

Stretch wrap film and pallet load stability

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Product damage caused by unstable stretch-wrapped pallets can be a costly problem for bulk solids manufacturers. This article discusses factors affecting the stability of stretch-wrapped pallets and how optimizing stretch film application can help reduce packaging costs and prevent losses from product damage.

In many bulk solids manufacturing applications, stretch wrap film is the most economical solution for stabilizing palletized packaged products for transport. Stretch wrap film is thin-gauge (typically 8 to 23 microns) cast or blown linear low-density polyethylene. The film, comprising up to 33 layers, comes in rolls and is wrapped around loaded pallets in layers either manually or by using a semi-automatic or fully automatic pallet wrapper. To ensure a stable pallet load, the stretch film must unitize the load by binding the stacked packaged items into a single, rigid unit. The film must also bind the unitized load to the pallet, which is typically achieved using a wrapping technique called "roping."

Approximately 6.2 million tons (5.6 million metric tons) of stretch film are manufactured worldwide each year. Stretch film is generally considered to be a commodity material, with the market driven predominantly by price per unit weight rather than by film performance. Because of this, stretch film end users will often take issue with distributors over the cost of film while writing off millions of dollars in ruined products caused by unstable pallet loads.

Pallet load instability has been a problem for years, but due to the complexity of the process chain, no defined levels of responsibility exist for when an unstable pallet causes product damage during transport. Because most stretch film is sold through distributors, film manufacturers often have little contact with end users and receive little to no feedback when a stretch-wrapped pallet fails. The film end user may get a credit note for the damaged products, but the manufacturer often has no way of knowing whether the film was correctly applied, used within specifications, or even appropriate for the application.

Load stability standards

In Europe, an estimated 4 percent of all transported goods are damaged upon arrival, and the integrity and security of transported loads is a major concern for many stretch film end users. The European Safe Logistics Association (EUMOS), a nonprofit group of packaging and logistics companies that advocates for cargo transport safety, has developed EUMOS 40509,[1] a standard for testing load unit stability. In 2013, the European Union passed EU Directive 2014/47[2] concerning the roadworthiness of commercial vehicles and incorporated EUMOS 40509 in the directive's annex on cargo securing.

EUMOS 40509 specifies acceptable levels of permanent and reversible load deformation during transportation. For example, a pallet transported on the road must remain completely rigid under a brake acceleration of 0.5 g (a force equivalent to 50 percent of the weight of the load). Because "real-life" truck braking tests are expensive, wrapped pallets may be tested using an acceleration test, in which a wrapped pallet load is accelerated on a testing track in a lab and the load's behavior is documented using a high-speed camera.

The independent engineering company, ESTL, has conducted more than 15,000 acceleration tests at its

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Belgian test facility and reports that, in the initial approximately 2,500 tests, roughly 70 percent of the pallets weren't sufficiently rigid; 20 percent were rigid but were excessively wrapped, making the packaging more costly than necessary; and only 10 percent of the pallets tested were optimized.

According to EUMOS, test facilities are also currently located in Germany, Italy, Poland, and Spain in the EU, with more to come. Test facilities based on the EUMOS standards are also located in Asia and Russia, and at least five are operating in the US based on local standards and field experience.

Factors affecting pallet load stability

Safely hauling stretch-wrapped pallets requires film with consistent mechanical properties. Film thickness is important but isn't the only factor that determines the film's strength. All process conditions are important, from the resin the film is made from to the pallet wrapper settings, to the amount of energy the loaded pallet must be able to absorb.

Key factors influencing the stability of stretch-wrapped pallets include:

- the shape and friction coefficient of the primary or secondary packaging units
- the stacking pattern on the pallet
- the use of tie sheets between the product layers
- the selection of a suitably tough stretch film for the application, with both a low impurity level and the necessary post-stretching cling
- the use of appropriate wrapper settings to create the necessary containment force according to the load's needs
- the use of bottom roping to ensure a good connection between the load and the pallet
- the wrapping pattern

Choosing the correct stretch film thickness, so the film can be applied by the wrapper in a way that creates the required containment force for the individual load, is extremely important. If the wrapper can't create sufficient containment force — that lasts over time — the load will be unstable during transportation. Even if a film with sufficient stiffness and resistance to breaking is chosen, the pallet will be unstable if the wrapper under or over stretches the film or if the wrapper can't apply the necessary tension to the film to create the on-pallet containment force. Some wrappers prestretch the film, sometimes as much as 350 percent depending on the film and load, before applying the necessary tension to the film while wrapping it around the load. Accurate film tension control during wrapping ensures that when acceleration forces start to shift the load, the film will have sufficient containment force to keep the load unitized on the pallet.

Optimizing stretch film application

For a stable stretch-wrapped pallet, three things must be harmonized: the load itself, the wrapper setup, and the stretch film properties. Once this harmony has been achieved, these parameters must remain the same for all future pallets. Consistent film quality is needed to maintain a repeatable load stability result, but must be married with consistent wrapper performance.

The film industry has traditionally — from a film performance measurement perspective — been focused primarily on force to stretch, rather than understanding post-stretch film tension and stress relaxation behavior. The containment force per layer of film on the pallet is derived mainly from the tension in the film between the wrapper's stretching head and the pallet. Further work needs to be done on stretch film relaxation behavior and how it affects tension both during wrapping and on-pallet, causing a reduction in containment force over time.

Tailoring both the film properties and the wrapper setup to the specific load can reduce film use, increase packaging line efficiency, and lower the costs of product damage during transportation. For many applications, optimizing wrapper settings to create the necessary containment forces, can improve pallet stability while allowing for the use of high performance thinner-gauge films and fewer film layers per pallet. This can significantly reduce costs, speed up production, and decrease the carbon footprint of the packaging operation, while respecting the stability needs of the load.

Photo courtesy of ESTL NV.

A loaded pallet undergoes an acceleration test at the independent test facility ESTL in Belgium. A high-speed camera documents the load's behavior under acceleration forces to determine the load's stability.

Intelligent, interconnected technologies are available that can help end users by collecting, uploading, and correlating data from pallet wrappers to establish performance standards and alert users of deviations from optimized settings, such as increased film use over time. New technologies also allow inline film quality measurement and the ability to identify each individual film reel with a unique QR code, allowing for full traceability if a pallet failure occurs.

Optimizing stretch film application and improving pallet load stability requires a deep understanding of the complete stretch film process chain and a partnership between all the parties involved, from the resin supplier to the film end user. When making palletizing decisions, end users must consider the required containment forces for the load in relation to total cost per stable pallet (including packaging materials; labor; equipment, etc. offset against the unsustainable cost of damaged goods) rather than just focusing on the price per unit weight of the stretch film.

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References

1. *EUMOS 40509-2012: Test method for load unit rigidity.* Available at www.nbn.be/en.
2. Available at https://tinyurl.com/EU2014-47

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