TechBrief

FHWA Contact: Ron Knipling, HCS-30, (202) 366-2981; NHTSA Contact: Paul Rau, NRD-13, (202) 366-0418

Development of the North American Cargo Securement Standard

The vision of the Office of Motor Carriers is to help move people, goods, and commercial motor vehicles on our Nation's highways in the most efficient, economical, and crash-free manner possible. The OMC research and technology program focuses on improving safety in interstate commercial motor vehicle operations and serves a trucking and motor coach industry that carries more than 40 percent of all intercity freight.

Studies are conducted in the following areas: commercial driver human factors, health, and performance needs; new and emerging driver and vehicle technologies; safety-related data collection and analysis needs; and performance-based changes to the Federal Motor Carrier Safety Regulations.

The OMC's technology research promotes safety by identifying, collecting, and communicating information about technological advances.

Office of Motor Carrier Research and Standards
400 Seventh Street, SW
HCS-30; Room 3107
Washington, DC 20590

Introduction

The Federal Highway Administration (FHWA) is responsible for regulations concerning the securement of cargo on commercial motor vehicles operated in interstate commerce. The regulations specify minimum requirements for restraint systems used to prevent cargo from shifting on the vehicles, or falling onto the roadway. Although cargo securement-related accidents are a small percentage of all accidents involving commercial motor vehicles, many of these accidents have resulted in serious injuries and fatalities.

A series of fatal accidents, most involving steel coils that had fallen off commercial motor vehicles during transit, prompted a Congressional hearing on July 27, 1993. This hearing concerned the adequacy and enforcement of Federal regulations on cargo securement. The FHWA Administrator indicated that the agency would be participating in an international research program organized by the Canadian Council of Motor Transport Administrators (CCMTA) to evaluate cargo securement regulations and industry practice.

The project received broad technical support in the United States, Canada, and Mexico, and met the needs of the FHWA, which had planned its own cargo securement research program to gather and evaluate the relevant information to begin in fiscal year 1995.

As a result of this multi-year, international research program, the FHWA and other agencies responsible for establishing and enforcing cargo securement regulations have identified areas in which current cargo securement regulations could be improved to further reduce the likelihood of cargo securement-related accidents, and to make the requirements easier to understand, use, and enforce. The research provides the safety agencies and industry partners with a sound technical foundation to support the development of a uniform North American Cargo Securement Standard.

The CCMTA published a series of 19 research reports covering each testing module and summarizing the research project as a whole. This Tech Brief outlines the research, findings, and subsequent recommendations; individual reports are available through the CCMTA.

Purpose

The current U.S. cargo securement regulations are more than 20 years old. When the FHWA conducted the rulemaking that led to the adoption of the current rules, the agency relied upon the best available information from the States and industry groups, and a limited number of published research reports and technical papers concerning cargo securement. Very little technical information was available to justify

Table 1.
Examples of truck floors, floor surface conditions, and cargo materials used to determine friction coefficients.*

Truck Floors	Floor Surface Condition	Cargo Materials
Solid hardwood	Clean and dry	Machine feet
Smooth steel	Wet	Steel pads
Grooved aluminum	Sandy	Concrete
Transdeck	Oily	Rubber

* Researchers tested combinations of truck floors, surface conditions, and cargo materials that best represented the range of conditions found in daily operation.

or support the specific details (e.g., longitudinal, lateral, and vertical accelerations used to determine whether a cargo system is adequate; the number of tiedowns required; etc.). Given the lack of engineering data, the adequacy of the current requirements and industry practices is uncertain.

The CCMTA and the provincial governments in Canada faced the same problems the FHWA was attempting to resolve and suggested an international research program to understand the mechanics of securement systems on heavy trucks. The research program had three objectives:

- To determine how parts of cargo securement systems contribute to the overall capacity of those systems;
- To demonstrate the adequacy of cargo securement system components, and the overall capacity of cargo securement systems; and
- To develop principles, based on sound engineering analysis, which could contribute to a North American Cargo Securement Standard.

Methodology

In 1993, the CCMTA held a meeting to bring together various stakeholders to review a draft research plan covering the scope of the research program and all types of testing that would be performed. The final research plan was published later that year and explained the research needs and the testing that would be performed.

Preliminary discussions and analysis indicated that many key mechanisms of cargo securement are not readily amenable to simple analysis. Therefore, the research was based almost entirely on the testing of real loads, and included investigations into the behavior of components of cargo securement systems.

The design of cargo securement systems is based on acceleration values that are close to the stopping and maneuvering performance limits of most heavy vehicles. Researchers set up conditions to ensure that the performance capabilities of interest could be measured reliably, without the influence of uncontrolled factors. Some tests were performed using trucks, either during stationary tests with simulated loads, or by driving the instrumented truck and monitoring the vehicle and cargo securement system responses.

The research program involved the testing of trailer anchor points (i.e., stake pockets, D-rings, tensioning ratchets, etc.); investigating the effect of binder type, chain size, and chain length on the tension of the tiedown assembly; equalization of tension in the spans of chain and webbing tiedowns; investigating the effect of lateral and longitudinal movement of the cargo on tiedown tension; blocking and bracing; friction between the load and the vehicle, and between individual articles being transported (e.g., concrete pipe, dressed lumber, etc.). Examples of truck floors, floor surface conditions and cargo materials that researchers used to determine friction coefficients are shown in **table 1**. The research program also examined securement practices for steel coils and intermodal cargo containers.

Findings

The research provided a number of important findings that will help improve government agencies' and the industry's understanding of how cargo securement systems work, and provide useful information to support the drafting of improved cargo securement regulations. The findings included:

- Friction plays a major role in keeping cargo from sliding forward and sideways on a truck. However, friction alone is not an acceptable means to ensure that loads stay in place while the vehicle is moving.

- The use of anti-skid mats between certain cargoes and the floor of the vehicle help to increase the coefficient of friction and improve the performance of the cargo securement system.

- Trailer anchor points vary considerably in strength which makes it difficult for truck operators to determine or estimate the performance limits of the anchor points.

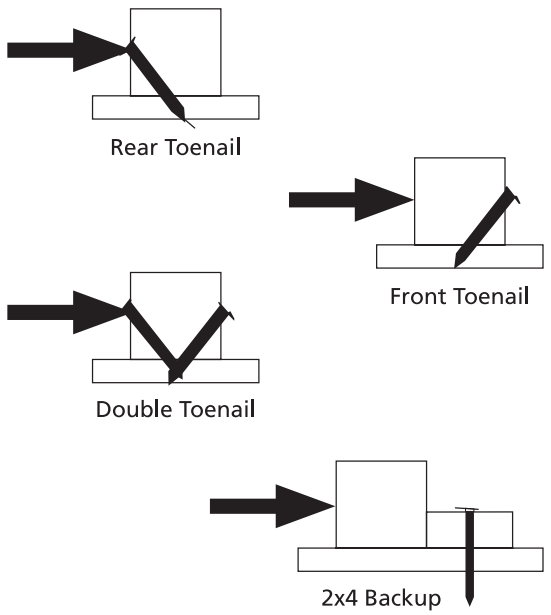
- Blocking is an important part of a cargo securement system but only in cases in which a large number of nails — a much larger number than most drivers use when securing loads — are used in certain arrangements, as illustrated in **figure 1**.

- When a chain or strap goes from one side of the trailer, over the cargo, to the opposite side of the trailer, the tension in the chains and straps does not equalize. The side on which the ratchet or other device used to tighten the chains is located remains much tighter than the opposing side, especially when the cargo has sharp edges.

Recommendations

Researchers sought to create clear statements that could serve as a basis for a new cargo securement standard. The recommendations included:

Figure 1.
Blocking Nailing Techniques



Arrow indicates force direction.

Anchor Points

An anchor point is the part of the structure of a vehicle, or a device firmly attached to that structure, that is designed or commonly used for attaching a tiedown assembly. Anchor points exist in a wide range of designs, with a wide range of load capacity.

- All anchor points should be marked with a load capacity rating.

- The possible directions of loading should be considered in developing the load capacity rating of anchor points.

- The manufacturer of an anchor point is in the best position to specify its load capacity rating and intended use. Manufacturers should develop anchor point standards and ratings of existing equipment.

- A systematic method should be developed to evaluate when a damaged anchor point should be repaired or replaced.

Tiedowns

Tiedowns are devices capable of taking tension, including cable, chain, strapping, and webbing. They can be attached to a vehicle and a unit of cargo, or they can be attached to a vehicle, passed over, around, or through a unit of cargo, then attached to the vehicle again.

- The current requirement concerning the aggregate working load limit for tiedowns may be adequate for general commodities secured by transverse tiedowns, but other cases could require different tiedown capacity, depending on the other securement provided.

- Where a vehicle is equipped with a rub rail, the tiedown should be passed inside the rub rail on both sides of the vehicle, to make use of the protection offered.

- Manufacturers should rate and mark all tiedown equipment with a working load limit.

- Manufacturers should clarify the meaning of tiedown ratings.

Friction

Friction is always present between tiedowns and cargo, and between cargo and the deck. It is a major factor in preventing cargo secured with tiedowns from shifting.

- The role that high friction coefficients play in preventing cargo movement should be formally recognized in the proposed standard to encourage

Researcher
This study was performed by the Ontario Ministry of Transportation; the Quebec Ministry of Transportation; Concordia University, Montreal, Quebec; CAMTECH, St-Nicolas, Quebec; and the Forest Engineering Research Institute of Canada, Pointe-Claire, Quebec.

Distribution
This Tech Brief is being distributed according to a standard distribution. Direct distribution is being made to the Regions and Divisions.

Availability
The research reports are available from the Canadian Council of Motor Transport Administrators, 2323 St. Laurent Blvd., Ottawa, Ontario K1G 4J8, Canada. Telephone: (613) 736-1003

Key Words
Canadian Council of Motor Transport Administrators, cargo securement, anchor points, blocking, bracing, steel coils, working load limit, tiedown, friction.

U.S. Department of Transportation
Federal Highway Administration

October 1998
Publication No. FHWA-MCRT-98-005

development and use of high friction surfaces and materials for use in areas where cargo is secured.

- Trailer manufacturers should develop and offer trailer decks with specified high coefficients of friction.
- Cargo handling equipment and materials, like pallets, skids, and wraps that are also used during transportation, should be designed with high coefficients of friction on both surfaces.
- Rubber mats, and any other materials with equivalent friction properties, appear to increase the coefficient of static friction over 0.5 (considered high) for many typical combinations of cargo and deck. Their use should be encouraged.
- No matter how high the level of friction, it remains inherently unreliable, and should never be considered the sole means of cargo securement.

Standard Development Process

Currently, the FHWA and the CCMTA are working together with U.S. and Canadian industry groups to draft the North American Cargo Securement Standard. The standard is being developed using an innovative approach to rulemaking. The FHWA is working very closely with all interested parties through a series of public meetings prior to developing a notice of proposed rulemaking (NPRM).

A drafting group is responsible for developing the format of the draft standard and adding the detailed performance criteria and securement methods as the research reports for the various testing modules are completed. Membership in the drafting group includes representatives from the FHWA, Transport Canada, CCMTA, the Ontario Ministry of Transportation, Quebec Ministry of Transportation — Ontario and Quebec conducted most of the research — and the Commercial Vehicle Safety Alliance.

Public meetings have helped to ensure that all interested parties have an opportunity to participate in the development of the standard, and to identify and consider the concerns of the Federal, State, and Provincial governments, carriers, shippers, industry groups, and associations as well as safety advocacy groups and the general public.

In addition, CCMTA posted information on the Internet. Individuals and organizations with Internet electronic mail addresses have the opportunity to e-mail comments to the drafting group. The website is http://www.ab.org.ccmta/ccmta.html.

The FHWA and CCMTA expect to finish drafting the standard and a set of model regulations that could be adopted by all North American jurisdictions by the end of 1998. The FHWA and CCMTA will establish an implementation committee to ensure that educational and training materials are developed to assist motor carriers and enforcement officials in understanding the North American Cargo Securement Standard and to resolve any issues that may come up during the State and Provincial governments' legislative and rulemaking processes.

Once the final versions of the standard and model regulations are published, the FHWA will publish an NPRM to replace its current regulations with the standard. Thus, all interested parties will have an opportunity to comment on the specific regulatory language and the FHWA's estimates of the costs and benefits for implementing the new requirements. If the NPRM is published in early 1999, the FHWA could issue a final rule by the end of 1999 with an effective date sometime in the year 2000.