DANGER! Falling Cargo

The importance of proper and safe securement of your load

Richard M. Ziernicki, Ph.D., P.E. and Ashley Heist, B.E.
Knott Laboratory, LLC

Transportation of cargo is a keystone of any market economy. Materials and products are often transported several times and travel hundreds if not thousands of miles before finding a home. For smaller items, transport does not pose much of a problem as they can be easily packaged and transported in well-secured storage containers. However, as objects get larger, they often become more burdensome to transport and necessitate more complex methods of securement during transport. Industrial materials, building supplies, construction equipment, even cars and trucks themselves are all transported as cargo at one time or another and all of these items have to be properly secured for the trip.

Cargo securement is a serious issue. Improper securement of cargo can lead to devastating consequences, especially during vehicular transportation where cargo trailers are constantly traveling alongside other vehicles. On the roads, flatbed trailers are often used to transport large or unusually shaped cargo which must be tied or anchored in some way to the trailer. While it may seem easy enough to load the cargo and throw a number of chains or straps over the top, proper cargo securement is often a technically challenging issue. A proper securement method must not only take into account the attachment of the items to the trailer but also how the cargo will affect the vehicle dynamics and how the system as a whole will respond to a multitude of driving conditions. The Large Truck Crash Causation Study conducted by the Federal Motor Carrier Safety Administration and the National Highway Traffic Safety Administration reports that seven percent of serious trucking accidents nation-wide were recorded to have cargo shift or cargo securement as a factor associated with the accident[1].

What can go wrong

The engineers at Knott Laboratory have been involved in a number of cases involving cargo securement failure. Perhaps the most obvious scenario is the malfunction or breakage of the securing components such as tie-downs, tightening devices, or anchors. Component failures can occur when the components are not rated for the forces encountered during transit. Hard braking or excessive speed through curves can dramatically increase the forces acting

on the tie-downs and other securing components. Additionally, poor maintenance of the components may reduce their strength. The breaking strength of synthetic webbing straps, for example, can be significantly reduced if the webbing is worn or weather-damaged.

Even when the securing components are properly maintained, they can become damaged during transport, unbeknownst to the driver. Tie-downs that are not properly guarded from abrasive surfaces can fray or tear while in transit, significantly reducing their strength.

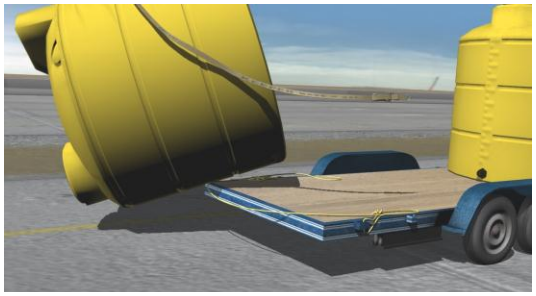

Figure 1: Loss of cargo during transport

Furthermore, the correct placement and tightening of the securing components is paramount to the proper securement of any load. Tie-downs that are incorrectly placed can become loose and fall off during transport. Figure 1 is a frame from a Knott Laboratory simulation depicting the loss of cargo due to improper placement of the tie-downs which lead to a fatal accident.

In addition to tie-downs, proper cargo securement often involves a number of other components such as shoring bars, friction pads, chocks, cradles, dunnage, or blocking. Failure to use the necessary components or improper use of any such component can lead to serious accidents.

Improper securement of cargo may result in unexpected cargo loss during transport but even properly secured cargo can cause or contribute to trucking accidents. The loading of cargo onto a trailer changes the center of gravity of the vehicle and therefore affects how the vehicle responds to different driving conditions. Stopping distance, acceleration, stability, and maneuverability can all be adversely affected by cargo loads. Drivers of vehicles hauling cargo must be aware of the limitations of the vehicle and adjust their driving accordingly.

Accidents involving cargo securement do not always occur while the vehicle is in transit. Loading and unloading cargo is often more dangerous than the transport, especially when the cargo has the ability to shift or roll. Knott Laboratory investigated a case in which the driver of a tractor-trailer was seriously injured while removing the tie-downs from his cargo. He had been hauling pipes that were bound in groups by steel strapping, layered on wooden blocking, and fastened to the trailer with synthetic winch straps as shown in Figure 2. As the driver released the tension in the winch straps, several pipes rolled off the top of the load and stuck the driver as they fell to the ground. Further inspection of the accident scene photos revealed broken steel strapping and unsupported segments of pipe.

Figure 2: Dangers involved in unloading

CFR Requirements

The Code of Federal Regulations (CFR) addresses the issues of proper cargo securement under the regulations set forth by the Federal Motor Carrier Safety Administration[2]. Parts 393.100 through 393.136 discuss general regulations for the proper securement of cargo as well as several commodity-specific regulations for items such as logs, boulders, and machinery.

General requirements include performance criteria for all components of the securement system. All components must be rated for forces encountered during specific acceleration or deceleration scenarios and must be properly maintained without damage or defect. Additionally, the regulations set forth manufacturing standards for devices used to secure cargo.

Beyond performance criteria, the regulations require a minimum number of tie-downs used to secure the load according to the weight and length of the cargo. The tie-downs must be capable of being tightened by the driver during periodic inspections. Furthermore, cargo must be restrained by necessary means to prevent rolling or shifting. While the regulations do not define which devices or components must be used, the cargo must be secured sufficiently to prevent loss of load or shifting of load during transit.

In addition, part 392.9 sets forth requirements for the inspection of the cargo and cargo securement system. Under these regulations the driver must ensure that the cargo is secured properly as specified in parts 393.100 through 393.136 and must periodically check on the cargo throughout the duration of the trip. The driver must make an inspection of the load within the first 50 miles of the trip and reexamine the load every 3 hours or 150 miles, whichever comes first.

Consequences

Knott Laboratory investigated a case involving a tractor-trailer that overturned while traveling through a tight curve. The trailer had been loaded with large pipes stacked in three layers as shown in Figure 3. During the accident, several of the pipes separated from the trailer and fell into oncoming traffic. Multiple factors were analyzed including the high center of gravity of the load, speed of the vehicle, use and securement of tie-downs, use and securement of chocks, and loading configuration. Tragically, the accident resulted in the loss of two lives.

Figure 3: Large pipes secured to trailer

The improper securement of cargo can result in catastrophic accidents and devastating consequences. Cargo trailers are traveling alongside other vehicles constantly. Any falling cargo is likely to affect the surrounding vehicles and often there is no escape path to avoid an accident. Falling items can act as missiles soaring across lanes of traffic and creating havoc in their wake. In the blink of an eye, cargo securement failures can lead to serious injury or death.

Conclusion

Every day cargo trailers are loaded up and sent on their way. Fortunately, most of those loads make it to their destination without a problem. Sadly, some do not. The Code of Federal Regulation sets forth specific requirements for the proper and safe securement of cargo. However, proper cargo securement is a technically challenging feat that requires experience, knowledge, and skill. There are multiple factors to consider and even seemingly insignificant errors or oversights can result in fatal consequences.

Richard M. Ziernicki, Ph.D., P.E. is the principal engineer and Ashley Heist, B.E. is a mechanical engineer at Knott Laboratory, LLC in Centennial, Colorado. They can be contacted at www.knottlab.com or by email at rziernicki@knottlab.com .

---

[1] Federal Motor Carrier Safety Administration, National Highway Traffic Safety Administration, Large Truck Crash Causation Study – Summary Tables, Table 14
< http://ai.fmcsa.dot.gov/ltccs/default.asp?page=reports> (15 September 2010).

[2] Code of Federal Regulations, 1 October 2009 revision, Title 49, Chapter III, Parts 392.9 and 393.100 through 393.136.