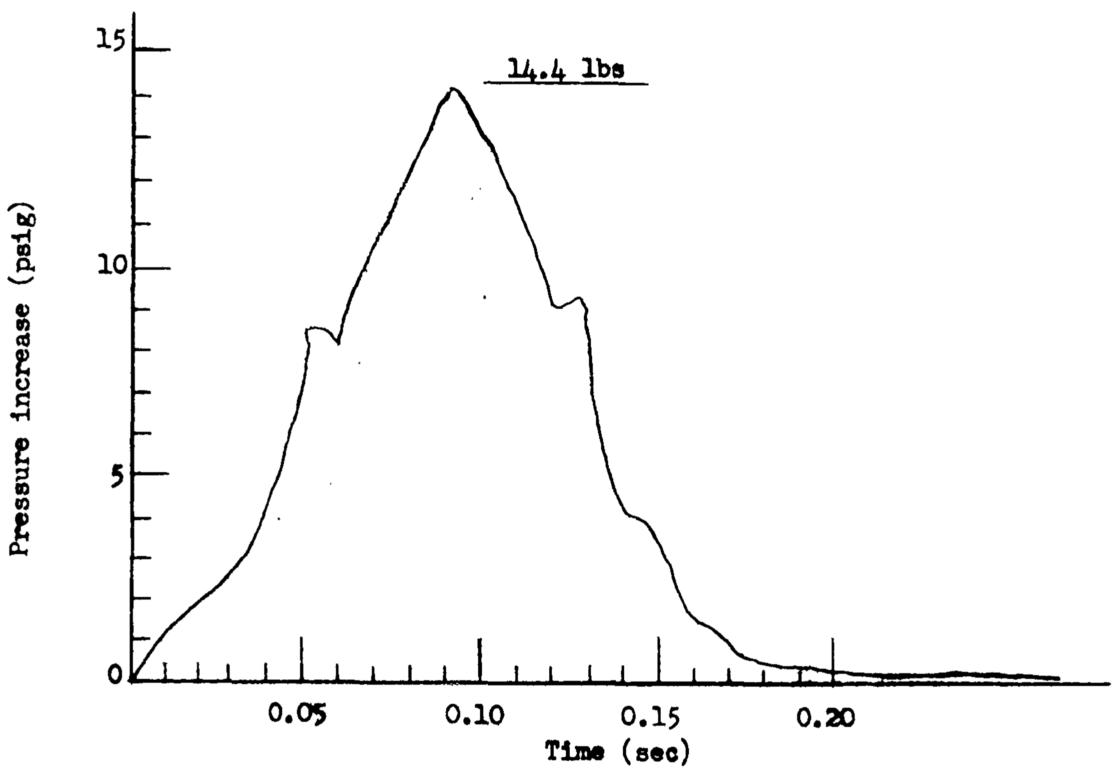


Figure 12. Typical trace of pressure increases in bags.