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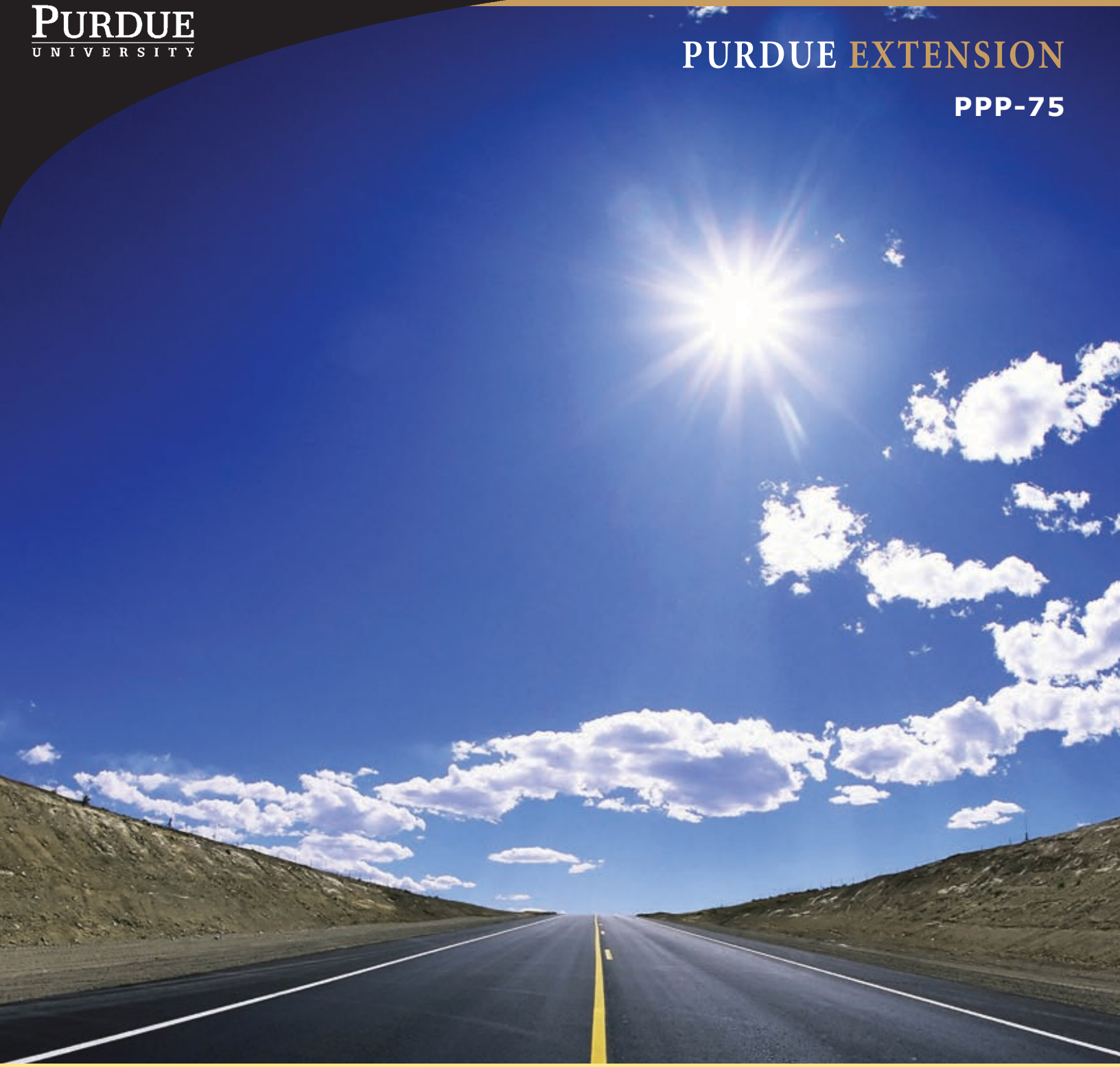

Securing the Load

A Guide to Safe and Legal Transportation of Cargo and Equipment

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Fred Whitford, Coordinator, Purdue Pesticide Programs

Steve Salomon, Risk Coordinator, Excel Co-op

Mike Templeton, President, Surface Transportation Consultant, LLC

Becky Thiessen, President, DLD Truck Straps, Inc.

John Katterjohn, President, Mark M. Holeman, Inc.

Shawn Lambert, Safety and Risk Manager, Co-Alliance, LLP

Joel Delashmit, Foreman, American Wire Rope and Sling

Arlene Blessing, Editor and Designer, Purdue University

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~ ACCIDENTS WAITING TO HAPPEN ~

A falling tire or bale of hay could cause a serious accident.

Introduction

We all experience anxious moments when we look in the rear view mirror and see our cargo leaning precariously, pesticide containers bouncing up and down as we drive, a disengaged load binder bouncing merrily off the pavement, a 500-gallon water tank shifting to one side, or a commercial lawn mower rolling back and forth in the bed of the truck.

Imagine your cargo spilling onto the roadway, vehicles on both sides of the road instinctively swerving toward the shoulder, others crossing the center line into the path of oncoming traffic. Imagine someone running over your spilled cargo, having a blowout and losing control. Imagine a horrible accident — all because you failed to properly secure your load.

One person's close call...

"I was able to attend your program on load securement...recently and I appreciate the work you are doing in this area. I experienced the problem firsthand yesterday and I want to pass along some pictures and information for your use.

"I was traveling on a two lane state highway...in my F250 company truck and met a full size van coming from the opposite direction. Just as we met, a 2x4 board fell from the cargo rack on the top of his van and it struck the post on the left side of my windshield and then wrapped around the outside of the door, destroying the mirror. The glass from the driver door came in the cab. I was sitting in a pile of glass but suffered no injuries.

"The van was hauling a few sheets of tin and a couple of 2x4s tied with three small ratchet straps. One strap came loose and let a single 2x4 fall into my lane as we met. If it had been a few inches farther to the right I would have been a shish kabob!"

Losing cargo on the road is serious business. First of all, it's a loss: whatever falls is spilled, damaged, or destroyed. Falling cargo can cause direct or indirect human injury and destruction of personal property. There may be environmental impacts if a fallen chemical contaminates surface water; and if your insurance doesn't cover the cost of remediation, you have to pay for cleanup and restoration.

The proper loading, positioning, and securing of cargo on a truck or trailer can prevent accidents in transit. But you must always select the right tie-downs for the job and use them correctly. This publication refers to the United States Department of Transportation (DOT) load securement regulation, 49 Code of Federal Regulations (CFR) Parts 392.9 and 393.100-136, as well as miscellaneous state regulations. It describes how the right tie-downs, placed correctly, can secure cargo carried on farm and commercial trucks and trailers.

The company that owns this equipment makes every attempt to secure both large and small objects. However, notice that the front strap is badly frayed and needs to be replaced.

Consider this real life example...

A pickup truck was pulling a trailer containing multiple five-gallon drums of a liquid cotton defoliant, set on pallets. Each pallet was factory-wrapped with plastic, but the pallets were not secured to the trailer. The driver, assuming the shrink-wrap would hold the drums for his short trip from the warehouse to a retail store, failed to secure the load. As he rounded a turn in a residential area, the wheels of the trailer went off the shoulder, causing the load to shift. The plastic wrap broke, sending containers toppling onto the roadway and rupturing.

Three years later, the case remains in litigation. The initial cost of cleanup was handled routinely; but the odor of the defoliant absorbed by the pavement permeated nearby homes each time it rained, resulting in multiple claims of respiratory problems and eye irritation. The company has paid $180,000 in medical costs, thus far, bringing the total loss to $350,000. The claims adjuster handling the loss says the most frustrating fact is that a few $15 tie-downs could have kept the load from shifting in the first place. *(Modified with permission from Foresight, Nationwide Agribusiness)*

Common Methods of Cargo Securement

Manufacturers offer a variety of tie-downs, blocks, braces, etc., for securing cargo, but tie-downs are the most frequently used. Tie-down assemblies may consist of rope, chain, cable, or webbing as well as ratchets, binders, bolts, or hooks. The most important criteria are strength and durability, and tie-downs are rated to aid your selection process. Never base your selection on price: a few dollars saved may result in very expensive road debris if the tie-downs prove inadequate for the job.

These tanks are well-secured to the trailer. However, notice the hoses lying unsecured on the trailer deck. All objects — large and small — need to be secured.

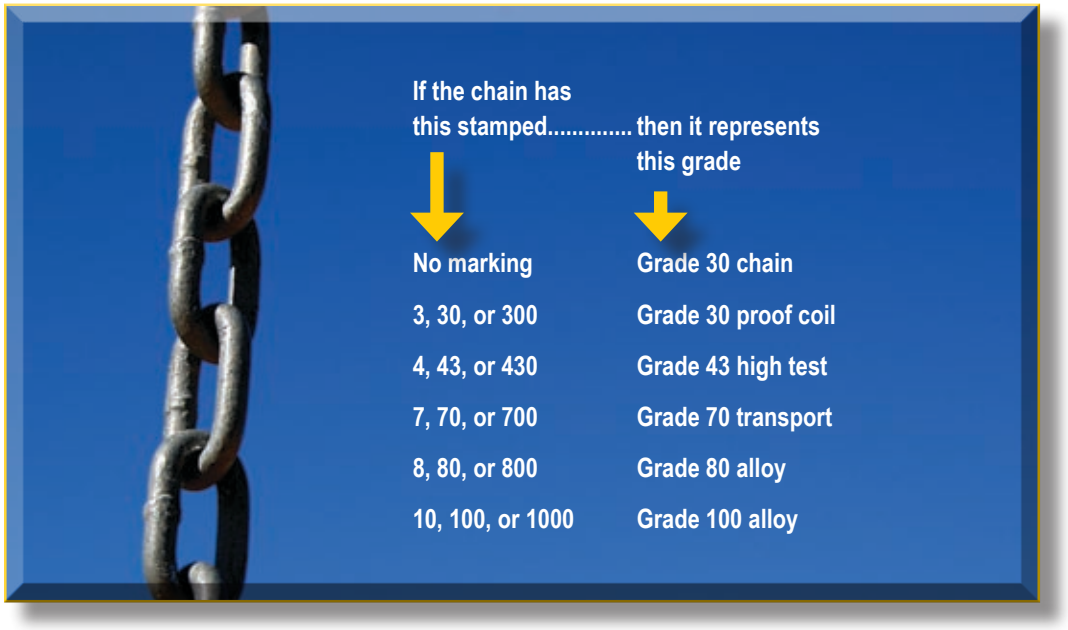
Chains

Chains offer the advantage of durability and strength. Their main drawbacks are weight and the potential to physically damage cargo. Steel chains are graded to industry standards based on their intended use: securing a load or lifting cargo. Grades 30 and 43 are utility chains, while Grade 70 signifies a transport chain. Grades 80 and 100 are lifting chains. The higher the grade, the greater the strength of the chain and the less "bend" it has.

- Grade 30 Proof Coil (top photo) is an economic, low-carbon chain widely used in agriculture and general industry.
- Grade 43 High Test chains (second photo) provide wear resistance and high tensile strength for the trucking, farming, and construction industries.
- Grade 70 Transportation chains (third photo) are lighter in weight but can be twenty percent stronger than similar Grade 43 products. Grade 70 is a popular chain for securing cargo for transport.
- Grade 80 and 100 Alloy chains are designed for lifting cargo such as rocks, tree balls, engines, etc.; they may be used as tie-downs but are more expensive than other chains. OSHA (29 CFR Part 1926.251) requires that chains used for lifting have permanently affixed, durable identification stating size, grade, capacity, and manufacturer.

Bottom photo: To the novice, there is no distinction between one unmarked chain and another.

Manufacturers stamp the chain grade on individual links at least once every 12 inches, with the exception that "generally manufactured chains" may not be marked. The following numbers are used to identify the grade of commonly used chains.



The diameter of a chain refers to the thickness of its links. The Working Load Limit (WLL) of a chain is determined by *grade* and *diameter* as demonstrated by the following chart.

Chain Link Diameter (inches)	Tie-Downs Only Working Load Limit (pounds)			Lifting Chains/Tie-Downs Working Load Limit (pounds)	
	Grade 30	Grade 43	Grade 70	Grade 80	Grade 100
1/4	1,300	2,600	3,150	3,500	4,300
5/16	1,900	3,900	4,700	4,500	5,700
3/8	2,650	5,400	6,600	7,100	8,800

Web Straps

Web straps are popular tie-downs used by multiple industries. They can be used to secure equipment, pallets of cargo, or individual items. Compared to steel chains, they are lighter, easier to handle, and less likely to damage cargo. However, rough edges or surfaces can cut or abrade the webbing.

Web straps can be purchased in various widths: the greater the width, the greater the load bearing capacity. They are labeled or marked with their own working load limit, set by the manufacturer.

A lot of work, but a great job of tying off the load! A single twist of the webbing is permissible to prevent wind whipping.

Wire Ropes

Wire ropes (cables) consist of multiple bundles (strands) of metal wires twisted around a core of steel or synthetic fibers such as polypropylene. They are lighter than chains, more durable than webbing, and less expensive than either.

Wire ropes (above and below) showing center cores wrapped by individual bundles.

A newly purchased wire rope feels tacky due to the construction process. Manufacturers lubricate the outside surface of individual wires as well as the bundles. This allows the lubricated wires within each bundle to flex smoothly against each other and lessens contact abrasion where the rope touches the cargo. Wire ropes are commonly used for lifting objects onto and off of trucks and trailers; occasionally, they are used as tie-downs in farming and commercial pesticide application businesses.

Industry has standardized wire rope classifications — based on the number of wires in a bundle and the number of bundles surrounding the core — to allow product comparison. For instance, a wire rope may be classified as a 6x19 product, indicating 6 bundles around the core, with each bundle consisting of 16 to 26 wires. Other wires may be classified 7x or 8x, the wire ropes having a core surrounded by 7 or 8 bundles, respectively.

The following table puts into perspective the bundles and number of wires per bundle.

Wire Rope Classifications

Classification	Number of Bundles	Range of Number of Wires Per Bundle
6x19	6	16–26
7x19	7	16–26
8x19	8	16–26
6x36	6	27–49
7x36	7	27–49
8x36	8	27–49
6x61	6	50–74
7x61	7	50–74
8x61	8	50–74

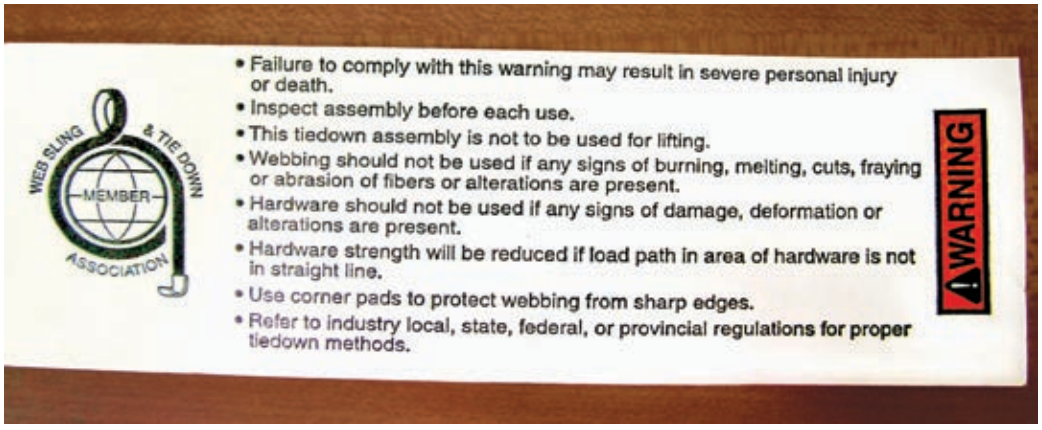
The number of wires per bundle is important: the more wires per bundle, the greater the flexibility of the cable. Conversely, the fewer wires per bundle, the more resistant the cable to abrasion and crushing. Imagine a wire the size of a metal coat hanger. It takes a lot of rubbing to abrade the wire, and it takes a lot of force to bend it. Once bent, it stays bent, and more pressure is required to reshape it. Even after reshaping, the bend point remains; that is, if the same pressure is reapplied, the wire will bend at exactly the same point; and the more the wire is bent, the weaker it becomes. Always consult your supplier to determine the cable classification that will satisfy the demands of your situation.

Working Load Limit: The Available Strength of Tie-Down Assemblies

Your first step in selecting a tie-down is to identify those that are right for the job. Primary consideration should be given to composition, classification, type of cargo, and mode of transport. Storage requirements, weight, and ease of use are secondary. And when you consider price, remember what you are paying for: 1) strength of the chain, webbing, or wire rope and 2) attachments to contain the weight of the cargo being transported.

Tie-downs manufactured in the Untied States must comply with specifications established by industry and the United States Department of Transportation (DOT). This allows direct comparison of all tie-down products offered for sale. Tie-down systems — chains, straps, and accompanying hooks, bolts, binders, and ratchets — are under constant pressure when in use. Vehicular movement when turning, braking, accelerating, or navigating rough terrain facilitates load shift, and the tie-downs must be strong enough to restrain the cargo.

Web assembly manufacturers provide guidelines such as these for the use of their products. The tag in this photograph is sewn to the webbing.



A tie-down may bend or stretch under the pressure of a load that exceeds its design limitations. And repeated use of weakened tie-down chains, webbing, hooks, binders, and ratchets can result in complete — sometimes catastrophic — failure. DOT regulations require the removal of weakened or damaged tie-down assemblies.

A chain link that broke at the weld when the pressure exceeded its breaking strength.

Minimum Breaking Strength

The breaking point of a securement device is determined by placing a brand new web strap, wire rope, or chain in a proof test machine (stretcher); one end is secured and the opposite end is pulled until the product begins to fail. The amount of pressure, measured in pounds of force, that causes complete failure is called the breaking point. Two identical tie-down products can have different breaking points, so industry standards require manufacturers to base their Working Load Limit (WLL) on the lowest breaking point achieved during the entire testing procedure.

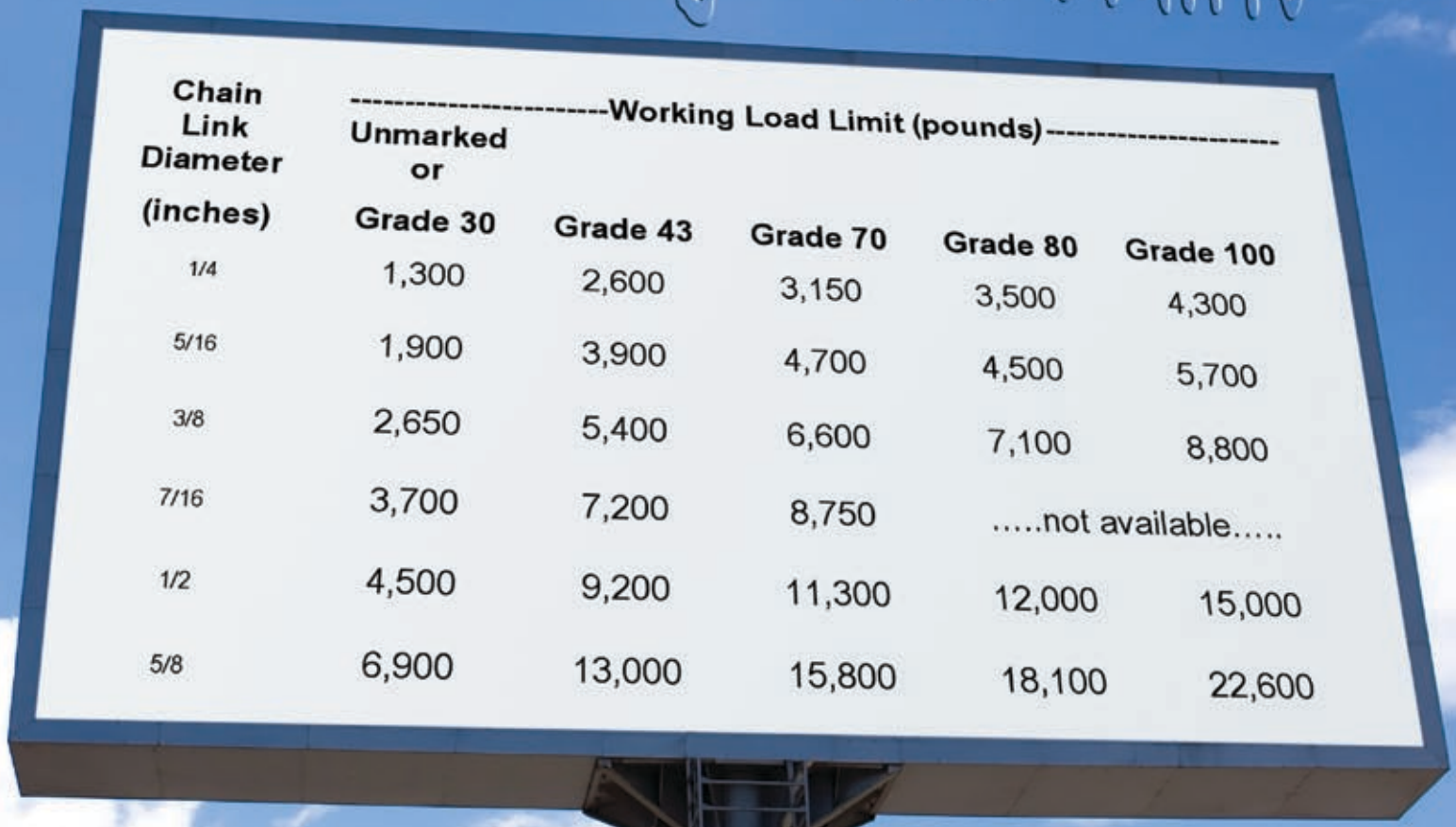
This machine is used to test the breaking strength of securement devices.

This chain has been stretched beyond its design limitations. Continued use could result in catastrophic failure.

Stretched links or cut webbing can dramatically reduce the point at which a tie-down fails. It is impossible to pinpoint the exact breaking point of a tie-down assembly due to wear and tear preceding its actual failure. Therefore, a design factor is calculated along with the breaking strength to determine a Working Load Limit. Breaking strength itself is never considered the WLL.

These links show evidence of damage sufficient to cause failure. Notice the pressure cracks at the welds.

Working Load Limits

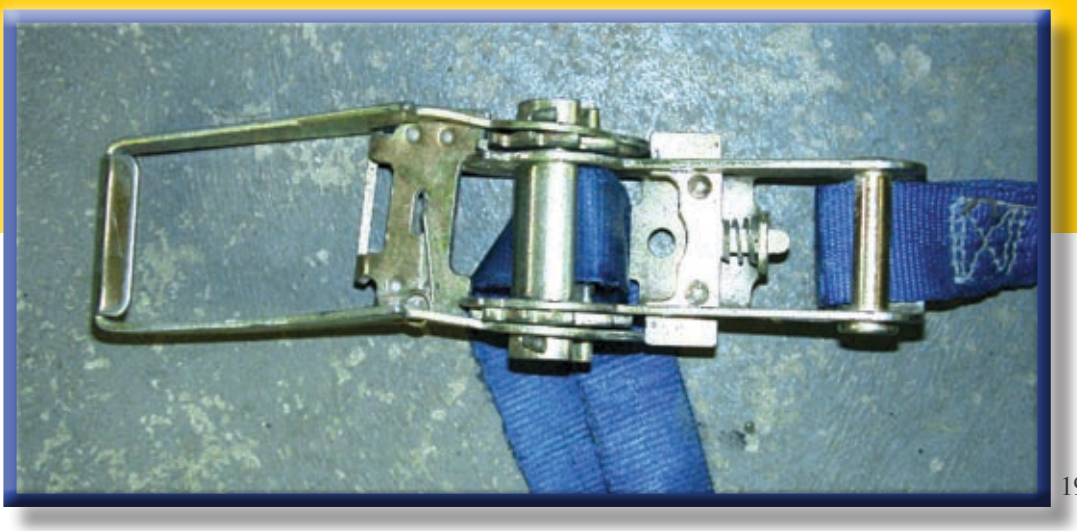


Chain Link Diameter (inches)	Working Load Limit (pounds)				
	Unmarked or Grade 30	Grade 43	Grade 70	Grade 80	Grade 100
1/4	1,300	2,600	3,150	3,500	4,300
5/16	1,900	3,900	4,700	4,500	5,700
3/8	2,650	5,400	6,600	7,100	8,800
7/16	3,700	7,200	8,750	.....not available.....	
1/2	4,500	9,200	11,300	12,000	15,000
5/8	6,900	13,000	15,800	18,100	22,600

Working Load Limit: The Bottom Line of Securement

The Working Load Limit (WLL) is the critical factor used to predict the dependable strength of a tie-down. The WLL is the maximum load, in pounds, that should be anchored by tie-down assemblies to attachment points that are in good condition. The WLL is calculated by multiplying the breaking strength by a design factor, often 1/3 of the breaking strength. For example, a tie-down with a 7,500-pound breaking strength has a WLL of approximately 2,500 pounds (7,500 x .33 = 2,500). This safety margin is critical because it is difficult to notice and allow for all of the weakened stress points on or within a cable, chain, or web: torn webbing or stitching; cracked, deformed, or broken hardware or links of chain.

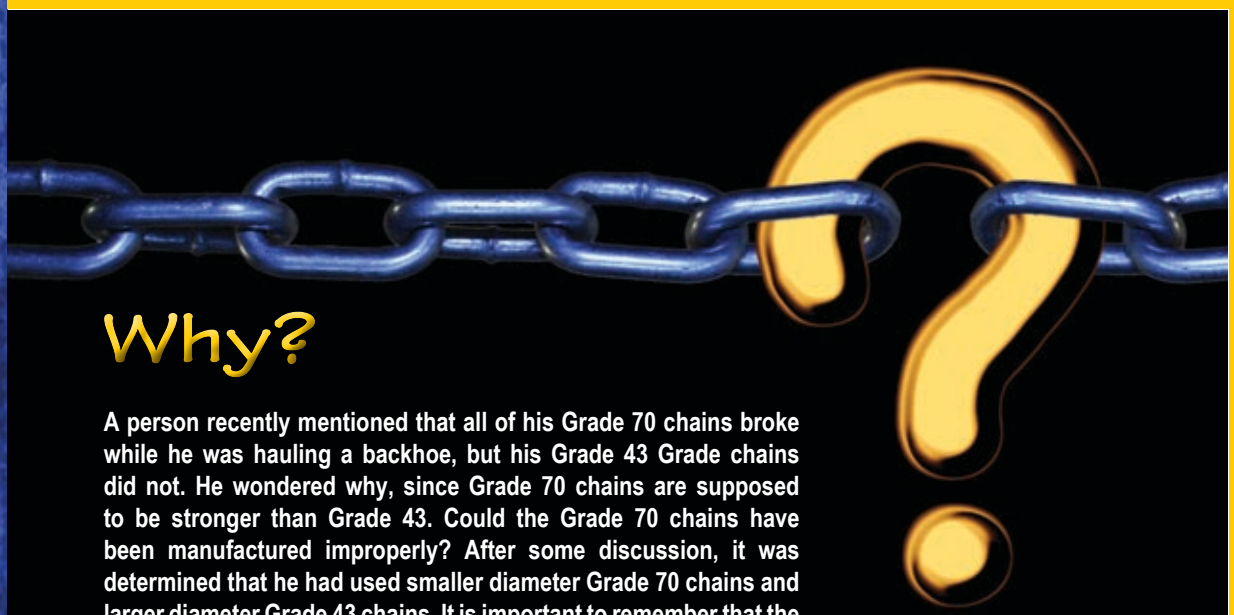
New web straps bear a tag that shows the Working Load Limit (above). The photo below shows that it is not always the webbing that fails. Too much pressure caused this metal ratchet to bend.



Working load limit for chains. The chain's grade and link diameter are used to calculate its WLL. Chains are designed by most U.S. manufacturers to meet the Working Load Limit for their grade, as described in the table on page 18.

Chain manufacturers and the United States Department of Transportation discourage the use of cheater bars when tightening chains. Cheater bars are pipes or other devices that extend the normal handle length of ratchets or pull-over-center binders for added leverage while tightening the chains. Tests have shown that tightening a chain by hand with a pull-over-center binder or ratchet creates enough tension to reach the chain's WLL. In similar tests, the use of a cheater bar allowed the chain to be tightened well beyond its WLL. If a cheater bar were used to tighten a chain with worn or stretch links, the securement device could fail, resulting in lost cargo.

Working load limits for web straps. Web straps are assigned WLLs based on width and strength, hardware assembly, and fiber content. Assuming two straps of different widths are otherwise identical, the wider strap has a higher WLL.

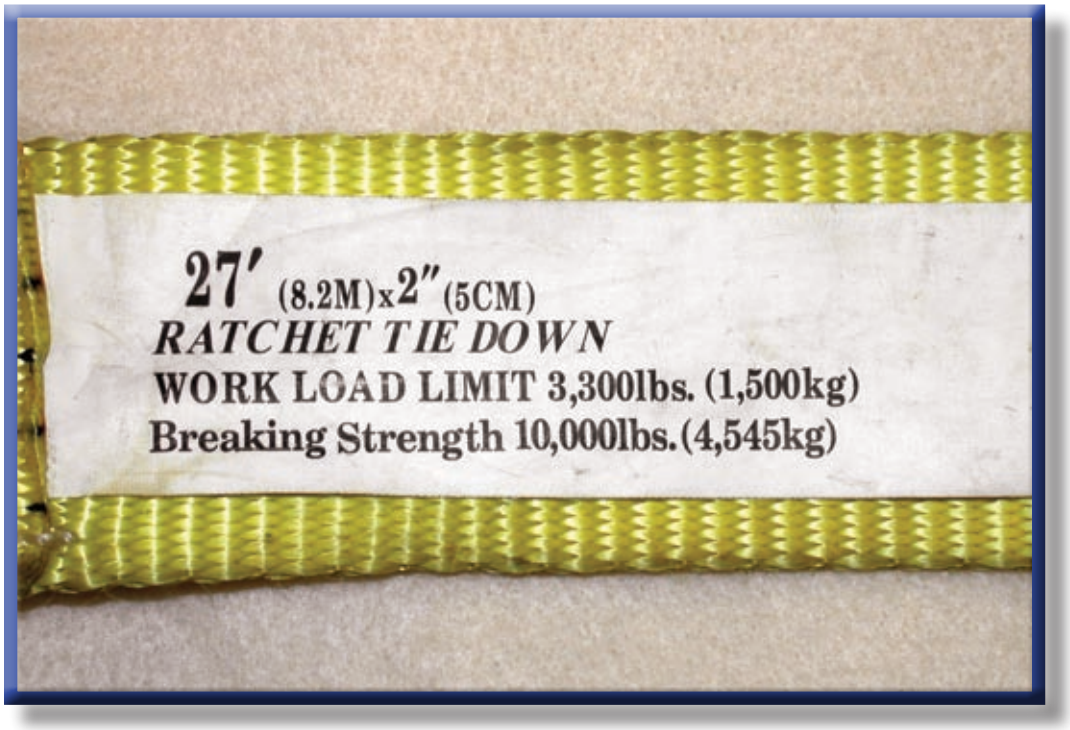


Why?

A person recently mentioned that all of his Grade 70 chains broke while he was hauling a backhoe, but his Grade 43 Grade chains did not. He wondered why, since Grade 70 chains are supposed to be stronger than Grade 43. Could the Grade 70 chains have been manufactured improperly? After some discussion, it was determined that he had used smaller diameter Grade 70 chains and larger diameter Grade 43 chains. It is important to remember that the amount of cargo a chain can secure is only partially determined by its grade; link diameter is also a factor. This incident reinforces the importance of considering both grade and diameter in determining the Working Load Limit of a chain.

Hand tightening a chain with a pull-over-center binder (below) keeps the pressure at or below the Working Load Limit. However, the use of a cheater bar (above) can result in too much pressure on the chain, binder, and attachments, thereby exceeding the WLL. Continued use of a cheater bar will weaken the chain and attachments.

The WLL generally is imprinted on a tag that is sewn near one end of the assembled web strap (examples below), although some manufacturers stencil or stamp it directly onto the webbing. Regulations recognize only these WLL labels and imprints.



Once a fabricator of tie-downs adds hardware and stitch patterns to the webbing, the WLL changes. Fabricators are required to pull-test their completed assemblies to determine the WLL that will be printed on the tag.

The working load limit of 2,000 pounds (left) is for the whole assembly. This includes the adjustable attachment bracket (below) which is secured to the trailer. In this case, the bracket might be the weakest link.

Making the Connection: Only as Strong as the Weakest Link

Think about the role that binders, anchor points, and hooks play in securing the load to the truck or trailer (below). It is important to understand that the WLL of a chain assembly is based on its weakest component.

Consider this example: A driver connects a 3/8" Grade 30 hook (WLL 2,650 pounds) to the end of a 3/8" Grade 70 chain (WLL 6,600 pounds) using a 3/8" Grade 70 connecting link (WLL 6,600 pounds). The weakest element in this example is the Grade 30 hook, so the assembly would have a WLL of 2650 pounds.

Keep in mind that anchor points (e.g., rails or eyes) on the truck or trailer may not have the same WLL rating as the tie-downs. It is recommended that you read the owner's manual or contact the manufacturer to learn the WLL of the anchor points on trucks and trailers. Drivers commonly use the side of the trailer as an anchor point, or they weld a 3/8" piece of steel to the trailer; but these solutions may not meet strength requirements.

Chain and web tie-down manufacturers list in their catalogs and sales brochures, and on their web sites, a disclaimer stating "not to exceed the Working Load Limits for chains and components." The weakest link concept is extremely important and will be discussed along with DOT securement regulations later in this publication.

The weakest link in this example is the attachment point!

Load Securement Regulations

DOT load securement regulations are published in 49 CFR Parts 393.100-136. Indiana's adoption of the Federal Motor Carrier Safety Regulations is found in Indiana Code (IC) 8-2.1-24-18. Commercial pesticide application companies and farmers must comply with DOT securement regulations if they transport cargo aboard a commercial motor vehicle.

Securement regulations are meant to keep equipment and supplies from falling off vehicles. The methods shown in these photos exemplify load securement.

DOT regulations define a commercial motor vehicle as any self-propelled or towed motor vehicle used in commerce to transport passengers or property on a highway under any of the following circumstances:

- The vehicle has a gross vehicle weight rating (GVWR), a gross combination weight rating, a gross vehicle weight, or a gross combination weight of 10,001 pounds or more.
- The vehicle is designed or used to transport more than eight passengers (including the driver) for compensation.
- The vehicle is designed or used to transport more than 15 passengers, including the driver, and is not used to transport passengers for compensation.
- The vehicle is used to transport hazardous materials requiring the vehicle to be placarded.

Drivers of government vehicles hauling cargo are exempt from DOT securement regulations. Drivers doing personal hauling are exempt, also; but if you haul your own lawn mower or skid loader for commercial use, you are not exempt.

If this mower is for personal use, federal regulations do not apply. However, state regulations require items to be generally secured, and the driver has met the requirement.

In all other situations, if the GVWR of the vehicle, trailer, or vehicle/trailer combination is less than 10,000 pounds, the hauler is exempt from DOT securement regulations. However, state laws require you to take general precautions to prevent cargo from escaping the transport vehicle.

Indiana Commercial Motor Vehicle Enforcement Division troopers and motor carrier inspectors are authorized to stop any vehicle if they believe its cargo is not being transported safely. The regulations state that a person who operates a vehicle hauling logs, lumber, pipe, poles, tanks, etc., on public roadways must secure the load with chains, wire cables, or webbing, and that the tie-downs must be strong enough to hold the load in place.

How would you like to be driving behind this load — and for how long?

Hopefully, the farmer driving this truck will make it home with all of his supplies...because if something tumbles off, it will be like leaving cash on the road.

It's just a matter of time before this ladder finds itself a new owner...or causes an accident.

Take the time and the simple steps to ensure that your equipment and supplies ride safely to your destination.

Have you seen a load like this on the highway? It is a common example of questionable judgment.

The securement regulations that deal specifically with farmers and commercial pesticide service industries address five major questions.

Question 1.
How many tie-downs are required?

The answer depends on the vehicle configuration, placement of cargo, and the cargo itself, including dunnage (anything not permanently mounted to the truck body or the trailer chassis, such as extra chains). Determine the length and weight of each piece of cargo and the number of pieces in the load to calculate the minimum number of securement devices required.

Bags of seed or boxes of pesticide on a trailer would constitute one load; that is, the "cargo" would be the collective load of bags or boxes.

When the article is not blocked or positioned to prevent movement in the forward direction (minimum number of tie-downs), follow these guidelines:

- Use one tie-down for articles five feet long or less and 1100 pounds or less.
- Use two tie-downs if the article is five feet long or less and more than 1100 pounds.
- Use two tie-downs if the article is longer than five feet but no longer than ten feet, regardless of weight.
- Use one tie-down for every ten linear feet or fraction thereof for articles greater than ten feet (49 CFR Part 393.100).

No matter how large or small, or how significant or insignificant, everything transported on the road must be secured.

Lots of logs.
One web strap.
Not a good idea.

The front pallet in this photo requires an additional tie-down. The load is less than 5 feet wide and greater than 1100 pounds.

The mowers below are blocked, braced, and strapped to the bed of the trailer. This meets or exceeds the securement requirement.

If the load being transported is 33 feet long, calculations based on these criteria would indicate the need for four tie-downs of adequate strength: one for each ten feet, plus one for the three additional feet. The number of tie-downs required is not dependent solely on cargo weight once the load is more than five feet long. The weight of the cargo is relevant to the working load, which will be addressed later.

How many tie-downs would be needed if transporting one 42-inch-wide pallet on a flat bed truck? One tie-down of adequate strength would be required if the load were less than 1,100 pounds, whereas a load greater than 1,100 pounds would require two tie-downs.

The pallets of copper sulfate were pushed to the front of this trailer and held together by one over the middle and one on the back side. The two straps combine the three pallets as a single load rather than three separate articles. Two additional straps are required (but not applied in this photo). AND: Because the headboard is less than four feet high and not as tall as the load, yet another securement device should have been applied over the front pallet (see page 78).

If you were transporting four pallets of bagged materials (each pallet weighing less than 1100 pounds) you would need one tie-down of adequate strength, per pallet. A minimum of two tie-downs would be required, provided the pallets are attached to each other and secured with a beam running the full combined length of the pallet.

When the article is blocked, braced, or immobilized to prevent forward movement (minimum number of tie-downs), it must be secured by at least one tie-down for every 10 feet of length and any fraction thereof.

Question 2.
How should the tie-downs be spaced along the cargo?

Tie-downs must be positioned to hold the cargo securely. Indiana law requires one strap each in the front, middle, and rear for loads more than 10 feet long.

"Officer! I didn't mean to draw your attention!"

Question 3.
How is the working load limit applied?

The collective WLL for all tie-downs must equal at least half the weight of the secured cargo; i.e., 10,000 pounds of cargo must be secured with chains and/or straps with a collective WLL of at least 5000 pounds.

Skill is needed to immobilize and secure this tree on the trailer.

Remember that attachments such as hooks and ratchets play a major role in the calculation of WLLs. Working Load Limits are calculated for each securement assembly. For example, let's say a binder with a 4700-pound WLL is used with a 3/8" Grade 43 chain that has a WLL of 5400 pounds. The lesser WLL (4700 pounds) is the official WLL of the assembly.

Question 4.
Are there special rules for transporting heavy machinery?

Additional regulations apply when transporting front end loaders, bulldozers, tractors, and power shovels that operate on wheels or tracks. The following four-point rule applies only when such equipment weighs more than 10,000 pounds:

- Accessory equipment must be completely lowered and secured to the transport vehicle.
- Equipment on articulated vehicles shall be restrained to prevent any change of position during transit.
- Equipment must be restrained against movement by using at least four tie-downs.
- Two tie-downs each must be affixed as close as possible to the front and as close as possible to the rear of the vehicle being transported, or to specifically designed mounting points on the vehicle.

Buckets that are not pinned (above and below) must be secured to the deck.

Equipment heavier than 10,000 pounds must be secured at four independent points, and each point of attachment must have its own binder. A separate, appropriate grade chain connected to each corner meets that requirement. But hooking the chain to the trailer and equipment and driving forward to tighten the chain, then using a binder just on the front, is not allowed. Note that the dozer below is totally unsecured!

A unit that weighs 10,000 pounds or more requires four adjustable securement devices, one on each corner. This load would also require a fifth to secure the hydraulic blade to the deck. The driver of this rig was pulled over for not having the dozer secured.

The machine on the trailer above weighs less than 10,000 pounds and measures between five and ten feet long, so at least two securement devices are required.

In the example above, a chain hook is attached to the trailer, run through a single attachment such as a clevis or hitch hole, and hooked on the other side. In this case, there is only one attachment on the equipment; it does not meet the regulations for equipment heavier than 10,000 pounds.

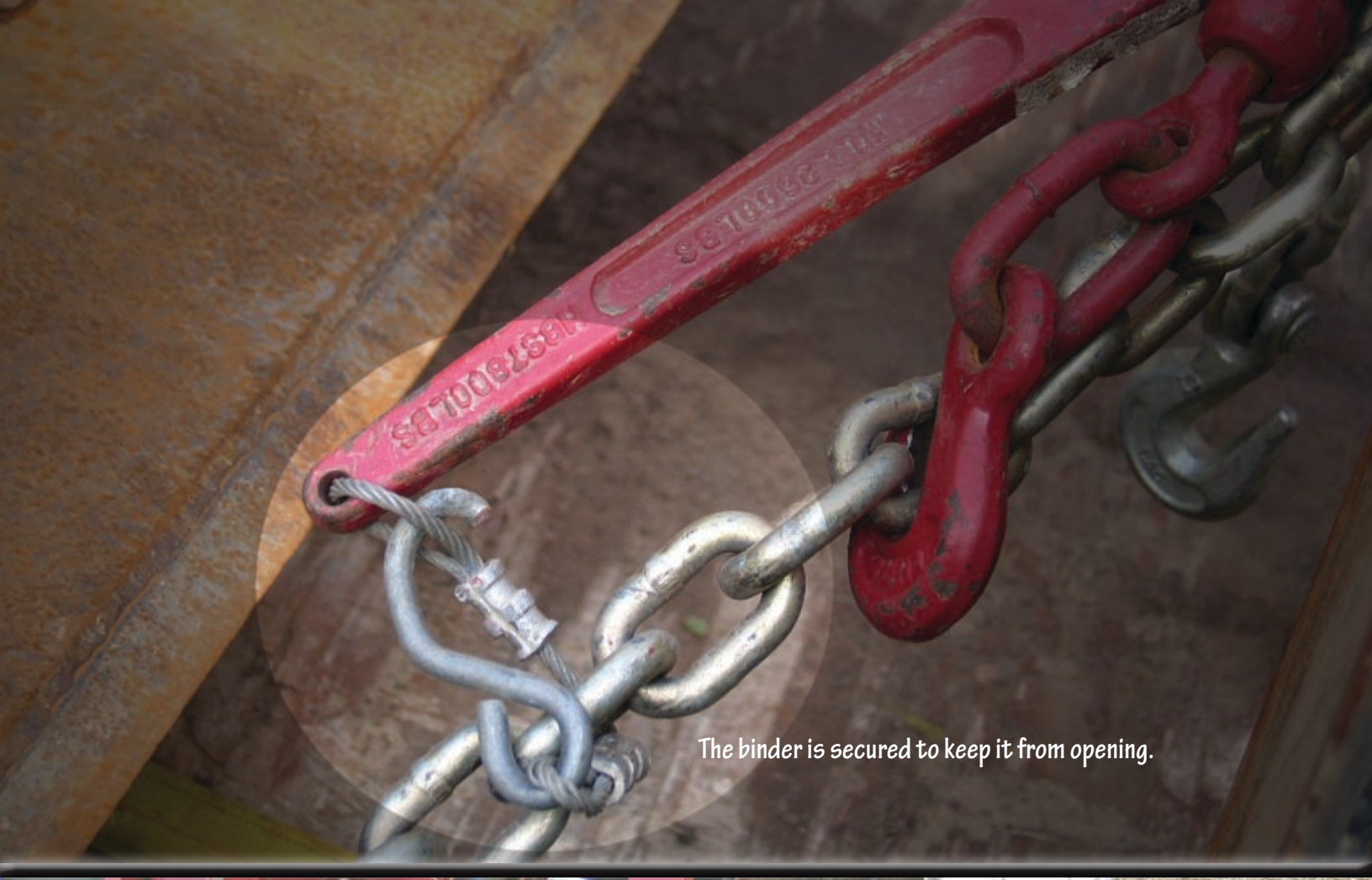
Drivers may use a single chain to make two separate attachments. Here is an example using a single chain with two separate and independent connections to the equipment:

> One hook on the side of a trailer is attached with a binder to a single spot around the right front. The hook on the other end of the chain is attached to the left front, and a binder is applied to that section. The extra length lies loose in the middle; it should be secured if it could pose a risk during transportation.

Question 5.
What is prohibited?

The regulations specify safety criteria for tie-downs:

- Cargo securement devices must be in proper working order with no damaged or weakened components.
- Tie-downs and other securement devices cannot contain knots.
- Securement devices (other than steel strapping) must have a means of tightening during the trip.
- Devices used to tighten chains, such as ratchets, must be secured to prevent opening during transport. The means of satisfying this requirement are left to the discretion of the transporter. The rules say only that tie-downs must be secured in a manner to prevent loosening or opening during transport.



The binder is secured to keep it from opening.

Loading the Truck and Trailer: Before the Tie-Downs Are Applied

The gross vehicle weight rating (GVWR) of a truck and trailer stipulates the maximum cargo weight that the unit may carry. Exceeding the GVWR is dangerous business: brakes work less efficiently, tires loose air pressure, and springs may be stressed to the limit. We've all seen overloaded trucks and trailers, but excessive weight can cause deadly consequences. Always position cargo carefully. Placing a load too far back on a long trailer may cause fishtailing; placing it too far forward on a trailer can overload the tongue, making steering difficult.

All DOT-regulated commercial motor vehicles and trailers require a pre- and post-trip inspection. It must be determined before departure that all tires are properly inflated and that the brakes, lights, and turn signals are in good working condition (49 CFR Part 396.9b2). Single commercial motor vehicles are exempt from post-trip inspections (49 CFR Part 396.1d), but it is wise to perform them anyway. Drivers must perform a visual inspection prior to operation.

Commercial motor vehicle drivers must inspect their loads to make sure that securement devices remain tight and that the cargo is not shifting. These inspections must occur at the following intervals:

- Once during the first 50 miles of transport.
- Every 3 hours or every 150 miles, whichever comes first.
- At every change of duty station (change of drivers).

Page 40: Carrying a load too heavy for the truck or pulling too much weight — not to mention driving on bad tires — is every bit as dangerous as not securing the load. Notice also that the trailer load is not properly secured, even though the driver has attached a couple of small straps.

Below: Loads do shift during transport, so check securement devices periodically along the way.

Loads need to be evenly distributed on the truck or trailer. Following are a few simple rules:

- Place the cargo as far forward as possible on trucks, stacking it from side rail to side rail.
- Place the heaviest part of the load at the bottom and the lighter portion on top.
- Use blocks and braces to secure the cargo (examples: nailing a 2x4 block to the wooden bed of a truck or trailer; placing a wedge under the load).
- Use tie-downs to supplement blocking and bracing.

Using, Inspecting, and Maintaining Tie-Downs

Make sure the anchor points to which you attach tie-downs can handle the load. Trucks and trailers generally are designed and manufactured to accommodate attachments, and chains are designed to hook back into themselves. When securing a load, make sure the chain is anchored in a stake pocket, crosses an integral part of the equipment (such as the framework), and ends in a stake pocket on the opposite side. Tighten the chain by using a chain binder, taking up as much slack as possible. There is no legal requirement to do anything with the slack, as long as it doesn't pose a transportation problem.

Pay special attention to the position of each tie-down when attaching it to the truck or trailer. Make sure the hook is in line with the tie-down at the anchor point. Pulling it at an angle from the tie-down results in force being exerted on the tip rather than on the throat of the hook; such tip-loading can reduce the WLL and cause deformed hardware or hardware failure.

Notice the point of attachment in the photo above: the attachment piece on the mower fits securely into the throat of the steel hook. But in the right-hand photo, the tip of the hook is the point of pressure; this is undesirable because the tip is the weakest point of the hook.

Exposed tie-downs on the outside of the truck or trailer can become compromised during an accident; therefore, always hook tie-downs inside the rub rail if possible. Some companies add an outside protector that allows the chain to be run between the bed and the protector and attached underneath. In an accident, the outside metal would protect the chain or webbing.

All points of securement should be inspected for damage before attaching a securement device.

Web straps should lay flat, without any twist, although some drivers twist them to reduce the annoying whistling they sometimes cause at highway speeds. Be sure to look for rough or sharp edges on cargo where it touches the webbing. An edge protector is required if the tie-down is subject to abrasion, cutting, or crushing (see page 76).

Inspections

It is nearly impossible to determine how long a web or chain will remain in usable condition, so visual inspection is critical. Tie-downs should be inspected prior to every use and immediately taken out of service when defects are found. The grade of chain, strength of webbing, frequency of use, and type of cargo are among the many factors that influence tie-down longevity.

Chains should be inspected for bent, cracked, twisted, broken, or stretched links; sharp nicks, gouges, abrasion, heat damage, discoloration, and wear. Knotting reduces chain strength, so knotted chains must be removed from service.

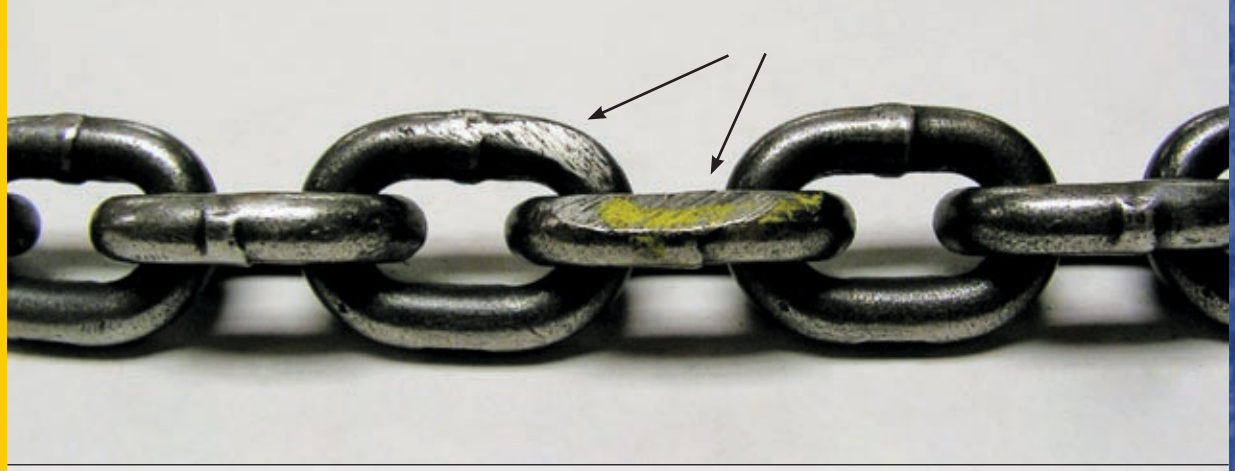
Look closely for wear and abrasion on web straps. Bent, cracked, twisted, or broken fittings and buckles compromise strength, as do cuts, burns, broken stitching, holes, and knotting. Extremely stiff webbing indicates ultra violet degradation. Each of these conditions warrants retirement of the tie-down.

This chain has been drastically abused. Notice that the links have been ground, twisted, elongated, and bent.

The chain in this photo displays classic negative effects from the use of a cheater bar. Tightening the chain beyond its Working Load Limit has caused individual links to twist out of shape.

This page: This web strap has served its time. Replacement is far past due.

Page 47: The grinding and general wear on these assembly pieces significantly lower the Working Load Limit (see arrows).

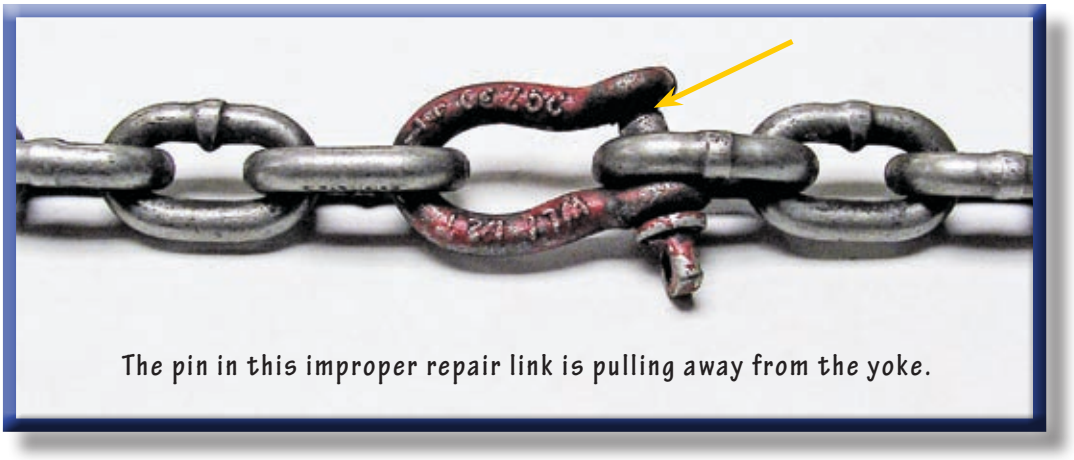


Maintenance

Cables and chains need periodic oiling to help reduce abrasion from metal-on-metal contact. Friction is created when the inner core of a cable moves independently of the outside strands and when chain links rub against each other. Oil helps to reduce the friction to minimize wear and tear. Buckles and fittings used with web straps also need lubrication to keep them operating efficiently.

Repairs

Chain repair is acceptable, but replacement links must be equal to or greater in strength than the originals. Actually, there are only a couple of repair links that are authorized by DOT. These are found in 49 CFR Part 393.100. Repair of damaged or defective webbing is not permitted.


The pin in this improper repair link is pulling away from the yoke.

Chains cannot contain welds (top) or bolts (middle).

The unrated 3/8" repair link (left) would be acceptable if attached to a 30-grade chain.

The standard repair link in the top photo is graded G-30, as stamped into the side of the link. The repair link in the middle photo is graded G-7 and will hold a chain 1/4" to 5/16" in diameter. Its Working Load Limit is 3,150 pounds (1/4" chain) to 4,700 pounds (5/16" chain).

There is no grade marked on the repair link in the bottom photo; therefore, it is treated as a G-30 and assumes a WLL of 1,300 pounds (1/4" chain) to 1,900 pounds (5/16" chain).


All devices shown on this page are unauthorized for load securement.

Special Considerations: Custom Designed Trailers and Chains

Special Trailers

It is extremely important that heavy loads be loaded onto and pulled with equipment suited to the job. Some companies and farmers modify their trailers or purchase new ones designed to haul specific pieces of heavy equipment, matching the trailer/equipment combination to the trucks they will be using to pull them.

Special Chains and Straps

Grade 43, Grade 70, and other common grades of chain can be purchased in lengths of 16–30 feet with hooks and links attached. Chains and webs can be made to order — length, strength, fasteners — based on cargo requirements to satisfy WLL.

DOT Out-of-Service Criteria: Safety Above Convenience

Defective tie-downs may be ordered removed during an inspection. And if the removal drops the number of tie-downs or the WLL below those required, the Indiana State Police can place your vehicle out of service. It can be parked until the defective tie-down is replaced, resulting in an expensive loss of time — and possibly fines.

Oops! Not what you want to see in your rearview mirror.

The **Working Load Limit** established by the manufacturer is the maximum load (in pounds) to which new and used tie-downs in good condition should be applied.

How Does DOT Calculate the Working Load Limit?

During inspections, DOT officers calculate the WLL by checking the grade markings on the chain and consulting a standard weight rating table (page 18). If chains are unmarked or unrated, they measure the diameter of the links to assign a rating, using the Grade 30 column of the table.

This photo shows a caliper used by DOT enforcement personnel to determine chain diameter.

For example, a marked ¼-inch Grade 70 chain has a WLL of 3,150 pounds, but the unmarked version of the same chain is assigned a WLL of only 1,300 pounds (¼-inch Grade 30).

Working Load Limits ~ Chains

Chain Link Diameter (inches)	Unmarked or Grade 30	Grade 43	Grade 70	Grade 80	Grade 100
¼	1,300	2,600	3,150	3,500	4,300

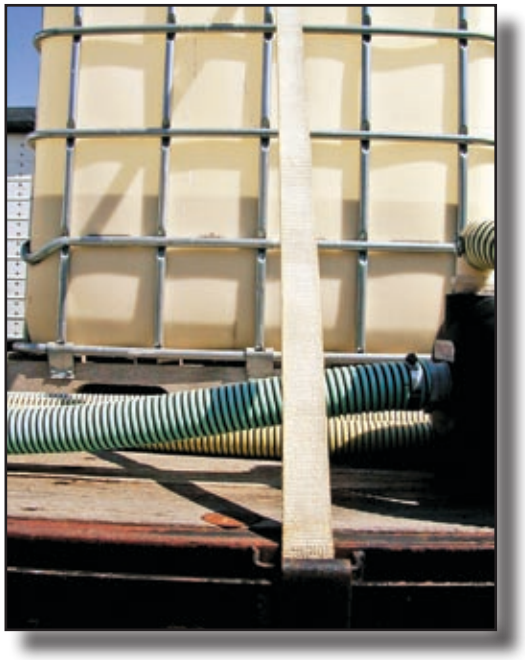
In this example, the driver will give up 1,850 pounds of WLL by using an unmarked chain. When using unmarked chains, determine the WLL as described above.

Manufacturers of web straps list the WLL on a tag sewn to or stenciled onto the webbing. When the tag is absent or worn, the WLL of the unmarked web strap is 1000 pounds per inch of width (see chart below).

It should be noted, however, that the Web Sling and Tie Down Association publication entitled "Recommended Standard Specifications for Synthetic Web Tie Downs" recommends removing from service any strap without a readable WLL assigned by the manufacturer.

Working Load Limits ~ Webbing ~

Unmarked Web Width (inches)	Working Load Limit (pounds)
1	1,000
1 ¾	1,750
2	2,000
3	3,000
4	4,000

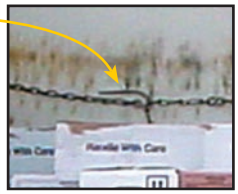


As a general rule, unmarked web assemblies such as this one (left) have lower Working Load Limits than those marked or tagged by the manufacturer.

How Does DOT Decide Whether a Securement Device is Defective?

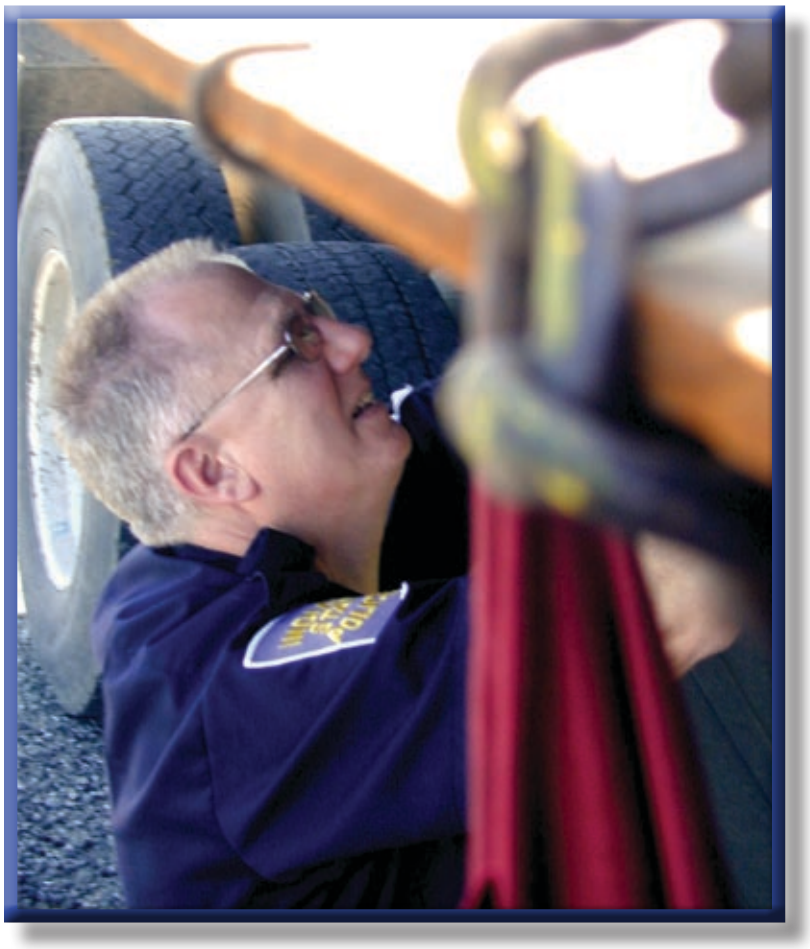
DOT officers may remove a tie-down from service during inspection and, by doing so, render your rig out-of-service if the remaining tie-downs don't satisfy the WLL. You can guard against an out-of-service order by carrying replacement chains and webbing — and you can reduce the likelihood of needing them by inspecting all tie-downs before each use.

Damaged chains should be removed from service. Look for broken, cracked, twisted, bent or stretched chain links; nicked, gouged, abraded, excessively worn, or welded (repaired) links; knotted chains.

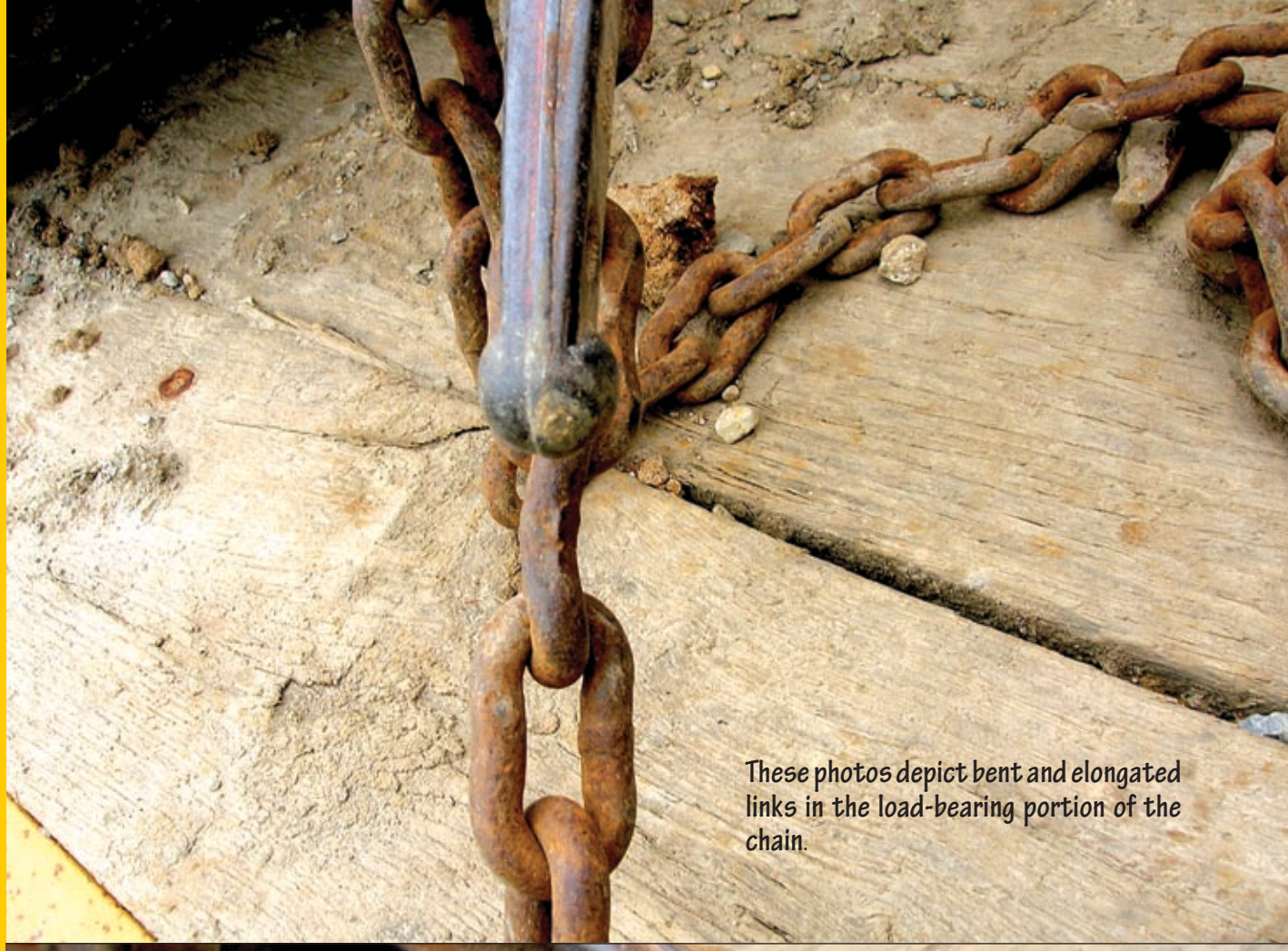


Enlargement shows wire holding chain together.

A wire connecting two ends of a chain (above) or a defective "chain" cobbled together with bolts (right) would not pass inspection.



A DOT enforcement officer conducts a roadside inspection (above). The yellow chalk marks (lower photo) indicate a chain that the officer has determined to be defective.



These photos depict bent and elongated links in the load-bearing portion of the chain.

A Properly Secured Load

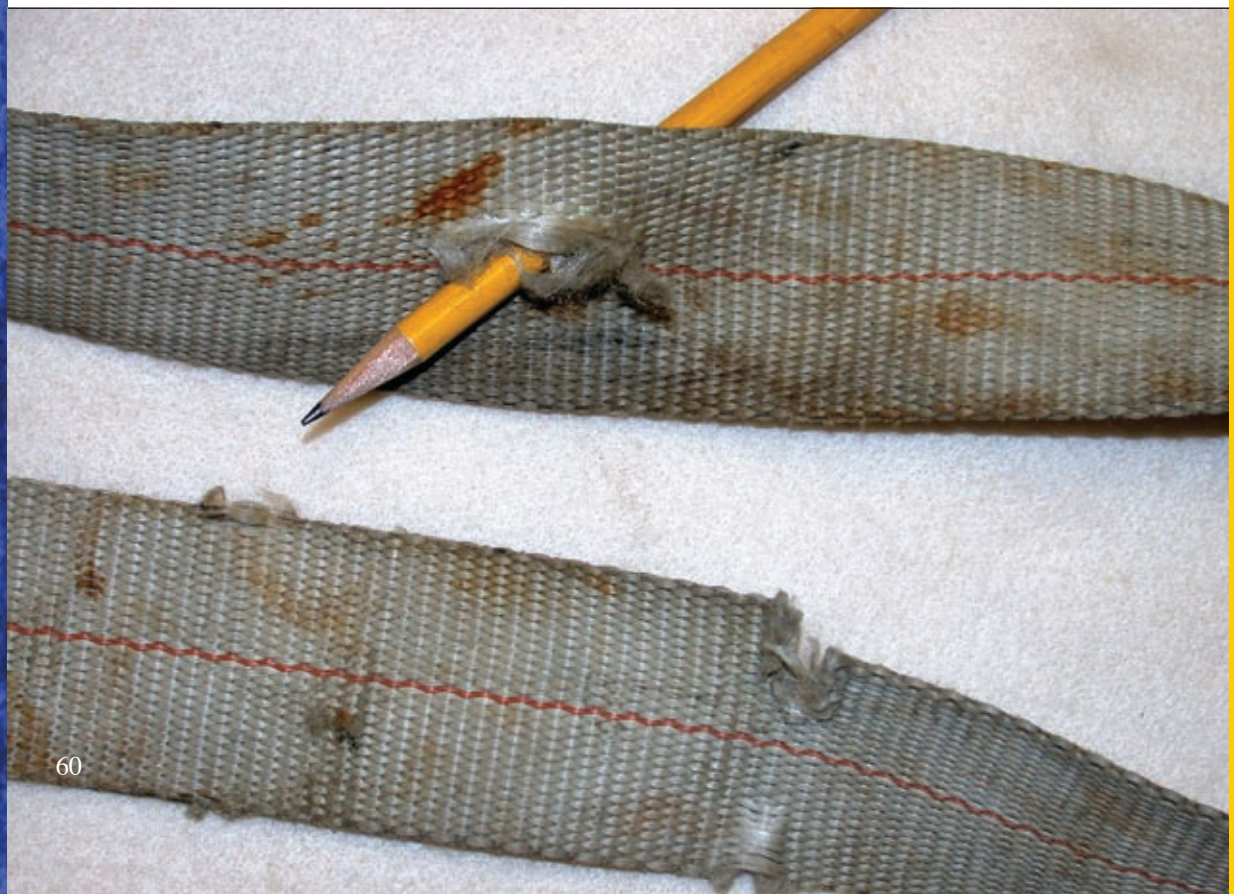
The anchor point is pulled out, making the whole web device ineffective.
Broken individual wires (below) weaken the cable and create injury potential for persons handling it.

Web straps should be discarded when they show major physical defects such cuts, cracks, burns, broken stitching, knotting, fraying, or holes in the webbing; attachments that are broken, sprung, bent, twisted, nicked, or gouged also should be removed from service. Repairs to web strap assemblies are not allowed.

However, most webs in use have minor defects, and DOT has established "out-of-service" limits for webbing, based on width. Any synthetic web strap with cuts, burns, and/or holes across the face of the webbing, throughout the load bearing portion, totaling more than the allowance stated in the table must be removed from service.

Webbing Defect Size Limits

Web Size (inches)	Out-of-Service Range (inches)
1 ¾	More than 3/8
2	More than 3/8
3	More than 5/8
4	More than 3/4



The photo on page 60 and the two on this page show webbing that would not pass a DOT roadside inspection.

Additional Questions About Load Securement

Additional regulations impact how loads are secured. Here are some frequently asked questions from growers and commercial pesticide applicators.

Do I have to do anything special if I don't have a DOT commercial motor vehicle?

Indiana general transportation regulations specify that any load over 10 feet long must be secured with at least three tie-down assemblies: one each in the front, middle, and back of the cargo (IC 9-20-18-14 and IC 9-21-8-48). The cargo must not drip, sift, leak, or otherwise escape from the vehicle. Information found in the load securement rules offers good advice for anyone involved in transporting cargo on the highway.

Are securement devices other than wire ropes, chains, and webs allowed?

Cargo securement can be accomplished with chains, webs, or wire ropes, but there are other ways as well. For instance, many horizontal liquid fertilizer tanks are held in place by steel hoops that go up an over them. These are bolted to the floor of the truck or trailer (see below). As long as the bed is solid and the bolts strong enough, this is acceptable.

Another example is the bolting of pesticide tanks directly onto the bed of a truck or trailer. In such cases, the cargo is considered secured if the bed of the truck or trailer is not rusted or otherwise deteriorated and if the load is prevented from shifting on or in the transport vehicle. Remember, the actual WLL of the assembly is the lowest WLL of any of the individual components — possibly the bolts.

Alternative means of securement, such as bolts, brackets, metal hoops, etc., meet standards for securement.

Routinely examine all nuts and bolts and immediately replace any that are stretched, bent, or defective. Bolts also have WLLs, so select them accordingly. Some companies use tie-downs as secondary protection for tanks bolted to the vehicle.

Rope may be used to help secure a load, but its WLL varies significantly, depending on its content. Some examples are provided below.

Working Load Limits ~ Rope

Expressed in Pounds

Rope Diameter (inches)	3/8	7/16	1/2	5/8	3/4	1
Manila	205	265	315	465	640	1050
Polypropylene Fiber	400	525	625	925	1275	2100
Polyester Fiber	555	750	960	1500	1880	3300
Nylon	278	410	525	935	1420	2520
Double Braided Nylon	336	502	655	1130	1840	3250

While rope is authorized for use as a securement device, it may not be a good idea to rely on it. The one shown below broke when its Working Load Limit was exceeded.

Does the DOT inspector count defects in the "tail" of the webbing?

No. DOT is concerned with the portion of the web strap that actually secures the load. Excess webbing (the tail) is not an active part of the securement assembly. However, if you were to use the same web strap on a larger load requiring use of the entire web length, any defects would become a significant factor.

How does DOT calculate the Working Load Limit and the number of straps needed when a tank is partially full?

DOT calculates the WLL and number of straps needed based on what the vehicle is actually transporting at the time of inspection. In this example, the 250-gallon tank (on the right, below) is about three-quarters full. It is holding 188 gallons at 10 pounds per gallon, or 1,880 pounds. Since the tank is less than five feet and more than 1100 pounds, two tie-downs would be needed. The tie-downs would have to have a WLL that meets or exceeds 940 pounds since the collective WLL for all tie-downs must equal at least half the weight of the secured cargo.

A DOT enforcement officer will determine the Working Load Limit and the number of securement devices required by calculating the weight of a tank and its contents.

Who is responsible for securing the load?

This is an important question. DOT places the responsibility for load securement on the person in control of the loaded vehicle when it leaves the property. A farmer or commercial applicator leaving a dealership with a pallet of seed and a pallet of pesticide product is in control of the vehicle and thus responsible for securing the load to the truck or trailer. The driver is responsible for using the correct number of tie-downs with appropriate WLLs. If the tie-downs fail and an accident occurs, the driver is liable.

The driver is responsible for securing the load — always.

Does my insurance provider have any input into the proper securement of my cargo?

Your insurance company presumes that you will secure cargo as required by DOT. If your failure to do so were to result in an accident, your insurance company could refuse to pay the claim. Your loss could become astronomical if personal injury or environmental contamination were involved.

Here's what happened...

I was hauling a small, shrink-wrapped pallet of fungicide that weighed only 750 pounds. The boxes were stacked three deep and stood just a little taller than the cab of my pickup. The shrink-wrap appeared good and tight; but as I was driving along, the top row of boxes broke loose and fell onto the highway. A semi behind me hit one of the boxes, and jugs of fungicide went flying. Luckily, the jugs did not break open and no vehicular accident occurred. But the potential for disaster was real, and I learned a valuable lesson.

ALWAYS SECURE YOUR LOAD!

Does the DOT regulate the safety chains used to secure a trailer to a vehicle?

Indiana law states only that safety chains must be of sufficient strength to "hold" the trailer when loaded. However, federal law specifies that the chain must have an absolute (i.e., breaking strength) not less than the gross weight of vehicle being towed. Some insurance companies state that if the manufacturer's recommendation for safety chains cannot be determined, the chain must be Grade 80. A locking mechanism must be in place to secure the coupling device to the ball.

Note the safety chains connecting the trailer to the truck.

Is it okay to twist webbing to prevent the whistling sound?

Yes, DOT does allow drivers to twist web straps to reduce wind noise.

Am I required to secure cargo inside an enclosed truck or trailer?

While more attention is given to proper securement of visible loads on trucks and trailers, enclosed cargo also must be secured against moving fore, aft, and sideways; i.e., cargo must be pushed toward the front and to the sides of a truck. If placed in other areas of an enclosed truck, it is treated exactly like cargo on an open truck or trailer and is subject to the same requirements.

The yellow poly tank inside this trailer is secured by a metal bar.

Every item transported inside an enclosed trailer must be secured according to the same regulations that apply to open trailers. The photographs on this and the following page show numerous examples.


WARNING

Are there any requirements for transporting bulk materials?

The driver must ensure that transported materials do not blow, sift, leak, or fall off the vehicle. Whether it is corn, hay, mulch, or other materials, the cargo and any residue such as dust or particles must not impair the vision of drivers following the transport vehicle. When in doubt, cover the cargo with a well-secured tarp.

Drivers must ensure that loose materials such as sand, mulch, hay, rocks, grain, etc., do not impact drivers following their vehicles. The photo below and those on page 73 show the loading, tarping, and securement of a load of mulch to prevent it from blowing during transport.


11


HIDAY

If the loader bucket is attached to the equipment, does it need to be tied down?

Regulations require that unless the bucket arm is mechanically locked, it must be secured to the deck as in the photo below.

Page 74

Top and middle: These loads are secured by tarps to ensure that no debris escapes during transport.

Bottom: This is evidence of a driver pulled over by DOT for not having the load tarped.

Since my skidsteer loader is transported on my trailer and weighs less than 10,000 pounds, how should it be secured?

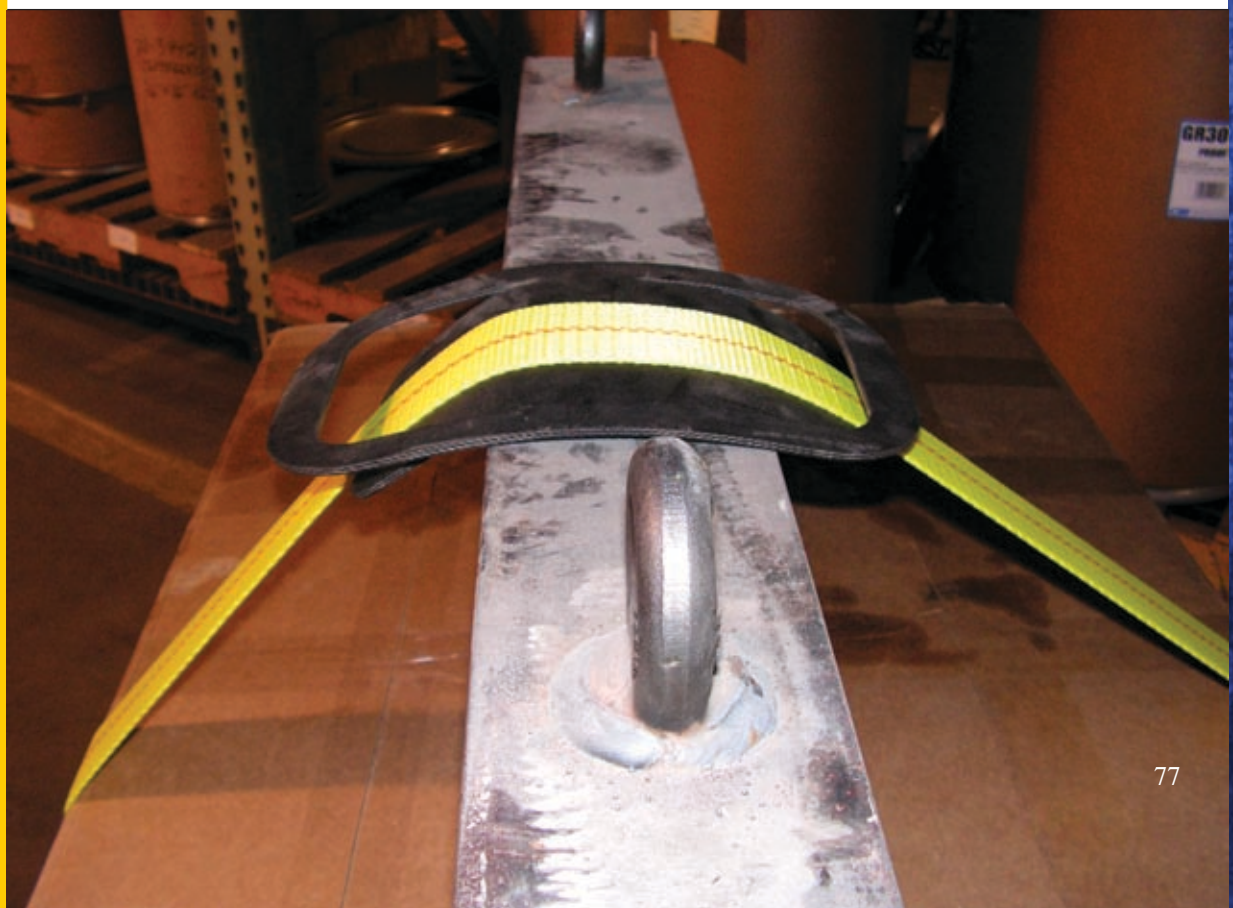
Equipment weighing 10,000 pounds or less has to meet the same requirements as any other cargo in that range. Any such vehicle over 10,000 pounds would require four independent points of attachment.

The driver of this rig was pulled over by DOT for failing to secure the skidsteer to the trailer.

What are the rules for edge protection?

Whenever cargo being secured with web straps has the potential to cut the webbing, the driver must provide some type of edge protection to prevent it. The rules can be found at 49 CFR Part 393.104(f)(5).

Edge protectors may be used to keep web straps from cutting into articles in transport (left) or to keep transported items from cutting into the webbing (below).



Are there specifications for front end structures used as part of the securement system?

In many cases, a front end structure such as a headboard is used to prevent cargo from moving forward. DOT regulations require front end barriers to extend four feet above the floor of the vehicle or to a height that will prevent forward movement of the cargo, whichever is lower.

Note the headboard on this trailer.

If my cargo is shrink-wrapped, does it meet the securement regulations?

No! Shrink-wrapping is designed to minimize damage during hauling. It can loosen or tear, allowing the wrapped cargo to shift, and there is the possibility that the entire shrink-wrapped unit could shift. Shrink-wrapped cargo must be secured for transport.

It's dangerous to transport unsecured pallets of materials. Shrink-wrap will not keep stacked items from shifting and breaking the wrap. Shrink-wrapped pallets must be secured to the deck.

Are there regulations that stipulate the use of one type of binder over another?

No. Both pull-over-center binders and ratchets are allowed.

A pull-over-center binder (top) and a ratchet (bottom).

Conclusions

Sometimes we're in a hurry. Sometimes we're more concerned about just getting to the first job of the day than getting there safely. We think the stuff in the back of the truck will be okay — it's never fallen off before! And as we move from site to site and finish the last job of the day, we're in a hurry to get home; the mower doesn't need to be anchored to the truck bed — even if it moves back and forth, it can't go anywhere, right? Maybe. Maybe not.

Almost without exception, cargo falling off a truck or trailer costs you money. A single bag of seed corn, for example, can cost $200 — a container of pesticide, even more. If your cargo falls into traffic and causes an accident, you may face legal repercussions due to personal injury, environmental contamination, or property damage. Hundreds of businesses experience losses due to fallen cargo each year. If you are found negligent, your insurance company can refuse payment in certain situations.

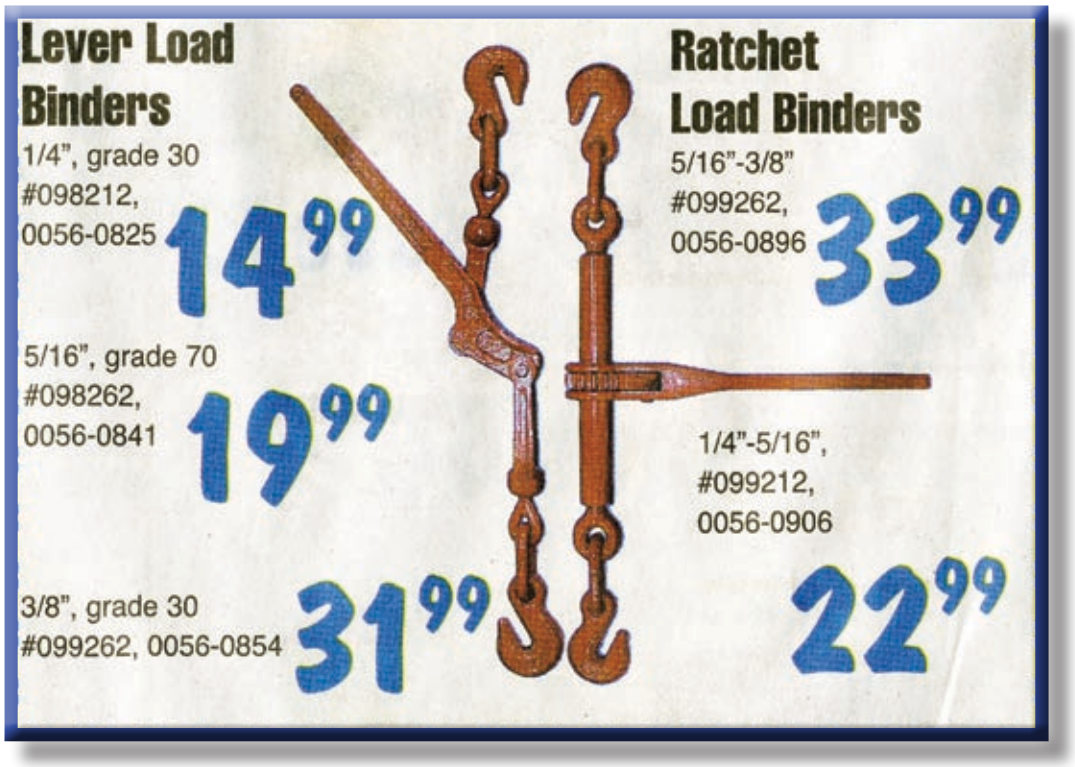
"Doing it right" is an inexpensive way to conduct business.

Understanding "Working Load Limit" is key to transporting your goods safely on the road.

Drivers can eliminate certain risks by selecting and using the right tie-downs for the job at hand. It is imperative that they know how to make the selection, based on the WLL and size of the cargo, and how to space and apply them properly. Drivers also are responsible for inspecting tie-downs before each use. The responsibility for having the appropriate tie-downs readily available lies with the employer.

Cargo securement is cheap insurance. It must take priority each and every time you hit the road with a load in tow. Taking the time to properly load and secure your cargo will ensure safer transport and reduce your loss potential. It just makes sense.

No driver wants to cause injury to others. Secure your load to protect everyone's safety.



Caption...

Know your securement products before you buy them.

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Acknowledgments

Work on this publication was partially supported with outreach funding from the Indiana Water Resources Research Center (IWRRC) at Purdue University.

The authors would like to thank John Obermeyer (Purdue University), Dee Davis (Indiana State Police), Michael Jansen (Jansen Landscaping), Stan Miles (Pioneer Hi-Bred) and Scott Guinn (Scott's Lawns) for some of the photographs used in this publication.

The front and back cover photos are from fotolia.com, as are the background photos on pages 3, 6, 11, 13, 14, 18, 20, 50, 53, and 59.

The following individuals provided numerous comments on early drafts of this publication, which greatly improved its technical accuracy.

Dave Baker, Kova Ag Products, Inc.
Paul Baute, Grammer Industries
Richard Blankenship, Mark M. Holeman, Inc.
Bernard Cook, Indiana State Police
Luann Downton, Maschmeyer's Nursery, Inc.
Charles Lovins, Indiana State Police
Ronald Clark, Clarks Cutting Edge
Matt Pearson, Office of Indiana State Chemist
Michael Pride, Indiana State Police
Mark Sawyer, Stone Center
Jim Wilson, South Dakota State University

Tie-Down Guidelines

Follow these guidelines for articles that are neither blocked nor positioned to prevent movement:

- **Use 1 tie-down for articles 5 feet long or less and 1100 pounds or less.**
- **Use 2 tie-downs for articles 5 feet long or less and more than 1100 pounds.**
- **Use 2 tie-downs for articles longer than 5 feet but less than or equal to 10 feet.**
- **Use 2 tie-downs for articles longer than 10 feet; and use 1 additional tie-down for each additional 10 feet (or fraction thereof) beyond the first 10 feet of length.**

~ Webbing ~

Working Load Limits

Width of Unmarked Web	Working Load Limit
1 inch	1000 pounds
1¾ inch	1750 pounds
2 inches	2000 pounds
3 inches	3000 pounds
4 inches	4000 pounds

Out-of-Service Criteria

If webbing damage measures 3/8 to 3/4 inch, depending on the web width, the web strap should be taken out-of-service.

Web Width	Size of Damage (holes, cuts, etc.)
1¾ inch	Larger than 3/8 inch
2 inches	Larger than 3/8 inch
3 inches	Larger than 5/8 inch
4 inches	Larger than 3/4 inch

~ Chains ~

Chain Link Diameter (inches)	Working Load Limit (pounds)				
	Unmarked or Grade 30	Grade 40	Grade 70	Grade 80	Grade 100
1/4	1,300	2,600	3,150	3,500	4,300
5/16	1,900	3,900	4,700	4,500	5,700
3/8	2,650	5,400	6,600	7,100	8,800
7/16	3,700	7,200	8,750	....not available....	
1/2	4,500	9,200	11,300	12,000	15,000
5/8	6,900	13,000	15,800	18,100	22,600

~ Rope ~

Type of Material	Rope Diameter (inches)					
	3/8	7/16	1/2	5/8	3/4	1
	Working Load Limit (pounds)					
Manila	205	265	315	465	640	1050
Polypropylene Fiber	400	525	625	925	1275	2100
Polyester Fiber	555	750	960	1500	1880	3300
Nylon	278	410	525	935	1420	2520
Double Braided Nylon	336	502	655	1130	1840	3250

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