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QUALITATIVE EVALUATION OF THE AIRDROP IMPACT CAPABILITY OF THE M44 INCAPACITATING CLUSTER

Technical Memorandum AEO-14

U. S. ARMY NATICK LABORATORIES
Natick Massachusetts

AIR DELIVERY EQUIPMENT DIVISION

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NATICK, MASSACHUSETTS

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Approved by:

GAETANO FALABELLA, JR.
Chief
Aeronautical Engineering Office

WILLIAM PENCAK, Colonel, QMC
Chief
Air Delivery Equipment Division

Prepared by:

MAURICE P. GIONFRIDDO
Project Officer

AIR DELIVERY EQUIPMENT DIVISION
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SUMMARY

M44 Incapacitating Clusters packed in shipping boxes were stacked two high and subjected to critical airdrop impact conditions to evaluate their ability to withstand airdrop impact loadings when rigged with standard air delivery equipment and techniques.

It was determined that the Clusters are capable of withstanding the airdrop impact loadings when using standard air delivery equipment and techniques.

INTRODUCTION

In October 1962, the US Army Natick Laboratories were requested by the Chemical Research and Development Laboratories, Edgewood Arsenal, Maryland, to evaluate the airdrop capability of the M44 Incapacitating Cluster.

The M44 Incapacitating Cluster is approximately 16 inches in diameter, 60¼ inches in length, and weighs approximately 175 pounds. The M44 Cluster when packed in its wooden shipping box is 67 3/4 inches long, 17 1/8 inches wide, 18½ inches high and weighs approximately 330 pounds.

Consideration of the available methods of airdrop indicated that there were at least three possible means of packaging the M44 Cluster for airdrop as follows:

a. A single M44 Cluster in an A-22 air delivery cargo bag.

b. Six M44 Clusters in an A-22 air delivery cargo bag.

c. Fourteen M44 Clusters on an 8-foot Modular Platform used as a load-bearing platform.

Normal rates of descent for the three methods would be in the range of 25 to 30 feet per second. When using the A-22 cargo bag or the Modular Platform to conduct the airdrop, the M44 Cluster shipping boxes would be stacked two high.

It was determined that the only critical design condition resulting from the airdrop environment would occur at impact. Since there are no criteria available that will permit an analysis of the ability of an item to withstand an airdrop impact, a series of tests were conducted to determine the airdrop impact capability of the M44 Incapacitating Cluster.

The criterion used to determine success or failure after each drop was whether or not the M44 Cluster would function aft impact.

TEST PROCEDURE

The impact tests were conducted at the Air Delivery Equipment Division Laboratory using a crane with a 50-foot boom to hoist the M44 Clusters to the proper drop height (see Figure 1). The tests described in this report were conducted from a drop height of 14 feet which resulted in an impact velocity of 30 feet per second. The raised items were released remotely by a solenoid-operated cargo hook and were allowed to free-fall to the concrete impact pad below.

All tests were conducted with the M44 Clusters stacked two high to simulate the critical stacking arrangement. Although the drop tests could have been conducted using just two M44 Cluster boxes stacked one on the other, the configuration tested consisted of two stacks each two high (Figure 2). This was done to provide a stable enough configuration to prevent toppling after impact.

After each drop, the shipping boxes were inspected and opened; the vapor barrier material was inspected and opened; and then the Cluster was inspected. The Cluster was then operated as a final determination of the success of the drop.

Still photographs were taken of the rigged configuration of M44 Clusters before and after each drop test.

The configurations of paper honeycomb used as an energy dissipater were calculated as shown in Appendix I.

RESULTS AND DISCUSSIONS

Based on previous drop test experience with items of similar ruggedness packed in wooden shipping boxes, it was determined that the 76 g deceleration provided by using an area of paper honeycomb equal to that of the base of the M44 Cluster would not be unduly severe. Either alternative to this results in a less desirable field configuration. Any energy dissipater area larger than the Cluster base area results in a rigged load that occupies more aircraft floor space than required by the Cluster alone; and an energy dissipater area smaller than the Cluster base area requires more careful positioning of the paper honeycomb stack or stacks to prevent excessive bending during impact of the unsupported portions of the shipping boxes.

Uniform loading of the lower shipping boxes was made difficult by the presence of the three skids on the underside of the boxes. A layer of paper honeycomb was used to fill the void between the skids of the lower box and the adjacent load spreader. Thus the forces developed during both the elastic and plastic deformation of the paper honeycomb in the voids prevented excessive deflection of the boxes.

A plywood load spreader was placed between the upper and lower shipping boxes to distribute the load introduced into the lower box through the upper box skids. The rigging configuration for test drop number 1 is shown in Figure 3. The condition of the load after drop test is shown in Figure 4. There was no apparent damage as a result of this drop test. Although the configuration tested is entirely suitable for use in the field, it was decided to conduct additional drop tests with configurations that would be even simpler to rig in the field.

The calculation of the required thickness of paper honeycomb as shown in Appendix I is based on the assumption that the energy dissipater absorbs all of the impact energy. In most practical cases, the items themselves absorb some of the impact energy (the exact amount depending on the elastic properties of the particular item) and the energy dissipater is not crushed the calculated amount. This was the case in drop test number 1.

The rigged load configuration of the M44 Clusters for drop test number 2 was identical to drop test number 1 except for the reduction in energy dissipater thickness from 6 inches to 3 inches. This configuration is shown in Figure 2. The rigged load after drop is shown in Figure 5.

Inspection of the rigged load after impact revealed some damage. As shown in Figure 6, a vertical cleat on one of the lower shipping boxes was cracked, apparently resulting from excessive deflection as a column. Also, the top of the same shipping box and the inner vapor barrier were punctured in corresponding locations (see Figures 7 and 8). It was apparent that the puncture was caused by the bomb shackle lug protruding from the M44 Cluster.

The four Clusters were operated and functioned normally. Since in normal airdrop operations, the delivered equipment is used within a short time after receipt, it was decided that penetration of the vapor barrier was not significant and thus the rigged configuration of drop test number 2 is suitable for field use. Since the drop test conditions were most critical, that is, a 30 fps. impact velocity and a concrete impact surface, and the shipping boxes were subjected to more than one impact; it is expected that the damage sustained in drop test number 2 will rarely occur in operations.

A third drop test was scheduled to determine if further rigging simplifications could be accomplished without increasing the amount of damage. The specific changes made are as follows:

a. No paper honeycomb was used to fill the void between the lower shipping boxes and the upper energy dissipater load spreader.

b. No plywood load spreader was used between the upper and lower shipping boxes.

The rigged configuration of the M44 Cluster for drop test number 3 is shown in Figure 9. The rigged load after drop is shown in Figure 10.

The damage was much more severe as a result of this drop test. One of the plywood sides of a lower shipping box was cracked along its length and the vertical cleats had pulled away from the plywood. A longitudinal cleat on an upper shipping box was cracked. The inner vapor barrier and the plywood top of the damaged lower shipping box was punctured in two places by the two bomb shackle lugs of the Cluster. Even in this case, the four M44 Incapacitating Clusters functioned normally.

The damage to the lower shipping box was severe enough to make ground handling of the box somewhat inconvenient and was probably not worth the rigging simplifications derived from this configuration.

Thus, the recommended field configuration is derived from drop test number 2 and is shown in detail in Figure 11.

CONCLUSIONS

It was concluded that the M44 Incapacitating Cluster is capable of withstanding airdrop impacts when rigged with standard air delivery equipment and techniques.

APPENDIX I

Sample Calculation of Configuration of Paper Honeycomb Energy Dissipater

Chosen test conditions:

Impact velocity, V, = 30 fps

Area of paper honeycomb, A, = base area of M44 Cluster

Base area of M44 Clusters $= \frac{67.75 \times 17.12}{144} = 8.05$ sq. ft.

Weight of stacked M44 Cluster = 2 x 330 = 660 pounds

Paper honeycomb characteristics:

Average dynamic crushing stress, S_a, = 6300 lbs/sq. ft.

Maximum strain before bottoming, E, = 70%

Calculate paper honeycomb input acceleration:

$$G = \frac{S_a A}{W} - 1$$

$$G = \frac{(6300)\ (8.05)}{660} - 1$$

$$G = 75.8$$

Calculate required thickness of paper honeycomb:

$$t = \frac{V^2}{2gGE}$$

$$t = \frac{(30)^2\ (12)}{(2)\ (32.2)\ (75.8)\ (.7)} = 3.16 \text{ inches}$$

Use two 3-inch layers of paper honeycomb

FIGURE 1

DROP TEST EQUIPMENT SHOWING CRANE, HOIST CABLE, REMOTELY-OPERATED RELEASE, AND RIGGED LOAD

FIGURE 2

TYPICAL RIGGED LOAD CONFIGURATION

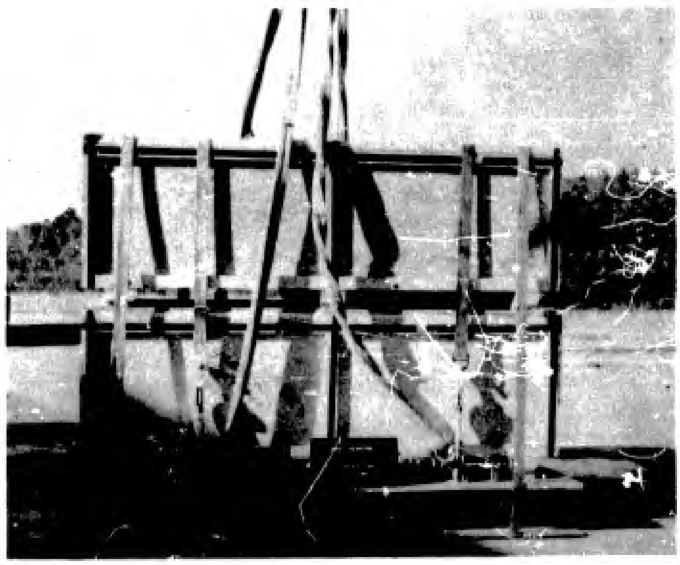


FIGURE 3

RIGGED LOAD CONFIGURATION BEFORE TEST DROP NO. 1

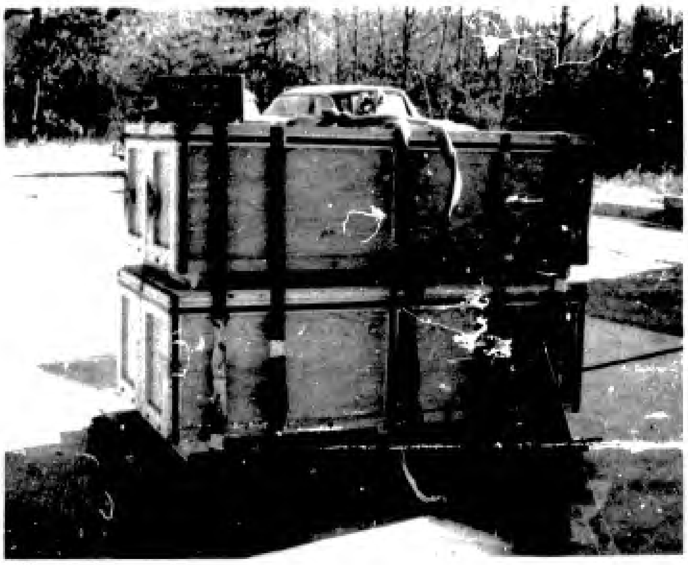


FIGURE 4

RIGGED LOAD CONFIGURATION AFTER TEST DROP NO. 1

FIGURE 5

RIGGED LOAD CONFIGURATION AFTER TEST DROP NO. 2

FIGURE 6

SHIPPING BOX CLEAT DAMAGE AFTER TEST DROP NO. 2

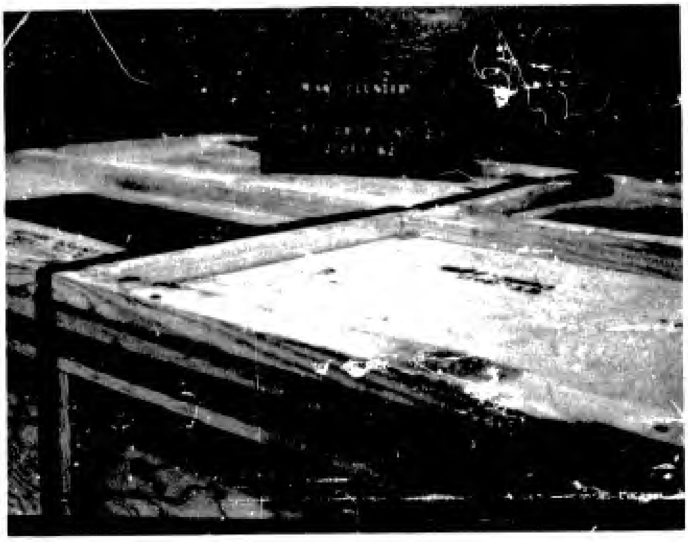


FIGURE 7

SHIPPING BOX DAMAGE AFTER TEST DROP NO. 2

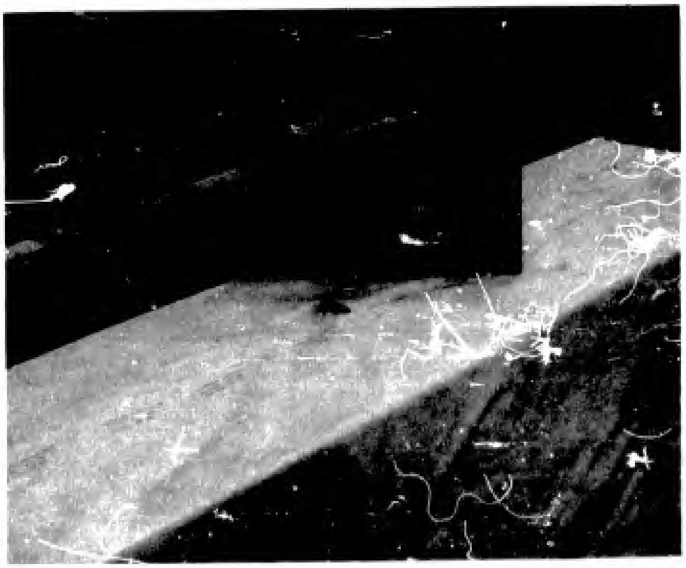


Figure - 8

VAPOR BARRIER DAMAGE AFTER DROP TEST NO. 2

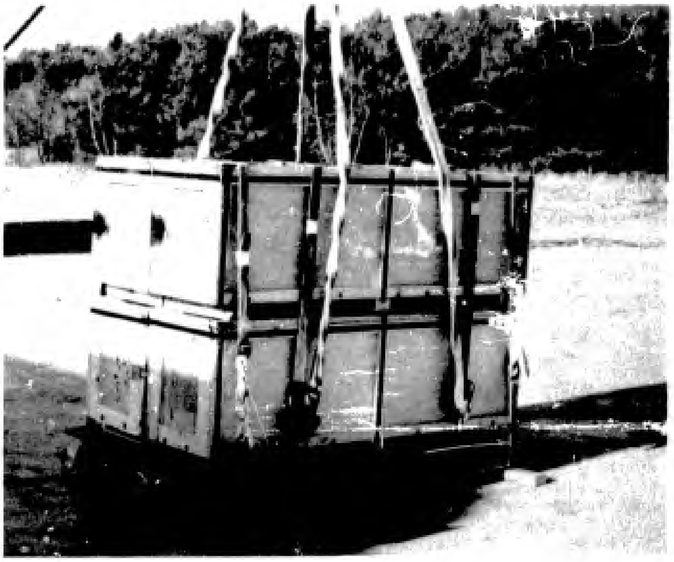


FIGURE 9

RIGGED LOAD CONFIGURATION BEFORE DROP TEST NO. 3

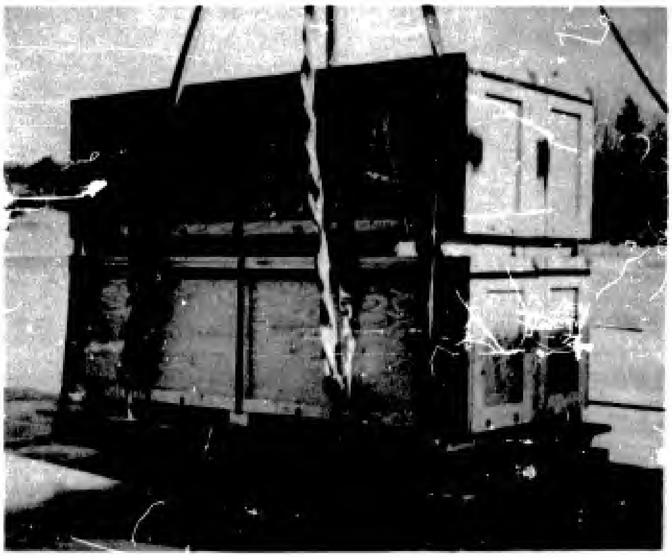
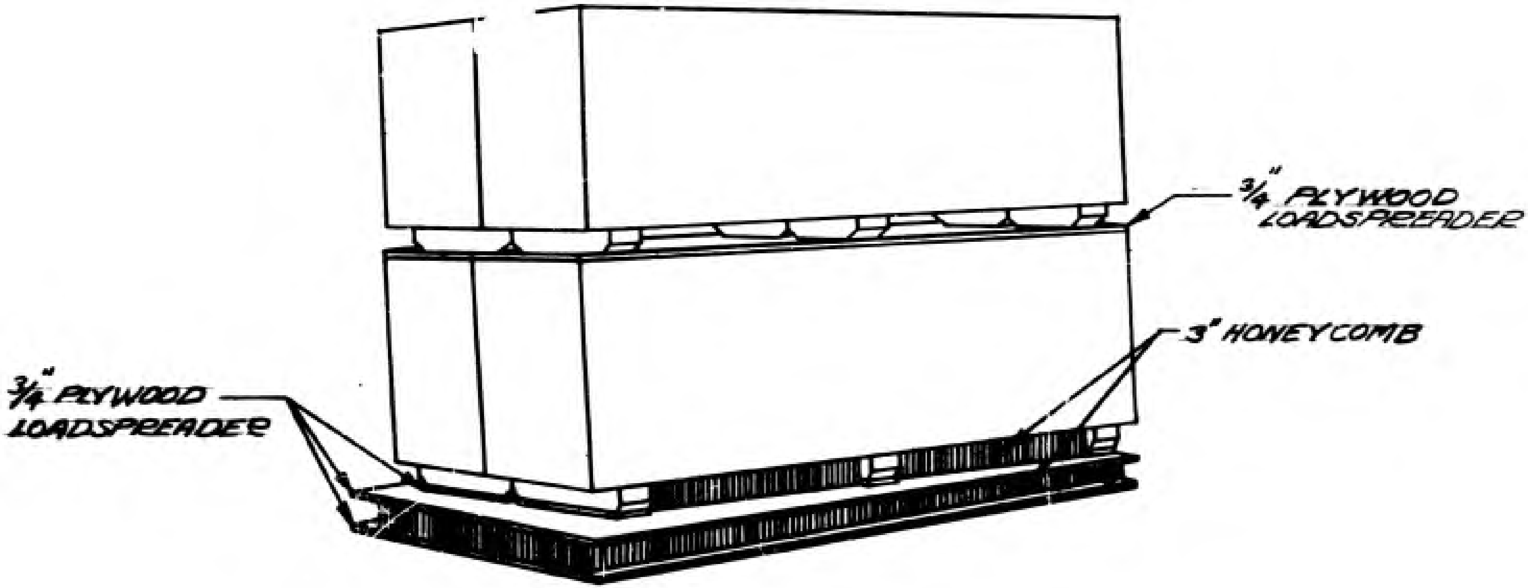


FIGURE 10

RIGGED LOAD CONFIGURATION AFTER DROP TEST NO. 3



RECOMMENDED RIGGED LOAD CONFIGURATION

FIG. II

UNCLASSIFIED

UNCLASSIFIED