TRANSPORTATION SIMULATION TESTING AND PRESSURE SENSITIVE TAPES: UNDERSTANDING THE WHOLE PACKAGE

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Abstract

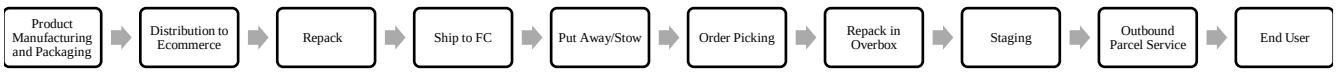
The E-Commerce industry grew 43% from 2019 to 2020 during the pandemic. Industries such as furniture, building materials and electronics have seen the fastest growth in E-commerce sales over the past 2 years. This means that how these products are packed and shipped has changed as well. More products are being shipped through fulfillment centers and parcel services. Consumer Packaged Goods now have over 20 touch points between the producer and end user, increasing frequency of failure modes from shock, vibration and atmosphere. The focus of this paper is to explore the purpose of transit testing (ISTA Methods), the steps involved in getting a package certified and the mechanics that affect pressure sensitive tapes.

Introduction

In 2023, nearly any product or service that an individual could need or want, can be purchased through E-Commerce. Growing by nearly 50% in one year due to the pandemic, almost every brand or product has an online presence. This swift shift in product delivery structure has forced many manufacturers to reevaluate their packaging materials and structures. When a package is shipped through traditional retail supply chains, it will go through 5 to 7 touchpoints but when shipped through an E-Commerce supply chain it will go through more than 20 touch points.

Figure 1: Traditional Brick and Mortar Supply Chain Touch Points

Figure 2: E-Commerce Supply Chain Touchpoints



The challenge faced by product manufacturers is that during these touchpoints the product packaging must be able to protect the product inside from supply chain hazards such as drops, atmosphere exposures and vibration from transit. In order to minimize damage through these distribution

systems, the packaging industry relies on procedural guidelines developed by the International Safe Transit Association (ISTA). ISTA is a global alliance of shippers, carriers, suppliers, testing labs and educational and research institutions focused on concerns of transport packaging. As an ANSI Accredited Standards Developer, ISTA has been recognized as the industry leader in the development of pre-shipment testing protocols for packaged products.

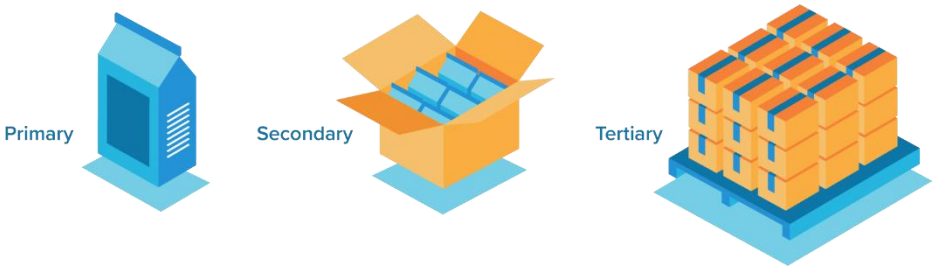
But What is Transit Testing?

When thinking about packaging, a manufacturer or supplier must consider the effect of all of the touchpoints in the supply chain, either traditional or E-Commerce. They will also want to optimize their packaging to be the most cost effective ie: spend less, protect more. One way to do this is to choose packaging, start shipping and hope that there are no returns on the product due to damages. This method can be painful and expensive for a product manufacturer. It risks their reputation and profit margins on a new product.

Another way is to understand your supply chain and test your packaging through rigorous testing to simulate the hazards your product will encounter. This is where transit testing comes in. Transit testing is a common way to simulate the hazards that a package is likely to experience during distribution systems. The testing will simulate an extreme shipping environment that will test a package or packaging system and its ability to handle these environments.

Transit testing standards cover packaging from envelopes and mailers all the way up to full truckloads of materials. It allows a producer to see the affect shipping will have on their product without the risk of failing at the end user. For example, transit testing allows a printer manufacturer to see if the vibration from shipping across country in a full truck affects the presentation and overall function of the printer at the end user. Using transit testing will allow a manufacturer to see how well the primary, secondary and tertiary packaging protects the product.

Figure 3: Primary, Secondary and Tertiary Packaging Examples



IMAGE

https://www.crbgroup.com/insights/food-beverage/food-packaging-process

How does Transit Testing Work?

Transit testing uses simulations of real-world hazards to test the efficacy of all layers of packaging as it navigates through distribution systems. The most frequent locations for a damage to occur are during transport and during warehousing. Different methods of transport affect a package differently so it's important to know what those are when designing a package. Modes of transport include air, truck, rail, boat and parcel services. With the growth of the E-commerce industry, a package

is likely to experience several or all of these transport methods before it gets to the end user. Understanding this path with help to determine the type of testing required for a new package or a product.

Let's use Generic Laundry Detergent as an example. This product historically would be put in to boxes, palletized and then shipped to a distribution center and or a retail store. This cycle would include a small number of touch points and likely just truck or rail transport. However, the manufacturer would like to start shipping this product through an E-Commerce Channel. Now the laundry detergent will have double the touch points as well as additional truck and parcel service transport methods where there is only primary or secondary packaging for protection.

Once the new distribution cycle is determined, the laundry detergent needs to be screened for performance against this new supply chain. But what test should be performed? Using the ISTA protocols, the manufacturer will need to choose the method that closely resembles the hazards the new supply chain will present. This means testing cases and even individual bottles separately to determine performance. Below is a guide to choosing the ISTA method by distributions system.

Figure 4: Guide to Selecting ISTA Test Series by Package Type and Distribution Type

Distribution Type	Package Type		
	Individual Packages		Unitized / Pallet Load
	up to 150 lbs. (68 kg)	over 150 lbs. (68 kg)	
Parcel Delivery	3A, 6-FedEx-A	Not Applicable	Not Applicable
LTL (Less-Than-Truckload) Delivery	3B	3B, 6-FedEx-B	3B, 6-FedEx-B
Manufacturing to Distribution Center	Not Applicable	Not Applicable	3E
Distribution Center to Retail	3F	Not Applicable	Not Applicable
eCommerce: e-retailer Fulfillment	6-Amazon.com-Over Boxing, 6-Amazon.com-SIOC	6-Amazon.com-SIOC	Not Applicable
Club Store	6-Sams Club	6-Sams Club	6-Sams Club
European Consumer Goods	3K	Not Applicable	Not Applicable
Specialized Furniture	2C	2C	2C
Thermal Testing/ Testing of Insulated Shipping Containers	7D, 7E	7D, 7E	Situational
Bulk/ Automotive Resuable	Not Applicable	Not Applicable	3H
User Defined/ Custom Test Planning	4AB	4AB	4AB
Preliminary Design Screening/ Integrity Test	1A, 1C, 1G	1B, 1D, 1H	1E
Partial Simulation	2A	2B	Not Applicable

For this exercise, the laundry detergent will be going through an e-commerce fulfillment distribution system. This means it would either require the specific series developed by the ISTA Member (ie: 6-Amazon) or would require a General Simulation Performance Test (3A).

Figure 5: ISTA Summary of Test Protocols.

3 Series: General Simulation Performance Tests.
Designed to provide a laboratory simulation of the general damage-producing motions, forces, conditions, and sequences of transport environments. Applicable across broad sets of circumstances, such as a variety of vehicle types and routes, or a varying number of handling exposures. Characteristics will include simple shaped random vibration, different drop heights applied to the sample package, and/or atmospheric conditioning.

6 Series: Member Performance Tests.
Test protocols created by ISTA members or by ISTA in cooperation with a member company, to meet their particular purposes and applications. The tests may be completely original, or may be modifications or variations or ISTA Procedures or Projects or other published and accepted tests. The tests are reviewed, approved, and formally accepted by successfully completing ISTA's procedure for developing Test Protocols, per ISTA's Technical Division Operating Guide.

Let's Test!

The laundry detergent manufacturer knows the distribution system and what test series to perform and it's time to get the package testing. Transit testing simulates the most common distribution hazard variables that a product will encounter. Prior to testing, performance tolerances and parameters will have to be established to create proper pass/fail criteria. This criteria is established by the manufacturer of the product (not the e-commerce company or ISTA). The criteria should state what is the allowable damage to the packaged product before the test would be considered a failure. For this example failures for the generic laundry detergent would include broken cap, leaking cap, leaking bottle, damaged/unreadable/unscannable labels,

Below are the major tests that are performed in a series that simulate the hazards that are likely to occur during handling or transit:

Drop/Shock

This test is designed to evaluate a containers ability to withstand the sudden shock resulting from a free fall or to evaluate the capability of a container and its inner packaging to protects its contents during the sudden shock of a free fall. This test is incredibly important because, as we have discussed previously, there are more than double touchpoints in the E-Commerce distribution cycle which is double the opportunity for a package to experience sudden shock from dropping.

Vibration

This test simulates the hazards present during transport or motion of a moving vehicle. Variables such as location of a package inside of a truck (over the wheel, back of the truck, middle of the truck), bumps on the road (railroad tracks, pot holes, speed bumps etc) have been measured and compiled to character the transport vibration environment in terms of random vibration PSD profiles. Using these profiles, testing can accurately simulate these hazards and see how the packaging can withstand the environment

Compression

This test simulates how a package will perform during stacking. By applying pressure to the package and holding it that pressure, the compression test can help identify how a package or packaging system may perform when stacked.

Environmental

When shipping a products from a manufacturer to end user, it's important to remember that distribution systems change by environments too. Shipping a packaging by truck in Florida can affect a packaged product different than shipping a packaging by truck in Alaska. Environmental considerations are important when looking at where a package is going and what the packaging is made of. Extreme temperature, humidity and air pressure exposures prior to testing will simulate the hazards presents during this shipping conditions.

Getting Certified

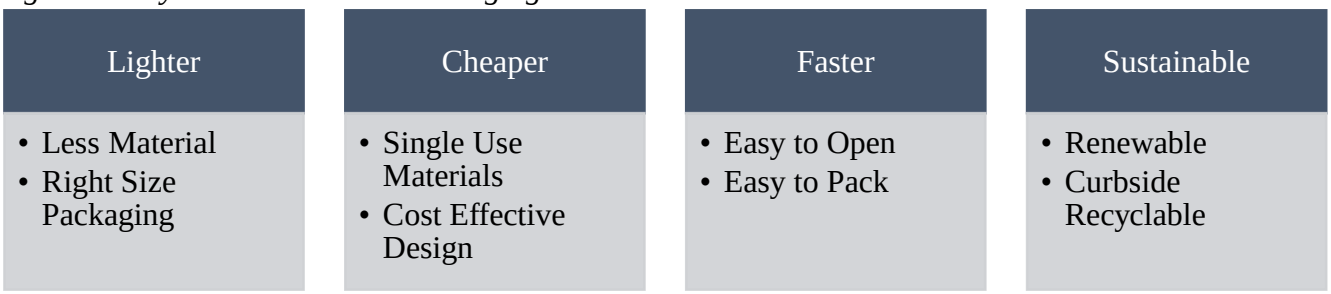
At this point, the manufacturer of the laundry detergent knows the new distribution system, has tested their product and determined the packaging to pass the ISTA testing. Below are the steps to certify the package

1) The packaged-product must be tested in an ISTA Certified Lab (current with their lab certification).
2) The testing must comply fully with all minimum requirements of a current ISTA testing procedure or project.
3) All samples must pass the test(s).
4) The results must be submitted to ISTA Headquarters (ISTA members can download our test report forms from the Member Center).
5) The report must pass review and be approved by ISTA Headquarters. Certification comes from ISTA, not the laboratory.
6) The shipper must be an ISTA member in goodstanding.
7) The shipper must sign a license agreement to use the Transit Tested Certification Mark, and will be assigned a Manufacturer's License Number.
8) The Mark, with manufacturer's license number, may then be placed on the packaged-products.

Understanding E-Commerce Packaging

Now that we understand why transit testing is important and what transit testing is, let's look at what E-Commerce packaging is and how to design products for shipping. The E-Commerce industry focuses on the customer experience. This means that the goal of packaging is to get a product to an end user in a way that makes sure the product works, the packaging is not damaged, is easy to open, the least amount of material is being used and that material is curbside recyclable.

Figure 6: Keys to E-Commerce Packaging



Many fulfillment center (FC) operations are now pushing vendors to ship products in containers that require no additional packaging (or overbox) in the FC. This is called Ship in Own Container or SIOC. For companies like Amazon, the push for SIOC allows them to just slap a shipping label on the product and ship it, not extra touch points, no extra packaging. For product manufacturers, this means designing special packaging for E-Commerce distribution. Let's go back to the laundry detergent we just tested and got ISTA certified. This package is different from the standard bottle that would sit on a grocery store shelf. For E-Commerce, the bottle was changed to a bag in a box and the box was designed to be placed on a shelf like the bottle. This allows the FC to ship in own container. If the laundry detergent was shipped in the bottle it would require additional packaging at the FC like a plastic bag and overbox.

Designing for E-Commerce

With industries such as appliance, furniture and electronics seeing major growths through e-commerce it's important to develop a strategy for supporting these end users reach their goals. Key areas to watch out for:

- *Reducing weight* – total weight of a package affects the overall cost so by reducing weight of such things as films, adhesives and coatings allows for lower cost shipping.

- *Reducing materials/ more sustainable materials* – shipping products to different states and countries means different requirements for sustainability – manufacturers will look to all parts of a product and package to remove banned substances or to reduce carbon footprint by using recyclable or renewable materials. This may mean that end users will be more aware of solvent based vs water based and PVC vs PE.

- *Same performance or better* – while looking to reduce and remove materials, product manufacturers will continue to need the same performance such as impact resistance. Remember that the E-Commerce industry now has over 20 possible touch points to damage a product so design should include the ability to with stand these hazards. A filament tape holding a drawer shut on a printer will need to with stand more impacts that it was originally designed.

Overall, understanding how new distribution systems affect products will help with designing new solutions for end users. Take a note out of the Amazon playbook and be "customer obsessed", understand your customers needs before they do.

1. https://www.census.gov/library/stories/2022/04/ecommerce-sales-surged-during-pandemic.html#:~:text=According%20to%20the%20most%20recent,to%20%24815.4%20billion%20in%202020.
2. International Safe Transit Association (July 2018), "Touchpoints E-Retailer Fulfillment"; ISTA.org
3. International Safe Transit Association (2022), "2022 Resource Book"; ISTA.org
4. https://www.aboutamazon.com/planet/improving-packaging/overview