EVALUATION OF IMPROVED STEVEDORE PALLET

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Nail (a): Industria de Arames Cleide, Santo Andre, S. P., Brazil

Nail (b): Air-Fix do Brasil Ind. e Com. Ltda., Sao Paulo, S. P., Brazil

Nails (c) and (d): Philstone Nail Corporation of Canton, Massachusetts, U.S.A.

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INTRODUCTION

Stevedore pallets are used in preference to other types of pallets in many ports. The function of stevedore pallets is to provide effective ways of handling materials at the docks. These pallets are designed to carry all kinds of products, such as bagged cereals and fertilizers, kegs, drums, boxes, and crates. The pallets are to withstand such heavy impacts as are exerted by the forks of lift trucks. Furthermore, these pallets are often used in atmospheres of high humidity, with the air having a high salt content, hence, being corrosive.

Since stevedore pallets are used mainly to facilitate materials handling at the docks, they can be considered captive pallets. For this reason, it is both feasible and desirable to design and build these pallets in such a way that they have a useful service life over a long period, thereby capitalizing on the fact that long-lasting pallets are normally the most efficient pallets.

Because of their more or less continuous rough use and exposure to the elements, stevedore pallets should be of optimum design and construction. Otherwise, they are subjected to excessive damage and deterioration which could require more or less continuous and expensive repairs.

In Brazil, where pallets are expected to play a major role in the rapid industrialization during the country's immediate future, stevedore pallets are used at the docks to a considerable extent. Relatively large numbers of Brazilian stevedore pallets are repaired daily, a situation which is aggravated by the fact that the workmen involved in pallet repair have received insufficient instruction to perform in a most effective manner. These pallets are of 48" by 63" (1200 by 1600 mm) size and usually assembled with mixed Brazilian hardwoods, some of which have densities similar to the density of the North American red oaks, a principal group of species, which are used for pallet assembly in many parts of North America.

The majority of the captive Brazilian pallets are assembled today with Brazilian helically fluted nails, while helically threaded hardened-steel nails are used for this purpose in North America. These fluted nails are normally non-hardened and relatively soft.

The performance of pallets is influenced by the properties of the wood and the fastener used as well as the pallet design and construction which result in interaction of wood and fastener under load. For a given species of wood, improvements of pallet performance may be attained either by improving the design and construction or the means of fastening.

One of the prevalent modes of failure is the separation of the top leading-edge deckboards from the stringers as a result of repeated impacts by the forks of lift trucks. To reduce this incidence of failure, nails of improved toughness and holding power can be used for the fastening of deckboards to stringers. In addition, reinforcing the leading-edge deckboards against impact may be achieved by locating the adjacent deckboard directly next to the leading-edge deckboard, in order to allow interaction among both deckboards when impact forces are applied by the lift trucks.

The observed Brazilian stevedore pallets are of conventional design, as shown in Fig. 1. Improvements in their design as well as in their construction have been recommended. Pallets of both conventional and improved designs and constructions, also shown in Fig. 1, were tested, in order to fulfill the objective of this study, that is, to demonsrate the effectiveness of these improvements. They included back-up deckboards for the leading-edge deckboards as well as a larger number of improved nails for fastening the deckboards to the stringers. No consideration was given to any other potential design and construction improvements during this study.

Whereas peroba (Aspidosperma polyneouron) and other mixed hardwoods have been used predominantly in Brazil for stevedore pallets, red oaks and other dense hardwoods are, as already indicated, the principal species used for this purpose in North America. The conventional and improved stevedore pallets under study were made of North American red oak, since data on red oak pallets are of significant value in North America and since South American woods were not as readily available to the investigator for the assembly of the pallets under scrutiny.

In order to provide needed data on the effectiveness of the fasteners used for the assembly of stevedore pallets as manufactured in the Americas, the pallet deckboards were nailed to the pallet stringers with four different nails, as shown in Fig. 2.

OBJECTIVES

The objectives of this study include the quantitative evaluation of

a) the stiffness, rigidity, and load-carrying capacity of stevedore pallets of conventional and improved designs as well as their resistance to forces exerted by the forks of forklift trucks;

b) the performance of two types of nails used in Brazil and two sizes of nails used in the U.S.A. for the assembly of pallets.

With such information at hand, it should be possible to advance recommendations which can result in the manufacture of more effective and longer lasting pallets which do not require such costly repairs throughout the pallet life as are experienced with the conventional pallets in common use today.

LITERATURE REVIEW

Pallets, as they are known today, are a product developed since World War II, when the forklift truck was introduced. It required the use of a platform on which products could be placed for moving, handling, storing, display, etc. These platforms are known as pallets (palle in Danish; palette in French; Palette in German; palete, estrado or plataforma in Portuguese; paleta in Spanish; and lastpall in Swedish). Most of them are made of wood. A sizeable quantity is made of plywood and relatively few are made of steel, aluminum, and plastic. The pallets made from these latter materials are usually special purpose pallets where use requirements may justify the high initial cost of these pallets. Because of the advantages offered by wooden pallets, they can be expected to remain in high demand wherever wood is economically available for their manufacture (8).

The economic significance of wooden pallets becomes evident from some of the statistics available. The manufacture of wooden pallets in the U.S.A. increased drastically during the past few years, as is evident from Table 1. The most recent statistics indicate that as many as 236 million wooden pallets, produced in the U.S.A. during 1977, required the use of 15% of the national lumber production (8). Worldwide, these figures are more limited, as is shown in Table 2 (22).

Research on and evaluation of pallets have been underway during the past two decades in order to assure that pallets perform as anticipated under given use conditions and to demonstrate the benefits of given improvements (9). The economic aspects of such improvements have been given special consideration (30). This experimental and market research has influenced pallet performance to such an extent that the importance of such research has been recognized by both pallet manufacturers and pallet users.

Methods of testing pallets were standardized by the American Society for Testing and Materials (ASTM) several years ago. Among these methods is the two-step pallet stiffness test which evaluates the stiffness (a) across the pallet width and (b) across the pallet length (4). Another ASTM test is the diagonal rigidity test (4) and a third one is the leading-edge impact resistance test (4). The latter two test methods were among those used during this study of the evaluation of stevedore pallets.

Among the test methods developed at the William H. Sardo Jr. Pallet and Container Research Laboratory (10) and published by the American National Standards

Institute (ANSI) is one which allows the simultaneous testing of the pallet for its stiffness across both its length and width as well as at the pallet center while the pallet is supported at its four corners and loaded at the center (3). Both the ASTM and VPI&SU stiffness test methods were evaluated at the Sardo Laboratory by performing fully comparative tests in order to provide comparative data resulting from the use of the two test methods (20). Pallets were tested for their stiffness and ultimate load at failure. The VPI&SU method, in comparison with the ASTM method, was found to be simpler, less time-consuming, better suited for yielding valuable supplementary data, and more stringent with respect to the ultimate load-carrying capacity of the tested pallet. This improved test method can yield highly reproducible and accurate test data. Consequently, it appears to be not only reliable but worthy of confidence (20).

Among the many experimental studies undertaken at the Sardo Laboratory and of particular interest to the Brazilian pallet manufacturer is one designed to determine the performance of warehouse and exchange pallets made of Eucalyptus saligna shook sawn from bolts of 55-year old and older trees. The fasteners used for shook assembly were NWPCA-approved (a) $2\frac{1}{4}$" x 0.113" and $2\frac{1}{2}$" x 0.119", helically threaded, hardened-steel, pallet nails, and (b) $2\frac{1}{2}$" x 15-gauge, 7/16"-crown, polymer-coated, pallet staples (26).

During tests on eucalyptus deckboard-stringer joints, the $2\frac{1}{2}$" x 0.119" pallet nail provided, on the average, a one-fifth higher immediate and delayed deckboard-stringer separation and shear resistance than the $2\frac{1}{4}$" x 0.113" pallet nail. The $2\frac{1}{2}$" x 15-gauge pallet staple provided, on the average, a 6% and 59%, respectively, lower immediate and delayed shear resistance than the $2\frac{1}{4}$" x 0.113" pallet nail. According to these test data, from 1.1 to 2.5 pallet staples may replace the $2\frac{1}{4}$" pallet nail; while from 1.3 to 3.0 pallet staples may replace the $2\frac{1}{2}$" pallet nail (26).

During tests on 48" by 40" eucalyptus pallets, no failures were observed during the static stiffness test up to a total load of 2000 lb. and only minor failures were noted during the impact rigidity test up to twelve free-fall drops. Furthermore, the average stiffness of the "standard" pallets, as described in the referenced report and assembled with $2\frac{1}{4}$" or $2\frac{1}{2}$" pallet nails or $2\frac{1}{2}$" pallet staples and that of the "food" pallets, as also described in the referenced report and assembled with $2\frac{1}{4}$" pallet nails were practically the same, varying as much as from -8% to +5% from the average values for the pallets tested. However, the average stiffness of the stapled pallets was 6% to 13% higher than that of the nailed pallets. In addition, the average rigidity of the nailed "standard" and "food" pallets was the same, varying only as much as from -2%

to +3% from the average rigidity of the nailed pallets. On the other hand, the average rigidity of the stapled pallets was considerably lower than that of the nailed pallets (26).

With respect to the analytical evaluation of pallets, a method was developed, during 1976, for use by pallet manufacturers who are continuously faced with the problem of providing a product of sufficient strength to perform as required, which is safe to use and low in cost (27). The design procedure uses graphs as an alternative to rather complex calculations. These methods are based on the use of three factors: (a) a pallet use factor, which depends on the conditions under which the pallet is used; (b) a pallet design factor, which refers to the characteristics of the pallet design; and (c) a material factor, which refers to the characteristics of the materials used.

This analytical design procedure was found to be valid and conservative in a study of southern pine pallets, during which the predicted values for the cost per use, the safe load, and the economic life were compared with those obtained by pallet testing. The procedure was found to be conservative, since the computed values were lower than the test values in all instances under observation (28).

A similar, however, simplified analytical procedure, based on the same engineering principles, was developed, during 1977, for the prediction of pallet performance (29). Certain engineering practices were recommended which should be adhered to during the design of pallets. Three loading situations were considered and formulae were advanced covering the stiffness and load-carrying capacity of pallets under these conditions.

The performance of wooden pallets is influenced by the performance of the fasteners, such as nails and staples, which are most commonly used for pallet assembly (11). The deckboard-stringer separation resistance depends to a great extent on the holding power of the fasteners in the wood used. The pallet rigidity is affected considerably by the ductility and toughness of the fastener. Its driveability, especially into dense hardwoods, is influenced by its buckling resistance, which is directly related to its ductility and toughness.

Ductility, pliability, and buckling resistance, as well as the brittleness of the fastener are properties which can be determined and quantified by testing the fastener with the "Morgan Impact Bend-Angle Nail Tester", the MIBANT device, according to established procedures (15, 21).

Since the introduction of any quality control requires the establishment of quality-control criteria, such criteria were suggested on the basis of the performance of

MIBANT tests on numerous helically threaded pallet nails taken from many manufacturing lots (17). The tested nails could be separated into three distinct groups of nails:

a) "Hardened-steel nails" having MIBANT bend angles ranging from 8° to 28°;

b) "Stiff-stock nails" having MIBANT bend angles ranging from 29° to 46°;

c) "Soft nails" having MIBANT bend angles beyond 46°.

The acceptance criteria also limit the number of partial and complete nail failures to 8% of the 25 samples randomly selected from each lot of nails.

MIBANT test procedures for pallet staples have been suggested (21). However, no acceptance criteria have been advanced to-date.

The design and construction of wooden warehouse and exchange pallets have been studied for many years. Improvements have been recommended and evaluated. Among the major improvements introduced are the use of (a) back-up deckboards placed directly next to the leading-edge deckboards (23, 26) and (b) appropriate numbers of helically threaded, instead of helically fluted, hardened-steel, instead of stiff-stock, nails (10, 13, 14, 16, 18, 19).

The use of the back-up deckboard was found to increase by one-fifth the rigidity of 30% heavier mixed hardwood pallets of improved design. The use of hardened-steel nails was found to increase the pallet rigidity as much as two-thirds regardless of the wood species used. Since pallet rigidity may, under given conditions, be equated with pallet life, these improvements are highly significant from the pallet cost-per-use aspect (23).

Information on the laboratory and field performance of stevedore pallets has not been found in the published literature. Thus, it appears that this study introduces a new dimension in the design and construction of stevedore pallets. On the other hand, they are basically similar to other captive warehouse pallets, with the stiffness resulting from the large size and weight and the inclusion of top and/or bottom deckboard wings in the design of stevedore pallets.

MATERIALS

Lumber

The two lots of lumber used for the assembly of the deckboard-stringer joints and the pallets tested during this study were of the red-oak family from the southwest region of Virginia, purchased directly from a Montgomery County sawmill. The lumber was received at the Sardo Laboratory in green condition, planed to uniform cross-sections and subsequently stored in the Laboratory's 100% relative humidity chamber until used. Therefore, it was considered to have been green during its assembly into pallet joints and pallets.

The oven-dry specific gravity (as determined according to a procedure described in the chapter on Test Procedures) of the pallet deckboards ranged from 0.50 to 0.68, with an average of 0.59 and a standard deviation of 0.06. The oven-dry specific gravity of the pallet stringers ranged from 0.60 to 0.78, with an average of 0.68 and a standard deviation of 0.04. The bar diagrams in Fig. 3 indicate that the randomly selected deckboards and stringers provided pallets of a comparable nature, since the pallet deckboards and stringers were of relatively uniform oven-dry specific gravity.

Nails

Prior to the mass-production of helically threaded pallet nails in Brazil during 1977, $2\frac{1}{2}$" helically fluted nails were predominantly used there for pallet assembly. Both types of nails, shown in Fig. 2, are readily available in Brazil at this time. These nails were tested at the Sardo Laboratory and used for the assembly of the tested joints and the pallets of both conventional and improved designs. In addition to these two types of Brazilian nails, two helically threaded nails, used in the U.S.A. for pallet assembly and shown also in Fig. 2, were tested during this study and used for the assembly of the deckboard-stringer joints as well as the pallets. Since the nail data obtained are of a fully comparative nature, the performance of the tested nails could be fully analyzed. The four different nails, numbered according to the VPI&SU Laboratory numbering system, are described in the following paragraphs:

Nail a.- The Brazilian helically fluted nail (VPI&SU No. 2017) is of $2\frac{1}{2}$" (length) x 0.143" (flute-crest diameter) size, with four helical flutes having an 80° flute angle, an 0.30"-diameter flat head, and a medium diamond point, and weighing 4.546 g.

The MIBANT bend angles of 25 random samples, given in Appendix Table 16a, ranged from 29° to 36°, with an average of 32°. Therefore, this nail can be classified as a stiff-stock nail.

Nail b.- The Brazilian pointless helically threaded nail (VPI&SU No. 2018) is of $2\frac{1}{2}$" (length) x 0.127" (wire diameter) size, with three helical thread flutes having a 68° thread angle, an 0.142" thread-crest diameter, and a $\frac{1}{2}$" clearance between thread and 0.287"-diameter umbrella head, and weighing 4.221 g. The MIBANT bend angles of 25 nail samples, given in Appendix Table 16b, ranged from 35° to 41°, with an average of 37°. Therefore, this nail can be classified as a stiff-stock nail.

Nail c.- The short helically threaded nail (VPI&SU No. 1999-A), commonly used in the U.S.A., is of 2 9/16" x 0.119" size, with four helical thread flutes having a 59° thread angle, an 0.138" thread-crest diameter, a $\frac{3}{4}$" clearance between thread and 0.276"-diameter flat head, and medium diamond point, and weighing 3.800 g. The MIBANT bend angles of 25 nail samples, given in Appendix Table 16c, ranged from 15° to 19°, with an average of 17°. Therefore, this nail can be classified as a hardened-steel nail.

Nail d.- The longer helically threaded nail (VPI&SU No. 1785) is of 3" x 0.120" size, with four helical thread flutes having a 63° thread angle, an 0.136" thread-crest diameter, and a $\frac{7}{8}$" clearance between thread and 0.316" flat-topped umbrella head. It is pointless and weighs 4.589 g. The MIBANT bend angles of 25 nail samples, given in Appendix Table 16d, ranged from 12° to 25°, with an average of 16°. Therefore, this nail can be classified as a hardened-steel nail.

Deckboard-Stringer Joints

Each deckboard-stringer joint was assembled with a single nail fastening the matched, clear, green, 1" x $1\frac{3}{4}$" x 6", deckboard specimens across a clear, green 2.3" x 3.6" stringer of appropriate length (48").

For matching purposes, the 6" deckboard specimens were sawn consecutively from representative deckboard strips of 63" length. The joints with the four nails tested were located in sequence next to each other and spaced $3\frac{1}{4}$" center-to-center along the stringers. The joints tested for nail withdrawal were adjacent to the joints tested for nail shear along the stringer length.

Ten replicate joints were made of wood from randomly selected deckboards and stringers. This resulted in data as representative of the wood used in this study as were feasible with decuple replications. Because of the matching procedure used, the deckboard-stringer joints yielded fully comparative individual and average test values for the four nails tested for withdrawal and shear resistance.

Six-week seasoning of the assembled joints prior to testing resulted in an average moisture content of 9.4% for the deckboards and 29.8% for the stringers during the deckboard-stringer separation tests and 10.6% for the deckboards and 31.3% for the stringers during the deckboard-stringer shear tests.

The average oven-dry specific gravity was 0.64 for the deckboards and 0.67 for the stringers of the deckboard-stringer separation joints and 0.70 for the deckboards and 0.72 for the stringers of the deckboard-stringer shear joints.

Pallets

The pallets of both conventional and improved designs were reversible, double-face, wing-type, two-way entry pallets, having the same overall 48" x 63" dimensions, as shown in Fig. 1. The pallets were accurately assembled with green red oak at the Sardo Laboratory. During assembly of the pallets, the best stringers were used for the outer stringers. The best deckboards of those at hand were chosen for the leading-edge deckboards and the better edges of the leading-edge deckboards were used for the outer edges. The inner deckboards were randomly selected.

Seasoning of the pallets took place in the Laboratory (nominal 50% relative humidity at 70°F. temperature) over a period of at least nine weeks prior to testing. The moisture content and the oven-dry specific gravity of the top center deckboard and of the center stringer were determined, after the testing of the pallets had been completed, by securing small samples. After testing the pallets to failure, their moisture content ranged from 9.3% to 10.7%, with an average of 9.8%, for the top center deckboards, and from 14.8% to 27.6%, with an average of 21.6%, for the center stringers.

The oven-dry specific gravity of the top center deckboards ranged from 0.50 to 0.68, with an average of 0.59, and that of the center stringers ranged from 0.60 to 0.78, with an average of 0.68. (For further details, see the Section on Lumber.)

The pallets of conventional design, shown in Fig. 1, had the same overall dimensions, the same lumber dimensions, and the same number and location of nails as the pallets being used at Brazilian docks. The quantity and size of the green pallet shook and the number of nails used for the assembly of pallets of conventional design are shown in Table 3.

The pallets of improved design, also shown in Fig. 1, utilize top and bottom follow-up deckboards placed tightly against the leading-edge deckboards during pallet assembly. As a result of seasoning of the originally green shook after pallet assembly, the follow-up deckboard is eventually spaced approximately $\frac{1}{4}$" from the leading-edge deckboard. Despite this spacing, the combination of the two boards at each pallet end is highly effective in increasing the pallet rigidity and its resistance to such forces as are exerted by the forklift truck. Because of the tight spacing of the first two top and bottom deckboards at each pallet end, it was found necessary to include an additional deckboard in each pallet face in order to avoid excessive spacing for the inner deckboards.

The pallet of improved design also used an additional nail for each deckboard-stringer joint because of the undernailing of the pallets of conventional design (12). This improvement was found highly desirable because of the large size and weight of the pallet with its shook both in green and seasoned conditions.

The material requirements for the pallet of improved design are also given in Table 3. A comparison of the material requirements of pallets of conventional and improved designs indicates that the pallets of improved design required 12% more lumber and 64% more nails than those of conventional design.

A detailed description of these pallets is given in Tables 4a and 4b.

The average assembly and test weights, in pounds, of the pallets of conventional and improved designs are summarized in Table 5. Consequently, the improved pallets were, on the average, 12.7% heavier during assembly and during the final testing phase than the conventional pallets if no adjustment is made for the difference in lumber from the two batches received for this study. If, on the other hand, weight adjustments are made, the improved pallets were, on the average, 14.0% heavier than the conventional pallets. Furthermore, on the average, the pallets of conventional and improved designs had, by the final testing phase, lost 36% of the initial pallet weights as a result of seasoning in the Laboratory.

To facilitate pallet identification, all test pallets were sequentially coded according to the following convention:

A) Conventional design

B) Improved design

a) $2\frac{1}{2}$" fluted nail as used in Brazil

b) 2½" threaded nail as used in Brazil

c) 2½" threaded nail as used in U.S.A.

d) 3" threaded nail as used in U.S.A.

1-5) Replications

Thus, Pallet Aa1 is a pallet of conventional design, assembled with the Brazilian fluted nail, and representing the first of five replications.

EXPERIMENTAL DESIGN

Deckboard-Stringer Joints

An analysis of variance was used for the decuple data obtained both for the deckboard-stringer separation and shear resistance of the joints assembled with the four nails tested. The purpose of such a statistical analysis was to determine whether the mean values differed significantly and to make comparisons between the means.

Pallets

A two-factor analysis of variance and a Duncan's multiple range test were chosen as the statistical models for the evaluation of the research data covering the pallets of conventional and improved designs on the one hand and the four nails used for the assembly of the pallets on the other hand. This statistical analysis was applied to the data on the initial static stiffness, impact rigidity, impact deckboard-stringer separation resistance, follow-up static stiffness, and static ultimate load-carrying capacity of the quintuplicate pallets.

The statistical design used for the 2 (designs) x 4 (nails) x 5 (replications) = 40 pallets tested during this study is given in Table 6.

TEST PROCEDURES

Minor Tests

1) Moisture Content of Pallet Shook

After completion of the tests on the deckboard-stringer joints as well as the tests on each pallet, small clear samples were sawn from the specimens and weighed immediately and after oven-drying at approximately 101° C. for a period of not less than 24 hours (6). In the case of the joints, all deckboard samples as well as all stringer samples were treated as single samples. This resulted in the determination of average moisture contents for both the deckboards and the stringers used. In the case of the pallets, small clear samples were sawn from the center part of the top center deckboard and center stringer of each pallet according to established Laboratory procedure, and each was weighed immediately and after oven-drying. Thus, the moisture content was obtained for one deckboard and one stringer of each pallet.

2) Oven-Dry Specific Gravity of Pallet Shook

After weighing each oven-dry specimen, its volume was determined by using the VPI&SU Mercury Volumeter (7, 25). The specific gravity of the pallet shook used was determined on the basis of oven-dry weight and volume of the samples.

Major Tests

1) Deckboard-Stringer Joints

Deckboard-stringer joints were assembled and tested to provide basic information on their performance.

The static deckboard-stringer separation resistance was determined six weeks after the assembly of the decuple red-oak joints with the four nails under investigation, with a single nail per joint. This was accomplished by holding the stringer in a static position and applying a normal force to the deckboard in the axial direction of the nail at a constant rate of motion of 0.100 inches per minute of the movable crosshead of a 3000-lb. capacity Tinius Olsen Electomatic testing machine. Whenever a head pull-through failure occurred, the fastener was subsequently tested by gripping the protruding nail shank and determining the axial withdrawal resistance of the nail.

The static deckboard-stringer shear resistance was determined in a similar manner with similar joints by holding the stringer in a static position and applying an axial force in the plane and parallel with the grain of the deckboard perpendicular to the nail axis and the grain of the stringer.

The ultimate test load and the mode of failure were observed and recorded for the eighty joints tested.

2) Pallets

Whole pallets were tested since the required information cannot be obtained in any other way.

The following tests were performed in sequence, as shown in Figs. 4a to 4f, on each of the forty pallets of conventional and improved designs, assembled with the four nails under investigation.

a) Initial Pallet Stiffness as Determined by Static Load-Deflection Test

The basic test procedure is described in American National Standard 1977, ANSI-MH 1.4.1 - 8.3 -- Combined Deckboard, Stringer, and Pallet Stiffness and Strength Test (3).

This test procedure was used to determine the relative stiffness of the deckboards, stringers, and complete pallets supported at the four pallet corners and loaded at the pallet center. The test frame has four 2" x 2" bearing plates supporting the four pallet corners, a 12" x 14" x $\frac{1}{2}$(0.56)" steel plate with a spherical loading device, and five linear position transducers allowing deflection recordings in one thousandth of an inch up to a maximum of 6" (Waters Manufacturing, Wayland, Massachusetts 01778). The sensors were located at the midpoints of the pallet sides and ends and directly below the pallet center. In order to provide sufficient space for the installation of the sensors, the wings of the top center deckboards of the pallets of improved design had to be sawed off prior to the performance of the initial stiffness tests.

In order to ascertain that the loading was uniform throughout the testing and to be able to observe any creep, the load was applied with a computer-controlled motorized 6000-lb. capacity pump in increments of 200 lb., with each step load maintained automatically for a period of two minutes, up to a load of 2000 lb., when the test was terminated.

The average load-deflection curves for the pallet sides and the pallet ends as well as the load-deflection curve for the pallet center were automatically plotted during the progress of the test. The initial and final deformations at every load step provided the information for the plot.

b) Pallet Rigidity as Determined by Impact Free-Fall Cornerwise Drop Test

The test procedure is described in American National Standard 1977, ANSI-MH 1.4.1 - 4.2 -- Corner Drop of Vertically Suspended Pallet (1).

The drop test simulates impact racking forces imposed by dropping the pallet onto one of its four corners during pallet handling. Such dropping may occur during unstacking of loaded and unloaded pallets as well as during their removal. The test was performed by dropping the pallet six times from a height of $33\frac{1}{2}$" above the level surface of a heavy concrete mass onto one of the pallet corners.

The unloaded pallet was suspended at one corner in such a manner that the diagonal across the pallet face from the suspended corner to the impact corner was vertical. The pallet was allowed to fall freely from its original position onto the impact surface. After the impact had occurred, the pallet was restrained to prevent a secondary fall.

Prior to the first drop and after each subsequent drop, the lengths of each of the two top-deck and two bottom-deck diagonals were measured with a graduated scale, measuring one hundredth of an inch, and recorded. The test was terminated after dropping the pallet for the sixth time.

c) Resistance of Pallet to Forces Exerted by Forklift Truck as Determined by Impact Incline Deckboard-Stringer Separation Test

The impact incline test is described in American National Standard 1977, ANSI-MH 1.4.1 - 5.6 -- Incline Impact Deckboard-Stringer Separation Test (2).

The purpose of this test is to simulate the forces imposed by the forks and fork heels of a lift truck, when they strike the top leading-edge deckboard during and upon termination of fork entry. The test is performed to determine the resistance to damage of the pallet's top leading-edge deckboard and its leading edge as well as the resistance of the top leading-edge deckboard to its separation from the stringers as a result of forces applied by the lift truck.

The pallets were tested in an apparatus which is described in ASTM Standard

D880-73 (5) and modified by affixing forks as shown in ANSI MH 1.4.1 - 5.6.2 (2).

The dolly of the tester was raised up the incline to leave a 30" space between the dolly front and the fork heel. The pallet was placed on the dolly in such a way that the forward leading edge of the pallet was parallel with the forward leading edge of the dolly and overhanging it by two inches. Furthermore, the bottom leading-edge deckboard of the pallet next to the "C" sensor, shown in Fig. 1, during the initial static stiffness test was placed in such a way as to become the top leading-edge deckboard which was to receive the impact. A 410-lb. weight box was placed onto the pallet in such a manner that the trailing upper edge of the 40"-wide and 32"-long box was flush with the trailing upper edge of the pallet and the kinetic energy of the box was transferred at impact directly to the stringers.

Failure was considered to have occurred when the forks had destroyed the leading edge of the pallet and/or when the top leading-edge deckboard was torn at least from two stringers. At that time, the test was terminated.

Immediately after test termination, the tested pallet was repaired. This was accomplished by completely separating the partially separated leading-edge deckboard of the conventional pallet and the partially separated leading-edge deckboard and its back-up deckboard of the improved pallet from the three stringers and by renailing these deckboards to the three stringers. Under given conditions, one or both of the damaged deckboards were replaced and fastened to the three stringers with the appropriate new nails. The exceptions were pallets Ba1, Bb1, and Bc1. The leading-edge deckboard of pallet Ba1 was renailed with eight nails and the follow-up deckboard was renailed with three nails, since the two deckboards were not removed completely from the three stringers. Similarly, the follow-up deckboard of pallet Bb1 was renailed with six nails and the follow-up deckboard of pallet Bc1 was not removed from the three stringers, hence, was not renailed.

d) Follow-Up Pallet Stiffness as Determined by Follow-Up Static Load-Deflection Test

The purpose of this test is to determine whether the impact free-fall cornerwise drop test and the subsequent incline impact deckboard-stringer separation test influenced the stiffness of the pallet after its repair. Any difference between the initial and the follow-up stiffness test values can be attributed to loss in stiffness as a result of a simulated field service by the pallet and the effect of the repair.

This test was performed with the pallet located in the test rack in the same way as during the initial stiffness test. Furthermore, the follow-up test was performed in the same manner as the initial stiffness test, except that the test was terminated only after a load of 6000 lb. had been applied.

e) Pallet Load-Carrying Capacity as Determined by Static Load-Deflection Test

The purpose of this test is to determine the pallet's ultimate load-carrying capacity in the same manner as the pallet's stiffness, except that the first 6000-lb. load was applied in a single step and that each subsequent 200-lb. load was applied only after a two-minute constant-load interval. Furthermore, a 20,000-lb. capacity hand-operated pump was used for loading instead of the computer-controlled motorized pump used for the determination of the pallet stiffness. During this test, no deflection readings were recorded. The type of failure was observed and recorded.

RESULTS AND DISCUSSION

Deckboard-Stringer Joints

1) Static Deckboard-Stringer Separation Resistance in Direction of Nail Axis

The detailed static ultimate nail-withdrawal and deckboard-stringer separation-resistance data are presented in Appendix Table 17a. The average nail-withdrawal values are summarized in Table 7.

In comparison with the withdrawal resistance of the $2\frac{1}{2}$" helically fluted nail (a), the $2\frac{1}{2}$" helically threaded nail (b) performed 44% better and the $2\frac{1}{2}$" and 3" helically threaded nails (c and d) performed 61% and 111%, respectively, better in resisting axial withdrawal forces.

The efficiency of the nails, on a uniform weight basis, indicates that, in comparison with the efficiency of the $2\frac{1}{2}$" helically fluted nail (a), the $2\frac{1}{2}$" helically threaded nail (b) was 56% more efficient, and the $2\frac{1}{2}$" and 3" helically threaded nails (c and d) were 93% and 109%, respectively, more efficient in resisting axial withdrawal forces.

These findings are presented graphically in the bar diagrams of Fig. 5. The three threaded nails performed considerably better than the fluted nail. The $2\frac{1}{2}$" and 3" threaded nails (c and d) performed similarly on the basis of uniform shank penetration into the nailing member.

The helically threaded nail (b) could, of course, have been provided with a considerably more effective thread, which would have increased its holding power and the energy required for driving. Increasing its length and head diameter would also have increased its effectiveness.

2) Static Deckboard-Stringer Shear Resistance in Direction Perpendicular to Nail Axis

The detailed static ultimate deckboard-stringer shear-resistance data are presented in Appendix Table 17b. The average shear values are also summarized in Table 7.

In comparison with the shear resistance of the deckboard-stringer joint assembled with the $2\frac{1}{2}$" helically fluted nail (a), that of the joint assembled with the $2\frac{1}{2}$" helically threaded nail (b) was 28% higher and that of the joints assembled with the

$2\frac{1}{2}$" and 3" helically threaded nails (c and d) was 35% and 70%, respectively, higher.

The efficiency of the nails, on a uniform weight basis, indicates that, in comparison with the efficiency of the $2\frac{1}{2}$" helically fluted nail (a), the $2\frac{1}{2}$" helically threaded nail (b) is 37% more efficient and the $2\frac{1}{2}$" and 3" helically threaded nails (c and d) are 61% and 69%, respectively, more efficient in resisting shear forces.

These findings are presented graphically in the bar diagram of Fig. 6. As in withdrawal, the three threaded nails performed considerably better than the fluted nail, with the 3" nail providing higher shear resistance than the $2\frac{1}{2}$" nail of same design.

Pallets

1) Initial Pallet Stiffness as Determined by Static Load-Deflection Test

The detailed load-deflection data are presented in Appendix Tables 18a and 18b. The average data are given in Appendix Table 19. The average load-deflection curves are plotted in Fig. 7.

During these tests, no failures were observed.

The average cumulative load-deflection values, throughout the test range from 0 to 2000 lb., for the quintuplicate pallets of conventional and improved designs, assembled with the four types of nails under study, are presented in Table 8.

The material for the pallets of improved design came from two lots of red oak. An examination of the pallet weights revealed a significant difference between the weights of the pallets assembled with the lumber of the two lots. In order to eliminate the influence of the differences in pallet weights on pallet stiffness, all average cumulative deflection values for the seven pallets of improved design assembled with lumber from the second lot (Nos. Bc4, Bc5, and Bd1 to 5) were adjusted, as is shown in Appendix Table 20, for differences in pallet weights according to D (in in.) = 46.23 - 0.198 W (in lb.). This least-square line regression relationship between pallet weight and cumulative deflectionvalues is indicated in Fig. 8. The relatively high value of the correlation coefficient justified this adjustment.

The weights of the 13 remaining pallets of improved design and of the 20 pallets of conventional design, having been assembled with lumber from the first lot, had similar narrow ranges of weight distribution, as is shown in Fig. 8. An adjustment of the cumulative deflection values for these pallets had no justification. (Likewise, no adjustments were justified for the test values emanating from the rigidity, deck-board-stringer separation resistance, follow-up stiffness, and ultimate load-carrying capacity tests on the pallets of both conventional and improved designs.)

In the light of the data presented, the use of the four types of nails was of no influence on the initial static stiffness of the pallets of conventional and improved designs. On the other hand, the 12% heavier pallets of improved design proved to be, on the average, 15% stiffer than those of conventional design.

The average deflections, in 1/1000 inch, of all pallets of conventional and improved designs per 100 lb. of static load applied at the pallet center, according to the deflections observed up to a test load of 2000 lb., are presented in Table 9. These findings are shown graphically in the bar diagram of Fig. 9.

In the light of these observations on quintuplicate pallets of conventional and improved designs, assembled with the four nails under scrutiny, the average deflections of the centers of the pallet sides per 100 lb. of load amounted to 0.007"; those of the centers of the pallet ends amounted to 0.031" and 0.027", respectively; and those of the pallet centers amounted to 0.035" and 0.031", respectively.

A statistical analysis of the adjusted initial static stiffness data is presented in Appendix Table 21. This analysis confirmed the conclusions drawn from the previous evaluation of the test data, as can be observed from the following statements:

1) The initial static stiffness of the pallets of improved design, being 15% higher than that of the pallets of conventional design, was significantly different at the 5% level of significance from that of the pallets of conventional design.
2) The nails did not influence the pallet performance.
3) No interaction existed between nails and designs.

2) Pallet Rigidity as Determined by Impact Free-Fall Cornerwise Drop Test

The detailed load-deformation data are presented in Appendix Tables 22a and 22b. The average changes in length of the diagonals for each pallet are plotted against the number of free falls in Fig. 10.

The grand-average changes in length as well as the percentile distortions, that is, the percentages of distortions based on the original dimensions of the pallets assembled with each type of nail, are given in Appendix Table 23 and presented graphically in Fig. 11.

During these tests, all pallets performed without major failures. However, three pallets of conventional design and two pallets of improved design were damaged by splitting of the leading-edge deckboards. Furthermore, some of the $2\frac{1}{2}$" and 3" threaded nails (c and d) backed out or failed, especially in pallets of conventional design.

Unexpectedly, the $2\frac{1}{2}$" threaded non-hardened Brazilian nail (b) performed better than the $2\frac{1}{2}$" threaded hardened-steel nail (c) used in the U.S.A. This may be explained by the lower flexibility of the latter nail in comparison with that of the former nail. The relatively large number of failures of the $2\frac{1}{2}$" hardened-steel nail (c) during the performance of the free-fall drop tests is one indication of this finding.

The average percentile distortion of the quintuplicate pallets of conventional and improved designs after the sixth drop and the cumulative average length changes of the pallet diagonals up to and including the sixth drop are presented in Table 10. These data are presented graphically in the bar diagrams of Fig. 12.

Based on these data, the pallets of both conventional and improved designs assembled with the $2\frac{1}{2}$" threaded nails (c) were most rigid; those assembled with the 3" threaded nails (d) were second best; those assembled with the $2\frac{1}{2}$" threaded nails (b) were the third best; and those assembled with the $2\frac{1}{2}$" fluted nails (a) were least rigid.

Furthermore, in comparison with the pallets of conventional design assembled with the four different nails, the corresponding pallets of improved design were 15%, 16%, 27%, and 24% more rigid.

The test findings indicate that the pallets of conventional design assembled with the $2\frac{1}{2}$" fluted nails (a) were less rigid than all other pallets. Specifically, the pallets of conventional design assembled with the $2\frac{1}{2}$" threaded nails (b) and $2\frac{1}{2}$" and 3" threaded nails (c and d) were 8%, 46%, and 42%, respectively, more rigid and the pallets of improved design assembled with the $2\frac{1}{2}$" fluted nails (a), $2\frac{1}{2}$" threaded nails (b), and $2\frac{1}{2}$" and 3" threaded nails (c and d) were 16%, 24%, 60%, and 55%, respectively, more rigid.

An analysis of variance performed on the sums of average changes in the lengths of the diagonals is shown in Appendix Table 24. It is evident that the rigidity of the pallets of both designs as well as the rigidity of the pallets assembled with the four different nails were significantly different at the 5% level. On the other hand, there was no interaction between the four different nails and the two different designs at the 5% level of significance.

The Duncan's test for equality of means, applied to the sums of average changes in the lengths of the diagonals, in inches (see Table 10), revealed that all the means were significantly different at the 5% level, except for the rigidity of pallets of conventional design assembled with the $2\frac{1}{2}$" and 3" threaded nails (c and d). Thus, the highest rigidity was obtained for the pallets of improved design assembled with the $2\frac{1}{2}$" threaded nail (c), which was 60% higher than the rigidity of the pallets of conventional design assembled with the Brazilian nail (a).

3) Resistance of Pallets to Forces Exerted by Forklift Truck as Determined by Impact Incline Deckboard-Stringer Separation Test

The detailed impact incline deckboard-stringer separation test data are presented in Appendix Tables 25 and 26. The numbers of runs and hits of each pallet are shown in the bar diagram of Fig. 13. The averages and grand-averages of the numbers of runs are presented in Fig. 14.

Prior to testing, the leading-edge deckboard of pallet Bc2 had a 12" crack and its back-up board had a 20" crack. The leading-edge deckboard of pallet Ba5 had a 14" crack. The leading-edge deckboard and the back-up board of pallet Bd3 had 2" splits. The leading-edge deckboard of pallet Bd4 was cupped.

During the tests, the leading-edge deckboards of 38 of the 40 pallets were torn off two stringers. Only in two instances, pallet Ad5 of conventional design and pallet Bb3 of improved design had their leading-edge deckboards destroyed by the forks.

Additional splits were observed during the testing of pallets of both designs. In pallets of conventional design, splits occurred at the beginning of the test and, in the pallets of improved design, splits occurred only after the leading-edge deckboard and the back-up deckboard had been torn off the center stringer just prior to test termination.

The major test findings are presented in Table 11.

Based on these test results, the pallets of both conventional and improved designs, assembled with 3" threaded nails (d) proved to be most resistant to impact deckboard-stringer separation; those assembled with $2\frac{1}{2}$" threaded nails (b) were the second best; those assembled with $2\frac{1}{2}$" threaded nails (c) were the third best; and those assembled with $2\frac{1}{2}$" fluted nails (a) were least resistant to impact deckboard-stringer separation forces.

In a comparison of the performance of all 20 pallets of conventional design, the corresponding pallets of improved design were, on the average, 23, 17, 17, and 6 times, respectively, more effective.

With the pallets of conventional design assembled with $2\frac{1}{2}$" fluted nails (a) serving as basis of comparison, the pallets of conventional design assembled with $2\frac{1}{2}$" threaded nails (b) and $2\frac{1}{2}$" and 3" threaded nails (c and d) appear to have been equally effective, with the average test values having been only 3, 3, and 11 times, respectively, higher. Furthermore, the pallets of improved design assembled with $2\frac{1}{2}$" fluted nails (a), $2\frac{1}{2}$" threaded nails (b), $2\frac{1}{2}$" and 3" threaded nails (c and d) were, on the average, 23, 52, 43, and 66 times, respectively, more effective than the pallets serving as basis of comparison.

Whereas the difference in performance of pallets of conventional and improved designs was relatively small, however, significant during the initial stiffness and rigidity tests on these pallets, the difference during the deckboard-stringer separation tests was very large and highly significant from the practical viewpoint.

According to an analysis of variance and Duncan's test, presented in Appendix Table 27, the above observations were confirmed, as is shown by the following statements:

1) The two pallet designs differed in performance at the 5% significance level.
2) The average numbers of runs were different for pallets assembled with the four different nails at the 5% significance level.
3) Some interaction existed between the pallets of both designs assembled with the four types of nails at the 5% significance level; but not at the 1% significance level.
4) According to Duncan's test, no significant difference was shown at the 5% level among the pallets of conventional design assembled with the four different nails. On the other hand, a significant difference was shown at the same level among the pallets of improved design assembled with the four different nails. Furthermore, the pallets of improved design assembled with the $2\frac{1}{2}$" threaded nail (b) used in Brazil and the 3" threaded nail (d) performed similarly and better than the other pallets of improved design. Also, the pallets of conventional design assembled with the 3" threaded nails (d) and the pallets of improved design assembled with the $2\frac{1}{2}$" fluted nails (a) performed in a similar manner. The same was observed for pallets of improved design assembled with the $2\frac{1}{2}$" threaded nails (b and c) used in South and North America.

Thus, according to the impact incline deckboard-stringer separation tests, pallets of conventional design assembled with the best (3" threaded) nail can replace pallets of improved design assembled with the poorest ($2\frac{1}{2}$" fluted) nail.

4) Follow-Up Pallet Stiffness as Determined by Follow-Up Static Load-Deflection Test

Detailed load-deflection data up to a test load of 6000 lb. --- obtained after the performance of the initial static stiffness test up to a concentrated load of 2000 lb., the rigidity test up to six free-fall drops, and the subsequent incline impact deckboard-stringer separation test, followed by pallet repair --- are presented in Appendix Tables 28 and 29. The average load-deflection curves are presented in Fig. 15.

Except in two cases, no failures were observed during these tests. The exceptions were pallet Ad3 with the center stringer broken at a knot and pallet Ad2 with one top deckboard completely separated from the center stringer.

The average cumulative load-deflection values throughout the test ranges from 0 to 2000 lb. and from 0 to 6000 lb. for the quintuplicate pallets of conventional and improved designs are presented in Table 12.

During the follow-up stiffness tests, the deflection of the pallets within the 0 to 2000-lb. test range was higher and, therefore, the stiffness of the pallets was lower than the corresponding values observed during the initial stiffness tests, as is indicated in Table 13.

The pallets of both conventional and improved designs appear to have been equally effective, with the average test values having been only 7% and 3%, respectively, lower than those during the initial stiffness despite the performance of the rigidity test, the incline impact deckboard-stringer separation test, and the pallet repair prior to the performance of the follow-up stiffness test.

The stringers of the pallets of improved design appear to have been as effective as those of conventional design during the initial static pallet stiffness tests, with the average test values being 5% stiffer. The stringers of the pallets of improved design were also equally effective as those of conventional design during the follow-up pallet stiffness tests, however, with the average test values being 6% lower.

Whereas the deckboards of the pallets of improved design were 16% stiffer during the initial static stiffness tests than those of conventional design, the deckboards of pallets of improved design were 18% stiffer during the follow-up stiffness tests within the same test range.

Furthermore, although the pallets of improved design were, on the basis of the deflection of the pallet sides, pallet ends, and pallet center, 15% stiffer during the initial static stiffness tests than the pallets of conventional design, the pallets of improved design were 16% stiffer during the follow-up stiffness tests within the same test range.

In the light of these findings, the stiffness of the stevedore pallets of conventional and improved designs were not affected to any great extent by the performance of the rigidity test and incline impact deckboard-stringer separation test prior to the performance of the follow-up stiffness test and may have been compensated for by the limited pallet repair prior to the performance of the follow-up stiffness test.

The analysis of variance of the data for the follow-up static load-deflection tests up to a load of 2000 lb. is presented in Appendix Table 20. On the basis of the data presented in this Table, the following conclusions could be advanced:

1) The two pallet designs differed significantly in performance at the 5% significance level, confirming that the reported 15% and 16% increased stiffness of pallets of improved design versus that of pallets of conventional design is indeed a difference.
2) The effectiveness of the four nails was significantly different at the 5% significance level. This can be explained by the fact that, during the free-fall drop test and the incline impact test, some of the nails broke, a fact which was of influence on the follow-up stiffness of the pallets.
3) No interaction existed between nails and design at the 5% significance level.

5) Pallet Load-Carrying Capacity as Determined by Static Load-Deflection Test

The detailed static ultimate load-carrying capacity of the tested pallets, when supported at their four corners and loaded at the center, is presented in Appendix Table 31.

The average values for the ultimate test loads for the quintuplicate pallets are shown in Table 14.

The test on the static ultimate load-carrying capacity of the pallets was terminated when a major failure occurred or when the pallet could no longer support the test load reached previously.

For almost all the pallets tested, the ultimate load was reached when two or more top or bottom deckboards broke. The exceptions were three pallets of conventional as well as two of improved designs (Ac2, Aa3, Ad2, Bc1, and Bc2), where the ultimate loads were limited by failure of the center stringer.

The pallets of improved design could, on the average, support an approximately 20% higher ultimate load than the pallets of conventional design, if supported at their four corners and loaded at the center.

The analysis of variance, presented in Appendix Table 32, indicated that

1) the static ultimate load-carrying capacity of the pallets of improved design was different at the 5% significance level from that of the pallets of conventional design;
2) the four nails did not influence the pallet effectiveness at the 5% significance level;
3) no interaction existed between nails and design at the 5% significance level.

When the ultimate test load per pallet was correlated with the pallet weight, the average specific ultimate test load supported by the pallet of improved design was only 7% higher than that of the pallet of conventional design. This observation confirmed the previous experience that density of the pallet shook was of lesser importance on the ultimate load-carrying capacity of a pallet than the shook's knots, grain deviations near knots, cross-grain, etc. (24).

LIMITATION AND APPLICATION OF DATA

Since pallets of designs different from those studied may perform in a significantly different manner, the data presented need to be limited to the two designs investigated.

The pallets tested during this study were assembled with wood of one species group, red oak, which is one of the most common species groups used for pallet assembly in the U.S.A. The performance of red oak is, however, not representative of many of the other wood species used for pallet assembly.

Four nails were selected for the assembly of the pallets under scrutiny, in order to obtain data which provide information on the influence of these nails on pallet performance. The use of similar nails from different production lots and of different nails may result in different pallet performance.

In the light of the above, the application of the presented data to pallets of different designs, made of different woods, and/or assembled with different nails is limited.

The test procedures used in this study yield data which are limited in their application. Some of these test procedures simulate certain field conditions, while others are specifically designed to yield representative data of a fully comparative nature, which are applicable only to given field conditions and not necessarily to others. Therefore, the findings must be used with discretion and should not be considered applicable to any and all situations encountered.

The data obtained during this study provide information which makes it possible to demonstrate how and to what extent stevedore pallets of conventional design and construction may be improved. This is of importance in the light of failures of innumerous stevedore pallets in use or their performance which is so often below justified expectations. Thus, it is demonstrated how and to what extent conventional stevedore pallets can be improved by the introduction of a basic design change and by the use of improved fasteners. Both improvements may, under given conditions, be incorporated to advantage also in pallets of other designs and constructions. Yet, the extent of a given improvement may be different in magnitude and nature under different environmental conditions.

Certain improvements may be achieved by using, for instance, four stringers instead of three, with the two inner stringers possibly of smaller cross-section than the conventional center stringer. Such a step may make it feasible to reduce the thickness of the deckboards without reducing the pallet performance below expectations, thereby saving lumber at the cost of the use of an increased number of deckboard-stringer fasteners and of labor if the nails are hammer- or gun-driven and not machine-driven. In such a design change, the presented data may be indicative of what might be expected, provided full consideration is given to the nature of the proposed change or changes in design and construction.

SUMMARY

1) The tested pallets of both conventional and improved designs were heavy. Their average assembly weights amounted to 217 lb., with a standard deviation of 2.8 lb., in the case of pallets of conventional design; and to 245 lb., with a standard deviation of 4.6 lb., in the case of pallets of improved design. The average weights of these pallets of conventional and improved designs after the performance of all tests were 138 lb., with a standard deviation of 2.2 lb., and 156 lb., with a standard deviation of 3.0 lb., respectively. Consequently, the pallets of conventional and improved designs lost, on the average, 36% of their assembly weight during seasoning.

2) The testing of the deckboard-stringer joints indicated that, both during the static deckboard-stringer separation-resistance test and during the static deckboard-stringer shear-resistance test, the 3" threaded hardened-steel nails (d) performed best, the $2\frac{1}{2}$" threaded hardened-steel nails (c) performed second best, the $2\frac{1}{2}$" threaded stiff-stock nails (b) performed third best, and the $2\frac{1}{2}$" fluted stiff-stock nails (a) offered the least resistance to separation and shear forces.

3) The testing of the two types of pallets revealed the following:
   a) The average initial stiffness of the 12% heavier pallets of improved design was 15% higher than that of the pallets of conventional design. Furthermore, the four different nails tested influenced the initial stiffness of the pallets of either design in the same manner.
   b) The testing of the two types of pallets for their rigidity indicated that those assembled with the $2\frac{1}{2}$" threaded nails (c) were the most rigid; those assembled with the 3" threaded nails (d) performed second best; those assembled with the $2\frac{1}{2}$" threaded nails (b) performed third best; and those assembled with the $2\frac{1}{2}$" fluted nails (a) were the least rigid. In addition, the pallets of conventional design assembled with the $2\frac{1}{2}$" fluted nails (a) were less rigid than all other pallets tested. Specifically, the pallets of conventional design assembled with the $2\frac{1}{2}$" threaded nails (b) and $2\frac{1}{2}$" and 3" threaded nails (c and d) were 8%, 46%, and 42%, respectively, more rigid, and the pallets of improved design assembled with the $2\frac{1}{2}$" fluted nails (a), $2\frac{1}{2}$" threaded nails (b), and $2\frac{1}{2}$" and 3" threaded nails (c and d) were 16%, 24%, 60%, and 55%, respectively, more rigid.

c) The testing of the pallets for their impact incline deckboard-stringer separation resistance revealed that the pallets of both conventional and improved designs assembled with 3" threaded nails (d) provided optimum resistance; those assembled with $2\frac{1}{2}$" threaded nails (b) were second best; those assembled with $2\frac{1}{2}$" threaded nails (c) were third best; and those assembled with $2\frac{1}{2}$" fluted nails (a) provided least resistance. Using the pallets of conventional design assembled with the $2\frac{1}{2}$" fluted nails (a) as the basis of comparison, the pallets of improved design assembled with the $2\frac{1}{2}$" fluted nails (a), $2\frac{1}{2}$" threaded nails (b), $2\frac{1}{2}$" and 3" threaded nails (c and d) were, on the average, 23, 52, 43, and 66 times, respectively, more effective.

d) The average follow-up static stiffness of the pallets of improved design was 16% higher than that of the pallets of conventional design within the 0 to 2000-lb. and 0 to 6000-lb. load ranges. In addition, the follow-up stiffness of the stevedore pallets of improved and conventional designs was not affected to any great extent by the performance of the rigidity test and the impact incline deckboard-stringer separation test prior to the performance of the follow-up stiffness test. Furthermore, the four different nails were of same influence on the performance of the pallets of both conventional and improved designs.

e) The average ultimate static load-carrying capacity of the pallets of improved design was 20% higher than that of the pallets of conventional design. During this test, the pallet performance was influenced in the same manner by the four nails tested.

Hence, based on all tests performed, the pallets of improved design were superior to those of conventional design. Based on the rigidity test, the pallets of improved design assembled with the $2\frac{1}{2}$" threaded hardened-steel nails (c) used in the U.S.A., were the best pallets and based on the deckboard-stringer separation test the pallets of improved design assembled with the 3" threaded hardened-steel nails (d) were better than all the pallets tested.

On the average, in comparison with the pallets of conventional design, the pallets of improved design were one-sixth stiffer during the initial and follow-up stiffness tests, one-fifth more rigid during the drop test, one-fifth stronger during the deflection test, and eleven times as strong in resisting deckboard-stringer separation.

The two hypotheses were fully substantiated that the pallets of improved design and the pallets assembled with improved nails would perform better than the pallets of conventional design assembled with the fluted nail commonly used in Brazil.

RECOMMENDATIONS

1) Since peroba and eucalyptus as well as mixed hardwoods from the Brazilian coastal rain forests are readily available in Brazil, comparative laboratory tests on improved pallets, assembled with these woods and Brazilian nails, would yield valuable information. The performance of comparative tests is recommended.

2) The Brazilian helically threaded nails (b) could be improved considerably by providing them with a less steep thread angle and with four, instead of three, improved thread flutes in the light of past experience covering the use of threaded nails in building construction and assembly. The effectiveness of these nails could also be improved if their length and head diameters were increased. To meet the MIBANT criteria adopted in the U.S.A. for pallet nails, those to be used for the assembly of stevedore pallets will have to be hardened-steel nails. This requirement is of special importance in the light of the large size and weight of the stevedore pallets. Therefore, it is recommended that preference be given to the use of such improved nails for the assembly of stevedore pallets.

3) It is desirable that comparative field tests on non-treated and preservatively treated stevedore pallets of improved design be conducted at the docks of Santos in the State of Sao Paulo, Brazil. A tentative outline of such field tests is presented in Table 15.

4) To reduce the weight of the improved stevedore pallets and to save lumber, it is suggested that the use be investigated of four, instead of three, stringers combined with the appropriate corresponding reduction in deckboard thickness, as justified on the basis of the following calculations:

   According to previous studies, the deflection of pallets supported along their sides and loaded at their center can be determined by the following equation:

$$d = ky \frac{W}{A} \frac{s^4}{h^3} \frac{1}{Eg} \qquad (27, 29)$$

   If similar pallets with three and four stringers are to serve the same purpose, and are to be equally stiff, that is, deflect the same amount under load, then

$$k_1 y \frac{W}{A} \frac{s^4}{h_1^3} \frac{1}{Eg} = k_2 y \frac{W}{A} \frac{s^4}{h_2^3} \frac{1}{Eg}$$

and $$k_1/h_1^3 = k_2/h_2^3$$

a) From the tables (29) presented for flush pallets assembled with hardened-steel nails,

$$k_1 = \frac{1.94}{32} \quad \text{and} \quad k_2 = \frac{1.25}{32}$$

If h_1 = 1.000", then the deckboard thickness, h_2 = 0.866".

b) From the tables (27) presented for flush pallets assembled with hardened-steel nails,

$$k_1 = 0.15225\ y^{-1} \text{ and } k_2 = 0.109375\ y^{-1}$$

If h_1 = 1.000", then the deckboard thickness, h_2 = 0.888".

Consequently, a three-stringer pallet with deckboards of 1" thickness can be replaced by a four-stringer pallet with deckboards of $\frac{7}{8}$" thickness, if the pallets are alike otherwise.

In the instance of pallets of improved design with four stringers (two outer $2\frac{3}{8}$" x 4" and two inner $1\frac{7}{8}$" x 4" stringers) and $\frac{7}{8}$" deckboards, the amount of lumber required is 5%, by weight and volume, less than that for pallets with three $2\frac{3}{8}$" x 4" stringers and 1" deckboards. On the other hand, the number of nails required for the four-stringer pallets (184 or 1.5 lb.) is 33% more than that for the three-stringer pallets (138 or 1.2 lb.). Despite this, the weight of the four-stringer pallets (233 lb. when green and 149 lb. when seasoned) should be approximately 5% less than that of the three-stringer pallets (245 lb. when green and 156 lb. when seasoned).

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FIGURES

1 - 15

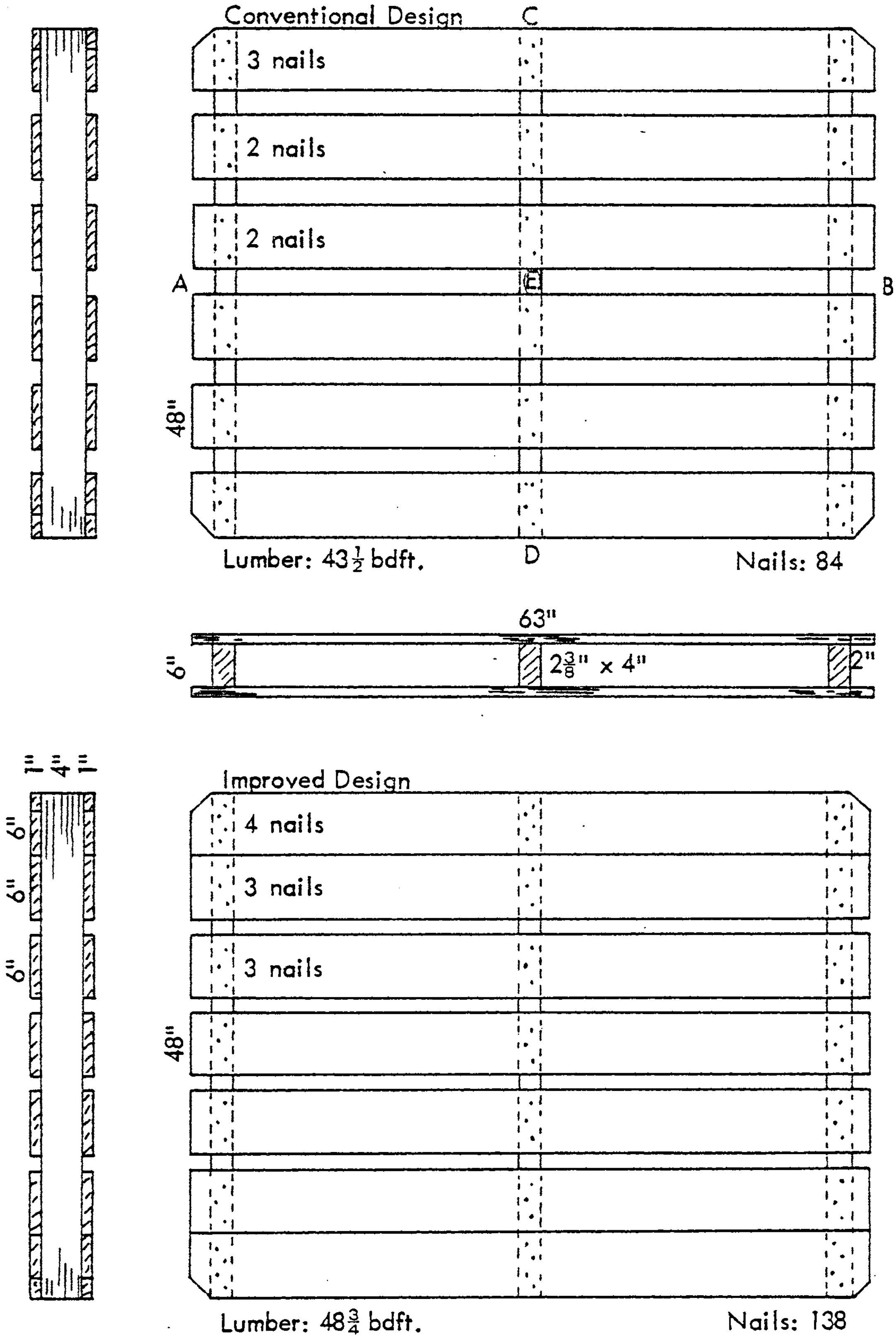


Fig. 1.- Stevedore pallets of conventional and improved designs, with locations of deflection sensors A, B, C, D, and E shown.

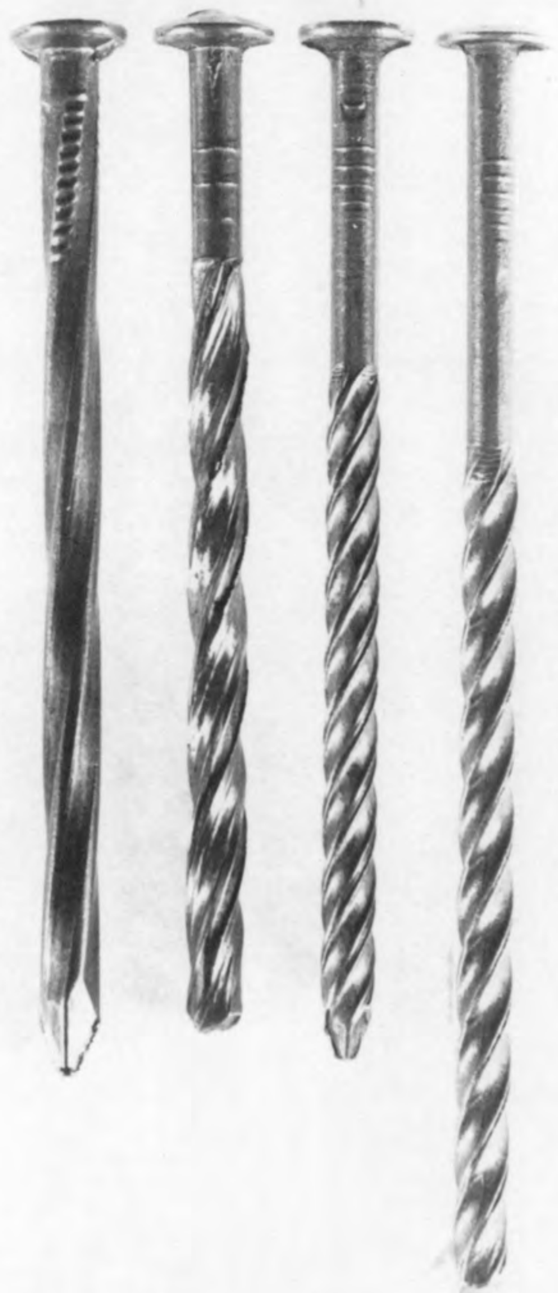
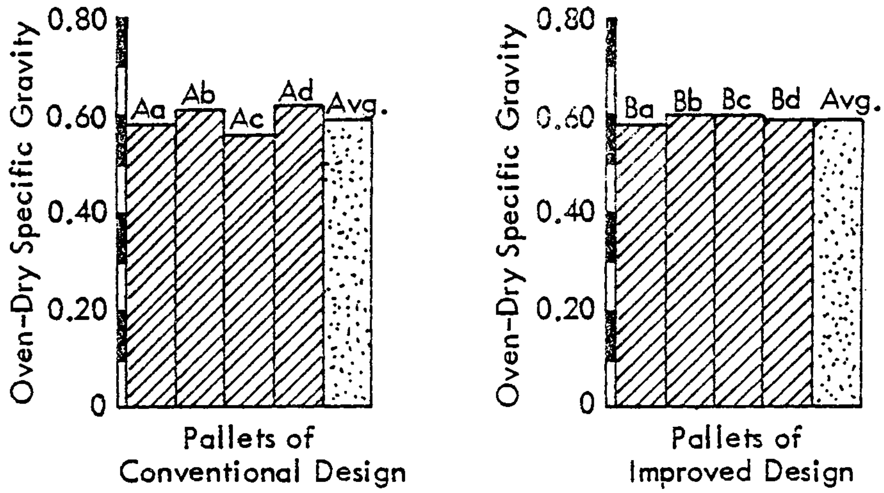


Fig. 2.- From left to right,
Nail (a) $2\frac{1}{2}$" x 0.143" Brazilian helically fluted nail (No. 2017);
Nail (b) $2\frac{1}{2}$" x 0.127" Brazilian helically threaded nail (No. 2018);
Nail (c) 2 9/16" x 0.119" helically threaded pallet nail (No. 1999A);
Nail (d) 3" x 0.120" helically threaded pallet nail (No. 1785).

Deckboards



Note.- A) Conventional design
B) Improved design
a) $2\frac{1}{2}$" fluted nail as used in Brazil
b) $2\frac{1}{2}$" threaded nail as used in Brazil
c) $2\frac{1}{2}$" threaded nail as used in U.S.A.
d) 3" threaded nail as used in U.S.A.

Stringers

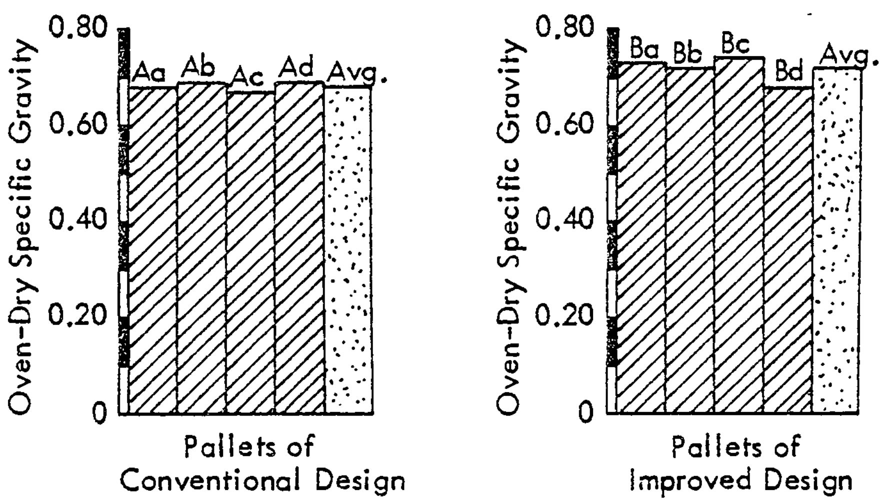


Fig.3.- Average oven-dry specific gravity of deckboards and stringers of pallets of conventional and improved designs.

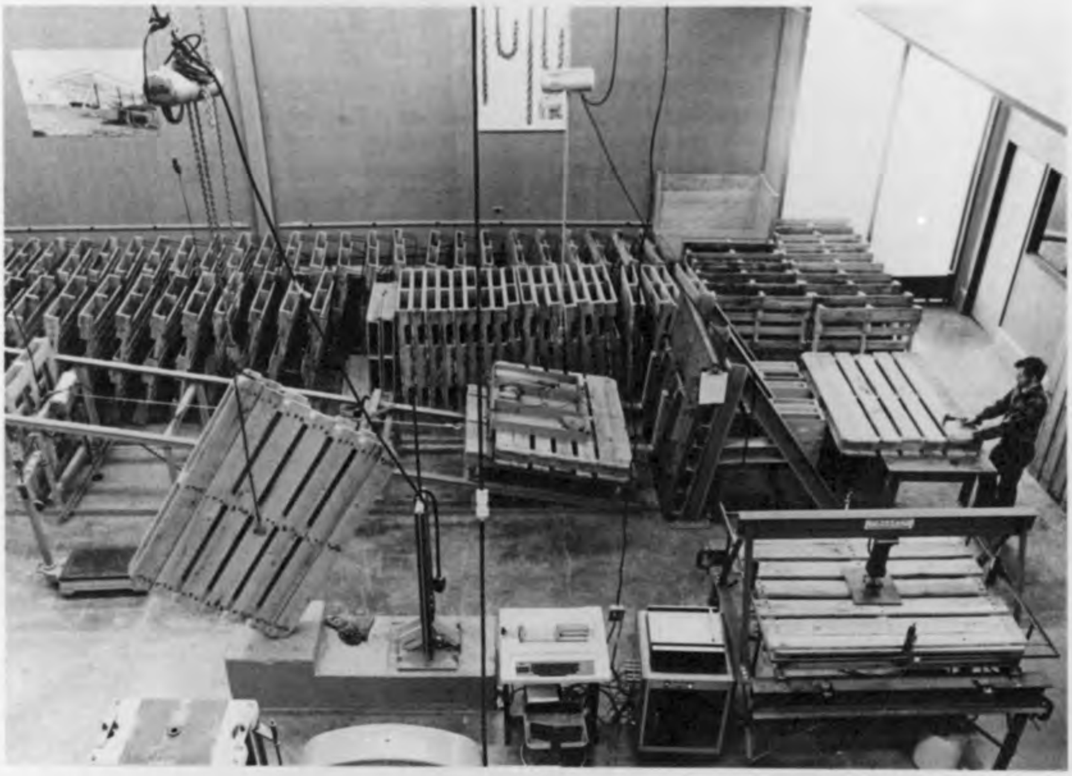


Fig. 4a.- Sequential tests on reversible, double-face, wing-type, two-way, three-stringer, nailed red-oak, 48" x 63", stevedore pallets:

a) Initial static stiffness as determined by computerized static load deflection test (bottom right);
b) Pallet rigidity as determined by impact free-fall cornerwise drop test (bottom left), followed by pallet weighing on platform scale (center left);
c) Resistance of pallet to forces exerted by forklift truck as determined by impact incline deck-board-stringer separation test (center), followed by pallet repair (center right);
d) Follow-up pallet stiffness as determined by computerized follow-up static load-deflection test (bottom right);
e) Pallet load-carrying capacity as determined by static load-deflection test (bottom right).

Note: The four pallets shown in the referenced locations in the foreground are pallets of improved design. The numerous pallets in the background are experimental red-oak pallets with steel-pin reinforced stringers provided with product-retention bars and the 20 pallets in the center background are experimental red-alder pallets.

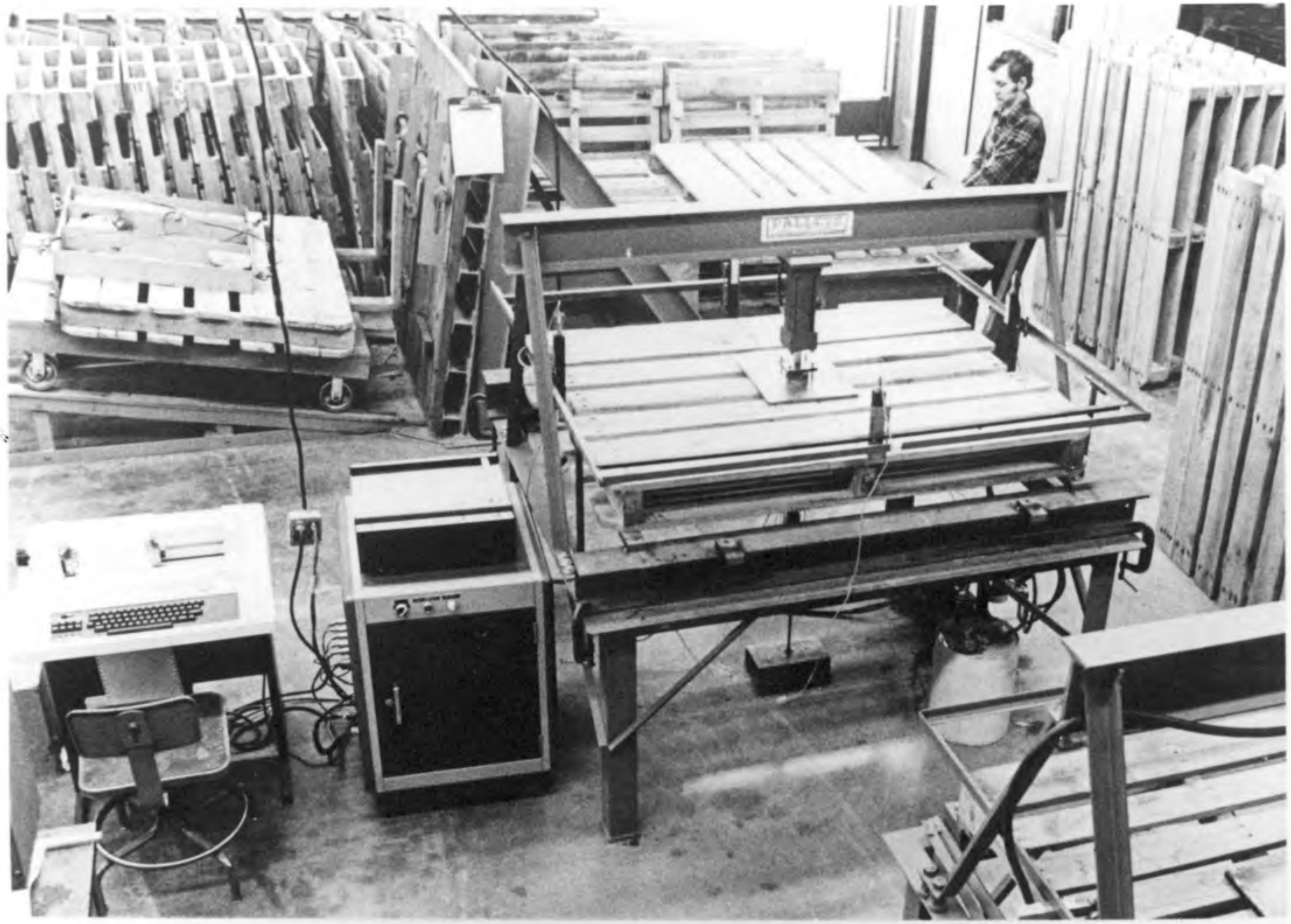


Fig. 4b.- Computerized static load-deflection tester, shown in foreground, with printer (at left), plotter (in center), and test rack with five sensors (at right).

Fig. 4c.- Impact free-fall cornerwise drop test on reversible, double-face, wing-type, two-way, three-stringer, nailed red-oak, stevedore pallet of improved design (held by Nilson Franco).

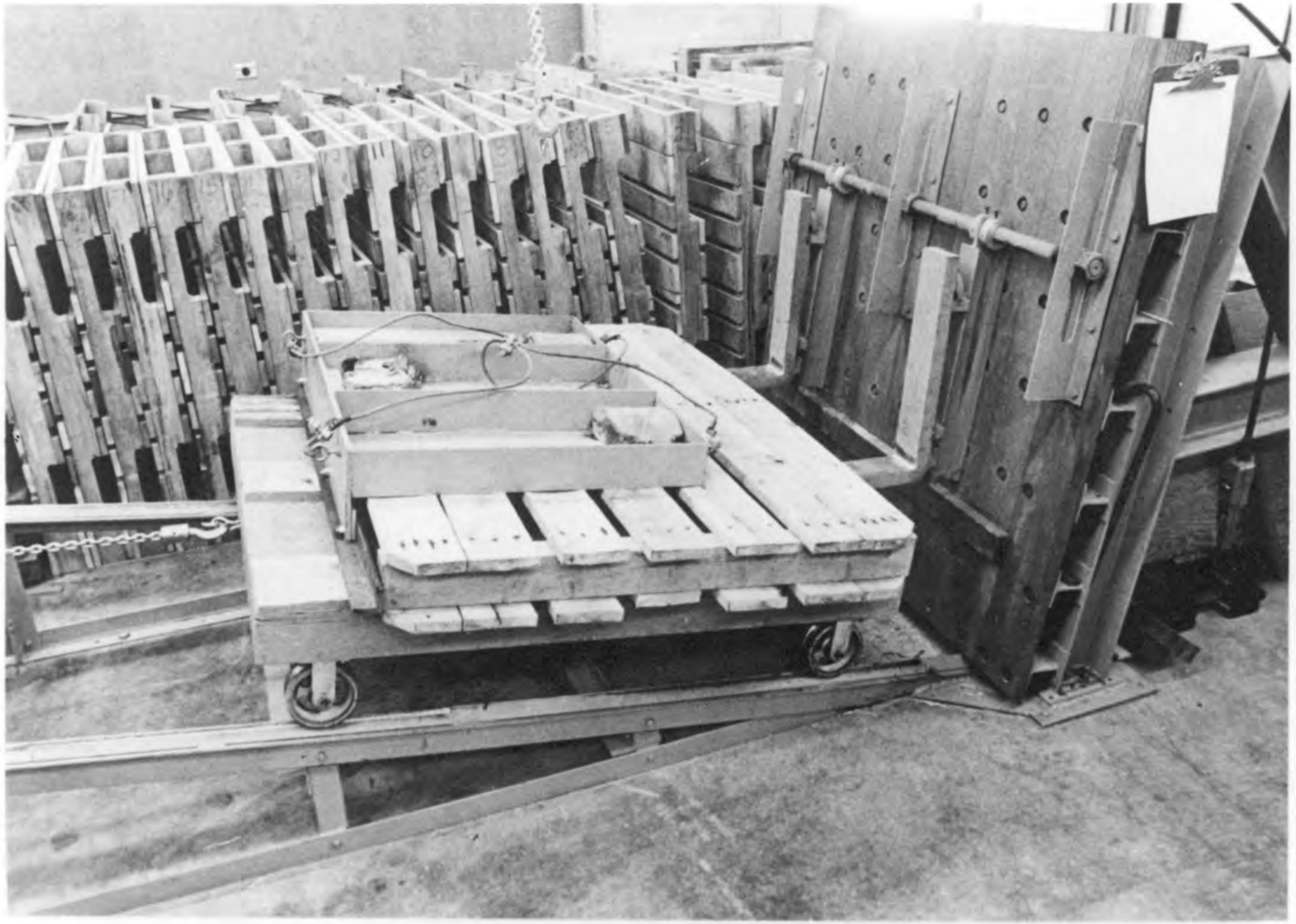


Fig. 4d.- Impact incline deckboard-stringer separation test on loaded, reversible, double-face, wing-type, two-way, three-stringer, nailed red-oak, stevedore pallet of improved design, placed on dolly, with stationary lift-truck forks in front of oak-faced steel rack.

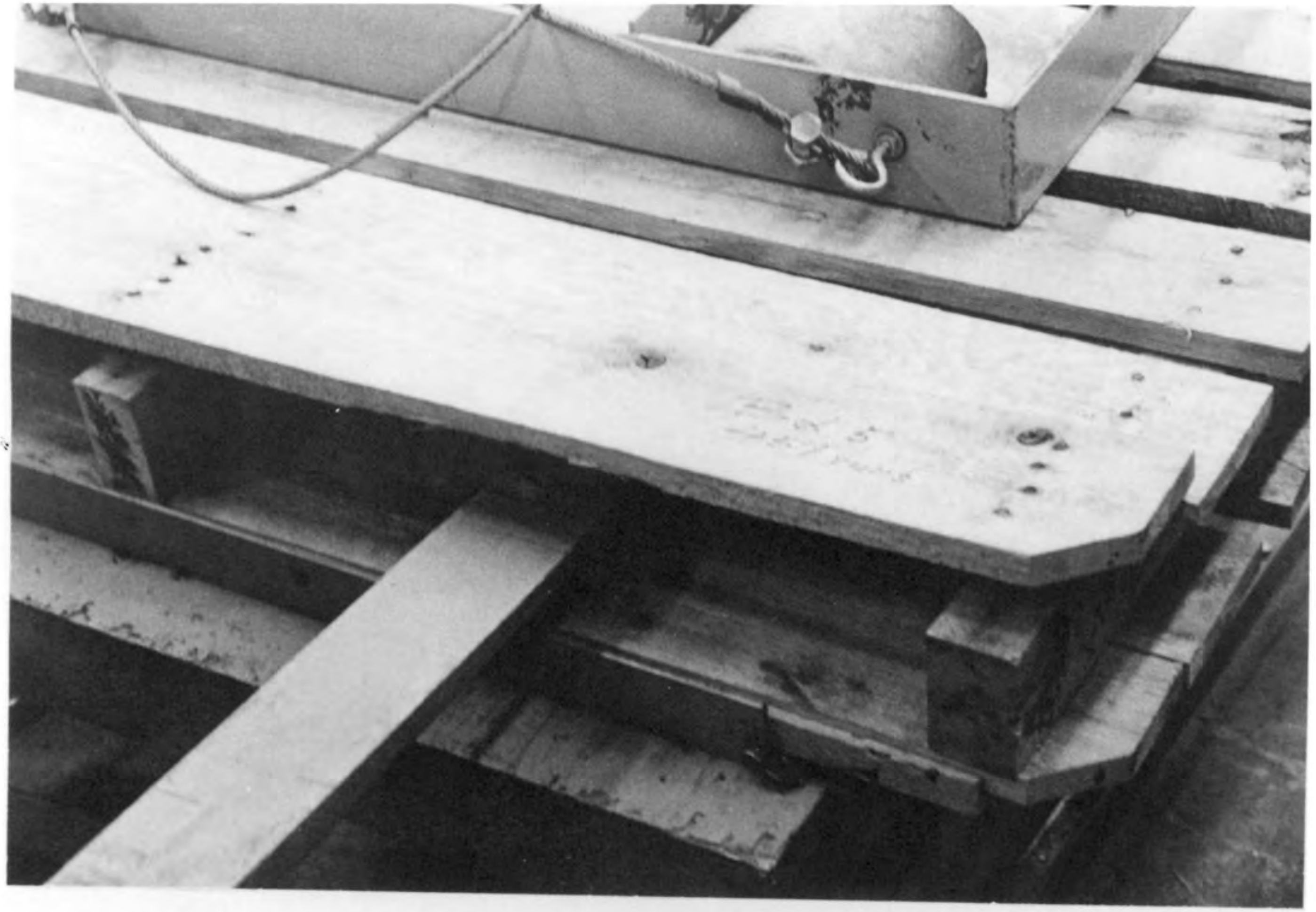


Fig. 4e.- Failure of stevedore pallet of improved design (Bd5), assembled with 3" x 0.120" helically threaded, hardened-steel pallet nails, after 451 runs during impact incline deckboard-stringer separation test, with impacted leading-edge deckboard fully separated from two stringers.

Fig. 4f.- Repair of pallet previously tested for initial static stiffness, impact rigidity, and impact resistance to forces exerted by forklift truck, when front top leading-edge deckboard was pried off stringers (renailed by James W. Akers).

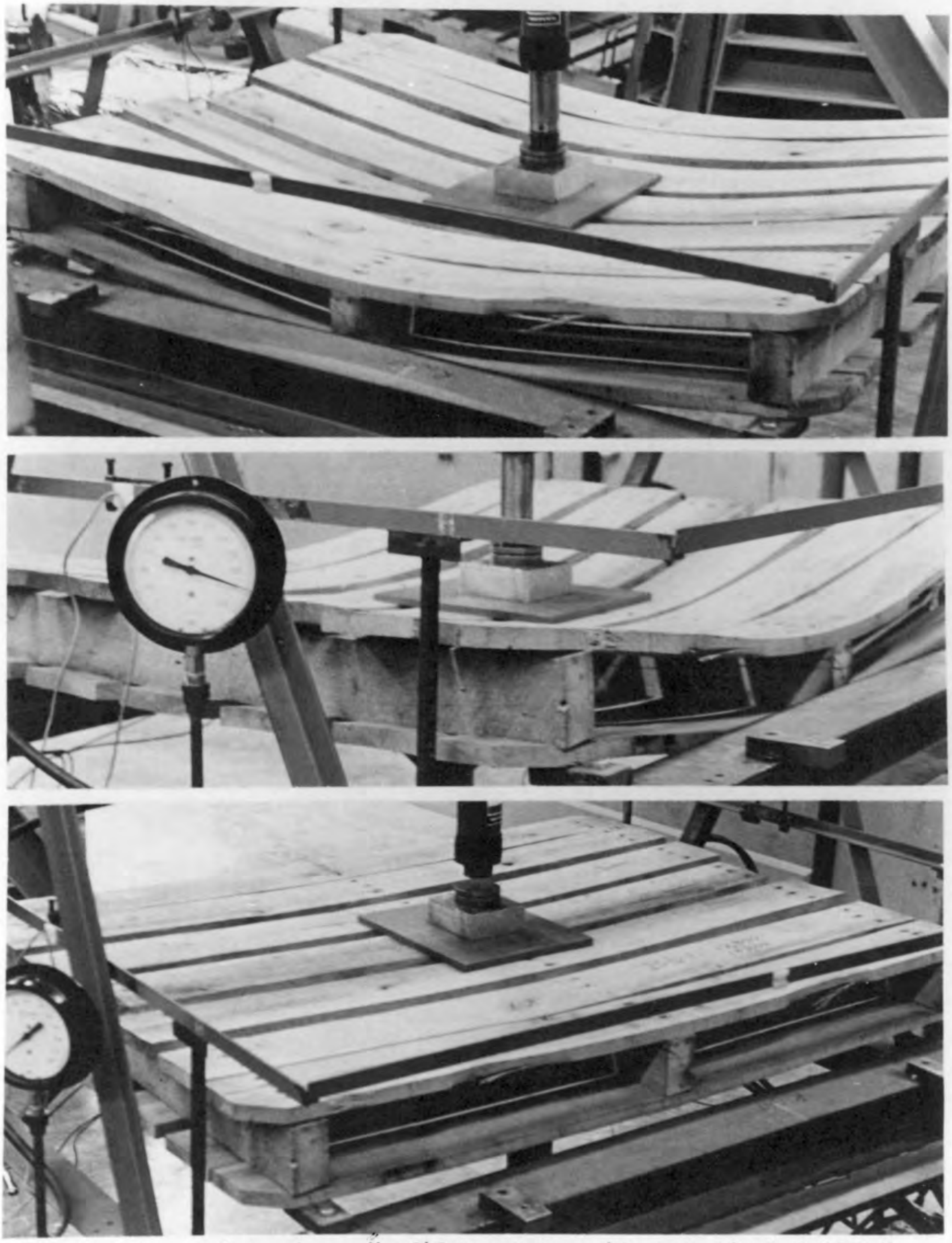


Fig. 4g.- Improved stevedore pallet Bb1 in test rig at ultimate test load of 13800 lb. (top and center) and after release of this load (bottom).

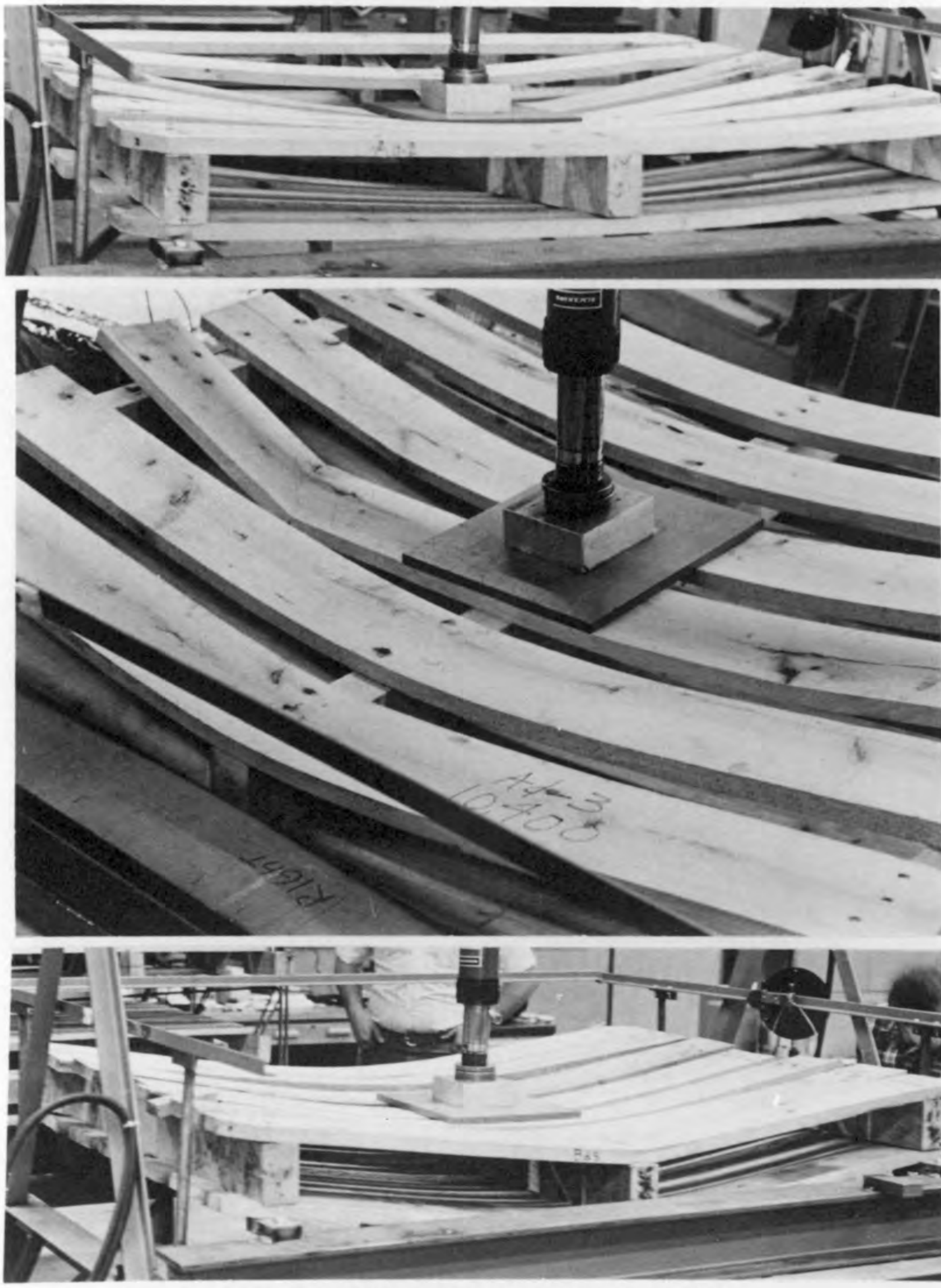


Fig. 4h.- Failures of stevedore pallets in test rig at ultimate test loads:

Top, conventional pallet Aa2 at 8800 lb., with two top deckboards separated from broken center stringer.

Center, conventional pallet Ad3 at 10400 lb., with near-center top deckboard broken at knots.

Bottom, improved pallet Bd5 at 12000 lb., with compression failure of front top leading edge deckboard and minor failure of inner top deckboard at knot near end.

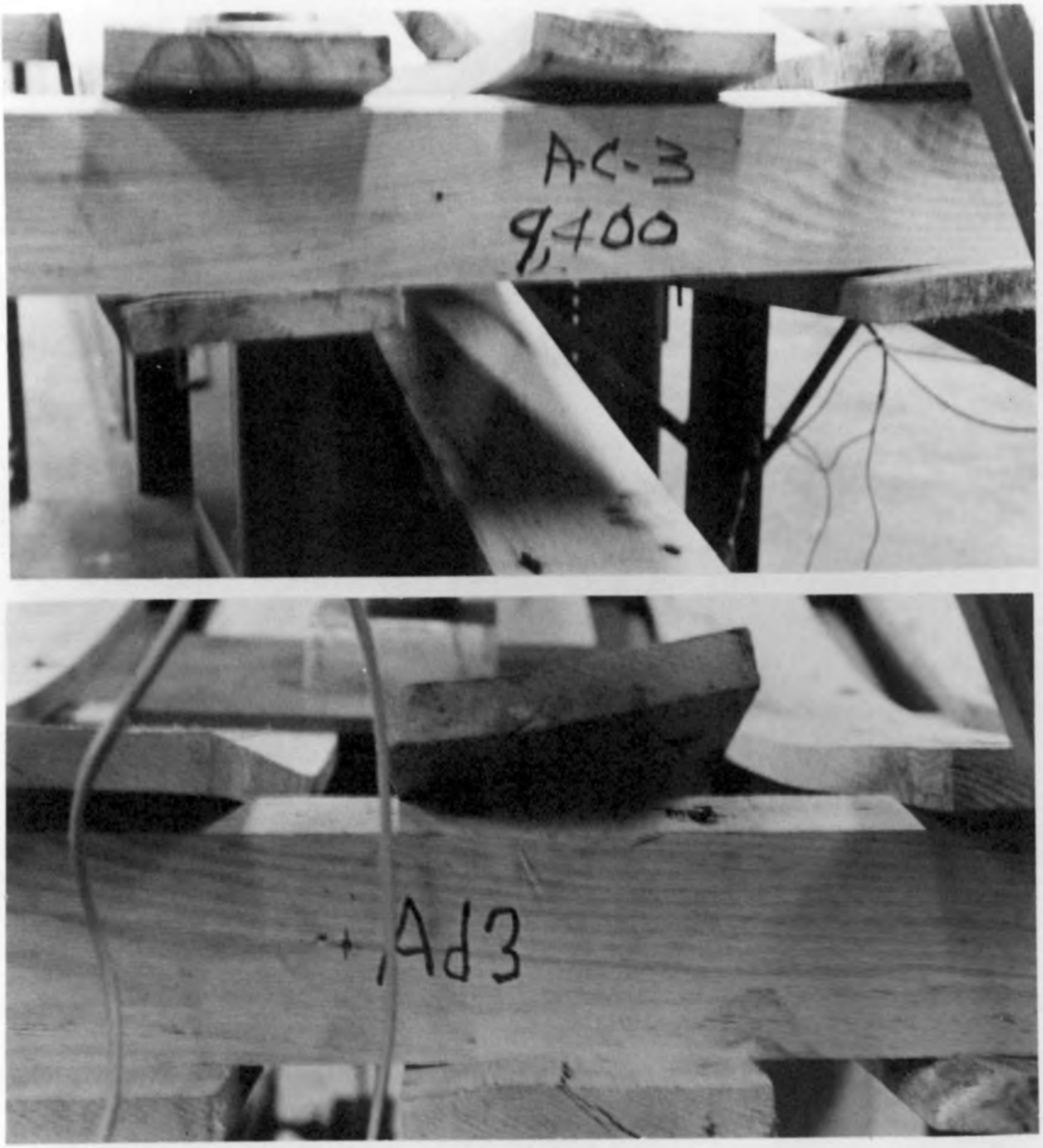


Fig 4i.- Failures of stevedore pallets in test rig at ultimate test loads:
Top, conventional pallet Ac3 at 9400 lb., with near-center bottom deckboard separated from outer stringer (nail failure).
Bottom, conventional pallet Ad3 at 10400 lb., with near-center top deckboard, broken at knot, separated from outer stringer (nail failure).

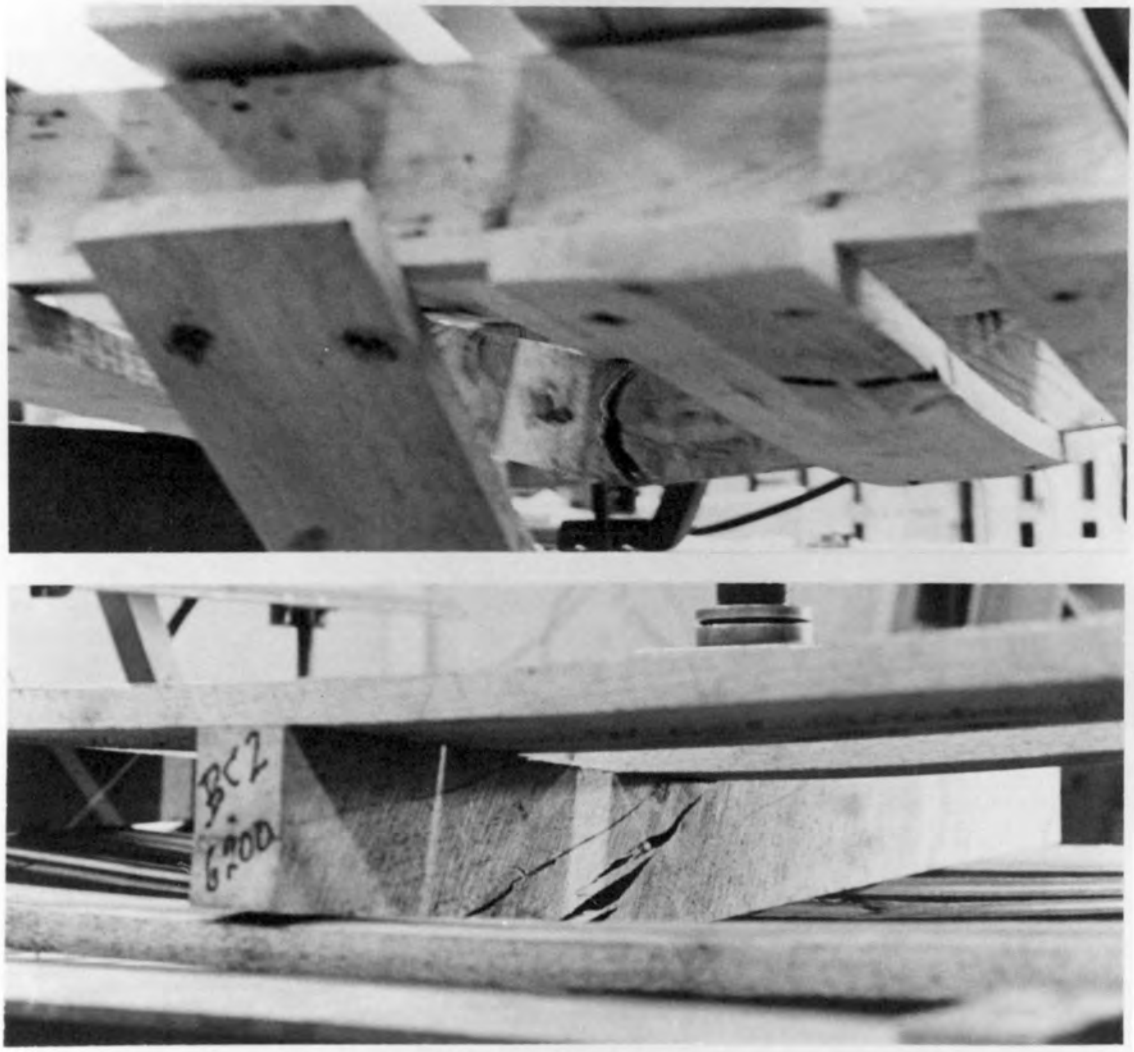


Fig. 4j.- Failures of stevedore pallets in test rig at ultimate test loads: Top, conventional pallet Aa2 at 8800 lb., and bottom, improved pallet Bc2 at 6200 lb., with cross-grain of center stringer being the reason for early failures.

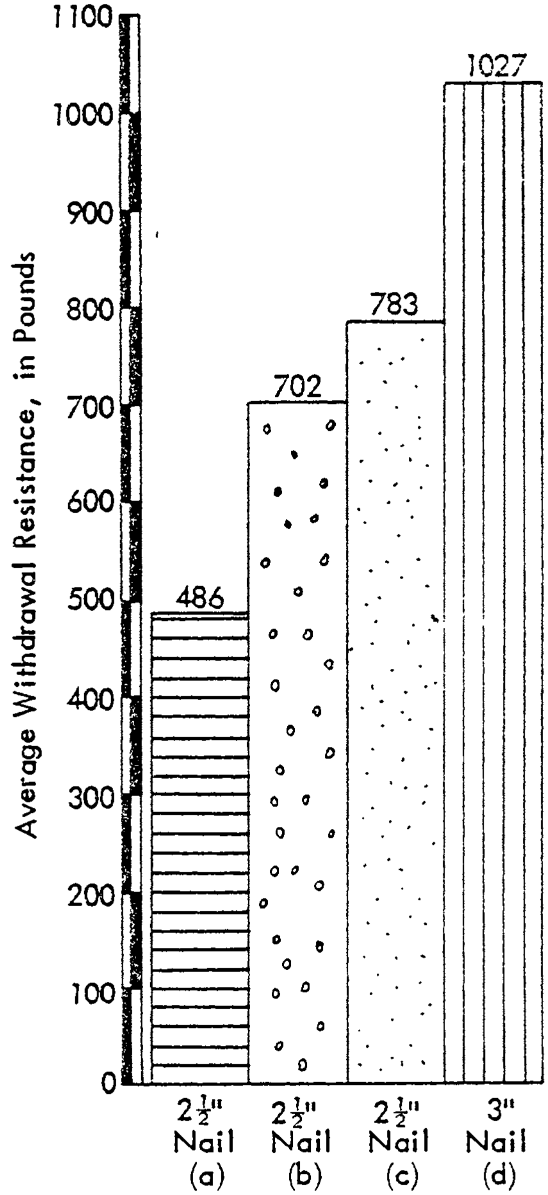


Fig.5.- Average nail-withdrawal resistance, in pounds.

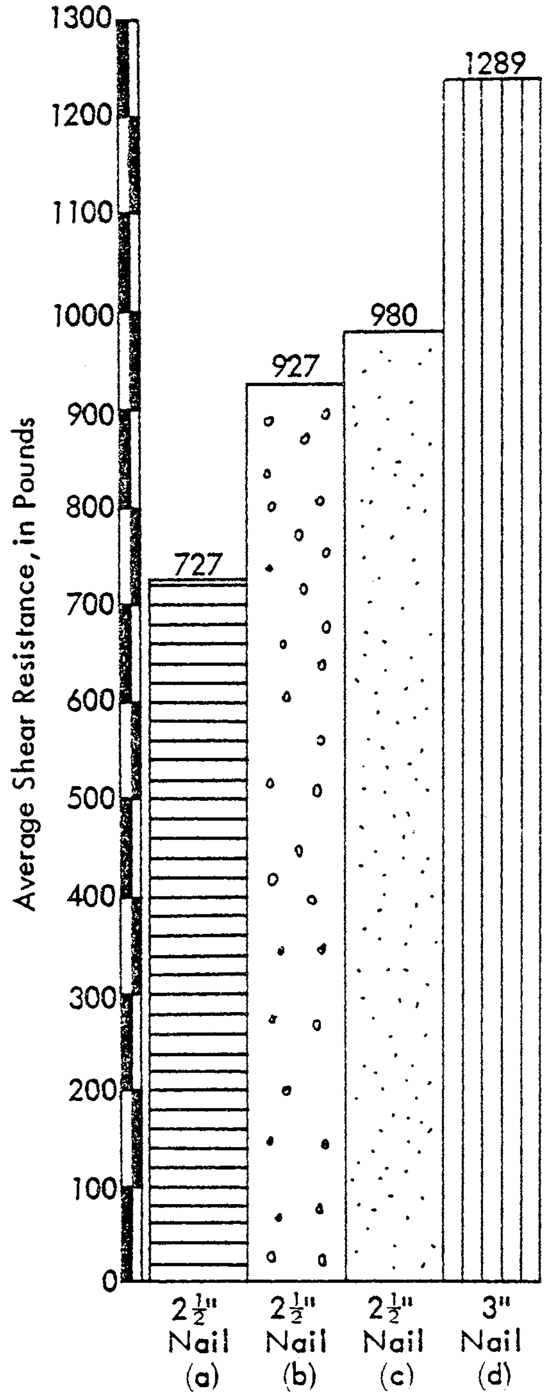


Fig.6.- Average nail-shear resistance, in pounds.

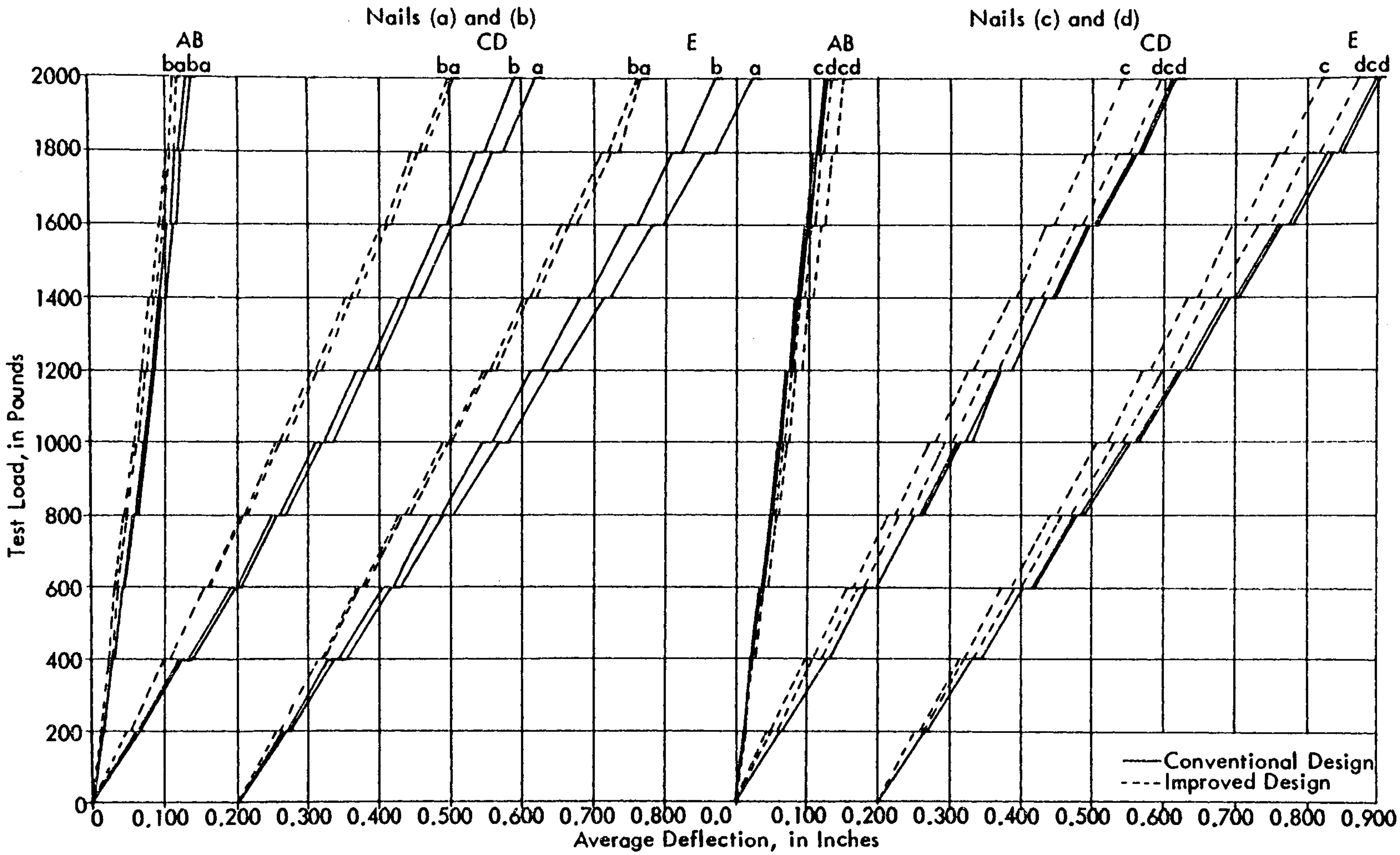


Fig.7.- Average load-deflection curves for initial stiffness tests on pallets of conventional and improved designs, with E curves off-set by 0.200 inches

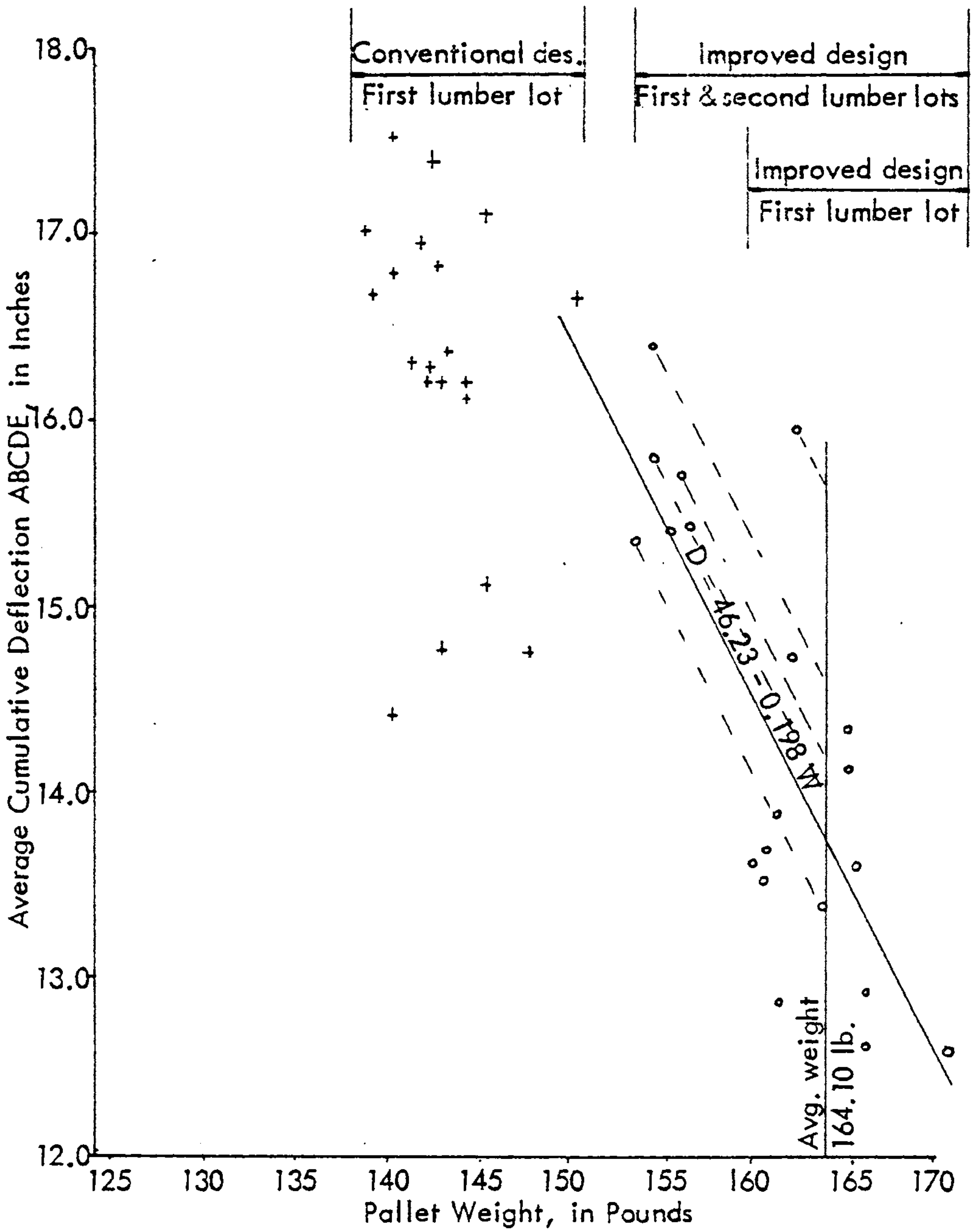


Fig.8.- Regression line showing relationship between weight and cumulative deflection of pallets of improved design.

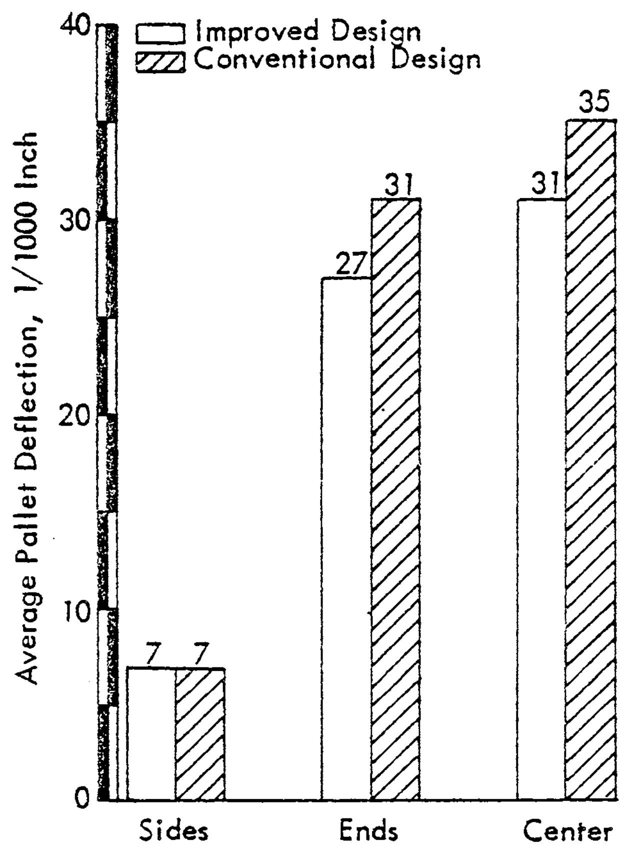


Fig.9.- Average deflection of pallets of conventional and improved designs, per 100 lb. of static load applied at center of pallet.

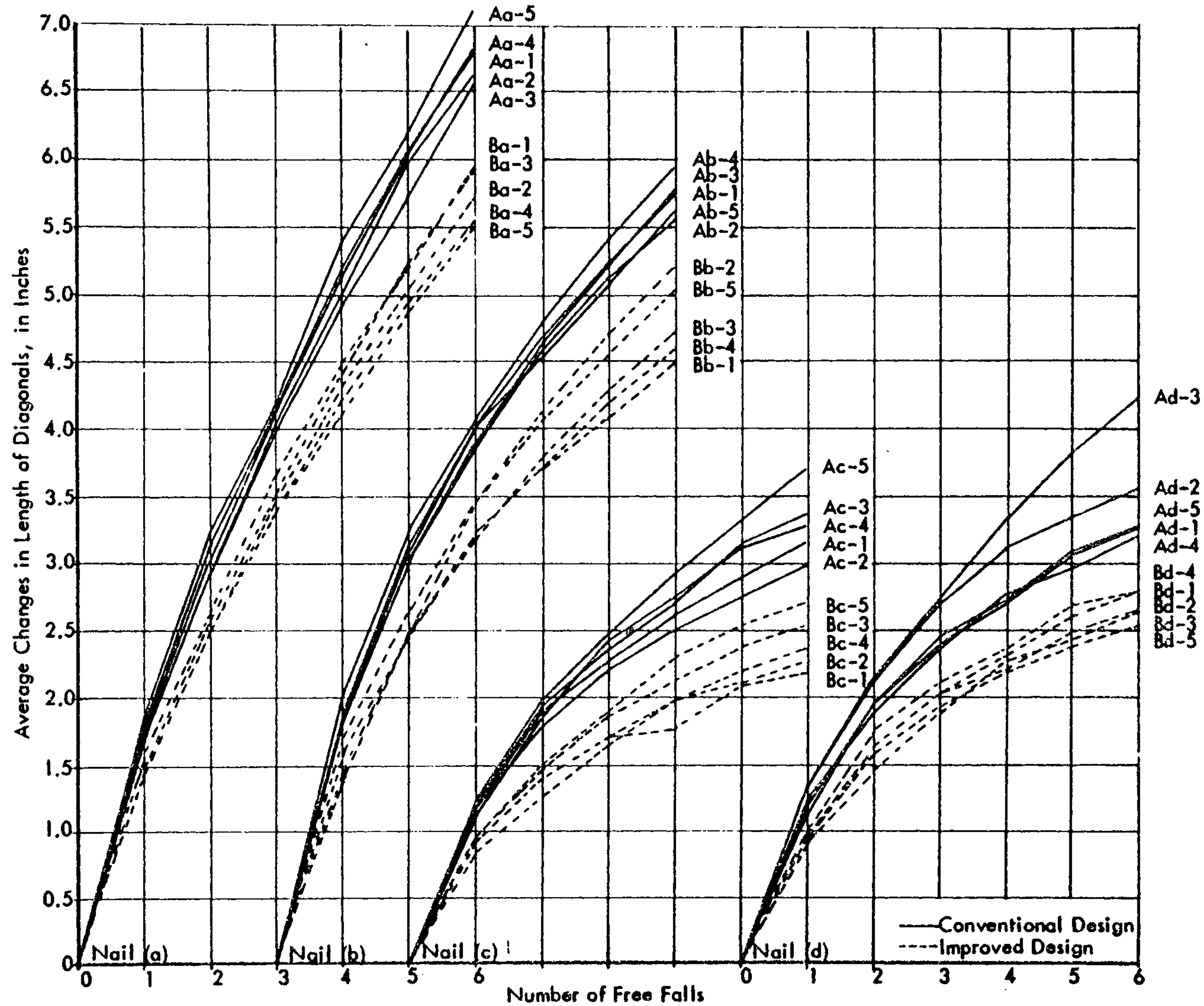


Fig. 10.-Average changes in length of diagonals, in inches, during six free-fall cornerwise drops of pallets, with curves of nails (b) and (c) off-set.

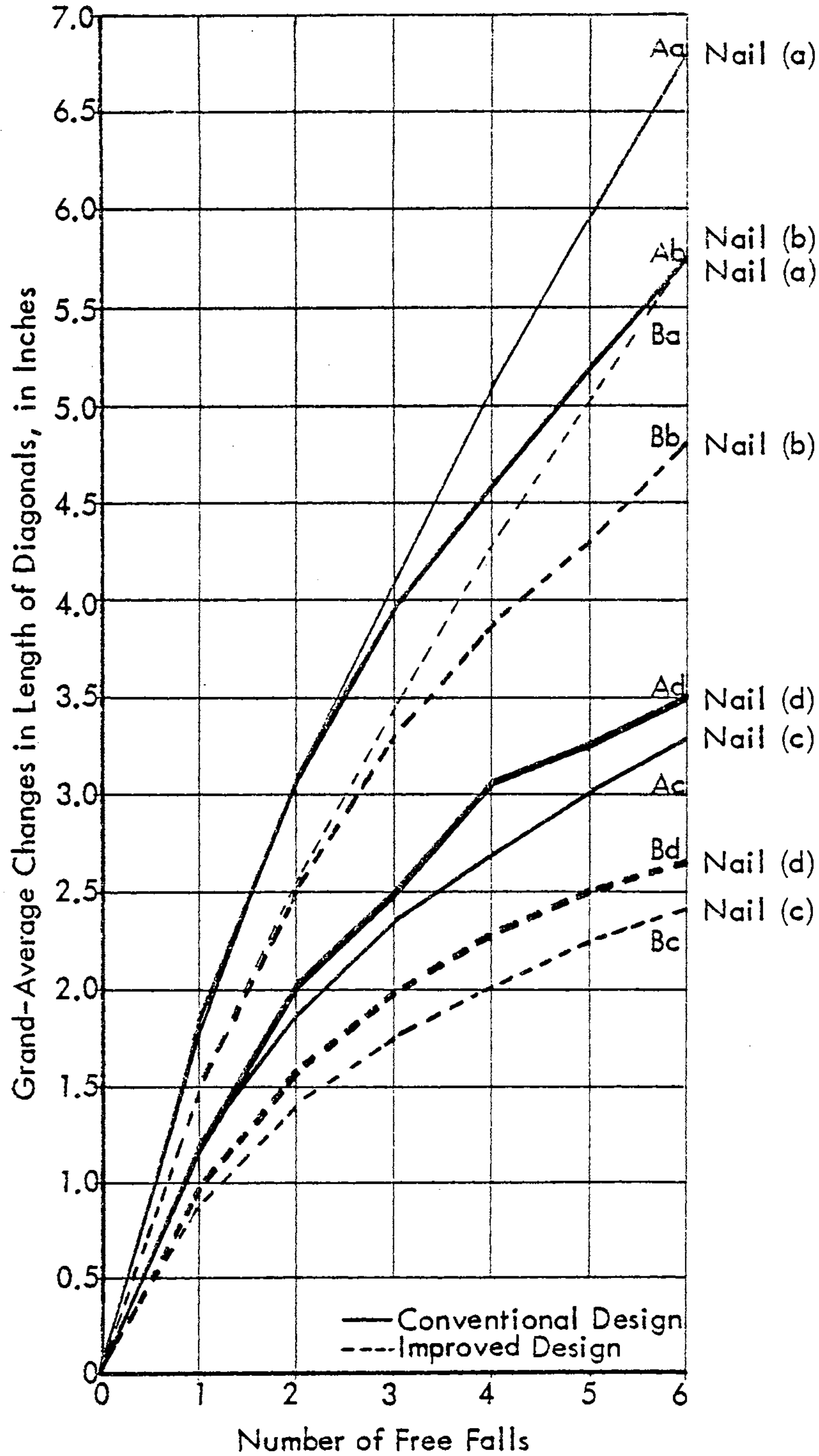
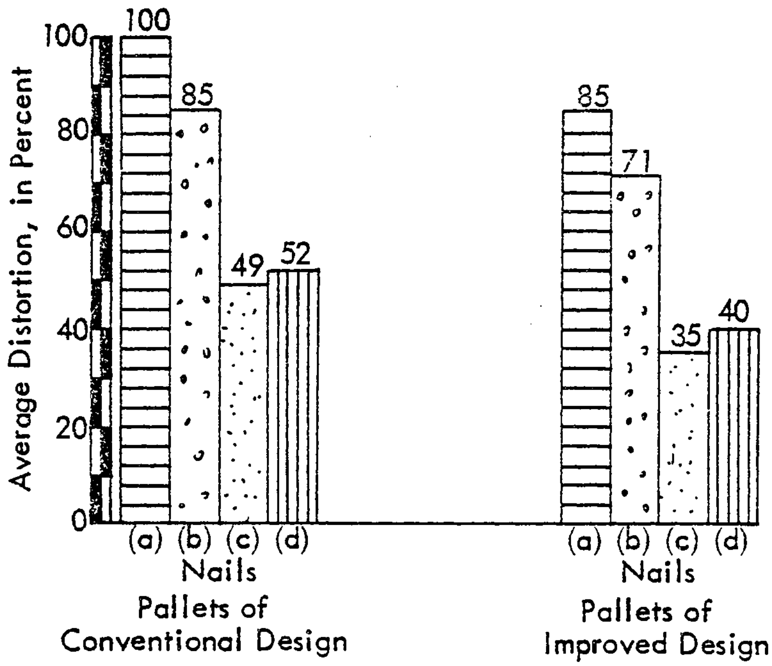


Fig. 11.- Grand-average changes in length of diagonals, in inches, during six free-fall cornerwise drops of pallets.



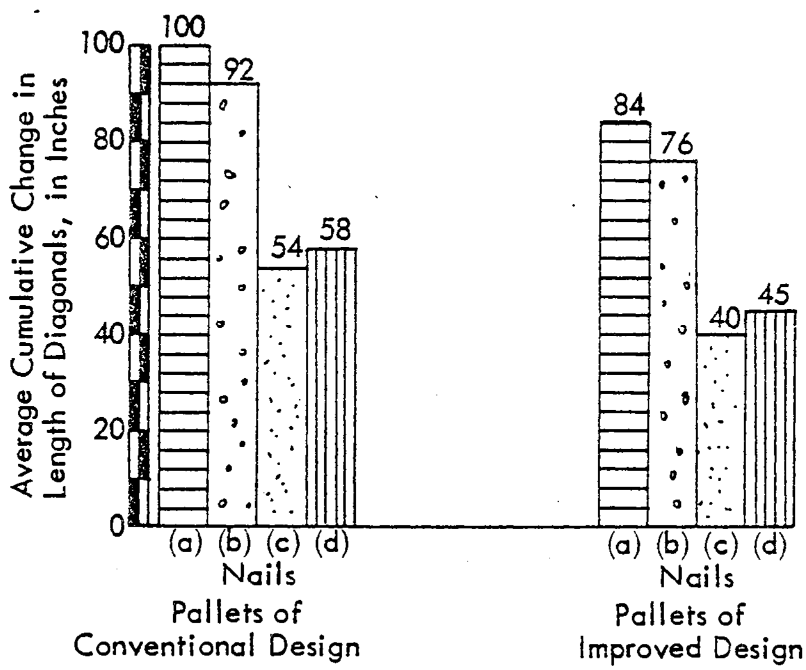


Fig. 12.— Average percentile distortions and cumulative average changes in length, in inches, of diagonals of pallets of conventional and improved designs up to and including 6th drop.

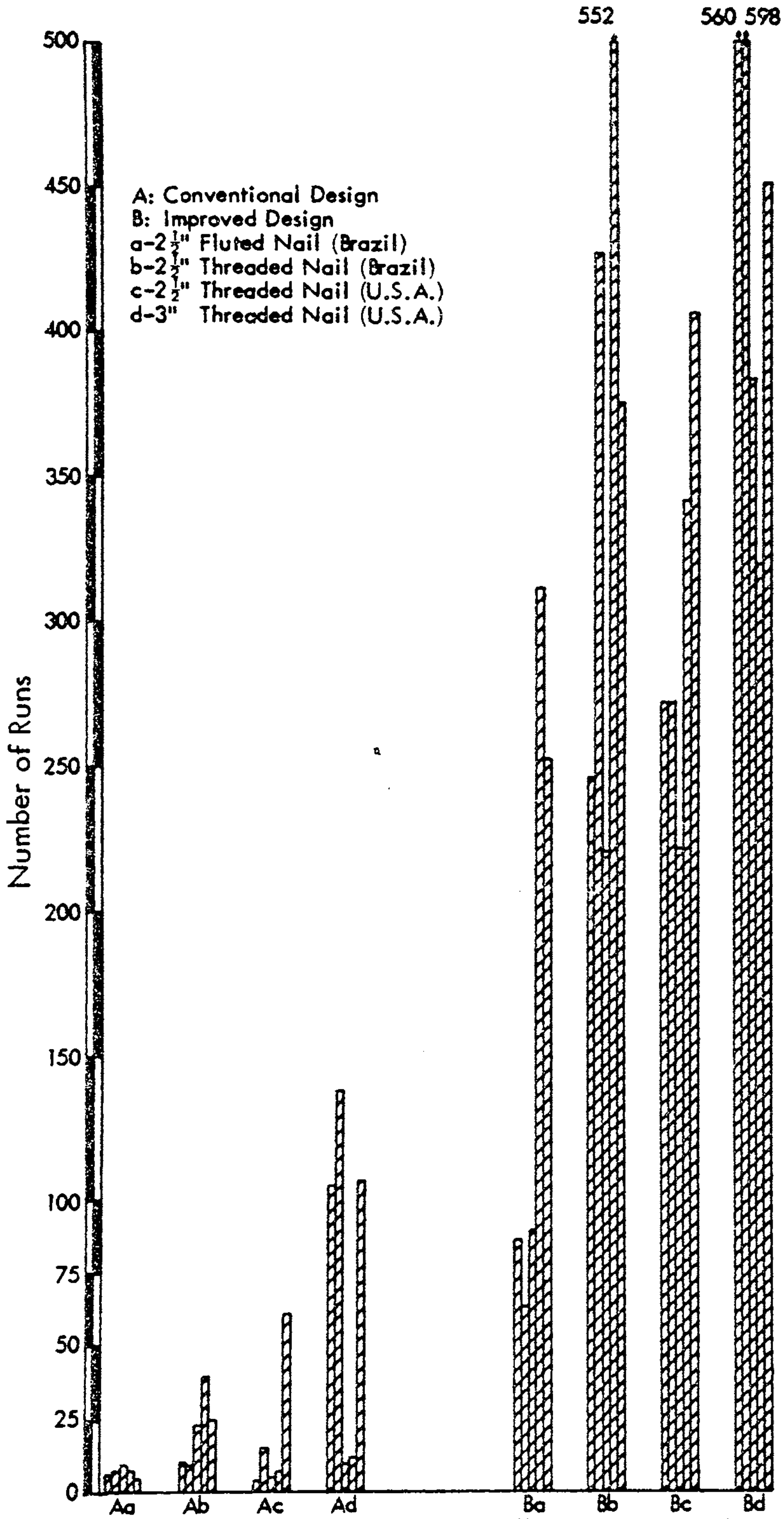


Fig. 13.- Number of runs during incline impact tests on pallets of conventional and improved designs.

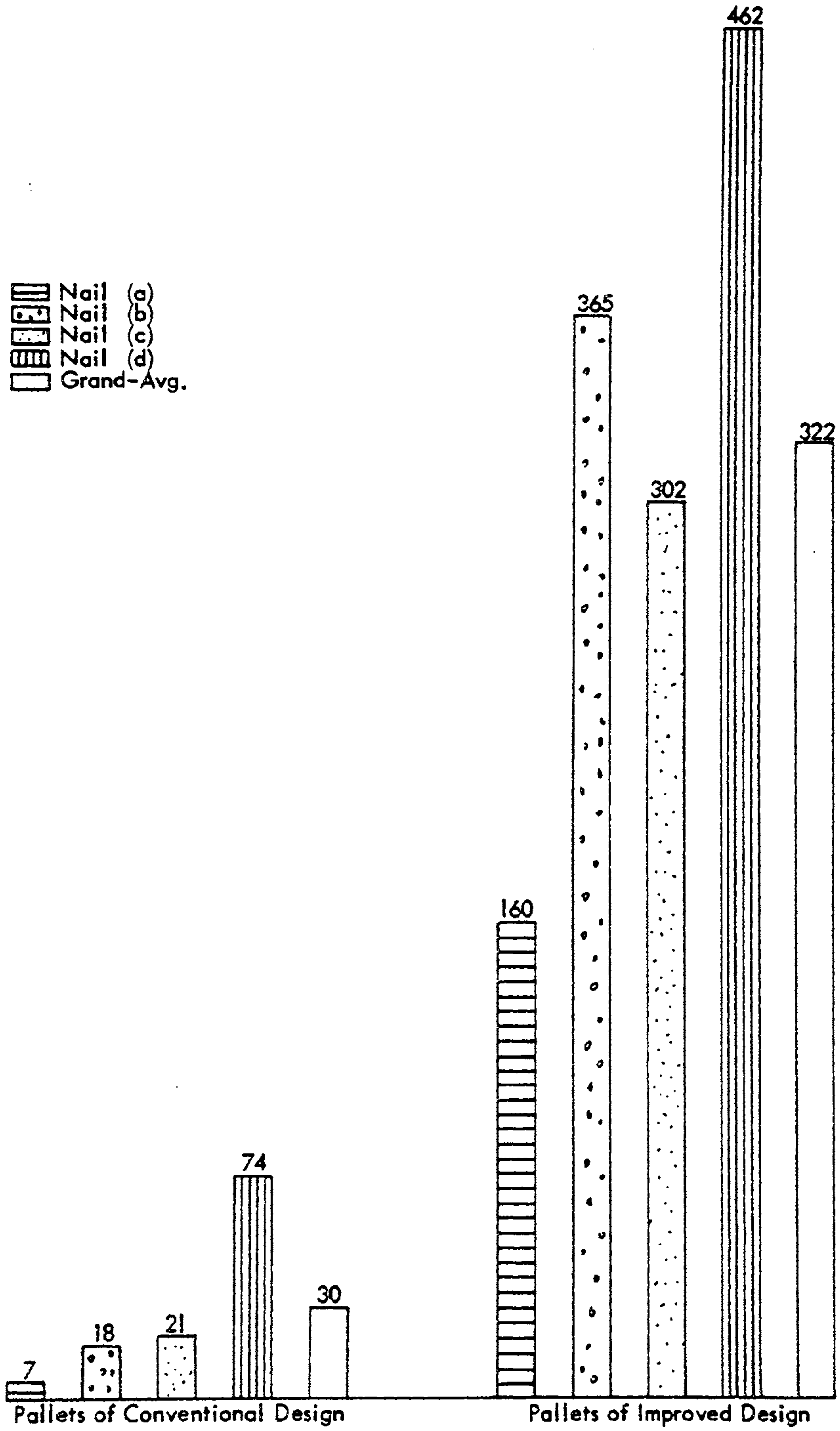


Fig. 14.- Average and grand-average numbers of runs of pallets of conventional and improved designs.

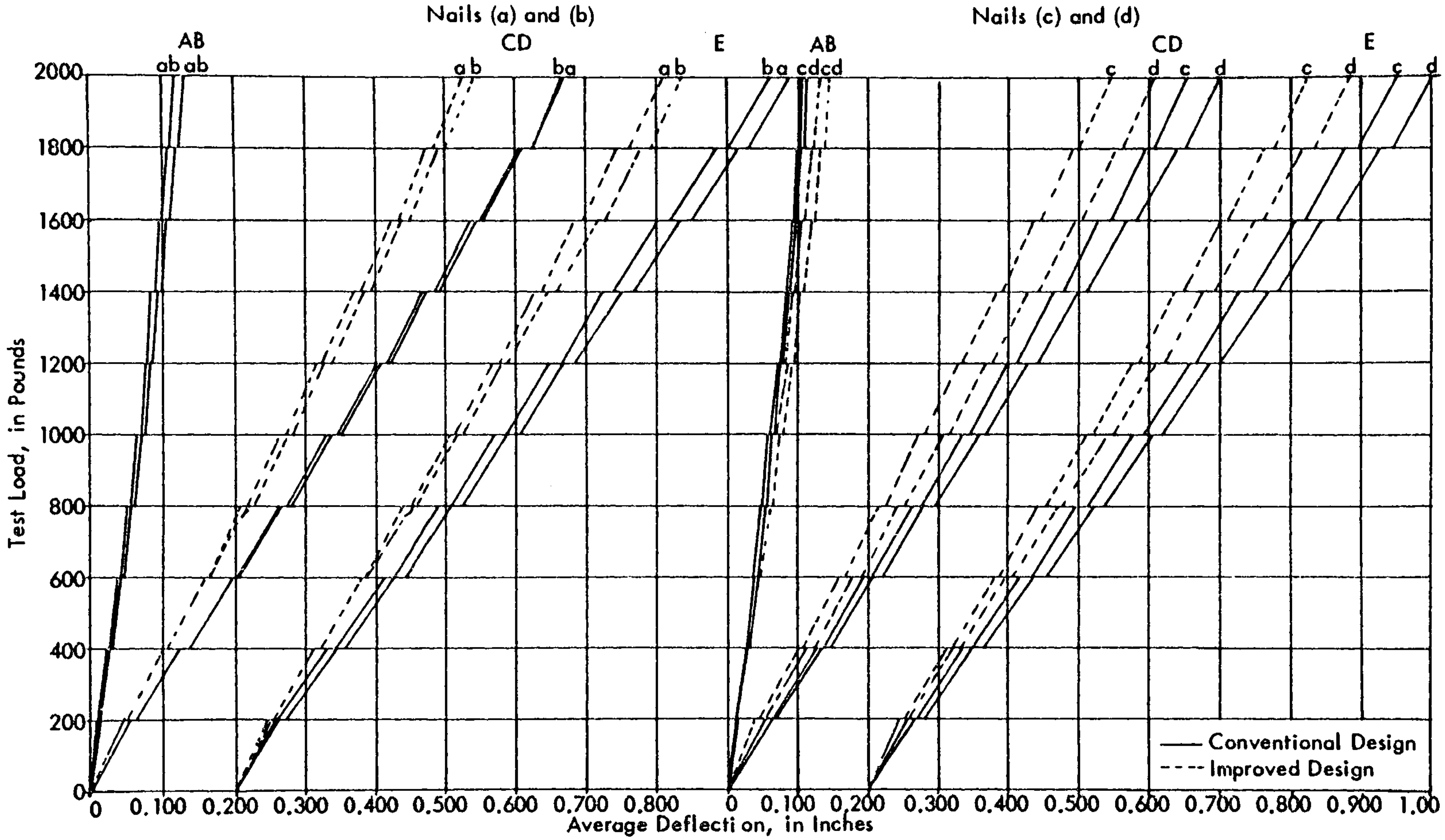


Fig.15a.- Average load-deflection curves for follow-up stiffness on pallets of conventional and improved designs, with E curves off-set by 0.200 inches.

Fig. 15b.- Average load-deflection curves for follow-up stiffness of pallets of conventional and improved designs, with E curves off-set by 0.200 inches.

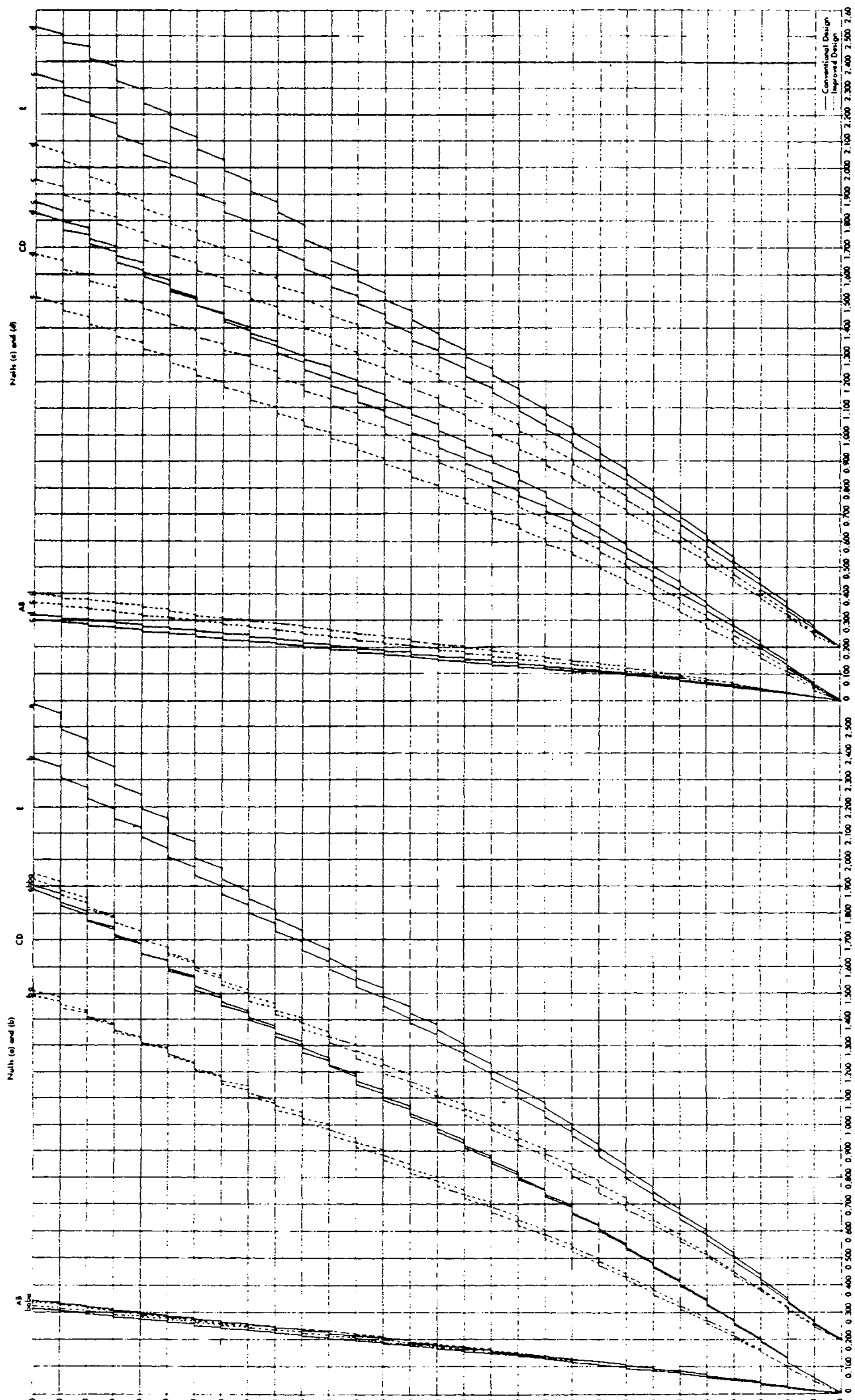


Fig. 13b.– Average load-deflection curves for follow-up stiffness of pallets of conventional and improved designs.

TABLES

1 - 15

In all Tables, 100% serves as basis of comparison.

TABLE 1

Production of Pallets in U.S.A.

Year	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Pallet Units (in millions):	87.7	103.8	104.3	115.0	133.7	126.3	138.0	154.7	185.4	205.1	159.3	195.7	235.9
U.S. Dollar Volume (in millions):	259	348	361	407	495	484	530	623	970	1206	1018	1117	1411
Percentage of National Lumber Production:	6.2	6.9	7.3	8.0	9.1	8.6	9.7	10.0	12.0	14.9	12.7	13	15

TABLE 2

Estimated Production of Pallets in Selected Countries During 1976

Country	Millions
Brazil	0.5
France	20
Italy	7
Japan	30
United Kingdom	14
U.S.A.	196
West Germany	25

TABLE 3

Material Requirements for Pallet Assembly

Design	Item	Quantity	Size	Amount
Conventional	Deckboards	12	1"x6"x63" (25x150x1600 mm)	$43\frac{1}{2}$ bdft. (94cm^3)
	Stringers	3	$2\frac{3}{8}$"x4"x48" (60x100x1200 mm)	
	Nails	84	....	0.71 to 0.86 lb.
Improved	Deckboards	14	1"x6"x63" (25x150x1600 mm)	$48\frac{3}{4}$ bdft. (106 cm^3)
	Stringers	3	$2\frac{3}{8}$"x4"x48" (60x100x1200 mm)	
	Nails	138	....	1.17 to 1.41 lb.

TABLE 4a

Inspection Record of Conventional Red-Oak Stevedore Pallets

Pallet Nails	Pallet No.	Assembly Weight, in Lb.	Test Weight, in Lb.					Moist. Cont. After Testing		Oven-Dry Sp. Grav.		Count of Nails	Deckboard End Split		Stringer End Split		Cupping	Center Stringer Height, In.	Top Center Deckboard Width, In.
			During Init. Stiff. Test	During Rigidity Test	During Incline Test	During Fol.-Up St. Test	During Ult. Load Test	Dkbd.	Stringer	Dkbd.	Stringer		Nails	Other	Nails	Other			
2½" Nail (a)	Aa1	220.14	139.50	138.34	136.98	136.98	135.06	9.6	17.4	0.52	0.68	84	1	4	0	0	7	3.87	5.73
	Aa2	220.48	143.50	141.62	139.89	139.89	137.95	9.3	22.5	0.61	0.66	84	1	5	0	1	6	3.87	5.58
	Aa3	218.00	141.00	138.62	137.45	137.45	135.47	9.3	25.2	0.56	0.62	84	1	7	0	0	3	3.83	5.49
	Aa4	212.88	142.47	139.53	138.19	138.19	136.44	9.9	27.6	0.68	0.70	84	2	3	0	1	3	3.93	5.65
	Aa5	217.95	142.00	139.28	137.91	137.91	136.62	9.9	24.7	0.55	0.75	84	1	4	0	1	7	3.90	5.62
	Avg.	217.85	141.69	139.48	138.08	138.08	136.31	9.6	23.4	0.58	0.68	84	1	5	0	1	5	3.88	5.61
2½" Nail (b)	Ab1	215.00	145.38	143.50	141.98	141.98	139.89	9.3	24.7	0.60	0.69	84	0	4	0	1	7	3.94	5.54
	Ab2	216.81	143.47	141.16	139.50	139.50	137.42	10.3	17.6	0.68	0.73	84	0	6	0	1	7	3.86	5.62
	Ab3	212.25	145.86	142.70	141.81	141.81	139.69	9.7	16.8	0.62	0.74	84	0	1	0	0	7	3.80	5.63
	Ab4	215.19	146.12	142.62	141.19	141.19	139.42	9.8	24.7	0.64	0.64	84	0	5	0	1	8	3.91	5.58
	Ab5	211.06	143.69	139.81	138.53	141.78	136.53	10.0	17.3	0.50	0.65	84	0	3	0	1	5	3.88	5.60
	Avg.	214.06	144.90	141.96	140.60	141.25	138.59	9.8	20.2	0.61	0.69	84	0	4	0	1	7	3.88	5.59
2½" Nail (c)	Ac1	217.81	143.00	140.59	138.70	138.70	136.75	9.8	22.7	0.50	0.71	84	0	6	0	0	5	3.93	5.69
	Ac2	216.31	142.97	140.56	139.59	139.59	137.67	9.8	19.6	0.56	0.60	84	1	3	0	0	6	3.84	5.68
	Ac3	215.56	139.88	137.44	136.26	139.33	134.56	9.7	22.9	0.62	0.68	84	0	4	0	0	5	3.83	5.57
	Ac4	216.50	143.28	140.03	139.25	142.31	137.53	9.6	22.5	0.58	0.68	84	0	3	0	2	5	3.75	5.64
	Ac5	219.62	140.86	138.16	136.75	141.36	135.81	10.0	22.5	0.54	0.70	84	0	4	0	1	8	3.88	5.57
	Avg.	217.16	142.00	139.36	138.11	140.26	136.46	9.8	22.0	0.56	0.67	84	0	4	0	1	6	3.85	5.63
3" Nail (d)	Ad1	220.69	148.31	145.86	143.80	143.80	142.88	9.7	21.4	0.59	0.68	84	0	5	0	1	9	3.87	5.54
	Ad2	220.38	150.88	148.28	147.06	147.06	140.28	9.8	14.8	0.59	0.78	84	0	3	1	2	7	3.81	5.56
	Ad3	215.12	144.06	142.30	141.06	141.06	139.44	9.7	23.7	0.66	0.64	84	0	5	0	0	5	3.95	5.65
	Ad4	217.56	141.23	139.41	138.02	142.12	137.55	10.7	17.6	0.66	0.67	84	0	6	0	1	5	3.83	5.65
	Ad5	216.86	144.76	142.76	141.95	147.42	141.25	9.7	23.6	0.62	0.66	84	0	2	1	1	6	3.94	5.57
	Avg.	218.12	145.85	143.72	142.38	144.29	140.28	9.9	20.8	0.62	0.69	84	0	4	0	1	6	3.88	5.59
Grand	Avg.	216.80	143.61	141.13	139.79	140.97	137.91	9.8	21.6	0.59	0.68	84	0	4	0	1	6	3.87	5.61

TABLE 4b

Inspection Record of Improved Red-Oak Stevedore Pallets

Pallet Nails	Pallet Nos.	Assembly Weight, in Lb.	Test Weight, in Lb. Prior to Init. Stiff. Test	During Init. Stiff. Test	During Rigidity Test	During Incline Test	During Fol.-Up St. Test	During Ult. Load Test	Moist. Cont. After Testing		Oven-Dry Sp. Grav.		Count of Nails	Deckboard End Split		Stringer End Split		Cupping	Center Stringer Height, In.	Top Center Deckboard Width, In.
									Dkbd.	Stringer	Dkbd.	Stringer		Nails	Other	Nails	Other			
2½"	Ba1	251.25	167.00	166.45	164.34	161.48	161.48	158.81	10.0	26.6	0.52	0.68	138	1	6	0	0	6	3.93	5.61
Nail (a)	Ba2	252.52	166.38	165.83	163.88	160.50	160.50	158.75	10.7	27.3	0.61	0.75	138	0	7	1	0	6	3.82	5.65
	Ba3	248.86	167.17	166.62	163.03	160.12	160.12	158.58	9.9	18.6	0.62	0.76	138	0	6	1	0	5	3.85	5.63
	Ba4	249.00	163.20	162.65	158.69	155.86	161.44	156.19	9.7	12.9	0.47	0.67	138	3	5	0	2	4	3.92	5.67
	Ba5	248.81	164.67	164.12	161.26	159.61	159.61	158.62	9.5	20.8	0.56	0.77	138	4	2	3	0	6	3.85	5.62
	Avg.	250.09	165.68	165.13	162.24	159.51	160.63	158.19	10.0	21.2	0.56	0.73	138	2	5	1	0	5	3.87	5.64
2½"	Bb1	241.00	162.25	161.70	159.12	157.20	157.20	154.66	10.4	23.8	0.64	0.68	138	2	3	0	1	7	3.91	5.66
Nail (b)	Bb2	246.00	171.66	171.11	167.81	162.53	168.31	161.72	10.4	20.6	0.61	0.68	138	1	5	0	0	9	3.87	5.64
	Bb3	244.75	166.55	166.00	161.33	158.16	158.16	157.00	11.1	24.8	0.57	0.68	138	0	7	0	0	3	3.91	5.63
	Bb4	246.12	161.22	160.67	158.33	156.48	156.48	155.72	10.4	17.8	0.62	0.78	138	0	1	0	1	8	3.88	5.58
	Bb5	242.00	161.55	161.00	158.59	156.92	156.92	156.06	10.4	19.3	0.55	0.78	138	0	3	0	1	3	3.89	5.56
	Avg.	243.97	164.65	164.10	161.04	158.26	159.41	157.03	10.5	21.3	0.60	0.72	138	1	4	0	1	6	3.89	5.61
2½"	Bc1	245.44	161.19	160.64	158.59	156.44	156.44	153.88	9.9	18.6	0.64	0.76	138	0	6	0	3	9	3.86	5.62
Nail (c)	Bc2	247.56	166.38	165.83	162.50	160.00	160.00	158.83	10.7	18.6	0.58	0.81	138	0	4	0	1	11	3.88	5.73
	Bc3	245.56	162.25	161.70	158.26	156.95	156.95	156.14	10.2	28.9	0.54	0.67	138	4	5	0	0	9	3.91	5.59
	Bc4	233.25	157.00	156.45	154.92	153.25	153.25	152.62	10.2	23.8	0.60	0.74	138	1	2	0	0	6	3.80	5.64
	Bc5	244.75	156.75	156.20	154.64	152.47	152.47	151.91	10.1	20.3	0.62	0.73	138	1	3	0	0	11	3.90	5.62
	Avg.	243.31	160.71	160.16	157.78	155.82	155.82	154.68	10.2	22.0	0.60	0.74	138	1	4	0	1	9	3.87	5.66
3"	Bd1	238.30	155.69	155.14	153.56	152.67	152.67	150.47	10.1	18.7	0.58	0.65	138	1	4	0	0	10	3.88	5.57
Nail (d)	Bd2	244.31	155.66	154.19	153.78	152.39	152.39	151.34	10.5	17.7	0.56	0.70	138	0	0	1	0	6	3.95	5.59
	Bd3	245.61	155.52	155.11	154.44	152.26	160.97	154.58	9.6	16.7	0.56	0.67	138	4	2	0	2	12	3.91	5.65
	Bd4	249.50	163.55	162.89	162.25	159.50	159.50	158.94	11.2	24.7	0.63	0.67	138	3	2	0	1	9	3.91	5.75
	Bd5	240.75	157.61	156.97	156.52	154.06	154.06	153.84	10.7	25.9	0.62	0.70	138	0	2	0	0	8	3.97	5.82
	Avg.	243.69	157.61	156.86	156.11	154.18	155.92	153.83	10.4	20.7	0.59	0.68	138	2	2	0	1	9	3.92	5.68
Grand	Avg.	245.27	162.16	161.56	159.29	156.94	157.95	155.93	10.3	21.3	0.59	0.72	138	2	4	0	1	7	3.89	5.64

TABLE 5

Average Assembly and Test Weights, in Pounds, of Pallets of Conventional and Improved Designs

Pallet Design	Assembly Weights		Test Weights* During: In. Stiffness Test		Drop Test		Incline Test		Fol.-Up Stiff. Test		Ult. Load Test	
	Avg.	s	Avg.	s	Avg.	s	Avg.	s	Avg.	s	Avg.	s
Conventional	216.80	2.76	143.61	2.78	141.13	2.69	139.79	2.65	140.97	2.82	137.91	2.18
Improved	245.27	4.57	161.56	4.71	159.29	3.97	156.94	3.27	157.95	3.94	155.93	3.02
Difference	+13%		+12%		+13%		+12%		+12%		+13%	

*Prior to testing the pallets of improved design, both wings of the top center deckboards were cut off to facilitate installation of the deflection sensors. This reduced the pallet weights, on the average, 0.60 lb.

TABLE 6

Statistical Design Used for Quintuplicate Pallets of Conventional and Improved Designs Assembled with Four Different Nails

Source of Variation	Degrees of Freedom
Designs (2-1)	1
Nails (4-1)	3
Interaction (2-1)x(4-1)	3
Error (40-7-1)	32
Total	39

TABLE 7

Static Deckboard-Stringer Separation Resistance in Direction of Nail Axis and Shear Resistance

Test Property	$2\frac{1}{2}$" Fluted Nail (a)	$2\frac{1}{2}$" Threaded Nail (b)	$2\frac{1}{2}$" Threaded Nail (c)	3" Threaded Nail (d)
Withdr. Resistance, in Pounds	486 (100%)	702 (144%)	783 (161%)	1027 (211%)
Withdr. Res., in Pounds/Inch of Shank Penetration into Stringer	324 (100%)	468 (144%)	522 (161%)	514 (159%)
Shear Resistance, in Pounds	727 (100%)	927 (126%)	980 (135%)	1239 (170%)

TABLE 8

Evaluation of Initial Static Stiffness of Pallets

Pallet Design	Pallet Nos.	Avg. Pallet Test Weight, in Lb.	Average Cumulative Deflection Value, in 1/1000 In. Sides (AB)	Ends (CD)	Center (E)	Sum (ABCDE)	Sum (ABCDE), in Percent
Conventional	Aa1 to 5	141.69	1560	7041	8153	16754	103%
	Ab1 to 5	144.90	1482	6779	7602	15863	97%
	Ac1 to 5	142.00	1382	6955	7855	16192	100%
	Ad1 to 5	145.85	1436	6958	7885	16279	100%
	Grand Avg.	143.61	1465	6933	7874	16272	100%
Improved	Ba1 to 5	165.13	1352	5684	6506	13542	95%
	Bb1 to 5	164.10	1281	5604	6346	13431	93%
	Bc1 to 5	160.16	1492	6064	6910	14466	102%
	Bd1 to 5	156.86	1670	6650	7449	15769	111%
	Grand Avg.	161.56	1449	6001	6802	14252	100%
Difference		+12%	-1%	-13%	-14%	-12%	
Improved with Adjusted Values	Ba1 to 5	165.13	1352	5684	6506	13542	98%
	Bb1 to 5	164.10	1281	5604	6346	13231	96%
	Bc1 to 5	160.16	1438	5846	6660	13944	101%
	Bd1 to 5	156.86	1517	6046	6770	14330	104%
	Grand Avg.	161.56	1397	5794	6571	13762	100%
Difference*		+12%	-5%	-16%	-17%	-15%	

*Adjusted values for improved pallets versus values for conventional pallets.

TABLE 9

Average Deflections, in 1/1000 Inches, of All Pallets of Conventional and Improved Designs Tested, per 100 Lb. of Static Load Applied at Pallet Center, According to Deflections Observed Up to Test Load of 2000 Lb.

Pallet Design	Sides (AB)		Ends (CD)		Center (E)	
	Range	Avg.	Range	Avg.	Range	Avg.
Conventional	6-7	7	30-32	31	34-35	35
Improved	6-8	7	25-31	27	28-34	31

TABLE 10

Evaluation of Pallet Rigidity Data

Pallet Design	Pallet Nos.	Pallet Weight in Lb.			Avg. Percentile Distortion of Diagonals After 6th Drop			Avg. Cumulative Length Change, in In., of Diagonals Up to and Including 6th Drop		
Conventional	Aa1 to 5	139.48	100%	100%	9.23	100%	100%	26.83	100%	100%
	Ab1 to 5	141.96	103%		7.81	85%	85%	24.58	92%	92%
	Ac1 to 5	139.36	101%		4.49	49%	49%	14.44	54%	54%
	Ad1 to 5	143.72	104%		4.78	52%	52%	15.53	58%	58%
Improved	Ba1 to 5	162.24	100%	113%	7.80	100%	85%	22.63	100%	84%
	Bb1 to 5	161.04	99%		6.55	84%	71%	20.44	90%	76%
	Bc1 to 5	157.78	97%		3.27	42%	35%	10.73	48%	40%
	Bd1 to 5	156.11	96%		3.65	47%	40%	12.10	53%	45%

TABLE 11

Evaluation of Impact Incline Pallet Deckboard-Stringer Separation Data

Pallet Design	Pallet Nos.	Avg. Pallet Test Weight, in Lb.	Range of Numbers of Runs Prior to End of Test	Average Numbers of Runs Prior to End of Test
Conventional	Aa1 to 5	138.08	4 to 9	7
	Ab1 to 5	140.60	9 to 38	21
	Ac1 to 5	138.11	5 to 60	18
	Ad1 to 5	142.38	10 to 137	74
Improved	Ba1 to 5	159.51	62 to 312	160
	Bb1 to 5	158.26	220 to 552	365
	Bc1 to 5	155.82	221 to 406	302
	Bd1 to 5	154.18	319 to 598	462

TABLE 12

Evaluation of Follow-Up Static Stiffness of Pallets

Pallet Design	Pallet Nos.	Avg. Pallet Weight, in Lb.	Avg. Cumulative Deflection Value from 0 to 2000 Lb., in 1/1000 In. Sides (AB)	Ends (CD)	Center (E)	Sum (ABCDE)	Sum (ABCDE), in Pct.	Avg. Cumulative Deflection Value from 0 to 6000 Lb., in 1/1000 In. Sides (AB)	Ends (CD)	Center (E)	Sum (ABCDE)	Sum (ABCDE), in Pct.
Conventional	Aa1 to 5	138.08	1522	7470	8707	17699	101%	11221	60441	72495	144157	102%
	Ab1 to 5	141.25	1359	7434	8271	17064	98%	10277	60824	68893	139994	99%
	Ac1 to 5	140.26	1266	7328	8314	16908	97%	9572	59025	67666	136263	97%
	Ad1 to 5	144.29	1404	7822	8941	18167	104%	10382	60434	73549	144365	102%
	Grand Avg.	140.97	1388	7514	8558	17460	100%	10363	60181	70651	141195	100%
Improved	Ba1 to 5	160.63	1334	5826	6715	13875	95%	10595	47851	55164	113610	96%
	Bb1 to 5	159.41	1438	6024	6997	14459	99%	11100	48385	55858	115343	97%
	Bc1 to 5	155.82	1451	5982	6850	14283	98%	11728	48564	56194	116486	98%
	Bd1 to 5	155.92	1664	6762	7513	15939	109%	13001	54425	61034	128460	108%
	Grand Avg.	157.95	1472	6148	7019	14639	100%	11606	49806	57063	118475	100%
Difference		+12%	+6%	-18%	-18%	-16%		+12%	-17%	-19%	-16%	

TABLE 13

Comparison of Initial and Follow-Up Pallet Stiffness Data

Pallet Design	Pallet Nos.	Increase in Average Cumulative Deflection Value, During Follow-Up Stiffness Test Sides (AB)	Ends (CD)	Center (E)	Sum (ABCDE)
Conventional	Aa1 to 5	- 2%	+ 6%	+ 7%	+ 6%
	Ab1 to 5	- 8%	+10%	+ 9%	+ 8%
	Ac1 to 5	- 8%	+ 5%	+ 6%	+ 4%
	Ad1 to 5	- 2%	+12%	+13%	+12%
	Grand Avg.	- 5%	+ 8%	+ 9%	+ 7%
Improved	Ba1 to 5	- 1%	+ 2%	+ 3%	+ 2%
	Bb1 to 5	+12%	+ 7%	+10%	+ 8%
	Bc1 to 5	- 3%	- 1%	- 1%	- 1%
	Bd1 to 5	- 0%	+ 2%	+ 1%	+ 1%
	Grand Avg.	+ 2%	+ 2%	+ 3%	+ 3%

TABLE 14

Average Ultimate Pallet Test Loads

Pallet Design	Pallet Nos.	Avg. Pallet Test Weight, in Lb.	Avg. Ult. Test Load, in Lb.	Avg. Ult. Test Load, in Lb., with Pallets with Stringer Failures Omitted
Conventional	Aa1 to 5	136.31	8480	8800
	Ab1 to 5	138.59	10120	10120
	Ac1 to 5	136.46	9980	9980
	Ad1 to 5	140.28	8920	9650
	Grand Avg.	137.91	9375	9638
Improved	Ba1 to 5	158.19	11360	11360
	Bb1 to 5	157.03	11640	11640
	Bc1 to 5	154.68	10680	11800
	Bd1 to 5	153.83	11600	11600
	Grand Avg.	155.93	11320	11600
Difference		+13%	+21%	+20%

TABLE 15

Tentative Outline of Proposed Field Tests on Stevedore Pallets of Improved Design

A) All three-stringer pallets of improved design, same size and type, and same construction, with best deckboards used for backing-up deckboards and with best edge of leading-edge deckboard used for outer edge

Pallet Sign (1)	Wood Species (2)	Nail Type (3)	Nail Steel (4)	Number of Nails per End-Deckbd. Joint (5)	Nail Treatment (6)	Pallet Treatment (7)
A(1-100)	Peroba	(a)	--	4	none	none
B	"	(b)	SS	4	none	none
C	"	(b)	HS	4	none	none
D	"	(b)	HS	4	galvanized	dipped
E	Eucalyptus	(a)	--	4	none	none
F	"	(b)	SS	4	none	none
G	"	(b)	HS	4	none	none
H	"	(b)	HS	6	none	none
I	"	(b)	HS	6	galvanized	dipped

9 x 100 = 900 pallets (400 peroba and 500 eucalyptus)

B) All pallets identical to those above, yet with four, instead of three, stringers, with the inner 2 x 4 (50 x 100 mm) stringers spaced 12" (300 mm) on centers

Pallet Sign (1)	Wood Species (2)	Nail Type (3)	Nail Steel (4)	Number of Nails per End-Deckbd. Joint (5)	Nail Treatment (6)	Pallet Treatment (7)
A(1-100)	Peroba	(b)	HS	4	none	none
B	Eucalyptus	(b)	HS	4	none	none

2 x 100 = 200 pallets (100 peroba and 100 eucalyptus)

SS = Stiff-Stock HS = Hardened-Steel

APPENDIX

TABLES 16 - 32

LIST OF APPENDIX TABLES

MIBANT DATA SHEET FOR PALLET NAILS
(use separate form for each lot of 25 nails)

APPENDIX TABLE 16a

1) Nails Submitted by (complete address): INDUSTRIA DE ARAMES CLEIDE
Avenida D. Pedro I, no 790
Santo Andre - Sao Paulo - Brazil

2) Nail Description (manufacturer, type, lot, identification): Same as above, Ardox nail.

3) Field Experience with Nails: ...

(to be filled out by pallet or nail manufacturer submitting nails)

4) Date of Submission: ...

5) Date of Receipt at VPI: Dec. 19, 1977 6) VPI Nail No. 2017

7) Nail Size (length x wire diameter): 2½" x 0.120"

8) Nail Type: Low-Carbon-Steel ... Stiff-Stock X. Hardened ... Tempered ...

9) Shank Deformation: Annularly Threaded ... Helically Threaded ... Fluted X. Twisted ...

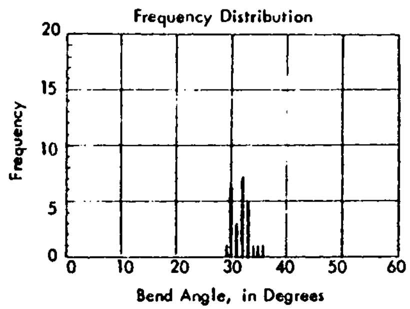
10) Thread-Crest Diameter: 0.143" 11) Thread Angle: 80° 12) Number of Flutes: 4

13) Appearance: ...

14) MIBANT TEST DATA: Date of Test: Dec. 20, 77 Machine Operator: Nilson Franco

Test No.	Angle in Degr.	Partial Failure	Complete Failure
1	35		
2	32		
3	32		
4	30		
5	32		
6	32		
7	32		
8	30		
9	29		
10	30		
11	36		
12	33		
13	33		
14	30		
15	31		
16	32		
17	31		
18	33		
19	30		
20	30		
21	33		
22	33		
23	32		
24	31		
25	34		
Avg.:	32	Total: 0	Total: 0

Notes and Remarks: ...



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MIBANT DATA SHEET FOR PALLET NAILS
(use separate form for each lot of 25 nails)

APPENDIX TABLE 16b

1) Nails Submitted by (complete address): AIR-FIX DO BRASIL IND. COM. LTDA. Rua Riachuelo, 201, 6 andar, conjunto A.
Sao Paulo - Sao Paulo - Brazil

2) Nail Description (manufacturer, type, lot, identification): Same as above. Air-Fix Catalogue No. AF-0.07

3) Field Experience with Nails: ...

(to be filled out by pallet or nail manufacturer submitting nails)

4) Date of Submission: ...

5) Date of Receipt at VPI: Dec. 19, 1977 6) VPI Nail No. 2018

7) Nail Size (length x wire diameter): 2½" x 0.127"

8) Nail Type: Low-Carbon-Steel ... Stiff-Stock X. Hardened ... Tempered ...

9) Shank Deformation: Annularly Threaded ... Helically Threaded X. Fluted ... Twisted ...

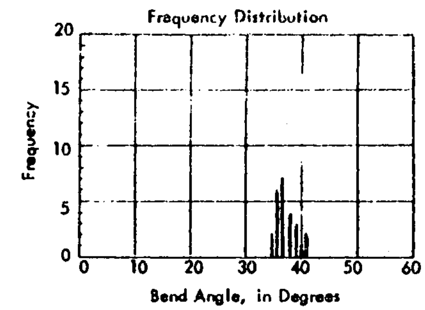
10) Thread-Crest Diameter: 0.142" 11) Thread Angle: 68° 12) Number of Flutes: 3

13) Appearance: Pointless

14) MIBANT TEST DATA: Date of Test: Dec. 20, 77 Machine Operator: Nilson Franco

Test No.	Angle in Degr.	Partial Failure	Complete Failure
1	36		
2	37		
3	38		
4	36		
5	41		
6	38		
7	38		
8	36		
9	35		
10	37		
11	36		
12	39		
13	37		
14	38		
15	35		
16	37		
17	40		
18	37		
19	36		
20	39		
21	39		
22	37		
23	36		
24	37		
25	41		
Avg.:	37	Total: 0	Total: 0

Notes and Remarks: ...



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MIBANT DATA SHEET FOR PALLET NAILS
(use separate form for each lot of 25 nails)

APPENDIX TABLE 16c

(to be filled out by pallet or nail manufacturer submitting nails)

1) Nails Submitted by (complete address): Philstone Nail Corporation
Canton, Massachusetts

2) Nail Description (manufacturer, type, lot, identification): ....

3) Field Experience with Nails: ....

4) Date of Submission: ....

5) Date of Receipt at VPI: October 4, 1977 6) VPI Nail No.: 1999A

7) Nail Size (length x wire diameter): 2.9/16x 0.119"

8) Nail Type: Low-Carbon-Steel ... Stiff-Stock ... Hardened .X. Tempered ...

9) Shank Deformation: Annularly Threaded ... Helically Threaded .X Fluted ... Twisted ...

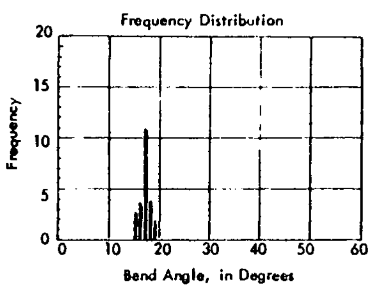
10) Thread-Crest Diameter: 0.138." 11) Thread Angle: 59° 12) Number of Flutes: 4.......

13) Appearance: ....

14) MIBANT TEST DATA: Date of Test: 10/5/77 Machine Operator: Kenneth Albert

Test No.	Angle in Degr.	Partial Failure	Complete Failure
1	15		
2	17		
3	15		
4	16		
5	16		
6	18		
7	17		
8	16		
9	16		
10	17		
11	18		
12	15		
13	17		
14	19		
15	17		
16	18		
17	17		
18	17		
19	17		
20	----------	----------	X
21	17		
22	17		
23	19		
24	17		
25	18		
Avg.:	17	Total: 0	Total: 1

Notes and Remarks: ....



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MIBANT DATA SHEET FOR PALLET NAILS
(use separate form for each lot of 25 nails)

APPENDIX TABLE 16d

(to be filled out by pallet or nail manufacturer submitting nails)

1) Nails Submitted by (complete address): Philstone Nail Corporation
P. O. Drawer G, Canton, Massachusetts 02021

2) Nail Description (manufacturer, type, lot, identification): Sample of 500-lb. lot

3) Field Experience with Nails: ....

4) Date of Submission: ....

5) Date of Receipt at VPI: July 22, 1974 6) VPI Nail No.: 1785

7) Nail Size (length x wire diameter): 3" x 0.120"

8) Nail Type: Low-Carbon-Steel ... Stiff-Stock ... Hardened .X. Tempered ...

9) Shank Deformation: Annularly Threaded ... Helically Threaded .X. Fluted ... Twisted ...

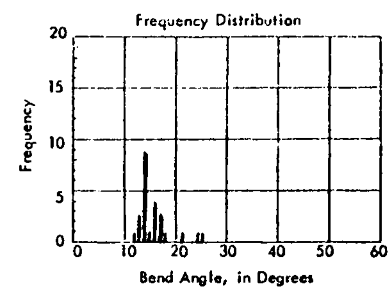
10) Thread-Crest Diameter: 0.132." 11) Thread Angle: 63° 12) Number of Flutes: 4.......

13) Appearance: Pointless --- Flattened Umbrella Head

14) MIBANT TEST DATA: Date of Test: July 26, 1974 Machine Operator: J. W. Akers

Test No.	Angle in Degr.	Partial Failure	Complete Failure
1	14°		
2	14°		
3	13°		
4	24°		
5	15°		
6	14°		
7	12°		
8	14°		
9	21°		
10	17°		
11	16°		
12	14°		
13	25°		
14	17°		
15	16°		
16	13°		
17	14°		
18	14°		
19	17°		
20	14°		
21	18°		
22	13°		
23	14°		
24	16°		
25	16°		
Avg.:	16°	Total: 0	Total: 0

Notes and Remarks: ....



Wood Research & Wood Construction Laboratory
Virginia Polytechnic Institute & State University
Blacksburg, Virginia 24061 E. George Stern

APPENDIX TABLE 17a

Six-Week Delayed Deckboard-Stringer *Separation* Resistance of Red-Oak Pallet Joints

Nails driven through 1.00"-thick deckboards of 99.8% moisture content and 0.64 oven-dry specific gravity into 2.40"-wide stringers of 70.0% moisture content and 0.67 oven-dry specific gravity.
Nails pulled through deckboard of 9.4% moisture content and/or withdrawn from stringer of 29.8% moisture content.

Oak Stick	Repli-cation	2½" Nail (a) (2017)	2½" Nail (b) (2018)	2½" Nail (c) (1999a)	3" Nail (d) (1785)		
		(b)	(b)	(b)	(a)	(b)	(c)
A	1	433	680	752		975	
A	2	567	715	838		1200	
B	3	434	775	772d	1100-	1120-	812
C	4	498	733	830		1065-	898
C	5	478	733	918		1095	
D	6	468	665	728	905-	968-	978
E	7	560	735	695d		888d	
E	8	440	600	680d		872d	
F	9	518	648	835	950-	955-	890
G	10	465	738	785	890-	1130-	690
	Avg.	486	702	783		1027	922
	Avg.	100%	144%	161%		211%	190%
	Coefficient of Variation	10.1%	7.5%	9.4%		10.8%	15.4%

(a) Head pull-through resistance. (b) Shank withdrawal resistance.
(c) Head failure. (d) Stringer split at nail location.

APPENDIX TABLE 17b

Six-Week Delayed Deckboard-Stringer *Shear* Resistance of Red-Oak Pallet Joints

Nails driven through 1.02"-thick deckboards of 74.3% moisture content and 0.70 oven-dry specific gravity into 2.40"-wide stringers of 63.8% moisture content and 0.72 oven-dry specific gravity.
Nails sheared or pulled through deckboards of 10.6% moisture content and/or withdrawn from stringers of 31.3% moisture content.

Oak Stick	Replication	$2\frac{1}{2}$" Nail (a) (2017)	$2\frac{1}{2}$" Nail (b) (2018)	$2\frac{1}{2}$" Nail (c) (1999a)	3" Nail (d) (1785)
A	1	718c	989c	1005c	1328b
B	2	812c	1025c	1070c	1335b
B	3	780c	970c	1100c	1415d
C	4	703c	965c	988c	1288c
D	5	752c	882c	895c	1028c
D	6	690c	833c	895c	1075b
E	7	670ce	935c	938ce	1195b
F	8	745c	915c	1058c	1125b
F	9	690c	945c	832a	1262c
G	10	712c	905c	1022b	1335b
	Avg.	727	927	980	1239
	Avg.	100%	128%	135%	170%
	Coefficient of Variation	6.1%	5.8%	8.9%	10.3%

(a) Nail shank sheared. (b) Nail pulled through deckboard. (c) Nail withdrawn from stringer.
(d) Nail head failure. (e) Stringer split at nail location.

APPENDIX TABLE 18a

Detailed Load-Deflection Data, in Lb. and 1/1000 In.
Pallets of Conventional Design

Test	Pallet No. Aa1					Pallet No. Aa2					Pallet No. Aa3					Pallet No. Aa4					Pallet No. Aa5				
Load	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
0	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
200	09	13	55	63	63	13	16	60	54	66	10	11	57	54	63	15	06	63	63	68	16	12	71	57	71
	10	15	63	71	72	14	18	65	60	73	12	13	63	61	70	16	07	68	68	74	16	13	76	60	76
400	23	29	122	132	138	30	33	123	120	142	27	25	121	118	137	32	12	130	129	142	32	25	138	117	141
	27	32	136	145	153	34	37	135	131	157	29	28	131	129	149	35	13	142	142	156	35	28	149	128	153
600	38	44	188	201	216	46	50	186	186	223	41	39	184	186	213	49	19	202	198	222	50	39	203	181	216
	40	48	202	212	230	49	53	197	197	237	45	41	195	198	227	52	21	214	210	236	52	43	213	192	228
800	52	63	252	266	290	63	65	244	249	301	57	52	246	253	289	65	27	273	262	299	65	53	265	239	286
	55	67	265	278	306	65	67	255	260	315	60	54	259	266	304	68	30	287	279	315	68	57	276	251	300
1000	67	82	316	329	365	79	78	301	310	375	75	64	311	322	367	79	37	344	328	374	82	66	328	298	355
	70	85	331	342	380	82	81	313	322	390	78	67	323	335	382	82	40	358	343	389	84	69	340	310	369
1200	82	101	380	394	438	93	92	359	371	450	90	76	372	388	443	92	47	411	394	448	98	76	387	350	418
	84	106	395	407	455	95	95	371	383	466	94	80	386	402	460	95	51	424	410	464	102	80	401	363	433
1400	96	114	443	457	510	106	106	416	433	524	106	89	432	457	520	106	57	473	457	519	114	87	447	405	484
	100	119	460	471	528	109	109	428	446	540	109	92	446	471	536	109	62	487	473	534	117	90	460	420	499
1600	112	126	508	515	585	120	119	472	494	600	122	101	490	522	595	118	68	534	517	589	129	97	502	462	548
	115	131	528	531	605	123	123	486	507	618	125	105	505	536	611	121	73	547	533	607	133	101	515	477	566
1800	126	139	574	575	660	133	133	527	551	675	136	113	549	584	666	131	79	591	579	660	146	107	558	518	617
	131	144	596	591	682	136	136	542	564	694	141	117	564	599	684	134	85	607	599	680	150	112	572	536	636
2000	144	150	641	635	734	146	144	581	607	747	151	125	606	642	735	144	91	648	643	730	160	119	611	577	683
	148	153	662	654	756	150	146	596	619	766	156	130	624	656	753	147	95	661	663	748	164	123	626	596	702

Test	Pallet No. Ab1					Pallet No. Ab2					Pallet No. Ab3					Pallet No. Ab4					Pallet No. Ab5				
Load	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
0	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
200	13	14	57	65	65	09	10	60	62	66	12	10	58	59	65	09	00	30	00	00	13	08	63	58	65
	13	16	61	68	68	10	12	64	66	71	14	13	64	65	72	21	10	60	42	43	14	08	67	63	69
400	27	27	111	128	130	25	23	122	127	138	28	25	126	131	142	37	21	115	103	109	30	16	126	124	136
	31	31	121	140	142	27	26	132	138	150	31	28	137	143	154	40	24	127	115	122	32	17	135	134	147
600	46	43	168	198	201	39	35	184	193	214	43	42	195	206	224	53	34	176	172	182	45	25	186	189	207
	50	46	179	212	215	41	39	196	205	227	46	45	206	218	237	55	36	186	185	194	47	27	194	200	218
800	65	57	222	267	271	52	48	243	259	286	57	57	260	279	300	66	45	231	235	249	57	35	237	248	272
	70	61	234	282	286	54	52	254	272	301	60	61	272	292	315	69	46	242	248	262	59	38	246	258	283
1000	86	71	276	336	342	66	61	303	324	357	69	73	325	347	375	81	56	287	298	320	68	46	286	304	334
	93	76	288	353	358	68	65	315	339	372	71	77	339	362	391	84	57	299	311	334	70	48	295	314	344
1200	104	86	326	405	410	80	73	361	391	427	80	89	391	418	449	95	65	343	360	386	79	56	334	355	392
	112	91	341	424	429	82	76	373	406	442	83	93	404	433	464	99	67	356	373	400	81	58	344	366	404
1400	123	100	378	474	479	91	84	417	454	495	91	101	451	484	519	110	76	402	426	456	89	66	381	407	449
	132	103	392	492	496	93	87	429	468	509	94	106	463	497	533	114	77	416	440	471	91	68	391	418	461
1600	143	112	429	539	545	107	94	472	514	564	102	114	508	544	587	124	84	457	488	521	100	75	428	457	507
	151	117	444	558	564	109	98	484	530	580	104	118	521	558	603	128	85	473	503	538	102	77	437	467	519
1800	161	125	481	602	613	117	103	523	573	630	112	126	564	602	654	138	92	512	546	588	110	84	473	504	564
	169	131	495	620	633	121	106	534	590	646	114	130	577	618	670	142	94	528	561	605	112	87	482	513	575
2000	180	139	531	662	679	135	112	575	635	696	121	139	615	662	718	151	100	566	600	652	120	93	517	549	619
	186	144	544	679	698	139	114	585	652	711	123	142	628	678	734	156	101	580	613	667	123	95	527	559	632

Test	Pallet No. Ac1					Pallet No. Ac2					Pallet No. Ac3					Pallet No. Ac4					Pallet No. Ac5				
Load	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
0	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
200	12	08	60	54	63	09	10	67	54	67	05	15	67	66	70	11	14	73	57	69	08	12	62	49	61
	13	08	65	59	69	10	10	71	58	71	07	17	71	70	74	12	16	80	62	76	08	13	65	52	65
400	27	16	121	117	133	20	19	131	112	136	15	30	133	129	142	24	30	144	117	140	16	24	122	101	123
	30	18	132	126	145	23	23	142	122	148	17	33	144	140	153	27	34	159	128	155	18	27	131	109	133
600	44	25	186	184	208	33	32	199	175	210	24	47	202	197	219	39	45	217	181	218	27	35	181	153	187
	48	27	196	194	220	35	36	210	186	224	26	49	214	208	232	42	50	232	193	232	27	38	191	161	197
800	60	34	245	246	279	44	46	265	235	285	33	63	271	262	295	54	60	287	242	292	35	47	236	205	249
	63	36	258	257	294	46	51	279	246	298	35	65	283	273	208	56	65	304	253	307	38	49	247	214	261
1000	76	43	307	311	353	58	60	331	295	358	42	77	338	323	368	67	74	360	300	364	47	57	293	256	313
	80	44	320	323	367	60	64	344	304	371	45	81	351	335	382	71	79	379	312	381	50	59	305	266	326
1200	93	50	369	376	426	71	73	396	355	431	54	92	403	386	440	85	90	437	359	440	62	72	353	307	379
	98	52	383	391	442	73	77	410	366	445	56	95	416	399	454	90	94	459	371	458	65	74	368	317	393
1400	109	57	430	444	498	81	85	458	416	501	63	104	463	447	509	103	101	510	416	511	75	81	412	354	440
	115	59	445	458	515	83	89	470	429	517	65	107	476	461	523	111	105	533	429	532	79	83	425	362	453
1600	127	64	490	508	572	95	96	516	480	575	74	117	520	510	578	128	117	592	476	593	90	90	471	402	502
	132	66	506	522	591	96	100	528	496	591	76	120	532	525	594	138	121	615	490	614	95	93	485	413	517
1800	142	72	550	568	645	106	108	575	544	648	86	129	576	572	648	150	127	668	531	668	103	101	527	450	563
	147	74	566	583	662	109	112	590	559	665	88	131	588	587	664	161	131	693	547	691	107	103	542	462	578
2000	158	80	608	627	714	115	120	634	607	717	97	139	630	629	714	172	139	739	585	740	118	117	586	505	629
	164	83	625	643	733	117	123	648	621	733	98	142	645	644	731	177	143	762	602	761	121	120	602	519	646

Test	Pallet No. Ad-					Pallet No. Ad2					Pallet No. Ad3					Pallet No. Ad4					Pallet No. Ad5				
Load	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
0	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
200	12	12	64	49	61	16	15	60	61	69	15	10	61	55	63	05	17	63	70	73	10	08	57	54	60
	13	13	68	52	65	17	16	64	65	73	16	11	67	61	70	06	18	68	76	79	10	09	61	58	63
400	24	22	128	95	123	27	29	121	118	137	34	18	125	114	131	13	32	125	141	146	21	18	117	116	126
	27	24	139	104	135	29	33	133	131	150	37	21	137	125	145	15	36	136	153	159	24	21	129	127	139
600	38	33	192	147	191	38	44	191	181	215	54	28	192	177	207	23	50	190	214	225	33	31	184	183	202
	40	35	204	157	203	41	48	205	194	230	57	31	205	189	221	26	54	203	227	239	36	34	196	195	215
800	50	44	254	197	257	51	58	261	240	290	71	38	257	238	279	34	66	257	283	301	46	42	244	258	274
	52	47	267	207	269	54	62	275	254	307	74	41	271	250	295	38	70	271	297	316	50	46	248	262	290
1000	62	55	318	245	322	63	71	331	298	366	88	47	323	297	351	46	83	323	353	375	59	53	311	314	348
	64	58	331	254	335	66	76	345	312	383	92	51	339	309	366	51	88	341	369	392	63	57	324	329	364
1200	74	66	379	292	384	76	86	399	358	440	106	57	390	355	423	60	99	391	426	451	72	65	375	380	421
	77	69	392	302	397	79	90	413	372	457	112	60	405	366	438	66	102	409	442	470	76	70	390	395	437
1400	87	76	440	339	446	88	99	463	416	513	125	66	455	413	493	77	111	458	496	526	84	76	440	444	492
	90	79	454	351	462	93	102	477	432	529	131	70	473	428	511	85	114	478	511	545	87	82	456	459	510
1600	101	87	501	388	510	101	111	524	475	583	146	76	522	474	566	97	123	526	558	602	95	89	504	505	566
	104	90	517	401	526	105	114	538	490	602	151	79	539	489	585	108	125	549	574	624	98	95	520	519	583
1800	115	97	563	439	575	114	121	583	531	654	162	85	588	533	639	122	131	596	618	676	106	102	569	564	638
	120	100	581	453	594	119	125	599	547	674	166	90	606	547	658	141	134	625	634	702	110	108	586	590	657
2000	131	106	626	490	643	132	137	647	587	728	176	95	649	588	708	150	141	669	676	750	118	115	632	622	708
	137	109	646	503	662	136	139	662	602	747	179	99	667	605	728	155	144	690	693	771	122	120	651	638	727

APPENDIX TABLE 18b

Detailed Load-Deflection Data, in Lb. and 1/1000 In.
Pallets of Improved Design

Test	Pallet No. Ba1					Pallet No. Ba2					Pallet No. Ba3					Pallet No. Ba4					Pallet No. Ba5				
Load	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
0	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
200	14	06	49	40	50	11	11	49	46	52	12	10	51	45	55	08	18	49	60	63	08	06	48	46	51
	16	07	52	43	54	12	12	53	49	56	13	11	54	48	59	10	21	55	64	68	09	08	53	51	55
400	31	13	99	83	103	25	24	99	94	107	24	21	101	93	111	23	29	103	115	122	20	14	100	99	109
	34	14	107	90	112	28	27	106	103	117	27	23	109	101	120	24	32	112	124	132	22	16	108	108	119
600	48	20	151	131	160	41	38	150	149	168	36	32	150	143	169	28	39	157	172	187	33	23	153	154	172
	51	21	160	139	170	45	41	159	160	180	41	32	159	152	180	42	41	168	183	200	35	25	161	164	183
800	63	27	201	176	216	59	53	202	204	230	49	41	199	192	226	54	48	211	228	251	45	32	202	208	233
	67	30	212	186	227	63	57	213	216	243	53	43	208	202	238	58	51	224	241	265	47	35	211	218	245
1000	79	35	253	221	272	75	68	254	256	293	62	51	248	241	284	71	57	271	286	316	57	43	252	261	295
	82	38	264	230	284	80	73	267	270	307	65	53	258	251	296	75	60	284	299	331	59	46	262	271	306
1200	93	43	306	265	328	92	84	309	312	355	73	60	295	290	339	87	66	328	343	380	68	53	302	314	353
	96	46	317	274	340	98	91	320	325	369	78	63	306	299	350	92	69	342	356	394	71	56	311	323	365
1400	107	51	355	308	380	107	102	362	366	418	86	70	342	336	392	103	75	387	399	443	80	63	351	363	412
	111	54	366	318	393	114	106	375	380	433	90	72	352	347	405	109	79	402	413	460	82	66	360	373	424
1600	122	60	404	350	434	134	117	420	424	484	98	79	387	384	446	120	84	443	453	506	92	74	401	413	471
	125	63	416	360	447	136	122	433	437	501	101	82	398	395	458	125	87	457	465	522	94	76	412	424	483
1800	136	68	450	391	487	145	131	473	473	547	108	88	431	431	498	136	93	496	501	566	103	84	451	462	529
	141	72	465	403	500	148	136	487	487	563	112	91	442	443	511	140	95	511	513	583	106	87	462	473	543
2000	152	78	498	433	538	158	146	525	522	608	119	98	474	476	551	150	101	547	547	624	116	94	498	507	588
	156	80	512	445	552	161	150	541	536	625	122	101	487	489	566	153	104	562	560	640	118	98	511	520	602

Test	Pallet No. Bb1					Pallet No. Bb2					Pallet No. Bb3					Pallet No. Bb4					Pallet No. Bb5				
Load	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
0	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
200	10	10	49	43	50	12	08	49	42	51	13	09	55	47	57	09	08	49	46	52	08	06	39	50	43
	12	13	54	47	55	13	09	54	46	56	14	09	60	49	60	10	08	52	49	54	08	07	42	54	47
400	24	24	101	91	106	27	18	98	90	106	27	18	110	97	114	21	16	98	99	108	19	15	84	106	100
	26	27	109	99	116	30	20	106	97	114	30	21	120	104	125	24	18	106	108	117	21	17	93	115	110
600	35	38	151	142	164	41	29	147	139	162	43	30	166	147	177	37	27	151	158	172	33	24	134	167	163
	38	41	159	150	173	43	31	156	148	172	46	32	177	157	187	40	27	160	166	182	35	27	142	179	174
800	46	50	200	189	219	54	38	194	188	219	58	39	220	197	237	52	34	202	212	232	46	35	182	228	227
	48	53	208	198	229	57	40	202	199	230	63	43	232	205	249	54	35	212	221	243	49	37	191	240	239
1000	56	63	249	238	275	68	48	239	238	273	75	49	273	243	295	67	41	254	267	295	60	45	230	287	288
	58	66	258	248	287	71	49	249	248	285	79	53	285	254	309	71	42	266	279	307	63	47	241	299	301
1200	67	75	295	284	331	81	57	284	286	327	91	60	324	390	352	82	47	308	322	356	75	54	279	344	350
	70	78	305	295	342	84	59	293	295	337	95	63	336	301	365	86	49	320	333	368	77	57	290	358	364
1400	78	86	342	333	386	93	65	327	331	377	106	70	374	336	408	98	54	362	376	416	89	63	328	402	411
	81	89	352	344	397	96	68	337	342	388	110	73	386	347	421	102	56	375	387	429	92	66	341	416	425
1600	90	98	389	378	440	106	74	369	377	427	121	81	421	382	462	112	62	418	430	476	103	72	380	462	473
	93	100	399	389	452	109	76	380	389	440	125	84	432	392	475	117	63	429	441	490	106	74	391	476	488
1800	101	108	435	425	493	119	82	412	424	479	136	92	467	427	517	127	68	471	482	536	118	80	429	521	534
	105	111	448	437	508	122	84	424	437	490	140	95	479	437	531	131	70	484	495	551	122	83	442	536	550
2000	114	118	482	471	549	131	90	454	469	526	150	102	510	469	570	140	74	522	531	596	134	88	479	577	595
	120	120	495	484	563	134	92	465	484	542	154	106	525	482	586	145	76	537	545	612	138	90	491	591	612

Test	Pallet No. Bc1					Pallet No. Bc2					Pallet No. Bc3					Pallet No. Bc4					Pallet No. Bc5				
Load	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
0	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
200	11	08	48	56	56	11	10	49	43	52	10	08	48	38	46	13	12	57	49	57	09	13	52	36	57
	12	08	51	60	60	12	12	53	46	55	11	09	52	42	50	15	13	62	53	63	10	14	56	41	61
400	24	16	95	111	114	23	24	101	90	109	21	19	103	86	101	27	27	119	106	122	23	28	109	96	123
	26	17	103	120	123	26	27	109	99	118	24	21	112	93	110	31	30	129	116	133	26	31	118	106	134
600	38	24	145	171	175	38	37	158	141	172	35	31	161	139	164	43	41	183	166	191	38	43	168	160	194
	41	26	153	180	186	41	40	169	150	183	40	34	172	148	175	47	43	193	177	202	42	47	177	171	205
800	52	33	192	227	238	53	50	218	190	238	53	43	218	194	226	60	55	244	225	258	54	60	223	224	262
	55	35	201	236	249	58	54	230	201	251	59	44	230	205	238	63	58	254	235	270	57	63	233	236	274
1000	66	41	241	284	299	70	63	279	238	302	73	54	273	249	290	73	70	304	281	325	68	76	278	287	329
	69	43	250	295	311	76	68	295	251	320	82	56	287	262	304	78	73	316	292	337	71	80	288	298	342
1200	79	50	290	339	358	87	78	341	289	369	93	65	329	306	353	86	85	366	336	389	83	93	332	344	394
	82	53	299	350	370	93	83	355	303	386	98	67	344	319	367	90	88	376	346	402	87	97	343	356	409
1400	93	60	337	391	416	102	93	399	340	434	109	76	389	361	417	98	99	424	388	452	98	109	386	405	462
	95	62	347	402	428	108	98	414	355	451	112	79	400	370	430	102	103	436	399	465	104	116	401	421	479
1600	105	69	386	443	474	117	108	454	392	498	120	89	445	413	477	110	114	483	440	514	116	128	443	469	533
	108	71	394	454	486	123	114	468	407	515	123	92	460	425	491	114	117	495	451	528	123	136	458	486	550
1800	117	80	431	492	530	132	123	508	445	560	132	101	501	465	539	123	127	542	487	577	134	146	498	533	600
	120	83	440	503	544	137	130	522	461	577	134	104	515	476	553	128	131	555	499	591	141	153	514	551	619
2000	129	90	475	544	588	147	138	560	497	623	143	112	555	512	598	135	139	600	531	637	151	164	553	596	666
	131	94	487	556	602	151	146	575	513	642	147	114	572	524	614	140	143	613	542	653	158	174	570	613	686

Test	Pallet No. Bd1					Pallet No. Bd2					Pallet No. Bd3					Pallet No. Bd4					Pallet No. Bd5				
Load	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
0	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
200	13	14	51	58	62	13	09	54	50	57	13	13	49	50	54	11	10	56	54	58	10	09	50	54	55
	14	15	54	61	65	15	10	60	54	63	14	16	55	55	60	13	13	61	59	63	11	10	54	58	60
400	30	30	108	117	127	28	18	117	103	120	27	30	114	106	120	27	27	118	112	122	26	18	106	112	117
	32	32	119	127	139	32	22	128	112	131	29	34	123	114	130	31	30	130	122	134	28	20	114	120	128
600	48	45	170	180	199	46	30	181	161	188	41	49	179	165	189	45	42	186	175	193	43	29	163	173	183
	52	49	183	191	213	49	32	192	172	200	43	52	190	175	201	50	45	200	186	206	47	30	175	184	195
800	65	60	231	241	272	63	40	241	220	257	54	67	243	224	260	64	57	251	236	264	62	38	223	234	252
	72	64	244	251	286	68	42	254	232	269	56	71	254	235	272	71	60	268	246	278	67	41	236	246	267
1000	86	75	292	301	344	82	48	302	277	324	65	87	305	281	329	84	72	320	295	336	82	48	284	295	323
	91	81	307	314	359	88	50	316	290	339	66	93	317	293	342	91	74	335	306	350	87	51	298	309	339
1200	103	95	356	361	416	101	56	364	336	391	75	109	369	339	398	103	86	383	353	402	101	57	344	358	393
	107	104	375	375	432	108	57	379	348	407	77	114	383	350	412	110	89	398	365	417	108	62	361	370	409
1400	119	117	424	422	488	122	62	427	392	459	85	128	432	397	467	121	98	443	410	468	121	68	407	419	462
	125	125	444	436	506	129	63	442	405	473	87	134	446	408	482	127	103	458	422	483	130	73	424	434	480
1600	139	136	491	482	559	143	68	491	451	526	96	153	499	459	540	138	112	502	471	533	145	79	471	484	532
	147	140	507	495	577	152	71	506	463	542	98	157	514	472	556	144	116	517	483	548	154	85	488	498	550
1800	160	148	552	537	629	166	74	553	509	594	105	172	562	517	612	154	125	560	528	599	167	92	529	547	602
	172	151	574	553	652	176	78	571	522	613	107	177	578	531	629	159	129	577	543	617	172	98	544	562	620
2000	191	159	622	596	706	190	82	616	565	664	114	193	627	575	665	169	138	618	585	666	180	106	582	605	667
	201	163	644	613	728	202	84	636	579	684	117	200	646	589	704	174	143	636	599	684	184	111	597	623	686

APPENDIX TABLE 19

Average Load-Deflection Value, in Lb. and 1/1000 In.

Test Load	Pallet	Deflections AB						Deflections CD						Deflection E					
	Aa	1	2	3	4	5	Avg.	1	2	3	4	5	Avg.	1	2	3	4	5	Avg.
0		000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
200		11	15	11	11	14	12	59	57	56	63	64	60	63	66	63	68	71	66
		13	16	13	12	15	14	67	63	62	68	68	66	72	73	70	74	76	73
400		26	32	26	22	29	26	127	122	120	130	128	125	138	142	137	142	141	140
		30	36	29	24	32	30	141	133	130	142	139	137	153	157	149	156	153	154
600		41	48	40	34	45	42	195	186	185	200	192	192	216	223	213	222	216	218
		44	51	43	37	48	45	207	197	198	212	203	203	230	237	227	236	228	232
800		58	64	55	46	52	55	259	247	250	268	252	255	290	301	289	299	266	293
		61	66	57	49	63	59	272	258	263	283	264	268	306	315	304	315	300	308
1000		75	79	70	58	74	71	323	306	317	336	313	319	365	375	367	374	355	368
		78	82	73	61	77	74	337	318	329	351	326	332	380	390	382	389	369	382
1200		92	93	83	70	87	85	387	365	380	403	369	381	438	450	443	448	418	439
		95	95	87	73	91	88	401	377	394	417	382	394	455	466	460	464	433	456
1400		105	106	98	82	101	98	450	425	445	465	426	442	510	524	520	519	484	511
		110	109	101	86	104	102	466	437	459	480	440	456	528	540	536	534	499	527
1600		119	120	112	93	113	111	512	483	506	526	482	502	585	600	595	589	548	583
		123	123	115	97	117	115	530	497	521	540	496	517	605	618	611	607	566	601
1800		133	133	125	105	127	125	575	539	567	585	538	560	660	675	666	660	617	656
		138	136	129	110	131	129	594	553	582	603	554	577	682	694	684	680	636	675
2000		147	145	138	118	140	138	638	594	624	646	594	619	734	747	735	730	683	726
		151	148	143	121	144	141	658	608	640	662	611	636	756	764	753	748	702	745

Test Load	Pallet	Deflections AB						Deflections CD						Deflection E					
	Ba	1	2	3	4	5	Avg.	1	2	3	4	5	Avg.	1	2	3	4	5	Avg.
0		000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
200		10	11	11	13	07	10	45	48	48	55	47	49	50	52	55	63	51	54
		12	12	12	16	09	12	48	51	51	60	52	52	54	56	59	68	55	58
400		22	25	23	26	17	23	91	97	97	109	100	999	103	107	111	122	109	110
		24	28	25	28	19	25	99	105	105	118	108	107	112	117	120	132	119	120
600		34	40	34	39	28	35	141	150	147	165	154	151	160	168	169	197	172	171
		36	43	37	42	30	38	150	160	156	176	163	161	170	180	180	200	183	183
800		45	56	45	51	39	47	189	203	196	220	205	203	216	230	226	251	233	231
		49	60	48	55	41	51	199	215	205	233	215	213	227	243	238	265	245	244
1000		57	72	57	64	50	60	237	255	245	279	257	255	272	293	284	316	275	292
		60	77	59	68	53	63	247	269	255	292	267	266	284	307	296	331	306	305
1200		68	88	67	77	61	72	286	311	293	336	308	313	328	355	339	380	353	351
		71	95	71	81	64	76	296	323	303	349	317	318	340	369	350	394	365	364
1400		79	105	78	89	72	85	332	364	339	393	357	357	380	418	392	443	412	409
		83	110	81	94	74	88	342	378	350	408	367	369	393	433	405	460	424	423
1600		91	126	89	102	83	98	377	422	356	448	407	408	434	484	440	506	471	467
		94	129	92	106	85	101	388	435	397	461	418	420	447	501	458	522	483	482
1800		102	138	98	115	94	109	421	473	431	499	457	456	487	547	498	566	529	525
		107	142	102	118	97	113	434	487	443	512	468	469	500	563	511	583	543	540
2000		115	152	109	126	105	121	466	524	475	547	503	503	538	608	551	624	588	582
		118	156	112	129	108	125	479	539	488	561	516	516	552	625	566	640	602	597

Test Load	Pallet	Deflections AB						Deflections CD						Deflection E					
	Ab	1	2	3	4	5	Avg.	1	2	3	4	5	Avg.	1	2	3	4	5	Avg.
0		000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
200		14	10	11	05	11	10	61	61	59	15	61	51	65	66	65	00	65	52
		15	11	14	16	11	13	65	65	65	51	65	62	68	71	72	43	69	65
400		27	24	27	29	23	26	120	125	129	109	125	122	130	138	142	109	136	131
		31	27	30	32	25	29	131	135	140	121	135	132	142	150	154	122	147	143
600		45	37	43	44	35	41	183	189	201	174	188	187	201	214	224	182	207	206
		48	40	46	46	37	43	196	201	212	186	197	198	215	227	237	194	218	218
800		61	50	57	56	46	54	245	251	270	233	243	248	271	286	300	249	272	276
		66	53	61	58	49	57	258	263	282	245	252	260	286	301	315	262	283	289
1000		79	64	71	69	57	68	306	314	336	293	295	309	342	357	375	320	334	346
		85	67	74	71	59	71	321	327	351	305	305	322	358	372	391	334	344	360
1200		95	77	85	80	68	81	366	376	405	352	345	369	410	427	449	386	392	413
		102	79	88	83	70	84	383	390	419	365	355	382	429	442	464	400	404	428
1400		112	88	96	93	78	93	426	436	468	414	394	428	479	495	519	456	449	480
		118	90	100	96	80	97	442	449	480	428	405	441	496	509	533	471	461	494
1600		128	101	108	104	88	106	484	493	526	473	443	484	545	564	587	521	507	545
		134	104	111	107	90	109	501	507	540	488	452	498	564	580	603	538	519	561
1800		143	110	119	115	97	117	542	548	583	528	489	538	613	630	654	588	564	610
		150	114	122	118	100	121	558	562	598	545	498	552	633	646	670	605	575	626
2000		160	124	130	126	107	129	597	605	639	583	533	591	679	696	718	652	619	673
		165	127	133	129	109	133	612	619	653	597	543	605	698	711	734	667	632	688

Test Load	Pallet	Deflections AB						Deflections CD						Deflection E					
	Bb	1	2	3	4	5	Avg.	1	2	3	4	5	Avg.	1	2	3	4	5	Avg.
0		000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
200		10	10	11	09	07	09	46	46	51	48	45	47	50	51	57	52	43	51
		13	11	12	09	08	11	51	50	55	51	48	51	55	56	60	54	47	54
400		24	23	23	19	17	21	96	94	104	99	95	98	106	106	114	108	100	107
		27	25	26	21	19	24	104	102	112	107	104	106	116	114	125	117	110	116
600		37	35	37	32	29	34	147	143	157	155	151	151	164	162	177	172	163	168
		40	37	39	34	31	36	155	152	167	163	161	160	173	172	187	182	174	178
800		48	46	49	43	41	45	195	191	209	207	205	201	219	219	237	232	227	230
		51	49	53	45	43	48	203	201	219	217	216	211	229	230	249	243	239	238
1000		60	58	62	54	53	57	244	239	258	261	259	252	275	273	295	295	288	285
		62	60	66	57	55	60	253	249	270	273	270	263	287	285	309	307	301	298
1200		71	69	76	65	65	69	290	285	307	315	312	302	331	327	352	356	360	343
		74	72	79	68	67	72	300	294	319	327	324	313	342	337	365	368	364	355
1400		82	79	88	76	76	80	338	329	355	369	365	351	386	377	408	416	411	400
		85	82	92	79	79	85	348	340	367	381	379	363	397	388	421	429	425	412
1600		94	90	101	87	88	92	384	373	402	424	421	401	440	427	462	476	473	456
		97	93	105	90	90	95	394	385	412	435	434	412	452	440	475	490	488	469
1800		105	101	114	98	99	103	430	418	447	477	473	449	493	479	517	536	534	512
		108	103	118	101	103	107	433	431	458	490	489	460	508	490	531	551	550	525
2000		116	111	126	107	111	114	477	462	490	527	528	497	549	526	570	596	595	567
		120	113	130	111	114	118	490	504	504	541	541	516	563	542	586	612	612	583

Test Load	Pallet	Deflections AB						Deflections CD						Deflection E					
	Ac	1	2	3	4	5	Avg.	1	2	3	4	5	Avg.	1	2	3	4	5	Avg.
0		000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
200		10	10	10	13	10	11	57	61	67	65	56	61	63	67	70	69	61	66
		11	10	12	14	11	12	62	65	71	71	59	66	69	71	74	76	65	71
400		22	20	23	27	20	22	119	122	131	131	112	123	133	136	142	140	123	135
		24	23	25	31	23	25	129	132	142	144	120	133	145	148	153	155	133	147
600		35	33	36	42	31	35	185	187	200	199	167	188	208	210	219	218	187	208
		38	36	38	46	33	38	195	198	211	213	176	199	220	224	232	232	197	221
800		47	45	48	57	41	48	246	250	267	265	221	250	279	285	295	292	249	280
		50	49	50	61	44	51	258	263	278	279	231	262	294	298	308	307	261	294
1000		60	59	60	71	52	60	309	313	331	330	275	312	353	358	368	364	313	351
		62	62	63	75	55	63	322	324	343	346	286	324	367	371	382	381	326	365
1200		72	72	73	88	67	74	373	376	395	398	330	374	426	431	440	440	379	423
		75	75	76	92	70	78	387	388	408	415	343	388	442	445	454	458	393	438
1400		83	83	84	102	78	86	437	437	455	463	383	435	498	501	509	511	440	492
		87	86	86	108	81	90	452	450	469	481	394	449	515	517	523	532	453	508
1600		96	96	96	123	90	100	499	498	515	534	437	497	572	575	578	593	502	564
		99	98	98	130	94	104	514	512	529	553	448	511	591	591	594	614	517	581
1800		107	108	197	139	102	113	599	560	574	600	489	564	645	648	648	668	563	634
		111	111	110	146	105	117	575	575	588	620	502	572	662	665	664	691	578	652
2000		119	118	118	156	118	126	618	621	630	662	546	615	714	717	714	740	629	703
		124	120	120	160	121	129	634	635	645	682	561	631	733	733	731	761	646	721

Test Load	Pallet	Deflections AB						Deflections CD						Deflection E					
	Bc	1	2	3	4	5	Avg.	1	2	3	4	5	Avg.	1	2	3	4	5	Avg.
0		000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
200		10	11	09	13	11	11	52	46	43	53	44	48	56	52	46	57	57	54
		10	12	10	14	12	12	56	50	47	58	49	52	60	55	50	63	61	58
400		20	24	20	27	26	23	103	96	95	113	103	102	114	109	101	122	123	114
		22	27	23	31	29	26	112	104	103	123	112	111	123	118	110	133	136	124
600		31	38	33	42	41	37	158	150	150	175	164	159	175	172	164	191	194	179
		34	41	37	45	45	40	167	160	160	185	174	169	186	183	175	202	205	190
800		43	52	48	58	57	52	210	204	206	235	224	216	238	238	226	258	262	244
		45	56	52	61	60	55	219	216	218	245	235	227	249	251	238	270	274	256
1000		54	67	64	72	72	66	263	259	261	293	283	272	299	302	290	325	329	329
		56	72	69	76	76	70	273	273	275	304	293	284	311	320	304	337	342	323
1200		65	83	79	86	88	80	315	315	318	351	338	327	358	369	353	389	394	373
		68	88	83	89	92	84	325	329	332	361	350	339	370	386	367	402	409	387
1400		77	98	93	99	104	94	364	370	375	406	396	382	416	434	417	452	462	436
		79	103	96	103	110	98	375	385	385	418	411	395	428	451	430	465	479	451
1600		87	113	105	112	122	108	415	423	429	462	456	437	474	498	477	514	533	499
		90	119	108	116	130	113	424	438	443	473	472	450	486	515	491	528	550	514
1800		99	128	117	125	140	122	462	477	483	515	516	491	530	560	539	577	600	561
		102	134	119	130	147	126	472	492	496	527	533	504	544	577	553	591	619	577
2000		110	143	128	137	158	135	510	529	534	566	575	543	508	623	598	637	666	622
		113	149	131	142	166	140	522	544	548	578	592	557	602	642	614	653	686	639

Test Load	Pallet	Deflections AB						Deflections CD						Deflection E					
	Ad	1	2	3	4	5	Avg.	1	2	3	4	5	Avg.	1	2	3	4	5	Avg.
0		000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
200		12	16	13	11	09	12	57	61	58	67	56	60	61	69	63	73	60	65
		13	17	14	12	10	13	60	65	64	72	60	64	65	73	70	79	63	70
400		23	28	26	23	20	24	112	120	120	133	117	120	123	137	131	146	126	133
		26	31	29	26	23	27	122	132	131	145	128	132	135	150	145	159	139	146
600		36	41	41	37	32	37	170	186	185	202	184	185	191	215	207	225	202	208
		38	45	44	40	35	40	181	200	197	215	196	198	203	220	221	239	215	222
800		47	55	55	50	44	50	226	251	248	270	246	248	257	290	279	301	274	280
		50	58	58	54	48	54	237	265	261	284	260	261	269	307	295	316	290	295
1000		59	67	68	65	56	63	292	315	310	338	313	312	322	366	351	375	348	352
		61	71	72	70	60	67	293	329	324	355	327	326	335	383	366	392	364	368
1200		70	81	82	80	69	76	336	379	373	409	378	375	384	440	423	451	421	424
		73	85	96	84	73	80	347	393	386	426	393	389	397	457	438	470	437	440
1400		82	94	96	94	80	89	390	440	434	477	442	437	446	513	493	526	492	494
		85	98	101	100	85	94	403	455	451	495	458	452	462	529	511	545	510	511
1600		94	106	111	110	92	103	445	500	498	542	505	498	510	583	566	602	566	565
		97	110	115	117	97	107	459	514	514	562	520	514	526	602	585	624	583	584
1800		106	118	124	127	104	116	501	557	561	607	567	559	575	654	639	676	638	636
		110	122	128	138	109	121	517	573	577	630	583	576	594	674	658	702	657	657
2000		119	135	136	146	117	131	558	617	619	673	627	619	643	728	708	750	708	707
		123	138	139	150	121	134	575	632	636	692	645	636	662	747	728	771	727	727

Test Load	Pallet	Deflections AB						Deflections CD						Deflection E					
	Bd	1	2	3	4	5	Avg.	1	2	3	4	5	Avg.	1	2	3	4	5	Avg.
0		000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
200		14	11	13	11	10	12	55	52	50	55	52	53	62	57	54	58	55	57
		15	13	15	13	11	13	58	57	55	60	56	57	65	63	60	63	60	62
400		30	23	29	27	22	26	113	110	110	115	109	111	127	120	120	122	117	121
		32	27	32	31	24	29	123	120	119	126	117	121	139	131	130	134	128	132
600		47	38	45	44	36	42	175	171	172	181	168	173	199	188	189	193	183	191
		51	41	48	48	39	45	187	182	183	193	180	185	213	200	201	206	195	203
800		64	52	61	61	50	58	236	231	234	244	229	235	272	257	260	264	252	261
		68	55	64	66	54	61	248	243	245	257	241	247	286	269	272	278	267	274
1000		81	65	76	78	65	73	297	290	293	308	290	296	344	324	329	336	323	331
		86	69	80	83	69	77	311	303	305	321	304	309	359	339	342	350	339	346
1200		99	79	92	95	79	89	359	350	354	368	351	356	416	391	398	402	393	400
		106	83	96	100	85	94	375	364	367	382	366	371	432	407	412	417	409	415
1400		118	92	107	110	95	104	423	410	415	427	413	418	488	459	467	468	462	469
		125	96	111	115	102	110	440	424	427	440	429	432	506	473	482	483	480	485
1600		138	106	125	125	112	121	487	471	479	487	478	480	559	526	540	533	532	538
		144	112	128	130	120	127	501	485	493	500	493	494	577	542	556	548	550	555
1800		154	120	139	140	130	137	545	531	540	544	538	540	629	594	612	599	602	607
		162	127	142	144	135	142	564	547	555	560	553	556	652	613	629	617	620	626
2000		175	136	154	154	143	152	609	591	601	602	594	599	706	664	685	666	667	679
		182	143	159	159	148	158	629	608	618	618	610	617	728	684	704	684	686	697

APPENDIX TABLE 20

Summary of Linear Regression Analysis for Parameters of $D = A + BW$ for Pallets of Improved Design

Intercept (1/1000 In.)	Slope (1/1000 In./Lb.)	r	r^2
46227	-198	0.76	0.58

D = Cumulative deflections (ABCDE)
W = Weight of pallets

Adjusted Values Based on Slope of Regression Line

Design	Nail a	Nail b	Nail c	Nail d
Conventional	17010	16192	16185	14750
	16817	16188	16269	16645
	16778	17082	16672	16359
	16940	15075	17372	17544
	16229	14753	14391	16098
Improved	12585	12841	13613	14605
	14126	12553	14269	13363
	12900	13573	13863	13982
	14698	13660	14161	15697
	13352	13514	13812	14002

APPENDIX TABLE 21

Two-Factorial Analysis of Variance of Initial Stiffness Test Data for Pallets of Two Designs, Assembled with Four Different Nails

a. for unadjusted values

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	Computed f	Critical f	
Design	39.86 E6	1	39.86 E6	60.58	4.15	S
Nail	11.19 E6	3	3.73 E6	5.67	2.90	S
Interaction	10.60 E6	3	3.53 E6	5.36	2.90	S
Error	21.05 E6	32	0.66 E6			
Total	82.70 E6	39				

b. for adjusted values

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	Computed f	Critical f	
Design	62.95 E6	1	62.95 E6	98.98	4.15	S
Nail	3.25 E6	3	1.08 E6	1.70	2.90	NS
Interaction	2.28 E6	3	0.76 E6	1.20	2.90	NS
Error	20.35 E6	32	0.64 E6			
Total	88.83 E6	39				

APPENDIX TABLE 22a

Detailed Test Data for Free-Fall Drop Tests from 33½" Height of Conventional Stevedore Pallets

Pallet Number	Test Condition	Length of Diagonals, in In. (a)	(b)	(c)	(d)	Change in Length, in In. (a)	(b)	(c)	(d)	Average Change
Aa1	Prior to test	73.86	73.59	74.03	73.31	—	—	—	—	—
	After 1st Drop	72.04	75.37	72.16	75.11	1.82	1.78	1.87	1.80	1.82
	After 2nd Drop	70.67	76.62	70.77	76.39	3.19	3.03	3.26	3.08	3.14
	After 3rd Drop	69.49	77.67	69.63	77.42	4.37	4.08	4.40	4.11	4.24
	After 4th Drop	68.50	78.54	68.61	78.30	5.36	4.95	5.42	4.99	5.18
	After 5th Drop	67.62	79.28	67.72	79.21	6.24	5.69	6.31	5.90	6.04
	After 6th Drop	66.75	79.98	66.86	79.75	7.11	6.39	7.17	6.44	6.78
	Total Distortion, in Percent:					9.63	8.68	9.69	8.78	
	Avg. Distortion, in Percent:					9.20				
Aa2	Prior to test	73.39	73.80	73.45	73.69	—	—	—	—	—
	After 1st Drop	71.61	75.49	71.56	75.41	1.78	1.69	1.89	1.72	1.77
	After 2nd Drop	70.31	76.67	70.21	76.61	3.08	2.87	3.24	2.92	3.03
	After 3rd Drop	69.25	77.61	69.11	77.55	4.14	3.81	4.34	3.86	4.04
	After 4th Drop	68.23	78.48	68.11	78.41	5.16	4.68	5.34	4.72	4.98
	After 5th Drop	67.22	79.32	67.11	79.23	6.17	5.52	6.34	5.54	5.89
	After 6th Drop	66.38	80.02	66.21	79.95	7.01	6.22	7.24	6.26	6.68
	Total Distortion, in Percent:					9.55	8.43	9.86	8.50	
	Avg. Distortion, in Percent:					9.09				
Aa3	Prior to test	73.45	73.89	73.51	73.74	—	—	—	—	—
	After 1st Drop	71.70	75.54	71.78	75.37	1.75	1.65	1.73	1.63	1.69
	After 2nd Drop	70.44	76.70	70.50	76.53	3.01	2.81	3.01	2.79	2.91
	After 3rd Drop	69.30	77.71	69.40	77.51	4.15	3.82	4.11	3.77	3.96
	After 4th Drop	68.26	78.59	68.39	78.38	5.19	4.70	5.12	4.64	4.91
	After 5th Drop	67.40	79.31	67.50	79.12	6.05	5.42	6.01	5.38	5.72
	After 6th Drop	66.47	80.07	66.55	79.86	6.98	6.18	6.96	6.12	6.56
	Total Distortion, in Percent:					9.50	8.36	9.42	8.30	
	Avg. Distortion, in Percent:					8.90				
Aa4	Prior to test	73.47	73.77	73.52	73.71	—	—	—	—	—
	After 1st Drop	71.72	75.40	71.78	75.37	1.75	1.63	1.74	1.66	1.70
	After 2nd Drop	70.35	76.68	70.37	76.63	3.12	2.91	3.15	2.92	3.03
	After 3rd Drop	69.18	77.70	69.21	77.66	4.29	3.93	4.31	3.95	4.12
	After 4th Drop	68.10	78.62	68.15	78.54	5.37	4.85	5.37	4.83	5.11
	After 5th Drop	67.08	79.48	67.14	79.40	6.39	5.71	6.38	5.69	6.04
	After 6th Drop	66.18	80.17	66.29	80.10	7.29	6.40	7.23	6.39	6.83
	Total Distortion, in Percent:					9.89	8.68	9.83	8.67	
	Avg. Distortion, in Percent:					9.27				
Aa5	Prior to test	73.50	73.70	73.91	73.28	—	—	—	—	—
	After 1st Drop	71.61	75.50	72.02	75.11	1.89	1.80	1.89	1.83	1.85
	After 2nd Drop	70.22	76.76	70.54	76.41	3.28	3.06	3.37	3.13	3.21
	After 3rd Drop	69.18	77.67	69.51	77.32	4.32	3.97	4.40	4.04	4.18
	After 4th Drop	67.89	78.78	68.19	78.44	5.61	5.08	5.72	5.16	5.39
	After 5th Drop	66.98	79.53	67.34	79.16	6.52	5.83	6.57	5.88	6.20
	After 6th Drop	65.98	80.33	66.28	80.00	7.52	6.63	7.63	6.72	7.13
	Total Distortion, in Percent:					10.23	9.00	10.32	9.17	
	Avg. Distortion, in Percent:					9.68				

APPENDIX TABLE 22b

Detailed Test Data for Free-Fall Drop Tests from 33½" Height of Conventional Stevedore Pallets

Pallet Number	Test Condition	Length of Diagonals, in In. (a)	(b)	(c)	(d)	Change in Length, in In. (a)	(b)	(c)	(d)	Average Change
Ab1	Prior to test	73.54	73.57	73.63	73.53	—	—	—	—	—
	After 1st Drop	71.64	75.37	71.70	75.36	1.90	1.80	1.93	1.83	1.87
	After 2nd Drop	70.37	76.55	70.40	76.53	3.17	2.98	3.23	3.00	3.10
	After 3rd Drop	69.38	77.40	69.44	77.40	4.16	3.83	4.19	3.87	4.01
	After 4th Drop	68.66	78.10	68.74	78.00	4.88	4.53	4.89	4.47	4.69
	After 5th Drop	68.04	78.53	68.14	78.50	5.50	4.96	5.49	4.97	5.23
	After 6th Drop	67.50	79.00	67.60	78.98	6.04	5.43	6.03	5.45	5.74
	Total Distortion, in Percent:					8.21	7.38	8.19	7.41	
	Avg. Distortion, in Percent:					7.80				
Ab2	Prior to test	73.58	73.66	73.57	73.64	—	—	—	—	—
	After 1st Drop	71.72	75.44	71.66	75.45	1.86	1.78	1.91	1.81	1.84
	After 2nd Drop	70.47	76.57	70.39	76.60	3.11	2.91	3.18	2.96	3.04
	After 3rd Drop	69.60	77.34	69.49	77.39	3.98	3.68	4.08	3.75	3.87
	After 4th Drop	68.85	77.99	68.73	78.03	4.73	4.33	4.84	4.39	4.57
	After 5th Drop	68.26	78.50	68.15	78.54	5.32	4.84	5.42	4.90	5.12
	After 6th Drop	67.71	78.96	67.57	79.02	5.87	5.30	6.00	5.38	5.64
	Total Distortion, in Percent:					7.98	7.20	8.16	7.31	
	Avg. Distortion, in Percent:					7.66				
Ab3	Prior to test	73.60	73.49	73.74	73.50	—	—	—	—	—
	After 1st Drop	71.77	75.24	71.80	75.30	1.83	1.75	1.94	1.80	1.83
	After 2nd Drop	70.51	76.37	70.56	76.43	3.09	2.88	3.18	2.93	3.02
	After 3rd Drop	69.57	77.10	69.61	77.26	4.03	3.61	4.13	3.76	3.88
	After 4th Drop	68.78	77.87	68.85	77.93	4.82	4.38	4.89	4.43	4.63
	After 5th Drop	68.16	78.42	68.19	78.48	5.44	4.93	5.55	4.98	5.23
	After 6th Drop	67.53	78.93	67.57	79.00	6.07	5.44	6.17	5.50	5.80
	Total Distortion, in Percent:					8.25	7.40	8.37	7.48	
	Avg. Distortion, in Percent:					7.88				
Ab4	Prior to test	73.77	73.58	73.78	73.59	—	—	—	—	—
	After 1st Drop	71.65	75.50	71.75	75.54	2.12	1.92	2.03	1.95	2.01
	After 2nd Drop	70.34	76.69	70.46	76.72	3.43	3.11	3.32	3.13	3.25
	After 3rd Drop	69.44	77.48	69.58	77.50	4.33	3.90	4.20	3.91	4.09
	After 4th Drop	68.70	78.10	68.81	78.17	5.07	4.52	4.97	4.58	4.79
	After 5th Drop	68.03	78.68	68.14	78.74	5.74	5.10	5.64	5.15	5.41
	After 6th Drop	67.46	79.16	67.52	79.25	6.31	5.58	6.26	5.66	5.95
	Total Distortion, in Percent:					8.55	7.58	8.48	7.69	
	Avg. Distortion, in Percent:					8.08				
Ab5	Prior to test	73.69	73.69	73.75	73.60	—	—	—	—	—
	After 1st Drop	71.78	75.51	71.75	75.46	1.91	1.82	2.00	1.86	1.90
	After 2nd Drop	70.43	76.71	70.45	76.64	3.26	3.02	3.30	3.04	3.16
	After 3rd Drop	69.50	77.53	69.53	77.45	4.19	3.84	4.22	3.85	4.03
	After 4th Drop	69.01	77.97	68.99	77.91	4.68	4.28	4.76	4.31	4.51
	After 5th Drop	68.41	78.47	68.37	78.43	5.28	4.78	5.38	4.83	5.07
	After 6th Drop	67.78	78.99	67.76	78.93	5.91	5.30	5.99	5.33	5.63
	Total Distortion, in Percent:					8.02	7.19	8.12	7.24	
	Avg. Distortion, in Percent:					7.64				

APPENDIX TABLE 22c

Detailed Test Data for Free-Fall Drop Tests from 33½" Height of Conventional Stevedore Pallets

Pallet Number	Test Condition	Length of Diagonals, in In. (a)	(b)	(c)	(d)	Change in Length, in In. (a)	(b)	(c)	(d)	Average Change
Ac1	Prior to test	73.58	73.64	73.78	73.46	—	—	—	—	—
	After 1st Drop	72.34	74.81	72.54	74.62	1.24	1.17	1.24	1.16	1.20
	After 2nd Drop	71.66	75.47	71.82	75.30	1.92	1.83	1.96	1.84	1.89
	After 3rd Drop	71.26	75.83	71.46	75.66	2.32	2.19	2.32	2.20	2.26
	After 4th Drop	70.90	76.10	71.08	76.00	2.68	2.50	2.70	2.54	2.61
	After 5th Drop	70.60	76.42	70.80	76.24	2.98	2.78	2.98	2.78	2.88
	After 6th Drop	70.30	76.70	70.50	76.51	3.28	3.06	3.28	3.05	3.17
	Total Distortion, in Percent:					4.46	4.16	4.45	4.15	
	Avg. Distortion, in Percent:						4.31			
Ac2	Prior to test	73.79	73.57	73.73	73.50	—	—	—	—	—
	After 1st Drop	72.57	74.71	72.53	74.67	1.22	1.14	1.20	1.17	1.18
	After 2nd Drop	71.98	75.30	71.91	75.26	1.81	1.73	1.82	1.76	1.78
	After 3rd Drop	71.50	75.71	71.46	75.65	2.29	2.14	2.27	2.15	2.21
	After 4th Drop	71.21	76.00	71.18	75.93	2.58	2.43	2.55	2.43	2.50
	After 5th Drop	70.97	76.22	70.90	76.18	2.82	2.65	2.83	2.68	2.75
	After 6th Drop	70.70	76.46	70.65	76.40	3.09	2.89	3.08	2.90	2.99
	Total Distortion, in Percent:					4.19	3.93	4.18	3.95	
	Avg. Distortion, in Percent:						4.06			
Ac3	Prior to test	73.47	73.93	73.43	73.75	—	—	—	—	—
	After 1st Drop	72.25	75.06	72.26	74.89	1.22	1.13	1.17	1.14	1.17
	After 2nd Drop	71.55	75.77	71.50	75.59	1.92	1.84	1.93	1.84	1.91
	After 3rd Drop	71.07	76.23	71.00	76.02	2.40	2.30	2.43	2.27	2.35
	After 4th Drop	70.68	76.60	70.63	76.37	2.79	2.67	2.80	2.62	2.72
	After 5th Drop	70.23	77.00	70.17	76.80	3.24	3.07	3.26	3.05	3.16
	After 6th Drop	69.98	77.23	69.94	77.00	3.49	3.30	3.49	3.25	3.38
	Total Distortion, in Percent:					4.75	4.46	4.75	4.41	
	Avg. Distortion, in Percent:						4.59			
Ac4	Prior to test	73.60	73.74	73.49	73.40	—	—	—	—	—
	After 1st Drop	72.48	74.88	72.36	74.50	1.12	1.14	1.13	1.10	1.12
	After 2nd Drop	71.74	75.59	71.61	75.19	1.86	1.85	1.88	1.79	1.85
	After 3rd Drop	71.12	76.14	71.00	75.75	2.48	2.40	2.49	2.35	2.43
	After 4th Drop	70.80	76.44	70.67	76.06	2.80	2.70	2.82	2.66	2.75
	After 5th Drop	70.43	76.77	70.29	76.40	3.17	3.03	3.20	3.00	3.10
	After 6th Drop	70.24	76.93	70.10	76.58	3.36	3.19	3.39	3.18	3.28
	Total Distortion, in Percent:					4.57	4.33	4.61	4.33	
	Avg. Distortion, in Percent:						4.46			
Ac5	Prior to test	73.22	73.89	73.53	73.79	—	—	—	—	—
	After 1st Drop	71.95	75.10	72.29	75.00	1.27	1.21	1.24	1.21	1.23
	After 2nd Drop	71.24	75.78	71.58	75.66	1.98	1.89	1.95	1.87	1.92
	After 3rd Drop	70.66	76.30	70.99	76.20	2.56	2.41	2.54	2.41	2.48
	After 4th Drop	70.21	76.72	70.53	76.61	3.01	2.83	3.00	2.82	2.92
	After 5th Drop	69.79	77.10	70.11	76.97	3.43	3.21	3.42	3.18	3.31
	After 6th Drop	69.37	77.48	69.69	77.34	3.85	3.59	3.84	3.55	3.71
	Total Distortion, in Percent:					5.26	4.86	5.22	4.81	
	Avg. Distortion, in Percent:						5.04			

APPENDIX TABLE 22d

Detailed Test Data for Free-Fall Drop Tests from 33½" Height of Conventional Stevedore Pallets

Pallet Number	Test Condition	Length of Diagonals, in In. (a)	(b)	(c)	(d)	Change in Length, in In. (a)	(b)	(c)	(d)	Average Change
Ad1	Prior to test	73.37	73.84	73.37	73.89	—	—	—	—	—
	After 1st Drop	72.13	75.02	72.11	75.06	1.24	1.18	1.26	1.17	1.21
	After 2nd Drop	71.37	75.73	71.36	75.80	2.00	1.89	2.01	1.91	1.95
	After 3rd Drop	70.89	76.16	70.89	76.22	2.48	2.32	2.48	2.33	2.40
	After 4th Drop	70.58	76.46	70.56	76.51	2.79	2.62	2.81	2.62	2.71
	After 5th Drop	70.19	76.80	70.19	76.86	3.18	2.96	3.18	2.97	3.07
	After 6th Drop	69.98	77.00	69.98	77.02	3.39	3.16	3.39	3.13	3.27
	Total Distortion, in Percent:					4.62	4.28	4.62	4.24	
	Avg. Distortion, in Percent:						4.44			
Ad2	Prior to test	73.58	73.70	73.45	73.51	—	—	—	—	—
	After 1st Drop	72.21	75.00	72.11	74.81	1.37	1.30	1.34	1.30	1.33
	After 2nd Drop	71.35	75.80	71.24	75.62	2.23	2.10	2.21	2.11	2.16
	After 3rd Drop	70.79	76.31	70.67	76.13	2.79	2.61	2.78	2.62	2.70
	After 4th Drop	70.34	76.72	70.22	76.55	3.24	3.02	3.23	3.04	3.13
	After 5th Drop	70.09	76.93	69.98	76.76	3.49	3.23	3.47	3.25	3.36
	After 6th Drop	69.89	77.12	69.75	76.97	3.69	3.42	3.70	3.46	3.57
	Total Distortion, in Percent:					5.01	4.64	5.04	4.71	
	Avg. Distortion, in Percent:						4.85			
Ad3	Prior to test	73.79	73.57	73.85	73.36	—	—	—	—	—
	After 1st Drop	72.45	74.84	72.54	74.64	1.34	1.27	1.31	1.28	1.29
	After 2nd Drop	71.60	75.66	71.68	75.46	2.19	2.09	2.17	2.10	2.14
	After 3rd Drop	70.96	76.25	71.04	76.05	2.83	2.68	2.81	2.69	2.75
	After 4th Drop	70.33	76.83	70.46	76.59	3.46	3.26	3.39	3.23	3.34
	After 5th Drop	69.79	77.30	69.91	77.07	4.00	3.73	3.94	3.71	3.85
	After 6th Drop	69.37	77.67	69.48	77.46	4.42	4.10	4.37	4.10	4.25
	Total Distortion, in Percent:					5.99	5.57	5.92	5.59	
	Avg. Distortion, in Percent:						5.77			
Ad4	Prior to test	73.43	73.78	73.44	73.61	—	—	—	—	—
	After 1st Drop	72.17	75.00	72.18	74.82	1.26	1.22	1.26	1.21	1.24
	After 2nd Drop	71.50	75.61	71.52	75.46	1.93	1.83	1.92	1.85	1.88
	After 3rd Drop	71.00	76.10	71.02	75.91	2.43	2.32	2.42	2.30	2.37
	After 4th Drop	70.55	76.50	70.60	76.30	2.88	2.72	2.84	2.69	2.78
	After 5th Drop	70.35	76.70	70.39	76.49	3.08	2.92	3.05	2.88	2.98
	After 6th Drop	70.09	76.94	70.14	76.70	3.34	3.16	3.30	3.09	3.22
	Total Distortion, in Percent:					4.55	4.28	4.49	4.20	
	Avg. Distortion, in Percent:						4.38			
Ad5	Prior to test	73.31	73.84	73.45	73.80	—	—	—	—	—
	After 1st Drop	72.11	75.00	72.23	74.98	1.20	1.16	1.22	1.18	1.19
	After 2nd Drop	71.29	75.74	71.42	75.71	2.02	1.90	2.03	1.91	1.97
	After 3rd Drop	70.80	76.20	70.92	76.19	2.51	2.36	2.53	2.39	2.45
	After 4th Drop	70.51	76.48	70.62	76.43	2.80	2.64	2.82	2.63	2.73
	After 5th Drop	70.15	76.80	70.27	76.77	3.16	2.96	3.18	2.97	3.07
	After 6th Drop	69.92	77.00	70.04	76.98	3.39	3.16	3.41	3.18	3.29
	Total Distortion, in Percent:					4.62	4.28	4.64	4.31	
	Avg. Distortion, in Percent:						4.46			

APPENDIX TABLE 22e

Detailed Test Data for Free-Fall Drop Tests from 33½" Height of Improved Stevedore Pallets

Pallet Number	Test Condition	Length of Diagonals, in In. (a)	(b)	(c)	(d)	Change in Length, in In. (a)	(b)	(c)	(d)	Average Change
Ba1	Prior to test	73.29	73.91	73.42	73.98	—	—	—	—	—
	After 1st Drop	71.82	75.41	71.92	75.39	1.47	1.50	1.50	1.41	1.47
	After 2nd Drop	70.63	76.38	70.73	76.47	2.66	2.47	2.69	2.49	2.58
	After 3rd Drop	69.65	77.23	69.74	77.34	3.64	3.32	3.68	3.36	3.50
	After 4th Drop	68.66	78.10	68.75	78.19	4.63	4.19	4.67	4.21	4.43
	After 5th Drop	67.85	78.80	67.90	78.91	5.44	4.89	5.52	4.93	5.20
	After 6th Drop	66.96	79.53	67.21	79.60	6.33	5.62	6.21	5.62	5.95
	Total Distortion, in Percent:					8.64	7.60	8.46	7.60	
	Avg. Distortion, in Percent:							8.08		
Ba2	Prior to test	73.31	73.75	73.97	73.84	—	—	—	—	—
	After 1st Drop	71.87	75.13	71.95	75.24	1.44	1.38	1.52	1.40	1.44
	After 2nd Drop	70.78	76.14	70.85	76.25	2.53	2.39	2.62	2.41	2.49
	After 3rd Drop	69.79	77.05	69.85	77.16	3.52	3.30	3.62	3.32	3.44
	After 4th Drop	68.91	77.81	68.96	77.93	4.40	4.06	4.51	4.09	4.27
	After 5th Drop	68.10	78.52	68.14	78.64	5.21	4.77	5.33	4.80	5.03
	After 6th Drop	67.33	79.17	67.37	79.28	5.98	5.42	6.10	5.44	5.74
	Total Distortion, in Percent:					8.16	7.35	8.30	7.37	
	Avg. Distortion, in Percent:							7.80		
Ba3	Prior to test	73.41	73.86	73.48	73.77	—	—	—	—	—
	After 1st Drop	71.78	75.36	71.87	75.30	1.63	1.50	1.61	1.53	1.57
	After 2nd Drop	70.64	76.43	70.64	76.34	2.77	2.57	2.74	2.57	2.66
	After 3rd Drop	69.63	77.33	69.72	77.26	3.78	3.47	3.76	3.49	3.63
	After 4th Drop	68.72	78.13	68.80	78.05	4.69	4.27	4.68	4.28	4.48
	After 5th Drop	67.92	78.81	68.01	78.73	5.49	4.95	5.47	4.96	5.22
	After 6th Drop	67.14	79.46	67.25	79.39	6.27	5.60	6.23	5.62	5.93
	Total Distortion, in Percent:					8.54	7.58	8.48	7.62	
	Avg. Distortion, in Percent:							8.06		
Ba4	Prior to test	73.45	73.72	73.63	73.67	—	—	—	—	—
	After 1st Drop	71.98	75.14	72.15	75.09	1.47	1.42	1.48	1.42	1.45
	After 2nd Drop	70.93	76.12	71.07	76.09	2.52	2.40	2.56	2.42	2.48
	After 3rd Drop	69.94	77.00	70.10	76.97	3.51	3.28	3.53	3.30	3.41
	After 4th Drop	69.07	77.77	69.23	77.73	4.38	4.05	4.40	4.06	4.22
	After 5th Drop	68.29	78.45	68.46	78.40	5.16	4.73	5.17	4.73	4.95
	After 6th Drop	67.62	79.01	67.78	78.97	5.83	5.29	5.85	5.30	5.57
	Total Distortion, in Percent:					7.94	7.18	7.95	7.19	
	Avg. Distortion, in Percent:							7.57		
Ba5	Prior to test	73.32	73.95	73.38	73.97	—	—	—	—	—
	After 1st Drop	71.80	75.41	71.80	75.45	1.52	1.46	1.58	1.48	1.51
	After 2nd Drop	70.67	76.45	70.65	76.49	2.65	2.65	2.73	2.52	2.60
	After 3rd Drop	69.87	77.17	69.83	77.23	3.45	3.22	3.55	3.26	3.37
	After 4th Drop	68.97	77.97	68.94	78.01	4.35	4.02	4.44	4.04	4.21
	After 5th Drop	68.27	78.56	68.25	78.60	5.05	4.61	5.13	4.63	4.86
	After 6th Drop	67.56	79.16	67.55	79.18	5.76	5.21	5.83	5.21	5.50
	Total Distortion, in Percent:					7.86	7.05	7.94	7.04	
	Avg. Distortion, in Percent:							7.47		

APPENDIX TABLE 22f

Detailed Test Data for Free-Fall Drop Tests from 33½" Height of Improved Stevedore Pallets

Pallet Number	Test Condition	Length of Diagonals, in In. (a)	(b)	(c)	(d)	Change in Length, in In. (a)	(b)	(c)	(d)	Average Change
Bb1	Prior to test	73.20	74.00	73.70	73.81	—	—	—	—	—
	After 1st Drop	71.79	75.32	72.21	75.19	1.41	1.32	1.49	1.38	1.40
	After 2nd Drop	70.66	76.46	71.10	76.23	2.54	2.46	2.60	2.42	2.51
	After 3rd Drop	69.84	77.10	70.30	76.96	3.36	3.10	3.40	3.15	3.25
	After 4th Drop	69.35	77.52	69.83	77.36	3.85	3.52	3.87	3.55	3.70
	After 5th Drop	68.97	77.90	69.41	77.73	4.23	3.90	4.29	3.92	4.09
	After 6th Drop	68.51	78.26	68.98	78.12	4.69	4.26	4.72	4.31	4.50
	Total Distortion, in Percent:					6.41	5.76	6.40	5.84	
	Avg. Distortion, in Percent:						6.10			
Bb2	Prior to test	73.66	73.58	73.84	73.49	—	—	—	—	—
	After 1st Drop	72.03	73.15	72.19	75.06	1.63	1.55	1.65	1.57	1.60
	After 2nd Drop	71.17	75.96	71.24	75.93	2.49	2.38	2.60	2.44	2.48
	After 3rd Drop	70.17	76.86	70.29	76.80	3.49	3.28	3.55	3.31	3.41
	After 4th Drop	69.36	77.57	69.51	77.48	4.30	3.99	4.33	3.99	4.15
	After 5th Drop	68.78	78.08	68.91	78.00	4.88	4.50	4.93	4.51	4.71
	After 6th Drop	68.22	78.58	68.35	78.49	5.44	5.00	5.49	5.00	5.23
	Total Distortion, in Percent:					7.39	6.80	7.43	6.80	
	Avg. Distortion, in Percent:						7.11			
Bb3	Prior to test	73.34	73.97	73.46	73.74	—	—	—	—	—
	After 1st Drop	71.84	75.39	71.98	75.21	1.50	1.42	1.48	1.47	1.47
	After 2nd Drop	70.75	76.39	70.92	76.20	2.59	2.42	2.54	2.46	2.50
	After 3rd Drop	70.02	77.03	70.18	76.85	3.32	3.06	3.28	3.11	3.19
	After 4th Drop	69.39	77.59	69.54	77.43	3.95	3.62	3.92	3.69	3.80
	After 5th D op	68.85	78.06	69.02	77.90	4.49	4.09	4.44	4.16	4.30
	After 6th Drop	68.39	78.48	68.55	78.30	4.95	4.51	4.91	4.56	4.73
	Total Distortion, in Percent:					6.75	6.10	6.68	6.18	
	Avg. Distortion, in Percent:						6.43			
Bb4	Prior to test	73.67	73.53	73.81	73.26	—	—	—	—	—
	After 1st Drop	72.22	74.94	72.26	74.72	1.45	1.41	1.55	1.46	1.47
	After 2nd Drop	71.16	75.91	71.22	75.71	2.51	2.38	2.59	2.45	2.48
	After 3rd Drop	70.43	76.58	70.47	76.40	3.24	3.05	3.34	3.14	3.19
	After 4th Drop	69.87	77.08	69.91	76.90	3.80	3.55	3.90	3.64	3.72
	After 5th Drop	69.35	73.53	69.41	77.33	4.32	4.00	4.40	4.07	4.20
	After 6th Drop	68.93	77.90	68.98	77.71	4.74	4.37	4.83	4.45	4.60
	Total Distortion, in Percent:					6.43	5.94	6.54	6.07	
	Avg. Distortion, in Percent:						6.25			
Bb5	Prior to test	73.73	73.43	73.87	73.31	—	—	—	—	—
	After 1st Drop	71.98	75.12	72.13	74.99	1.75	1.69	1.74	1.68	1.72
	After 2nd Drop	71.01	76.02	71.14	75.92	2.72	2.59	2.73	2.61	2.66
	After 3rd Drop	70.17	76.87	70.29	76.69	3.56	3.35	3.58	3.38	3.47
	After 4th Drop	69.53	77.35	69.65	77.26	4.20	3.92	4.22	3.95	4.07
	After 5th Drop	69.01	77.80	69.13	77.73	4.72	4.37	4.74	4.42	4.56
	After 6th Drop	68.49	78.25	68.61	78.17	5.24	4.82	5.26	4.86	5.05
	Total Distortion, in Percent:					7.11	6.56	7.12	6.63	
	Avg. Distortion, in Percent:						6.86			

APPENDIX TABLE 22g

Detailed Test Data for Free-Fall Drop Tests from 33½" Height of Improved Stevedore Pallets

Pallet Number	Test Condition	Length of Diagonals, in In. (a)	(b)	(c)	(d)	Change in Length, in In. (a)	(b)	(c)	(d)	Average Change
Bc1	Prior to test	73.31	73.84	73.55	73.76	—	—	—	—	—
	After 1st Drop	72.40	74.82	72.69	74.62	0.91	0.98	0.86	0,86	0.90
	After 2nd Drop	71.90	75.23	72.18	75.10	1.41	1.39	1.37	1.34	1.38
	After 3rd Drop	71.58	75.54	71.82	75.40	1.73	1.70	1.73	1.64	1.70
	After 4th Drop	71.48	75.59	71.76	75.48	1.83	1.75	1.79	1.72	1.77
	After 5th Drop	71.17	75.90	71.46	75.77	2.14	2.06	2.09	2.01	2.08
	After 6th Drop	71.10	75.96	71.33	75.86	2.21	2.12	2.22	2.10	2.16
	Total Distortion, in Percent:					3.01	2.87	3.02	2.85	
	Avg. Distortion, in Percent:						2.94			
Bc2	Prior to test	73.32	73.65	73.61	73.69	—	—	—	—	—
	After 1st Drop	72.49	74.46	72.75	74.49	0.83	0.81	0.86	0.80	0.83
	After 2nd Drop	72.03	74.87	72.31	74.93	1.29	1.22	1.30	1.24	1.26
	After 3rd Drop	71.64	75.23	71.93	75.29	1.68	1.58	1.68	1.60	1.64
	After 4th Drop	71.38	75.49	71.64	75.53	1.94	1.84	1.97	1.84	1.98
	After 5th Drop	71.16	75.68	71.45	75.73	2.16	2.03	2.16	2.04	2.10
	After 6th Drop	71.00	75.84	71.28	75.90	2.32	2.19	2.33	2.21	2.26
	Total Distortion, in Percent:					3.16	2.97	3.17	3.00	
	Avg. Distortion, in Percent:						3.08			
Bc3	Prior to test	73.69	73.65	73.72	73.58	—	—	—	—	—
	After 1st Drop	72.74	74.55	72.79	74.49	0.95	0.90	0.93	0.91	0.92
	After 2nd Drop	72.17	75.01	72.21	75.04	1.52	1.36	1.51	1.47	1.46
	After 3rd Drop	71.81	75.45	7.182	75.40	1.88	1.80	1.90	1.82	1.85
	After 4th Drop	71.51	75.71	71.53	75.67	2.18	2.06	2.19	2.09	2.13
	After 5th Drop	71.27	75.95	71.29	75.90	2.42	2.30	2.43	2.32	2.37
	After 6th Drop	71.09	76.12	71.13	76.04	2.60	2.47	2.59	2.46	2.53
	Total Distortion, in Percent:					3.53	3.35	3.51	3.34	
	Avg. Distortion, in Percent:						3.43			
Bc4	Prior to test	73.35	73.93	73.67	73.61	—	—	—	—	—
	After 1st Drop	72.52	74.75	72.80	7.447	0.83	0.82	0.87	0.86	0.85
	After 2nd Drop	71.98	75.26	72.26	75.00	1.37	1.33	1.41	1.38	1.38
	After 3rd Drop	71.65	75.56	71.92	75.29	1.70	1.63	1.75	1.68	1.69
	After 4th Drop	71.36	75.82	71.62	75.58	1.99	1.89	2.05	1.97	1.98
	After 5th Drop	71.13	76.04	71.41	75.80	2.22	2.11	2.26	2.19	2.20
	After 6th Drop	71.95	76.20	71.21	75.97	2.40	2.27	2.46	2.36	2.37
	Total Distortion, in Percent:					3.27	3.07	3.34	3.21	
	Avg. Distortion, in Percent:						3.22			
Bc5	Prior to test	73.29	73.76	73.43	73.68	—	—	—	—	—
	After 1st Drop	72.35	74.70	72.47	74.59	0.94	0.94	0.96	0.91	0.94
	After 2nd Drop	71.77	75.23	71.87	75.14	1.52	1.47	1.56	1.46	1.50
	After 3rd Drop	71.35	75.61	71.46	75.52	1.94	1.85	1.97	1.84	1.90
	After 4th Drop	70.95	76.00	71.08	75.89	2.34	2.24	2.36	2.21	2.29
	After 5th Drop	70.69	76.23	70.83	76.12	2.60	2.47	2.60	2.44	2.53
	After 6th Drop	70.50	76.40	70.64	76.28	2.79	2.64	2.79	2.60	2.71
	Total Distortion, in Percent:					3.81	3.58	3.80	3.52	
	Avg. Distortion, in Percent:						3.68			

APPENDIX TABLE 22h

Detailed Test Data for Free-Fall Drop Tests from 33½" Height of Improved Stevedore Pallets

Pallet Number	Test Condition	Length of Diagonals, in In. (a)	(b)	(c)	(d)	Change in Length, in In. (a)	(b)	(c)	(d)	Average Change
Bd1	Prior to test	73.34	73.92	73.44	73.75	—	—	—	—	—
	After 1st Drop	72.36	74.86	72.42	74.70	0.98	0.94	1.02	0.95	0.97
	After 2nd Drop	71.67	75.50	71.72	75.35	1.67	1.58	1.72	1.60	1.64
	After 3rd Drop	71.26	75.87	71.30	75.74	20.8	1.95	2.14	1.99	2.04
	After 4th Drop	70.95	76.16	71.00	76.02	2.39	2.24	2.44	2.27	2.34
	After 5th Drop	70.67	76.43	70.72	76.29	2.67	2.51	2.72	2.54	2.61
	After 6th Drop	70.48	76.60	70.52	76.47	2.86	2.68	2.92	2.72	2.80
	Total Distortion, in Percent:					3.90	3.63	3.98	3.59	
	Avg. Distortion, in Percent:					3.77				
Bd2	Prior to test	73.68	73.38	73.84	73.40	—	—	—	—	—
	After 1st Drop	72.69	74.33	72.84	74.33	0.99	0.95	1.00	0.93	0.97
	After 2nd Drop	72.01	74.98	72.16	75.00	1.67	1.60	1.68	1.60	1.64
	After 3rd Drop	71.63	75.34	71.74	75.39	2.05	1.96	2.10	1.99	2.03
	After 4th Drop	71.43	75.54	71.55	75.58	2.25	2.16	2.29	2.18	2.22
	After 5th Drop	71.14	75.80	71.26	75.84	2.54	2.42	2.58	2.44	2.50
	After 6th Drop	70.97	75.97	71.08	76.00	2.71	2.59	2.76	2.60	2.67
	Total Distortion, in Percent:					3.68	3.53	3.74	3.54	
	Avg. Distortion, in Percent:					3.62				
Bd3	Prior to test	73.81	73.44	73.77	73.47	—	—	—	—	—
	After 1st Drop	72.87	74.35	72.84	74.39	0.94	0.91	0.93	0.92	0.93
	After 2nd Drop	72.27	74.90	72.45	84.93	1.54	1.46	1.32	1.46	1.45
	After 3rd Drop	71.89	75.28	71.86	75.30	1.92	1.84	1.91	1.83	1.88
	After 4th Drop	71.53	75.60	71.52	75.63	2.28	2.16	2.25	2.16	2.28
	After 5th Drop	71.28	75.84	71.25	75.90	2.53	2.40	2.52	2.43	2.47
	After 6th Drop	71.08	76.02	71.05	76.06	2.73	2.58	2.72	2.59	2.66
	Total Distortion, in Percent:					3.70	3.51	3.69	3.53	
	Avg. Distortion, in Percent:					3.61				
Bd4	Prior to test	73.85	73.32	73.80	73.39	—	—	—	—	—
	After 1st Drop	72.77	74.34	72.76	74.40	1.08	1.02	1.04	1.01	1.04
	After 2nd Drop	72.04	75.05	72.03	75.11	1.81	1.72	1.77	1.72	1.76
	After 3rd Drop	71.66	75.39	71.65	75.47	2.19	2.07	2.15	2.08	2.12
	After 4th Drop	71.40	75.63	71.39	75.70	2.45	2.31	2.41	2.31	2.37
	After 5th Drop	71.05	75.93	71.06	76.02	2.80	2.61	2.74	2.63	2.70
	After 6th Drop	70.96	76.02	70.95	76.11	2.89	2.70	2.85	2.72	2.79
	Total Distortion, in Percent:					3.91	3.68	3.86	3.71	
	Avg. Distortion, in Percent:					3.79				
Bd5	Prior to test	73.41	73.95	73.60	73.86	—	—	—	—	—
	After 1st Drop	72.42	74.90	7.261	74.83	0.99	0.95	0.99	0.97	0.98
	After 2nd Drop	71.80	75.49	71.99	75.41	1.61	1.54	1.61	1.55	1.58
	After 3rd Drop	71.41	75.83	71.62	75.76	2.00	1.88	1.98	1.90	1.94
	After 4th Drop	71.15	76.09	71.35	76.00	2.26	2.14	2.25	2.14	2.20
	After 5th Drop	70.96	76.25	71.14	76.19	2.45	2.30	2.46	2.33	2.39
	After 6th Drop	70.79	76.42	70.98	76.36	2.62	2.47	2.62	2.50	2.55
	Total Distortion, in Percent:					3.57	3.34	3.56	3.38	
	Avg. Distortion, in Percent:					3.46				

APPENDIX TABLE 23

Average Data for Free-Fall Drop Tests from 33½" Height of Conventional and Improved Stevedore Pallets

Pallet Design	Pallet No.	Test Weight in Lb.	Average Changes in Length of Diagonals, in In., After Given Free-Fall Drop 1st	2nd	3rd	4th	5th	6th	Average Distortion After 6th Drop, In Pct.	Sum of Average Change in Length of Diag., in In., After 6th Drop
Conventional	Aa1	138.34	1.82	3.14	4.24	5.18	6.04	6.78	9.20	27.20
	Aa2	141.62	1.77	3.03	4.04	4.98	5.89	6.68	9.09	26.39
	Aa3	138.62	1.69	2.91	3.96	4.91	5.72	6.56	8.90	25.75
	Aa4	139.53	1.70	3.03	4.12	5.11	6.04	6.83	9.27	26.83
	Aa5	139.28	1.85	3.21	4.18	5.39	6.20	7.13	9.68	27.97
	Avg.	139.48	1.77	3.06	4.11	5.11	5.98	6.80	9.23	26.83
	Ab1	143.50	1.87	3.10	4.01	4.69	5.23	5.74	7.80	24.64
	Ab2	141.16	1.84	3.04	3.87	4.57	5.12	5.64	7.66	24.08
	Ab3	142.70	1.83	3.02	3.88	4.63	5.23	5.80	7.88	24.39
	Ab4	142.62	2.01	3.25	4.09	4.79	5.41	5.95	8.08	25.50
	Ab5	139.81	1.90	3.16	4.03	4.51	5.07	5.63	7.64	24.30
	Avg.	141.96	1.89	3.11	3.98	4.64	5.21	5.75	7.81	24.58
	Ac1	140.59	1.20	1.89	2.26	2.61	2.88	3.17	4.31	14.01
	Ac2	140.56	1.18	1.78	2.21	2.50	2.75	2.99	4.06	13.41
	Ac3	137.44	1.17	1.91	2.35	2.72	3.16	3.38	4.59	14.69
	Ac4	140.03	1.12	1.85	2.43	2.75	3.10	3.28	4.46	14.53
	Ac5	138.16	1.23	1.92	2.48	2.92	3.31	3.71	5.04	15.57
	Avg.	139.36	1.18	1.87	2.35	2.70	3.04	3.31	4.49	14.44
	Ad1	145.86	1.21	1.95	2.40	2.71	3.07	3.27	4.44	14.61
	Ad2	148.28	1.33	2.16	2.70	3.13	3.36	3.57	4.85	16.25
	Ad3	142.30	1.29	2.14	2.75	3.34	3.85	4.25	5.77	17.62
	Ad4	139.41	1.24	1.88	2.37	2.78	2.98	3.22	4.38	14.47
	Ad5	142.76	1.19	1.97	2.45	3.73	3.07	3.29	4.46	14.70
	Avg.	143.72	1.25	2.02	2.53	3.14	3.27	3.52	4.78	15.53
Improved	Ba1	164.34	1.47	2.58	3.50	4.43	5.20	5.95	8.08	23.13
	Ba2	163.88	1.44	2.49	3.44	4.27	5.03	5.74	7.80	22.41
	Ba3	163.03	1.57	2.66	3.63	4.48	5.22	5.93	8.06	23.49
	Ba4	158.69	1.45	2.48	3.41	4.22	4.95	5.57	7.57	22.08
	Ba5	161.26	1.51	2.60	3.37	4.21	4.86	5.50	7.47	22.05
	Avg.	162.24	1.49	2.56	3.47	4.32	5.05	5.74	7.80	22.63
	Bb1	159.12	1.40	2.51	3.25	3.70	4.09	4.50	6.10	19.45
	Bb2	167.81	1.60	2.48	3.41	4.15	4.71	5.23	7.11	21.58
	Bb3	161.33	1.47	2.50	3.19	3.80	4.30	4.73	6.43	19.99
	Bb4	158.33	1.47	2.48	3.19	3.72	4.20	4.60	6.25	19.66
	Bb5	158.59	1.72	2.66	3.47	4.07	4.56	5.05	6.86	21.53
	Avg.	161.04	1.53	2.53	3.30	3.89	4.37	4.82	6.55	20.44
	Bc1	158.59	0.90	1.38	1.70	1.77	2.08	2.16	2.94	9.99
	Bc2	162.50	0.83	1.26	1.64	1.98	2.10	2.26	3.08	10.07
	Bc3	158.26	0.92	1.46	1.85	2.13	2.37	2.52	3.43	11.26
	Bc4	154.92	0.85	1.38	1.69	1.98	2.20	2.37	3.22	10.47
	Bc5	154.64	0.94	1.50	1.90	2.29	2.53	2.71	3.68	11.87
	Avg.	157.78	0.89	1.40	1.76	2.03	2.26	2.40	3.27	10.73
	Bd1	153.56	0.97	1.64	2.04	2.34	2.61	2.80	3.77	12.40
	Bd2	153.78	0.97	1.64	2.03	2.22	2.50	2.67	3.62	12.03
	Bd3	154.44	0.93	1.45	1.88	2.28	2.47	2.66	3.61	11.67
	Bd4	162.25	1.04	1.76	2.12	2.37	2.70	2.79	3.79	12.78
	Bd5	156.52	0.98	1.58	1.94	2.20	2.39	2.55	3.46	11.64
	Avg.	156.11	0.98	1.61	2.00	2.28	2.53	2.69	3.65	12.10

APPENDIX TABLE 24

Two-Factorial Analysis of Variance of Free-Fall Drop Test Data for Pallets of Two Designs, Assembled with Four Different Nails

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	Computed f	Critical f	
Design	149.61	1	149.61	202.01	4.15	S
Nail	1117.72	3	372.53	503.47	2.90	S
Interaction	1.00	3	0.33	0.45	2.90	NS
Error	23.70	32	0.74			
Total	1292.03	39				

Duncan's Multiple Range Test on Average Cumulative Length Changes of Diagonals After 6th Drop

p	2	3	4	5	6	7	8
rp	2.882	3.029	3.125	3.193	3.245	3.285	3.318
Rp	1.11	1.17	1.20	1.23	1.25	1.26	1.28

Avg.	Differences						
10.73	1.37	3.71	4.80	9.71	11.90	13.85	16.10
12.10	2.34	3.43	8.34	10.53	12.48	14.73	
14.44	1.09	6.00	8.19	10.14	12.39		
15.53	4.91	7.10	9.05	11.30			
20.44	2.19	4.14	6.39				
22.63	1.95	4.20					
24.58	2.25						
26.83							

Bc	Bd	Ac	Ad	Bb	Ba	Ab	Aa
10.73	12.10	14.44	15.53	20.44	22.63	24.58	26.83
(60%)	(55%)	(46%)	(42%)	(24%)	(15%)	(8%)	

APPENDIX TABLE 25

Detailed Deckboard-Stringer Separation Data for Pallets of Conventional Design

Pallet Nails	Pallet No.	Pallet Test Weight, in Lb.	Failure of Leading-Edge Deckboard	Number of Runs Prior to End of Test
2½" Nail (a)	Aa1	136.98	Splitting (6); first deckboard off two stringers (6); six nails withdrawn.	6
	Aa2	139.89	Splitting (5); first deckboard off two stringers (7); six nails withdrawn.	7
	Aa3	137.45	First deckboard off two stringers (9); six nails withdrawn.	9
	Aa4	138.19	Splitting (1); first deckboard off two stringers (7); six nails withdrawn and one nail pulled through at split.	7
	Aa5	137.91	First deckboard off two stringers (4); six nails withdrawn.	4
	Avg.	138.08		7
2½" Nail (b)	Ab1	141.91	First deckboard off two stringers (10); one nail broken and five nails withdrawn.	10
	Ab2	139.50	Splitting (2,5); first deckboard off two stringers (9); one nail broken, two nails pulled through, and three nails withdrawn.	9
	Ab3	141.81	First deckboard off two stringers (22); one nail broken and five nails withdrawn.	22
	Ab4	141.19	First deckboard off two stringers (38); six nails withdrawn.	38
	Ab5	138.53	Splitting (3, 8, 10); first deckboard off two stringers (24); five nails withdrawn and one nail pulled through at split; first deckboard destroyed.	24
	Avg.	140.60		21
2½" Nail (c)	Ac1	138.70	First deckboard off two stringers (3); two nails broken and four nails withdrawn.	3
	Ac2	139.59	Splitting (6, 13, 14); first deckboard off two stringers (14); one nail broken, two nails pulled through, and two nails withdrawn.	14
	Ac3	136.26	Splitting (1, 1); first deckboard off two stringers (5); one broken nail, two nails pulled through, and three nails withdrawn; first deckboard destroyed.	5
	Ac4	139.25	Splitting (4, 5, 6); first deckboard off two stringers (7); four nails withdrawn, two nails pulled through, and one nail broken; first deckboard destroyed.	7
	Ac5	136.75	Splitting (32); first deckboard off two stringers (60); two nails broken, three nails withdrawn, and one nail pulled through at split; first deckboard destroyed (60).	60
	Avg.	138.11		18
3" Nail (d)	Ad1	143.80	Splitting (71, 97); first deckboard off two stringers (100); four nails broken, one nail pulled through, and two nails withdrawn.	104
	Ad2	147.06	Splitting (5, 129, 131, 132); first deckboard off two stringers (137); three nails broken and two nails pulled through.	137
	Ad3	141.06	Splitting (4); first deckboard off two stringers (10); two nails broken, two nails pulled through, and two nails withdrawn.	10
	Ad4	138.02	Splitting (6, 11, 11); first deckboard off two stringers (12); one nail broken, three nails withdrawn, and two pulled through at splits; first deckboard destroyed (12).	12
	Ad5	141.95	Splitting (6, 35, 48, 106); first deckboard off central stringer (106); first deckboard destroyed (106).	106
	Avg.	142.38		74

APPENDIX TABLE 26

Detailed Deckboard-Stringer Separation Data for Pallets of Improved Design

Pallet Nails	Pallet No.	Pallet Test Weight, in Lb.	Failure of End Deckboard	Number of Runs Prior to End of Test
2½" Nail (a)	Ba1	161.48	First deckboard off two stringers (85); eight nails withdrawn; second deckboard off one stringer; three nails withdrawn (85).	85
	Ba2	160.50	First and second deckboards off two stringers (62); eight and six nails withdrawn.	62
	Ba3	160.12	First deckboard off two stringers (88); eight nails withdrawn; second deckboard off one stringer (88); three nails withdrawn.	88
	Ba4	155.86	Splitting (222, 227, 292); first deckboard off two stringers (312); seven nails withdrawn and one nail pulled through; second deckboard off two stringers (312); one nail broken and five nails withdrawn.	312
	Ba5	159.61	Splitting (199); first deckboard off two stringers (252); eight nails withdrawn; second deckboard off one outer stringer (252); two nails withdrawn and one nail pulled through.	252
	Avg.	159.51		160
2½" Nail (b)	Bb1	157.20	Splitting (47); first and second deckboards off two stringers (245); three nails broken and five nails withdrawn; two nails broken and three nails withdrawn (one nail for the second deckboard was a shiner.)	245
	Bb2	162.53	Splitting (432); first and second deckboards off two stringers (434); seven nails broken and two nails withdrawn; four nails broken and one nail pulled through.	434
	Bb3	158.16	Splitting (4); first deckboard off center stringer and one-half of first deckboard, split in two, off one outer stringer (220); two nails broken and four nails withdrawn.	220
	Bb4	156.48	First deckboard off two stringers (552); five nails broken and three nails withdrawn; second deckboard off center stringer (552); three nails broken	552
	Bb5	156.92	Splitting (373); first and second deckboards off two stringers (375); four nails broken and four nails withdrawn; three nails broken and three nails withdrawn.	375
	Avg.	158.26		365
2½" Nail (c)	Bc1	156.44	First deckboard off two stringers (271); seven nails broken and one nail withdrawn.	271
	Bc2	160.00	First and second deckboards off two stringers (271); six nails broken and two nails withdrawn; six nails broken.	271
	Bc3	156.95	First and second deckboards off two stringers (221); five nails broken and three nails withdrawn; three nails broken and three nails withdrawn.	221
	Bc4	153.25	Splitting (3); first deckboard off two stringers (341); five nails broken and three nails withdrawn; four nails broken.	341
	Bc5	152.47	First deckboard off two stringers (406); eight nails broken; one nail broken and two nails withdrawn at center stringer.	406
	Avg.	155.82		302
3" Nail (d)	Bd1	152.67	Splitting of leading deckboard (498) and of second deckboard (521); first deckboard off two stringers (560); eleven nails broken; four nails broken.	560
	Bd2	152.39	Splitting of second deckboard (551); first deckboard off two stringers (598); ten nails broken; second deckboard off one stringer (598); three nails broken.	598
	Bd3	152.26	First and second deckboards off two stringers (383); six nails broken, one nail withdrawn, and one nail pulled through at split; four nails broken and two nails pulled through at split; first and second deckboards destroyed (383).	383
	Bd4	159.50	Splitting (316); first and second deckboards off two stringers (319); seven nails broken and one nail pulled through at split; five nails broken and one nail withdrawn.	319
	Bd5	154.06	First deckboard off two stringers (451); eight nails broken; five nails broken.	451
	Avg.	156.94		462

APPENDIX TABLE 27

Two-Factorial Analysis of Variance of Incline Impact Test Data for Pallets of Two Designs, Assembled with Four Different Nails

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	Computed f	Critical f	
Design	856.15 E3	1	856.15 E3	124.72	4.15	S
Nail	176.21 E3	3	58.74 E3	8.56	2.90	S
Interaction	78.46 E3	3	26.15 E3	3.81*	2.90	S
Error	219.67 E3	32	6.86 E3			
Total	1330.49 E3	39				

*not significant at 1% level of significance.

Duncan's Multiple Range Test on Average Number of Runs during Incline Impact Test

p	2	3	4	5	6	7	8
rp	2.882	3.029	3.125	3.193	3.245	3.285	3.318
Rp	107	112	116	118	120	122	123

Avg.	Differences						
7	11	14	67	153	295	358	455
18	3	56	142	284	347	444	
21	53	139	281	344	441		
74	86	228	291	388			
160	142	205	302				
302	63	160					
365	97						
462							

Aa	Ac	Ab	Ad	Ba	Bc	Bb	Bd
7	18	21	74	160	302	365	462

APPENDIX TABLE 26a

Detailed Follow-Up Load-Deflection Data, in Lb. and 1/1000 In.
Pallets of Conventional Design

Test	Pallet No. Aa1					Pallet No. Aa2					Pallet No. Aa3					Pallet No. Aa4					Pallet No. Aa5				
Load	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
0	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
200	15	09	38	68	67	14	07	41	32	50	10	08	38	57	53	07	09	48	55	57	13	13	52	66	65
	17	10	46	78	76	20	09	52	46	66	16	13	49	68	64	09	13	64	73	76	15	15	59	74	74
400	32	20	106	145	149	45	17	107	112	136	30	21	100	126	128	18	27	128	148	152	30	27	116	145	145
	35	22	121	158	164	51	18	119	122	150	38	30	112	140	139	21	32	139	163	167	33	29	126	156	157
600	47	32	180	220	237	71	27	175	175	219	54	39	163	198	202	30	47	198	241	245	49	38	180	227	229
	51	34	196	235	254	75	28	188	186	235	60	47	175	211	215	32	52	208	258	261	52	40	194	241	244
800	61	45	249	298	323	88	36	235	234	296	73	54	221	268	275	39	65	262	329	333	65	47	244	303	310
	65	47	263	315	340	92	39	249	244	312	82	60	239	282	292	43	68	273	345	348	69	49	259	321	327
1000	74	57	315	383	407	103	48	298	292	375	94	66	284	338	352	49	79	325	410	412	82	56	315	379	391
	80	59	331	402	427	106	49	310	303	391	102	70	299	353	368	51	82	339	429	430	85	58	331	400	409
1200	90	68	380	466	492	117	60	358	350	452	113	76	347	405	428	57	93	391	494	496	95	65	380	463	472
	95	70	398	481	511	120	62	370	363	470	120	79	363	422	446	60	95	405	513	514	99	67	395	482	490
1400	105	75	464	536	580	131	72	418	413	531	131	84	413	478	508	65	103	457	574	579	107	74	443	540	550
	109	77	478	551	598	135	73	429	424	547	142	87	428	492	524	68	106	470	593	598	109	76	457	556	567
1600	120	84	527	607	663	145	81	475	473	608	152	92	479	543	585	75	113	520	656	665	117	83	506	615	632
	123	86	540	621	683	149	83	488	487	626	167	96	498	560	605	78	116	534	674	684	120	87	522	632	650
1800	133	93	589	676	744	158	90	532	533	687	175	103	547	610	668	89	122	585	736	748	127	93	569	687	711
	136	95	604	690	761	161	93	544	547	705	184	104	565	630	690	91	125	599	756	767	129	96	587	704	729
2000	145	102	651	742	820	172	105	588	583	764	193	110	610	678	746	98	131	645	814	826	136	103	633	756	785
	150	101	672	761	840	175	108	601	606	783	198	112	627	695	766	101	134	658	835	846	137	105	652	774	804
2220	159	108	719	813	898	183	114	643	647	837	207	118	671	741	821	108	139	700	894	903	144	112	695	823	860
	164	110	739	830	918	188	116	658	666	860	212	119	687	758	843	111	142	714	914	924	146	114	711	839	878
2400	172	117	734	878	974	197	122	698	708	913	221	123	728	803	894	120	149	761	970	980	159	121	760	890	935
	180	120	808	898	996	200	124	711	724	936	224	125	744	820	915	123	152	775	991	1001	161	123	777	903	953
2600	187	125	851	944	1048	211	137	751	768	990	232	132	784	862	966	131	156	822	1042	1053	167	130	818	947	1003
	193	127	871	962	1069	214	139	765	785	1012	235	135	802	881	988	134	159	840	1064	1077	170	132	840	967	1022
2800	202	132	914	1008	1120	224	145	802	821	1060	243	139	839	920	1034	142	165	881	1111	1129	177	138	877	1007	1070
	208	135	934	1025	1142	227	147	819	840	1086	246	142	858	941	1060	145	169	900	1134	1153	179	139	895	1024	1091
3000	215	141	973	1064	1189	236	158	857	878	1136	253	148	894	981	1107	153	174	939	1179	1201	190	146	936	1065	1141
	223	142	996	1084	1213	239	165	877	898	1164	257	150	915	1004	1133	156	177	961	1203	1227	191	150	971	1089	1168
3200	230	148	1034	1124	1258	246	169	908	932	1207	264	156	950	1040	1177	163	183	1002	1247	1273	195	156	1004	1127	1211
	238	151	1059	1144	1283	250	177	929	954	1237	268	160	970	1065	1206	166	186	1026	1273	1300	199	159	1027	1152	1236
3400	245	156	1096	1182	1326	257	182	958	986	1278	275	166	1004	1100	1246	175	191	1064	1311	1344	203	166	1060	1187	1278
	254	158	1127	1204	1353	260	186	977	1008	1307	279	170	1027	1124	1276	179	194	1091	1341	1375	207	170	1086	1215	1305
3600	262	164	1163	1240	1396	270	191	1010	1040	1350	284	174	1060	1162	1317	186	200	1127	1379	1417	215	176	1124	1252	1348
	269	166	1193	1264	1425	273	196	1032	1062	1382	289	179	1084	1186	1349	190	203	1155	1409	1450	217	180	1150	1280	1375
3800	279	172	1229	1300	1467	281	210	1068	1094	1424	296	184	1116	1217	1387	197	207	1194	1446	1492	222	186	1180	1314	1415
	288	175	1261	1327	1497	286	218	1092	1121	1461	303	187	1143	1246	1417	202	212	1223	1477	1524	225	190	1205	1341	1442
4000	295	180	1294	1360	1538	293	223	1119	1148	1497	309	191	1172	1275	1455	209	217	1256	1514	1564	232	197	1241	1373	1481
	303	183	1327	1387	1570	296	227	1144	1173	1533	320	196	1199	1306	1488	213	221	1283	1546	1597	235	201	1265	1398	1509
4200	310	188	1359	1423	1612	305	232	1175	1200	1571	326	198	1231	1343	1532	219	227	1315	1582	1637	240	207	1292	1434	1546
	322	190	1398	1457	1650	309	243	1200	1224	1608	336	202	1259	1373	1565	224	230	1344	1615	1671	237	210	1325	1472	1587
4400	328	196	1429	1493	1691	314	252	1233	1250	1646	342	207	1287	1404	1604	231	236	1376	1650	1711	245	217	1361	1504	1627
	336	200	1467	1520	1727	319	256	1258	1277	1686	350	211	1312	1436	1641	236	240	1408	1683	1746	248	221	1390	1530	1658
4600	342	204	1498	1555	1767	324	260	1281	1302	1720	355	215	1339	1464	1677	242	246	1437	1716	1784	255	227	1424	1561	1697
	348	208	1534	1585	1803	329	263	1305	1330	1759	362	222	1335	1478	1735	248	249	1470	1752	1822	258	232	1452	1590	1728
4800	355	213	1565	1620	1842	337	268	1335	1352	1795	366	226	1356	1505	1774	255	254	1501	1785	1859	263	238	1477	1621	1763
	359	216	1602	1650	1881	338	272	1363	1399	1849	379	226	1369	1698	1926	262	259	1535	1823	1901	266	244	1509	1656	1799
5000	364	223	1634	1683	1922	344	277	1386	1426	1884	384	230	1395	1730	1968	269	263	1565	1857	1940	273	250	1548	1686	1840
	369	226	1671	1719	1963	348	282	1413	1459	1931	390	235	1407	1765	2023	276	268	1601	1900	1985	276	255	1580	1724	1881
5200	375	231	1700	1751	2001	353	287	1442	1490	1972	395	238	1433	1795	2063	284	273	1632	1934	2023	284	261	1617	1753	1921
	380	235	1740	1784	2044	355	292	1476	1529	2025	399	245	1447	1830	2124	291	276	1670	1982	2072	287	265	1648	1790	1959
5400	384	241	1769	1817	2083	362	296	1506	1554	2062	404	249	1470	1858	2161	298	282	1698	2014	2108	295	271	1683	1817	1997
	389	245	1817	1856	2129	366	301	1533	1590	2110	418	265	1415	1851	2321	306	287	1734	2058	2154	298	275	1717	1857	2041
5600	395	250	1844	1888	2167	372	306	1560	1616	2145	423	269	1434	1875	2361	314	292	1764	2091	2191	303	279	1752	1889	2082
	399	256	1887	1924	2211	376	311	1589	1649	2193	433	284	1385	1860	2491	321	296	1804	2135	2238	306	285	1786	1932	2126
5800	405	260	1913	1958	2247	381	321	1626	1675	2232	438	290	1402	1881	2535	330	302	1834	2167	2275	314	291	1821	1962	2165
	409	266	1959	1997	2294	386	325	1653	1716	2284	444	301	1404	1902	2624	337	305	1874	2216	2325	317	296	1856	2003	2208
6000	415	271	1987	2030	2331	391	329	1674	1743	2318	448	303	1419	1927	2663	345	310	1903	2247	2360	323	301	1893	2031	2247
	420	276	2032	2067	2378	395	332	1700	1777	2365	454	314	1423	1955	2746	353	314	1942	2291	2408	327	306	1927	2072	2290

APPENDIX TABLE 28b

Detailed Follow-Up Load-Deflection Data, in Lb. and 1/1000 In.
Pallets of Conventional Design

Test	Pallet No. Ab1					Pallet No. Ab2					Pallet No. Ab3					Pallet No. Ab4					Pallet No. Ab5				
Load	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
0	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
200	09	13	52	37	58	08	11	49	54	56	08	11	55	59	61	08	09	50	60	58	06	11	59	54	38
	10	15	57	43	65	10	13	54	60	63	10	13	63	65	69	12	11	58	68	68	08	15	69	62	48
400	18	32	108	105	125	25	21	112	122	128	24	23	131	127	142	22	21	115	134	136	13	27	134	121	117
	22	36	118	118	139	29	24	123	134	141	27	25	145	135	153	26	24	125	145	149	15	31	149	133	132
600	30	54	170	182	205	43	32	177	196	206	39	35	210	195	221	35	32	180	216	218	21	43	209	191	197
	33	59	184	201	224	45	35	187	208	218	42	37	221	206	234	38	35	190	227	232	23	46	222	202	210
800	43	79	238	265	290	56	42	239	268	283	53	46	281	267	302	45	44	240	291	296	29	57	278	256	276
	46	84	249	283	307	63	43	254	283	298	56	49	293	279	315	47	46	251	303	309	21	60	293	268	289
1000	54	103	298	345	372	73	50	306	342	364	65	58	352	339	382	55	54	299	364	372	38	69	344	323	349
	60	106	311	365	390	86	53	324	362	382	68	60	364	353	396	57	57	311	375	385	41	72	359	339	365
1200	67	116	357	425	451	94	60	380	416	444	79	69	423	414	464	64	65	358	432	445	47	80	409	393	424
	71	120	369	442	468	97	63	395	427	460	81	69	437	429	478	65	67	370	445	459	49	83	421	406	438
1400	76	130	415	499	527	109	69	457	484	525	91	78	497	490	544	72	74	415	500	516	57	92	471	462	498
	82	133	427	517	544	111	73	473	498	542	95	87	514	506	561	73	76	430	513	532	59	94	484	473	512
1600	87	142	473	572	604	118	80	528	550	605	106	95	578	566	633	82	83	479	566	591	66	103	536	525	570
	91	145	488	591	621	120	83	544	565	624	108	100	593	582	651	83	85	492	579	608	70	106	553	540	586
1800	100	167	547	646	690	128	90	597	615	686	114	108	650	637	714	92	91	547	629	670	77	112	602	588	644
	103	171	564	665	711	131	95	613	632	705	117	112	668	655	735	94	93	564	656	689	82	114	624	608	664
2000	107	177	607	714	763	142	104	669	684	768	125	121	719	708	796	100	99	605	692	741	88	120	671	652	720
	111	180	622	734	783	144	107	684	700	787	127	125	735	724	814	104	103	623	709	762	93	122	693	670	739
2200	115	187	665	783	835	150	113	733	747	843	136	134	788	778	875	111	109	666	757	814	99	128	741	713	793
	120	189	679	803	853	151	117	749	768	863	137	138	806	796	894	114	111	684	774	833	101	131	763	731	813
2400	123	207	724	859	910	162	125	802	818	922	145	146	855	846	951	119	117	725	819	883	108	136	808	771	862
	127	208	739	879	930	166	128	822	840	942	146	150	873	864	971	123	120	743	837	902	111	139	832	791	884
2600	131	214	777	922	977	173	133	867	884	994	155	157	917	914	1026	128	127	785	879	950	117	145	873	827	932
	135	216	794	942	997	180	137	887	906	1017	156	161	937	933	1048	130	128	804	898	969	120	148	898	846	955
2800	143	221	831	986	1045	188	145	933	952	1069	164	167	979	980	1100	136	135	843	939	1016	125	156	940	882	1000
	146	224	848	1009	1066	193	148	955	976	1094	165	171	1001	1000	1124	137	137	863	958	1037	129	159	969	904	1027
3000	150	241	884	1056	1117	198	153	992	1016	1141	174	177	1042	1045	1172	145	143	903	998	1085	136	165	1009	937	1070
	154	242	903	1079	1141	201	157	1016	1040	1167	175	180	1065	1067	1198	147	145	925	1018	1108	139	168	1038	958	1097
3200	158	247	936	1114	1181	209	164	1061	1084	1216	184	186	1105	1111	1245	152	152	961	1056	1152	145	174	1079	991	1141
	162	248	954	1138	1204	213	169	1086	1108	1242	186	191	1131	1135	1271	155	154	983	1078	1177	148	177	1108	1013	1171
3400	169	254	985	1172	1243	220	175	1124	1146	1286	194	196	1169	1177	1316	162	160	1023	1114	1220	154	183	1147	1045	1210
	174	256	1002	1198	1270	223	177	1148	1170	1313	196	200	1196	1201	1344	165	162	1047	1138	1245	158	188	1181	1069	1241
3600	179	260	1034	1230	1306	230	184	1187	1208	1357	202	205	1235	1242	1389	171	167	1081	1172	1286	164	194	1216	1096	1278
	184	264	1065	1255	1334	233	187	1211	1231	1385	204	210	1264	1265	1417	174	170	1105	1196	1311	168	198	1249	1119	1310
3800	189	268	1095	1289	1371	241	195	1249	1269	1428	211	217	1302	1305	1462	180	176	1140	1229	1350	175	203	1286	1146	1346
	193	271	1120	1314	1399	244	198	1273	1292	1456	213	221	1330	1330	1491	183	179	1166	1253	1377	178	207	1318	1171	1379
4000	198	290	1155	1360	1445	251	204	1308	1327	1497	224	227	1369	1368	1536	190	186	1199	1286	1415	183	212	1350	1196	1413
	202	292	1182	1387	1475	254	207	1333	1354	1527	226	230	1396	1395	1566	191	188	1226	1311	1443	188	218	1385	1221	1447
4200	207	295	1213	1414	1510	262	215	1368	1390	1568	232	234	1430	1433	1609	197	195	1259	1341	1481	194	223	1419	1248	1483
	210	298	1237	1438	1538	265	217	1393	1414	1597	235	238	1457	1460	1639	200	198	1285	1371	1513	198	227	1454	1274	1517
4400	217	302	1267	1464	1572	271	224	1426	1448	1638	244	242	1500	1496	1683	205	205	1317	1402	1549	205	233	1489	1300	1552
	220	305	1291	1494	1603	275	227	1453	1474	1668	247	246	1526	1526	1715	207	208	1344	1430	1581	210	238	1526	1327	1588
4600	226	309	1315	1522	1635	282	234	1489	1508	1708	254	250	1561	1563	1755	213	214	1376	1461	1619	216	243	1559	1352	1622
	231	312	1341	1552	1667	287	237	1516	1535	1740	257	254	1590	1590	1788	216	218	1404	1488	1650	221	248	1596	1379	1659
4800	238	330	1371	1601	1711	293	243	1552	1569	1779	265	257	1628	1625	1830	221	224	1437	1519	1687	227	254	1628	1402	1694
	241	331	1398	1631	1746	297	246	1580	1596	1812	268	260	1657	1653	1864	223	229	1464	1548	1721	234	259	1668	1432	1734
5000	248	336	1430	1653	1779	304	254	1615	1629	1853	276	265	1693	1686	1905	230	235	1498	1576	1757	239	265	1697	1457	1767
	251	338	1456	1680	1812	309	257	1645	1658	1887	279	268	1723	1716	1940	233	239	1529	1607	1793	245	270	1737	1489	1807
5200	259	342	1485	1702	1843	314	262	1679	1691	1928	286	272	1758	1747	1979	240	246	1561	1636	1828	249	276	1766	1512	1839
	263	344	1511	1734	1878	319	265	1709	1720	1964	289	276	1787	1778	2015	243	251	1590	1668	1864	255	282	1808	1543	1882
5400	270	357	1536	1780	1918	325	271	1744	1751	2002	296	280	1820	1809	2052	249	257	1620	1696	1900	261	286	1837	1566	1914
	273	360	1568	1812	1957	330	274	1773	1783	2039	299	284	1851	1839	2089	251	262	1650	1729	1937	266	292	1880	1598	1959
5600	280	364	1599	1832	1989	336	280	1806	1814	2077	306	288	1886	1868	2126	257	268	1682	1755	1971	271	297	1910	1621	1991
	284	365	1626	1860	2024	340	284	1839	1847	2118	309	293	1919	1900	2165	260	273	1713	1791	2011	276	302	1957	1655	2039
5800	290	369	1654	1883	2055	347	290	1872	1877	2156	317	295	1954	1929	2200	265	279	1741	1818	2046	282	306	1984	1676	2071
	295	372	1685	1918	2094	351	293	1905	1911	2195	319	299	1987	1961	2239	271	284	1779	1853	2087	287	314	2032	1711	2118
6000	301	384	1708	1966	2133	357	298	1939	1942	2233	326	303	2022	1989	2274	273	290	1800	1881	2120	293	319	2061	1732	2151
	306	386	1741	1999	2175	364	301	1981	1974	2274	329	305	2056	2023	2311	276	295	1834	1921	2163	298	325	2105	1767	2198

APPENDIX TABLE 28c

Detailed Follow-Up Load-Deflection Data, in Lb. and 1/1000 In.
Pallets of Conventional Design

Test	Pallet No. Ac1					Pallet No. Ac2					Pallet No. Ac3					Pallet No. Ac4					Pallet No. Ac5				
Load	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
0	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
200	08	11	51	60	60	07	08	45	51	53	08	09	55	57	61	16	14	52	68	63	08	08	43	38	46
	09	12	59	67	68	09	09	56	63	66	09	10	65	68	72	19	16	63	79	74	09	09	49	43	54
400	19	24	119	132	137	18	18	113	120	131	21	19	129	137	145	36	27	131	145	147	23	21	104	95	114
	21	27	128	142	148	21	21	123	132	143	24	22	143	150	159	42	31	147	158	164	27	22	116	105	126
600	30	39	186	203	216	30	28	176	191	208	33	29	204	214	232	55	42	212	233	240	38	32	168	157	186
800	32	42	196	214	229	32	30	188	205	222	37	31	218	226	247	61	44	227	246	257	41	35	180	166	198
800	38	54	251	276	296	41	37	238	260	284	47	38	279	284	317	72	54	289	309	328	51	45	230	216	257
	39	58	260	287	309	43	40	249	273	299	49	41	294	297	333	76	56	306	322	343	54	46	242	226	270
1000	44	71	315	350	375	49	45	298	328	361	60	46	354	353	399	84	68	364	381	409	63	57	290	273	327
	46	74	325	361	388	51	47	309	343	375	63	48	371	365	415	89	71	382	397	427	65	60	304	283	341
1200	52	87	380	421	451	57	54	361	397	437	72	54	429	420	481	96	81	438	458	492	73	70	350	330	394
	53	90	391	432	466	62	56	375	410	452	75	56	446	432	496	98	84	457	476	511	75	71	364	340	407
1400	58	101	443	489	529	68	60	423	463	510	84	62	501	485	559	106	93	510	533	575	82	79	406	383	459
	59	104	454	501	543	76	63	438	480	528	87	63	517	497	575	109	95	530	552	594	83	82	420	394	473
1600	65	114	505	555	607	82	67	487	529	586	96	68	572	549	640	116	103	582	603	657	90	88	462	439	523
	67	117	515	566	621	83	68	500	544	603	99	71	588	560	658	120	107	602	625	677	92	90	475	450	536
1800	73	125	562	616	678	88	73	545	590	660	107	76	641	610	718	127	115	653	680	737	98	97	514	493	586
	75	128	572	629	692	90	75	559	605	678	109	78	660	622	736	131	119	674	698	758	101	98	529	505	602
2000	80	138	619	677	747	95	80	604	651	733	117	83	708	670	794	137	126	720	750	813	107	104	566	547	652
	82	141	630	690	761	98	82	619	667	750	120	86	726	684	812	142	130	745	771	835	110	106	582	561	668
2200	87	149	675	735	814	103	87	665	713	804	126	92	772	730	866	149	136	795	819	890	117	112	621	599	716
	89	149	692	750	829	106	89	681	730	824	129	95	792	746	886	154	142	822	840	914	120	114	635	612	733
2400	94	156	731	793	878	112	95	722	774	876	136	100	836	790	938	160	147	869	887	966	127	120	673	650	777
	97	159	746	809	893	114	96	739	793	895	139	103	856	807	958	166	151	899	908	991	129	121	688	663	794
2600	102	166	785	849	940	120	101	781	835	944	145	109	896	848	1008	172	158	943	952	1042	136	128	723	703	837
	105	170	800	865	958	123	103	799	854	966	148	112	917	867	1029	177	162	970	976	1068	138	130	740	716	855
2800	111	177	840	904	1002	128	109	837	895	1012	155	117	955	907	1075	183	168	1012	1016	1115	144	136	774	751	895
	113	180	854	920	1021	131	110	857	915	1035	158	120	977	928	1100	188	172	1042	1041	1144	146	138	794	766	914
3000	120	186	892	961	1067	137	115	893	954	1060	165	126	1015	966	1145	194	177	1082	1078	1187	153	143	830	799	954
	123	190	911	983	1090	139	117	914	976	1105	167	130	1039	988	1171	201	182	1115	1107	1218	156	145	851	815	976
3200	128	197	948	1021	1135	147	123	949	1013	1148	174	136	1074	1026	1214	207	188	1153	1142	1259	161	152	881	846	1014
	132	200	969	1045	1159	150	125	972	1038	1174	177	139	1099	1050	1240	213	192	1187	1169	1292	164	154	904	866	1037
3400	137	207	1002	1080	1199	156	131	1004	1073	1214	183	145	1133	1087	1281	218	198	1223	1204	1332	169	161	934	895	1074
	142	210	1026	1105	1226	158	134	1029	1097	1241	186	148	1160	1110	1308	224	202	1257	1231	1365	173	163	960	915	1100
3600	147	216	1059	1140	1267	164	138	1063	1132	1281	194	155	1197	1146	1349	230	208	1292	1264	1404	177	169	989	944	1136
	152	219	1086	1168	1296	166	141	1089	1159	1311	197	159	1224	1170	1378	236	213	1327	1294	1439	181	172	1018	964	1163
3800	157	225	1119	1201	1335	172	146	1122	1190	1349	204	164	1260	1205	1418	243	219	1360	1326	1476	187	178	1047	992	1198
	162	229	1144	1228	1365	175	148	1152	1218	1380	207	169	1288	1229	1447	248	224	1396	1355	1512	190	181	1075	1013	1226
4000	167	234	1177	1261	1404	181	153	1186	1250	1418	213	175	1322	1263	1487	253	230	1429	1387	1549	195	186	1103	1040	1259
	172	238	1202	1289	1434	185	156	1214	1278	1450	216	179	1349	1288	1516	259	235	1468	1417	1587	198	191	1133	1064	1288
4200	178	242	1240	1320	1475	190	161	1246	1309	1487	223	185	1382	1321	1554	265	241	1500	1448	1623	204	197	1160	1090	1320
	183	246	1264	1349	1507	193	164	1276	1338	1520	226	189	1412	1347	1585	270	246	1541	1482	1662	207	200	1192	1114	1351
4400	188	251	1294	1381	1545	200	169	1306	1368	1555	232	195	1447	1377	1624	276	251	1571	1513	1697	213	205	1219	1139	1383
	194	255	1320	1411	1577	202	172	1335	1397	1590	236	200	1478	1404	1656	282	257	1612	1547	1738	221	207	1257	1166	1415
4600	199	260	1348	1441	1612	208	177	1364	1426	1625	242	205	1511	1434	1694	287	263	1643	1576	1772	226	212	1283	1191	1447
	205	264	1374	1472	1646	210	180	1395	1456	1660	245	210	1544	1463	1728	293	268	1687	1612	1816	238	216	1318	1216	1481
4800	210	268	1401	1501	1681	217	185	1423	1485	1695	252	216	1576	1493	1763	299	273	1717	1639	1850	242	221	1343	1242	1513
	216	272	1430	1533	1717	221	188	1457	1516	1731	255	220	1612	1524	1801	304	279	1761	1677	1896	253	224	1378	1270	1548
5000	221	277	1458	1561	1752	227	193	1485	1543	1765	262	225	1642	1552	1836	309	285	1790	1705	1930	257	229	1404	1294	1579
	227	282	1488	1596	1789	230	197	1519	1577	1804	266	230	1682	1582	1875	314	290	1836	1743	1976	263	232	1442	1322	1617
5200	232	286	1515	1623	1825	236	201	1548	1604	1839	273	236	1712	1610	1911	320	296	1865	1768	2009	268	238	1469	1346	1648
	238	290	1545	1657	1862	246	204	1589	1642	1880	277	241	1752	1642	1953	326	302	1914	1807	2058	274	241	1507	1375	1684
5400	242	294	1571	1683	1896	251	208	1615	1667	1913	284	246	1780	1669	1987	331	307	1942	1834	2090	279	247	1535	1398	1716
	248	298	1602	1718	1935	261	212	1653	1705	1957	288	251	1822	1701	2029	337	313	1993	1873	2140	284	251	1575	1427	1755
5600	253	303	1626	1745	1969	265	216	1679	1731	1990	295	255	1853	1728	2063	342	319	2020	1898	2171	287	257	1600	1451	1786
	259	308	1657	1781	2010	270	218	1719	1770	2038	305	260	1902	1765	2109	349	324	2075	1940	2223	293	260	1640	1481	1825
5800	263	312	1683	1807	2044	274	223	1743	1795	2069	311	265	1930	1791	2143	354	328	2102	1967	2255	297	265	1665	1503	1856
	270	316	1714	1844	2086	279	227	1781	1833	2115	318	271	1979	1827	2189	361	335	2158	2008	2310	301	270	1708	1535	1899
6000	275	320	1739	1870	2118	284	231	1805	1858	2148	323	276	2007	1850	2221	366	340	2184	2036	2342	306	275	1734	1557	1930
	281	325	1768	1905	2158	290	235	1843	1894	2192	332	281	2053	1886	2266	377	344	2253	2072	2399	310	278	1774	1600	1977

APPENDIX TABLE 28d

Detailed Follow-Up Load-Deflection Data, in Lb. and 1/1000 In.
Pallets of Conventional Design

Test	Pallet No. Ad1					Pallet No. Ad2					Pallet No. Ad3					Pallet No. Ad4					Pallet No. Ad5				
Load	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
0	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
200	12	06	22	36	67	32	13	79	58	75	10	16	57	69	67	13	07	60	57	62	09	05	41	68	59
	13	08	25	41	73	34	14	88	66	84	12	27	70	83	82	15	08	68	66	71	12	08	53	86	74
400	25	15	79	109	139	43	26	150	133	158	24	39	133	154	154	32	22	135	139	148	21	16	108	164	147
	30	16	90	120	152	45	28	160	145	170	27	48	147	170	169	43	30	151	155	166	24	18	121	179	161
600	42	24	141	183	216	54	40	219	213	245	40	57	205	238	242	57	38	210	221	237	33	25	173	252	233
	48	26	154	200	233	57	42	230	225	260	43	62	219	251	257	64	45	227	238	256	35	27	184	268	248
800	56	33	201	260	295	65	53	284	290	331	55	71	273	317	328	75	52	282	296	320	43	35	236	340	319
	62	35	213	274	312	67	57	297	304	347	57	75	287	333	344	79	57	299	314	341	46	36	252	358	336
1000	71	42	258	333	373	73	67	349	368	415	68	83	340	397	410	87	65	353	373	402	52	44	306	425	402
	74	44	272	348	388	76	71	364	381	431	70	87	356	414	427	89	68	369	388	419	54	46	321	443	421
1200	83	51	318	406	449	83	80	412	446	498	81	97	408	484	495	99	75	421	447	483	60	54	375	512	487
	87	54	330	423	466	85	84	425	460	514	84	100	423	500	511	101	78	443	463	502	63	56	391	531	506
1400	94	60	375	479	525	93	93	474	523	580	94	107	472	561	577	110	84	492	528	565	68	62	442	600	572
	97	63	380	498	537	95	97	487	537	596	97	111	489	578	595	113	89	509	544	584	71	64	457	620	591
1600	104	71	427	555	599	103	105	531	596	662	108	118	538	638	662	121	94	558	595	643	76	71	511	684	660
	109	73	441	571	616	104	109	546	612	680	111	122	551	654	678	125	98	576	611	663	79	73	526	703	678
1800	115	80	489	624	676	112	117	590	670	742	121	130	600	714	743	132	103	626	660	720	84	79	579	763	742
	119	84	503	637	694	114	120	605	686	760	125	134	615	732	761	136	106	655	676	743	87	82	597	785	762
2000	127	90	547	690	751	122	130	650	744	821	134	142	661	789	821	143	112	701	720	795	93	89	647	843	822
	131	93	563	705	769	123	133	664	760	838	139	145	674	806	839	147	115	720	739	814	95	92	667	865	844
2200	136	99	603	753	821	128	142	707	815	897	147	153	719	861	898	153	120	766	784	866	101	97	714	918	901
	139	102	626	769	841	130	146	725	835	917	152	156	734	879	917	157	124	786	805	886	103	99	732	938	922
2400	144	109	665	814	890	136	155	767	887	974	161	164	779	931	972	164	129	832	847	936	109	104	782	992	980
	147	111	682	831	910	136	166	814	913	1005	164	166	794	949	992	167	133	854	867	957	112	106	802	1012	1001
2600	161	117	724	877	960	141	174	851	959	1057	173	174	836	996	1043	174	138	897	908	1005	117	111	846	1060	1052
	163	121	742	896	983	143	178	866	979	1080	177	177	852	1018	1066	177	142	918	928	1026	121	114	868	1083	1077
2800	166	127	776	937	1027	153	185	905	1021	1132	185	184	888	1062	1115	183	147	959	965	1073	126	118	908	1129	1127
	168	131	792	956	1048	155	188	920	1042	1155	188	186	907	1084	1138	186	150	983	986	1096	131	122	933	1155	1153
3000	172	136	826	995	1092	165	195	958	1086	1204	197	194	942	1125	1185	193	156	1024	1021	1141	136	126	972	1198	1200
	174	141	846	1018	1115	167	199	974	1105	1228	200	197	961	1149	1209	196	159	1053	1045	1166	139	130	1000	1226	1229
3200	185	147	884	1057	1163	175	205	1011	1144	1274	208	205	995	1187	1252	202	165	1093	1079	1209	144	134	1038	1267	1272
	186	150	903	1079	1187	179	208	1013	1156	1309	212	208	1015	1211	1277	205	168	1120	1102	1234	148	139	1067	1297	1303
3400	190	156	933	1117	1228	186	214	1043	1192	1354	219	215	1048	1249	1319	212	173	1158	1135	1275	153	143	1101	1334	1344
	191	160	950	1140	1251	190	219	1044	1204	1387	223	217	1073	1278	1345	215	178	1188	1157	1301	156	147	1132	1365	1378
3600	201	166	988	1177	1295	200	224	1075	1241	1437	230	224	1105	1313	1386	221	183	1228	1191	1343	161	151	1166	1402	1417
	202	169	1006	1200	1320	206	230	1041	1235	1506	235	228	1127	1344	1414	224	186	1257	1212	1370	164	156	1197	1433	1453
3800	206	176	1035	1235	1359	212	236	1064	1267	1552	242	235	1161	1380	1456	231	191	1296	1242	1409	168	161	1229	1469	1491
	208	179	1055	1259	1385	218	241	1053	1273	1606	246	239	1182	1409	1484	234	194	1324	1264	1437	172	164	1261	1501	1528
4000	219	186	1092	1294	1426	222	248	1075	1305	1652	252	246	1215	1445	1524	241	200	1361	1295	1476	175	170	1291	1535	1565
	220	189	1112	1319	1454	239	262	947	1242	1850	257	249	1240	1475	1553	244	202	1389	1316	1503	179	175	1322	1570	1603
4200	225	195	1141	1354	1492	246	270	967	1268	1899	263	256	1271	1510	1593	251	207	1428	1344	1542	183	179	1352	1604	1639
	227	200	1163	1381	1522	252	276	963	1275	1957	267	259	1296	1539	1624	256	210	1459	1367	1571	188	185	1387	1638	1679
4400	236	205	1199	1413	1561	262	281	983	1303	2004	273	266	1324	1571	1662	263	215	1495	1395	1608	191	190	1417	1672	1716
	238	208	1222	1441	1591	270	287	981	1312	2063	276	271	1352	1602	1697	267	218	1528	1418	1639	194	195	1455	1709	1755
4600	241	213	1248	1472	1627	276	292	999	1337	2107	283	276	1381	1633	1732	273	224	1564	1444	1675	197	200	1485	1741	1790
	242	217	1271	1502	1648	283	299	990	1342	2178	288	280	1407	1663	1765	276	228	1598	1469	1707	200	205	1524	1779	1834
4800	251	222	1308	1533	1698	290	305	1007	1367	2227	295	287	1437	1694	1803	282	233	1632	1494	1741	205	209	1553	1809	1869
	252	225	1331	1564	1732	298	313	987	1366	2313	301	292	1466	1726	1838	285	235	1672	1524	1774	208	215	1592	1849	1914
5000	256	230	1355	1593	1765	304	318	1004	1390	2361	307	298	1495	1756	1874	292	241	1708	1551	1809	213	220	1620	1878	1950
	257	232	1379	1625	1798	314	327	987	1390	2457	312	302	1527	1792	1913	295	243	1743	1578	1845	216	225	1660	1917	1995
5200	265	238	1417	1652	1837	320	332	1002	1411	2504	319	309	1552	1820	1949	301	249	1776	1602	1880	220	230	1689	1946	2030
	265	241	1442	1686	1873	331	341	1000	1420	2583	323	312	1584	1856	1986	305	252	1814	1631	1918	224	236	1729	1987	2075
5400	269	245	1466	1713	1907	336	347	1017	1442	2626	331	319	1610	1884	2021	311	256	1847	1654	1952	227	241	1755	2014	2109
	270	248	1490	1746	1943	347	355	1131	1486	2771	335	323	1641	1916	2060	315	260	1888	1683	1990	232	246	1820	2052	2165
5600	279	253	1527	1771	1980	353	360	1148	1508	2771	343	329	1669	1945	2095	321	265	1921	1707	2023	236	250	1844	2081	2197
	279	257	1553	1809	2020	364	367	1148	1523	2771	348	335	1701	1978	2136	326	268	1964	1738	2063	240	257	1888	2124	2245
5800	283	261	1574	1833	2050	370	372	1164	1544	2771	355	339	1724	2004	2169	333	273	1997	1760	2097	244	262	1916	2151	2277
	284	265	1599	1867	2087	381	380	1173	1566	2771	361	346	1760	2041	2212	339	276	2041	1791	2139	249	267	1961	2194	2328
6000	293	269	1637	1891	2124	389	386	1198	1585	2771	368	350	1784	2067	2244	344	281	2077	1814	2173	251	271	1988	2222	2362
	295	273	1663	1925	2162	400	394	1207	1606	2771	374	355	1817	2101	2284	350	284	2115	1845	2214	256	279	2031	2263	2409

APPENDIX TABLE 28e

Detailed Follow-Up Load-Deflection Data, in Lb. and 1/1000 In.
Pallets of Improved Design

Test Load	Pallet No. 8a1					Pallet No. 8a2					Pallet No. 8a3					Pallet No. 8a4					Pallet No. 8a5				
	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
0	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
200	10	07	39	42	47	10	14	40	42	46	00	06	38	35	41	10	09	39	55	51	08	05	36	37	40
	11	08	45	47	54	12	16	46	46	52	00	12	58	49	61	11	10	46	63	59	09	06	44	45	49
400	21	18	92	92	107	24	39	98	90	107	08	20	103	97	113	25	24	94	128	122	21	14	93	96	105
	24	20	99	99	116	27	45	109	96	117	09	23	110	104	123	27	26	101	137	131	24	16	101	104	115
600	34	29	146	145	169	40	57	156	135	167	17	30	153	149	172	38	38	142	203	190	36	24	149	157	173
	35	31	156	152	178	43	60	166	142	176	19	33	163	157	183	41	41	151	214	201	38	25	158	166	182
800	46	41	199	194	230	57	73	212	182	229	28	41	204	198	232	51	52	191	276	261	48	33	200	216	237
	46	43	209	203	242	65	77	225	190	243	31	43	214	207	245	53	55	202	287	273	51	35	209	225	249
1000	57	52	250	245	291	76	89	267	231	292	39	49	255	248	292	64	65	241	350	332	60	42	248	273	301
	57	54	260	254	303	83	94	283	241	308	43	52	266	258	303	68	69	252	362	344	63	43	258	284	313
1200	68	63	300	295	353	93	106	325	279	357	51	58	307	296	350	76	79	290	420	399	73	51	297	332	364
	69	65	310	304	363	99	112	339	289	372	53	60	319	307	362	79	83	301	432	412	76	52	306	342	377
1400	78	75	350	344	410	108	123	379	330	418	62	66	358	346	405	88	93	339	491	465	84	60	343	388	427
	79	79	361	353	421	110	127	396	342	432	65	68	370	358	416	91	97	351	503	479	88	61	353	398	437
1600	89	87	400	391	468	121	142	437	386	482	73	75	411	397	459	100	106	388	556	530	97	68	388	444	487
	91	92	411	402	481	123	146	453	399	498	76	76	422	407	469	103	117	402	575	546	100	69	398	455	501
1800	100	101	449	441	526	134	160	492	445	547	86	82	461	443	511	112	128	438	627	598	109	75	432	497	547
	101	105	461	452	539	134	165	510	458	564	91	85	474	456	524	115	132	454	644	615	112	76	443	508	561
2000	107	113	495	488	583	142	176	551	500	613	98	90	511	489	566	124	140	490	688	663	120	84	476	547	606
	109	118	507	499	596	144	183	571	516	632	103	92	524	502	580	128	143	504	700	678	125	87	487	558	620
2200	118	126	543	536	641	156	197	609	558	682	112	97	561	537	623	136	150	539	744	725	132	92	518	595	662
	120	131	555	547	656	157	202	626	570	699	114	98	576	553	638	141	153	555	756	742	136	93	530	607	676
2400	130	139	591	583	698	164	213	665	610	746	123	103	613	585	680	150	159	591	798	785	143	99	560	641	716
	131	142	604	595	713	167	210	684	626	763	125	106	626	596	694	154	161	610	813	804	148	101	573	654	731
2600	138	149	637	629	752	179	231	719	665	809	134	110	660	628	733	162	169	646	854	846	156	106	604	687	769
	140	153	651	642	766	180	236	738	679	827	139	113	683	642	753	167	172	667	870	866	159	108	617	700	785
2800	149	159	684	674	804	187	246	770	714	867	147	119	715	672	790	175	177	698	906	905	166	119	651	733	822
	150	164	698	689	821	188	252	790	732	888	151	120	731	686	804	179	180	717	922	924	171	118	670	748	838
3000	157	169	729	720	856	194	260	819	766	925	158	125	766	714	840	186	186	747	958	961	177	123	695	782	873
	159	175	745	735	874	199	267	839	785	946	163	127	784	729	859	192	189	769	977	981	180	124	711	796	892
3200	170	180	780	767	911	205	273	867	819	985	171	131	815	756	892	200	196	800	1012	1018	186	128	738	825	924
	172	185	798	785	930	209	279	888	840	1009	175	134	832	776	911	204	197	824	1033	1039	194	131	761	842	946
3400	179	191	825	814	962	215	286	913	871	1042	182	139	860	802	942	210	202	853	1065	1073	200	136	785	868	976
	181	196	843	832	983	219	292	934	891	1064	186	142	880	821	962	215	206	878	1088	1098	203	137	804	887	998
3600	190	202	872	861	1017	225	298	958	921	1099	191	147	908	847	994	221	211	904	1119	1131	208	141	829	912	1029
	192	206	890	882	1039	230	303	981	943	1124	196	150	928	872	1017	227	216	931	1141	1157	216	145	854	933	1056
3800	201	212	920	908	1070	235	312	1006	973	1159	202	156	958	896	1047	232	221	957	1172	1190	221	149	876	956	1084
	203	216	940	931	1094	245	317	1035	996	1187	207	158	985	915	1071	238	224	985	1195	1215	226	151	898	978	1108
4000	210	222	963	957	1124	251	322	1058	1023	1219	214	163	1010	938	1099	245	229	1010	1223	1246	231	155	920	1001	1135
	212	227	985	980	1149	254	328	1084	1045	1246	218	166	1029	961	1124	251	232	1038	1248	1272	237	159	944	1022	1160
4200	221	232	1014	1007	1180	262	333	1112	1077	1281	224	171	1052	985	1151	258	237	1064	1278	1303	243	163	966	1046	1188
	223	238	1038	1030	1206	268	338	1136	1100	1307	229	174	1074	1008	1177	264	241	1091	1302	1329	246	156	989	1067	1214
4400	230	243	1064	1056	1236	274	345	1160	1129	1338	235	179	1098	1030	1203	271	246	1115	1330	1359	251	174	1015	1089	1242
	232	248	1089	1082	1262	279	351	1185	1153	1365	239	183	1122	1053	1228	276	249	1146	1355	1387	254	177	1039	1112	1270
4600	239	253	1114	1105	1291	286	358	1208	1180	1393	245	188	1145	1076	1253	282	255	1170	1385	1417	263	179	1067	1135	1299
	241	258	1139	1131	1318	290	364	1236	1206	1423	250	191	1171	1102	1283	290	257	1207	1410	1450	267	182	1090	1158	1327
4800	249	263	1166	1156	1347	298	369	1258	1231	1453	256	197	1195	1125	1309	296	263	1232	1440	1480	271	186	1110	1180	1354
	251	268	1190	1182	1374	303	375	1287	1258	1485	261	200	1223	1150	1338	302	267	1265	1467	1510	276	189	1133	1205	1381
5000	259	273	1216	1206	1404	310	380	1308	1283	1513	267	203	1247	1170	1367	309	273	1289	1497	1541	284	193	1160	1228	1409
	261	279	1240	1231	1431	314	388	1336	1306	1543	270	207	1272	1195	1403	315	276	1323	1525	1571	287	197	1184	1251	1438
5200	268	284	1265	1256	1460	321	392	1357	1330	1571	276	212	1294	1217	1430	321	282	1346	1554	1602	293	201	1204	1273	1462
	271	289	1289	1282	1489	327	397	1389	1363	1609	280	217	1318	1239	1465	327	286	1377	1581	1634	299	205	1234	1295	1494
5400	278	293	1313	1305	1516	334	401	1411	1387	1636	286	221	1340	1259	1491	333	290	1401	1608	1663	303	210	1253	1319	1520
	280	298	1337	1330	1544	339	407	1440	1410	1668	290	225	1365	1282	1526	339	294	1435	1635	1694	307	213	1276	1343	1549
5600	287	303	1360	1353	1572	346	413	1461	1434	1696	295	230	1388	1303	1553	345	300	1457	1662	1724	313	216	1302	1364	1578
	290	309	1396	1382	1608	352	417	1492	1461	1732	301	234	1433	1326	1596	353	303	1494	1691	1756	316	222	1327	1389	1610
5800	296	315	1419	1403	1634	359	423	1511	1485	1758	305	240	1455	1348	1623	358	307	1514	1719	1784	322	225	1352	1409	1638
	298	321	1445	1433	1665	364	429	1543	1513	1792	310	243	1483	1374	1657	364	312	1552	1747	1819	326	229	1376	1436	1669
6000	306	326	1470	1453	1694	371	435	1563	1538	1820	315	249	1506	1395	1684	370	317	1574	1775	1847	332	233	1400	1456	1695
	308	331	1494	1481	1724	376	441	1593	1565	1856	320	254	1530	1415	1721	377	320	1607	1804	1882	335	237	1426	1481	1727

APPENDIX TABLE 28f

Detailed Follow-Up Load-Deflection Data, in Lb. and 1/1000 In.
Pallets of Improved Design

Test	Pallet No. Bb1					Pallet No. Bb2					Pallet No. Bb3					Pallet No. Bb4					Pallet No. Bb5				
Load	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
0	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
200	11	13	43	46	40	12	12	39	48	46	13	10	39	54	54	07	07	35	30	35	10	05	49	16	46
	13	15	49	52	46	16	18	49	60	60	15	11	45	60	61	08	09	45	38	44	13	06	58	22	54
400	24	30	98	105	105	26	31	97	117	117	30	23	93	125	125	18	21	94	90	100	26	16	115	69	113
	28	32	106	115	115	29	37	106	127	133	35	24	101	134	136	23	24	103	98	109	30	18	125	76	123
600	40	45	152	167	172	39	46	147	178	184	48	36	147	194	197	30	36	150	148	163	41	27	180	122	179
	46	49	164	177	190	41	52	156	188	195	54	38	156	203	208	32	38	159	157	173	43	29	191	129	188
800	56	58	206	224	238	51	60	197	235	246	62	49	195	257	265	41	49	208	210	230	54	38	241	172	243
	64	62	219	234	254	53	65	206	246	257	65	51	204	267	275	43	52	218	220	241	57	39	251	182	256
1000	77	70	262	280	303	62	73	246	293	306	72	63	240	323	331	52	63	265	271	298	66	49	301	224	309
	85	73	274	291	318	65	77	256	304	320	76	65	247	335	342	55	67	279	284	312	71	51	314	235	321
1200	96	82	313	336	364	73	87	295	350	369	83	76	282	386	394	64	76	328	332	369	79	61	364	276	375
	103	85	326	347	381	75	93	305	361	381	87	79	290	399	405	66	79	342	343	383	83	63	376	385	386
1400	113	93	364	393	424	82	102	344	405	429	93	90	326	454	457	72	87	389	391	435	92	72	422	324	434
	120	96	377	405	440	85	108	347	418	535	98	92	335	468	470	76	93	405	403	448	95	73	433	333	445
1600	128	103	411	450	483	93	117	396	462	583	104	103	369	519	520	83	100	451	450	500	104	82	477	371	492
	134	107	424	462	498	96	125	408	476	599	108	106	379	533	532	88	103	468	463	514	107	84	489	381	503
1800	142	114	457	503	542	103	135	446	518	645	114	117	412	578	580	95	110	510	511	564	117	94	531	418	550
	146	118	468	515	560	106	140	461	532	662	128	120	427	595	596	100	114	525	525	577	120	95	543	428	561
2000	154	125	501	552	597	113	149	496	572	704	135	128	460	636	641	106	120	565	568	626	128	104	585	465	607
	158	127	512	561	611	117	152	511	587	722	141	131	469	650	654	112	123	580	582	642	132	106	599	476	621
2200	166	134	546	599	651	124	161	545	626	763	147	141	501	692	700	118	129	621	623	689	140	117	639	513	666
	171	137	561	613	668	128	164	561	643	780	151	143	512	708	714	121	132	634	635	703	144	116	653	523	681
2400	178	144	593	648	706	134	172	595	678	820	162	154	545	747	759	127	138	673	676	747	152	125	692	558	725
	182	147	606	661	726	139	177	614	695	837	171	157	562	766	775	131	142	687	690	763	156	126	706	569	739
2600	189	154	637	696	763	146	185	648	731	876	178	166	594	802	815	136	147	721	727	804	164	134	744	604	780
	193	157	651	711	779	149	190	668	747	893	186	169	609	819	831	139	150	737	742	820	169	136	764	616	796
2800	200	164	681	744	815	156	197	700	783	930	196	179	640	855	871	145	155	771	778	859	177	142	799	646	833
	204	168	698	761	836	161	201	717	797	949	206	183	657	872	887	148	158	787	794	875	190	147	823	660	850
3000	210	175	725	792	867	166	207	748	830	985	212	191	684	907	925	154	164	821	829	914	197	156	858	692	888
	214	178	742	809	888	170	211	768	847	1004	224	196	700	927	944	156	167	839	847	932	206	158	880	706	906
3200	226	183	772	841	920	176	218	797	878	1038	234	205	728	960	981	162	172	868	878	967	214	163	913	735	942
	228	189	789	860	944	180	224	819	897	1061	245	208	746	979	1001	166	176	887	898	990	217	167	934	750	962
3400	234	194	813	888	972	185	230	848	928	1094	251	216	772	1011	1034	172	181	914	928	1023	224	172	966	776	995
	237	199	832	908	998	188	236	871	948	1119	257	220	790	1032	1055	184	183	941	952	1050	227	175	988	792	1017
3600	243	204	856	935	1026	193	241	897	977	1150	265	227	817	1064	1090	189	188	966	980	1081	232	183	1020	819	1051
	247	210	876	957	1050	197	246	922	998	1175	271	231	837	1085	1113	191	192	986	1000	1102	237	186	1045	837	1073
3800	254	216	901	983	1078	201	252	946	1025	1204	278	241	861	1115	1145	196	199	1011	1030	1133	243	191	1073	862	1105
	258	221	922	1004	1104	205	258	972	1046	1228	282	243	879	1137	1168	198	202	1032	1050	1156	247	197	1097	880	1128
4000	264	226	945	1032	1130	209	262	995	1073	1256	290	251	904	1164	1201	203	207	1056	1075	1185	253	201	1127	903	1159
	268	231	969	1051	1154	212	267	1021	1095	1281	294	254	924	1185	1223	207	211	1078	1098	1207	255	205	1148	920	1182
4200	273	237	991	1075	1182	217	273	1045	1119	1308	299	262	945	1212	1251	213	216	1101	1123	1236	262	213	1179	944	1214
	278	241	1012	1097	1207	221	279	1073	1144	1334	303	265	966	1236	1275	216	220	1124	1146	1259	265	216	1201	963	1237
4400	284	248	1034	1124	1235	225	283	1095	1168	1360	312	271	993	1263	1306	221	225	1147	1169	1285	271	221	1227	985	1265
	288	251	1056	1144	1257	230	289	1123	1192	1387	315	275	1013	1285	1331	225	230	1171	1193	1310	274	225	1250	1005	1288
4600	294	257	1078	1170	1285	234	293	1145	1216	1413	320	282	1033	1310	1358	230	235	1195	1217	1336	281	232	1277	1027	1316
	298	260	1100	1190	1312	238	298	1175	1242	1440	325	284	1052	1334	1383	235	238	1219	1240	1362	284	235	1304	1050	1341
4800	304	266	1123	1213	1336	242	303	1196	1265	1465	332	291	1077	1360	1413	239	243	1242	1264	1389	291	241	1330	1071	1369
	308	271	1146	1235	1368	246	309	1227	1292	1493	336	295	1096	1382	1439	244	249	1268	1289	1415	295	242	1355	1092	1396
5000	313	277	1167	1260	1393	251	313	1248	1315	1519	342	301	1119	1407	1467	249	254	1290	1313	1441	301	250	1382	1118	1425
	319	282	1192	1282	1420	254	319	1278	1339	1546	347	305	1139	1432	1493	254	257	1315	1337	1469	305	253	1406	1139	1450
5200	324	287	1212	1307	1445	259	324	1299	1363	1572	351	312	1158	1456	1520	260	262	1337	1360	1495	312	257	1434	1159	1478
	328	293	1237	1329	1477	262	329	1330	1389	1602	355	316	1178	1482	1546	264	267	1362	1385	1522	314	261	1458	1179	1504
5400	334	298	1256	1352	1499	266	335	1351	1411	1628	364	323	1204	1505	1575	269	271	1382	1407	1548	322	265	1484	1199	1531
	338	303	1278	1374	1524	270	339	1381	1437	1658	368	327	1224	1531	1603	273	276	1408	1432	1575	325	269	1509	1220	1557
5600	343	309	1298	1398	1552	274	344	1401	1459	1684	373	334	1242	1555	1630	279	281	1428	1455	1601	331	278	1535	1244	1585
	347	313	1322	1420	1580	277	350	1434	1487	1716	377	337	1262	1582	1657	284	286	1456	1481	1629	335	282	1550	1265	1615
5800	353	320	1343	1444	1606	282	355	1456	1510	1741	385	343	1288	1605	1686	289	290	1477	1502	1655	342	286	1587	1284	1642
	358	323	1370	1468	1634	285	361	1492	1538	1776	388	347	1305	1632	1715	295	295	1505	1530	1685	345	290	1614	1306	1670
6000	364	330	1390	1492	1660	290	366	1513	1560	1801	393	353	1322	1656	1741	299	300	1526	1553	1709	352	295	1640	1326	1697
	368	334	1417	1516	1690	293	372	1545	1586	1835	398	358	1340	1683	1770	304	304	1552	1579	1739	356	299	1670	1349	1725

APPENDIX TABLE 28g

Detailed Follow-Up Load-Deflection Data, in Lb. and 1/1000 In.
Pallets of Improved Design

Test	Pallet No. Bc1					Pallet No. Bc2					Pallet No. Bc3					Pallet No. Bc4					Pallet No. Bc5				
Load	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
0	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
200	10	08	39	55	54	00	07	08	43	44	08	08	32	45	37	12	06	32	18	24	10	10	41	49	49
	11	08	42	59	57	00	08	15	51	52	10	11	37	53	43	17	11	45	30	38	12	13	50	60	60
400	23	18	85	114	114	05	19	65	103	110	23	24	77	117	100	32	19	89	87	92	24	29	101	120	124
	25	20	93	123	123	06	21	73	112	120	26	27	85	126	109	36	24	100	98	104	25	31	109	128	134
600	37	30	132	177	177	18	32	123	164	177	38	38	123	186	163	49	33	141	153	157	36	47	159	188	197
	38	31	141	186	187	23	35	132	175	189	41	41	132	196	172	52	37	151	162	168	38	50	167	197	207
800	48	41	178	236	239	38	46	178	226	249	52	52	171	254	226	63	45	189	216	218	49	65	216	255	271
	50	43	187	247	250	43	49	189	238	264	56	54	180	263	235	67	49	199	227	231	53	71	226	266	282
1000	58	52	223	294	300	61	59	236	292	323	68	65	217	316	289	77	57	233	279	282	65	82	271	325	342
	60	53	231	304	311	68	63	248	306	339	74	70	230	328	301	82	61	244	290	295	68	87	281	336	353
1200	69	62	266	351	360	82	73	290	356	394	88	78	267	379	351	92	69	277	339	344	79	97	324	393	411
	71	64	274	362	371	87	77	301	370	409	93	82	279	391	364	96	74	290	352	359	83	102	334	406	424
1400	79	72	309	407	419	98	86	342	415	463	104	88	314	439	411	106	82	323	402	407	93	113	376	462	460
	82	74	319	419	431	103	91	353	429	478	109	90	325	451	424	111	85	335	416	420	96	116	386	473	492
1600	88	82	355	465	478	117	99	394	474	531	121	97	362	503	472	120	93	368	466	468	107	126	426	523	547
	90	84	365	479	490	122	104	407	489	548	128	101	375	517	485	126	97	381	482	483	110	131	436	535	561
1800	101	92	401	524	539	131	113	446	531	599	141	109	411	569	535	136	105	413	533	530	122	140	476	582	614
	103	95	411	536	550	136	117	459	544	615	146	111	425	582	548	141	110	425	550	546	125	145	487	596	628
2000	109	101	446	578	596	145	125	497	586	665	157	117	460	629	594	150	117	456	598	590	134	156	525	639	678
	112	103	457	590	609	150	128	509	599	680	165	121	476	646	611	156	122	468	613	605	139	158	536	651	691
2200	123	110	492	632	657	161	136	546	640	727	175	128	506	691	658	164	128	500	660	653	150	167	573	691	736
	125	112	503	645	671	165	139	561	653	744	180	131	520	706	674	168	131	512	678	668	153	171	582	700	747
2400	132	118	536	683	714	175	147	596	691	788	190	137	553	751	720	177	140	541	721	712	165	180	618	741	792
	134	120	549	698	729	178	149	611	705	806	196	140	566	768	736	180	143	554	737	730	168	183	630	753	804
2600	145	127	582	737	773	192	157	650	744	851	205	148	598	811	780	138	150	583	776	769	177	192	663	787	845
	147	130	594	752	788	196	160	666	759	370	211	151	614	829	797	193	155	597	794	788	183	195	678	799	859
2800	153	136	628	788	827	204	166	699	793	909	218	158	644	867	837	200	161	625	831	826	191	204	710	832	898
	156	139	641	801	843	207	170	715	808	929	224	162	660	887	856	205	165	640	848	845	194	207	725	846	914
3000	162	145	673	836	882	220	177	751	843	969	232	168	687	924	894	211	171	667	882	880	203	217	756	879	952
	165	147	692	852	900	224	181	769	860	991	238	172	702	943	912	216	175	684	900	900	207	221	774	895	971
3200	173	154	722	886	938	231	188	799	891	1028	246	186	735	978	951	222	181	710	933	933	215	229	803	928	1008
	175	156	738	904	957	235	192	819	908	1050	252	189	753	1001	972	227	186	728	952	955	221	234	826	948	1031
3400	181	163	765	935	991	245	199	851	937	1087	260	195	777	1034	1007	234	191	752	982	986	230	241	853	977	1067
	184	166	782	955	1011	249	202	873	957	1111	266	199	794	1056	1027	238	196	770	1001	1007	235	246	876	999	1091
3600	192	173	812	987	1048	256	209	899	984	1146	273	210	824	1091	1064	244	200	794	1029	1037	245	253	910	1029	1128
	195	176	828	1006	1067	260	214	921	1007	1173	278	213	841	1114	1085	248	205	816	1048	1059	250	258	933	1053	1154
3800	200	183	854	1036	1101	271	221	951	1034	1207	284	218	863	1146	1119	256	210	838	1076	1089	259	268	961	1081	1187
	204	187	876	1057	1123	275	227	973	1056	1233	290	221	881	1168	1140	262	214	860	1097	1111	267	273	988	1104	1215
4000	213	193	903	1089	1158	281	232	996	1082	1262	296	231	906	1200	1175	268	218	880	1124	1139	276	282	1014	1133	1247
	221	195	924	1109	1180	284	237	1016	1103	1288	301	232	923	1221	1198	273	223	900	1146	1164	282	287	1040	1156	1274
4200	229	202	950	1138	1213	295	243	1046	1128	1319	308	238	945	1253	1228	279	228	918	1171	1191	290	295	1066	1183	1305
	239	207	971	1162	1236	298	247	1068	1150	1346	312	241	963	1277	1251	284	232	939	1192	1215	296	301	1092	1207	1333
4400	245	212	995	1188	1266	303	253	1089	1175	1374	319	251	988	1308	1283	291	238	960	1217	1241	304	310	1117	1235	1365
	252	216	1016	1212	1289	308	257	1111	1198	1400	323	254	1007	1332	1307	296	242	980	1239	1265	308	315	1149	1261	1393
4600	258	221	1039	1236	1319	317	263	1139	1220	1430	330	259	1026	1360	1335	303	246	999	1263	1289	316	323	1172	1288	1423
	263	227	1059	1261	1344	322	268	1163	1245	1458	334	262	1046	1384	1360	308	250	1021	1286	1314	321	329	1201	1313	1453
4800	270	232	1084	1286	1373	328	273	1182	1268	1485	342	272	1073	1415	1391	315	254	1040	1310	1341	329	336	1223	1341	1483
	273	237	1105	1311	1398	333	278	1207	1293	1513	347	276	1092	1440	1416	320	259	1062	1333	1365	335	343	1252	1368	1515
5000	279	241	1127	1335	1426	343	283	1234	1313	1542	253	280	1111	1468	1445	327	263	1081	1357	1391	344	350	1275	1395	1546
	283	247	1149	1361	1453	347	288	1259	1339	1573	358	284	1132	1494	1470	333	267	1102	1388	1420	350	358	1304	1423	1578
5200	290	252	1172	1384	1481	353	294	1278	1362	1599	365	293	1157	1522	1501	340	272	1123	1413	1447	357	365	1327	1449	1607
	293	255	1196	1407	1508	358	298	1302	1388	1629	371	297	1179	1551	1527	347	276	1146	1437	1472	363	372	1357	1478	1641
5400	299	262	1218	1433	1537	369	304	1331	1409	1658	377	301	1197	1577	1553	354	281	1166	1460	1498	369	380	1378	1503	1669
	303	265	1240	1456	1563	373	311	1355	1434	1688	383	305	1217	1604	1579	359	285	1190	1483	1524	376	387	1409	1533	1703
5600	309	272	1263	1481	1590	379	316	1373	1456	1715	388	314	1242	1631	1610	366	290	1209	1506	1549	383	394	1430	1557	1731
	313	277	1288	1508	1618	385	320	1394	1478	1746	394	317	1265	1659	1637	372	295	1233	1531	1576	390	402	1460	1585	1765
5800	319	282	1309	1533	1646	394	326	1423	1497	1774	400	321	1251	1685	1664	379	299	1253	1554	1600	397	409	1481	1609	1793
	323	286	1334	1560	1676	399	331	1446	1524	1806	406	325	1304	1713	1691	386	304	1278	1581	1628	403	417	1512	1640	1829
6000	329	293	1357	1584	1703	405	336	1464	1546	1834	412	334	1327	1740	1720	393	309	1298	1603	1654	410	424	1533	1664	1858
	332	296	1376	1609	1732	410	342	1488	1572	1865	417	336	1346	1768	1748	397	313	1319	1627	1681	416	432	1563	1694	1891

APPENDIX TABLE 28h

Detailed Follow-Up Load-Deflection Data, in Lb. and 1/1000 In.
Pallets of Improved Design

Test Load	Pallet No. Bd1 A	B	C	D	E	Pallet No. Bd2 A	B	C	D	E	Pallet No. Bd3 A	B	C	D	E	Pallet No. Bd4 A	B	C	D	E	Pallet No. Bd5 A	B	C	D	E
0	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
200	13	07	37	43	45	11	11	41	93	47	13	08	43	47	49	13	09	38	45	43	07	08	41	42	43
	17	08	46	53	56	13	12	47	105	54	16	10	51	54	57	17	15	52	58	56	09	10	51	54	55
400	38	17	97	107	119	27	20	99	164	114	35	23	110	112	124	39	29	109	114	118	18	25	107	117	123
	43	10	109	117	131	30	22	108	174	125	38	25	120	121	134	48	35	125	127	133	21	27	116	125	133
600	60	28	155	169	188	46	30	156	231	184	55	36	175	179	198	62	50	177	186	194	32	40	170	184	197
	64	30	166	178	202	49	32	166	241	196	58	40	188	188	211	68	57	192	195	206	34	42	179	193	207
800	81	38	210	224	255	65	40	214	295	254	75	47	240	243	273	81	73	241	251	266	47	54	235	249	271
	86	40	222	235	268	68	42	225	306	266	79	51	254	254	287	87	81	258	262	281	49	56	246	259	282
1000	101	48	264	280	321	82	49	271	360	323	95	57	306	307	349	98	94	306	315	337	62	68	302	316	347
	104	51	275	291	335	85	52	282	372	336	99	62	323	319	364	102	100	318	325	349	63	70	312	325	357
1200	118	60	316	338	388	101	59	328	426	394	116	68	377	372	425	113	109	363	378	404	74	82	367	381	420
	130	66	331	355	406	104	62	339	437	407	120	73	392	383	439	117	113	374	388	416	76	84	376	390	430
1400	147	73	374	402	460	119	68	386	493	463	135	84	448	438	501	128	123	416	437	468	85	95	427	444	490
	153	81	387	416	476	122	71	397	505	476	141	86	468	452	520	131	125	429	448	482	87	97	437	454	501
1600	171	89	432	467	533	134	78	440	555	528	156	96	522	508	582	142	135	473	501	536	95	107	487	505	561
	172	93	444	481	547	136	79	455	569	543	161	99	540	523	600	147	138	487	514	550	97	109	497	514	572
1800	183	101	484	525	598	152	86	499	517	598	175	103	589	573	660	156	147	528	565	604	104	118	543	563	627
	186	106	496	541	613	158	87	516	633	615	181	108	610	590	679	160	151	542	578	619	106	120	554	572	639
2000	205	115	540	588	668	168	94	557	676	664	194	113	657	638	735	170	160	582	626	670	116	130	599	617	692
	207	119	553	601	682	175	97	574	692	680	199	118	676	654	755	174	170	599	646	689	117	132	608	626	703
2200	225	129	596	647	735	186	103	614	736	728	121	123	723	703	810	183	180	639	692	737	123	141	653	669	753
	228	133	610	660	750	191	105	631	750	744	218	127	745	720	829	187	187	656	708	755	124	142	665	680	766
2400	238	141	649	701	796	204	112	673	794	791	230	132	791	764	880	195	195	692	753	801	131	152	708	722	814
	241	145	665	717	813	207	114	690	812	808	236	136	814	781	900	200	201	711	769	818	136	154	720	733	828
2600	260	155	706	761	864	218	120	728	853	853	249	141	856	822	948	208	210	749	811	864	142	161	760	774	873
	262	158	722	776	883	223	123	747	870	870	257	144	884	483	971	212	216	769	829	883	144	164	770	785	887
2800	271	166	756	814	923	235	128	785	908	911	268	150	925	881	1017	219	224	804	867	925	150	172	807	821	929
	287	168	806	834	956	238	131	806	925	929	276	154	956	903	1042	224	229	821	882	944	155	174	818	835	944
3000	295	176	839	868	998	248	137	842	961	966	287	159	993	939	1085	232	238	857	921	987	163	180	853	868	984
	299	180	859	887	1021	252	140	860	980	986	296	163	1023	966	1113	237	243	878	940	1010	165	183	865	880	999
3200	308	188	890	920	1059	262	146	893	1014	1023	307	168	1058	999	1155	245	251	911	975	1050	172	191	899	912	1037
	312	193	914	940	1084	266	150	913	1034	1046	316	172	1089	1026	1184	250	257	935	995	1074	175	192	913	925	1052
3400	331	200	953	975	1126	275	155	944	1065	1082	325	177	1122	1059	1222	259	265	967	1029	1111	183	199	945	954	1088
	334	206	977	995	1149	279	158	963	1086	1105	334	182	1155	1086	1252	264	271	993	1050	1136	186	201	958	967	1103
3600	341	213	1006	1026	1185	288	164	994	1116	1139	342	190	1187	1119	1289	271	279	1025	1083	1171	193	207	989	996	1138
	353	218	1045	1047	1216	293	168	1015	1138	1163	352	195	1223	1146	1319	276	285	1051	1105	1198	196	211	1004	1011	1153
3800	360	225	1071	1078	1250	303	174	1045	1168	1196	361	200	1255	1174	1355	284	293	1082	1135	1232	203	217	1034	1038	1186
	369	229	1101	1105	1276	306	177	1067	1190	1218	369	205	1287	1198	1382	294	296	1134	1155	1267	205	221	1048	1052	1202
4000	386	235	1136	1135	1313	315	184	1095	1218	1251	377	211	1316	1230	1417	320	303	1163	1183	1298	212	227	1077	1078	1233
	394	241	1162	1160	1341	319	188	1116	1240	1275	386	216	1349	1255	1447	307	311	1190	1206	1325	216	230	1091	1094	1250
4200	401	246	1186	1188	1373	327	194	1146	1267	1305	394	223	1377	1285	1482	314	317	1220	1232	1356	220	237	1115	1119	1278
	406	251	1208	1212	1400	331	199	1168	1291	1330	402	228	1412	1306	1512	319	325	1247	1256	1384	222	241	1129	1133	1294
4400	421	258	1243	1240	1437	340	205	1197	1317	1360	410	235	1442	1335	1546	326	331	1275	1282	1414	231	246	1160	1157	1325
	427	263	1265	1265	1465	344	209	1219	1339	1385	418	240	1478	1358	1578	331	339	1302	1308	1442	235	250	1174	1175	1344
4600	434	269	1286	1292	1495	352	215	1248	1364	1415	427	246	1506	1385	1610	338	346	1328	1333	1472	241	256	1195	1198	1370
	440	273	1308	1317	1524	355	219	1270	1387	1440	436	249	1545	1409	1643	344	352	1356	1357	1500	243	260	1210	1213	1387
4800	458	280	1344	1344	1560	364	225	1299	1413	1470	444	255	1573	1434	1674	350	359	1382	1382	1530	251	265	1238	1234	1416
	463	285	1367	1371	1592	367	230	1321	1436	1497	453	260	1612	1461	1709	355	366	1410	1409	1560	256	270	1254	1252	1437
5000	470	290	1387	1395	1620	375	236	1349	1461	1526	461	266	1637	1489	1741	362	372	1437	1433	1589	260	275	1274	1274	1461
	482	303	1430	1423	1659	379	241	1370	1486	1552	471	272	1680	1517	1776	368	380	1465	1458	1619	265	279	1291	1293	1481
5200	489	309	1450	1447	1686	387	246	1398	1510	1582	479	278	1706	1541	1806	374	386	1490	1483	1647	271	283	1322	1311	1510
	495	313	1475	1476	1719	390	251	1420	1536	1609	490	283	1747	1570	1843	379	392	1520	1509	1678	274	287	1339	1330	1531
5400	510	318	1509	1499	1752	398	257	1450	1560	1638	498	289	1770	1595	1874	385	399	1544	1533	1705	280	293	1358	1352	1555
	516	322	1535	1530	1787	402	258	1479	1588	1666	508	295	1812	1621	1912	390	405	1573	1560	1735	284	297	1376	1371	1577
5600	522	327	1554	1552	1814	410	264	1504	1609	1694	517	300	1837	1645	1941	396	411	1596	1582	1763	291	302	1406	139C	1605
	528	332	1578	1581	1847	414	268	1528	1637	1722	529	306	1880	1677	1982	401	418	1625	1610	1794	295	306	1427	1413	1629
5800	544	336	1614	1602	1881	421	274	1555	1659	1749	536	312	1902	1701	2011	407	424	1647	1632	1822	301	312	1452	1433	1655
	555	340	1645	1636	1917	425	279	1577	1687	1779	548	318	1946	1729	2050	412	432	1678	1660	1854	306	317	1479	1458	1681
6000	561	345	1664	1658	1945	433	285	1603	1710	1807	557	325	1970	1753	2081	418	438	1701	1681	1880	313	321	1504	1478	1709
	575	349	1689	1687	1977	437	290	1624	1737	1836	569	331	2011	1780	2119	422	445	1729	1709	1912	316	326	1525	1502	1737

APPENDIX TABLE 29a

Average Follow-Up Load-Deflection Values, in Lb. and 1/1000 In.

Pallet Aa

Test Load	Deflections AB 1	2	3	4	5	Avg.	Deflections CD 1	2	3	4	5	Avg.	Deflection E 1	2	3	4	5	Avg.
0	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
200	12	11	09	8	13	11	53	37	48	52	59	50	67	50	53	57	65	58
	14	15	15	11	15	14	62	49	59	69	67	61	76	66	64	76	74	71
400	26	31	26	23	29	27	126	110	113	138	131	124	149	136	128	157	145	142
	29	35	34	27	31	31	140	121	126	152	141	136	164	150	139	167	157	155
600	40	49	47	39	44	44	200	175	181	220	204	196	237	219	202	245	220	226
	43	52	54	42	46	47	216	187	193	233	218	209	254	235	215	261	244	242
800	53	62	64	52	56	57	274	235	245	296	274	265	323	296	275	333	310	307
	56	66	71	56	59	62	289	247	261	309	290	279	340	312	292	348	327	324
1000	66	76	80	64	69	71	349	295	311	368	347	334	407	375	352	412	391	387
	70	78	86	67	72	75	367	307	326	384	366	350	427	391	368	430	409	405
1200	79	89	95	75	80	84	423	354	376	443	422	404	492	452	428	496	472	468
	83	91	100	78	83	87	440	367	393	459	439	420	511	470	446	514	490	486
1400	90	102	108	84	91	95	500	416	446	516	492	474	580	531	508	579	550	550
	93	104	115	87	93	98	515	427	460	532	507	488	598	547	524	598	567	567
1600	102	113	122	94	100	106	567	474	511	588	561	540	663	608	585	665	632	631
	105	116	132	97	104	111	581	488	529	604	577	556	683	626	605	684	650	650
1800	113	124	139	106	110	118	633	533	579	661	628	607	744	687	668	748	711	712
	116	127	144	108	113	122	647	546	598	678	646	623	761	705	690	767	729	730
2000	124	139	152	115	120	130	697	591	644	730	695	666	820	764	746	826	785	788
	126	142	155	118	121	132	717	604	661	747	713	688	840	783	766	846	804	808
2200	134	149	163	124	128	140	766	645	706	797	759	735	898	837	821	903	860	864
	137	152	166	127	130	142	785	662	723	814	775	752	918	860	843	924	878	885
2400	145	160	172	135	140	150	831	703	766	866	825	798	974	913	894	980	935	939
	150	162	175	138	142	153	853	718	782	883	840	815	996	936	915	1001	953	960
2600	156	174	182	144	149	161	898	760	823	932	883	853	1048	990	966	1053	1003	1012
	160	177	185	147	151	164	917	775	842	952	904	878	1069	1012	988	1077	1022	1034
2800	167	185	191	154	158	171	961	812	880	996	942	918	1120	1060	1034	1129	1070	1083
	172	187	194	157	159	174	980	830	900	1017	960	937	1142	1086	1060	1153	1091	1106
3000	178	197	201	164	168	176	1019	868	938	1059	1001	977	1189	1136	1107	1201	1141	1155
	183	202	204	167	171	185	1040	888	960	1082	1030	1000	1213	1164	1133	1227	1168	1181
3200	189	208	210	173	176	191	1079	920	995	1125	1066	1037	1258	1207	1177	1273	1211	1225
	195	214	214	176	179	196	1102	942	1018	1150	1090	1060	1283	1237	1206	1300	1236	1252
3400	201	220	221	183	185	202	1139	972	1052	1188	1124	1095	1326	1278	1246	1344	1278	1294
	206	223	225	187	189	206	1166	993	1076	1216	1151	1120	1353	1307	1276	1375	1305	1323
3600	213	231	230	193	196	213	1202	1025	1111	1253	1188	1156	1396	1350	1317	1417	1348	1366
	218	235	234	197	199	217	1229	1047	1135	1282	1215	1182	1425	1382	1349	1450	1375	1396
3800	226	246	240	202	204	224	1265	1081	1167	1320	1247	1216	1467	1424	1387	1492	1415	1437
	232	252	245	207	208	229	1294	1107	1195	1350	1273	1244	1497	1461	1417	1524	1442	1468
4000	238	258	250	213	215	235	1327	1134	1224	1385	1307	1275	1538	1497	1455	1564	1481	1507
	243	262	258	217	218	240	1357	1159	1253	1415	1332	1303	1570	1533	1488	1597	1509	1539
4200	249	269	262	223	224	245	1391	1188	1287	1449	1363	1336	1612	1571	1532	1637	1546	1584
	256	276	269	227	224	250	1428	1212	1316	1480	1399	1367	1650	1608	1565	1671	1587	1616
4400	262	283	275	234	231	257	1461	1242	1346	1513	1433	1399	1691	1646	1604	1711	1627	1656
	268	288	281	238	235	262	1494	1268	1374	1546	1460	1428	1727	1686	1641	1746	1658	1692
4600	273	292	285	244	241	267	1527	1292	1402	1577	1493	1458	1767	1720	1677	1784	1697	1729
	278	296	292	249	245	272	1560	1318	1407	1611	1521	1483	1803	1759	1735	1822	1728	1769
4800	284	303	296	255	251	278	1593	1344	1431	1643	1549	1512	1842	1795	1774	1859	1763	1807
	288	305	303	261	255	282	1626	1381	1534	1679	1583	1561	1881	1849	1926	1901	1799	1871
5000	294	311	307	266	262	288	1659	1406	1563	1711	1617	1591	1922	1884	1968	1940	1840	1911
	298	315	313	272	266	293	1695	1436	1586	1751	1652	1624	1963	1931	2023	1985	1881	1957
5200	303	320	317	279	273	298	1726	1466	1614	1783	1685	1655	2001	1972	2063	2023	1921	1996
	308	324	322	284	276	303	1762	1503	1639	1826	1719	1690	2044	2025	2124	2072	1959	2045
5400	313	329	327	290	283	308	1793	1530	1664	1856	1750	1719	2083	2062	2161	2108	1997	2082
	317	334	342	297	287	315	1837	1562	1633	1896	1787	1743	2129	2110	2321	2154	2041	2151
5600	323	339	346	303	291	320	1866	1588	1655	1928	1821	1772	2167	2145	2361	2191	2082	2189
	328	344	359	309	296	327	1906	1619	1623	1970	1859	1795	2211	2193	2491	2238	2126	2252
5800	333	351	364	316	303	333	1936	1651	1642	2001	1892	1824	2247	2232	2535	2275	2165	2291
	338	356	373	321	307	339	1978	1685	1653	2045	1930	1858	2294	2284	2624	2325	2208	2347
6000	343	360	376	328	312	344	2009	1709	1673	2075	1962	1886	2331	2318	2663	2360	2247	2384
	348	364	384	334	317	349	2050	1739	1689	2117	2000	1919	2378	2365	2746	2408	2290	2437

Pallet Ab

Test Load	Deflections AB 1	2	3	4	5	Avg.	Deflections CD 1	2	3	4	5	Avg.	Deflection E 1	2	3	4	5	Avg.
0	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
200	11	10	10	09	09	10	45	52	57	55	57	53	58	56	61	58	38	54
	13	12	12	12	12	12	50	57	64	63	66	60	65	63	69	68	48	63
400	25	23	24	22	20	23	107	117	129	125	128	121	125	128	142	136	117	130
	29	27	26	25	23	26	118	129	140	135	141	133	139	141	153	149	132	143
600	42	38	37	34	32	37	176	187	203	198	200	193	205	206	221	218	197	209
	46	40	40	37	35	40	193	198	214	209	212	205	224	218	234	232	210	224
800	61	49	50	45	43	50	252	254	274	266	267	263	290	283	302	296	276	289
	65	53	53	47	46	53	266	269	286	277	281	276	307	298	315	309	289	304
1000	79	62	62	55	53	62	322	324	346	332	334	332	372	364	382	372	349	368
	83	70	64	57	57	66	338	343	359	343	349	346	390	382	396	385	365	384
1200	92	77	74	65	64	74	391	398	419	395	401	401	451	444	464	445	424	446
	96	80	75	66	66	77	406	411	433	408	414	414	468	460	478	459	438	461
1400	103	89	85	73	75	85	457	471	494	458	467	469	527	525	544	516	498	522
	108	92	91	75	77	89	472	486	510	472	479	484	544	542	561	532	512	538
1600	115	99	101	83	85	97	523	539	572	523	531	538	604	605	633	591	570	601
	118	102	104	84	88	99	540	555	588	536	547	553	621	624	651	608	586	618
1800	134	109	111	92	95	108	597	606	644	588	595	606	690	686	714	670	644	681
	137	113	115	94	98	111	615	623	662	605	616	624	711	705	735	689	664	701
2000	142	123	123	100	104	118	661	677	714	649	662	673	763	768	796	741	720	758
	146	126	126	104	108	122	678	692	730	666	682	690	783	787	814	762	739	777
2200	151	132	135	110	114	128	724	740	783	712	727	737	835	843	875	814	793	832
	155	134	138	113	116	131	741	759	801	729	747	755	853	863	894	833	813	851
2400	165	144	146	118	122	139	792	810	851	772	790	803	910	922	951	883	862	906
	168	147	148	122	125	142	809	831	869	790	812	822	930	942	971	902	884	926
2600	173	153	156	128	131	148	850	876	916	832	850	865	977	994	1026	950	932	976
	176	159	159	129	134	151	868	897	935	851	872	885	997	1017	1048	969	955	997
2800	182	167	166	136	141	158	909	943	980	891	911	927	1045	1069	1100	1016	1000	1046
	185	171	168	137	144	161	929	966	1001	911	937	949	1066	1094	1124	1037	1027	1070
3000	196	176	176	144	151	169	970	1004	1044	951	973	988	1117	1141	1172	1085	1070	1117
	198	179	178	146	154	171	991	1028	1066	972	998	1011	1141	1167	1198	1108	1097	1142
3200	203	187	185	152	160	177	1025	1073	1108	1009	1035	1050	1181	1216	1245	1152	1141	1187
	205	191	189	155	163	181	1046	1097	1133	1031	1061	1074	1204	1242	1271	1177	1171	1213
3400	212	198	195	161	169	187	1079	1135	1173	1069	1096	1110	1243	1286	1316	1220	1210	1255
	215	200	198	164	173	190	1100	1159	1199	1093	1125	1135	1270	1313	1344	1245	1241	1253
3600	220	207	204	169	179	196	1132	1198	1239	1127	1156	1170	1306	1357	1389	1286	1278	1323
	224	210	207	172	183	199	1160	1221	1265	1151	1184	1196	1334	1385	1417	1311	1310	1351
3800	229	218	214	178	189	206	1192	1259	1304	1185	1216	1231	1371	1426	1462	1350	1344	1391
	232	221	217	181	193	209	1217	1283	1330	1210	1245	1257	1399	1456	1491	1377	1379	1420
4000	244	228	226	188	198	217	1258	1318	1369	1243	1273	1292	1445	1497	1536	1415	1413	1461
	247	231	228	190	203	220	1285	1344	1393	1269	1303	1319	1475	1527	1566	1443	1447	1492
4200	251	239	233	196	209	226	1314	1379	1432	1300	1334	1352	1510	1568	1609	1481	1483	1530
	254	241	237	199	213	229	1338	1404	1459	1328	1364	1379	1538	1597	1639	1513	1517	1561
4400	260	248	243	205	219	235	1366	1437	1498	1360	1395	1411	1572	1638	1683	1549	1552	1599
	263	251	247	208	224	239	1393	1464	1526	1387	1427	1439	1603	1668	1715	1581	1588	1631
4600	268	258	252	214	230	244	1419	1499	1562	1419	1456	1471	1635	1708	1755	1619	1622	1668
	272	262	256	217	235	248	1447	1526	1590	1446	1488	1499	1667	1740	1788	1650	1659	1701
4800	284	268	261	223	241	255	1486	1561	1627	1478	1515	1533	1711	1779	1830	1687	1694	1740
	286	272	264	226	247	259	1515	1508	1655	1506	1550	1563	1746	1812	1864	1721	1734	1775
5000	292	279	271	233	252	265	1542	1622	1690	1537	1577	1594	1779	1853	1905	1757	1767	1812
	295	283	274	236	258	269	1568	1652	1720	1568	1613	1624	1812	1887	1940	1793	1807	1848
5200	301	288	279	243	263	275	1594	1685	1753	1599	1639	1654	1843	1928	1979	1828	1839	1883
	304	292	283	247	269	279	1623	1715	1783	1629	1676	1685	1878	1964	2015	1864	1882	1921
5400	314	298	288	253	274	285	1658	1748	1815	1658	1702	1716	1918	2002	2052	1900	1914	1957
	317	302	292	257	279	289	1690	1778	1845	1690	1739	1748	1957	2039	2089	1937	1959	1996
5600	322	308	297	263	284	295	1716	1810	1877	1719	1766	1778	1989	2077	2126	1971	1991	2031
	325	312	301	267	289	299	1743	1843	1910	1752	1806	1811	2034	2118	2165	2011	2039	2071
5800	330	319	306	272	294	304	1769	1875	1942	1780	1830	1839	2055	2156	2200	2046	2071	2106
	334	322	309	278	301	309	1802	1908	1974	1816	1872	1874	2094	2195	2239	2087	2118	2147
6000	343	328	315	272	306	315	1837	1941	2006	1841	1897	1904	2133	2233	2284	2120	2151	2182
	346	333	317	286	312	319	1870	1978	2040	1878	1936	1940	2175	2274	2311	2163	2198	2224

APPENDIX TABLE 29b

Average Follow-Up Load-Deflection Values, in Lb. and 1/1000 In.

Test Load	Pallet Ac	Deflections AB 1	2	3	4	5	Avg.	Deflections CD 1	2	3	4	5	Avg.	Deflection E 1	2	3	4	5	Avg.
0		000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
200		10	08	09	15	08	10	56	48	56	60	41	52	60	53	61	63	46	57
		11	09	10	18	09	11	63	60	67	71	46	61	68	66	72	74	54	67
400		22	18	20	32	22	23	126	117	133	138	100	123	137	131	145	147	114	135
		24	21	23	37	25	26	135	128	147	153	111	135	148	143	159	164	126	148
600		35	29	31	49	35	36	195	184	209	223	163	195	216	208	232	240	186	216
		37	31	34	53	38	39	205	197	222	237	173	207	229	222	247	257	198	231
800		46	39	43	63	48	48	264	249	282	299	223	263	296	280	317	328	257	296
		48	42	45	66	50	50	274	261	296	314	234	276	309	299	333	343	270	311
1000		58	47	53	76	60	59	333	313	354	373	282	331	375	361	399	409	327	374
		60	49	56	80	63	62	343	326	368	390	294	344	388	375	415	427	341	389
1200		70	56	63	89	72	70	401	379	425	448	340	399	451	437	481	492	394	451
		72	59	66	91	73	72	412	393	439	467	352	413	465	452	496	511	407	466
1400		80	64	73	100	81	80	466	443	493	522	395	464	529	510	559	575	459	526
		82	70	75	102	83	83	478	459	507	541	407	478	543	528	575	594	473	543
1600		90	75	82	110	89	89	530	508	561	595	451	529	607	586	640	657	523	603
		92	75	85	114	91	92	541	522	574	614	463	543	621	603	658	677	536	619
1800		99	81	92	121	98	98	589	568	626	667	504	591	678	660	718	737	586	676
		102	83	94	125	100	101	601	582	641	686	517	605	692	678	736	758	602	693
2000		109	88	100	132	106	107	648	628	689	735	557	651	747	733	894	813	652	748
		112	90	103	136	108	110	660	643	705	758	572	668	761	750	812	835	668	765
2200		118	95	109	143	115	116	705	689	751	807	610	712	814	804	866	890	716	818
		119	98	112	148	117	119	721	706	769	831	624	730	829	824	886	914	733	837
2400		125	104	118	154	124	125	762	748	813	878	662	773	878	876	938	966	777	887
		128	105	121	159	125	128	778	766	832	904	676	791	893	895	958	991	794	906
2600		134	111	127	165	132	134	817	808	872	948	713	832	940	944	1008	1042	837	954
		139	113	130	170	134	137	833	827	892	973	728	851	958	966	1029	1068	855	975
2800		144	119	136	176	140	143	872	866	931	1014	763	889	1002	1012	1075	1115	895	1020
		147	121	139	180	142	146	887	886	953	1042	780	910	1021	1035	1100	1144	914	1043
3000		153	126	146	186	148	152	927	924	991	1080	815	947	1067	1080	1145	1187	954	1087
		157	128	149	192	151	155	947	945	1014	1111	833	970	1090	1105	1171	1218	976	1112
3200		163	135	155	198	157	162	985	981	1050	1148	864	1006	1135	1148	1214	1259	1014	1154
		166	138	158	203	159	165	1007	1005	1075	1178	885	1030	1159	1174	1240	1292	1037	1180
3400		172	144	164	208	165	171	1041	1039	1110	1214	915	1064	1199	1214	1281	1332	1074	1220
		176	146	167	213	168	174	1066	1063	1135	1244	938	1089	1226	1241	1308	1365	1100	1248
3600		182	151	175	219	173	180	1100	1098	1172	1278	967	1123	1267	1281	1349	1404	1136	1287
		186	154	178	225	177	184	1127	1124	1197	1311	991	1150	1296	1311	1378	1439	1163	1317
3800		191	159	184	231	183	190	1160	1156	1233	1343	1020	1182	1335	1349	1418	1476	1198	1355
		196	162	188	236	186	194	1186	1185	1259	1376	1044	1210	1365	1380	1447	1512	1226	1386
4000		201	167	194	242	191	199	1219	1218	1293	1408	1072	1242	1404	1418	1487	1549	1259	1423
		205	171	198	247	195	203	1246	1246	1319	1443	1099	1271	1434	1450	1516	1587	1288	1455
4200		210	176	204	253	201	209	1280	1278	1352	1474	1125	1302	1475	1487	1554	1623	1320	1492
		215	179	208	258	204	213	1307	1307	1380	1512	1153	1332	1507	1520	1585	1662	1351	1525
4400		220	185	214	264	209	218	1338	1337	1412	1542	1179	1362	1545	1555	1624	1697	1383	1561
		225	187	218	270	214	223	1366	1366	1441	1580	1212	1393	1577	1590	1656	1738	1415	1595
4600		230	193	224	275	219	228	1395	1395	1473	1610	1237	1422	1612	1625	1694	1772	1447	1630
		235	195	228	281	227	233	1423	1426	1504	1650	1267	1454	1646	1660	1728	1816	1481	1666
4800		239	201	234	286	232	238	1451	1454	1535	1678	1293	1482	1681	1695	1763	1850	1513	1700
		244	205	238	292	239	244	1482	1487	1568	1719	1324	1516	1717	1731	1801	1896	1548	1739
5000		249	210	244	297	243	249	1510	1514	1597	1748	1349	1544	1752	1765	1836	1930	1579	1772
		255	214	248	302	248	253	1542	1548	1632	1790	1382	1579	1789	1804	1875	1976	1617	1812
5200		259	219	255	308	253	259	1569	1576	1661	1817	1408	1606	1825	1839	1911	2009	1648	1846
		264	225	259	314	258	264	1601	1616	1697	1861	1441	1643	1862	1880	1953	2058	1684	1887
5400		268	230	265	319	263	269	1627	1641	1725	1888	1467	1670	1896	1913	1987	2090	1716	1920
		273	237	270	325	268	275	1660	1679	1762	1933	1501	1707	1935	1957	2029	2140	1755	1963
5600		278	241	275	331	272	279	1686	1705	1791	1959	1526	1733	1969	1990	2063	1271	1786	1996
		284	244	283	337	277	285	1719	1745	1834	2008	1561	1773	2010	2038	2109	2223	1825	2041
5800		288	249	288	341	281	289	1745	1769	1861	2035	1584	1799	2044	2069	2143	2255	1856	2073
		293	253	295	348	286	295	1779	1807	1903	2083	1622	1839	2086	2115	2189	2310	1899	2120
6000		298	258	300	353	291	300	1805	1832	1929	2110	1646	1864	2118	2148	2221	2342	1930	2152
		303	263	307	361	294	306	1837	1869	1970	2163	1687	1905	2158	2192	2266	2399	1977	2198

Test Load	Pallet Ad	Deflections AB 1	2	3	4	5	Avg.	Deflections CD 1	2	3	4	5	Avg.	Deflection E 1	2	3	4	5	Avg.
0		000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
200		09	23	13	10	07	12	29	69	63	59	55	55	67	75	67	62	59	66
		11	24	20	12	10	15	33	77	77	67	70	65	73	84	82	71	74	77
400		20	35	32	27	19	27	94	142	144	137	136	131	139	158	154	148	147	149
		23	37	38	37	21	31	105	153	159	153	150	144	152	170	169	166	161	164
600		33	47	49	48	29	41	162	216	222	216	213	206	216	245	242	237	233	235
		37	50	53	55	31	45	177	228	235	233	226	220	233	260	257	256	248	251
800		45	59	63	64	39	54	231	287	295	289	288	278	295	331	328	320	319	319
		49	62	66	68	41	57	244	301	310	307	305	293	312	347	344	341	336	336
1000		57	70	76	76	48	65	296	359	369	363	366	351	373	415	410	402	402	400
		59	74	79	79	50	68	310	373	385	379	382	366	388	431	427	419	421	417
1200		67	82	89	87	57	76	362	429	446	434	444	423	449	498	495	483	467	482
		71	85	92	90	60	80	377	443	462	453	461	439	466	514	511	502	506	500
1400		77	93	101	97	65	97	427	499	517	510	521	495	525	580	577	565	572	564
		80	96	104	101	68	90	439	512	534	527	539	510	537	596	595	584	591	581
1600		88	104	113	108	74	97	491	564	588	577	598	564	599	662	662	643	660	645
		91	107	117	112	76	101	506	579	603	594	615	579	616	680	678	663	678	663
1800		98	115	126	118	82	108	557	630	657	643	671	639	676	742	743	720	742	725
		102	117	130	121	85	111	570	646	674	666	691	649	694	760	761	743	762	744
2000		109	126	137	128	91	118	619	697	725	711	745	699	751	821	821	795	822	802
		112	128	142	131	94	121	634	712	740	730	766	716	769	838	839	814	844	821
2200		118	135	150	137	99	128	678	761	790	775	816	764	821	897	898	866	901	877
		121	138	154	141	101	131	698	780	807	796	835	783	841	917	917	886	922	897
2400		127	146	163	147	107	138	740	827	855	840	887	830	890	974	972	936	980	950
		129	151	165	150	109	141	757	864	872	861	907	852	910	1005	992	957	1001	973
2600		139	158	174	156	114	148	801	905	916	903	953	896	960	1057	1043	1005	1052	1023
		142	161	177	160	118	152	819	923	935	923	976	915	983	1080	1066	1026	1077	1046
2800		147	169	187	165	122	158	857	963	975	962	1019	955	1027	1132	1115	1073	1127	1095
		150	172	187	168	127	161	874	981	996	985	1044	976	1048	1155	1138	1096	1153	1118
3000		154	180	196	175	131	167	911	1022	1034	1023	1085	1015	1092	1204	1185	1141	1200	1164
		158	183	199	178	135	171	932	1040	1055	1049	1113	1038	1115	1228	1209	1166	1229	1189
3200		166	190	207	184	139	177	971	1078	1091	1086	1153	1076	1163	1274	1252	1209	1272	1234
		168	194	210	187	144	181	991	1085	1113	1111	1182	1096	1187	1309	1277	1234	1303	1262
3400		173	200	217	193	148	186	1025	1118	1149	1147	1218	1131	1228	1354	1319	1275	1344	1304
		176	205	220	197	152	190	1045	1124	1176	1173	1249	1153	1251	1387	1345	1301	1378	1332
3600		184	212	227	202	156	196	1083	1158	1209	1210	1284	1189	1295	1437	1386	1343	1417	1376
		186	218	232	205	160	200	1103	1138	1236	1235	1315	1205	1320	1506	1414	1370	1453	1413
3800		191	224	239	211	165	206	1135	1166	1271	1269	1349	1238	1359	1552	1456	1409	1491	1453
		194	230	243	214	168	210	1157	1163	1296	1294	1381	1256	1385	1606	1484	1437	1528	1488
4000		203	235	249	221	173	216	1193	1190	1330	1328	1413	1291	1426	1652	1524	1476	1565	1529
		205	251	253	223	177	222	1216	1095	1358	1353	1446	1294	1454	1850	1553	1503	1603	1593
4200		210	258	260	229	181	228	1248	1118	1391	1386	1478	1324	1492	1899	1593	1542	1639	1633
		214	264	263	233	187	232	1272	1119	1418	1413	1513	1347	1522	1957	1624	1571	1679	1671
4400		221	272	270	239	191	239	1306	1143	1448	1445	1545	1377	1561	2004	1662	1608	1716	1710
		223	279	274	243	195	243	1332	1147	1477	1473	1582	1402	1591	2063	1697	1639	1755	1749
4600		227	284	280	249	199	248	1360	1168	1507	1504	1613	1430	1627	2107	1732	1675	1790	1786
		230	291	284	252	203	252	1387	1166	1535	1534	1652	1455	1658	2178	1765	1707	1834	1828
4800		237	298	291	258	207	258	1421	1187	1566	1563	1681	1484	1698	2227	1803	1741	1869	1868
		239	306	297	260	212	263	1448	1177	1596	1598	1721	1508	1732	2313	1838	1774	1914	1914
5000		243	311	303	267	217	268	1474	1197	1626	1630	1749	1535	1765	2361	1874	1809	1950	1952
		245	321	307	269	221	273	1502	1189	1660	1661	1789	1560	1798	2457	1913	1845	1995	2002
5200		252	326	314	275	225	278	1535	1207	1686	1689	1818	1587	1837	2504	1949	1880	2030	2040
		253	336	318	279	230	283	1564	1210	1720	1723	1858	1615	1873	2583	1986	1918	2075	2007
5400		257	342	325	284	234	288	1590	1230	1747	1751	1885	1641	1907	2626	2021	1952	2109	2123
		259	351	329	288	239	293	1618	1309	1779	1786	1936	1686	1943	2771	2060	1990	2165	2186
5600		266	357	336	293	243	299	1649	1328	1807	1814	1963	1712	1980	2771	2095	2023	2197	2213
		268	366	342	297	249	304	1681	1336	1840	1851	2006	1743	2020	2771	2136	2063	2245	2247
5800		272	371	347	303	253	309	1704	1354	1864	1879	2034	1767	2050	2771	2169	2097	2277	2273
		275	381	354	308	258	315	1733	1370	1901	1916	2078	1800	2087	2771	2212	2139	2328	2307
6000		281	388	359	313	261	320	1764	1392	1926	1946	2105	1827	2124	2771	2244	2173	2362	2335
		284	397	365	317	268	326	1794	1407	1959	1980	2147	1857	2162	2771	2284	2214	2409	2368

APPENDIX TABLE 29c

Average Follow-Up Load-Deflection Values, in Lb. and 1/1000 In.

Test Load	Pallet Ba	Deflections AB 1	2	3	4	5	Avg.	Deflections CD 1	2	3	4	5	Avg.	Deflection E 1	2	3	4	5	Avg.
0		000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
200		09	12	03	10	07	08	41	41	37	47	37	41	47	46	41	51	40	45
		10	14	06	11	08	10	46	46	54	55	45	49	54	52	61	59	49	55
400		20	32	14	25	18	22	92	94	100	111	95	98	107	107	113	122	105	111
		22	36	16	27	20	24	99	103	107	119	103	106	116	117	123	131	115	120
600		32	49	24	38	30	35	146	146	151	173	153	154	169	167	172	190	173	174
		33	52	26	41	32	37	154	154	160	183	162	163	178	176	183	201	182	184
800		44	65	35	52	41	47	197	197	201	234	208	207	230	229	232	261	237	238
		45	71	37	54	43	50	206	208	211	245	217	217	242	243	245	273	249	250
1000		55	83	44	65	51	60	248	249	252	296	261	261	291	292	292	332	301	302
		56	89	48	69	53	63	257	262	262	307	271	272	303	308	303	344	313	314
1200		66	100	55	78	62	72	298	302	302	355	315	314	353	357	350	399	364	365
		67	106	57	81	64	75	307	314	313	367	324	325	363	372	362	412	377	377
1400		77	116	64	91	72	84	347	355	352	415	366	367	410	418	405	465	427	425
		79	119	67	94	75	87	357	369	364	427	376	379	421	432	416	479	437	437
1600		88	132	74	103	83	96	396	412	404	472	416	420	468	482	459	530	487	485
		92	135	76	110	85	100	407	426	415	489	427	433	481	498	469	546	501	499
1800		101	147	84	120	92	109	445	469	452	533	465	473	526	547	511	598	547	546
		103	150	88	124	94	112	457	484	465	549	476	486	539	564	524	615	561	561
2000		110	159	94	132	102	119	492	526	500	589	512	524	583	613	566	663	606	606
		114	164	98	136	106	124	503	544	513	602	523	537	596	632	580	678	620	621
2200		122	177	105	143	112	132	540	584	549	642	557	574	641	682	623	725	662	667
		126	180	106	147	115	135	551	598	565	656	569	588	656	699	638	742	676	682
2400		135	189	113	155	121	143	587	638	599	695	601	624	698	746	680	785	716	725
		137	193	116	158	125	146	600	655	611	712	614	638	713	763	694	804	731	741
2600		144	205	122	166	131	154	633	692	644	750	646	673	752	809	733	846	769	782
		147	208	126	170	134	157	647	709	663	769	659	689	766	827	753	866	785	799
2800		154	217	133	176	143	165	679	742	694	802	692	722	804	867	790	905	822	838
		157	220	136	180	145	168	694	761	709	820	709	739	821	888	804	924	838	855
3000		163	227	142	186	150	174	725	793	740	853	739	770	856	925	840	961	873	891
		167	233	145	191	152	178	740	812	757	873	754	787	874	946	859	981	892	910
3200		175	239	151	198	157	184	774	843	786	906	782	818	911	985	892	1018	924	946
		179	244	155	201	163	188	792	864	804	929	802	838	930	1009	911	1039	946	967
3400		185	251	161	206	168	194	820	892	831	959	827	866	962	1042	942	1073	976	999
		189	256	164	211	170	198	838	913	851	983	846	886	983	1064	962	1098	998	1021
3600		196	262	169	216	175	204	867	940	878	1012	871	914	1017	1099	994	1131	1029	1054
		199	267	173	222	181	208	886	962	900	1036	894	936	1039	1124	1017	1157	1056	1079
3800		207	274	179	227	185	214	914	990	927	1065	916	962	1070	1159	1047	1190	1084	1110
		210	281	183	231	189	219	936	1016	950	1090	938	986	1094	1187	1071	1215	1108	1135
4000		216	287	189	237	193	224	960	1041	974	1117	961	1011	1124	1219	1099	1246	1135	1165
		220	291	192	242	198	229	983	1065	995	1143	983	1034	1149	1246	1124	1272	1160	1190
4200		227	298	198	248	203	235	1011	1095	1019	1171	1006	1060	1180	1281	1151	1303	1188	1221
		231	303	202	253	206	239	1034	1118	1041	1197	1028	1084	1206	1307	1177	1329	1214	1247
4400		237	310	207	259	213	245	1060	1145	1064	1223	1052	1109	1236	1338	1203	1359	1242	1276
		240	315	211	263	216	249	1086	1169	1088	1251	1076	1134	1262	1365	1228	1387	1270	1302
4600		246	322	217	269	221	255	1110	1194	1111	1278	1101	1159	1291	1393	1253	1417	1299	1331
		250	327	221	274	225	259	1135	1221	1137	1309	1124	1185	1318	1423	1283	1450	1327	1360
4800		256	334	227	280	229	265	1161	1245	1160	1336	1145	1209	1347	1453	1309	1480	1354	1389
		260	339	231	285	233	270	1186	1273	1187	1366	1169	1236	1374	1485	1338	1510	1381	1418
5000		266	345	235	291	239	275	1211	1296	1209	1393	1194	1261	1401	1513	1367	1541	1409	1446
		270	351	239	296	242	280	1236	1321	1234	1424	1218	1287	1431	1543	1403	1571	1438	1477
5200		276	357	244	302	247	285	1261	1344	1256	1450	1239	1310	1460	1571	1430	1602	1462	1505
		280	362	249	307	252	290	1286	1376	1279	1479	1265	1337	1489	1609	1465	1634	1494	1538
5400		286	368	254	312	257	295	1309	1399	1300	1505	1286	1360	1516	1636	1491	1663	1520	1565
		289	373	258	317	260	299	1334	1425	1324	1535	1310	1386	1544	1668	1526	1694	1549	1596
5600		295	380	263	323	265	305	1357	1448	1346	1560	1333	1409	1572	1696	1553	1724	1578	1625
		300	385	268	328	269	310	1389	1477	1380	1593	1358	1439	1608	1732	1596	1756	1610	1660
5800		306	391	273	333	274	315	1411	1498	1402	1617	1381	1462	1634	1758	1623	1784	1638	1687
		310	397	277	338	278	320	1439	1528	1429	1650	1406	1490	1665	1792	1657	1819	1669	1720
6000		316	403	282	344	283	326	1462	1551	1451	1675	1428	1513	1694	1820	1684	1847	1695	1748
		320	409	287	349	286	330	1488	1579	1473	1706	1454	1540	1724	1856	1721	1882	1727	1782

Test Load	Pallet Bb	Deflections AB 1	2	3	4	5	Avg.	Deflections CD 1	2	3	4	5	Avg.	Deflection E 1	2	3	4	5	Avg.
0		000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
200		12	12	12	07	08	10	45	44	47	33	33	40	40	46	54	35	46	44
		14	17	13	09	10	13	51	55	53	42	40	48	46	60	61	44	54	53
400		27	29	27	20	21	25	102	107	109	92	92	100	105	117	125	100	113	112
		30	33	30	24	24	28	111	117	118	101	101	110	115	133	136	109	123	123
600		43	43	42	33	34	39	160	163	171	149	151	159	172	184	197	163	179	179
		48	47	46	35	36	42	171	172	180	158	160	168	190	195	208	173	188	191
800		57	56	56	45	46	52	215	216	226	209	207	215	238	246	265	230	243	244
		63	59	58	48	48	55	227	226	236	219	217	225	254	257	275	241	256	257
1000		74	68	68	58	58	65	271	270	282	268	263	271	303	306	331	298	309	309
		79	71	71	61	61	69	283	280	291	282	271	281	318	320	342	312	321	323
1200		89	80	80	70	70	78	325	323	334	330	320	326	364	369	394	369	375	374
		94	84	83	73	73	81	337	333	345	343	331	338	381	381	405	383	386	387
1400		103	92	92	80	82	90	379	375	390	390	373	381	424	429	457	435	434	436
		108	97	95	85	84	94	391	388	402	404	383	394	440	535	470	448	445	468
1600		116	105	104	92	93	102	431	429	444	451	424	436	483	583	520	500	492	516
		121	111	107	96	96	106	443	442	456	466	435	448	498	599	532	514	503	529
1800		128	119	116	103	106	114	480	482	495	511	475	489	542	645	580	564	550	576
		132	123	124	107	108	119	492	497	511	525	486	502	560	662	596	577	561	591
2000		140	131	132	113	116	126	527	534	548	567	525	540	597	704	641	626	607	635
		143	135	136	118	119	130	537	549	560	581	538	553	611	722	654	642	621	650
2200		150	143	144	124	129	138	573	586	597	622	576	591	651	763	700	689	666	694
		154	146	147	127	130	141	587	602	610	635	588	604	668	780	714	703	681	709
2400		161	153	158	133	139	149	621	637	646	675	625	641	706	820	759	747	725	751
		165	158	164	137	141	153	634	655	664	689	638	656	726	837	775	763	739	768
2600		172	166	172	142	149	160	667	690	698	724	674	691	763	876	815	804	780	808
		175	170	178	145	153	164	681	708	714	740	690	707	779	893	831	820	796	824
2800		182	177	188	150	160	171	713	742	748	775	723	740	815	930	871	859	833	862
		186	181	195	153	169	177	730	757	765	791	742	757	836	949	887	876	850	880
3000		193	187	202	159	177	184	759	789	796	825	775	789	867	985	925	914	888	916
		196	191	210	162	182	188	776	808	814	843	793	807	888	1004	944	932	906	935
3200		205	197	220	167	189	196	807	838	844	873	824	837	920	1038	981	967	942	970
		209	202	227	171	192	200	825	858	863	893	842	856	944	1061	1001	990	962	992
3400		214	208	234	177	198	206	851	888	892	921	871	865	972	1094	1034	1023	995	1024
		218	212	239	184	201	211	870	910	911	947	890	906	998	1119	1055	1050	1017	1045
3600		224	217	246	189	208	217	896	937	941	973	920	933	1026	1150	1090	1081	1051	1080
		229	222	251	192	212	221	917	960	961	993	941	954	1050	1175	1113	1102	1073	1103
3800		235	227	260	198	217	227	942	986	988	1021	968	981	1078	1204	1145	1133	1105	1133
		240	232	263	200	222	231	963	1009	1008	1041	989	1002	1104	1228	1168	1156	1128	1157
4000		245	236	271	205	227	237	989	1034	1034	1066	1015	1028	1130	1256	1201	1185	1159	1186
		250	240	274	209	230	241	1010	1058	1055	1088	1034	1049	1154	1281	1223	1207	1182	1209
4200		255	245	281	215	238	247	1033	1082	1079	1112	1062	1074	1182	1308	1251	1236	1214	1238
		260	250	284	218	241	251	1055	1109	1101	1135	1082	1096	1207	1334	1275	1259	1237	1262
4400		266	254	292	223	246	256	1079	1132	1128	1158	1106	1121	1235	1360	1306	1285	1265	1290
		270	260	295	228	250	261	1100	1158	1149	1182	1128	1143	1257	1387	1331	1310	1288	1315
4600		276	264	301	233	257	266	1124	1181	1172	1206	1152	1167	1285	1413	1358	1336	1316	1342
		279	268	305	237	260	270	1145	1209	1193	1230	1177	1191	1312	1440	1383	1362	1341	1358
4800		285	273	312	241	266	275	1168	1231	1219	1253	1201	1214	1336	1465	1413	1389	1369	1394
		290	278	316	247	269	280	1191	1260	1239	1279	1224	1239	1368	1493	1439	1415	1396	1422
5000		295	282	322	252	276	285	1214	1282	1263	1302	1250	1262	1393	1519	1467	1441	1425	1449
		301	287	326	256	279	290	1237	1309	1286	1326	1273	1286	1420	1546	1493	1469	1450	1476
5200		306	292	332	261	285	295	1260	1331	1307	1349	1297	1309	1445	1572	1520	1495	1478	1502
		311	296	336	266	288	299	1283	1360	1330	1374	1319	1333	1477	1602	1546	1522	1504	1530
5400		316	301	344	270	294	305	1304	1381	1355	1395	1342	1355	1499	1628	1575	1548	1531	1556
		321	305	348	275	297	309	1326	1409	1378	1420	1365	1380	1524	1658	1603	1575	1557	1583
5600		326	309	354	280	305	315	1348	1430	1399	1442	1390	1402	1552	1684	1630	1601	1585	1610
		330	314	357	285	309	319	1371	1461	1422	1469	1413	1427	1580	1716	1657	1629	1615	1639
5800		337	319	364	290	314	325	1394	1483	1447	1490	1436	1450	1606	1741	1686	1655	1642	1666
		341	323	368	295	318	329	1419	1515	1469	1518	1460	1476	1634	1776	1715	1685	1670	1696
6000		347	328	373	300	324	334	1441	1537	1489	1540	1483	1498	1660	1801	1741	1709	1697	1722
		351	333	378	304	328	339	1467	1566	1512	1566	1510	1524	1690	1835	1770	1739	1725	1752

APPENDIX TABLE 29d

Average Follow-Up Load-Deflection Values, in Lb. and 1/1000 In.

Test Load	Pallet Bc	Deflections AB 1	2	3	4	5	Avg.	Deflections CD 1	2	3	4	5	Avg.	Deflection E 1	2	3	4	5	Avg.	Pallet Bd	Deflections AB 1	2	3	4	5	Avg.	Deflections CD 1	2	3	4	5	Avg.	Deflection E 1	2	3	4	5	Avg.
0		000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000		000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
200		09	04	08	09	10	08	47	26	39	25	45	36	54	44	37	24	49	42		10	11	11	11	08	10	40	67	45	42	42	47	45	47	49	43	43	45
		10	04	11	14	13	10	51	33	45	38	55	44	57	52	43	38	60	50		13	13	13	16	10	13	50	76	53	55	53	57	56	54	57	56	55	56
400		21	12	24	26	27	22	100	84	97	88	111	96	114	110	100	92	123	108		28	24	29	34	22	27	102	132	111	112	112	114	119	114	124	118	123	120
		23	14	27	30	28	24	108	93	106	99	119	105	123	120	109	104	134	118		31	26	32	42	24	31	113	141	121	126	121	124	131	125	134	133	133	131
600		34	25	38	41	42	36	155	144	155	147	174	155	177	177	163	157	197	174		44	38	46	56	36	44	162	194	177	182	177	178	188	184	198	194	197	192
		35	29	41	45	44	39	164	154	164	157	182	164	187	189	172	168	207	185		47	41	49	63	38	48	172	204	188	194	186	189	202	196	211	206	207	204
800		45	42	52	54	57	50	207	202	213	203	236	212	239	249	226	218	271	241		60	53	61	77	51	60	217	255	242	246	242	240	255	254	273	266	271	264
		47	46	55	58	62	54	217	214	222	213	246	222	250	264	235	231	282	252		63	55	65	84	53	64	229	266	254	260	253	252	268	266	287	281	282	277
1000		55	60	67	67	74	65	259	264	267	256	298	269	300	323	289	282	342	307		75	66	76	96	65	76	272	316	307	311	309	303	321	323	349	337	347	335
		57	66	72	72	78	69	268	277	279	267	309	280	311	339	301	295	353	320		78	69	81	101	67	79	283	327	321	322	319	314	335	336	364	349	357	348
1200		66	78	83	81	88	79	309	323	323	308	359	324	360	394	351	344	411	372		89	80	92	111	78	90	327	377	375	371	374	365	388	394	425	404	420	406
		68	82	88	85	93	83	318	336	335	321	370	336	371	409	364	359	424	385		98	83	97	115	80	95	343	388	388	381	383	377	406	407	439	416	430	420
1400		76	92	96	94	103	92	358	379	377	363	419	379	419	463	411	409	480	436		110	94	110	126	90	106	388	440	443	427	436	427	460	463	501	468	490	476
		78	97	100	98	106	96	369	391	388	376	430	301	431	478	424	420	492	449		117	97	114	128	92	110	402	451	460	439	446	440	476	476	520	482	501	491
1600		85	108	109	107	117	105	410	434	433	417	475	434	478	531	472	468	547	499		130	106	126	139	101	120	450	498	515	487	496	489	533	528	582	536	561	658
		87	113	115	112	121	110	422	448	446	432	486	447	490	548	485	483	561	508		133	108	130	143	103	123	463	512	532	501	506	503	547	543	600	550	572	562
1800		97	122	125	121	131	119	463	489	490	473	529	489	539	599	535	530	614	563		142	119	139	152	111	133	505	558	581	547	553	549	598	598	660	604	627	617
		99	127	129	126	135	123	474	502	504	488	542	502	550	615	548	546	628	577		146	123	145	156	113	137	519	575	600	560	563	563	613	615	679	619	639	633
2000		105	135	137	134	145	131	512	542	545	527	582	542	596	665	594	590	678	625		160	131	154	165	123	147	564	617	648	604	608	608	668	664	735	670	692	686
		108	139	143	139	149	136	524	554	561	541	594	555	609	680	611	605	691	639		163	136	159	172	125	151	577	633	665	623	617	623	682	680	755	689	703	702
2200		117	149	152	146	159	145	562	593	599	580	632	593	657	727	658	653	736	686		177	145	168	182	132	161	622	675	713	666	661	667	735	728	810	737	753	753
		119	152	156	150	162	148	574	607	613	595	641	606	671	744	674	668	747	701		181	148	173	187	133	164	635	691	733	682	673	683	750	744	829	755	765	769
2400		125	161	164	159	173	156	610	644	652	631	680	643	714	788	720	712	792	745		190	158	181	195	142	173	675	734	778	723	715	725	796	791	880	801	814	816
		127	164	168	162	176	159	624	658	667	646	692	657	729	806	736	730	804	761		193	161	186	201	145	177	691	751	798	740	727	741	813	808	900	816	828	833
2600		136	175	177	169	185	168	660	697	705	680	725	693	773	851	780	769	845	804		208	169	195	209	152	187	734	791	839	780	757	782	864	853	948	864	873	880
		139	178	181	174	189	172	673	713	722	696	739	709	788	870	797	788	859	820		210	173	201	214	154	190	749	809	864	799	778	800	883	870	971	883	887	899
2800		145	185	188	181	198	179	708	746	756	728	771	742	827	909	837	826	898	859		219	182	209	222	161	199	785	847	904	836	814	837	923	911	1017	925	929	941
		148	189	193	185	201	183	721	762	774	744	786	757	843	929	856	845	914	877		228	185	215	227	165	204	820	866	930	852	827	859	956	929	1042	944	944	968
3000		154	199	200	191	210	191	755	797	806	775	818	790	882	969	894	880	952	915		236	193	223	235	172	212	854	902	966	889	861	894	998	966	1085	987	984	1004
		156	203	205	196	214	195	772	815	823	792	835	807	900	991	912	900	971	935		240	196	230	240	174	216	873	920	995	909	873	914	1021	986	1113	1010	999	1026
3200		164	210	216	202	222	203	804	845	857	822	866	839	938	1028	951	933	1008	972		248	204	238	248	182	224	905	954	1029	943	906	947	1059	1023	1155	1050	1037	1065
		166	214	221	207	228	207	821	864	877	840	887	858	957	1050	972	955	1031	993		253	208	244	254	184	229	927	974	1058	965	919	969	1084	1046	1184	1074	1052	1088
3400		172	222	228	213	236	214	850	894	906	867	915	886	991	1087	1007	986	1067	1028		266	215	251	262	191	237	964	1005	1091	998	950	1002	1126	1082	1222	1111	1088	1126
		175	226	233	217	241	218	869	915	925	886	938	907	1011	1111	1027	1007	1091	1049		270	219	258	268	194	242	986	1025	1121	1022	963	1023	1149	1105	1252	1136	1103	1149
3600		183	233	242	222	249	226	900	942	958	912	970	936	1048	1146	1064	1037	1128	1085		277	226	266	275	200	249	1016	1055	1153	1054	993	1054	1185	1139	1289	1171	1138	1184
		186	237	246	227	254	230	917	964	978	932	993	957	1067	1173	1085	1059	1194	1116		286	231	274	281	204	255	1046	1077	1185	1078	1008	1079	1216	1163	1319	1198	1153	1210
3800		192	246	251	233	264	237	945	993	1005	957	1021	984	1101	1207	1119	1089	1187	1141		293	239	281	289	210	262	1075	1107	1215	1109	1036	1108	1250	1196	1355	1232	1186	1244
		196	251	256	238	270	242	967	1015	1025	979	1046	1006	1123	1233	1140	1111	1215	1164		299	242	287	295	213	267	1103	1129	1243	1145	1050	1134	1276	1218	1382	1267	1202	1269
4000		203	257	264	243	279	249	996	1039	1053	1002	1074	1033	1158	1262	1175	1139	1247	1196		311	250	294	303	220	276	1136	1157	1273	1173	1078	1163	1313	1251	1417	1298	1233	1302
		208	261	267	248	285	254	1017	1060	1072	1023	1098	1054	1180	1288	1198	1164	1274	1221		318	254	301	309	223	281	1161	1178	1302	1198	1093	1186	1341	1275	1447	1325	1250	1328
4200		216	269	273	254	293	261	1044	1087	1099	1045	1125	1080	1213	1319	1229	1191	1305	1251		324	361	309	316	229	288	1187	1207	1331	1226	1117	1214	1373	1305	1482	1356	1278	1359
		223	273	277	258	299	266	1067	1109	1120	1066	1150	1102	1236	1346	1251	1215	1333	1276		329	265	315	322	232	293	1210	1230	1359	1252	1131	1236	1400	1330	1512	1384	1294	1384
4400		229	278	285	265	307	273	1092	1132	1148	1089	1176	1127	1266	1374	1283	1241	1365	1306		340	273	323	329	239	301	1242	1257	1389	1279	1159	1265	1437	1360	1546	1414	1325	1417
		234	283	289	269	312	277	1114	1155	1170	1110	1205	1151	1289	1400	1307	1265	1393	1331		345	277	329	335	243	306	1265	1279	1418	1305	1175	1288	1465	1385	1578	1442	1344	1443
4600		240	290	295	275	320	284	1138	1180	1193	1131	1230	1174	1319	1430	1337	1289	1423	1360		352	284	337	342	249	313	1289	1306	1446	1331	1197	1314	1495	1415	1610	1472	1370	1472
		245	295	298	279	325	288	1160	1204	1215	1154	1257	1198	1344	1458	1360	1314	1453	1386		357	287	343	348	252	317	1313	1329	1477	1357	1212	1338	1524	1440	1643	1500	1387	1499
4800		251	301	307	285	333	295	1185	1225	1244	1175	1282	1222	1373	1485	1391	1341	1483	1415		369	295	350	355	258	325	1344	1356	1504	1382	1236	1364	1560	1470	1674	1530	1416	1530
		255	306	312	290	339	300	1208	1250	1266	1198	1310	1229	1398	1513	1416	1365	1515	1441		374	299	357	361	263	331	1369	1379	1537	1410	1253	1390	1592	1497	1709	1560	1437	1559
5000		260	313	317	295	347	306	1231	1274	1290	1219	1335	1270	1426	1542	1445	1391	1546	1470		380	306	364	367	268	337	1391	1405	1563	1435	1274	1414	1620	1526	1741	1589	1461	1587
		265	318	321	300	354	312	1255	1299	1313	1245	1364	1295	1453	1573	1470	1420	1578	1499		393	310	372	374	272	344	1427	1428	1599	1462	1292	1442	1659	1552	1776	1619	1481	1617
5200		271	324	329	306	361	318	1278	1320	1340	1268	1388	1319	1481	1599	1501	1447	1607	1527		399	317	379	380	277	350	1449	1454	1624	1487	1317	1466	1686	1582	1806	1647	1510	1646
		274	328	334	312	368	323	1302	1345	1365	1292	1418	1344	1508	1629	1527	1472	1641	1555		404	321	387	386	281	356	1476	1478	1659	1515	1335	1493	1719	1609	1843	1678	1531	1676
5400		281	337	339	318	375	330	1326	1370	1387	1313	1441	1367	1537	1658	1553	1498	1669	1583		414	328	394	392	287	363	1504	1505	1683	1539	1355	1517	1752	1638	1874	1705	1555	1705
		284	342	344	322	382	335	1348	1395	1411	1337	1471	1392	1563	1688	1579	1524	1703	1611		419	330	402	398	291	368	1533	1534	1717	1557	1374	1549	1787	1666	1912	1735	1577	1735
5600		291	348	351	328	389	341	1372	1415	1437	1358	1494	1415	1590	1715	1610	1549	1731	1639		425	337	409	404	297	374	1553	1557	1741	1589	1398	1568	1814	1694	1941	1763	1605	1763
		295	353	356	334	396	347	1398	1436	1462	1382	1523	1440	1618	1746	1637	1576	1765	1668		430	341	418	410	301	380	1580	1583	1779	1618	1420	1596	1847	1722	1982	1794	1629	1795
5800		301	360	361	339	403	353	1421	1460	1483	1404	1545	1463	1646	1774	1664	1600	1793	1695		440	348	424	416	307	387	1608	1607	1802	1640	1443	1620	1881	1749	2011	1822	1655	1824
		305	365	366	345	410	358	1447	1485	1509	1430	1576	1489	1676	1806	1691	1628	1829	1726		448	352	433	422	312	393	1641	1632	1838	1669	1469	1650	1917	1779	2050	1854	1681	1855
6000		311	371	373	351	417	365	1471	1505	1534	1451	1599	1512	1703	1834	1720	1654	1858	1754		453	359	441	428	317	400	1661	1657	1862	1691	1491	1672	1945	1807	2081	1880	1709	1884
		314	376	377	355	424	369	1493	1530	1557	1473	1629	1536	1732	1865	1748	1681	1891	1783		462	364	450	434	321	406	1688	1681	1896	1719	1514	1700	1977	1836	2119	1912	1737	1916

APPENDIX TABLE 30

Two-Factorial Analysis of Variance of Follow-Up Stiffness Test Data for Pallets of Two Designs, Assembled with Four Different Nails

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	Computed f	Critical f	
Design	79.25 E6	1	79.25 E6	87.09	4.15	S
Nail	13.61 E6	3	4.54 E6	4.99	2.90	S
Interaction	3.68 E6	3	1.23 E6	1.35	2.90	NS
Error	29.15 E6	32	0.91 E6			
Total	125.69 E6	39				

APPENDIX TABLE 31

Detailed Load-Carrying Capacity Data, in Lb.

Pallet Design	Pallet No.	Pallet Weight	Ultimate Test Load	Pallet No.	Pallet Weight	Ultimate Test Load
Conventional	Aa1	135.06	8800	Ac1	136.75	11000
	Aa2	137.95	8800*	Ac2	137.67	10400
	Aa3	135.47	7200*	Ac3	134.56	9400
	Aa4	136.44	9200	Ac4	137.53	8600
	Aa5	136.62	8400	Ac5	135.81	10500
	Avg.	136.31	8480	Avg.	136.46	9980
	Ab1	139.89	10200	Ad1	142.88	9600
	Ab2	137.42	10800	Ad2	140.28	6000*
	Ab3	139.69	9800	Ad3	139.44	10400
	Ab4	139.42	10400	Ad4	137.55	9800
	Ab5	136.53	9400	Ad5	141.25	8800
	Avg.	138.59	10120	Avg.	140.28	8920
Improved	Ba1	158.81	11800	Bc1	153.88	11800*
	Ba2	158.75	12000	Bc2	158.83	6200*
	Ba3	158.58	11600	Bc3	156.14	11600
	Ba4	156.19	9800	Bc4	152.62	12600
	Ba5	158.62	11600	Bc5	151.91	11200
	Avg.	158.19	11360	Avg.	154.68	10680
	Bb1	154.66	13800	Bd1	150.47	11600
	Bb2	161.72	12400	Bd2	151.34	11400
	Bb3	157.00	10800	Bd3	154.58	11800
	Bb4	155.72	9400	Bd4	158.94	11200
	Bb5	156.06	11800	Bd5	153.84	12000
	Avg.	157.03	11640	Avg.	153.83	11600

*Ultimate test load limited by failure of center stringer.

APPENDIX TABLE 32

Two-Factorial Analysis of Variance for Ultimate Static Load Test Data for Pallets of Two Designs, Assembled with Four Different Nails

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	Computed f	Critical f	
Design	37.83 E6	1	37.83 E6	20.23	4.15	S
Nail	4.74 E6	3	1.58 E6	0.84	2.90	NS
Interaction	7.87 E6	3	2.62 E6	1.40	2.90	NS
Error	59.90 E6	32	1.87 E6			
Total	110.34 E6	39				

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EVALUATION OF THE IMPROVED STEVEDORE PALLET

by

Nilson Franco

(ABSTRACT)

An evaluation was made of the performance of 48" x 63", reversible, double-face, wing-type, two-way entry, nailed red-oak, stevedore pallets of two designs assembled with four different nails. Special consideration was given to Brazilian situations in the light of the interest of the author in the industrial potential of Brazil.

The pallets of improved design had their top and bottom leading-edge deckboards backed up by follow-up deckboards. Furthermore, four nails, instead of three, were used for fastening the leading-edge deckboards and three nails, instead of two, were used for fastening the inner deckboards to each stringer.

The sequence of tests on each pallet started with the initial stiffness test, followed by the rigidity test, the impact-incline deckboard-stringer separation test, and the follow-up static stiffness and load-carrying capacity tests.

The pallets of improved design were better than those of conventional design during all tests performed. The influence of the nails on pallet performance was significantly different only during the performance of the rigidity and impact-incline tests. During the latter test, the pallets of improved design assembled with 3" helically threaded hardened-steel nails were, on the average, 66 times better than the conventional pallets assembled with the Brazilian $2\frac{1}{2}$" helically fluted nails.

Recommendations were advanced, suggesting that the study be continued and that special consideration be given to the wood species available in Brazil for pallet assembly, to the use of improved nails, and to the environmental conditions under which stevedore pallets are exposed.