Unit Load Center Eliminates Product Damage

Imagine walking on a warehouse floor covered in antifreeze—antifreeze dripping from soaked boxes and bowed pallets in overhead racks. While clean-up efforts were underway, I walked into this warehouse scenario last year. Why did the antifreeze leak? Was the pallet designer at fault? Should the box designer pay for the clean-up?

Packaging, pallets and material handling equipment are interactive components. The product damage and leaks resulted from a lack of communication between the various component designers. The boxes would have supported the antifreeze on certain pallets. The pallets would have performed well in certain racks. Together, they failed.

The Virginia Tech Center for Unit Load Design was asked to develop a unit load design for future shipments. The most efficient and economical solution balances the overall performance of packaging, pallets, and material handling equipment using a unit load material handling analysis. This article summarizes the steps in conducting this analysis.

Data Collection

• Packaging: The product was liquid antifreeze, in one-gallon high-density polyethylene plastic bottles. The bottles were designed for containment only and not to support compressive stresses. The corrugated box was a 275 pound, single wall, C-flute. There were six bottles per box, nine boxes per layer, stacked four layers high, for 36 boxes per pallet. The total weight per pallet was approximately 2,100 pounds.

• Pallet: The pallets were used, 48x40, grade A GMA. Most were hardwood. Deck boards ranged from ½ to ¾" thick.

• Storage Equipment: Loaded pallets were racked across the 40" deck boards in drive-through racks. The open rack span was 36 inches. The racks were installed last year. Previously, antifreeze was stored on the floor, stacked two high.

• Damage Observed: Boxes were wet with antifreeze and crushed. Many bottles were crushed at the top cap, the neck and the bottom. Some pallets were bowed one to two inches even after unloading. Other pallets were not bowed at all.

Audit Analysis

Individually, the packaging, pallets and racks were adequate. An analysis of the corrugated boxes determined that they were strong enough when evenly supported on a flat pallet deck. After four months in the drive-through rack, however, the pallets were not flat. An analysis indicated that many of the pallets would support 2100 pounds when racked across the stringers but not when racked across the deck in the drive-through rack. When overloaded, pallet deflection gradually increased during storage, and excessive deflection changed how compressive stresses were distributed across the layers of antifreeze cases. As the pallets deflected, some boxes and bottles carried more of the load than others and began to fail. As adjacent boxes got wet with antifreeze, they supported even less load and the bottle failures increased.

Packaging, pallets and material handling equipment are interactive components. Product damage results from a lack of communication between the various component designers. Boxes support the product better on certain pallets. Pallets perform well in certain racks. Together, they either fail or succeed.

Potential Solutions

• Change the Pallet—The pallets lacked stiffness across the 40" direction. Plastic and corrugated paper pallets were not feasible for this application. A new hardwood 48x40 GMA pallet with 13/16" thick deck boards was stiff enough to support the load, but at a significant cost increase. As an alternative, Grade A repaired pallets with at least ¾" thick deck boards were considered.

• Change the Box—Corrugated boxes are stronger if supported by deck boards at the box corners. New pallets could have deck boards located under the box corners. Deck board placement is not consistent with repaired pallets, and box corner support was not guaranteed. Corrugated supports inside the box add compression strength and distribute compressive stresses over a greater area. These boxes with inserts are better suited for repaired pallets with random deck board placement.

• Change the bottle—The bottle had relatively thin walls and a relatively weak shoulder design. Stronger bottles were available but were not economically feasible.

• Modify the Storage Rack—The drive-through rack support required a stiffer pallet than many other storage systems. A one-time change in storage systems is often the most economical solution over time but requires significant up-front investment.

• Captive pallets—You could use high-quality captive pallets to support the current pallet and packaging in the drive-in racks. The shipping pallet is put on the captive pallet before being placed in the rack. This may be cost effective for fast turns or repeated sales over time. It was not cost effective in this instance due to long-term storage.

Recommendations

The relative cost and performance of each of the above solutions was assessed in cooperation with the vendors and customer. The best solution was repaired Grade A hardwood pallets with ¾" thick deck boards combined with a 200 pound, C-flute box with "winged H" interior corrugated inserts. Although this solution represented a slight increase over the previous unitization costs, the increase was less than alternative solutions that addressed only individual components.