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PALLET REPAIR AND SALVAGE

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ABSTRACT

Efficient unit-load handling with permanent pallets requires a well-organized pallet repair program. To provide basic information on pallet damage that could be used in establishing repair standards, we inspected a total of 1700 damaged pallets at four repair facilities. All damage was recorded by type, severity, and location. This survey determined that missing deckboards at the ends of the pallet account for more than 50 percent of the total deck damage and longitudinal breaks and splits outside the stringer notches account for more than 80 percent of the total stringer damage. This information should benefit those who use and repair wooden pallets.

INTRODUCTION

One aspect of the pallet industry that receives relatively little attention is the market for used pallets. Of the wood used for pallets, skids, bases, crates, containers, and dunnage for shipping products in the United States, approximately 10 board feet is consumed for each pallet-load-equivalent shipped. Only about one-fifth of the total product transported on pallets is shipped on permanent structures, and millions of board feet of reusable wood is discarded annually. The waste is greatest in industries with high-value products, where the cost of wood shipping materials is an insignificant addition to the total cost of the product.

But the absolute cost is of major concern to the final consumer, who ultimately must pay for the wasteful use of raw materials. Wood packing and shipping materials cost the economy of the United States approximately $1.75 for each pallet-load-equivalent of product shipped, instead of approximately $0.60 as they would if high-quality permanent pallets were used. This amounts to an avoidable expense of approximately $690 million annually for the 600,000,000 pallet-load-equivalents shipped.

Although the most efficient use of materials is in high-quality reusable structures, nearly 80 percent of the wood now used in packing and shipping is not reusable in its original form. To reuse the discarded materials, it is necessary to disassemble the structures, salvage usable materials, and reassemble them, often into different products. At a time when wood raw material is scarce and in demand, there is increased interest in the potential of salvage. This interest is further stimulated by public concern over the disposal of waste products and its effects on the environment.

Unfortunately, although the restricted supply of wood has resulted in increased prices, the reaction of industry is an attempt to maintain the present costs by purchasing lower quality shipping materials. This aggravates the supply situation because even less material can be reused, and costs and prices begin to spiral upward. The net result is that al-

ready scarce materials are used less efficiently and become more scarce.

A more rational course would be to maintain the present costs in the long run by purchasing and using reusable shipping materials, which have a higher initial cost but a lower cost per use because they last longer and need less maintenance and repair. In the competitive marketplace, such a course of action would require concerted action by all the firms in an industry. Individual firms that want to follow such a policy must make a concerted effort to induce other firms with which they do business to follow the same policy. This rarely happens, and one result is that the salvage and repair industry booms.

BACKGROUND

Pallet users do a limited amount of repair work to protect their investment in pallets. Pallet manufacturers repair pallets on a limited scale as a service to special customers, but the pallet manufacturer views a damaged pallet as a potential replacement order. The pallet user views a damaged pallet as a piece of packaging material that is not compatible with his paper compactor and a liability because of its high disposal cost. This attitude is especially prevalent among nonmanufacturing firms that receive pallets under materials but do not use them to ship their products.

The underlying problem is that the pallet manufacturer has little knowledge of how a pallet is used in a materials-handling and distribution system, while the pallet user has little knowledge of the principles and mechanics of pallet manufacturing. Both the pallet manufacturer and the pallet user need education about the value of a pallet in a total materials-handling and physical distribution system.

In recent years commercial pallet repair companies have emerged. Several of these companies are well-established going concerns. When they perform low-quality repairs, it is because they have no vested interest in the utility of the repaired pallets. Still, the repair companies are providing an essential service and an accepted product in an ever-expanding market.

THE STUDY

Purpose

The purpose of this study was to: (1) measure the frequency and kind of damage sustained by pallets and (2) compare the repair criteria used by different companies. This information should provide a basis for:

(1) development of objective pallet-repair standards,
(2) reasonably accurate estimation of repair costs, and
(3) more efficient application of pallet-repair technology.

Methods

Pallets were inspected at four locations. Two were well-established commercial pallet repair and salvage (R & S) companies, one in Massachusetts and one in New Jersey; two were "in-house" pallet repair facilities in large food distribution centers (DC) in Maryland.

Approximately 800 48- by 40-inch 4-way-entry reusable hardwood food-industry pallets were inspected at the R & S companies, and another 900 were inspected at the DC repair facilities. The location, type, and severity of damage was recorded for each damaged part of each pallet. The damage locations tallied were:

TDEB	top deck endboard
BDEB	bottom deck endboard
BDNB	bottom deck notchboard (chamfered boards in the center cluster of the bottom deck)
BDCB	bottom deck centerboard (nonchamfered boards in the center of the bottom deck)
TDCB	top deck centerboard
ES	edge stringer
CS	center stringer

The types of damage tallied were:

MISS	part missing
CB	cross break
DB	diagonal break
LB	longitudinal break
LS	longitudinal split
JT	joint failure

Using a scale developed for previous studies, we rated the severity of damage from one to nine. There were three classes of damage: minor damage that did not influence the structural strength of the pallet; moderate damage that caused a weakening of the structure but did not require repair; and severe damage that caused major weakening of the structure and inactivated the pallet until it could be repaired. Only severe pallet damage (rated seven to nine) was recorded in this study.

The damage severity codes in the "severe" class are:

Damage rating	*Pallet part*	*Extent of damage*
7	Deckboards	A cross break or a longitudinal break with the parts in place and not more than one joint damaged.
		A diagonal break with not more than one-eighth of the part missing and not more than one joint damaged.
	Stringers	Any break with the parts in place and not more than one joint damaged.
8	Deckboards	Any break or combination of damages which causes two joints of one part to be ineffective.
		Any break with more than one-eighth but less than one-half of the part missing.
	Stringers	Any break with not more than one-half of the cross-section area of the part missing.
		Any break which causes two joints in any one part to be ineffective.
9	Deckboards	Any break or combination of damages which causes three joints in one part to be ineffective.
		Any break with more than one-half of the part missing.
	Stringers	Any break with one-half or more of the cross-section area of the part missing.
		Any break which causes three joints in one part to be ineffective.

RESULTS

Damage

The average severity of damage rating per damaged part was essentially the same at all four repair locations: 8.3 at R & S #1, R & S #2, and DC #1; and 8.6 at DC #2.

Although the parts at all repair locations were damaged with the same severity, they were not damaged with the same frequency (table 1). The pallets processed at the R & S companies needed repair of 16 percent of their parts; those processed at the DC facilities needed repair of only 6 percent of their parts.

The pallets processed at the R & S companies had 13 percent of their deckboards damaged, and those at the DC facilities had 7 percent damaged. At the R & S companies 30 percent of the stringers were damaged; at the DC facilities 5 percent were damaged.

Missing parts accounted for about 55 percent of the damaged deckboards, while lengthwise splits and breaks accounted for about 85 percent of the damaged stringers.

At the R & S companies, 76 percent of the damaged stringers had complete breaks (CB, DB, LB), while at the DC facilities only 50 percent had complete breaks. Lengthwise splits and breaks accounted for 91 and 81 percent, respectively, of the damage to stringers.

Table 1 shows the frequencies of different types of deckboard damage, as percentages of the total deckboard damage. For example, 47

Table 1.—Types of damage to deckboards, in percentage of all deckboard damage

Part location	Type of damage						Percent of all deckboard damage
	MISS	CB	DB	LB	LS	JT	
				DC FACILITIES			
TDEB	47	16	18	12	1	6	26
TDCB	34	34	3	0	0	28	7
BDEB	64	9	9	7	1	10	28
BDNB	86	3	3	3	0	5	30
BDCB	77	13	0	5	0	5	9
Deckboard average	53	21	6	4	0	16	100
				R & S COMPANIES			
TDEB	42	9	27	8	1	12	26
TDCB	45	25	10	0	1	18	11
BDEB	60	10	15	6	1	8	30
BDNB	79	12	3	2	1	3	26
BDCB	86	8	4	0	0	2	7
Deckboard average	57	16	11	2	1	11	100

percent of the TDEB damages tallied at the DC facilities were missing parts, 16 percent were cross breaks, and 6 percent were joint failures. The last column shows that damaged TDEBs accounted for 26 percent of all the deckboard damage tallied. The bottom row shows that 23 percent of the total deckboard damages were missing parts, 21 percent were cross breaks, and 16 percent were joint failures.

The frequencies of different types of damage to stringers are shown in table 2.

Table 2.—Types of damage to stringers, in percentage of all stringer damage

Part location	Type of damage				Percent of all stringer damage
	CB	DB	LB	LS	
			DC FACILITIES		
ES	4	1	34	60	81
CS	6	6	56	31	19
Stringer average	5	3	41	50	100
			R & S COMPANIES		
ES	10	10	57	23	73
CS	9	6	58	27	27
Stringer average	10	9	57	24	100

The proportion of damage in the different parts of the pallet was similar at all facilities, although the incidence of damage was considerably greater at the R & S companies (table 3).

For example, 13 percent of the TDEBs were damaged in the pallets processed through the DC facilities, and they represented 22 percent of the total pallet damage. The pallets procesed through the R & S companies had 25 percent of the TDEBs damaged, and they accounted for 17 percent of the total pallet damage.

The different areas of the stringers were found to be damaged in about the same proportion at all facilities; the end areas were damaged the most and the notch areas were damaged the least:

	Percent of damage			
	End areas	*Center areas*	*Notch areas*	*Total*
DC	63	33	4	100
R & S	62	30	8	100

Each stringer has two notch areas, two end areas, and only one center area. The actual frequency of damage to each of the ends was nearly the same as to the center. However, the frequency of damage in the notch areas

Table 3.—Percentage of parts damaged and repaired at two types of repair facilities

Part location	DC				R & S			
	No. parts per pallet	Percentage of parts damaged	Percentage of damaged parts repaired	Percentage of total damage per pallet	No. parts per pallet	Percentage of parts damaged	Percentage of damaged parts repaired	Percentage of total damage per pallet
TDEB	2	13	94	22	2	25	97	17
BDEB	2	15	97	26	2	29	92	20
EB average	4	14	95	48	4	27	95	37
BDNB	2	15	19	26	2	25	96	17
BDCB	2	5	76	9	2	8	99	5
TDCB	6	1	86	2	6	3	94	2
CB average	10	2	83	37	10	4	96	24
Deckboard average	14	7	77	85	14	13	95	61
ES	2	6	48	10	2	32	100	22
CS	1	3	37	5	1	24	100	16
Stringer average	3	5	45	15	3	30	100	38
Average—all parts	17	6	72	100	17	16	96	100

was considerably less; notch area damage accounted for less than 20 percent of the total stringer damage at the R & S companies, and less than 10 percent at the DC facilities.

REPAIR PRACTICES

Commercial Pallet Repair and Salvage Companies

The repair criteria used by the two R & S companies were similar: if a pallet could be repaired, they repaired all damaged parts of it; if a pallet could not be repaired, the usable parts were salvaged. The repair criteria used by the DC facilities were different: one DC facility repaired about 85 percent of the damage and the other repaired less than 60 percent. The policy of the latter DC facility was to do the minimal repair needed to allow the pallet to be used for one more trip.

The commercial pallet repair and salvage companies acquire pallets by three primary means: they get discards from the food distribution center repair facilities; they have contracts with pallet-using firms to repair damaged pallets for a fee, and retain some of the damaged pallets which cannot be repaired for the specified fee; and they acquire pallets and skids free or at minimal cost from pallet users with excess pallet inventories.

One of the commercial repair and salvage companies (R & S #1) dismantles pallets with hydraulic pallet-dismantling machines, which hold one deck of the pallet stationary and force the stringers away from that deck. Nails protruding from the disassembled parts are cut off with a right-angle grinder. This company salvages enough lumber to repair the damaged pallets and manufacture new pallets. About 1,500 pallets are repaired per day, and the company serves an area roughly 200 miles in diameter.

R & S #1 sorts all pallets and skids by size and condition into piles to be dismantled, repaired, or returned to service as is. Two-man crews, each with its own work table, pneumatic nail guns, hand tools, and repair parts, operate at a work station served by forklift trucks that supply damaged pallets and remove repaired ones. Each two-man crew repairs an average of 30 to 40 pallets per hour—15 to 20 per man-hour.

The other commercial repair and salvage company (R & S #2) dismantles pallets manually with crowbars and hammers. This company also purchases new lumber to supple-

ment the salvaged lumber. All the new and used lumber goes into the repair of pallets; no new pallets are manufactured. About 500 pallets are repaired per day, and the company serves an area roughly 75 miles in diameter.

R & S #2 does no sorting and the repair personnel work individually, not in crews. There are no definite work stations, and each man is responsible for sorting the repaired pallets by size as well as for manually disassembling the pallets that are damaged beyond repair. Each man averages 10 to 12 pallets repaired or dismantled per hour.

Both companies used chamfered and square-edge 4-inch and 6-inch lumber for deckboard repairs. Six-inch and 18-inch long 2- by 4-inch blocks are used for stringer repairs. Both facilities use pneumatically-driven helically-threaded nails. Neither company sets a limit on the number of repairs per pallet, but R & S #2 sells reusable pallets with six or more repairs as expendables.

Both companies leave trailers at the pallet users', and the users load the damaged and discarded pallets and skids on the trailer as they are discarded. When the trailer is loaded the repair company picks it up and replaces it with an empty one.

The mix of pallets handled by the commercial repair and salvage companies averaged:

62 percent 48- by 40-inch 4-way entry reusable food industry pallets
25 percent reusable pallets of other types
9 percent expendable pallets
4 percent skids

At the R & S companies 5 percent of the food pallets processed were not damaged; the other 95 percent had an average of 3.5 damages per pallet. At R & S #1, 91 percent of the pallets were damaged; they had an average of 3.3 damages per pallet. At R & S #2, 100 percent were damaged, with an average of 4.3 damages each. Eight percent of the total food pallets processed were damaged too severely to be repaired and were disassembled for salvage. The R & S companies repaired 95 percent of the damaged deckboards and 100 percent of the damaged stringers in the pallets they returned to service.

Food Distribution Center Repair Facilities

The food distribution center (DC) in-house pallet repair facilities are part of the distribution centers' salvage operations. The distribution centers collect from the retail stores and dispose of such items as milk cases, fiber containers, and pallets.

At the DC facilities a smaller proportion of the food pallets were damaged than at the R & S companies, and they had fewer damages per pallet. Sixty-nine percent of the food pallets (73 percent at DC #1 and 65 percent at DC #2) were damaged, with an average of 2.2 damages per pallet. Ten percent of the food pallets processed through the DC facilities were discarded and sent to the R & S companies.

Each DC repair facility employed a two-man repair crew, whose full-time job was pallet inspection and repair. Each crew was provided with a work table, pneumatic nail guns, hand tools, and powered forklift equipment. The repair crews inspect and sort all the pallets returned from the retail stores as well as the pallets damaged at the distribution centers. Many of the pallets do not need repairs, and this is reflected in a greater number of pallets handled per hour than at the R & S companies. The repair facilities usually discard pallets if two or more stringers are damaged severely. Neither limits the number of deckboards repaired per pallet.

One DC facility (DC #1) uses new chamfered and square-edge 4- and 6-inch lumber for deckboard repairs and 48-inch notched stringers for reinforcing damaged stringers. This facility uses pneumatically-driven helically-threaded nails. The two-man repair crew handles an average of 40 to 50 pallets per hour (10 to 25 per man-hour).

The other DC facility (DC #2) uses only new square-edge 4-inch lumber for deckboard repairs, and does not repair damaged stringers. This facility uses pneumatically-driven smooth shank "T" nails. The two-man repair crew handles 50 to 60 pallets per hour (25 to 30 per man-hour).

The mix of pallets handled by the DC repair facilities averaged:

72 percent food industry pallets
15 percent dairy pallets (36- by 36-inch 2-way entry)
10 percent reusable pallets other than food and dairy pallets
4 percent expendable pallets and skids

The pallets returned to service at DC #1 had 100 percent of the damaged end and center deckboards and 90 percent of the damaged stringers repaired; however, only 5 percent of the damaged bottom deck notchboards were repaired. The pallets returned to service at DC #2 had only 69 percent of the damaged deckboards and none of the damaged stringers repaired.

Compared to the DC companies, the R & S companies started with more extensively damaged pallets and repaired a greater percentage of the damaged parts before the pallets were returned to service. Pallets discarded by the DC facilities averaged 3.3 damages each; those received by R & S companies averaged 3.6 damages each. The DC facilities repaired 72 percent of the damaged parts and the R & S companies repaired 96 percent before the pallets were returned to service. The R & S companies do a more complete job of repair because the pallets must be restored to salable condition.

DISCUSSION

Instead of an expense and a nuisance, damaged pallets can be an asset if they can be repaired and salvaged. With the pallet dismantling machines, R & S #1 was able to salvage 83 percent of the undamaged notched stringers, 97 percent of the undamaged solid stringers, and 95 percent of the undamaged deckboards.

Although virtually all the food pallets handled by the R & S companies were damaged more severely than those repaired by the DC facilities, 92 percent of them were repaired by the R & S companies and resold. An average of 16 pallets per trailer load were damaged too severely for the R & S companies to repair. When these pallets were disassembled with the hydraulic dismantler they produced an average of 8.5 board feet of undamaged deckboard material and 2.2 board feet of undamaged stringer material each.

There were 182 48- by 40-inch 4-way-entry pallets that could be repaired in the average trailer load of pallets received at R & S #1; they averaged 332 damaged deckboards and 164 damaged stringers. The repair of these damaged pallets required approximately 40 board feet of deckboard material and 80 linear feet (55 board feet) of stringer material.

There is a limited demand for the 80 reusable pallets of other types in the average trailer load. If two-thirds of these were dismantled they would yield as much lumber per pallet as the severely damaged food pallets. This would provide an additional 450 board feet of deckboard lumber and 75 board feet of stringer lumber. This material plus the lumber salvaged from the disassembled food pallets would be enough to repair the damaged food pallets and the remaining third of the reusable pallets of other types.

One company has recently produced a pallet dismantling machine which uses cutter discs to cut the nails. The pallet is hydraulically forced against two stationary cutter discs which cleanly sever the nails at the deckboard-stringer joints. Pallets can be disassembled by this machine about as rapidly as by the R & S #1 dismantling machine. However, the machine is not yet in commercial production.

The price of a used food pallet, delivered to the user, is about 65 percent of the delivered price of a new food pallet. The experience of the commercial pallet repair and salvage companies is that most pallet users are not averse to purchasing repaired pallets. Indeed, when the price differential between new and repaired pallets is 35 percent, the preference is usually for the repaired pallets.