INCREASING RESISTANCE OF WOOD PALLETS TO HANDLING IMPACTS

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ABSTRACT

Nearly one-eighth of the lumber produced in the United States goes into wood pallets, stimulating the Forest Products Laboratory to search for better techniques of pallet construction and handling. Extensive research at the Laboratory centered on impacts between pallets and forklift tines during loading.

This report covers two successive studies that showed:

The strong desirability of using an "impact panel" attachment to the forklift trucks that handle wood pallets

A strong advantage in butting the first and second top end deckboards if the pallets are to be handled by a conventional forklift truck

Nailed pallets resisted handling impacts better than mastic-jointed ones

Recessing the top edge deckboards from the ends of the stringers did not increase impact resistance

Use of an impact panel can greatly decrease the damage to reusable pallets. If adopted for general use in service, this innovation could substantially increase the service life of reusable wood pallets and thereby extend the Nation's timber supply.

RELATED INFORMATION

Patent information, regulations of the Occupational Safety and Health Administration, and research equipment are discussed on page 18.

(This Research Paper supersedes "Increasing Serviceability of Wood Pallets" by R. K. Stem, and published in 1973 as USDA Forest Service Research Paper FPL 215.)

Insert in USDA Forest Service Research Paper FPL 258

Since this report was published, at least three manufacturers are selling some version of the device described here. This has interest for many questioners in view of the concerns we expressed in the report. The three firms are:

LITCO Products Company
1411 Youngstown-Kingsville Road, S.E.
Vienna, OH 44473

Product: "Pallet Guard"
(Strikes all stringers on ends)

Perfected Packaging Components
610 Lilac Street
Webster Groves, MO 63119

Product : "Pallet Helper"
(Strikes center stringer)

Little Giant Products, Inc.
1600 NE Adams Street
Peoria, IL 61601

Product: "Pallet Saver"
(Strikes center stringer)

If other firms are making versions of this device and will notify us, those names can be added.

INCREASING RESISTANCE OF WOOD PALLETS TO HANDLING IMPACTS

By

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U.S. Department of Agriculture

INTRODUCTION

Serviceability of reusable wood pallets has traditionally been evaluated in the laboratory through such tests as: Free fall drop, edgewise drop, cornerwise drop, revolving drum, conventional incline impact, and static bending. But appreciable uncertainty has existed about correlation between the resulting data and pallet performance under service conditions. Correlation has been complicated by the difficulty of obtaining truly representative information on the nature and the levels of physical stress associated with pallet use.

The problem of accelerated laboratory simulation of rough handling the pallets used by a major Canadian carrier was studied by Reeves and others of the Eastern Forest Products Laboratory, Department of Environment, Ottawa, Canada. They concluded that about 75 percent of all initial damage to reusable wood pallets (two-way entry type) entailed splitting or loss of the top leading-edge deckboards.[3] They also observed that these failure patterns were caused by the nature of the loading action of the forklift trucks that handle the pallets.

At about the same time, research in the United States also was aimed at simulating forklift truck impact against pallet top leading-edge deckboards.[4] This

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[1] The author gratefully acknowledges the experimental research on this project by J. D. Wiese, D. P. Schroeder, and G. Wilson, Engineering Technicians at the Forest Products Laboratory.

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

[3] Reeves, J. R. The Development of Improved Grocery Product Pallets: A Preliminary Evaluation. For. Prod. Lab., Ottawa, Ont. Inf. Rep. OP-X-31, Canadian For. Serv., Dep. Fish, and For. Mar. 1970.

[4] Kurtenacker, R. S. Appalachian Hardwoods for Pallets: Effect of Fabrication Variables and Lumber Characteristics on Performance. USDA For. Serv. Res. Pap, FPL 112. For. Prod. Lab., Madison, Wis. 1969.

laboratory work recognized the susceptability of leading-edge deckboards to damage by handling and studied their performance under impact in conjunction with a national program,

Nethercote and Reeves[5] further observed that, while the forklift tines are entering the voids between the stringers during handling, the forks are often tilted 4Á forward, This causes the pallets to receive a particularly damaging loading sequence:

1. The top leading-edge deckboard is impacted and pried upward, so the first rank of nails provides the principal resistance during the initial contact of the forklift truck with the loaded pallet.

2. A sharply increased upward force is received by the top leading-edge deckboard when the fillets at the inside 90° angles of the forks are in contact.

In attacking the problem just outlined, we decided to investigate not only different pallet constructions, but also methods which would reduce the highly concentrated loads on the top leading-edge deckboards. Our approach to this is what we have termed an "impact panel" which would be attached to the forks of a forklift truck. This work could lead to longer pallet service life by more efficient pallet handling. At present the impact energy of the forklift truck is absorbed principally by the top leading-edge deckboard. This new concept was that the maximum unit stress per joint could be reduced to a more tolerable level if handling impact energy were applied through stringers to many more joints.

The impact panel concept looked good but we wanted to test it under more realistic conditions. For this we used a very common commercial size of pallet, 48 by 40 in. The load employed was 750 lb, roughly a light load for a pallet this size. Results were so promising that we realized we could extend the information.

Considering that the 750-lb values represent the low end of the loading range for a 48- by 40-in. pallet, we ran a later experiment with a load four times that heavy--3,000 lb. We felt that by determining pallet performance for the practical boundaries of the loading range, the performance over the customary loading range might be implied.

Work with the 750-lb load is summarized here in part I and that with the 3,000-lb load in part II. Each part also involves further research on specific construction features that were additional attempts to bolster pallet performance.

Wood used in all these experimental pallets was No. 3A and 3B Common red oak (Quercus rubra L.) lumber, typical of that commonly used for pallets. Material was selected and evaluated by experimental design procedures to produce findings that would represent pallet performance.

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[5] Nethercote, C. H., and Reeves, J. R. A Modem Outlook on Pallet Research. For. Prod. Lab., Ottawa, Ont. Inf. Rep. OP-X-38, Canadian For. Serv., Dep. Fish. and For. Apr. 1971.

PART I: 750-LB. LOAD

This study was conducted to evaluate the effectiveness of the following changes in pallet construction and handling techniques:

Change	Principle
Adding an impact panel to the forks of a forklift truck.	Reduction of unit stresses applied to all pallet joints by applying stresses to the stringer ends during impacting.
Making top leading-edge deckboards recessive from ends of stringers and attaching an impact panel to the fork assembly.	Reduction of unit stresses applied to pallet joints of the top leading-edge deckboards by applying stresses to the stringer ends during impacting.
Joining pallet parts with mastic instead of nails.	Shock transmitted to load reduced because of increased cushioning action by mastic joints.

Initially, we simulated impacting of loaded pallets in service with a modified incline impact testing machine. However, preliminary research with the system, and monitoring by high-speed motion picture photography and an electronic monitoring system, indicated that our testing system produced unnaturally severe handling impact conditions. Two direct indications of this were upward rotation of the pallet with impact and tension perpendicular-to-the-grain failure beginning at the ends of the stringers. While these problems of accelerated simulation of service-type handling impact conditions probably could have been solved eventually, for expediency we decided to conduct the research with a hand-type forklift truck weighing 2 tons (fig. 1).

MATERIALS AND ASSEMBLY

Materials

The following materials were used for the pallets:

Lumber.--Green, red oak logs were purchased in Wisconsin and stored underwater in a holding tank until they were sawn into lumber.

Nails.--Diamond point pallet nails, 2-1/2 by 0.120 in., helically threaded, and hardened. All nails were hand driven.

Adhesive.--Synthetic elastomeric sealant applied with a calking gun to a thickness of about 1/32 in.

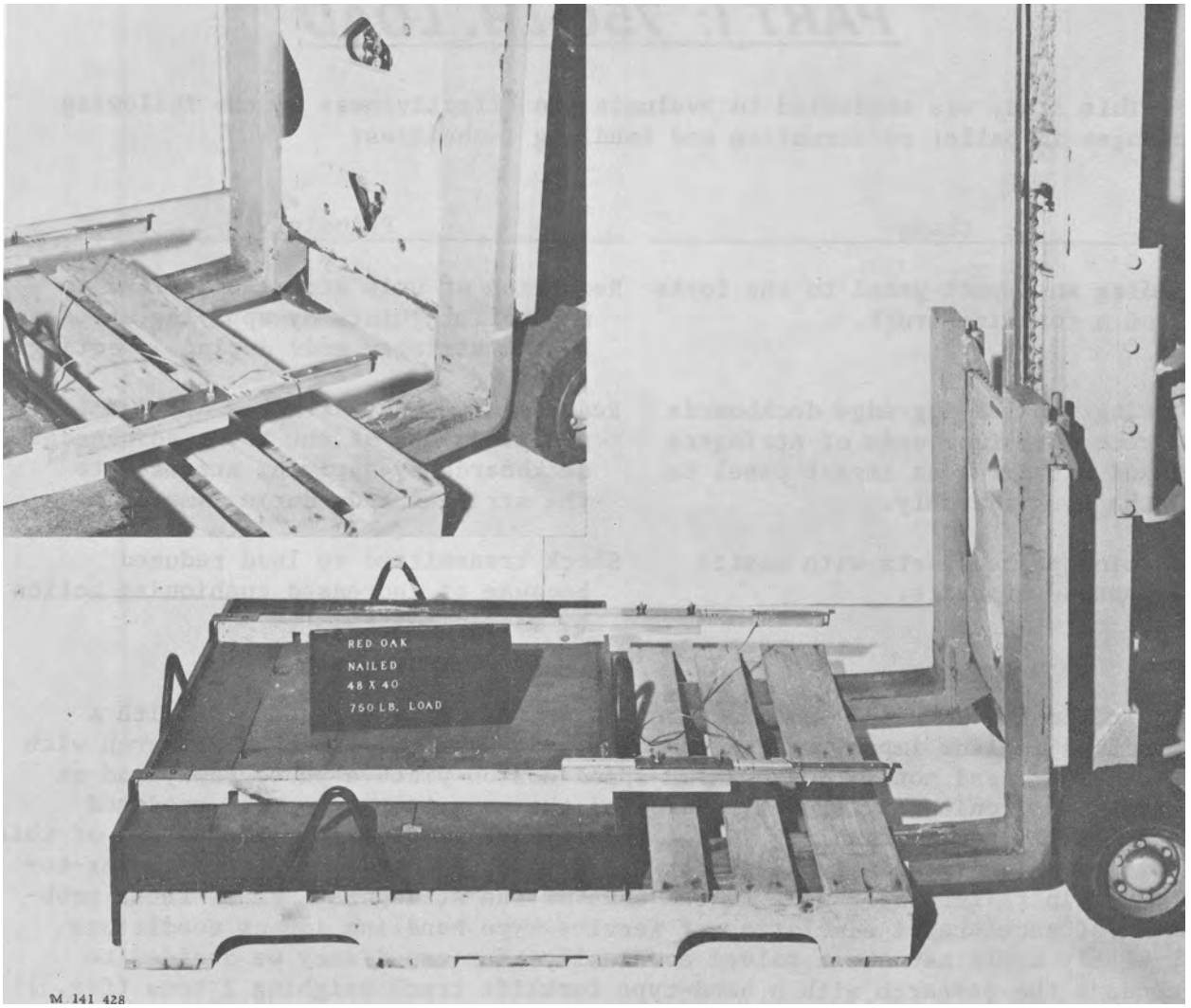

Figure 1.--Handling of a loaded pallet by a hand-type forklift truck without an impact panel. M 141 428

While the red oak logs were still at a moisture content well above the fiber saturation point, they were ripped, trimed, and planed into 3/4-in. deckboards or 1-5/8-by 3-5/8-in. stringers. The stringers were notched, and the pallet parts were then selected randomly. Next, the boards and stringers were wrapped in polyethylene sheets and stored in an atmosphere of 36° F and 82 percent relative humidity until fabrication. Components were then nailed or glued together under ambient conditions as notched-stringer, nonreversible, reusable 48- by 40-in, pallets. The completed pallets were stored for at least 30 days under uncontrolled atmospheric conditions and allowed to reach a moisture content of about 14 percent before testing. Equal numbers of pallets were made (1) with the top leading-edge deckboards flush with the ends of the stringers and (2) recessed 3/8 in. All top deckboards were uniformly spaced,

Additional pallet construction details are given in appendix I.

RESEARCH

Modification of Testing Equipment

The equipment with modification based on this research is shown in figure 2. A powered, hand-type forklift truck impacted the loaded pallets at 2 miles per hour, the maximum speed attainable.

Simulated load.--Aload of 750 lb, consisting of a 1/2-in. steel, open-top retaining box with immovable weights, was assembled (fig. 2). The individual plates were arranged in the box to prevent secondary impacts between the individual plates. The rear vertical panel extended downward 3-1/2 in. from the top surface of the pallet. Therefore, inertial loading (in response to the handling stress applied by the forklift truck) simulating cargo was always applied through the stringers.

Impact panel.--Constructionof a suitable impact panel to transfer the basic energy from the forklift truck to the pallet stringers involved these principal requirements:

a. Sufficient stiffness to withstand the rigors of testing. The flexure of the panel when loaded anywhere between support points could not allow for proportional limit to be exceeded. Should this occur, the panel would permanently deform, varying with overstress, and lead to severe misalinement with the fork tines.

b. Be compact, and preferably adjustable in service.

Initially a 2-in.-thickred oak panel with portions extending below and beyond the forks was tried. This panel had insufficient strength in shear for the span between the forks, and failed early in the exploratory testing program.

The next attempt was to mount a 46-in. length of American Standard steel channel, 8 by 2-1/4 in, and 13.75 lb/ft with the open side adjacent to the vertical portions of the forks. For these research purposes, the fillet at the right angle formed by the horizontal and the vertical portions of the forks was removed to allow stable support of the impacting surface of the impact panel. Exploratory calculations and testing confirmed that the impact panel thus attached, had sufficient strength to resist the handling forces within the elastic region. Unfortunately, after only a few impacts, some of the pallets failed in shear parallel to the grain at the top of the stringer ends. Restated, the wood (with an allowable slope of grain of 1:l0) failed in shear parallel to the grain for the small area of wood loaded under this arrangement.

To meet this challenge, we bolted steel bars, 2 in. deep and 2-3/8 in. wide, to the bottom of the channel so the load would be distributed over a greater area at the stringer end (fig. 2). Exploratory research with the panel and its attached downward projections indicated that this combination successfully overcame the deficiencies of earlier prototypes.

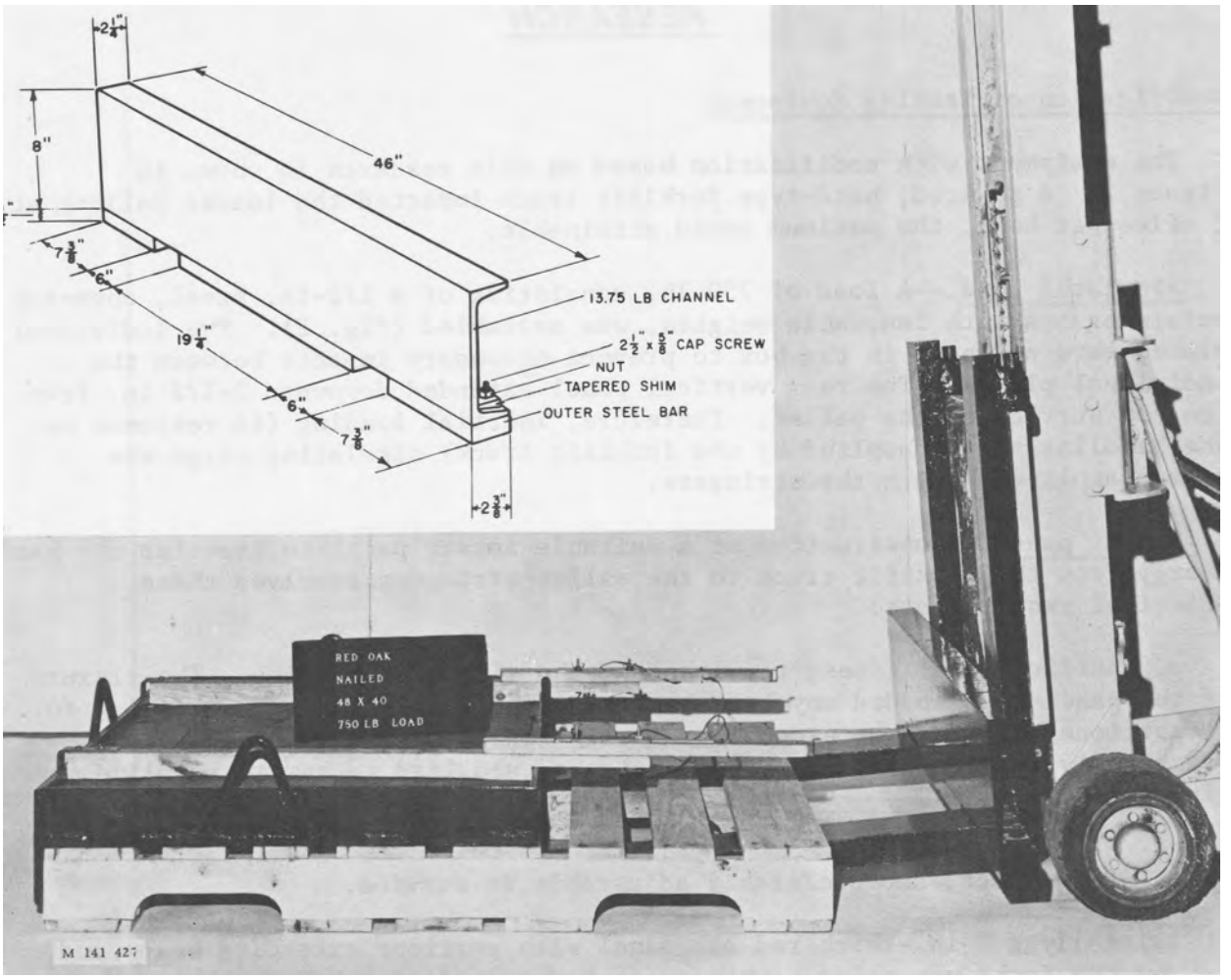

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Figure 2.--Modified fork tine assembly developed by the U.S. Forest Products Laboratory to lower unit stresses caused by handling. Inset: Detail of impact panel used in this research.

Monitoring Test Results

Research data were recorded by three techniques: (1) An accelerometer-oscilloscope Land process camera system; (2) high-speed motion picture photography with suitable reference lines; and (3) a count of the cumulative number of handling impacts required to cause failure requiring repair. Visual observations of effects were made before, during, and after impacts.

The initial element of the electronic system used for recording shock was a strain-gage accelerometer mounted at the center of the rear panel of the simulated load. The acceleration registered by the accelerometer was coupled through a bridge balance into the y-amplifier of an oscilloscope. With the proper gain settings, acceleration-time relationships were recorded for each set of impact conditions.

A high-speed motion picture camera, set to operate up to 4,000 frames per second, was used with appropriate lighting, triggering, and measurement reference systems to photograph significant parts of the exploratory portion of the work, especially during impact.

The last and simplest, but most extensively used, data-recording system involved counting the elapsed number of handling-type impacts with a full-size forklift truck.

Major Test procedure

With the exploratory work concluded, the experimental work was planned so that the principal variables and their interactions could be compared. A 2^3 full-factorial experiment design that involved a total of 32 pallets was used as follows:

Fasteners	Edge Deckboards	Fork Assembly
Nails	Flush	Conventional
Mastic	Recessed	Equipped with impact panel

Each pallet was handled (impacted) by a forklift truck on one end with tine entry parallel to the stringers. Impacting was continued until (1) a substantial part of the pallet became separated or (2) the operator decided the pallet would have been withdrawn from service for repair. However, if a pallet remained usable after the 300th impact, further testing was discontinued.

For the first group of eight pallets--each with a different set of major characteristics--acceleration-time (a-t) records were made for the lst, 5th, 50th, and 300th impacts (if the test series lasted that long). To facilitate data interpretation, photographs of pallet condition were also taken before and after testing wherein a-t records were made.

Pallets had top leading-edge deckboards either flush with the ends of the stringers or recessed 3/8 in. They were handled by a forklift truck with either conventional forks (with the usual curvature at the inside right angle of the forks) or with the modified fork with the impact panel attached.

PART I RESULTS

Failures in the pallets occurred for several reasons. Nails broke or were withdrawn. Sometimes the top leading-edge deckboard broke. Pallets joined with mastic usually failed at the joints or by tensile stress in the mastic itself. In general, pallets with uniformly spread top deckboards failed by damage to the top leading-edge deckboard or its fastening. This was true even though the first deckboard often contacted the second before failure.

The performance of the individual test pallets and forklift truck with the test variables is presented in table 1. Nailed pallets when handled by the forklift truck with an impact panel performed best. All eight of these pallets were still serviceable after 300 impacts; further testing was discontinued. A typical condition is shown in figure 3.

Table 1.--Performance of pallets with two types of fasteners, deckboards, and fork assemblies oaded with 750 lb

Variables[1]			Number of impacts[2]				
Pallet fasteners	Pallet deckboard condition	Fork assembly	Individual				Average
Nails	Flush	Conventional	[3]137	38	20	8	51
Mastic	...do....	.....do.....	6	1	2	8	4
Nails	Recessed	.....do.....	37	7	10	41	24
Mastic	...do....	.....do.....	1	5	2	3	3
Nails	Flush	With panel	[4]300	[4]300	[4]300	[4]300	[4]300
Mastic	...do....	.....do.....	5	93	65	27	48
Nails	Recessed	.....do.....	[4]300	[4]300	[4]300	[4]300	[4]300
Mastic	...do....	.....do.....	[5]300	83	116	156	164

[1]For experimental design, see Westinghouse Electric Corp., Design of Experiments. Factorial design; book 4. 1968.

[2]With a forklift truck until the pallets were either unserviceable or testing was stopped arbitrarily.

[3]A major part of the leading-edge deckboard was lost after 5 impacts.

[4]Pallet in usable condition.

[5]Pallet practically unusable.

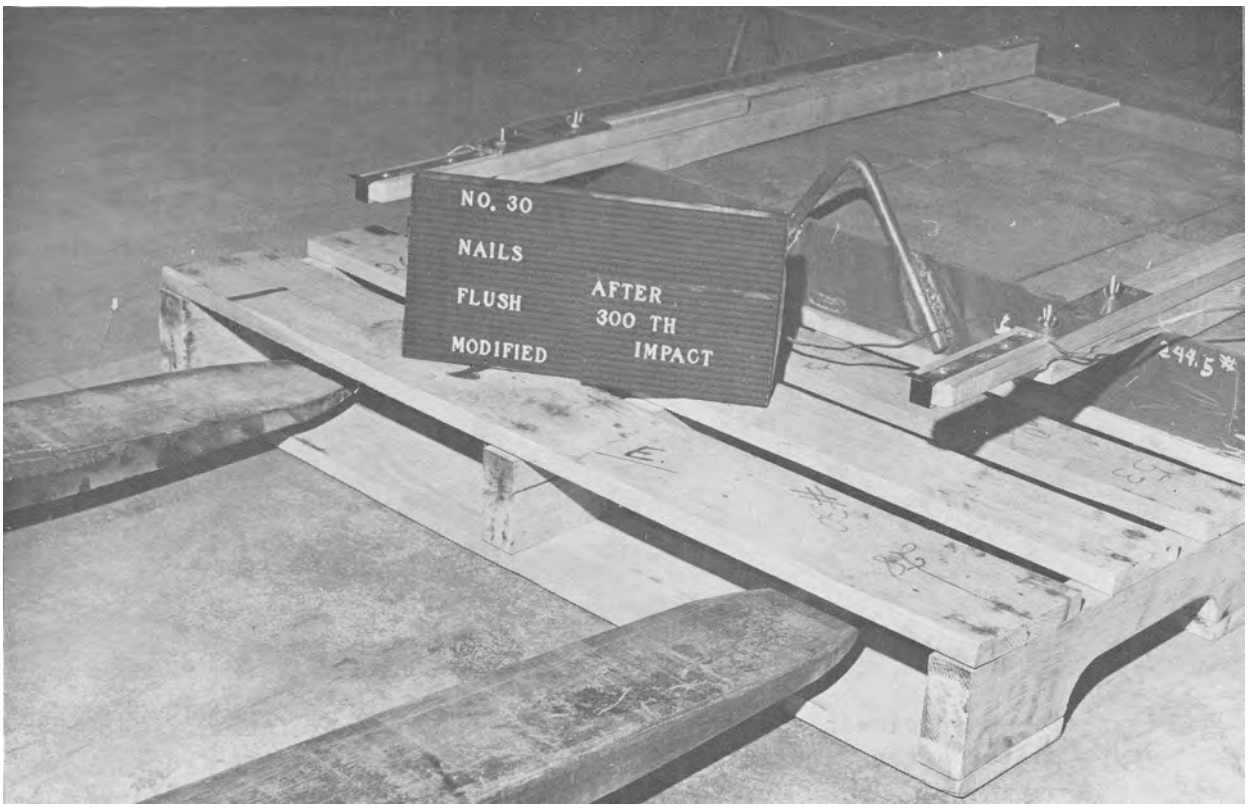

Figure 3.--Serviceable condition of a typical loaded, nailed, flush pallet when testing was arbitrarily halted after 300 impacts by a modified forklift truck. M 140 876-9F

In sharp contrast to pallets made with nails and handled by a forklift truck with the modified panel, pallets made with mastic and handled by a conventional forklift truck averaged only four impacts. Typical pallet condition at failure is shown in figure 4. The maximum value obtained by any of eight pallets was only eight impacts. Performance of pallets with recessed end deckboards was not greatly different from that of similar conventionally made pallets (table 1).

Representative a-t recordings are shown (fig. 5) for the electronically monitored position on the simulated load of a pallet with deckboards flush with its stringers and handled by a modified forklift truck. The pulses representing the first impact rose sharply from 0 to about 20.5 g (ratio of absolute acceleration to that of gravity); then the pulses oscillated through a period of about 20 milliseconds. Typically, the joints loosened progressively with additional testing so that the duration of the a-t pulses for the 300th impact of this pallet had extended beyond 30 milliseconds. However, the peak acceleration for the 300th impact was not greatly different from that of the first impact.

Unavoidable (but distinguishable) shock-excited ringing in the 1/2-in. steel plate of the simulated load caused a primary plate resonance of about 900 hertz. This complicated interpretation of the performance of the pallet proper. The oscillation on the leading edge of the pulse without a corre-

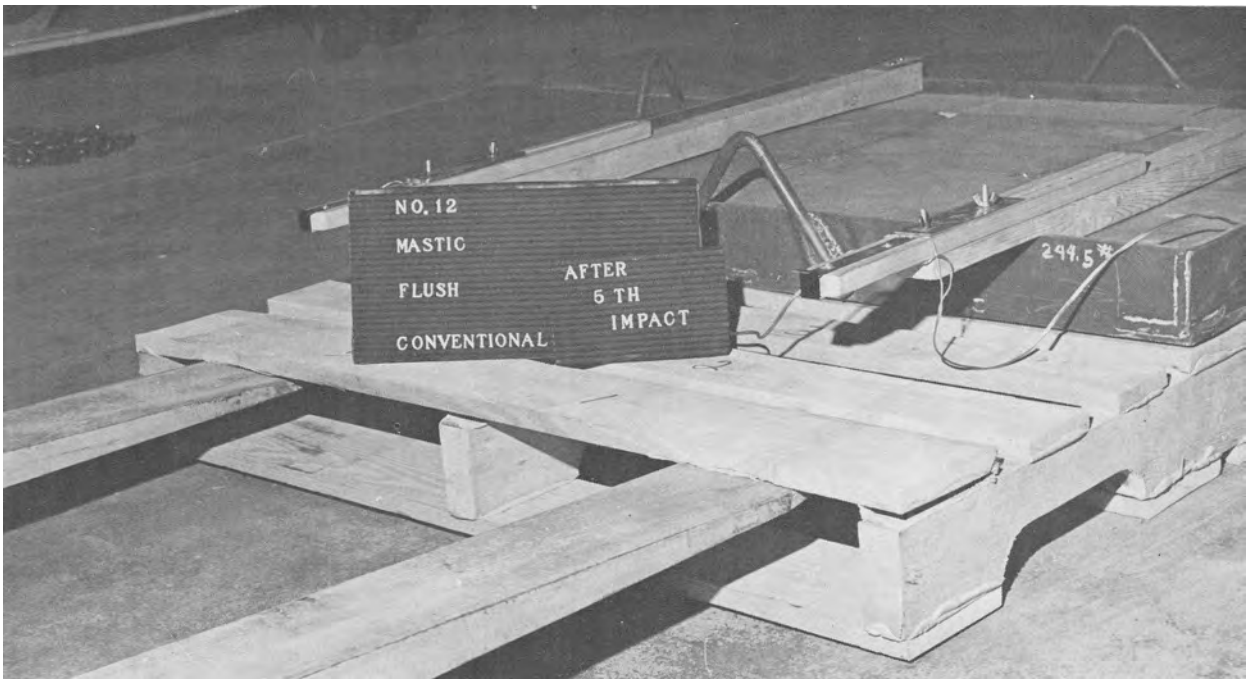

Figure 4.--Unserviceable condition of loaded, mastic-jointed, flush-type pallet after five impacts by a conventional forklift truck.
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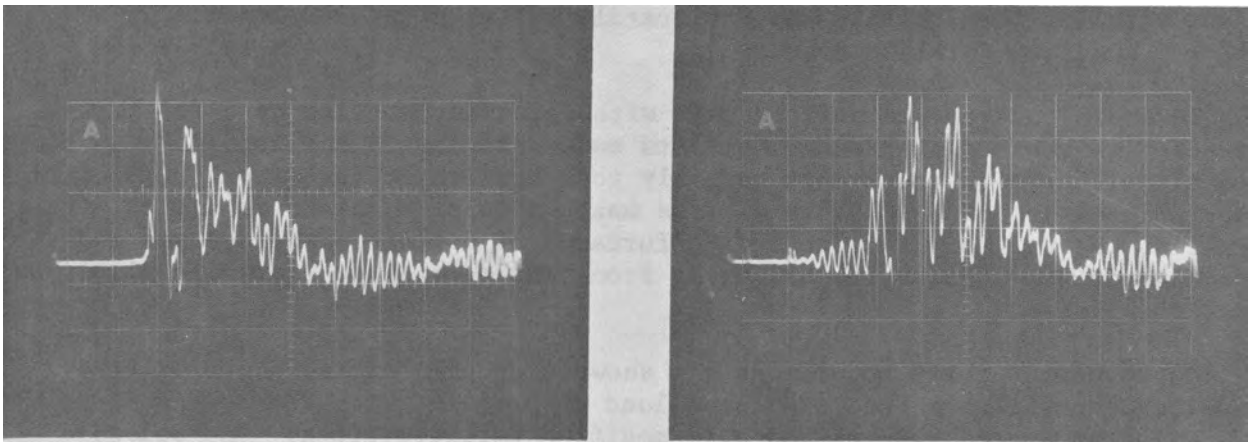

A **B**

Figure 5.--Typical acceleration (force) time pulses from rough handling of a loaded pallet by a modified forklift truck: A, after first impact; B, after 300th. M 141 429

sponding increase of the mean pulse along the y-axis signified (in this impact) that only one fork had contacted the loaded pallet initially. About 8 milliseconds later the other fork also made contact, and the full energy transfer began. This caused a rapid increase in the acceleration of the pallet and its load to about 19 g. The trace then oscillated back to 0 about 21 milliseconds later. Slight misalinement between the motion direction of the forklift truck and the surface contacted in pallet handling caused this behavior frequently during the testing, but this was considered typical of service-handling conditions. In summary, while the pallet joints loosened with successive impacts, the shock pulses lengthened but did not appreciably increase in magnitude.

PART I CONCLUSIONS

1. Performance of wood reusable pallets loaded with 750 lb can be significantly improved during handling by powered, hand-type forklift trucks, if handling stresses are applied simultaneously to all joints by contact with the stringers. This can be achieved by adding an impact panel to the forks of a forklift truck.

2. Nailed conventional pallets will withstand handling by a forklift truck much better than similar mastic-bonded pallets.

3. Apparently, recessing leading-edge deckboards from the ends of stringers does not markedly change the resistance of pallets to shocks imparted during handling operations.

PART II: 3,000-LB. LOAD

The primary objective of this portion was to evaluate the effectiveness of using the impact panel for handling pallets supporting a load four times heavier than that used in the work reported in part I.

A second important objective of this work was to compare quantitatively the difference in performance yielded by pallets with uniformly spread deckboards and those having butted first and second top deckboards.

RESEARCH

Experimental Design

As in part I, we limited this work to a 2^3 full factorial experimental design. This approach enabled us to establish conclusive results by limiting the study to relatively few main effects and interactions of variables. The experiment was designed as follows:

Fork Assembly	Top Deckboard Spacing	Pallet Load
Conventional	Evenly spaced	750 lb
Equipped with impact panel	Butted first and second deckboards	3,000 lb

Based on variation of test results encountered in part I and to enhance the chance of producing valid data, we used four replicates for each effect and its interactions. Each pallet was tested on only one end in order to represent more pallets and better sampling. Therefore, the total number of pallets tested was 32.

Materials and Pallet Preparation

Lumber.--Redoak lumber was purchased from a Wisconsin firm and shipped so that it arrived at the Laboratory while still green.

Nails.--Helically threaded pallet nails 2-1/2 by 0.120 in.

After brief storage the lumber was planed and cut into deckboards and stringers. Next, the pallet parts were selected randomly and nailed together as green 48- by 40-in., 4-way entry, nonreversible, flush type, notched-stringer, reusable pallets. Checks were made of the moisture content of the component parts during, and immediately after, construction as pallets. Results confirmed that the moisture content of these components remained above the fiber saturation point during pallet fabrication. Deckboards were cut to meet minimum standards for NWPMA Grade A pallet material[6] in order to repre-

sent typical service conditions. The completed pallets also were stored in a relatively dry atmosphere for at least 30 days before testing to allow the moisture content of pallet parts to simulate service conditions more closely. The moisture content values of the pallet parts immediately after testing were as follows:

Pallet part	Moisture content Range (Pct)	Moisture content Average (Pct)
Deckboards	7 – 9	8
Stringers	10 - 21	12

TESTING

Modification of Testing Equipment

Load construction.--A uniformly distributed loading device (fig, 6) was constructed to represent a 3,000-lb pallet load. The outer box was constructed of welded 1/2-in. steel plate, and the ballast consisted of sand and lead plates. As with the 750-lb load (part I), the steel frame of the 3,000-lb load had a downward projection to butt squarely against the rear, vertical ends of the stringers during impact.

Impact panel.--Thedevice used in this portion of the work was the same one used for part I.

Test Procedure

Testing technique and equipment used was the same as described under part I, except that the incline impact tester and high-speed photography analysis were not used. Also, pallets were tested while supporting loads of both 750 and 3,000 lb. Specifically, testing consisted of a series of impacts of loaded pallets by a hand-type forklift truck weighing 2 tons and traveling at 2 miles per hour. Each pallet supported either the 750- or 3,000-lb load during impacting, and the loaded pallet was at rest until contacted by the forklift truck. The principal data recording system was the same as in part I; the total number of handling type impacts required was recorded.

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[6] National Wooden Pallet Manufacturers Association. Specifications and Grades for Hardwood Warehouse, Permanent, or Returnable Pallets. 1962.

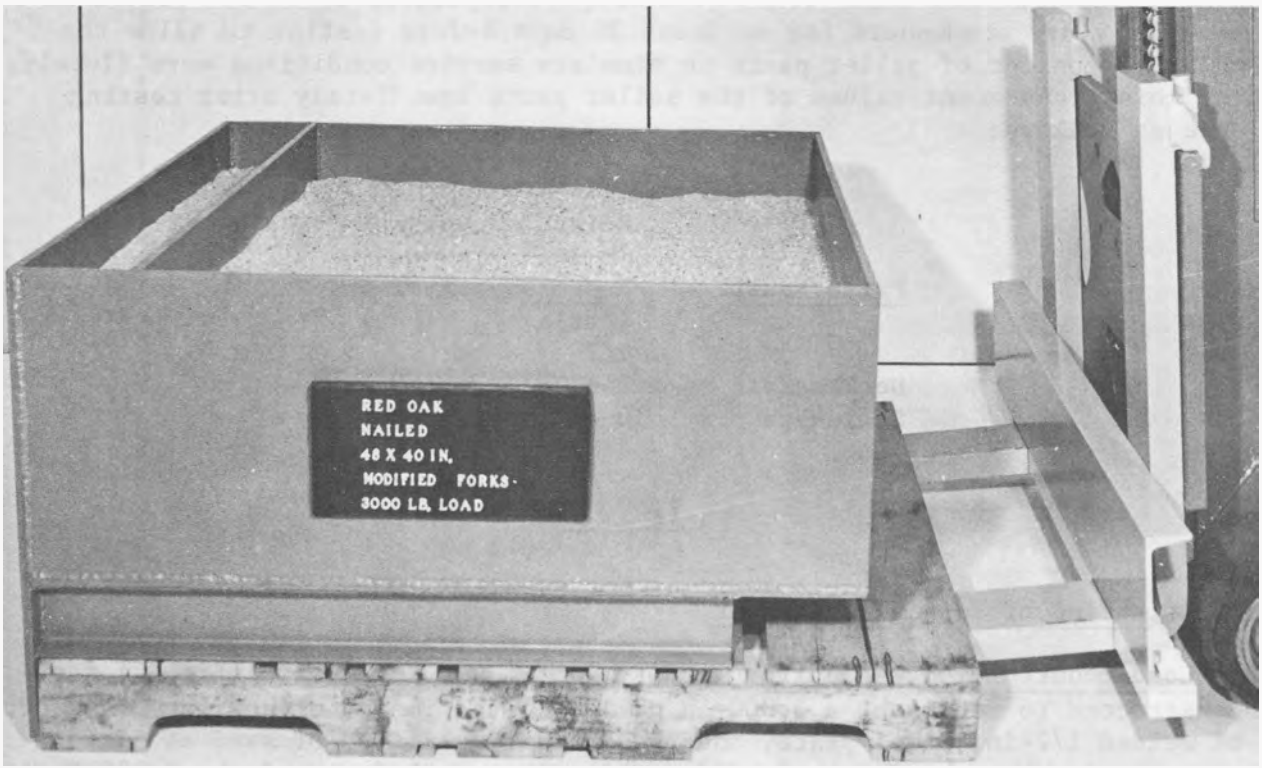

Figure 6.--The 3,000-lb load used in some of the handling impacts described in part II. M 141 829-12

PART II RESULTS

A summary of the primary results obtained from the work is given in table 2. Nailed pallets with evenly spaced top deckboards supporting a 750-lb load, and impacted by a conventional forklift truck, were unserviceable after an average of 70 impacts. However, under the same handling impact conditions, pallets of the same type supporting a 3,000-lb load needed repair after an average of only eight impacts (fig. 7). The pallets for all other combinations of test variables having a 750-lb pallet load were still serviceable after 300 impacts.

Table 2 also indicates that performance of pallets may be improved by butting the first and second deckboards. This was shown when pallets supporting a 3,000-lb load were impacted with a conventional forklift truck. Butting the first and second deckboards resulted in an average of 195 impacts compared with eight for pallets with uniformly spaced deckboards. This is directly attributable to the principle that doubling the number of nails resisting failure has a disproportionately larger effect in preventing damage to the leading-edge deckboard and its fasteners. Typical pallet conditions when testing was halted is indicated by figure 8.

Table 2.--Performance of nailed pallets with two types of fork assemblies and deckboard spacing and loaded with 750 and 3,000 lb[1]

Variables			Number of impacts					
Fork assembly	Deckboard spacing	Load	Individual					Average
		Lb						
Conventional	Evenly spaced	750	122	52	32	73		70
With panel	.....do.....	750	[2]300	[2]300	[2]300	[2]300		[2]300
Conventional	First and second deckboards butted	750	[2]300	[2]300	[2]300	[2]300		[2]300
With panel	.....do.....	750	[2]300	[2]300	[2]300	[2]300		[2]300
Conventional	Evenly spaced	3,000	15	7	5	3		8
With panel	.....do.....	3,000	[2]300	[2]300	[2]300	[2]300		[2]300
Conventional	First and second deckboards butted	3,000	201	162	210	209		195
With panel	.....do.....	3,000	[2]300	[2]300	[2]300	[2]300		[2]300

[1]With a forklift truck until the pallets were either unserviceable or testing was stopped arbitrarily.

[2]Pallet in usable condition.

Analysis of the table 2 data indicated that it would be highly desirable to continue testing one group of four pallets beyond the arbitrary stopping point of 300 impacts. This was done for pallets having butted first and second deckboards, loaded with 3,000 lb, and impacted with the forklift truck having the modified fork assembly. The pattern of failure beyond 300 impacts became obvious as further testing progressed: The top leading-edge deckboard slowly raised until testing was stopped at 546 impacts. This condition (fig. 9) was assumed to be the point at which the pallet probably would have been repaired before being returned to further service. Similar gradual failure patterns were experienced during test series of the other three pallets in the group, and testing was also stopped at 546 impacts for each of them.

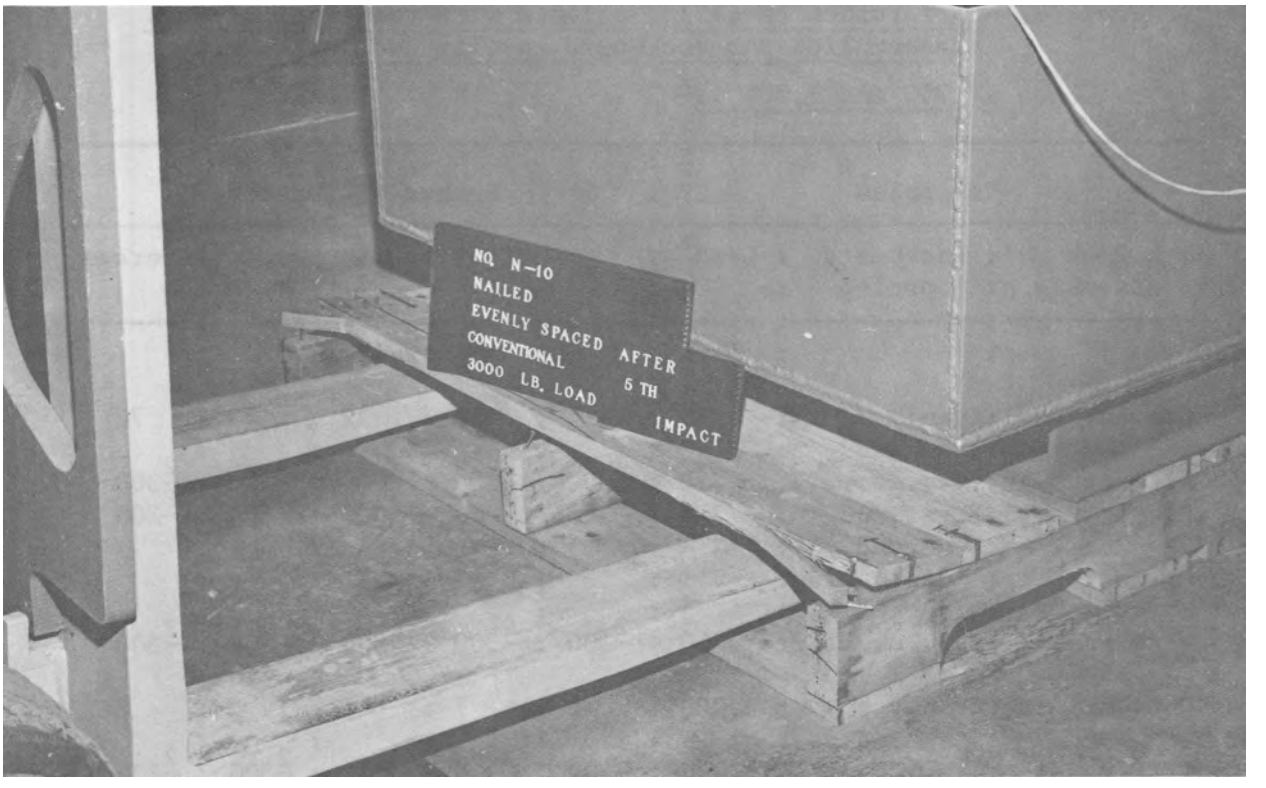

Figure 7.--Failure of a conventional pallet with evenly spaced deck-boards after only five impacts by a conventional forklift truck weighing 2 tons and traveling at 2 miles per hour. M 141 867-10

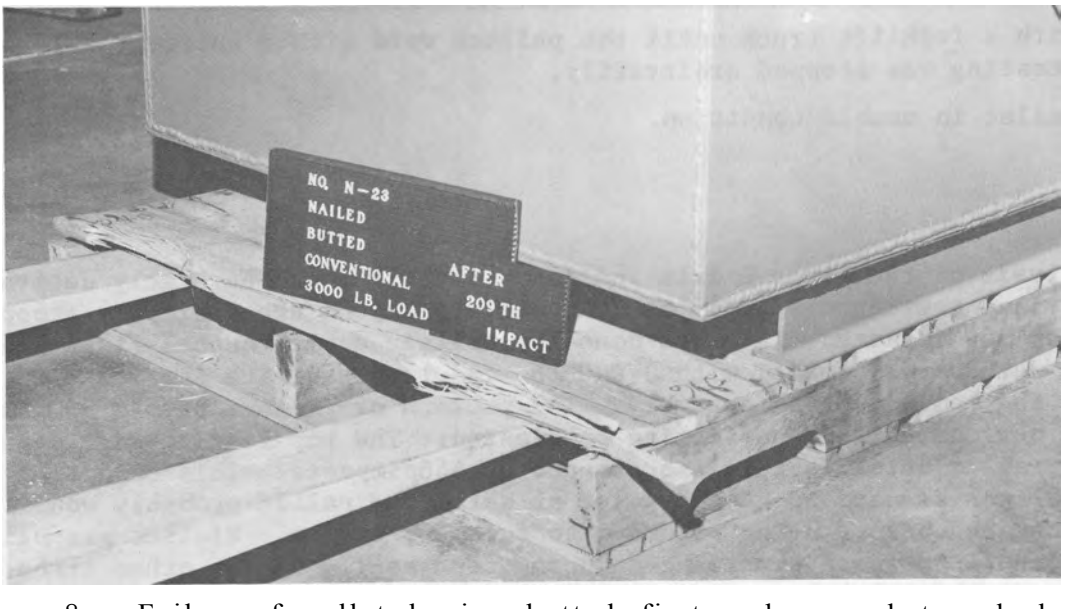

Figure 8.--Failure of pallet having butted first and second top deck-boards and continuously supporting a 3,000-lb load after 209 impacts by a conventional forklift truck weighing 2 tons and traveling at 2 miles per hour. M 142 367-12

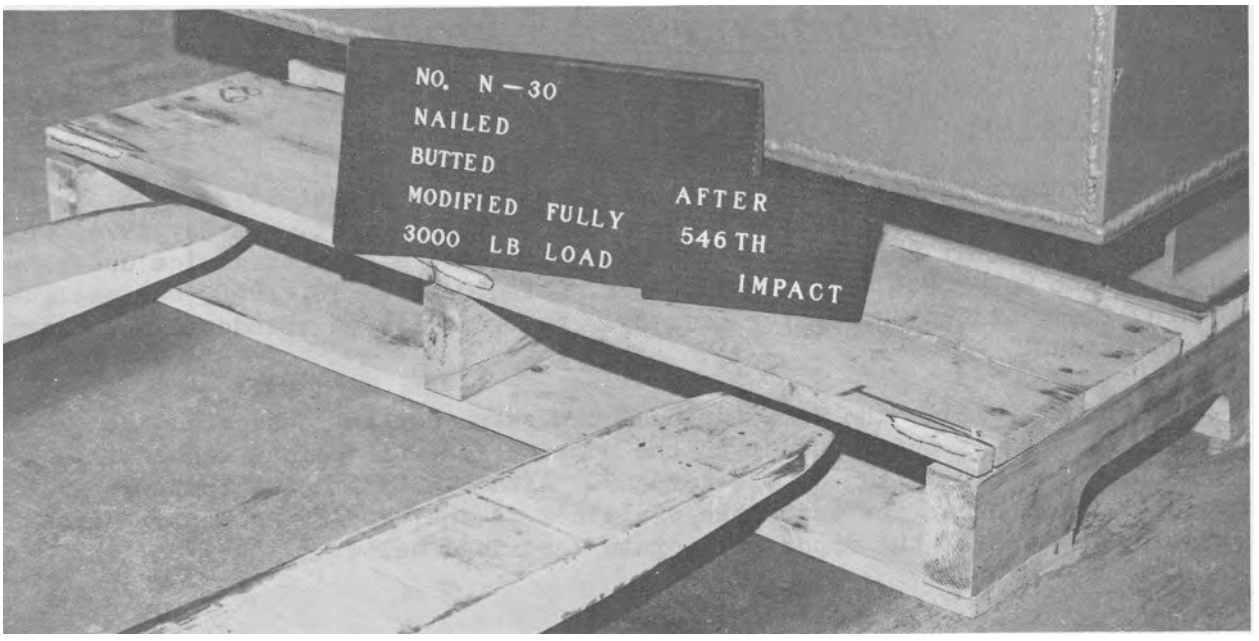

Figure 9.--Condition of pallet after 546 impacts by a forklift truck weighing 2 tons and traveling 2 miles per hour and equipped with an impact panel. M 142 361-1

OVERALL CONCLUSIONS

Highlights of the results in both parts I and II are:

1. Use of an impact panel by a forklift truck for handling reusable wood pallets can greatly extend their service life expectancy.

2. Butting the leading and second top deckboards during pallet construction can produce decidedly better pallet performance over evenly spaced deckboards.

3. No apparent advantage exists in pallet construction with the top edge deckboards recessed from the ends of the stringers.

4. The use of presently available mastics for pallet construction is of questionable value.

Although data in this report are limited, it is obvious that other methods can be used to extend pallet life further. For example, incorporating a suitable cushioning device, such as a cushioning material next to the impact panel or shock absorbers coupled to the panel, will greatly enhance the effectiveness of the impact panel in reducing handling shock to the pallet.

IMPORTANT RELATED INFORMATION

Patent Situation

A Government patent application was submitted in August 1973 to obtain public protection for the device described in this report. In May 1974, we were notified that the patent search had disclosed a similar device under U.S. Patent No. 2,956,701. That patent, dated October 18, 1960, was assigned to the International Harvester Company. Accordingly, we abandoned our patent application.

In November 1974, the International Harvester Company dedicated the entire remaining term of their patent to the public. The Laboratory gratefully acknowledges this action by the company. Although this means that the public will be free to use the principle explained in the report, potential users should be aware of the important points described below.

Occupational Safety and Health Administration Regulations

Attention is directed to paragraph a(4) of Part 1910.178 of the OSHA regulations covering powered industrial trucks which states, "Modifications and additions which affect capacity and safe operation shall not be performed by the customer or user without manufacturer's prior written approval. Capacity, operation, and maintenance instruction plates, tags, or decals shall be changed accordingly." Thus, such modification of a forklift truck, including attachment of a device like that described in the report, is subject to the regulation quoted.

FPL Research Equipment

The device described in this report was a heavy, stiff steel channel. Its form and the method of mounting were solely for the purposes of our research and should not be taken as recommendations for modifications of commercial forklift trucks.

Similarly, the panel used in our research was adapted to the Laboratory's powered, hand-type forklift truck. We removed the fillet at the apex of the inside right angle of each fork to facilitate installation of the panel. Although removal of this fillet was satisfactory for our research, this could be an unsafe procedure and should not be done on forklift trucks in commercial use.

Our Position

The research described in the report demonstrates a basic principle, namely that pallet life can be extended by redistributing the forces applied by a forklift truck. Results of this research proved dramatically that pallet service life and performance can be greatly increased through the impact panel principle. Adoption of the principle, therefore, is recommended as a way to use our timber resource most efficiently and extend our timber supply.

APPENDIX I

SUPPLEMENTARY PALLET CONSTRUCTION DETAILS

This additional information is provided to present details not given in the main body of this report. Figure 10A shows component dimensions and construction details of pallets with evenly spaced deckboards as used in parts I and 11. Figure 10B shows details of pallets with butted first and second top deckboards as used in part 11. The nailing pattern for ends of each width of top deckboard is shown in figure 10C.

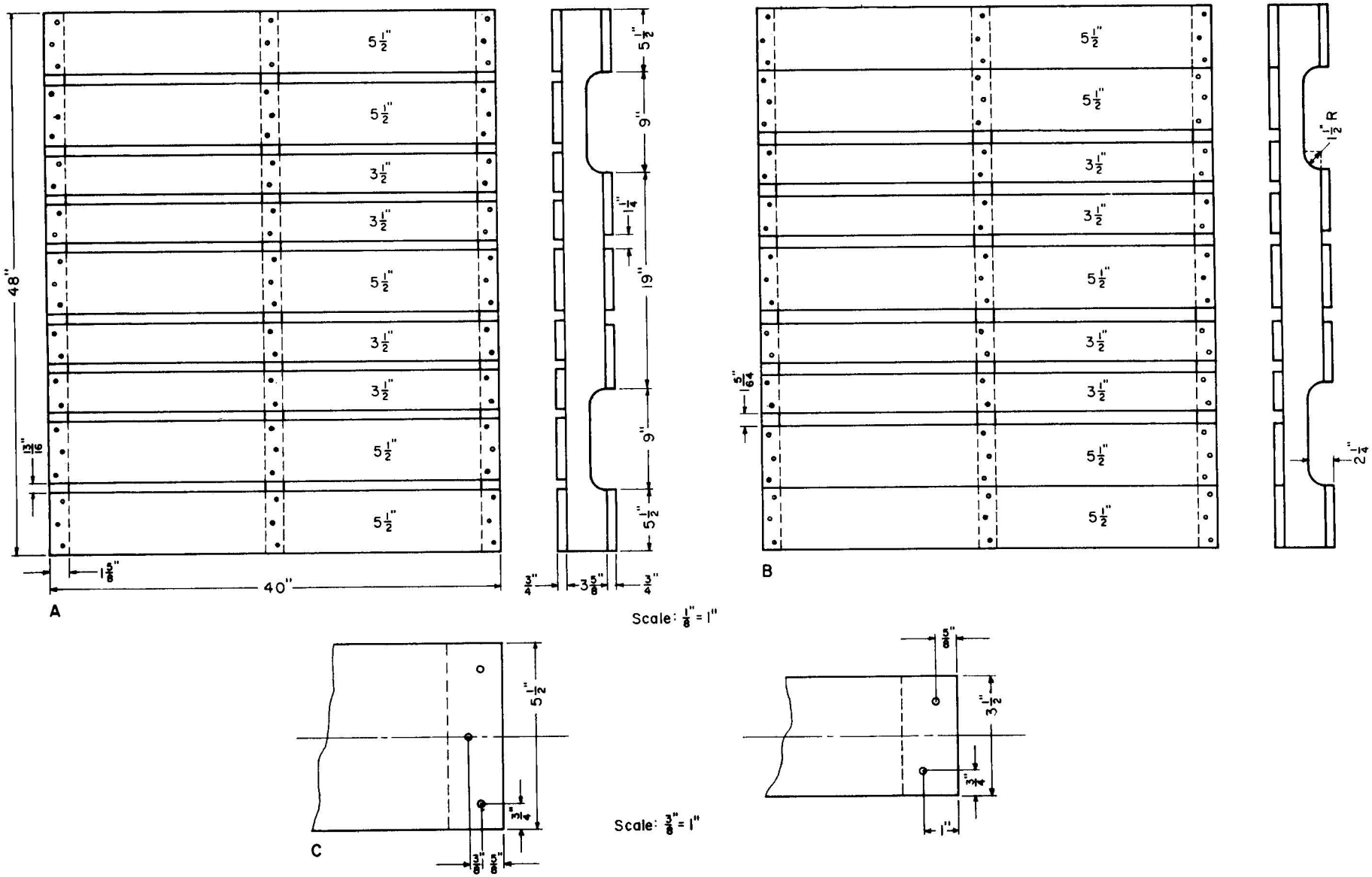

Figure 10.--Pallet construction details: (A) With uniformly spaced deckboards, (B) with butted first and second top deckboards, and (C) nailing patterns.

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