# Cushioning

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Package cushioning is used to help protect fragile items during shipment. It is not uncommon for a transport package to be dropped, kicked, and impacted: These events may produce potentially damaging shocks. Transportation vibration from conveyors, trucks, railroads, or aircraft can also damage some items. Shock and vibration are controlled by cushioning so that the chance of product damage is greatly reduced.

Cushioning is usually inside a shipping container such as a corrugated box. It is designed to deform or crush to help keep levels of shock and vibration below levels that which may damage the product inside the box. Depending on the specific situation, package cushioning can often be between two and three inches thick.

Internal packaging materials (sometimes the same ones used for cushioning) are also used for functions other than cushioning. Some are used just to immobilize the products in the box and to block them in place. Others are just used to fill a void and do not have a cushioning function.

Contents [hide]



Molded expanded polystyrene (Styrofoam) cushioning

## Design factors [edit]

When designing packaging, the choice of cushioning may depend on many factors:

- effective protection of product from shock and vibration
- whether cushioning is resilient (performs for multiple impacts)
- resistance to creep – cushion deformation under static load
- material costs
- labor costs, productivity
- effects of temperature [1], humidity, and air pressure on cushioning
- cleanliness of cushioning (dust, insects, etc)
- effect on size of external shipping container
- environmental and recycling issues
- sensitivity of product to static electricity.
- etc

## Common Types of Cushioning [edit]

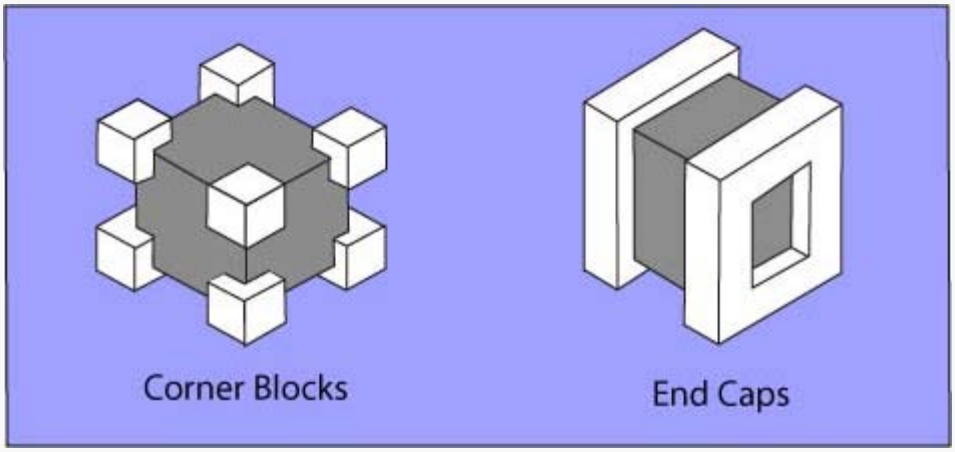
Loose Fill - Some cushion products are flowable and are packed loosely around the items in the box.

The box is closed to tighten the pack. This includes expanded polystyrene foam pieces (Foam peanuts), similar pieces made of starch based foams, and common Popcorn.

Paper - Paper can be manually or mechanically wadded up and used as a cushioning material. Heavier grades of paper provide more weight bearing ability than old newspapers. Creped cellulose wadding is also available.

Corrugated fiberboard pads - Multi-layer or cut-and-folded shapes of corrugated board can be used as cushions. These structures are designed to crush and deform under shock stress and provide some degree of cushioning. Honeycomb paper structures are also used for cushioning[2].

Foam structures - Several types of polymeric foams are used for cushioning. The most common are: Expanded Polystyrene (also Styrofoam), polypropylene, polyethylene, and polyurethane. These can be molded engineered shapes or sheets which are cut and glued into cushion structures.




Foam-in-place is another method of using polyurethane foams. These fill the box, fully encapsulating the product to immobilize it. It is also used to form engineered structures.

Inflated Products - Bubble Wrap consists of sheets of plastic film with enclosed “bubbles” of air. These sheets can be layered or wrapped around items to be shipped. Engineered inflated structures are also available. Note that inflated air pillows used for void-fill are not suited for cushioning.

Molded pulp -

Pulp can be molded into shapes suitable for cushioning and for immobilizing products in a package. Molded pulp is made from recycled newspapers and is recyclable.


Molded pulp cushioning

Other - Several other types of cushioning are available including suspension cushions, thermoformed end caps, and shock mounts.

## Design for Shock Protection [edit]

Proper performance of cushioning is dependent on its proper design and use. It is often best to use a trained packaging engineer, reputable vendor, consultant, or independent laboratory. An engineer needs to know the severity of shock (drop height, etc) to protect against. This can be based on an existing specification, published industry standards and publications, field studies, etc.

Knowledge of the product to be packaged is critical. Field experience may indicate the types of damage previously experienced. Laboratory analysis can help quantify the fragility [3] of the item, often reported in g-s. Engineering judgment can also be an excellent starting point. Sometimes a product can be made more rugged or can be supported to make it less susceptible to breakage.

The amount of shock transmitted by a particular cushioning material is largely dependent on the thickness of the cushion, the drop height, and the load bearing area of the cushion (static loading). A

cushion must deform under shock for it to function. If a product is on a large load bearing area, the cushion may not deform and will not cushion the shock. If the load bearing area is too small, the product may “bottom out” during a shock; the shock is not cushioned. Engineers use “cushion curves” to choose the best thickness and load bearing area for a cushioning material. Often two to three inches (50 - 75 mm) of cushioning are needed to protect fragile items.

## Design for Vibration Protection [edit]

The process for vibration protection (or isolation) involves similar considerations as that for shock. Cushions can be thought of as performing like springs. Depending on cushion thickness and load bearing area and on the vibration frequency, the cushion may 1) not have any influence on input vibration, 2) amplify the input vibration at resonance, or 3) isolate the product from the vibration. Proper design is critical for cushion performance.

## Evaluation of Finished Package [edit]

Verification and validation of prototype designs are highly recommended. The design of a package and its cushioning is often an iterative process involving several designs, evaluations, redesigns, etc. Several (ASTM, ISTA, and others) published laboratory test protocols are available to evaluate the performance of a proposed package. Field performance should be monitored for feedback into the design process.

## See also [edit]

- Impact force
- Packaging and labelling
- Shock
- Vibration
- Vibration-isolation

## ASTM Standards [edit]

- D1596 Standard Test Method for Dynamic Shock Cushioning Characteristics of Packaging Material
- D2221 Standard Test Method for Creep Properties of Package Cushioning Materials
- D3332 Standard Test Methods for Mechanical-Shock Fragility of Products, Using Shock Machines
- D3580 Standard Test Methods for Vibration (Vertical Linear Motion) Test of Products
- D4168 Standard Test Methods for Transmitted Shock Characteristics of Foam-in-Place Cushioning Materials
- D4169 Standard Practice for Performance Testing of Shipping Containers and Systems
- D6198 Standard Guide for Transport Packaging Design
- D6537 Standard Practice for Instrumented Package Shock Testing For Determination of Package Performance
- and others

## Notes [edit]

1. ^ Marcondes, Jorge; Hatton, Graham, Schueueman (July 2003). "Effect of temperature on the cushioning properties of some foamed plastic materials". *Packaging Technology and Science* 16 (2): 69-76.
2. ^ Wang, Dong-Mei; Wang, Zhi-Wei (October 2008). "Experimental investigation into the cushioning properties of honeycomb paperboard". *Packaging Technology and Science* 21 (6):

309-373. DOI: 10.1002/pts.808.
3. ^ Burgess, G (March 2000). "Extensnion and Evaluation of fatigue Model for Product Shock Fragility Used in Package Design". *J. Testing and Evaluation* 28 (2).

## Further reading [edit]

- MIL-HDBK 304C, “Package Cushioning Design”, 1997
- Brody, A. L., and Marsh, K, S., "Encyclopedia of Packaging Technology", John Wiley & Sons, 1997, ISBN 0-471-06397-5
- Root, D, “Six-Step Method for Cushioned Package Development”, Lansmont, 1997, http://www.lansmont.com/

## External links [edit]

- Institute of Packaging Professionals
- International Safe Transit Association

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