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General Packaging Recommendations for the Less-Than-Truckload (LTL) Environment

Revision: 1.2

ABF Freight does not guarantee that following the packaging guidelines contained herein will result in no damage to freight. This document is to be used as a voluntary guideline only. It does not address every design consideration. Contact your local supplier(s) of packaging materials for more information on packaging design and implementation.

This document does not purport to address all of the human and freight safety concerns, if any, associated with its use. It is the responsibility of the user of this guideline to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

The guidelines in this document are in addition to those promulgated by the Commodity Classification Standards Board (CCSB) as published in the National Motor Freight Classification® (NMFC®).

Guidelines By:
ABF Freight Packaging Engineering Department and Material Handling Department
ABF Freight System, Inc.

Contents

I. Introduction

Properly packaging freight for shipment through the Less-Than-Truckload (LTL) distribution environment is critical to ensure that it is safe to handle and that it reaches its destination undamaged. Generally, distribution packaging must protect against: Mechanical Shock, Vibration, Abrasion, Compression, Temperature & Relative Humidity and Water. Based on more than 100 years of handling LTL freight and 90+ years of Packaging Engineering knowledge, ABF Freight has developed these general LTL packaging guidelines.

A. About the National Motor Freight Classification System

The NMFC groups all freight into 18 classes based on four transportation characteristics: ***density, handling, stowability and liability***. This system provides a standard platform to allow for carriers and shippers to negotiate pricing.

Packaging plays a significant role in the evaluation of the four transportation characteristics. Minimum packaging requirements are specified for each NMFC Item Number. These minimum packaging requirements are designed to ensure that typical freight is adequately protected and that it can be handled and stowed in a manner that is safe and practicable, so as to withstand the normal rigors of the LTL distribution environment. For more information on the NMFC and the packaging requirements specified therein, visit their website at www.NMFTA.org

B. ABF Freight Rules Tariff

The ABF Freight System, Inc. (ABF Freight) Rules Tariff governs and covers specific topics particular to ABF Freight, including but not limited to: carrier regulations, special services offered and prohibited or restricted articles.
ABF LTL Tariff 111

C. Evaluation of Packaging using a Certified Laboratory Testing Facility

Prior to implementation, it is recommended that packaging designs be evaluated in a certified ISTA, ASTM or Registered CCSB package testing laboratory. While laboratory testing may not reveal all likely failure modes, the testing procedures (ISTA Procedure 3B, ASTM D4169 and NMFC Rule 180 or 181), will often expose some of the shortcomings in the package design. Websites: www.ista.org, https://www.astm.org/COMMITTEE/D10.htm.

Additionally, prototype packages can be sent for evaluation to the ABF Freight Packaging Engineering and Material Handling Department. An ArcBest Account Representatives can coordinate packaging evaluations with the ABF Freight Packaging Engineering and Material Handling Department.

If a chosen package design does not comply with the minimum NMFC requirements, it can be accepted as compliant only if it has successfully been certified to meet the performance test requirements in NMFC Rule 180 or 181.

D. Utilization of a Packaging Engineer

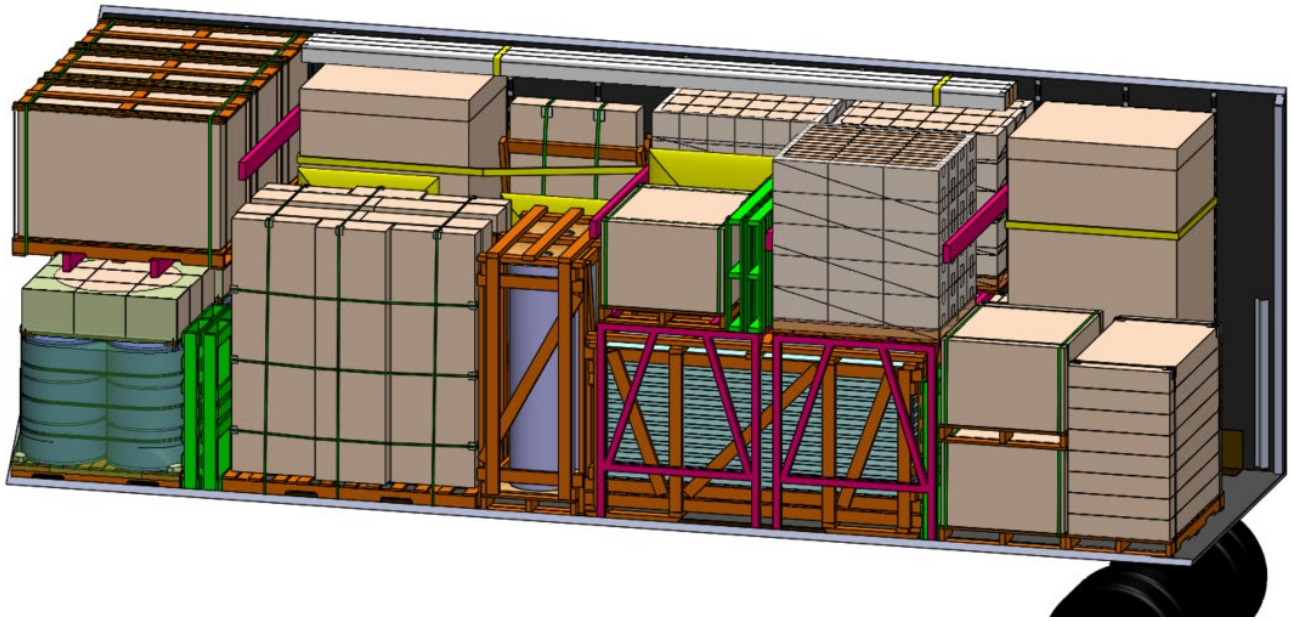
Packaging Engineers are trained professionals who have a breadth of experience, including but not limited to: research and development, designing packaging systems, testing and validation of designs, planning and purchasing of materials, manufacturing processes, marketing & graphic design theory and application, and regulatory requirements.

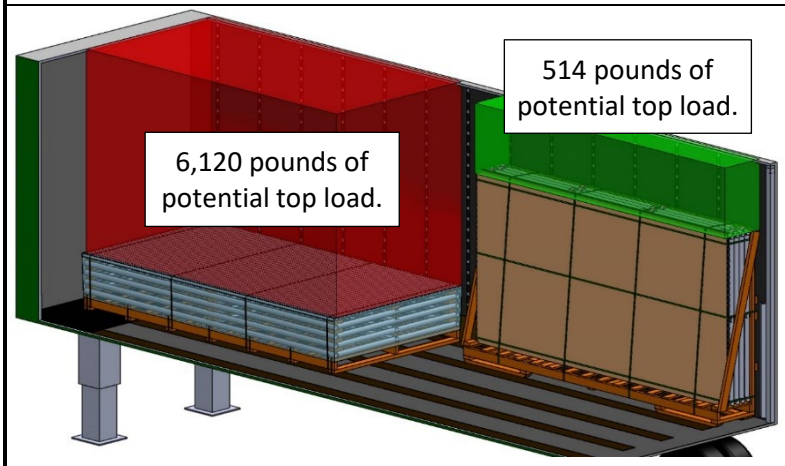
A Packaging Engineer can reduce damage, reduce material cost, specify packaging equipment, optimize for manufacturing processes, and implement packaging components across the entire supply chain.

II. The LTL Environment

The Less-Than-Truckload (LTL) distribution environment exerts unique forces on freight, which will result in freight contacting other freight and/or dunnage. When contact happens, and there's insufficient packaging to counteract these dynamic forces, damage is likely. Damage-free shipping through the LTL environment requires packaging that meets or exceeds the minimum requirements specified in the NMFC.

Cubing is essential to optimize a trailer's space utilization. Cubing also plays an important role in securing freight and ensuring it is roadworthy. ABF Freight cargo handlers are well-trained at cubing freight inside trailers by loading shipments for optimum transportation and applying dunnage to freight where required. Examples of dunnage are shown in the image below; pallets are **green**, air bags & straps are **yellow** and decking beams & tables are **pink**.





The average cubic density of freight in the LTL environment is approximately 12 pounds per cubic foot.

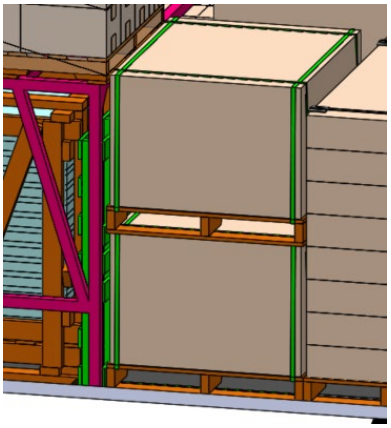
The image to the left shows the same product packaged in two different orientations. The flat orientation allows a large top load volume (shown in **red**), while the vertical orientation allows a much smaller top load volume (shown in **green**).

Reducing the volume of the space between the top of the freight and the ceiling of the trailer reduces potential top loading weight

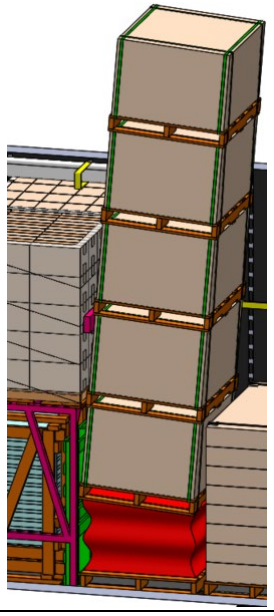
A theoretical top load calculation is shown to the right, based on the average LTL freight density of 12 lb/ft^3 for the flat package (**red**) shown above.

Length: 144 in	Width: 72 in	Distance to ceiling: 85 in
144 x 72 x 85 = 881,280 in^3		
881,210 in^3 = 510 ft^3		
510 ft^3 x 12 lb/ft^3 = 6,120 pounds of potential top freight.		

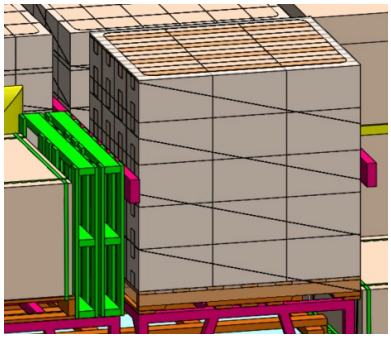
Vertical Forces - The up-and-down dynamic forces, from normal road conditions, can cause significant vertical forces which often exceed 5 times the force of gravity (5g). Road hazards include, but are not limited to: railroad crossings, pot holes, speed bumps, curbs, expansion joints and rough pavement. The average ABF Freight shipment weighs approximately 1,200 pounds.



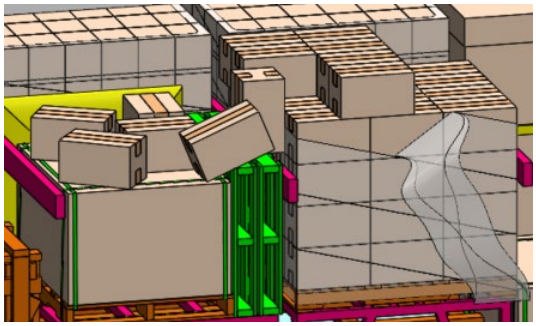
Normal road hazards create short term compressive forces that may reach or exceed 5 times the weight of the upper shipment(s).

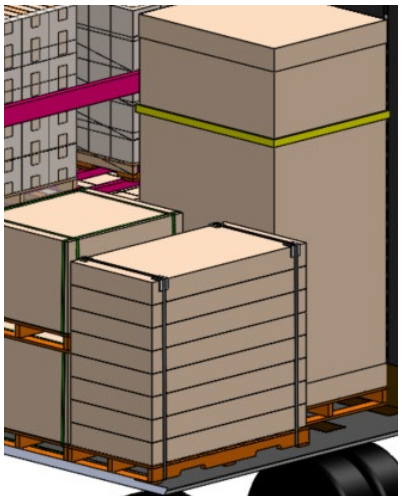


Horizontal Forces - The sideways dynamic forces experienced from normal traffic and road hazards can cause significant horizontal forces that can exceed 0.8 times the force of gravity. Normal driving activities include, but are not limited to, turning, accelerating and braking. This horizontal force can be significant, depending on the dimensions and shape of the freight, and the dimensions, shape, and mass of adjacent freight.

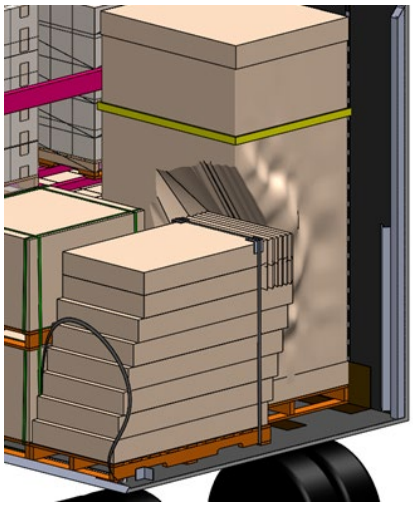


Poorly applied stretch film has failed due to the forces associated with braking.

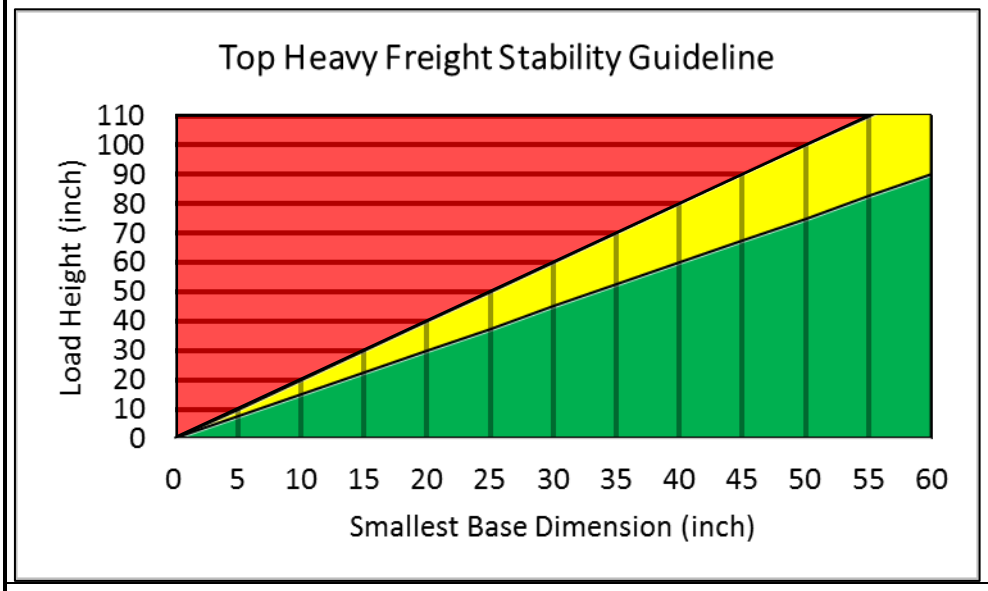




The freight was only stabilized along the width, allowing the flat boxes to shift into the large adjacent freight due to the forces associated with turning.



Top Heavy Freight

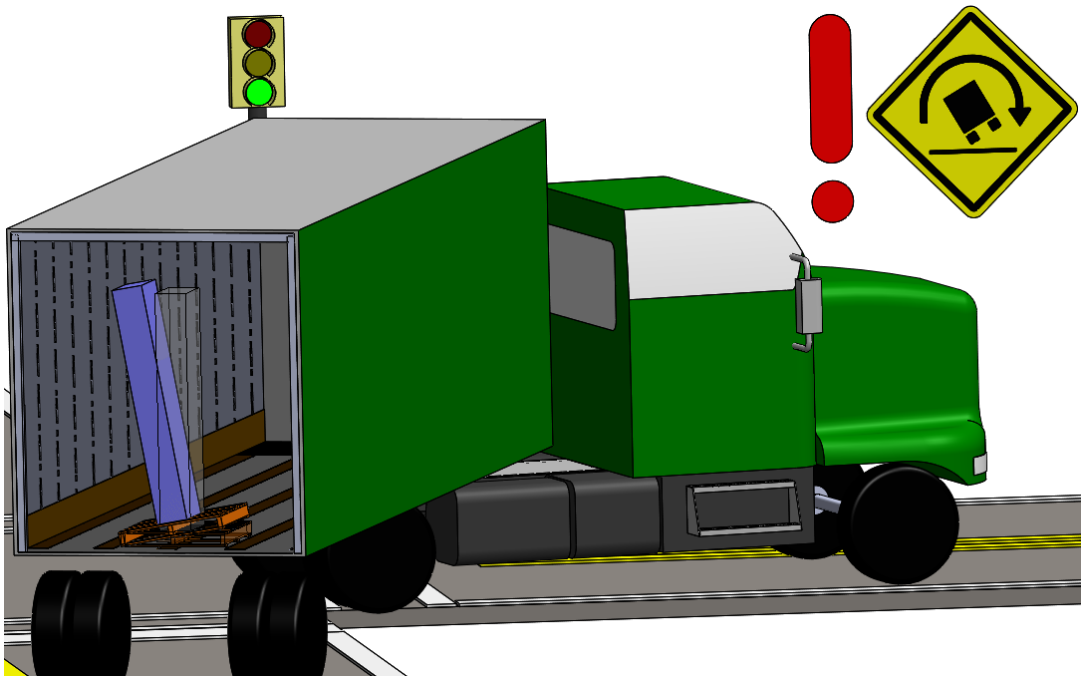


Assuming uniform density:

Green area is stable: the height of the freight is less than 1.5x the smallest base dimension (usually pallet width).

Yellow area is potentially unstable.

Red Area is unstable: the height of the freight is greater than 2x the smallest base dimension (usually pallet width).

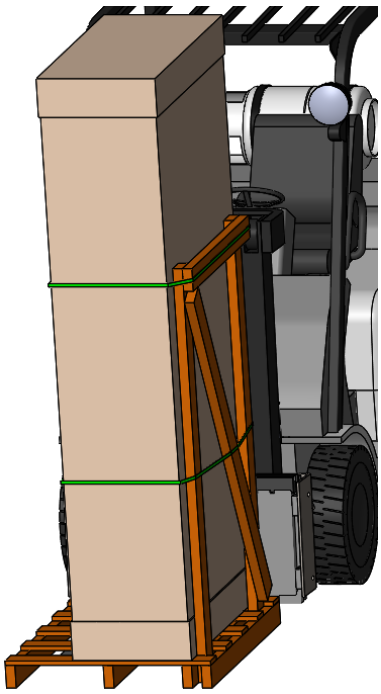


Top-heavy freight is inherently unstable under normal driving conditions.

When a truck turns a corner, the freight tries to resist the change in direction, and If the freight is top heavy it will tip over or lean on adjacent freight.

The correct packaging systems should be able to protect freight from damage that may occur due to top heavy shipments tipping over or leaning on adjacent loads.

- Consider making the pallet (base) larger so that the freight dimensions fit within the **green** section of the graph above.
- Protect the freight with the appropriate packaging to protect against the normal rigors of the LTL environment.
- NOTE: Top-heavy freight is often stabilized with cargo straps, shoring beams, adjacent freight and trailer walls. The freight needs to be packaged to withstand the concentrated forces associated with these stabilizing methods. See additional information on pages 2 and 11.

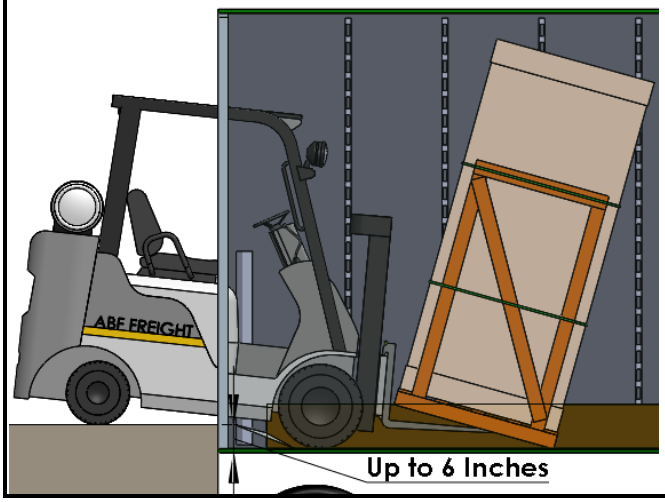


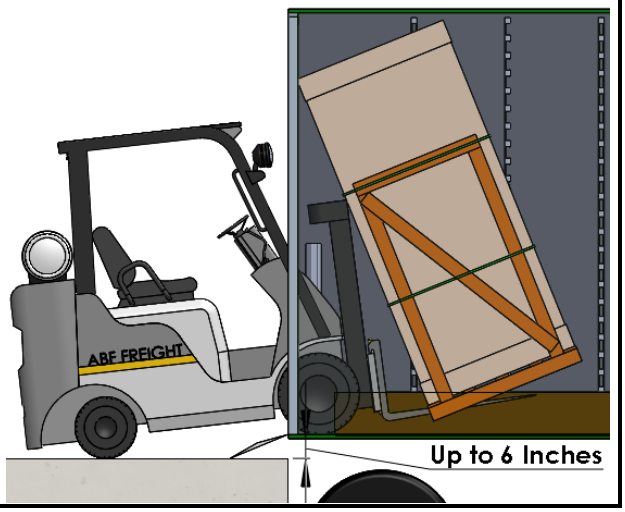
Top-heavy freight without pallet bottom deck boards is more likely to tip off of the fork tines.

See the secure links below that show video examples of tall freight with, and without bottom deck boards.

The height of the dock and the height of the trailer floor may be different. The dock plate acts as a ramp to enable material handling equipment to drive into and out of a trailer. The difference in height between the dock surface and the trailer floor can be +/- 6 inches, and this transition can exacerbate the tendency of top-heavy freight to tip during trailer loading and unloading.

NOTE: Bottom deck boards are recommended as they help to prevent freight from falling off the fork tines.





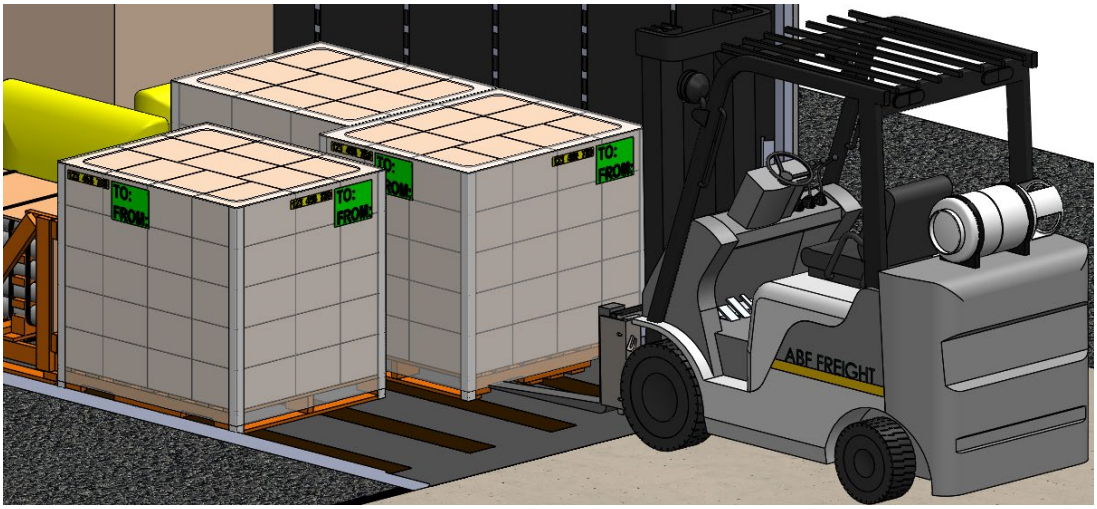
[Secure Video Link - Pallet WITHOUT Bottom Deck Boards]

[Secure Video Link - Pallet WITH Bottom Deck Boards]

III. Properly Labeling Freight for Transport

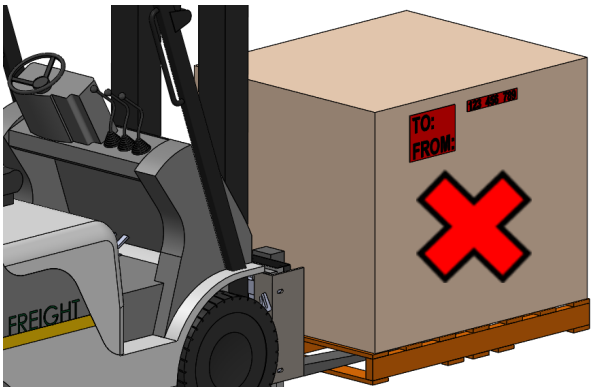
Properly labeling freight is the best way to ensure that it is not separated or lost during transit.

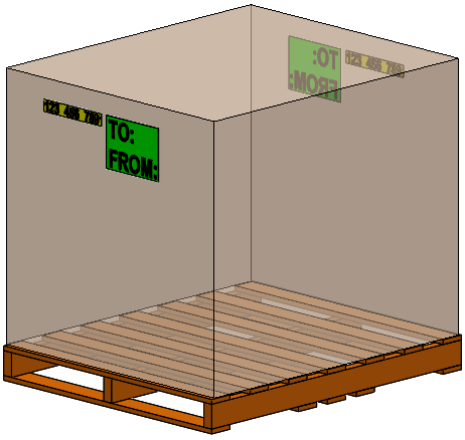
- Ensure that all old PRO labels and address labels are removed or obliterated prior to reshipping.
- The proper labeling of freight is a NMFC requirement; please reference Item 580 and Item 299.



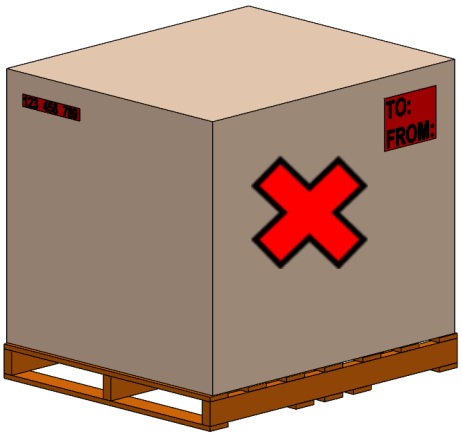
The PRO Number and Address Label should be visible to the forklift driver when the freight is unloaded or handled.

Labels applied to sides without fork tine access are hard to read from the forklift

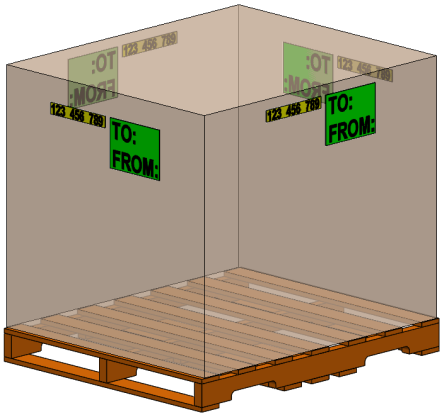




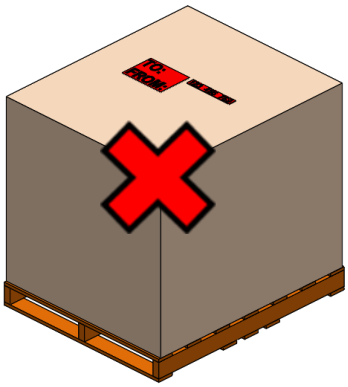
PRO Number and Address Labels are on all fork tine entry faces.



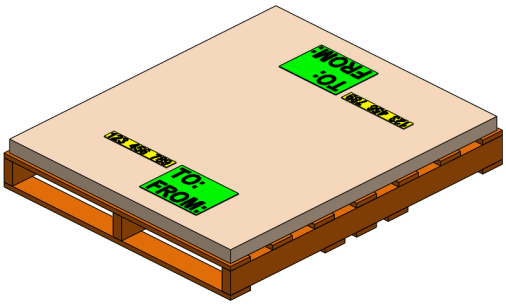
While a shipment may have multiple PRO Number labels, ensure at least one PRO label is adjacent to the address label.

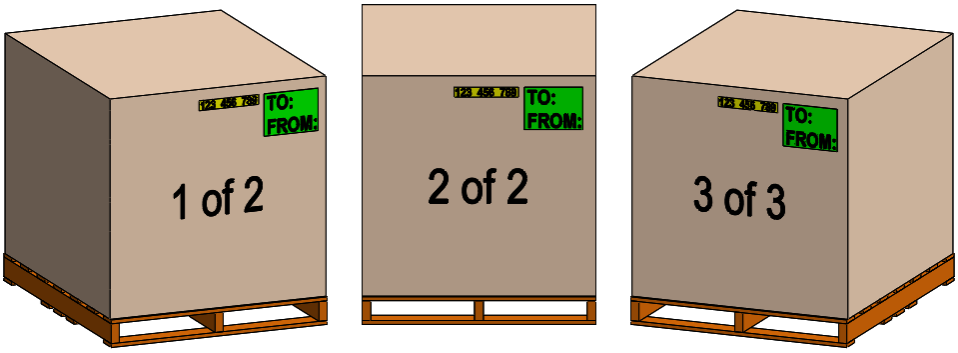


PRO number is located close to shipping information.



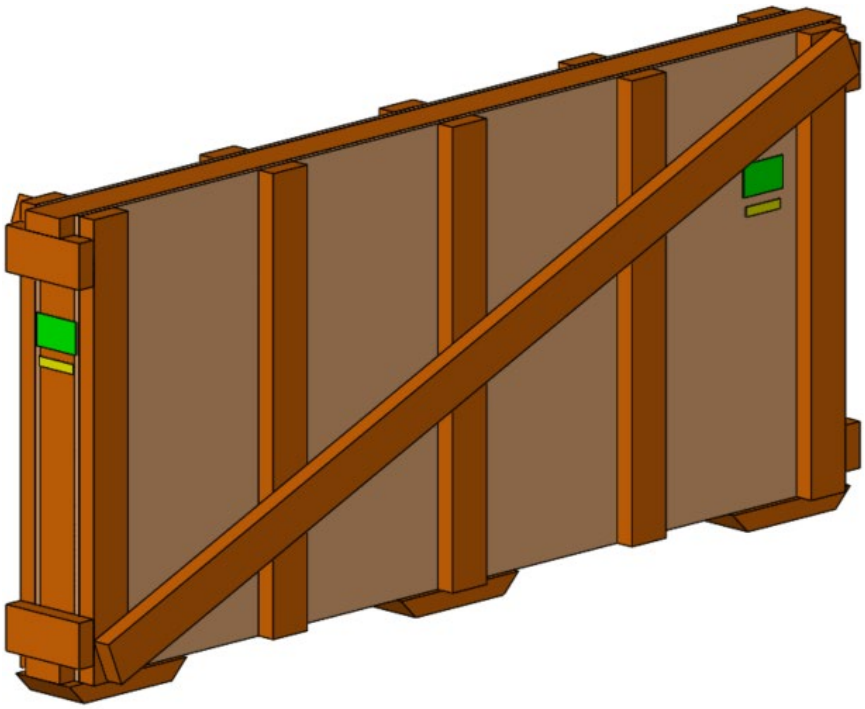
PRO Number and Address Labels on the top of the load are not required, unless the load is so short that the labels will not fit on the side.





Place a PRO Number and Address Label on each handling piece.

Number all packages (x of X).

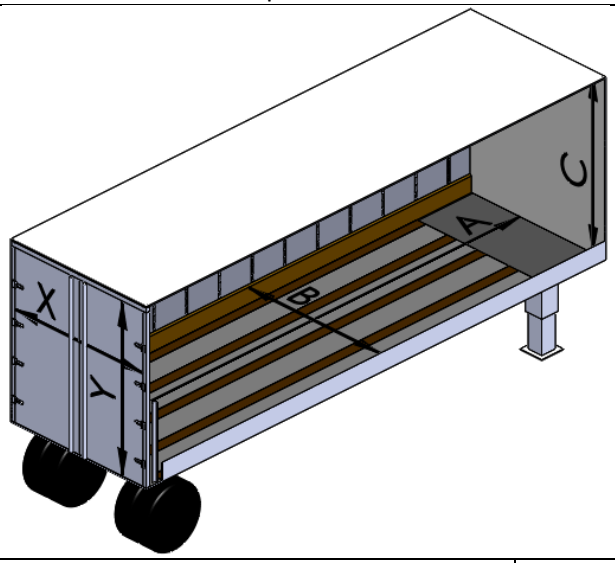


Freight longer than 96 inches should have a PRO Number and Address Label on or near both ends of the freight.

IV. Material Handling & Equipment Dimensions

A. Van Trailer Dimensions

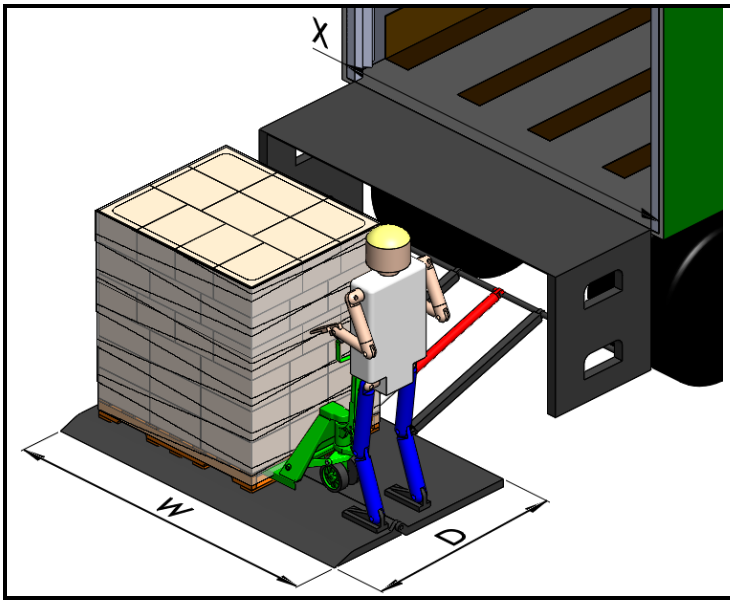
ABF Freight trailers have either a Rollup Door or Swing Doors. Door sizes vary between manufactures of trailers and door types, therefore the dimensions listed are a range of the most common door sizes within the ABF Freight system. NOTE: ABF Freight dock employees need a minimum of two inches of clearance in order to move the freight in and out of the trailer safely and without damage. If you have questions regarding trailer types and dimensions, please contact an ArcBest Account Representative for additional information.



28 Foot Trailer	
A Interior Length	27’ 2”
B Interior Width at Floor	92” to 97”
C Interior Height	105” to 112”

Swing Door Trailer		Roll Door Trailer	
X Door Width	**Y** Door Height	**X** Door Width	**Y** Door Height
92” to 97”	105“ to 112”	88” to 93”	100” to 107”

B. Lift Gate Dimensions



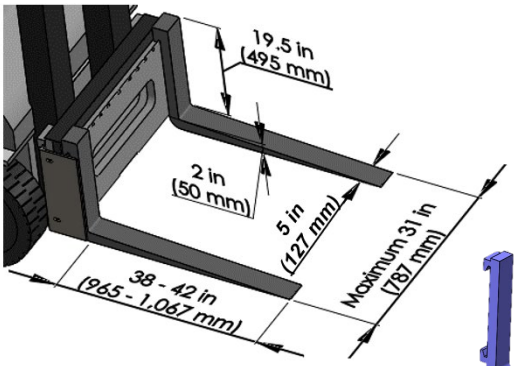
Freight requiring lift gate delivery must meet the dimensional and weight restrictions of ABF Freight’s equipment. If you have questions please contact an ArcBest Account Representative.

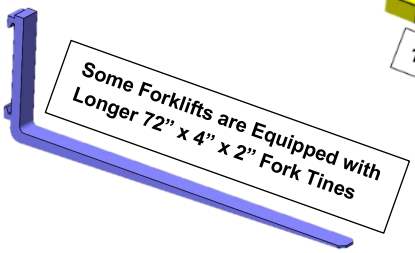
W Width of platform	84” To 88”
D Depth of platform	48” To 52”
X Roll Door Width	93”
Maximum Weight Capacity	3,000 pounds

C. Material Handling Equipment Dimensions

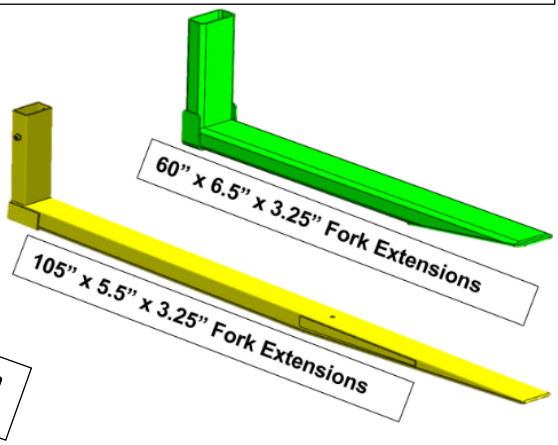
Product packaging, pallets and crates should take into account material handling dimensions and likely contact points. **NOTE: The primary method of loading and unloading freight is with a forklift.**

Fork Tine Dimensions

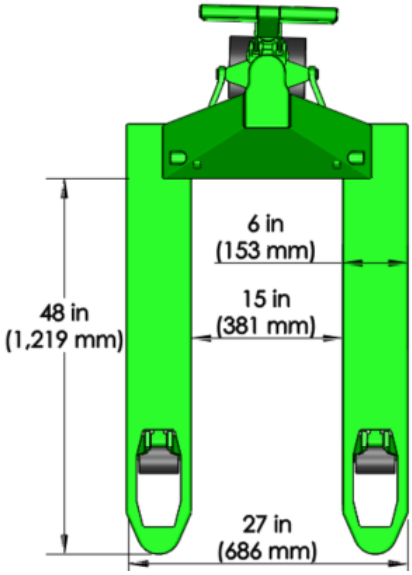




Fork Extensions: All ABF Freight Service Centers are equipped with 105" fork extensions, and many also have 60" extensions.

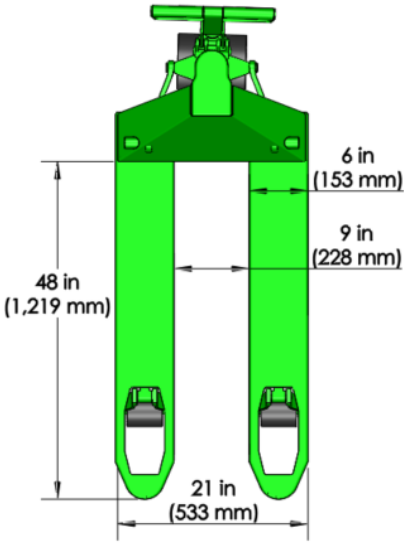


Industry Standard Pallet Jack

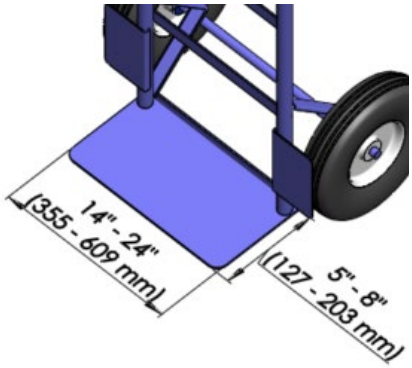


Narrow Pallet Jack

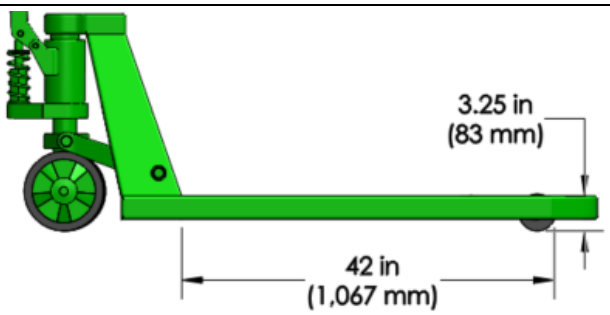
(Available in some locations)

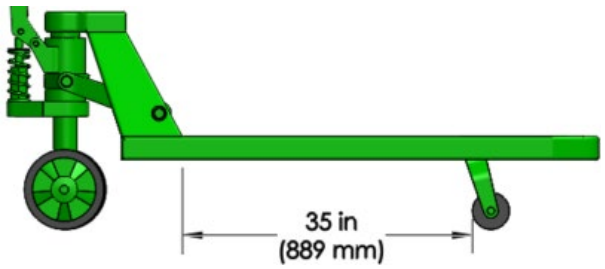


Hand Truck Dimensions



Do Not Place Bottom Deck Boards Under Pallet Jack Wheel Locations.

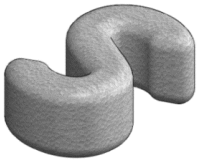
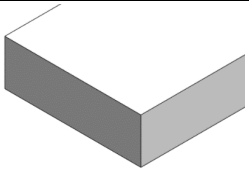
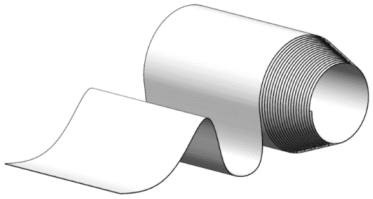
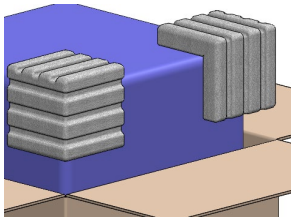




V. Protective Packaging and Padding

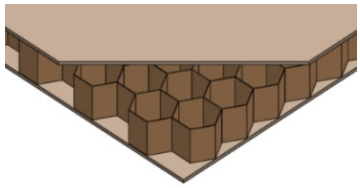
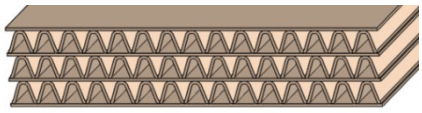
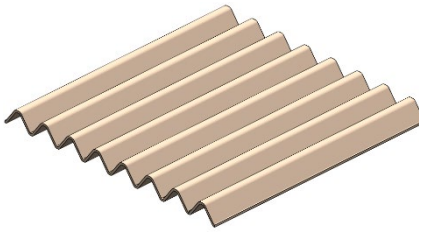
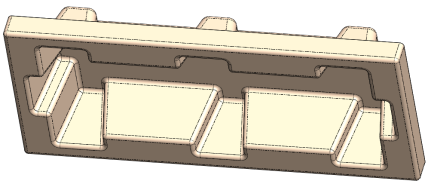
Cushioning Suitable for LTL Shipments

Expanded Polystyrene, Polyurethane, Polyethylene, paper-based, and air-filled

 Loose Fill (Foam Peanuts) Do Not Use – Freight can settle through the loose-fill, reducing its cushioning properties.	 Plank Foam (Square or Rectangular Forms)
 Sheet Foam	 Molded (Custom Forms)
 Bubble Wrap	 Foam-In-Place (Spray-In or Preforms)
 Cellulose-Based Fiber Wall Board (AKA Homasote®)	 On-Demand Inflatable Void-Fill

- Utilize the proper cushion curve to ensure selection of the correct cushion for the application, as not all materials are suitable for all applications. About cushion curves: Cushion Curve Information . Contact your cushioning supplier for proper material selection, application methods and associated cushion curves.

Paper Based Padding

 Honeycomb Fiberboard	Layered Corrugated fiberboard, or Corrupad® (which is manufactured by Multi-Wall Packaging Corporation). 
 SuperFlute / Rollerboard Solid Fiberboard	 Molded Pulp

Application of Protective Packaging and Padding

Since product robustness (fragility) varies, always consult with a reputable packaging supplier regarding the proper padding or cushioning material and design.

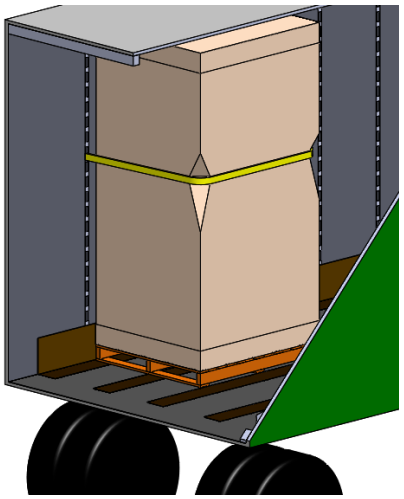
Application Rules

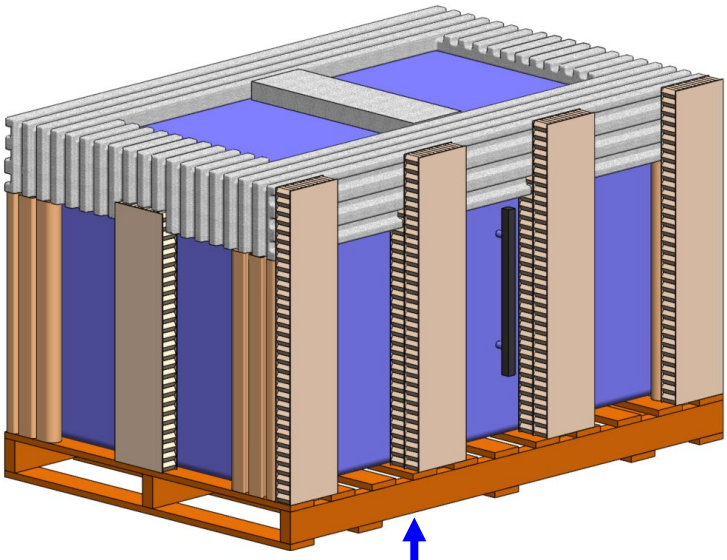
- The vertical & horizontal edges must be protected by standoff pads that are at least 2 inches thick and at least 6 inches in width.
- Pads must extend outward at least 2 inches beyond all protrusions (Handles, Knobs, Control Panels, Gauges, etc.).
- Outer most surface of the standoff pads must be strong enough to support at least 80% of the item's weight without damage to the pad or product.
- 50% of any product surface area must be protected by evenly distributed standoff pads that occupy the space between the product and the exterior packaging.
    - Space between pads must be less than 12 inches.
    - Outer coverings (Stretch film, Shrink Film, Fiberboard, etc.) used to enclose the packaged product must pass ASTM D6344 - Standard Test Method for Concentrated Impacts to Transport Packages. (see image below)
- Product and the packaging must not extend beyond the pallet perimeter.

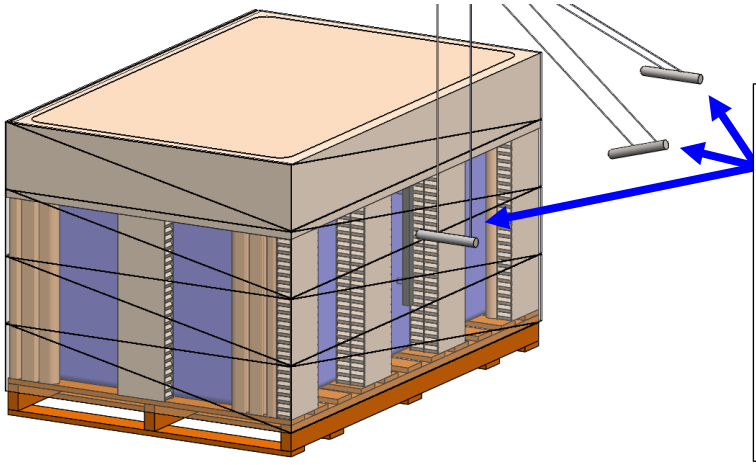
Top Heavy Items

Items that might appear top heavy require reinforced corner protection to withstand the application of rope or strapping, in addition to the forces associated with the normal rigors of the LTL environment.

For more information on these materials, see Section VIII, Corner Boards (Page 16).







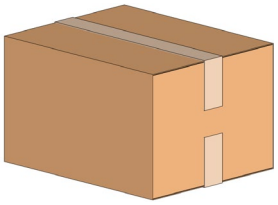
Stretch film and top cap removed for clarity.

In this example (left) the swinging weight specified in the ASTM D6344 test procedure cannot contact the product due to proper pad spacing and stretch film application.

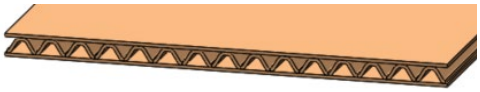
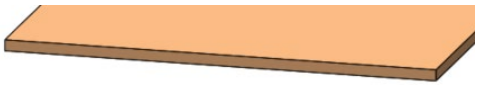
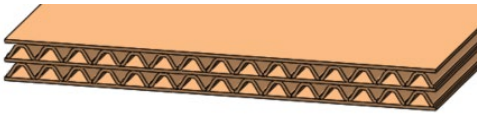
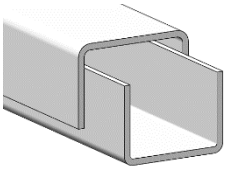
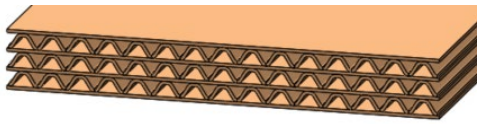
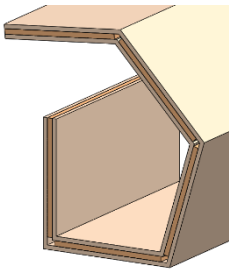
See Section IX Stretch Film Application on pages 17-20 for additional information.

VI. Corrugated and Solid Fiberboard Boxes

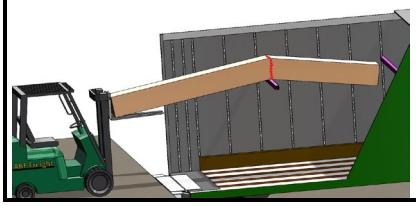
Corrugated fiberboard boxes are the most prevalent container for shipping products from manufacturing to the retailer and end user. Corrugated fiberboard boxes do have limitations as their strength is degraded by moisture and time. The use of corrugated boxes in the LTL distribution environment is governed by NMFC Item 222 as to maximum size and weight.



NMFC Item 222 recognizes four different types of fiberboard wall construction: Single-wall corrugated, Double-wall corrugated, Triple-wall corrugated, and Solid fiberboard.

Single-wall Corrugated Fiberboard 	Solid Fiberboard Sheet 
Double-wall Corrugated Fiberboard 	Solid Fiberboard – Channel® by Laminations® Quik-Crate® by Signode® 
Triple-wall Corrugated Fiberboard 	Solid Fiberboard – FlatCrate™ by Laminations® DuraCrate by Dura Fiber® 

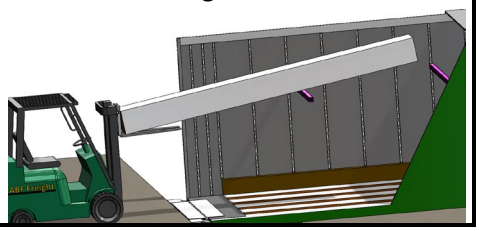
NOTE: Solid fiberboard works well for packaging long freight with a small profile. The solid fiberboard can keep its rigidity over longer lengths, and has a greater durability and puncture resistance than corrugated fiberboard.



Long Box Being Lifted onto Decking Beams

<<< Corrugated Fiberboard Box Fails

Solid Fiberboard Box Does Not Fail >>>



The Box Manufactures Certificates (BMC) are markings that indicate the box meets the material requirements stated in the BMC, the stated requirements of Item 222 of the National Motor Freight Classifications (NMFC) and Rule 41 of the Uniform Freight Classifications.

All Box Manufactures Certificates Include:

- Number of Corrugated Walls
- Maximum Sum of Outside Dimensions
- Maximum Allowable Gross Weight

In addition, the Box Manufactures Certificate will include either: Burst Test Rating coupled with Minimum Combined Weight of Facings OR Edge Crush Rating.

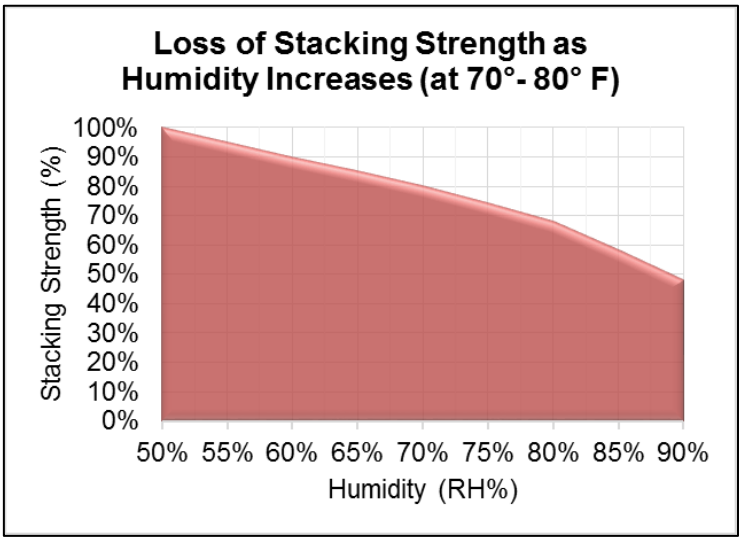
Environmental Factors That Affect the Strength of Corrugated Containers

The reduction in strength from environmental factors and misalignment of corrugated fiberboard box corners are additive. There are many additional factors that may affect corrugated fiberboard strength.

Humidity

As the ambient relative humidity increases, the stacking strength can decrease by more than 50%.

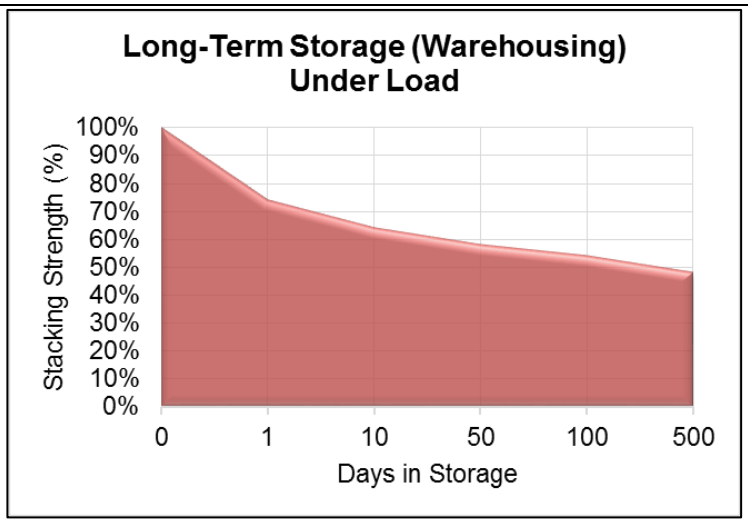
Source: Goodwin & Young, Protective Packaging for Distribution – Design and Development, DEStech Publications, Lancaster, PA 2011.



Long-term storage / warehousing of filled containers

Filled containers, under load, subjected to long-term storage (over 90 days) can lose up to 50% or more, of their stacking strength.

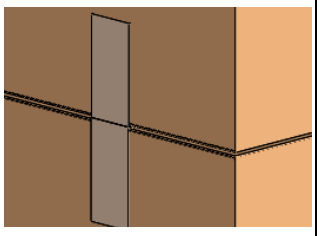
Source: Meisner, Transport Packaging – Third Edition, Institute of Packaging Professionals, Oakbrook Terrace, IL, 2016



Loss of Strength Due to Misalignment of Corrugated Box Fiberboard Corners

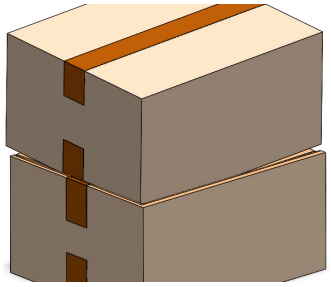
Perfect alignment of corners

Loss in strength = About 8%



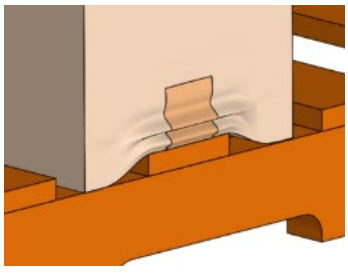
Slight misalignment of corners.

Loss in strength = About 12.5%



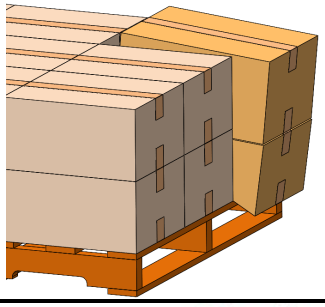
Pallet deck misalignment

Loss in strength = About 32%



Total misalignment of corners (pallet overhang or interlock stacking)

Loss in strength = About 50%



Size and Weight Limitations for Corrugated Fiberboard Containers

The size and weight limitations for each of construction methods are laid out in the tables of Section 3 in NMFC Item 222 Specifications for Fiberboard Boxes Corrugated or Solid shown below.

- (There are exceptions where the weights and lengths can be extended for long freight. Contact the ABF Freight Packaging Engineering and Material Handling Department for questions.)

NMFC Item 222 – Section 3: Minimum Bursting Test Requirements

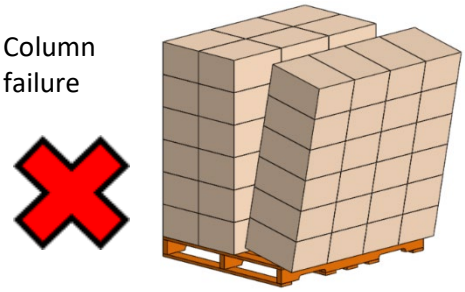
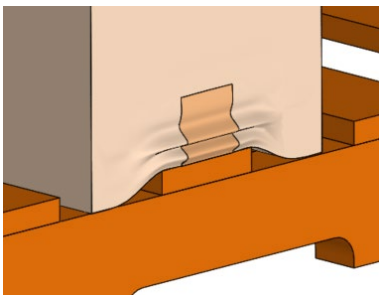
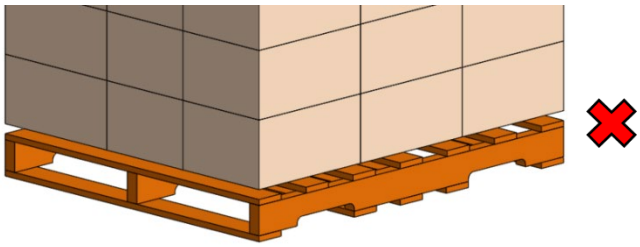
Maximum Weight of Box and Contents (pounds)	Maximum Outside Dimensions, Length, Width and Depth Added (inches)	Minimum Bursting Test (inch ounce per inch of tear)	Minimum Combined Weight of Facings (pounds per 1,000 square feet)
SINGLEWALL CORRUGATED FIBERBOARD BOXES			
20	**40**	125	52
35	**50**	150	66
50	**60**	175	75
65	**75**	200	84
80	**85**	250	111
95	**95**	275	138
120	**105**	350	180
DOUBLEWALL CORRUGATED FIBERBOARD BOXES			
80	**85**	200	92
100	**95**	275	110
120	**105**	350	126
140	**110**	400	180
160	**115**	500	222
180	**120**	600	270
TRIPLEWALL CORRUGATED FIBERBOARD BOXES			
240	**110**	700	168
260	**115**	900	222
280	**120**	1100	264
300	**125**	1300	360
SOLID FIBERBOARD BOXES			
20	**40**	125	114
40	**60**	175	149
65	**75**	200	190
90	**90**	275	237
120	**100**	350	283

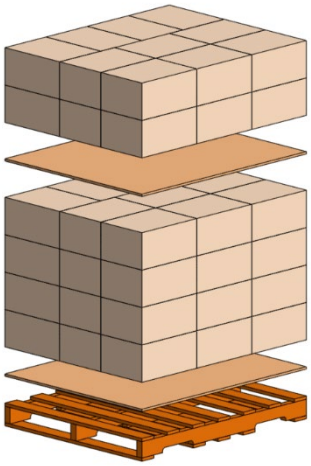
NMFC Item 222 – Section 3: Minimum Edge Crush Test Requirments

Maximum Weight of Box and Contents (pounds)	Maximum Outside Dimensions, Length, Width and Depth Added (inches)	Minimum Edge Crush Test (ECT) (pounds per inch width)
SINGLEWALL CORRUGATED FIBERBOARD BOXES		
20	40	23
35	50	26
50	60	29
65	75	32
80	85	40
95	95	44
120	105	55
DOUBLEWALL CORRUGATED FIBERBOARD BOXES		
80	85	42
100	95	48
120	105	51
140	110	61
160	115	71
180	120	82
TRIPLEWALL CORRUGATED FIBERBOARD BOXES		
240	110	67
260	115	80
280	120	90
300	125	112

NOTE: It is the opinion of ABF that these minimum material strengths are often not sufficient to prevent damage in boxes with large surfaces, headspace and flowable contents.

VII. Tie Sheets

Tie sheets help reduce the chances of the following failures:	
Column failure 	Box collapse around pallet decking 
Load shifting off of the pallet 	

CAUTION: Effectiveness of tie sheets depends on quality and material used.	
	Tie sheets can increase unit load stability. A significant benefit for column stacked pallets.
	Tie sheets can act as a pallet deck leveling device.
	Tie sheets can help lock the load to the pallet.

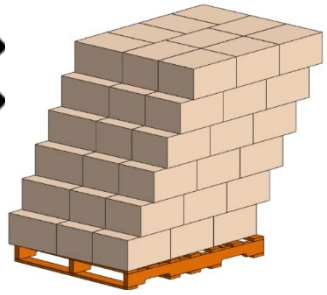
Common tie sheet materials include, but are not limited to:	
Single-wall corrugated	Solid Fiber
Double-wall corrugated	Plywood / OSB
Triple-wall corrugated	Plastic / Composite
New or Recycled materials can be used within any of these categories. Effectiveness of the tie sheet may depend on initial quality/integrity of the sheet.	

VIII. Corner Boards

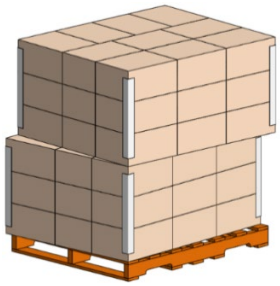
Some uses for corner boards are:

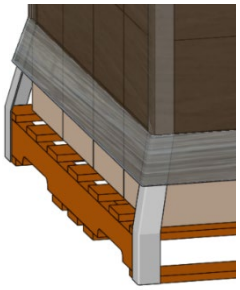
- Increased unit load stacking strength.
- Lateral unit load stability.
- Protection against damage from high stretch film wrapping forces.
- Protection against damage from strapping.

Without corner boards, loads can shift.



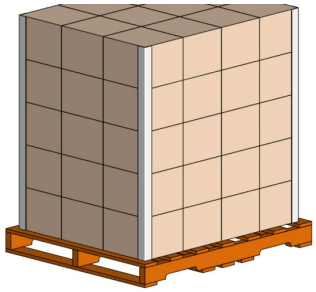
Short, multi-piece corner boards will significantly reduce their effectiveness as a load stabilizer.

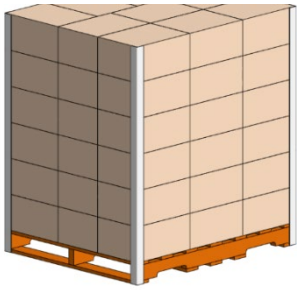




Extending corner boards to the floor on pallet loads with large amounts of underhang can cause the stretch film to roll up the load. This will reduce the ability of the stretch film and corner boards to hold the load to the pallet.

If there is more than one inch of underhang, the corner boards should rest on the top deck.

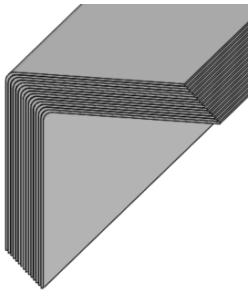




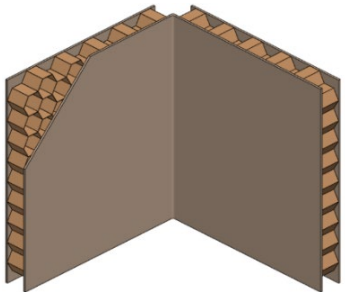
Only use full-length, single piece corner boards.

Corner boards should extend to the ground if there is less than one inch of underhang.

Common corner board materials include:

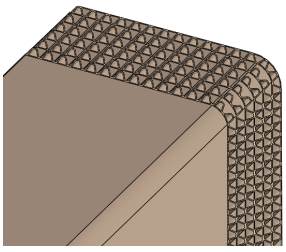


Solid Fiber



Honeycomb Fiberboard (NOTE: Does not properly protect against roping or strapping forces).

3-Dimensional Paperboard Corner Posts

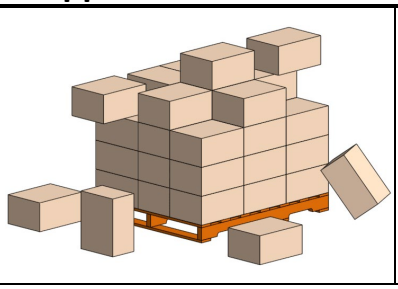


Built-up corrugated fiberboard

- Proper corner board application depends on material type, thickness and objective of application. Consult your corner board supplier for optimum usage recommendations.

IX. Stretch Film Application to Unit Loads

Loads that are improperly stabilized will fail.

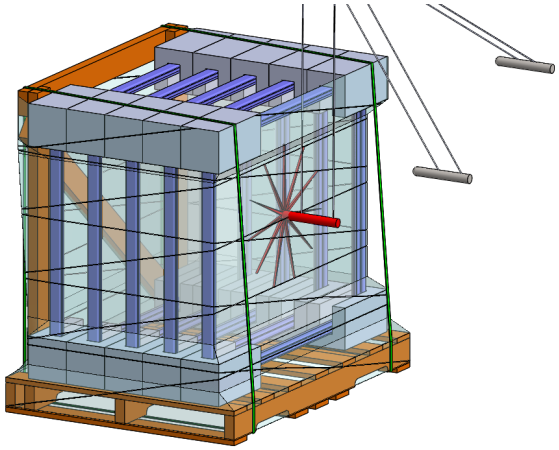


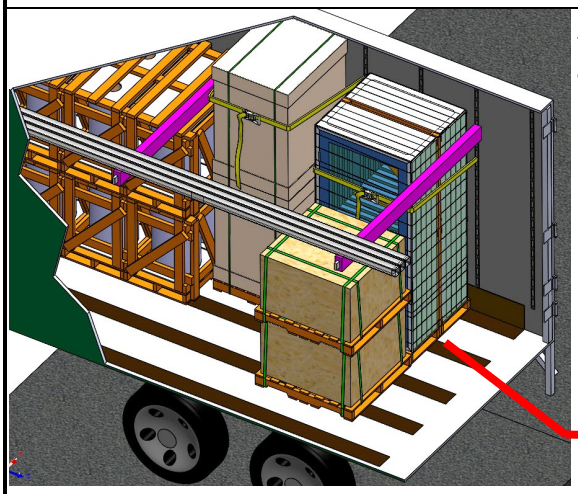
A well-wrapped unit load will keep the product contained and on the pallet, which will help the shipment withstand the normal rigors of the LTL distribution environment.

NMFC Item 680, Section 10 "Definition of Wrapped" addresses the testing requirements for freight that is protected by stretch film. The one of the tests listed is ASTM D6344 Standard Test Method for Concentrated Impacts to Transport Packages.

Stretch film is not designed to prevent damage to fragile or critical surfaces (such as the shipment of glass shown at right).

NOTE: There is a similar test in ISTA 3B.

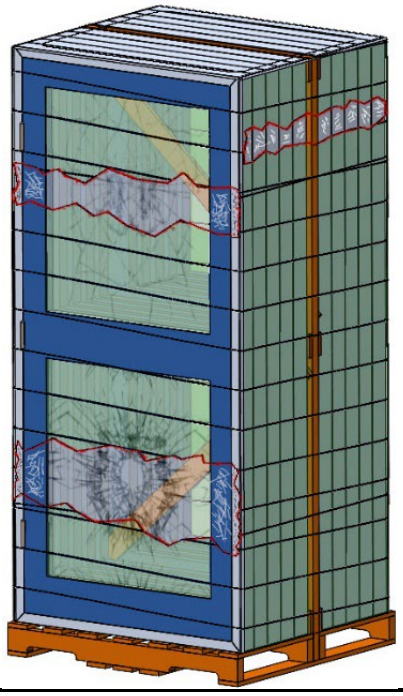




Stretch film does not provide adequate product protection to prevent damages caused by the normal LTL environment rigors.

Shown in the image at left is a pallet load of glass doors covered only with stretch film and strapped to the wall of a trailer. Next to the doors are stacked crates, and at the end of the doors is a decking beam that is supporting other long freight.

After transport (shown right), the doors have been damaged because stretch film does not protect critical surfaces and fragile products from damage caused by normal LTL rigors.



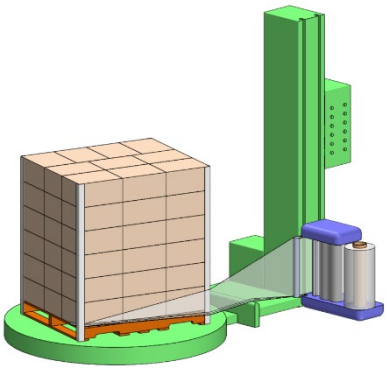
- The top and bottom glass is broken in the first door.
- There is significant abrasion to the face of the first door, and sides of all the doors, from rubbing against the adjacent freight, the decking beam, and the strap/strap ratchet.

ABF Freight recommends applying stretch film with a stretch wrapping machine.

- It is difficult to achieve proper wrapping patterns and film tensions if applying stretch film by hand.
- Proper stretch film application by hand requires the user to pull the film taut (or even slightly stretch the film) before it is applied to face of the load; this is difficult to do consistently and repeatably.

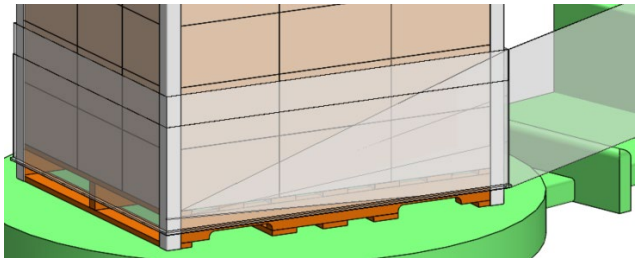
The majority of stretch films have a recommended pre-stretch of at least 200%. Generally, the film should be stretched to at least 80% of a film's recommended stretch to be effective in stabilizing the load. Contact the film supplier for recommended stretch percentages for that particular film..

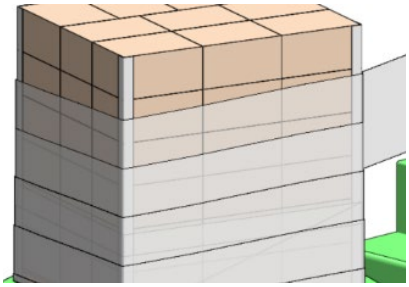
The wrap pattern shown below is considered best practice by the stretch film industry for a load that is 48 x 40 x 50 inches and weighs about 1,000 pounds. Proper stretch film application by machine depends on machine settings, film used and the packaged product being wrapped. Consult the stretch wrapping machine and the stretch film supplier for optimum settings.



- Attach stretch film to pallet.

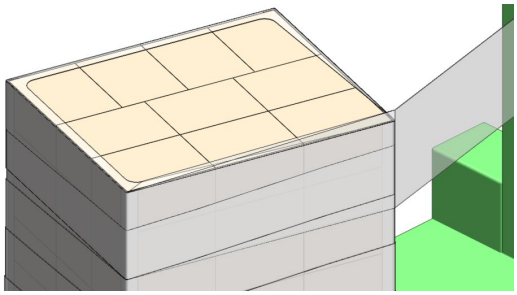
- Wrap around the pallet two times.
  - Two inches of film should cover the pallet.
- Using a roping method for one of the wraps is recommended.
  - More on stretch roping below.





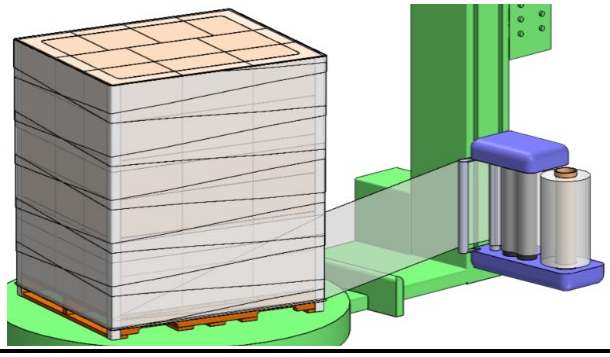
- Moving upward, overlap the previous layer of film by 40-60% of the film width.

- Wrap around the top 3 times.
  - Two to six inches of film should go over the top of the load.

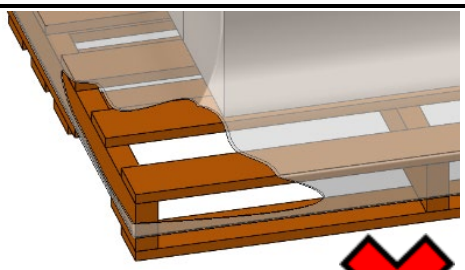


- Spiral back down the load, again overlapping the previous applied layer of film by 40-60% of the film width.

- At the bottom, wrap around the bottom layer & pallet two times.
  - Two inches of film should cover the pallet.

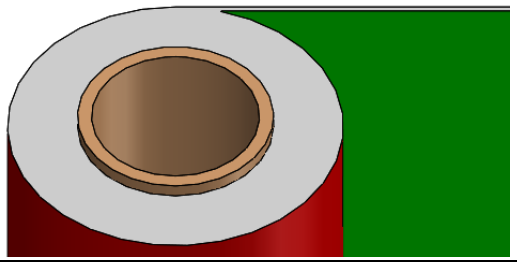


Large amounts of underhang can cause the pallet to tear the stretch film.



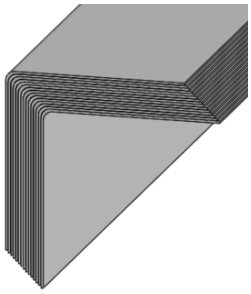
This increases the chance of the load shifting off the pallet during transport.

The cling side of the film should be in contact with the load. Most often the cling side of the film is on the inside face of the film roll.



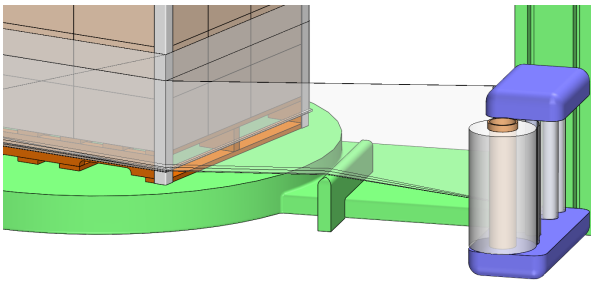
Corners of corrugated boxes can collapse due to high tension between the box and stretch wrapper. This significantly reduces the compression strength of the box.

ABF Freight recommends using corner boards to protect corners from collapse.

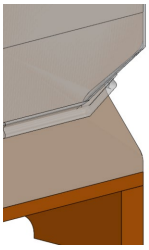


Stretch roping is the recommended practice of bunching the edges of film together to form a highly-concentrated band of stretch film. This process is used to:

- The stretch rope acts an anchor point to prevent the film from slipping upward off the pallet.
- Reduce probability of film tearing from film edge inconsistencies.

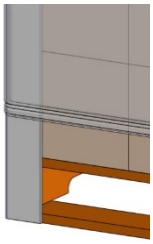


Stretch roping generally bunches the bottom three to six inches of film width into a rope before it is applied to the load.



CAUTION: Using stretch roping can focus significant compression force on a single point.

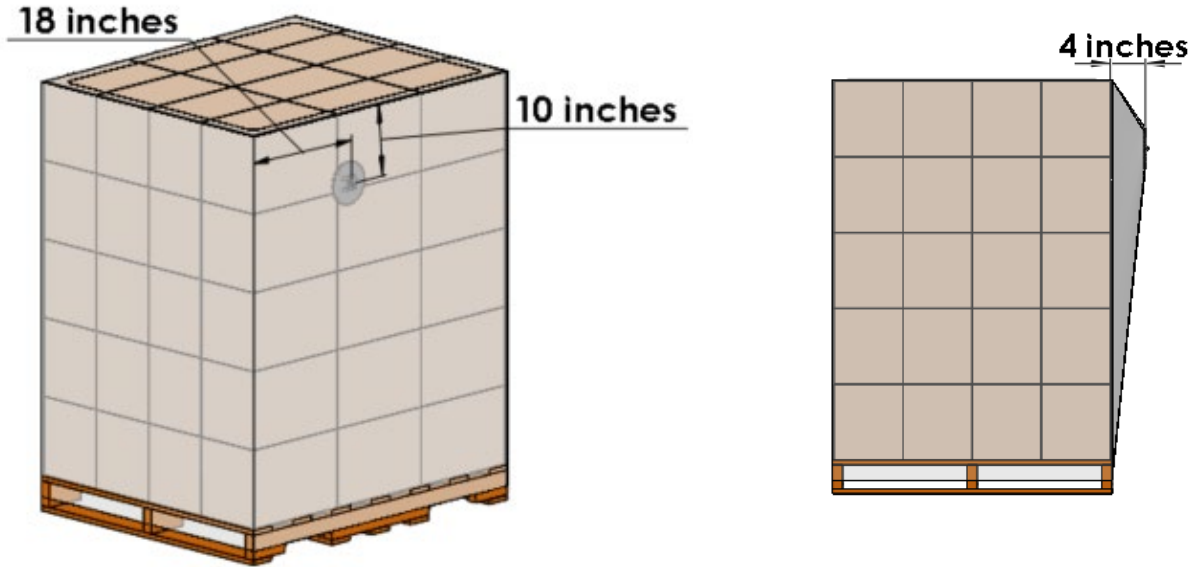
High forces can lead to damaged product.



Corners of load are protected from the high forces of roping by a corner board.

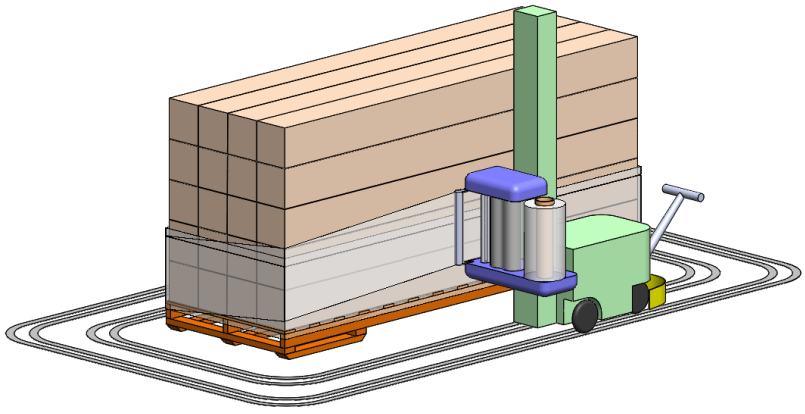
The containment force that a stretch film exerts on a unit load is the generally accepted quality control measure for applied stretch films. This measurement is outlined in ASTM D-4649 Standard Guide for Selection and Use of Stretch Wrap Films, Section A1.10 – Pull Plate Method.

- Containment force is measured using a 6 inch diameter plate.
- The plate is placed behind the film on the long side of the load at 18 inches over and 10 inches down from an upper corner.
- Record the force (in pounds) that is required to pull the plate out 4 inches.



Highlight Industries offers an ASTM evaluation kit and a smartphone app, which can help guide a user toward applying correct containment force values. [Highlight Industries - Stretch Film Testing Equipment]

Lantech offers a non-standard containment force evaluation tool; the CFT-6. More information can be found on their website [https://www.lantech.com/stretch-wrapping/containment force tool]



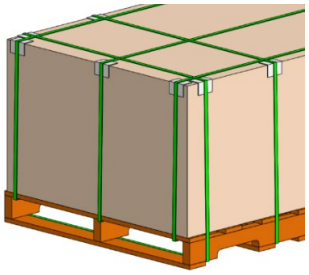
Robotic stretch wrappers are generally recommended for loads that will not fit onto traditional stretch wrappers.

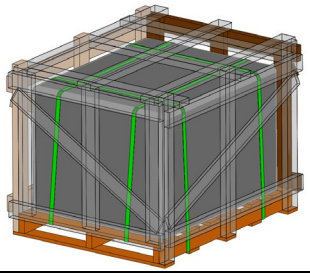
OR

If within a facility, floor space is limited or there are multiple locations within a facility that require stretch wrapping.

X. Strapping Freight to Pallets

Strapping (banding) is used to stabilize containers on a pallet or to stabilize items within a crate.





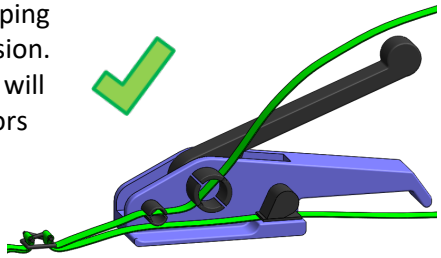
CAUTION: If the load changes size due to load shift or compression of packaging materials, strapping can become ineffective as a load stabilizer.

✗ Polypropylene (PP) Strapping is known to stretch or loosen in the LTL environment.

✓ Steel Strapping

✓ Polyester (PET) Strapping (solid, woven or composite)

Use a strapping tensioner or strapping machine to apply appropriate tension. This will help ensure that the load will be able to manage the normal rigors of the LTL environment.



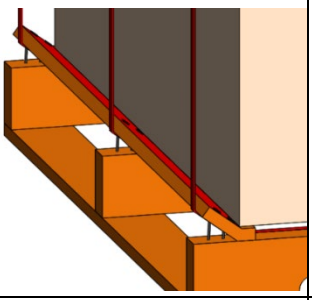
Common Strapping Materials – Property Comparisons of Assembled Half-Inch Strapping*

	Steel (Double Seal)	**Steel** (Single Seal)	**Polyester** (Composite) (Galvanized Buckle)	**Polyester** (Woven) (Phosphate Buckle)	**Polyester** (Solid) (Welded)	**Polyester** (Solid) (Seal)	**Polypropylene** (Welded)	**Polypropylene** (Buckle)
Image								
Strength	*****	***	****	****	***	**	*	*
Tension Retainment	*****	****	*****	*****	*****	****	**	*
Resistance to Elongation	*****	*****	****	****	****	****	**	**
Elongation Recovery	*	*	***	***	***	***	****	****
Shock Absorption	*	*	****	*****	****	****	***	***
Will Not Damage Surface Finish	*	*	****	****	*****	***	*****	****

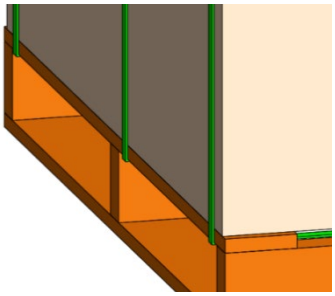
* Exact strapping performance may vary depending on seal/buckle integrity and material specification.
NOTE: Strap color of polypropylene, woven and composite polyester, can vary.

CAUTION: High strapping tensions on pallets with a large amount of underhang can cause fasteners to fail and the deck board to pullup, or even break.

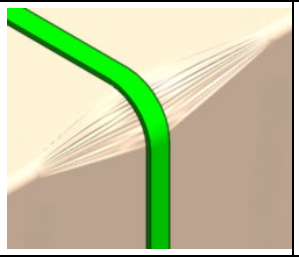
The failure will cause the strapping to become loose and ineffective as a load stabilizer.



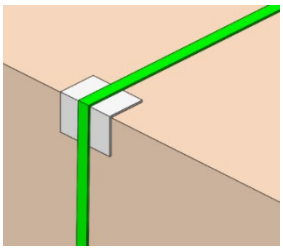
End boards are covered by packaging.

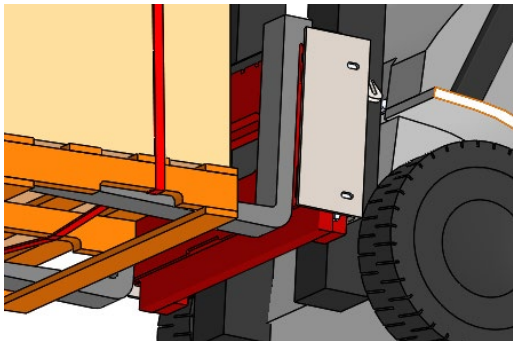


Strapping can damage corrugated fiberboard if corner protectors are not used.



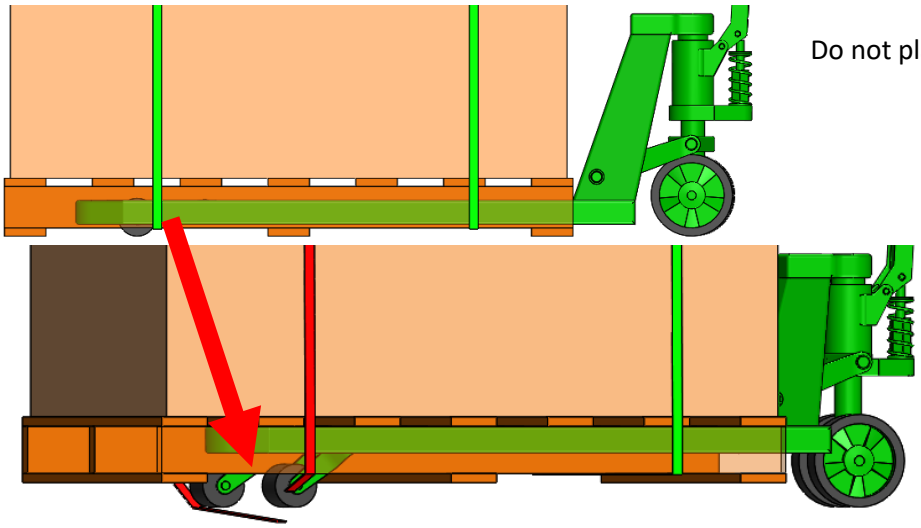
Use strap protectors between strapping and corrugated fiberboard packaging to reduce point-loading damage.



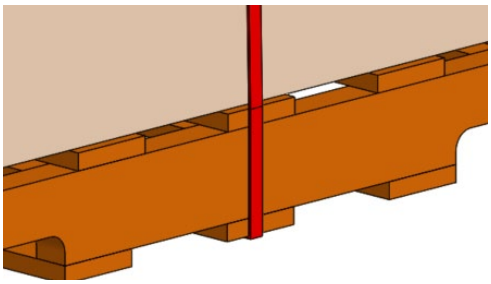


If the strapping is in the notch, the fork tines of a forklift could fit under the strapping.

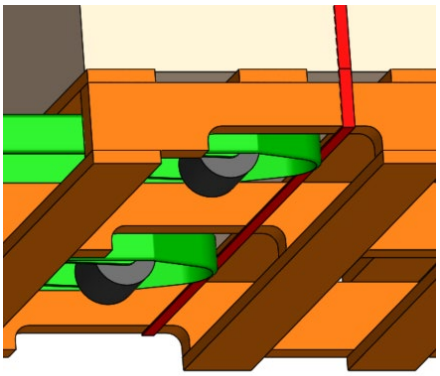
When the fork tines lift the freight, the strapping tension can be increased, which could damage the freight.



Do not place strapping where pallet jack wheels may contact and break it.



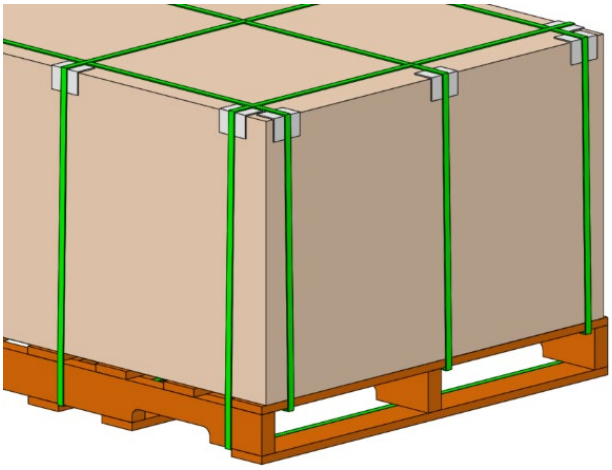
Do not place strapping under the bottom deck. The strapping can be damaged by contact with the dock surface.

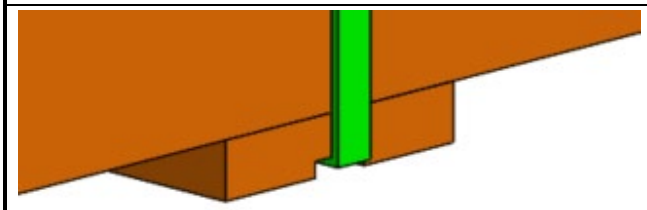


The red strap will prevent the pallet jack from entering the pallet.

CAUTION: When straps are impacted by fork tines the strapping tension is increased. This excess tension can damage the packaging or the freight and cause failure of the packaging system.

Utilize strapping in both the length and width directions; placed under stringers and under the deck boards. For loads longer than 48 inches, additional straps are required





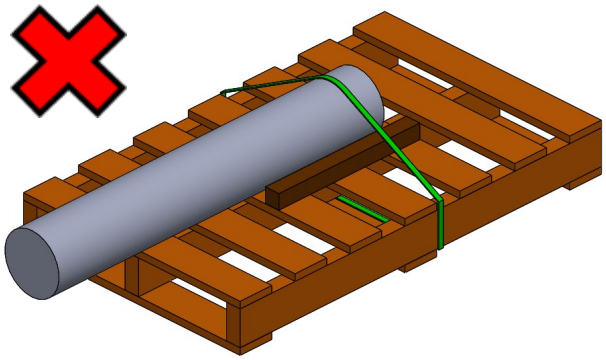
Recess the strapping into a dado cut the deck board to prevent the strapping from contacting the floor.

- See ASTM D-4675-14a Standard Guide for Selection and Use of Flat Strapping Materials for additional information.
- Proper strapping application depends on the type of strapping used, strapping securement method, method of tensioning and product to be strapped. Consult your strapping supplier for optimum application.

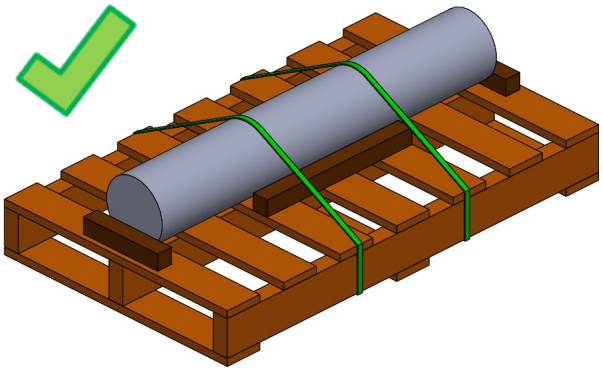
XI. Chocking of Freight

Freight can move in all directions during transport. Chock freight in a way that prevents movement in both the length and width directions.

Note: Chocking is used in conjunction with a load stabilizer that prevents vertical movement, such as strapping.



Freight can still move along the length of the pallet.



Freight is chocked to prevent movement along the length and width of the pallet.

Strapping for Freight Stabilization

See Strapping of Freight to Pallets, Section X (page 21) for guidelines on strapping application.

XII. Wood Quality, Fasteners and Fastener Application

A. Wood Species Selection and & Lumber Quality

More information in Wood species and Lumber quality is available here: USDA: Forest Products Laboratory: Wood Handbook – Wood as an Engineered Material: [USDA - Wood handbook]

Softwood		Hardwood	
Recommended	**Not Recommended**	**Recommended**	**Not Recommended**
Douglas Fir Hem-Fir Spruce Pine Fir (SPF) Southern Yellow Pine (SYP)	Cedar Recycled Wood	Ash Cherry Maple Oak Walnut	Aspen Basswood Cottonwood Poplar Recycled Wood

Softwood

1) Use #3 Standard (or better) grade lumber.

2) Do not use lumber that is less than or equal to #4 Utility (A.K.A. Economy) grade.
   a. The defect rate is too high to insure structural integrity of the pallet, crate or packaging system.

3) Moisture content should be less than 20% to prevent mold growth

Hardwood

1) Use #3A Common (or better) grade lumber.

2) **Do not use** lumber that is less than or equal to #3B Common grade.
   a. The defect rate is too high to insure structural integrity of the pallet, crate or packaging system.
   b. Knots weaken lumber so significantly knotty wood should be avoided. NMFC Item 245 specifically forbids using lumber with knots that exceed 1/3 the wood's width.

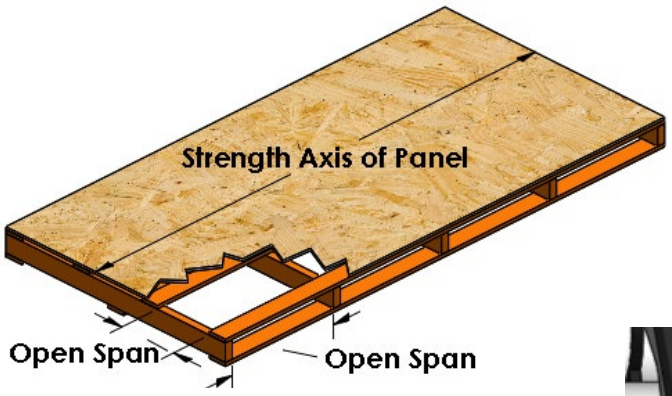
3) To prevent mold growth moisture content should be less than 20%.

B. Export of Lumber and Wood Based Packaging Materials

The International Plant Protection Convention (IPPC) publishes the International Standards for Phytosanitary Measures (ISPM). ISPM-15 addresses the Regulation of Wood Packaging Material in International Trade. For more information, please click the following link. https://ispm15.com/

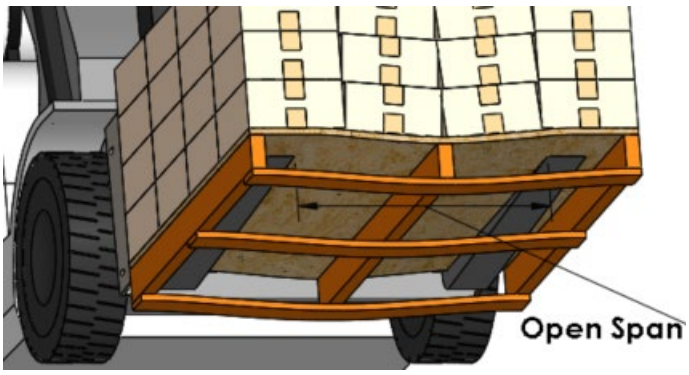
C. Plywood & OSB

- Caution: Improperly applied Oriented Strand Board (OSB) or Plywood can lead to product damage.
- Use APA certified Structural 1 Rated Sheeting for maximum cross-panel strength.
- Use Exterior or Exposure 1 graded material for protection against moisture.
- For more information visit the APA website: www.apawood.org



OSB and Plywood are often used as solid wood substutes. All plywood and OSB must be applied with the appropriate span rating, open span and fasteners for the desired loading weight.

For more information on span ratings, open span distances, fasteners, and loading weights, follow the infomration found in the APA – The Engineered Wood Assiocation's E30 guideline.

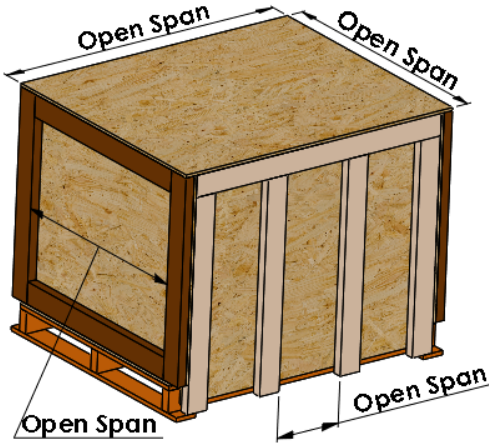


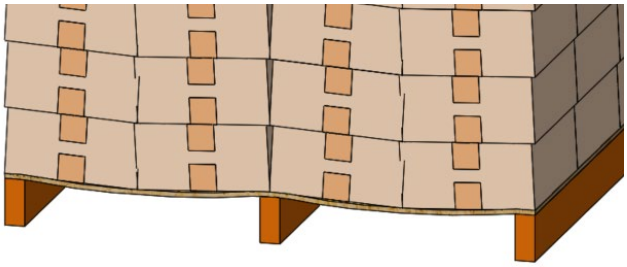
Some of the more common open spans that are found in the LTL enviroment are shown.

The strength axis of the panel is the long dimensions of the panel unless marking on the panel indicate otherise. The strength axis must be perpendictular to the supports.

Fastener type and application patterns are specified by the APA. Ensure to follow their guidelines when utilizing OSB or plywood.

Generally, fasteners should be used at least every 6 inches along every plywood or OSB edge.





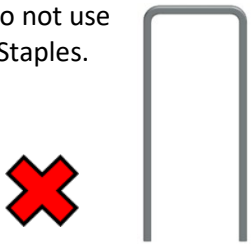
Improperly applied OSB or plywood may bend or fail in the LTL enviroment.

D. Fasteners & Securing Freight

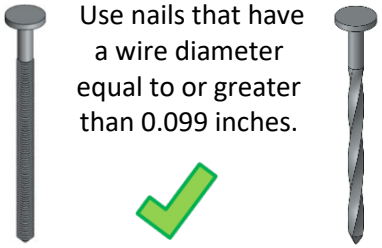
1. Nails, Staples & Screws

Do not use plain shank nails.

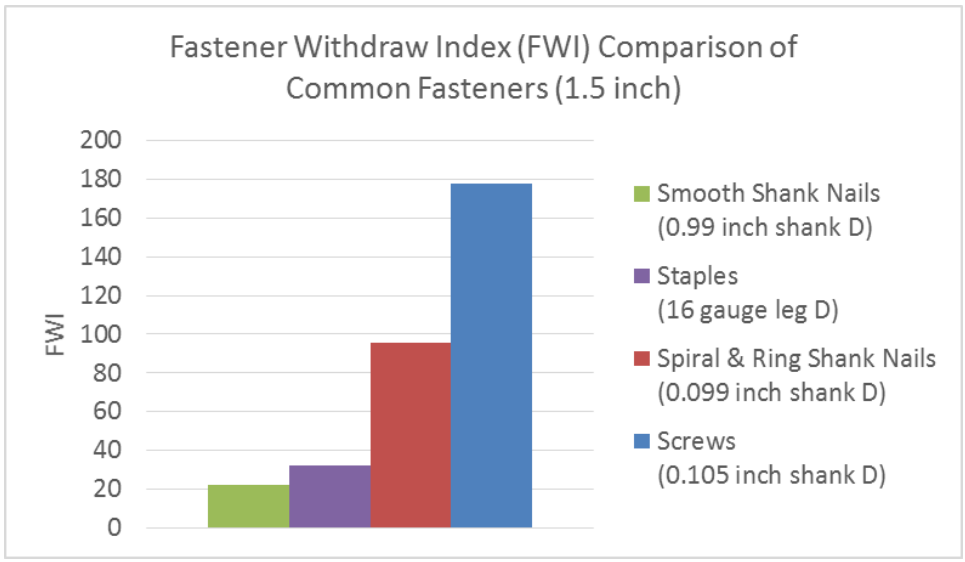
Do not use Staples.



Use nails that have a wire diameter equal to or greater than 0.099 inches.

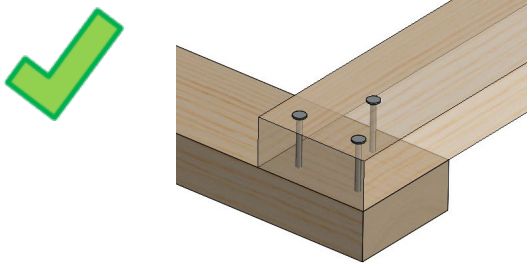


Use screws that have a wire diameter that is equal to or greater than 0.105 inches.

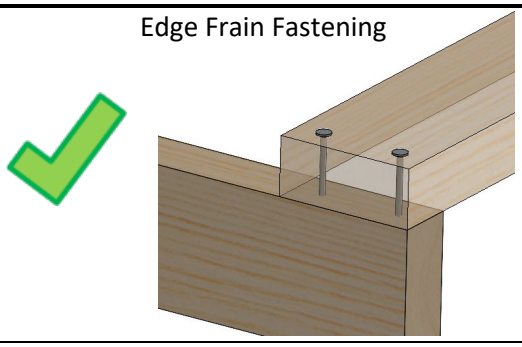


Nail shank coatings (Cement or Thermoplastic Polymer) are recommended to increase withdraw resistance <u>for all fastener types</u>.

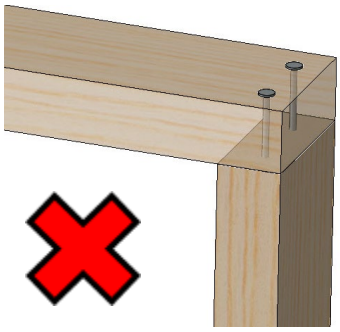
Side Grain Fastening



Edge Frain Fastening



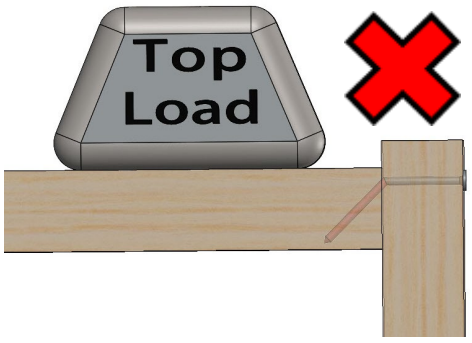
End Grain Fastening

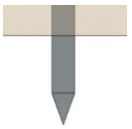


End grain fastening has little holding capability.

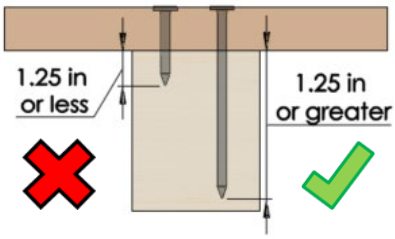
Sheer Loading of Fasteners

Fasteners are not designed to be loaded with sheer forces. Fasteners may bend and wood may fail.



Fastener head is flush with surface. 	Fastener head is protruding from surface.  Freight and safety hazard.	Fastener head is significantly below surface.  Reduction in holding power.	Protruding fastener tip.  Freight and safety hazard.

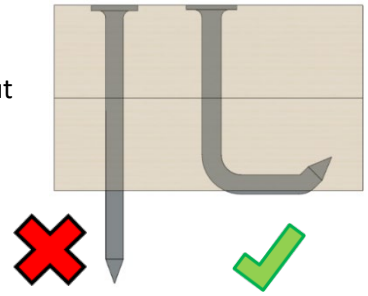
Fastener penetration should go through primary board and at least 1.25” into secondary board.



If secondary board is less than 1.25 inches, see clinching (to the right →).

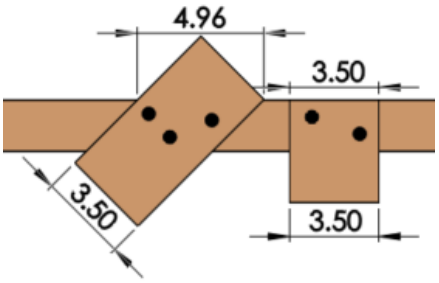
If the secondary board is less than 1.25 inches, the nail should be clinched. Clinching nails significantly increases the holding power of the nail.

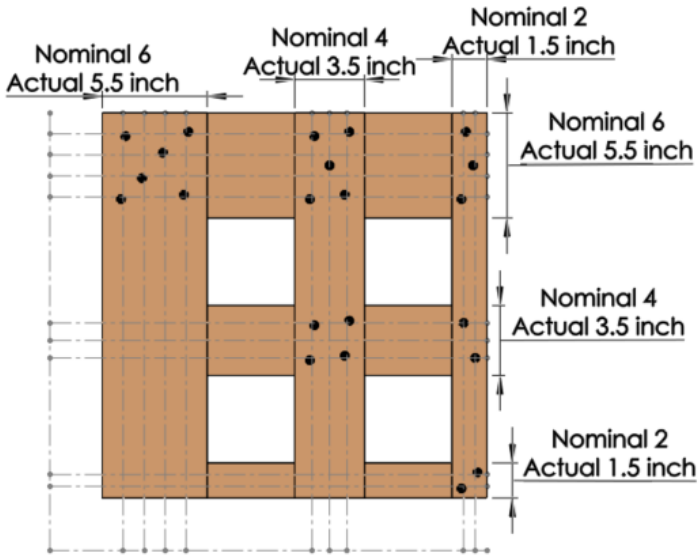
Do not leave nail tips exposed. They may put freight and human safety in danger.



NOTE: The nail tip of the clinched nail is buried in the board.

More fasteners may be required when securing components on an angle.

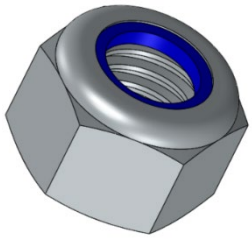
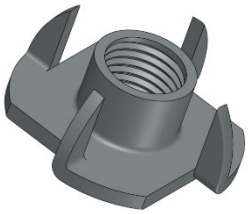




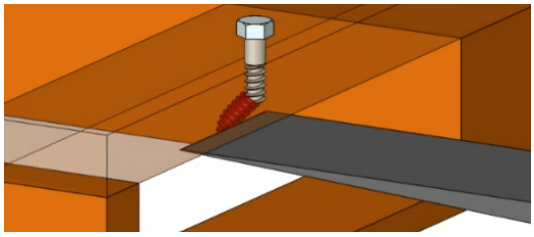
The number of fasteners and suggested nailing pattern per width of components is shown to the left.

Ensure fasteners are staggered in all directions and equally spaced to prevent splitting and joint rotation.

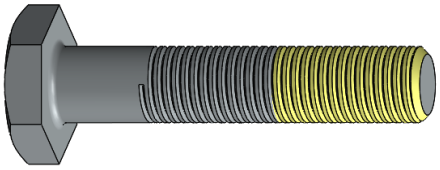
2. Lag & Machine Bolts

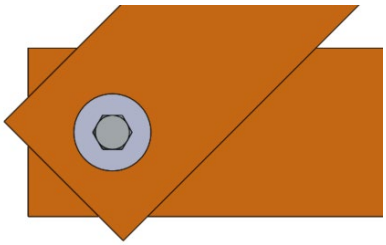
Lag Bolt	Machine Bolt	Carriage Bolt	Lock Nut	T-Nut
				

Keep fork tine entry area clear. Fork tines may impact fasteners which may cause failure.



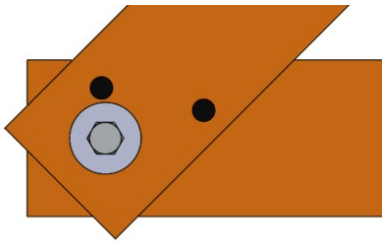
Apply thread locking liquid to help prevent nuts from loosening during transit.

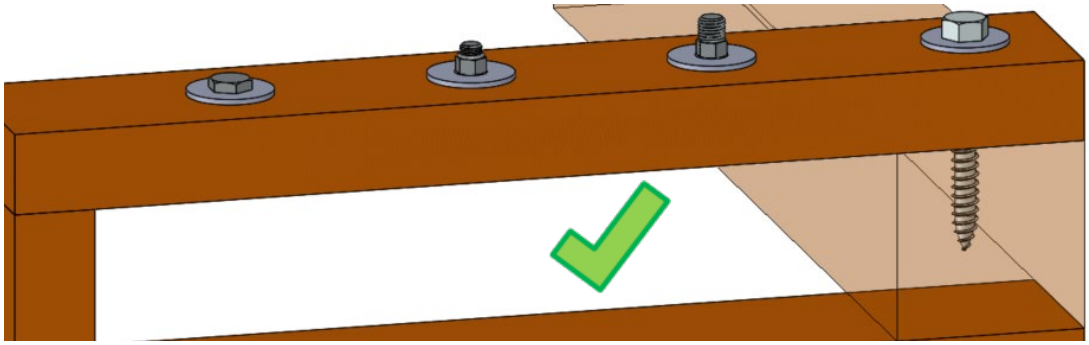




Single fastener allows joint to rotate.

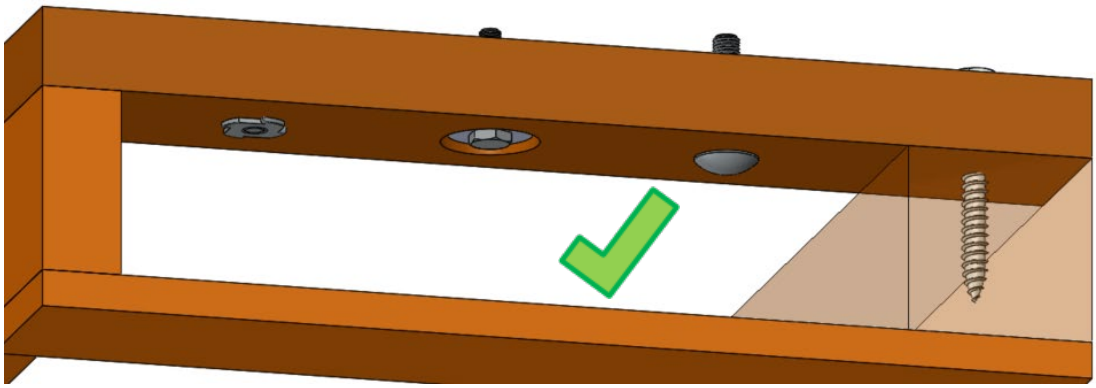
Additional fasteners prevent joint rotation.





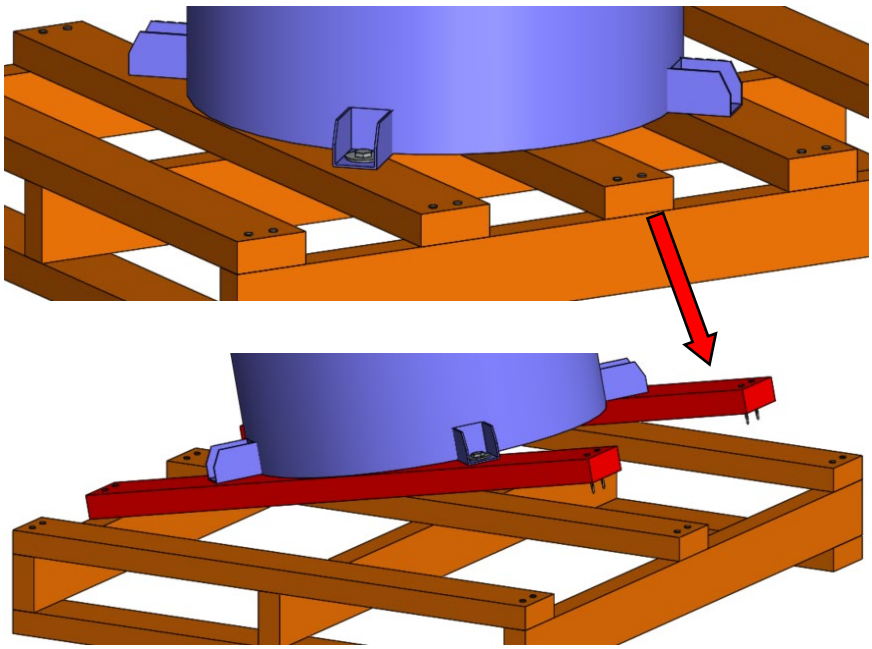
Fork tine entry area is clear of fasteners.

Lag bolt is through the decking and into the stringer.

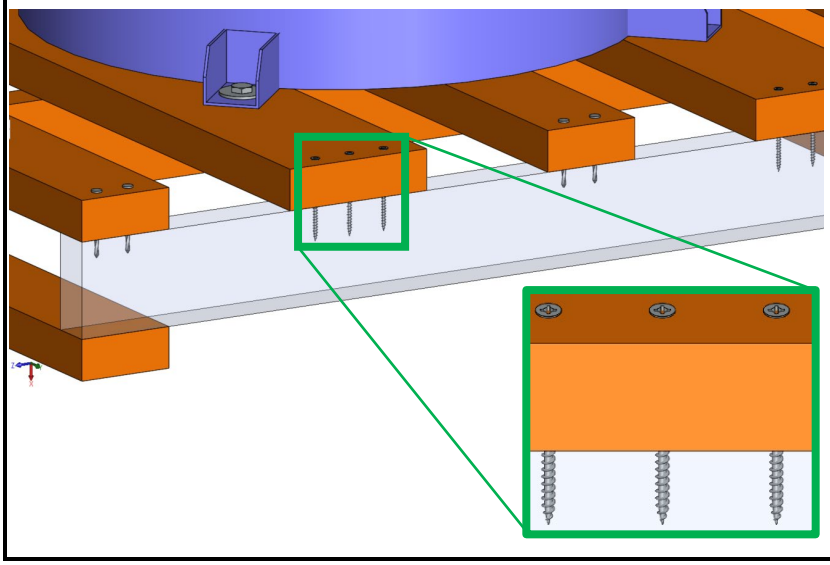


Bolt head is recessed to prevent tine impact.

Washers are used to prevent fasteners from recessing into wood.



Sometimes pallet deck fasteners can fail even when proper fasteners are used to secure freight to top deck boards. This is especially true when large/tall freight is secured only to the deckboards (as shown at left). Normal LTL rigors can cause the deck board fasteners to pull out of the stringer.



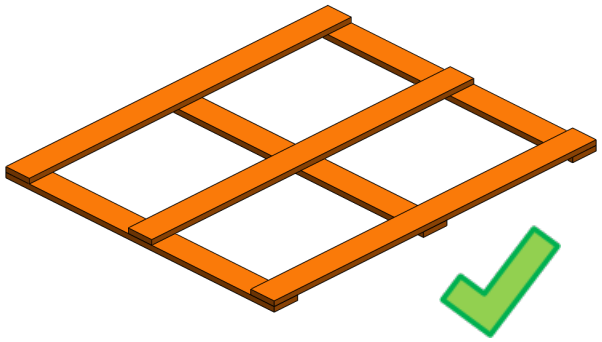
Use wider lumber that allows for more fasteners.

Use screws instead of nails to secure these critical deck boards.

Use longer screws to fasten the pallet decking to the stringer.

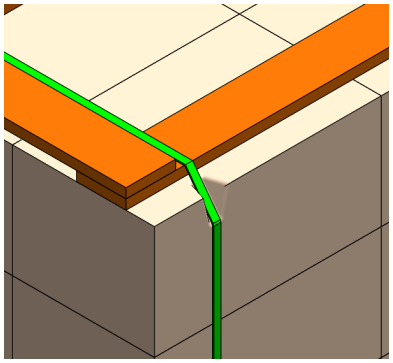
XIII. Top Frames

For recommended wood types, fasteners and fastening patterns, see Pallets in section XI.



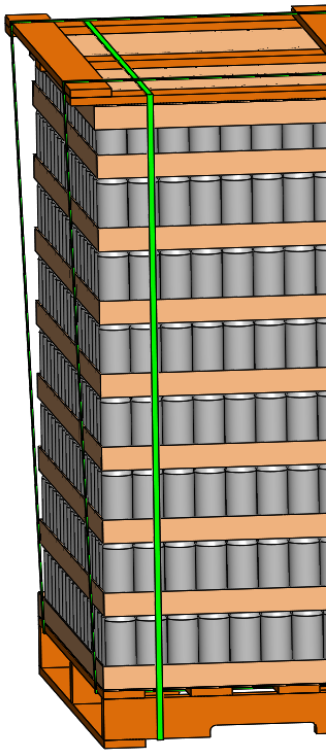
Top frames are typically wooden structures that consist of 2 layers of boards fastened on their face.

The number of boards and thickness of the boards can vary depending on the application.

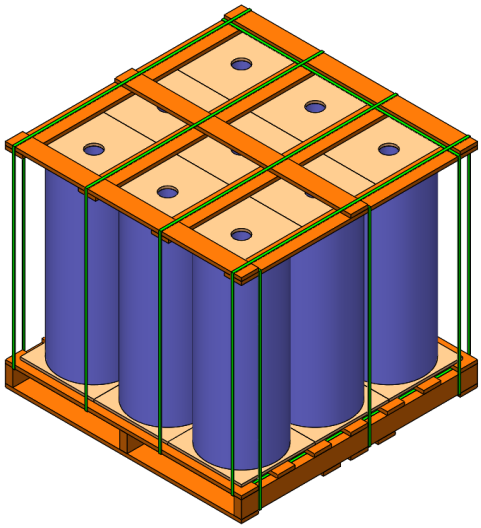


Top frames that are too small may cause the strapping to cut into the load.

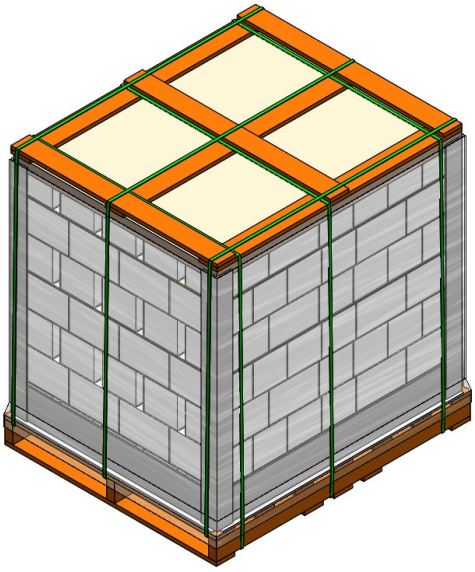
Top frames that are longer or wider than the base of the load are more likely to be damaged from the normal rigors of the LTL environment, or cause damage to adjacent freight."



Stabilize unstable loads.



Evenly distribute strapping forces

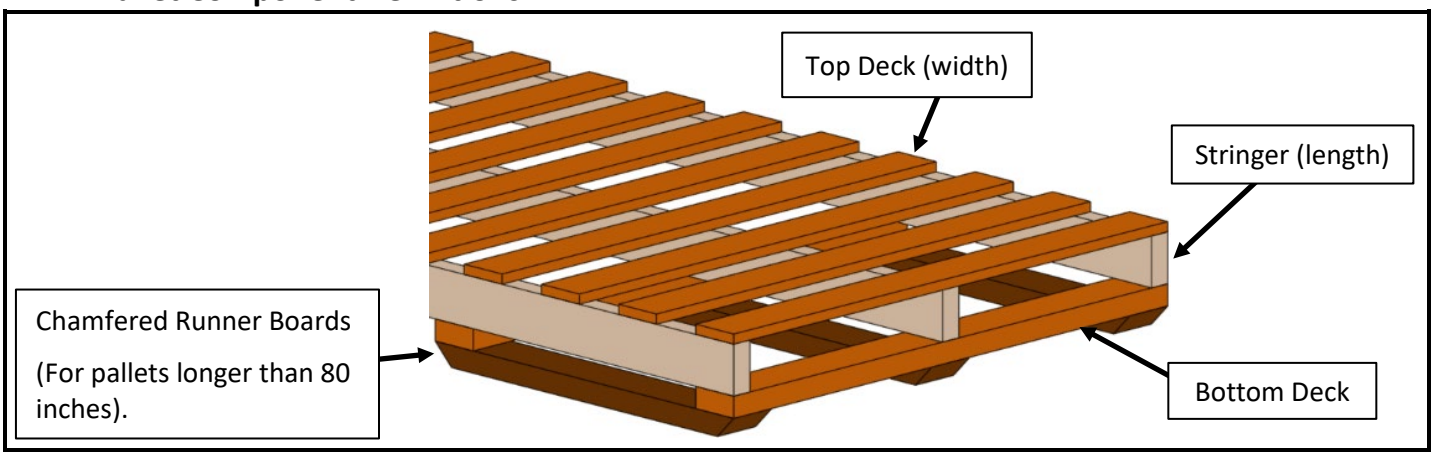


XIV. Pallet Introduction & Additional References (Crate Base)

A pallet is a flat platform that allows goods to be stacked upon and then easily moved by material handling equipment. This utilization allows for increased efficiency of transport of goods in the LTL environment. Proper design and construction are critical for ensuring that your product is not damaged from the normal rigors of the LTL environment. More information on pallet design is available in the following documents:

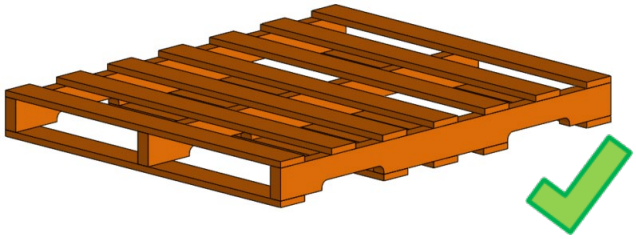
1) NMFC Item 265 Definition of, or Specifications for Lift Truck Skids, Pallets or Platforms
2) NWPCA: Uniform Standard for Wood Pallets
3) MH1: Pallet, Slip Sheets, & Other Bases for Unit Loads

Pallet Component Definitions

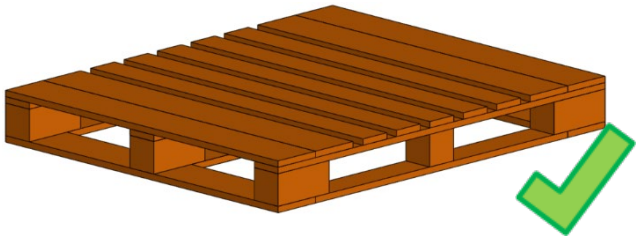


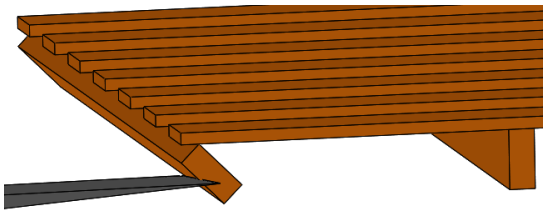
A. Pallet Construction

Stringer Pallet



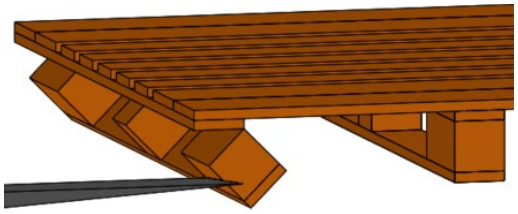
Block Pallet



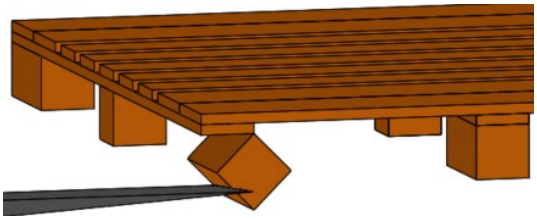


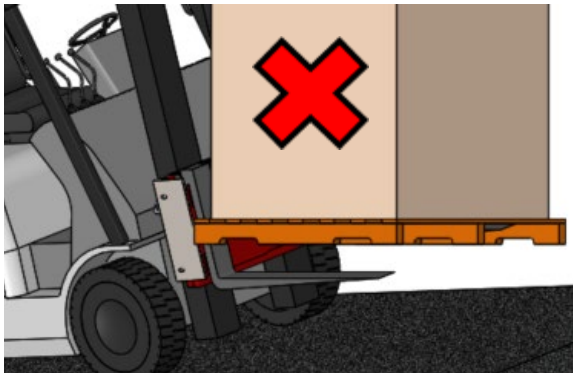
All pallets should have a bottom deck. Bottom deck boards help prevent lateral collapse of the pallet, caused by fork tine pressure (fork tine pressure on the corner of a pallet is often used to turn pallets before loading into a trailer).

Stringers can collapse without bottom deck reinforcement.



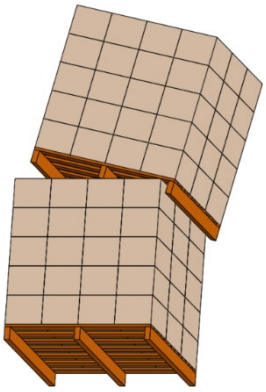
Blocks are likely to fail without bottom deck support in both directions.



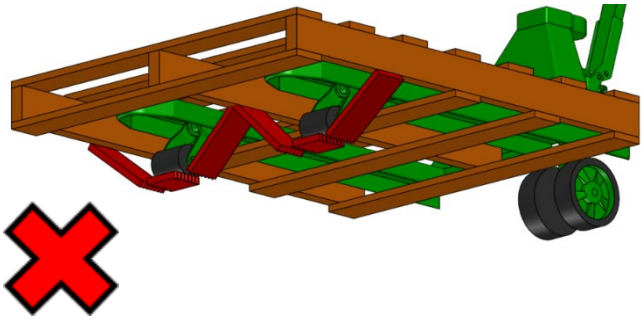


A bottom deck helps to prevent items from tipping off the tines when handled.

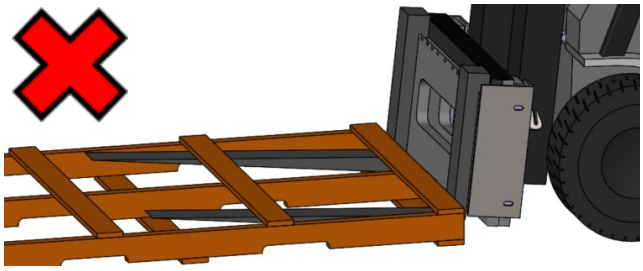
A bottom deck helps to prevent tipping when double stacking unit loads.

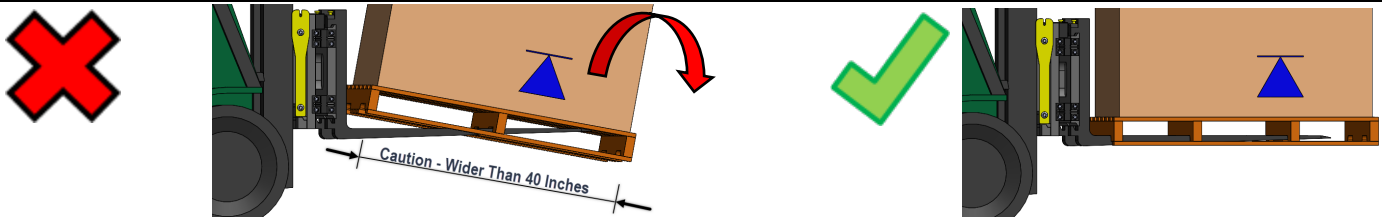


Improperly placed bottom deck boards are in danger of being broken by pallet jack wheels.



Large spacing between deck boards may allow the fork tines to contact the freight and does not comply with NMFC Item 265.

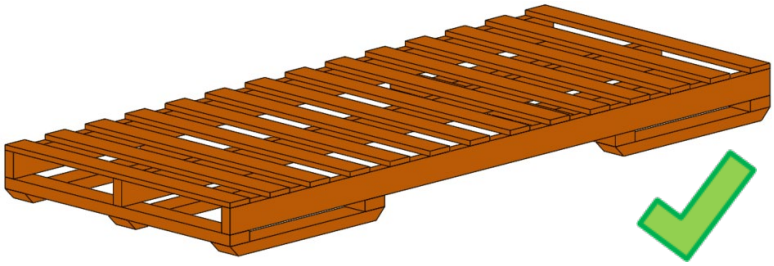




Wide, 3-stringer pallets, may be difficult to move, when accessing the load perpendicular to the stringers (via the notches) if the load CG is not centered on the pallet and the pallet load is more than 40 inches in width. **Click the secure video links below for animated depictions of this issue and solution.**

Wide 3-Stringer Pallet Issue Wide 4-Pallet Solution

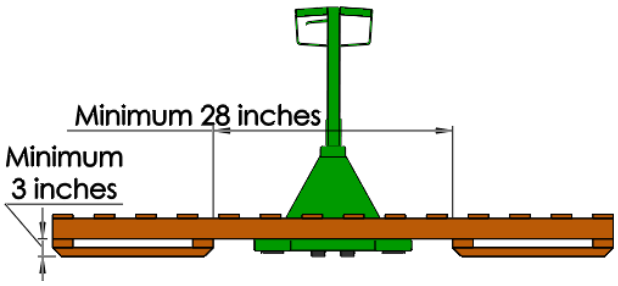
B. Long Pallets – Longer Than 80 inches

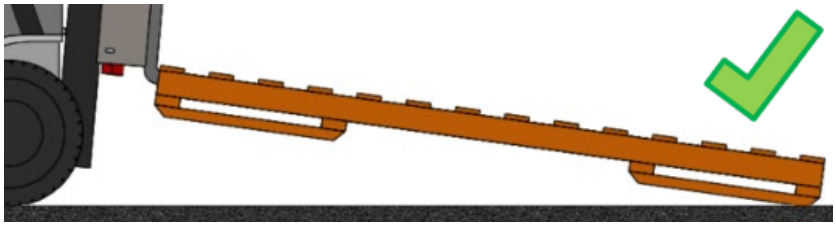


Long pallets (more than 80 inches) should be designed with access on all sides and include chamfered runner boards.

Minimum 3 inches of clearance is necessary for pallet jack access from the side. This is typically achieved with a 1.5 inch thick bottom deck and a 1.5 inch thick chamfered runner board.

The space between chamfered runner boards should be at least 28 inches to allow for pallet jack access.

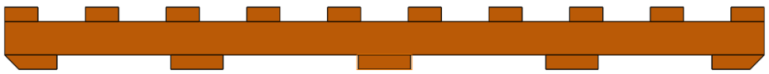




Chamfered runner boards facilitate the safe and damage-free handling of long pallets when the pallet is slid over dock plates and cracks in the floor. **Click the secure video link below for an animated depiction.**

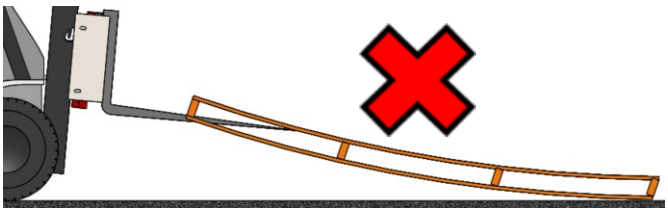
Chamfered Runners on Long Pallets

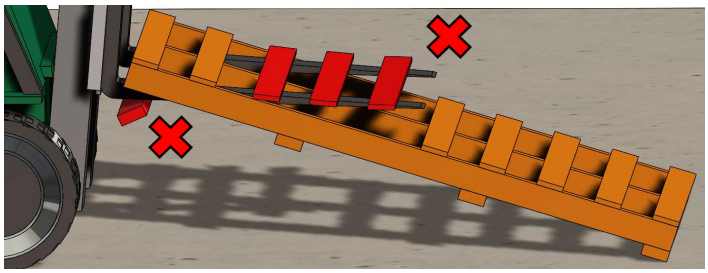
Pallets that are too wide to be handled by pallet jack should have the leading bottom deck boards chamfered to allow the pallet to side over dock plates and cracks in the floor.



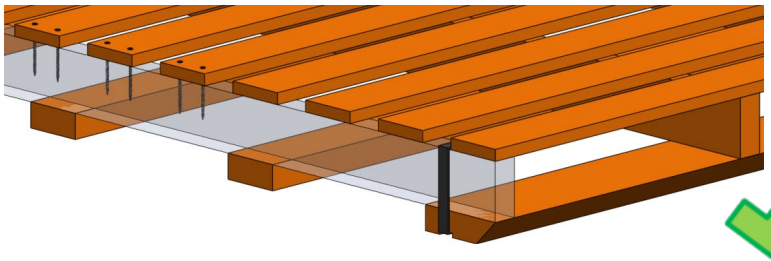
Do not build pallets with decking as the primary structural component.

Lumber on face is not stiff enough to prevent bending when handled by the end.

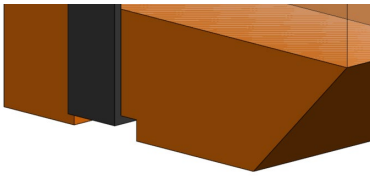




Fork tine heel and tip forces on long pallets can cause the deck boards to fail if they are not properly reinforced (see images and recommendations below).



Reinforce the top deck by utilizing screws.
Reinforce the lead bottom deck with a strap.



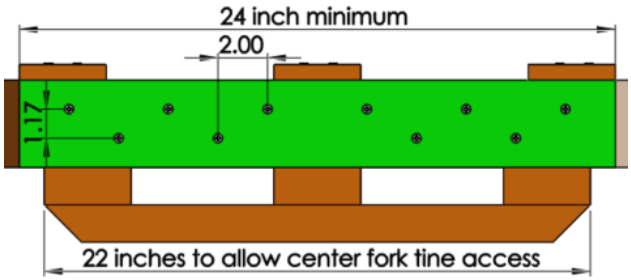
Dado cut in bottom deck prevents strap from contacting the ground.

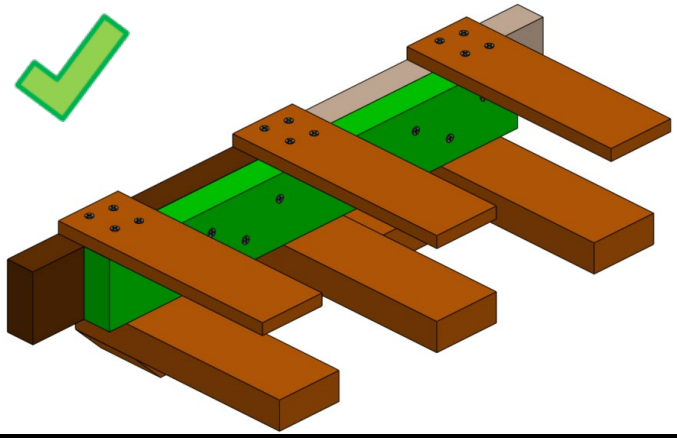
Splicing Long Pallets

Stringer splices are not recommended, but if required they should follow the guidelines in ASTM D6039 - Standard Specification for Open and Covered Wood Crates. There are two types of splices:

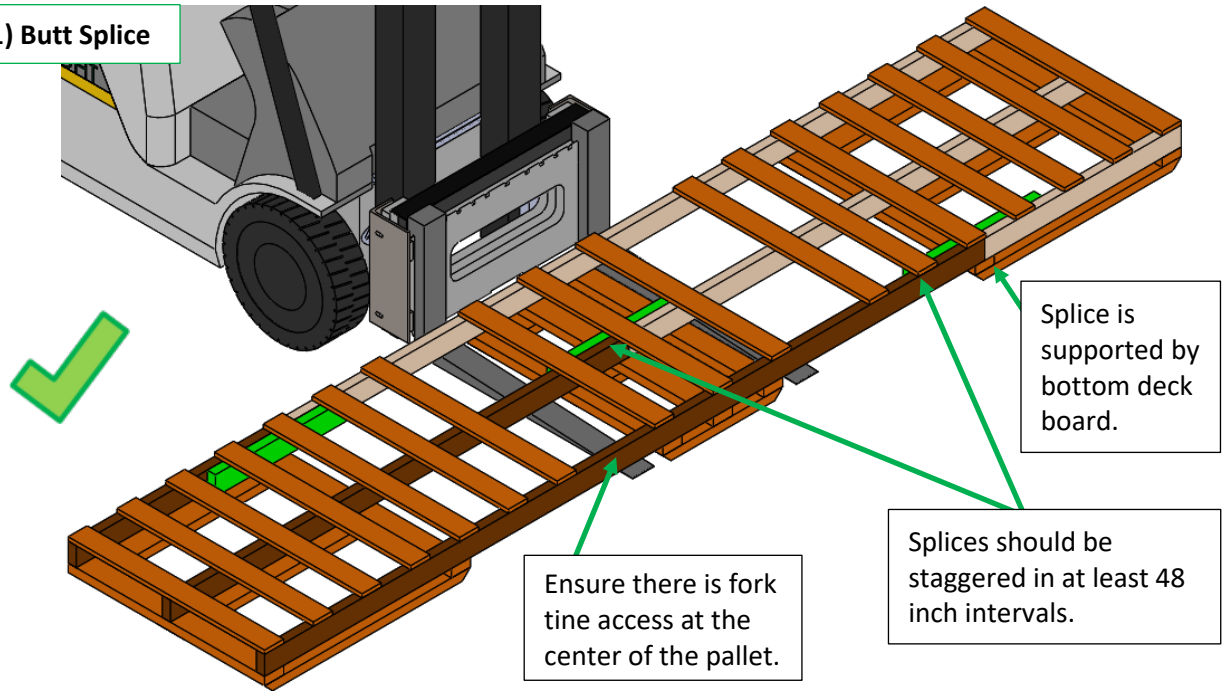
1) Butt Splice
2) Telescoping Overlap Splice

Fasteners are applied through the top deck, bottom deck, and splice and/or overlap.

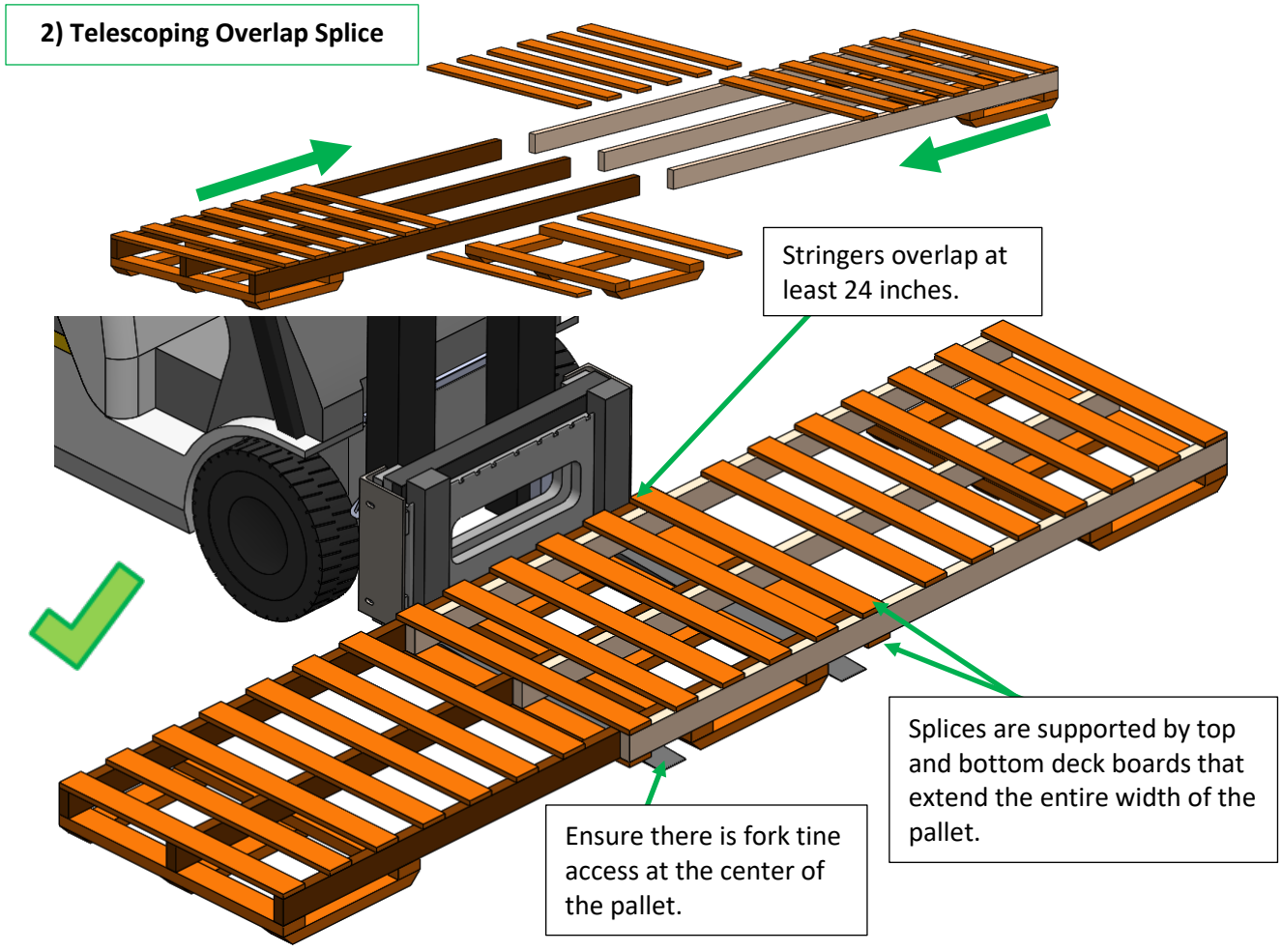




1) Butt Splice



2) Telescoping Overlap Splice

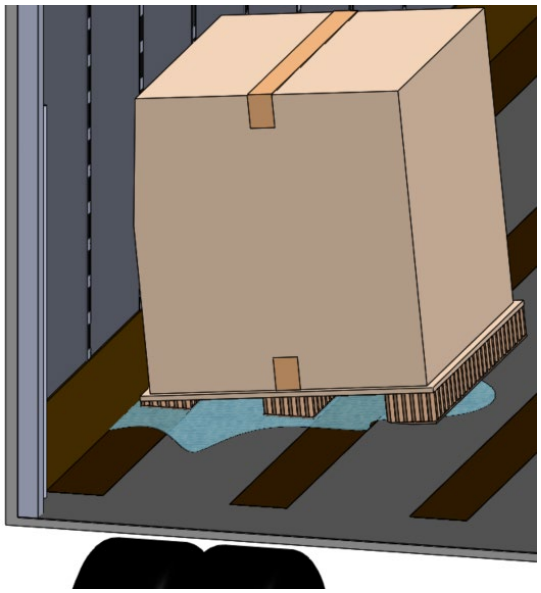


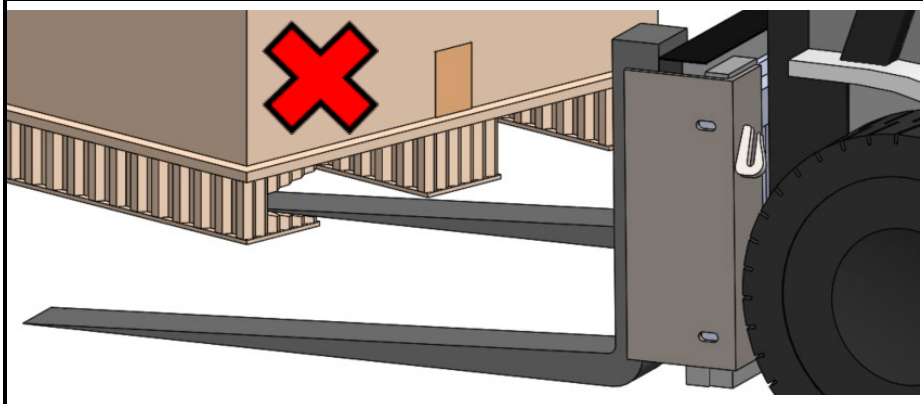
C. Paper Pallets

ABF Freight does not recommend the use of paper-based pallets (paperboard, corrugated, honeycomb paper, etc.) for use in the LTL distribution environment, due to their likelihood of failure.

Humidity – Paper pallets generally lose significant strength when exposed to high humidity conditions. See Section VI, Corrugated Fiberboard Boxes (Page 13) for more information.

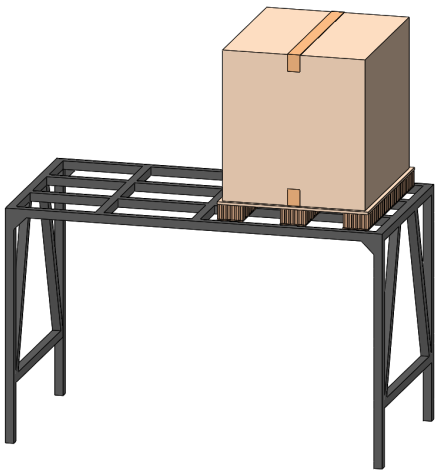
Liquid Water – Paper pallets can be exposed to liquid water through condensation forming on the inside of a trailer and puddling on the floor or through exposure to the natural elements on a dock during transfers. Liquid water reduces the strength of paper based packaging by more than 90%.





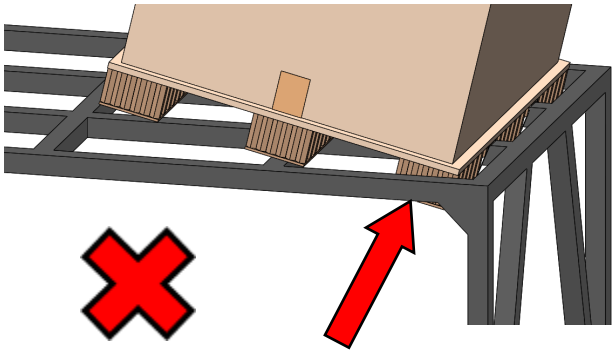
LTL freight is handled with forklifts at origin, during transfers, and at destination.

Forks are often used to manipulate (turn) the freight to achieve the proper orientation for fitting into the trailer. Paper-based pallets are generally not robust enough to withstand these normal LTL handling rigors.



Paper pallets are generally not rigid enough to support the weight of the load when the pallet is placed on decking tables (or load beams) in trailers.

This causes the pallet to sink into the decking table, making it very hard to remove without damaging the freight.



XV. Crate Introduction & Additional References

A crate is an enclosed wooden shipping container that offers a high level of protection. Crates can be fully enclosed or have a skeletal frame, depending on the needs of the freight.

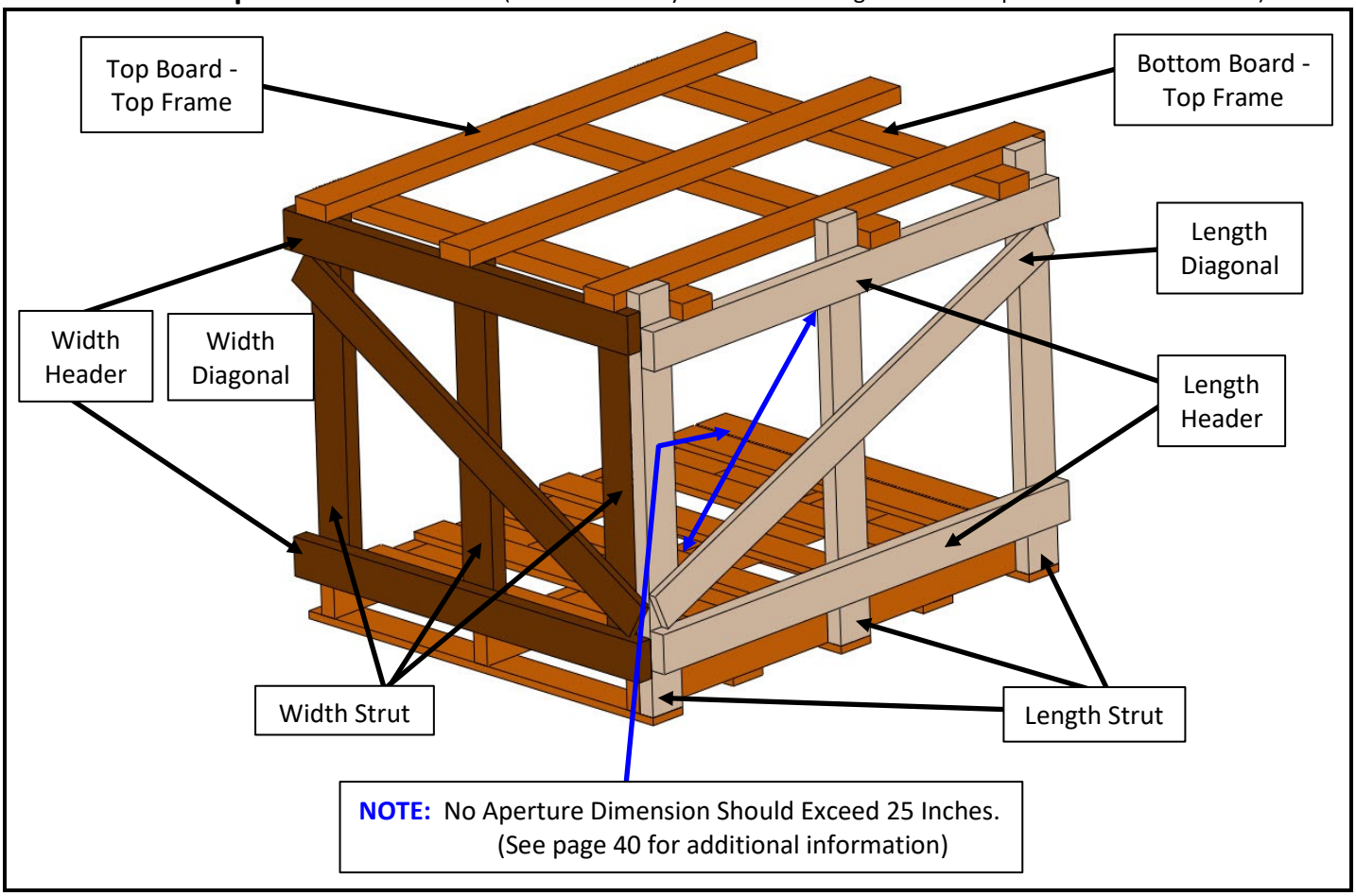
Proper design and construction are critical for ensuring that the crate successfully functions, and the product is not damaged from the normal rigors of the LTL distribution environment.

All objects within a crate must be blocked, braced and properly cushioned to prevent damage during shipment through the LTL distribution environment.

More information on crate design is available in the following documents:

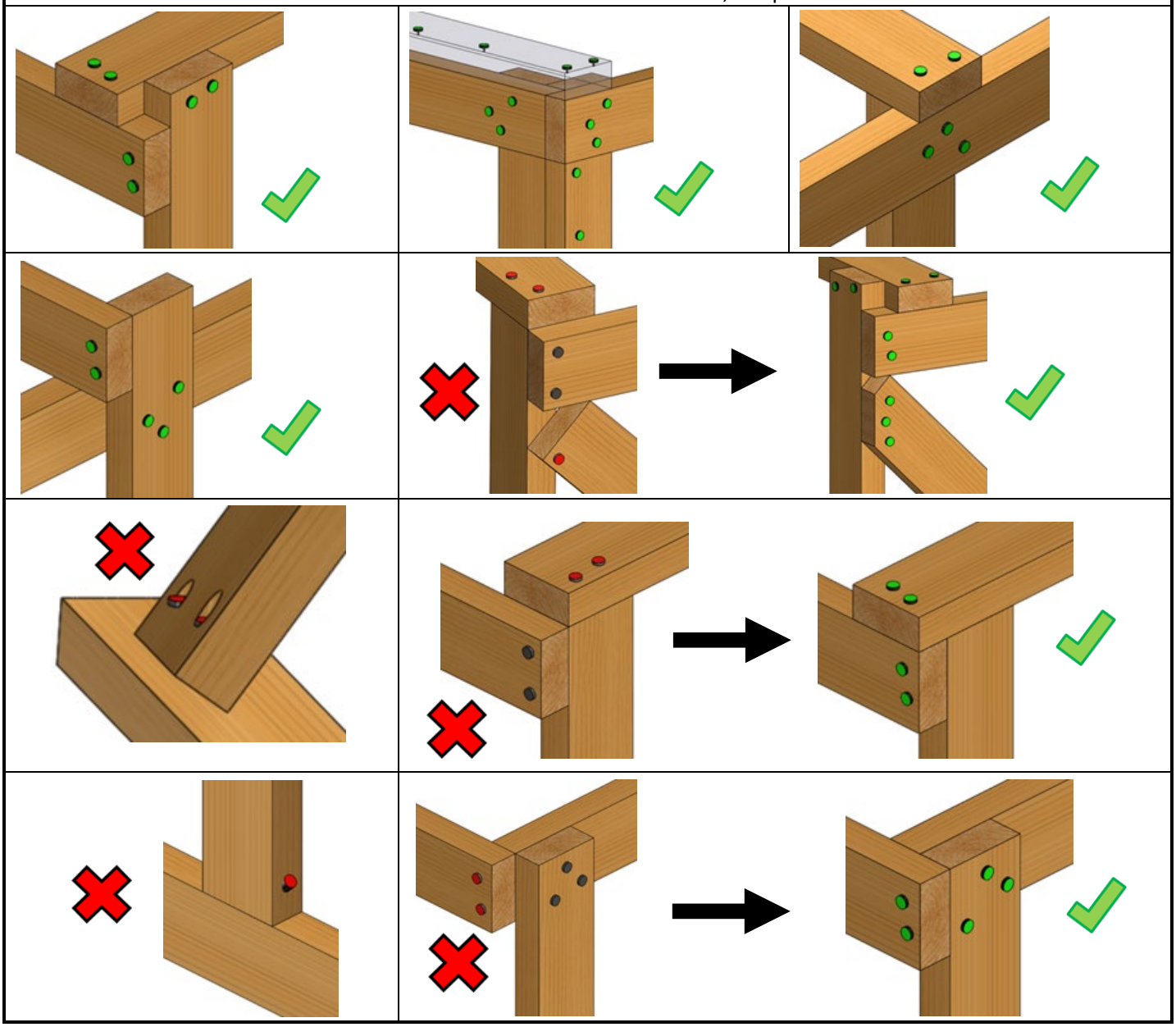
1) NMFC Item 245 Definition of or Specifications for Crates
2) NWPCA: Uniform Standard for Wood Containers
3) ASTM D6039 - Standard Specification for Open and Covered Wood Crates
4) ASTM D7478 - Standard Specification for Heavy Duty Sheathed Wood Crates

Crate Component Definitions (Note: For clarity the backside length and width panels have been hidden)



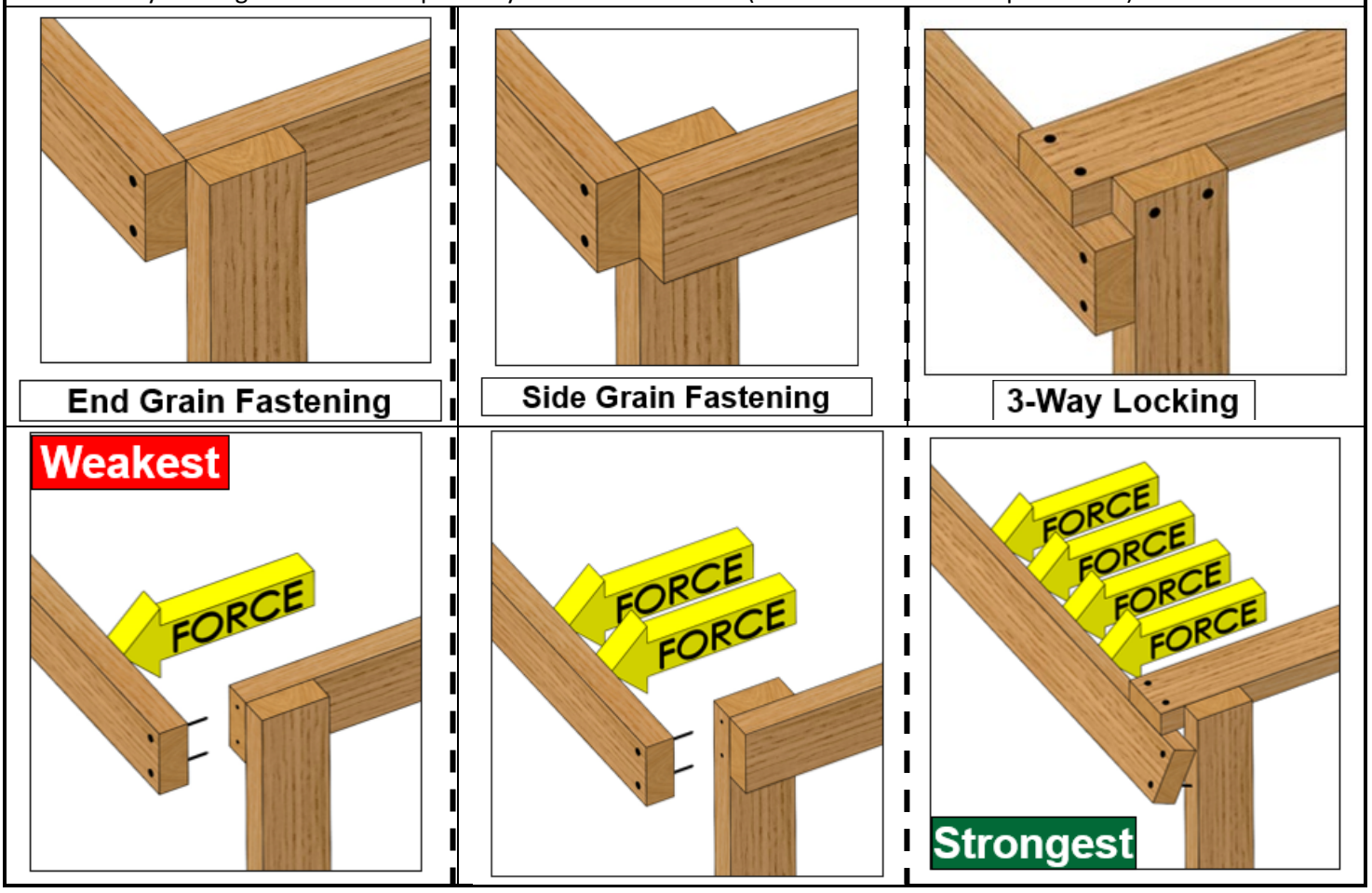
Crate Connection Examples

Below are examples of proper and improper wooden crate connections and their appropriate nailing sequence. For more information on fasteners, see Section XII (page 25) – Wood Quality, Fasteners and Fastener Application. The NMFC definition of a crate can be found in NMFC Item 245: Definition of, or Specification for Crates.



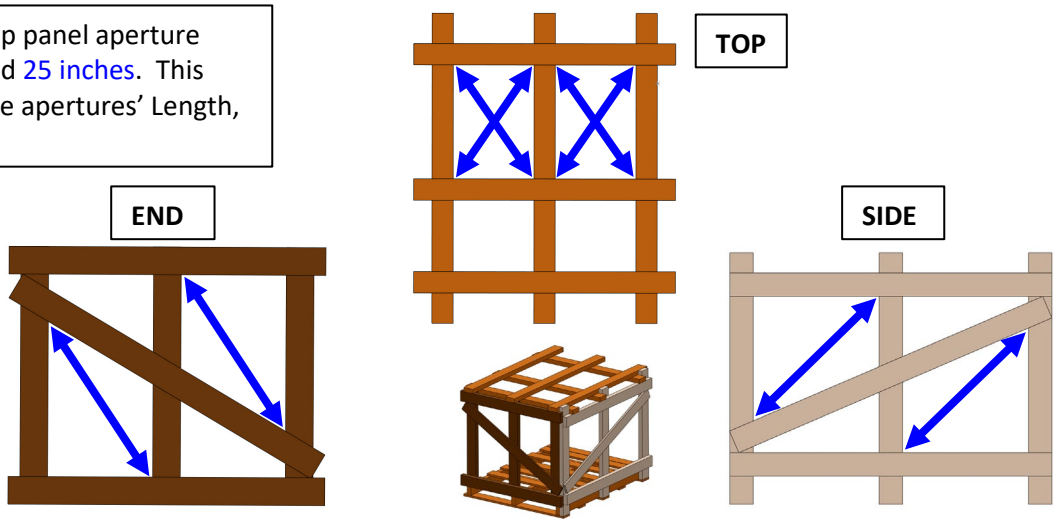
3-Way Locking Corners and Joint Strength Comparisons

Below are examples of corner joints and their strengths in comparison to each other.
Note: 3-Way Locking Corners are required by the NMFC Item 245 (Crate Construction Requirements)



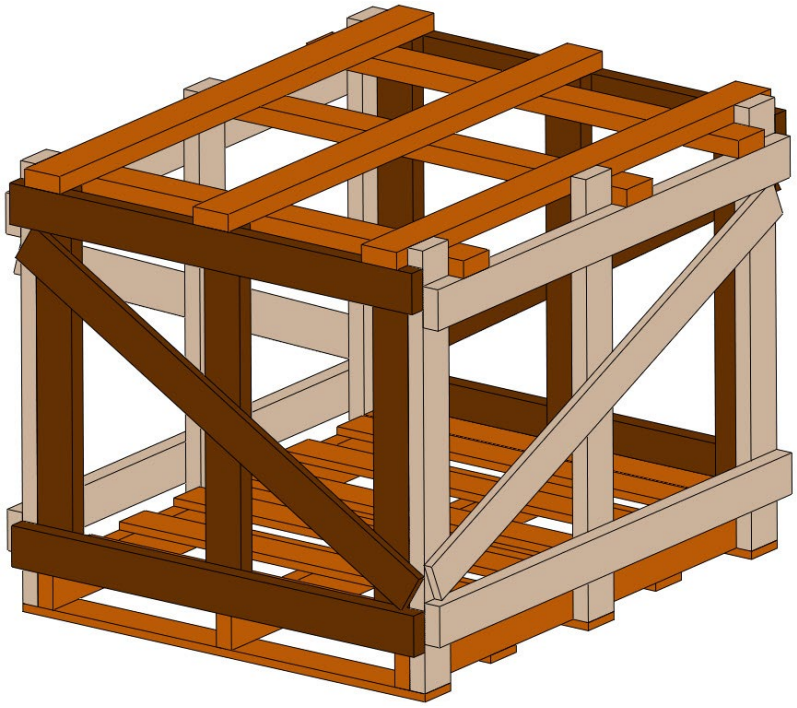
Crate Apertures – Maximum Size Explanations

Skeletal crate side, end, or top panel aperture dimension should **NOT** exceed 25 inches. This includes measurements of the apertures' Length, Width, Height, or Diagonal.



D. Standard Skeletal Crate

Diagonals are recommended to ensure crate is rigid enough to handle the normal rigors of the LTL distribution environment.
(Enclosed crate panels, using OSB, of plywood are acceptable substitutes for diagonals)



For maximum rigidity, diagonals should be angled between 30° and 60° from the adjacent strut or header.

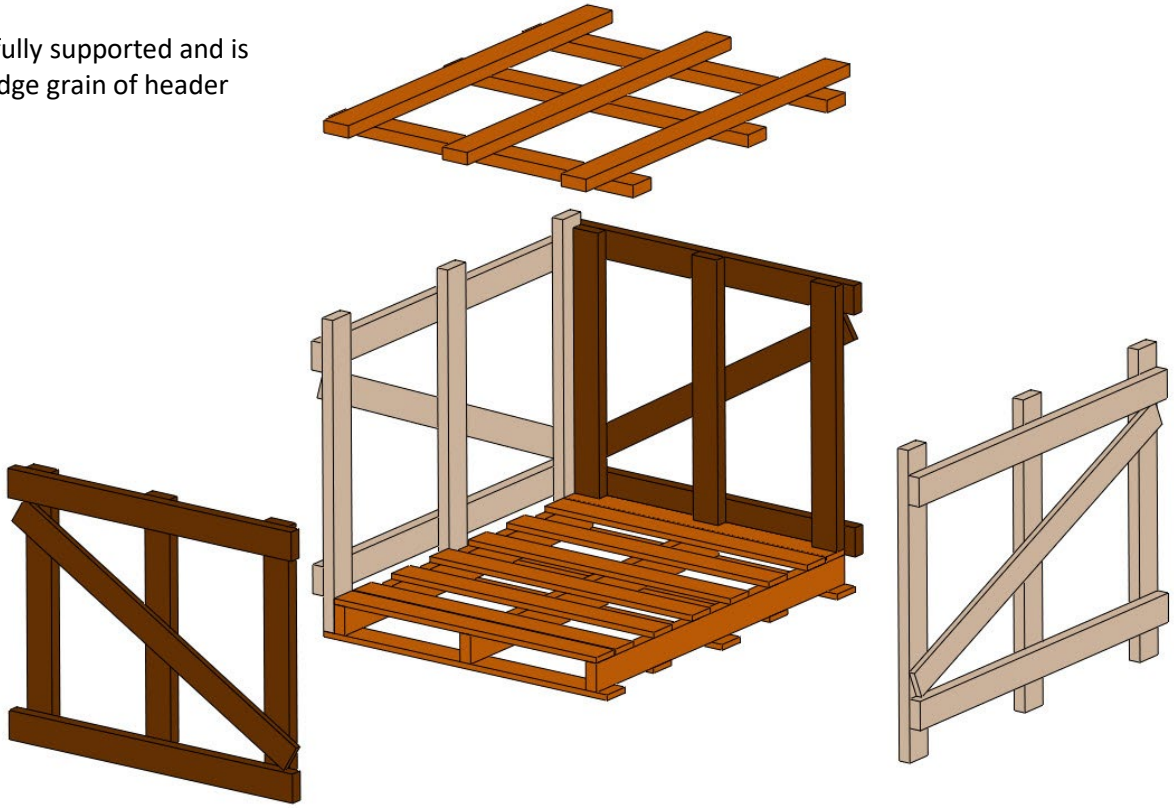
Strut corner members can be fastened to the adjacent member along the entire length of the board.

A modular design is recommended for easier, repeatable, and consistent assembly.

The struts land on extended bottom deck boards, which prevents the struts from dragging on the ground.

Headers are on the outside face to help prevent the crate from catching on adjacent freight.

Top of crate is fully supported and is fastened into edge grain of header board.



E. Long Skeletal Crate

Long crates (greater than 80 inches) should be designed with access on all sides and include chamfered runner boards. The chamfered runners allow the crate to be slid safely and without damage.

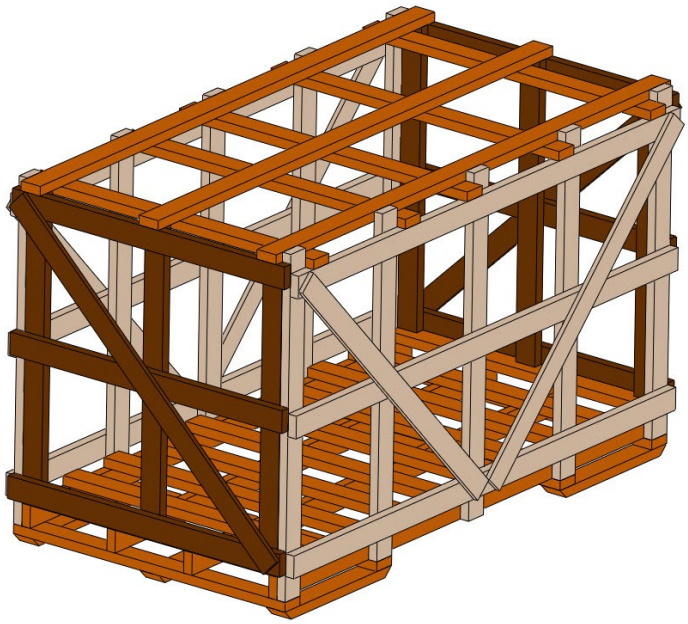
To allow pallet jack access, the space between the chamfered runner boards should be at least 28 inches.

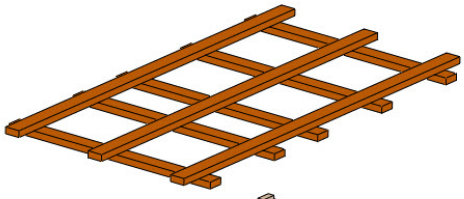
1.5 inch thick bottom deck boards, between stringers and chamfered runner boards, provide pallet jack access from the side.

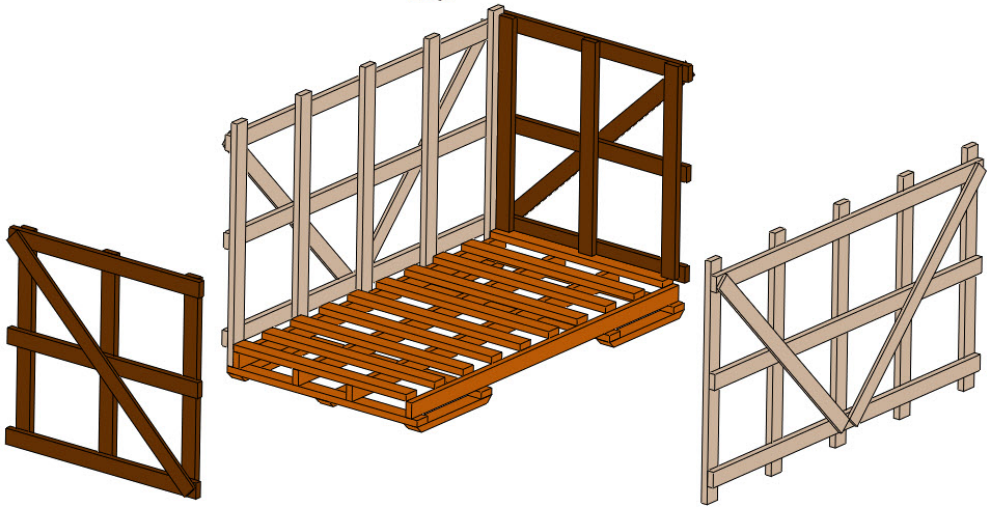
Ensure that the angle of all diagonals is between 30 and 60 degrees to the headers.

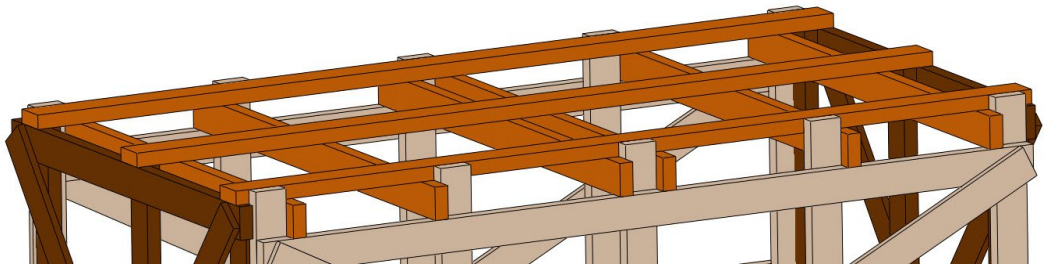
See standard crate and/or long pallets above for more information.

See Section XIV – Pallet Construction (page 34) for crate bases that are longer than 80 inches and too wide for pallet jack handling.





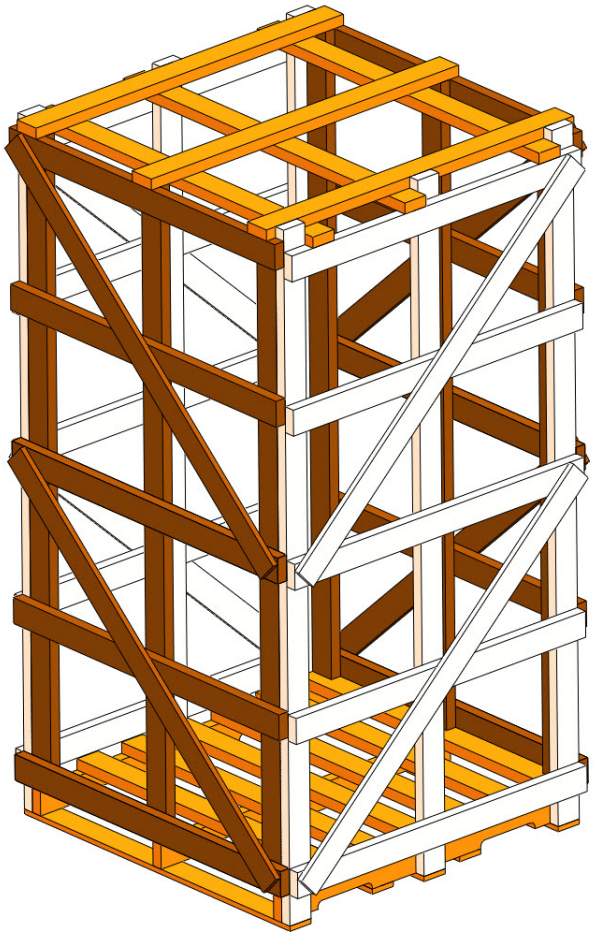




DESIGN OPTION: High strength top utilizes header boards on edge.

Designed to be used with large, open span tops, and shorter crates; which are more likely to experience greater top-loads.

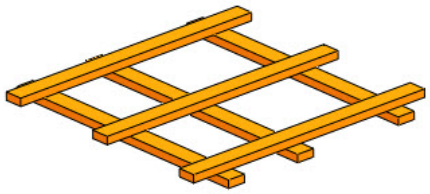
F. Tall Skeletal Crate

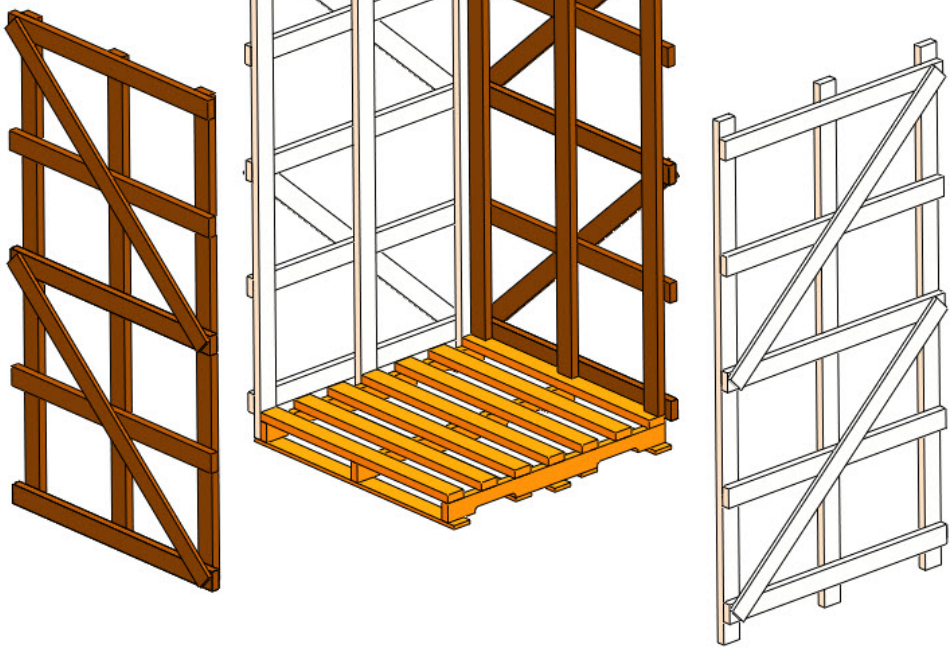


Tall crates can be designed with additional header boards on the length or the width.

For greatest strength and rigidity, ensure that the angle of all diagonals are between 30 and 60 degrees to the headers.

See standard crate and/or long pallets above for more information.



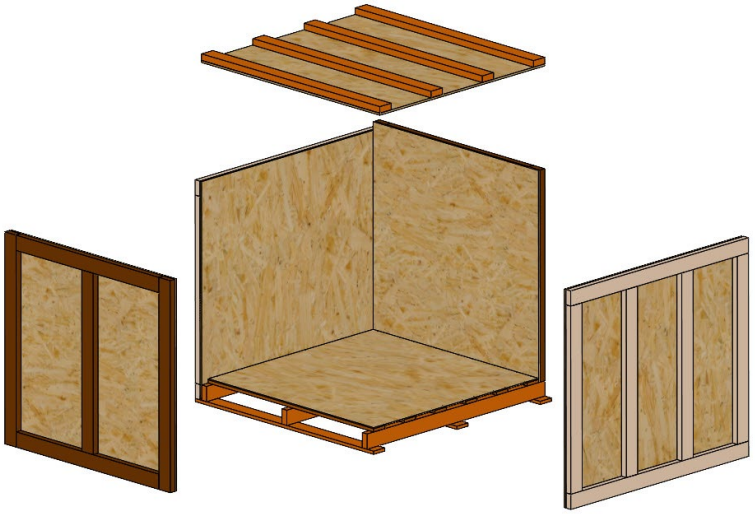


G. Enclosed Crate

Features of standard, long or tall crates may be used in conjunction with enclosed crates.

All plywood or OSB edges should be fully supported by solid wood.

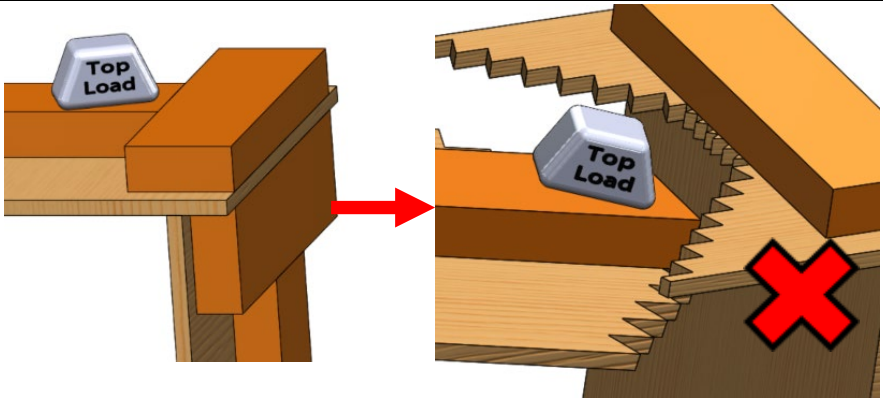
All plywood and OSB should be applied with the appropriate span rating and open span for the desired loading characteristics.



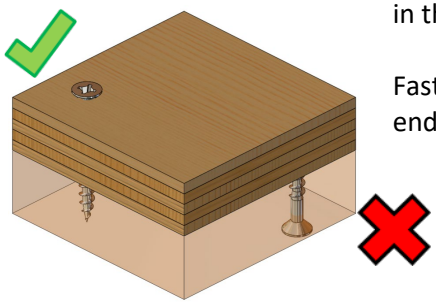
For more information on proper Plywood or OSB usage, see the APA Engineered Wood Construction Guide – E30 www.apawood.org

Solid wood should support solid wood in the top of the enclosed crate.

When solid wood is supported only by plywood or OSB, a top load can cause the solid wood to puncture the plywood or OSB, causing failure.



When attaching plywood or OSB to solid wood, the fastener should extend through plywood or OSB and end in the solid wood.

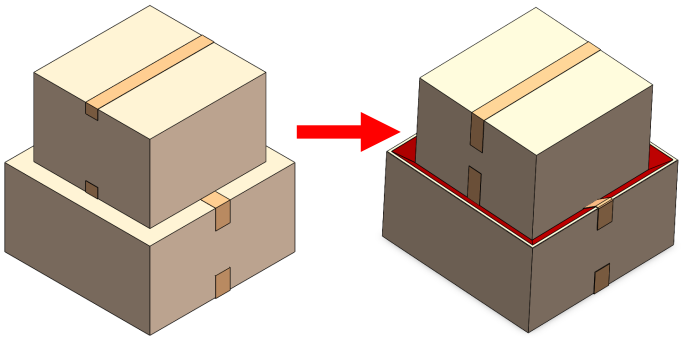


Fasteners should not end in plywood or OSB.

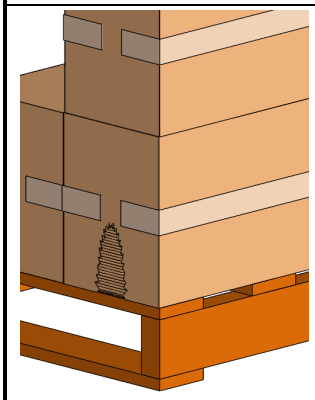
More information about the correct application of OSB and Plywood is found in Section XII. C. Plywood and OBS (page 26).

XVI. Packaging Specific Unit Load Designs

A. Corrugated Fiberboard Boxes on Pallets



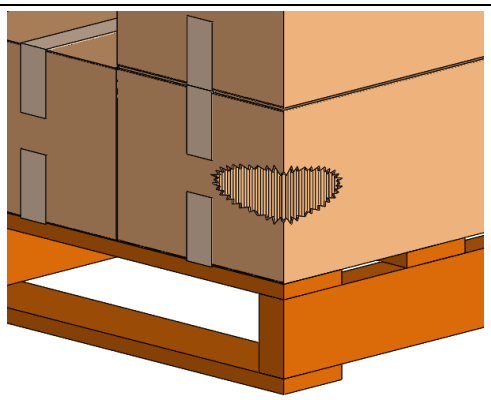
When small boxes are placed on top of large boxes (or visa-versa) the smaller box is likely to sink into the larger box, potentially putting most of the vertical compressive forces on the product.



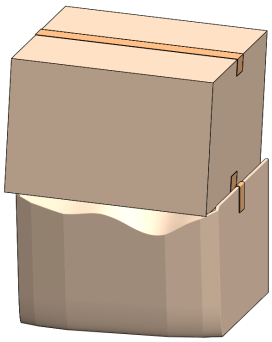
Ensure flutes are parallel to the primary compression forces within the unit load, this means the flutes should be oriented vertically.

Horizontal Flutes

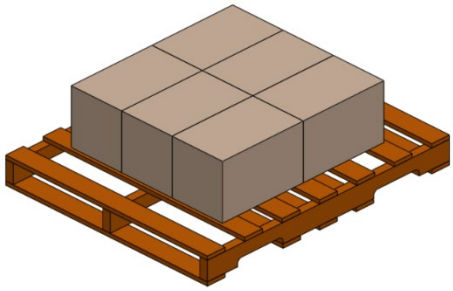
Vertical Flutes



When box corners are not aligned properly, the boxes can nest into one another, potentially causing product damage.

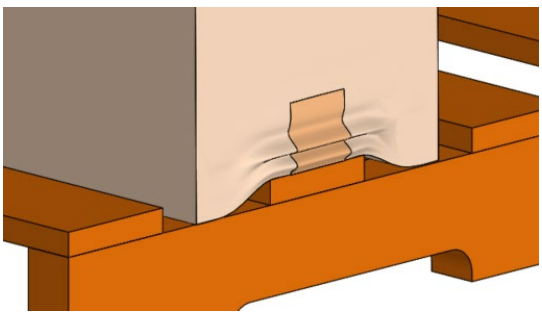


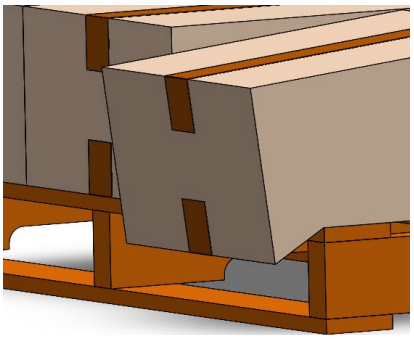
More than two inches of underhang increases the chances that adjacent freight will fall into the load.



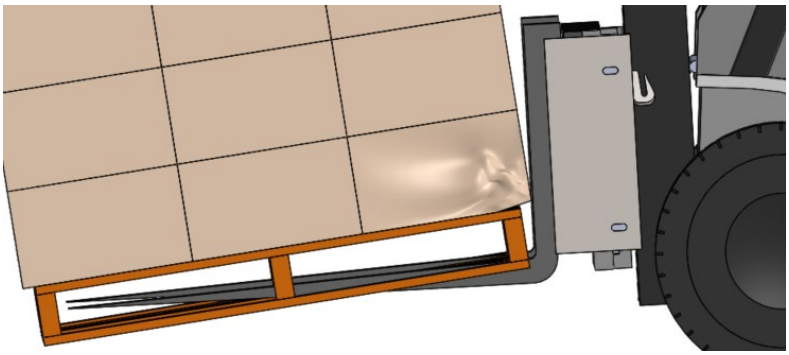
In cases of extreme under hang, there is the possibility of incurring additional freight charges.

When the corners of corrugated fiberboard boxes are not supported by the top deck of the pallet, the box is likely to fail; this includes pallet overhang.



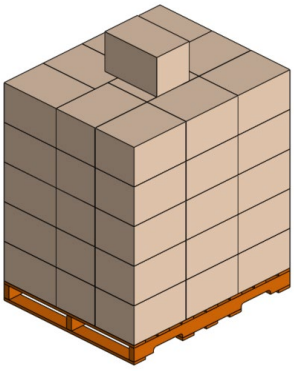


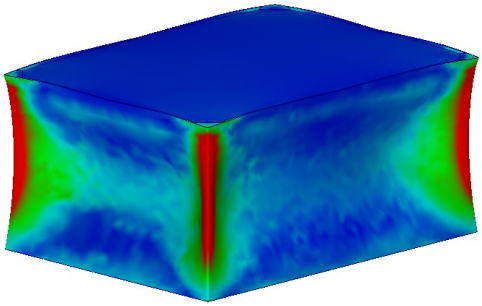
If the boxes overhang in the width direction, there is potential that the fork tines will not be able to reach the third stringer, causing load instability.



Do not pyramid stack loads. Pyramid stacking potentially increases the volume of your shipment and therefore, potentially, the cost.

In addition, the top container(s) is exposed to potential damage and loss due to poor load stabilization.



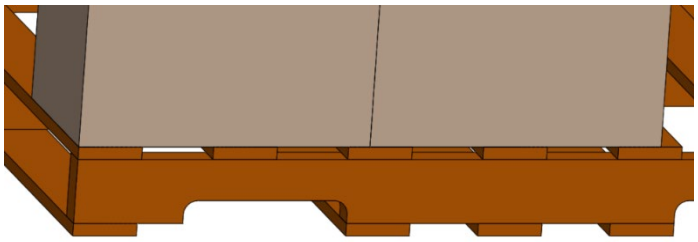


Visualization of the stress concentration in the corners of a corrugated fiberboard box undergoing compression.

<u>The corners of the box support 2/3 of the weight when properly loaded.</u>

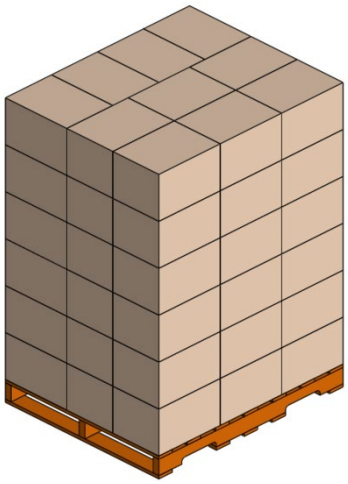
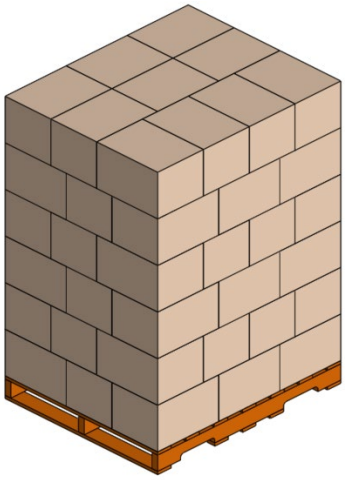
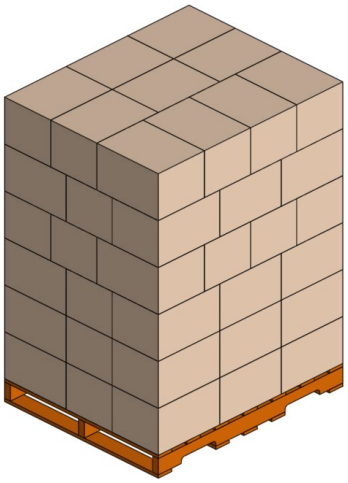
Red indicates the areas of high stress demonstrating the fact that the corners of the box provide the majority of the strength.

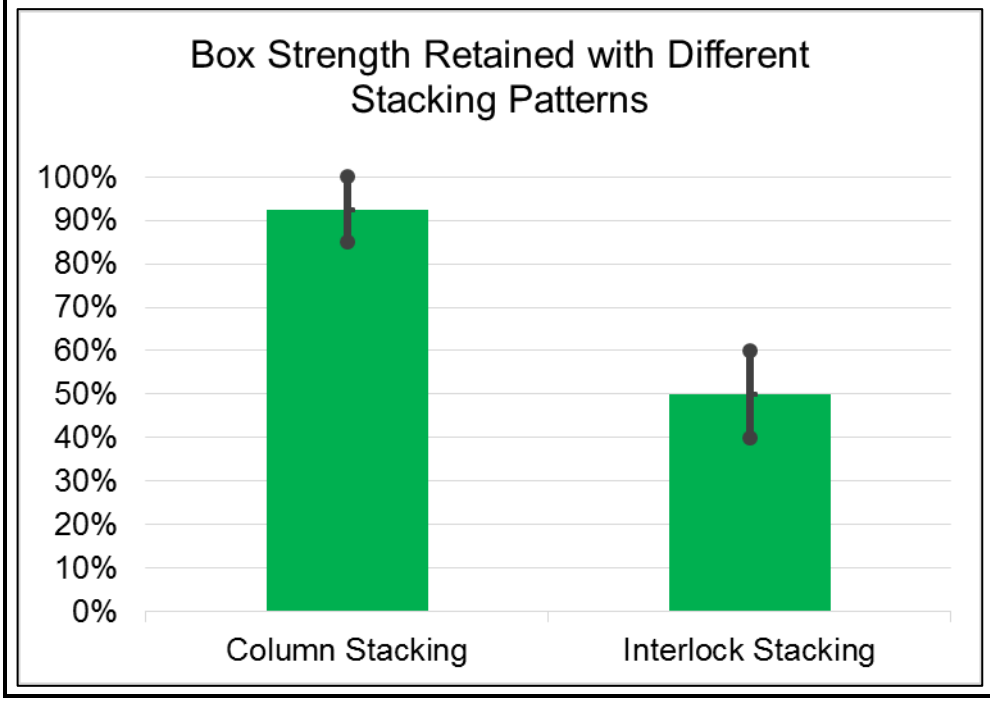
Corrugated fiberboard box corners must be supported by the top deck of the pallet. The corners and vertical edges of a box support two-thirds of the compression strength.



Cubed loads are the best method to prevent against lost product and product damage.

There are three general ways to stack corrugated fiberboard boxes on a pallet. They each have their advantages and disadvantages. They include:

	Column Stacking	Interlock Stacking	Hybrid Stacking
			
Benefits	Aligning corners increases box stacking strength	Layers are tied together, increasing lateral stability.	The bottom 3 layers align box corners for strength while the top layers are interlocked for improved stability.
Drawbacks	Columns are more unstable when exposed to lateral forces.	Box corners are not aligned, therefore stacking strength is decreased 40-60%.	Complex assembly process.



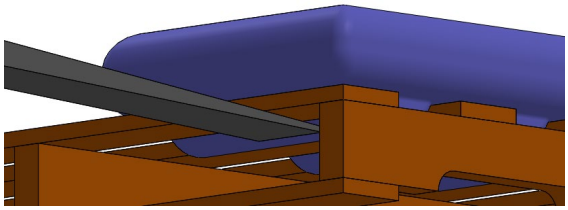
Green bar indicates the potential original box stacking strength.

Black bar identifies potential variability of box stacking strength.

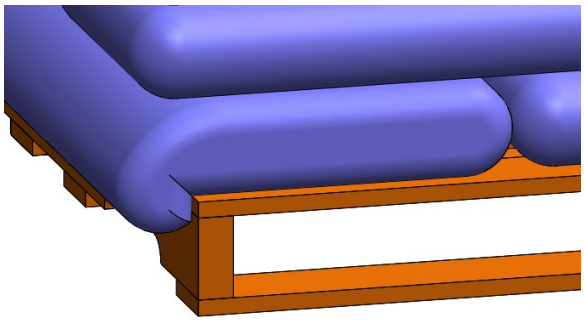
B. Bags on Pallets

Bags are addressed in NMFC Item 680, 200, 201, 202, 203 & 204.

Do not column stack bags.

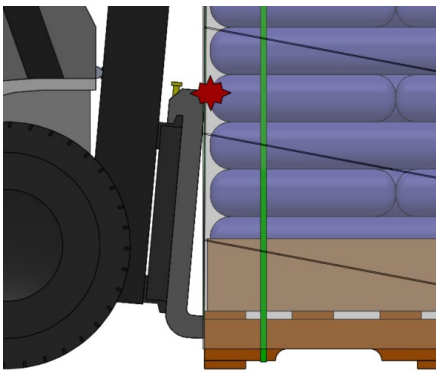


Pallet deck spacing should prevent bags from sagging through the pallet deck, potentially coming in contact with fork tines.

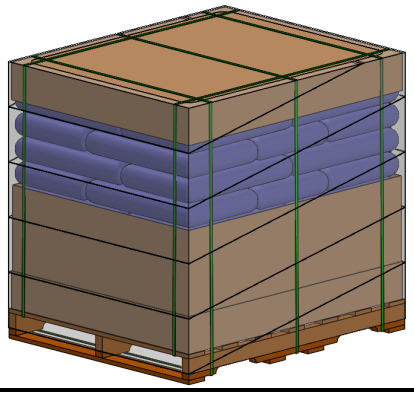


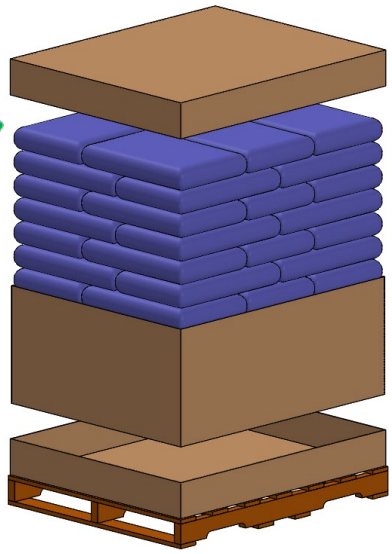
Bags that overhang the pallet are exposed to the sharp edge of the pallet deck and to the normal rigors of the LTL environment.

Bags that are not protected by the corrugated wrap are more likely to be damaged by contact with the fork tine mast.



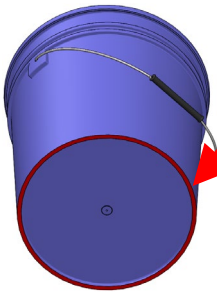
Bags should be interlocked for increased stability. According to NMFC Item 680, Section 7. B. (2), bags must have a fiberboard bottom tray (or tray and sleeve combination) rising at least 20 inches from the pallet. This will help provide protection from punctures caused by adjacent freight or material handling equipment.





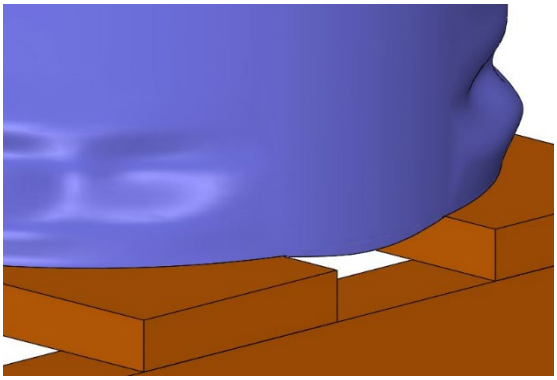
C. Buckets and Pails on Pallets

Pails are addressed in NMFC Item 225.

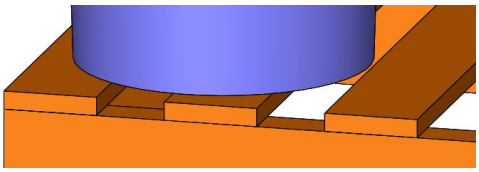


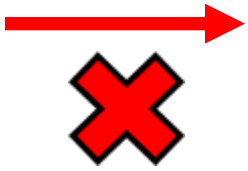
Buckets and pails have a small load bearing area. To prevent failure this area should be properly supported.

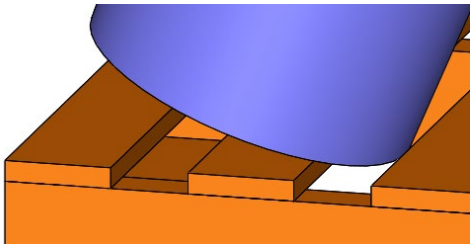
Poorly supported buckets may collapse during transit.



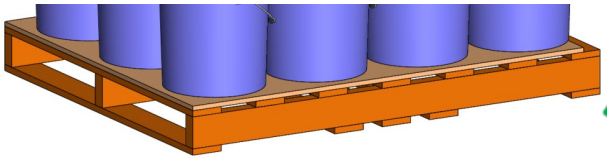
Improperly supported buckets have a higher chance of tipping over when exposed to the normal rigors of the LTL environment.

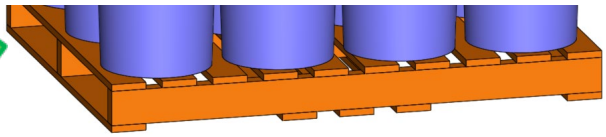






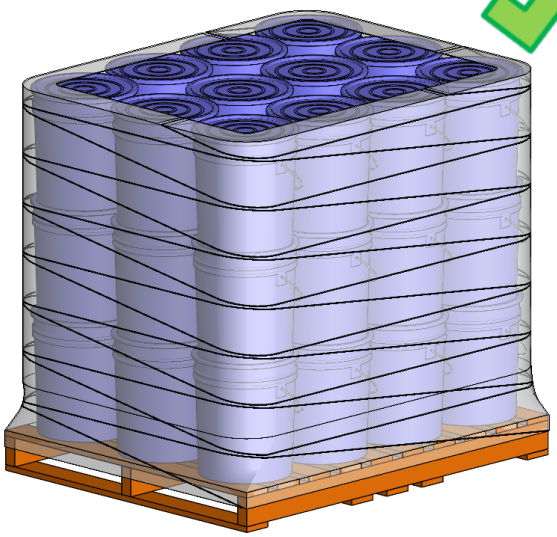
Buckets should either be properly supported by pallet deck boards or a stiff slip sheet.



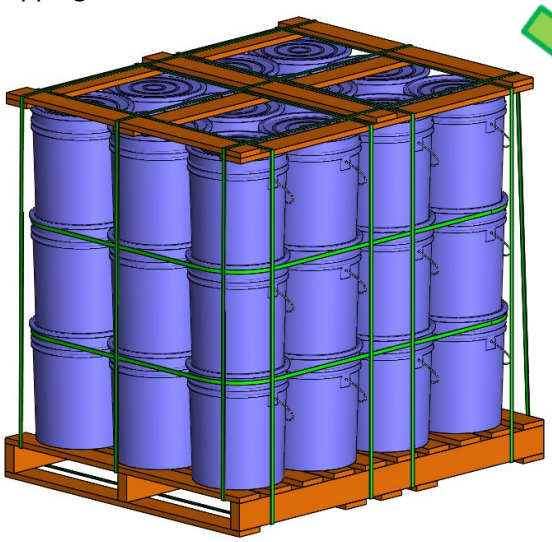


Recommended maximum stacking height for pails is three layers.

Use extra stretch film to properly stabilize pails.

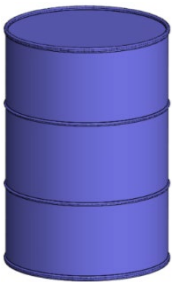


Use a top frame when securing the load with strapping. This helps to prevent the strap from slipping off a rounded surface.

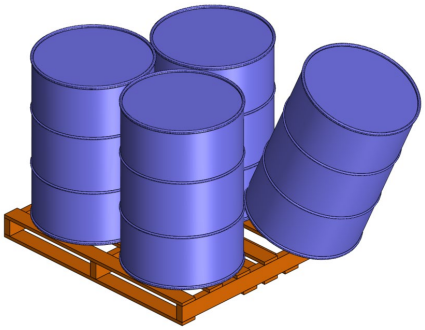


D. Drums on Pallets

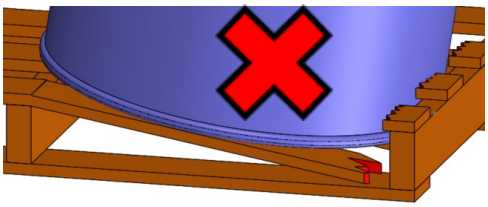
Drums can be difficult to stabilize due to their cylindrical nature and the small contact surface area between the drum and the pallet.



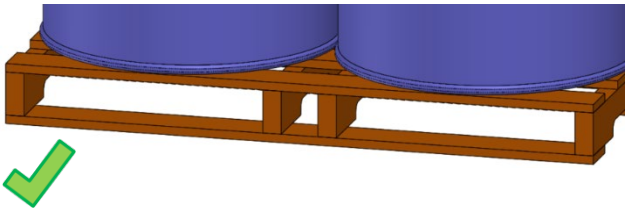
Improperly stabilized drums may start to nest within each other, causing the strapping or stretch film to become ineffective and allowing the drums to shift.



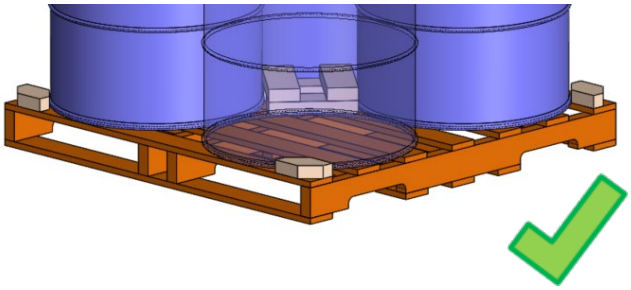
The combination of the normal rigors of the LTL environment and heavy a drum can cause pallet decking failure.

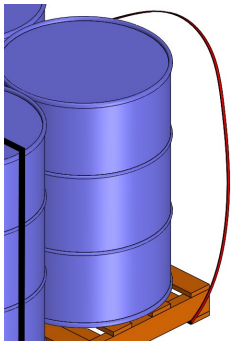


All drums that are over 35 gallons or 300 pounds should be supported by at least 2 stringers.



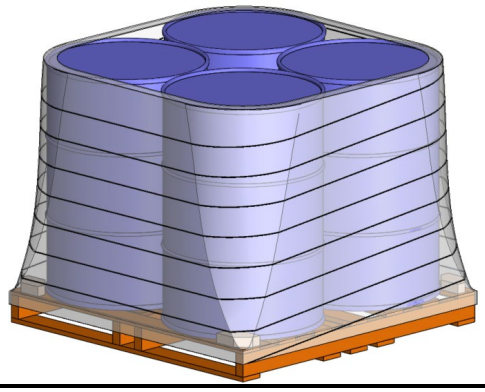
Drums should be chocked in place to prevent movement in the length or the width directions.



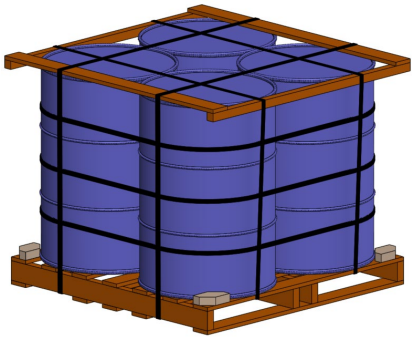


Strapping directly on a drum is not recommended. The cylindrical nature of the drum can easily cause the strap to slide off the edge of the drum, making the strap ineffective.

Stretch film can be used to stabilize drums. Greater than 75% overlap is recommended for proper stabilization. Use a film that will not tear on the corners of the pallet. Consider utilizing stretch roping to help stabilize the drums. See section IX Stretch Film Application (Page 17) for more information.



The use of a light top frame will prevent the strapping from sliding off the radius of the barrels.



To prevent movement during transport, it is recommended that barrels be strapped together with a least three straps; and secured to the pallet with at least two straps in each the length and width directions.

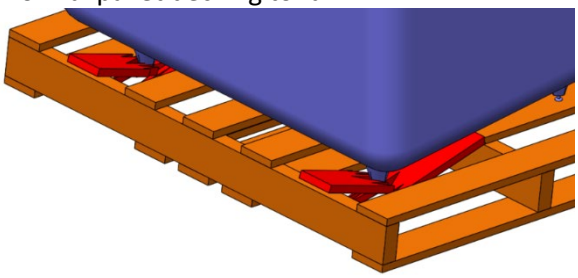
E. Legs, Casters and Wheels on Pallets

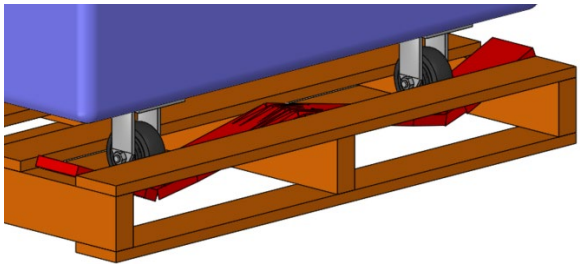
CAUTION: Legs, Casters and Wheels are generally not designed to handle the forces associated with the normal rigors of the LTL distribution environment.

Wheels are made to roll. Freight that can roll (on floor or pallet) during transport may lead to product damages.

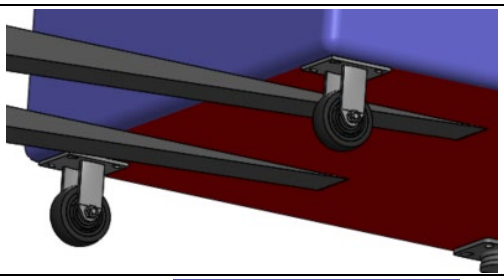
ABF Freight does not recommend shipping freight with the weight of the freight supported by the wheels or casters.

All of the weight of the freight is focused into the four feet (or wheels), creating high pressure points that may cause normal pallet decking to fail.

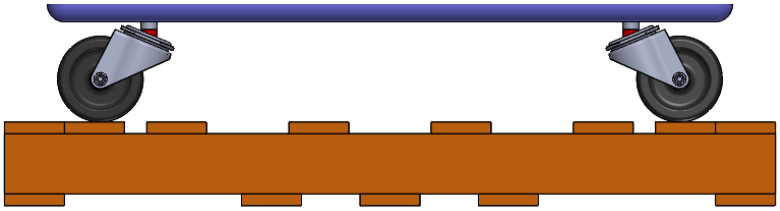


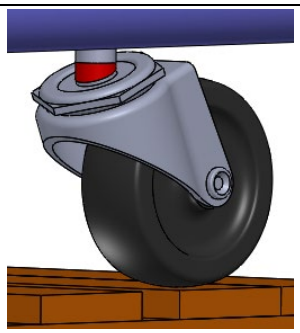


Products that are not on pallets may experience underside damage due to fork tine contact.



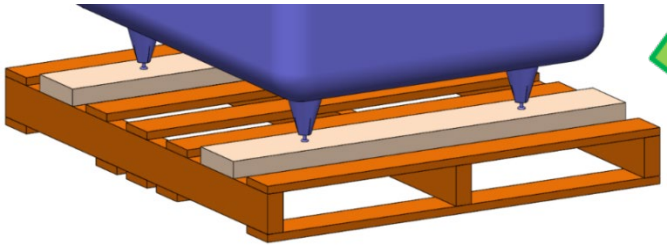
Caster components may bend or break due to normal dynamic forces associated with the LTL distribution environment.





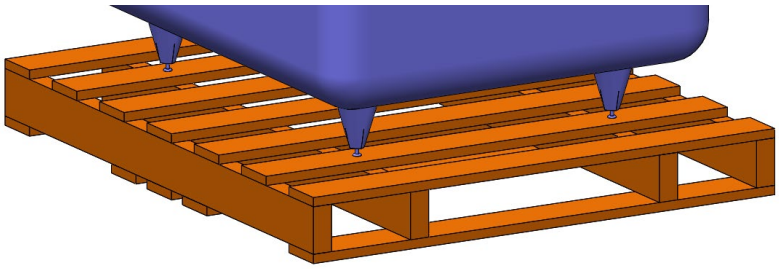
If the freight must have the legs or wheels installed prior to shipment (not recommended), either the pallet should be properly designed to support the potential point-loading, or the freight should be supported in a manner that lifts the legs or wheels off the pallet (or ground). Some examples of pallet designs and freight stabilization methods are shown below.

NOTE: Additional vertical stabilization may be required. See Section X, Strapping of Freight to Pallets (Page 21).



Option 1 Legs: High-Quality Decking
Consider using the following to help distribute the pressure points of the feet:

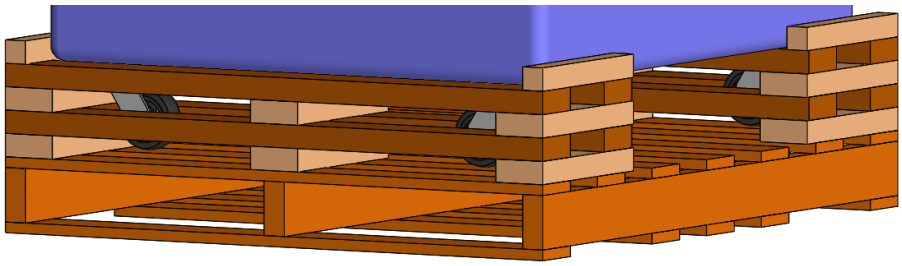
- Thicker deck boards
- Wider deck boards
- Utilize lumber with a higher specific gravity (Density)



Option 2 Legs: Stringer Support
Use additional stringers, directly under the feet, to help distribute forces.

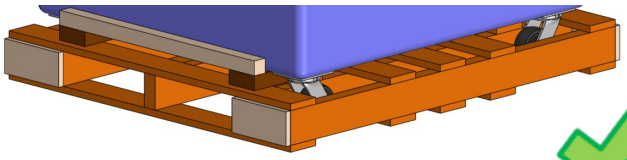
Option 3 Legs and Casters: Blocking Up The Freight
Freight is blocked up to remove the weight from the casters.

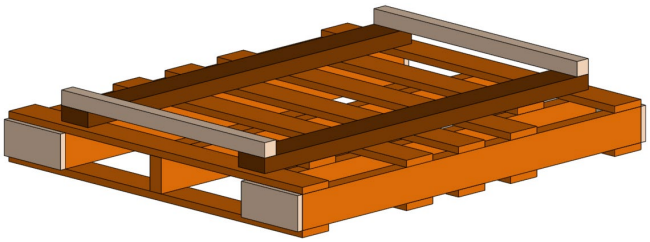
The freight is chocked in the length and width directions.



This design provides side access to the product for removal of freight from pallet by forklift.

Option 4 Legs and Casters: Closed Edge Pallet





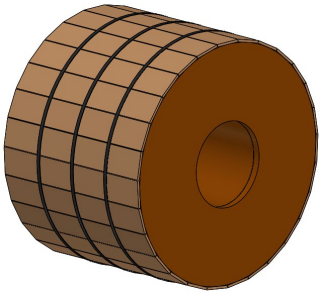
Light colored plugs at end of stringers help prevent fork tine entry and subsequent damage to wheels.

Outside stringers offer additional protection for wheels and a surface for crate strut attachment.

F. Reels

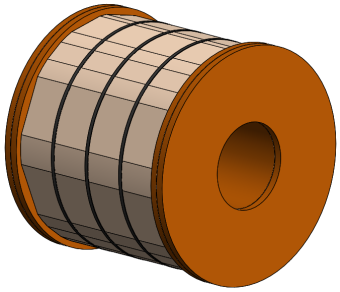
Products on reels should be protected from the normal rigors of the LTL environment. Reels are addressed in NMFC Item 235. There are many ways to protect the product on reels, they include but are not limited to:

Board Lagging



Plywood Lagging

Corrugated Wrap



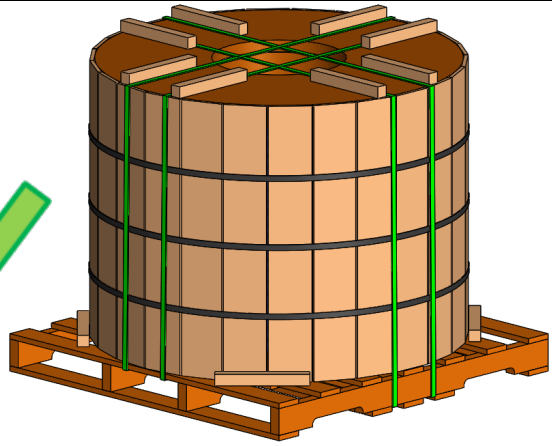
If the product allows, reels should be shipped flat on a pallet, chocked and strapped in the length and width directions.

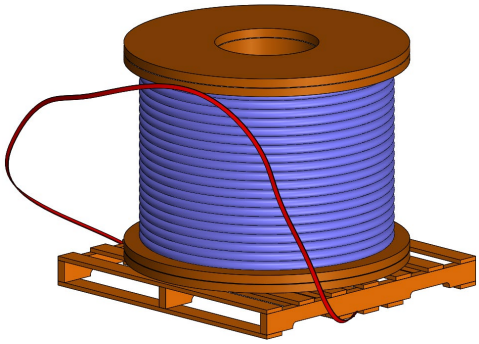
This orientation will ensure that the reel will not roll during transit, due to the forces associated with the over-the-road tractor trailer distribution environment.

The product is protected by board lagging.

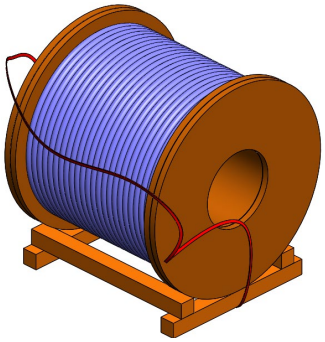
The chocks on top prevent the straps from sliding off the radius of the reel.

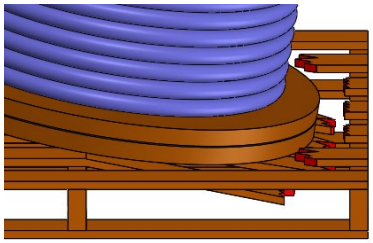
Reel is supported by at least two stringers.
(If the outside stringers are not utilized for support, then two center stringers are necessary.)





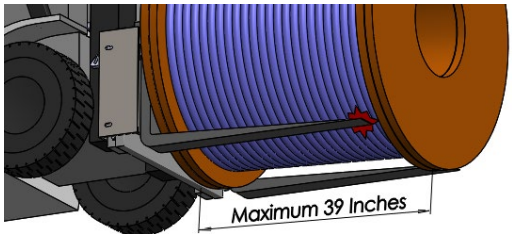
Strapping on rounded surfaces, without chocks to hold the strapping in place, is not recommended. The cylindrical nature of the reel can cause the strap to slide off the edge of the reel making the strap ineffective.



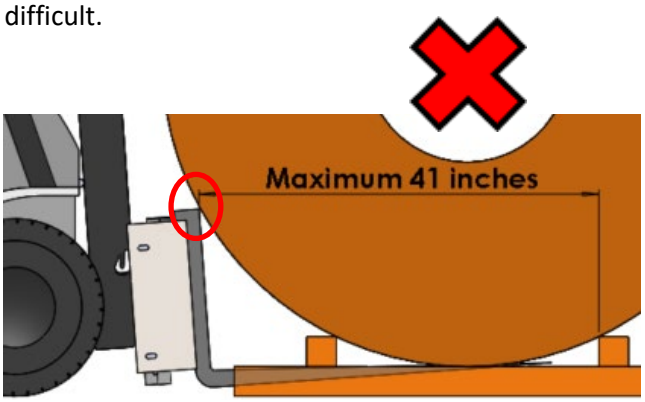


Reels that are only supported by one center stringer can cause deck boards to fail.

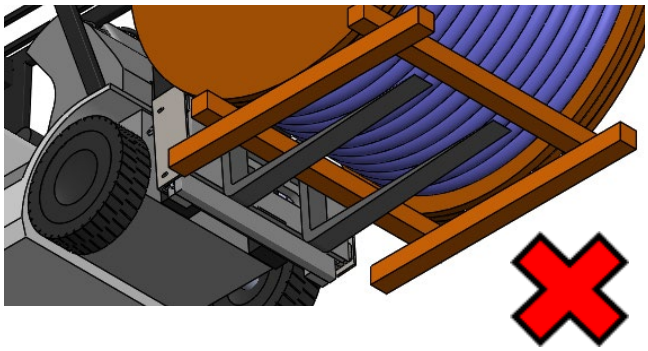
Reels that are not on pallets and are wider than 39 inches in width are in danger of being contacted by fork tines.



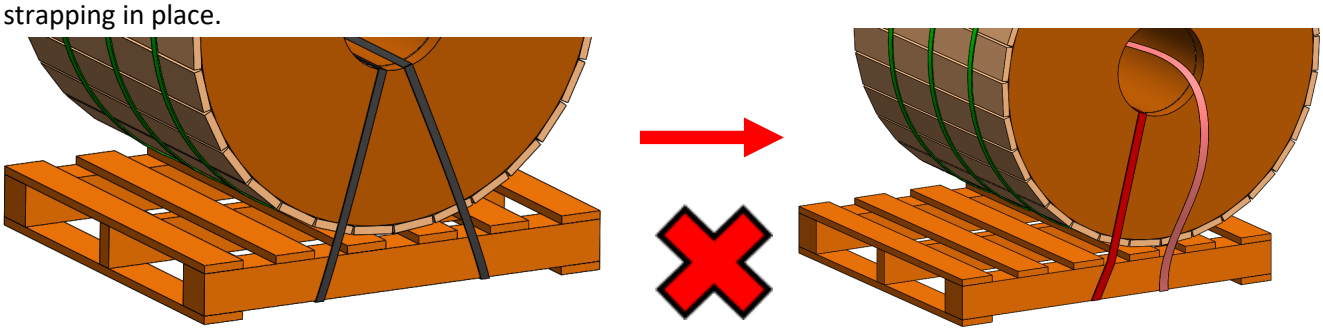
Reels on cradles/pallets where the pallet does not extend to the full reel radius makes fork tine access difficult.



Reels on cradles often leave the reel exposed to potential fork tine impact.



Properly strapping & chocking, and the proper utilization of bottom deck boards, are all necessary to stabilize a reel. Straps hold the reels in place, while chocks reduce the potential shock loading of the straps and help prevent the initial roll that may be caused by the normal rigors of the LTL environment. The bottom deck boards keep the strapping in place.



In the example above, the reel has shifted to the right. The dark red strap, while still taut, was able to slide along the bottom of the stringer and the light red strap was able to come loose.

Some reels cannot be shipped on their side due to the nature of the product. If this is a characteristic of the product you are shipping, it must be noted on the freight and on the Bill of Lading (BOL).

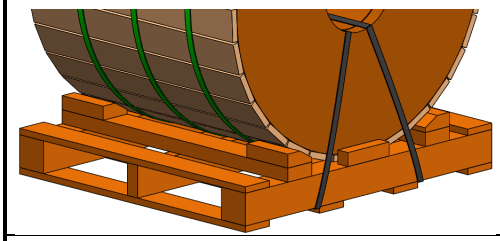
Some examples of pallets and roll stabilization methods are shown below.

Medium and Small Reels

Option 1

The wheel flange sits on the stringers.

The reel is chocked in the length and width directions.

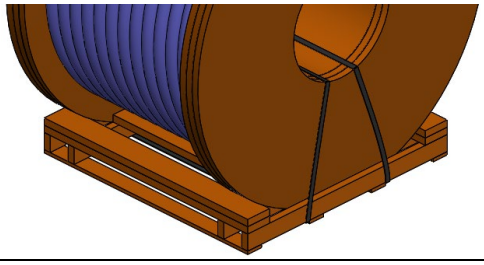


Straps are held in place by the bottom deck boards.

Option 2

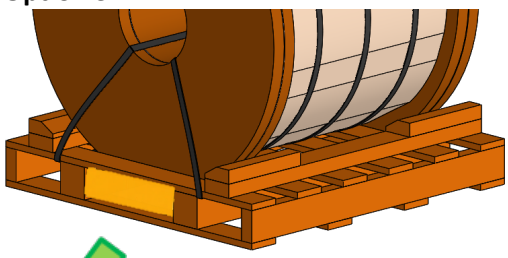
Reel flange sits in between stringers.

Reel is chocked in place by deck boards.



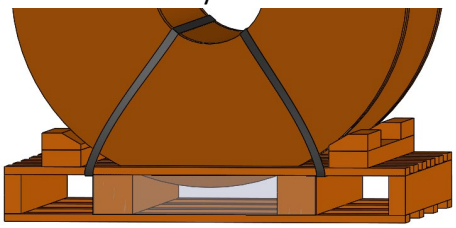
Straps are held in place by bottom deck boards.

Option 3



The reel flange is nested within the stringers. This allows the top deck to act as a chock in the length direction.

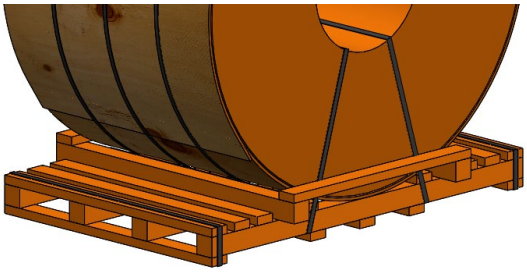
Stringer spacing must allow for fork tine entry on the outside of the inner stringer.



The strapping is threaded on the outside of the inner stringers and through the closest point on the drum of the reel.

The center is blocked off to reduce the potential for fork tine damage.

Large, Medium and Small Reels



Option 4

Reel flange sits on the large stringers.

Reel is chocked in place in the length and width.

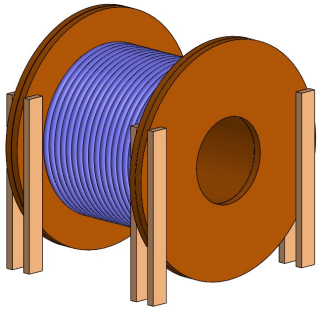
Straps are held in place by bottom deck boards.

Straps over lead boards reinforce the board. See Section XIV, C Pallet Construction (page 35) for more information about heel - toe forces.

Option 5

Minimal design to prevent the reel from rolling.

The legs should be spaced far enough apart to fork tines can lift the reel along the circumference of both flanges.



Must be assembled with high quality lumber that is over 1” thick and high quality fasteners (screws).

END OF DOCUMENT