PERFORMANCE COMPARISON OF BISON PALLETS USING MILLERDOWEL FASTENING SYSTEMS TO REDUCE PRODUCT AND PACKAGE DAMAGE AND MEET SUSTAINABILITY INITIATIVES

Final Report

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INTRODUCTION:

Pallets have been widely used as material-handling platforms to assist in moving packaged products through the supply chain the past seven decades. The growing trends and shifts to palletized handling over break-bulk handling of single parcel saves time and cost during cross-docking and loading/unloading processes in today's transportation environment. The design of this pallet structure is important since it plays a role in transferring dynamic forces to the products loaded on these platforms during the transportation and handling environments.

Initial wood pallet designs introduced in the 1960's and 1970's used hardwoods and provided large deck coverage with stiff wood members (deck-boards and stringers). However over the last three decades the quality and bending stiffness of wood members continues to go down as cost and weight of these structures goes down. Alternate pallet materials such as plastics and corrugated fiber-board also reduce the stiffness of pallet decks. In addition the fastening systems (nails and screws) used to combine various members of the pallet (deckboard, blocks or stringers) play a role in the structural stiffness of the final structure. During reuse, the fastening systems are pivotal in creating a "moving" or weaker structure that will transmit higher levels of vibration and shock energy to the product placed on top.

It has been well established in various research projects conducted by the researcher at Michigan State University that stiffer pallets transfer less dynamic force when subjected to vibration levels observed and measured in rail and truck transportation environments. The transmissibility levels go down as the stiffness or natural frequency of the palletized load goes up. Based on this fundamental premise Michigan State University Center for Distribution Packaging Research engaged in a project that is evaluating a new wood based pallet developed by MillerDowel Company, Inc. that uses stiffer wood members and combines them using a patented technology with dowels that allow for very little "loosening" and "softening" of the overall pallet structure during transportation and reuse. In this

study pallets that are loaded with a range of food and beverage products are subjected to transportation vibration levels. Packaged items include beverage metal cans, plastic bottles in corrugated shippers, metal food cans and consumer product packaging.

The vibration levels that are transmitted to the secondary and primary packaging components that are stacked on the pallet loads are compared between these new pallets and other GMA pallets currently being used.

RESEARCH HYPOTHESIS:

This study will measure the transmissibility of vibration levels through pallet structures that are made with conventional wood pallet materials and fastening systems. These pallet systems will be compared to newly designed and manufactured wood pallets provided by MillerDowel Company. The study will compare the new pallet structures to existing designs used by CHEP (block style pallets) and GMA wood stringer pallet designs. In addition the stiffness of these pallets will be compared. Tests will be conducted in accordance with ASTM and ISO test methods.

The study will show the results in terms of reduction in dynamic forces produced by the new pallet in comparison to existing pallets. This data will be then used to predict the reduction of secondary packaging (corrugated boxes and trays) that would not be needed with the use of the new pallet structure to provide the same level of protection to primary packaging (bottles, cans and products) when palletized and shipped. The study will conduct testing of three types of products in cartons, beverage cans and instrumented cases with shock recorders to validate the possible reduction of packaging materials.

In the past year major retailers like Wal-Mart have initiated sustainability initiatives over a five year period. One way to achieve this is by reducing overall packaging use by 5%. It is clear that if this new pallet system can provide a reduction in damage by attenuating vibration levels, the amount of secondary packaging being used will reduce by a significant amount and may meet these sustainability initiative targets.

TEST METHODS AND DATA COLLECTION:

The study is evaluating the performance of the loads using existing GMA standard pallets and comparing the same types of loads on the "BISON pallet". The tests are conducted using ASTM sinusoidal and random vibration test methods (ASTM D999 and ASTM D4788). The tests include developing the transmitted vibration to the top of the loads and measuring the transmitted shock levels.

Four types of packaged and palletized load configurations were studied. These included cased goods, carbonated beverage cans in cartons, packaged processed food, and juice beverage in cans.

RESULTS AND CONCLUSIONS:

The study compared transmitted vibration levels to the products on GMA pallets versus *BISON* pallets. Results show that in all four cases, the *BISON* pallet reduces the amount of transmitted vibration to the product due to the stiffness and less shifting of product during transit. As a result of this the amount of primary and secondary packaging needed to protect contents during shipping and handling can be reduced.

The transmitted Power Spectral Density plots have been compared between 1-10 Hz which causes predominant displacement in the vibrating loads and is attributed to damage. Data is also compared in the 1-100 Hz range.

The data shows that there is a significant reduction (10-20%) in transmitted vibration between the GMA wood pallets and the "*BISON*" pallet. The "BISON" pallet significantly reduces the amount of energy transmitted to the load. Based on this premise the amount of primary and secondary packaging can be reduced when using the "BISON" pallets.

PREVIOUS STUDIES DESCRIBING LOSS DUE TO POOR PALLETS:

- **The 2006 FMI/GMA Unsaleables Benchmark Report highlighted the 2005 industry averages for "warehouse delivered" products to Manufacturers and Retailers as follows:**

- **Manufacturer reported weighted average = 0.81% of sales $ = $2.05 billion**
- **Retailer reported weighted average = 0.97% of sales $ = $2.45 billion**

A portion of the total damage is attributed to the interaction of the top of the pallet to the bottom layer of stacked product. Poor quality can result in damage to both primary and secondary packaging.

SUMMARY OF FINDINGS

Packaging design incorporates all components of packaging: primary, secondary and tertiary. It is therefore clear that to reduce primary (bottles, cartons, cans, etc) and secondary packaging (corrugated shippers, trays, etc.), importance must be given to the tertiary packaging components (pallets, unitization methods, etc.). Stiffer pallets will reduce transmitted vibration and therefore require a reduced level of package protection. In addition this attributes to less damage to the product (e.g. fresh produce, cereal, crackers, etc.) and requires less strength in primary and secondary packaging, namely shipping containers such as boxes, and primary packaging containers made from plastic, glass and metal.

In addition the absence of nails and sturdier deck-boards, will result in both reduced vibration as well as a reduction in damage attributed to protruding nails and wood splinters.