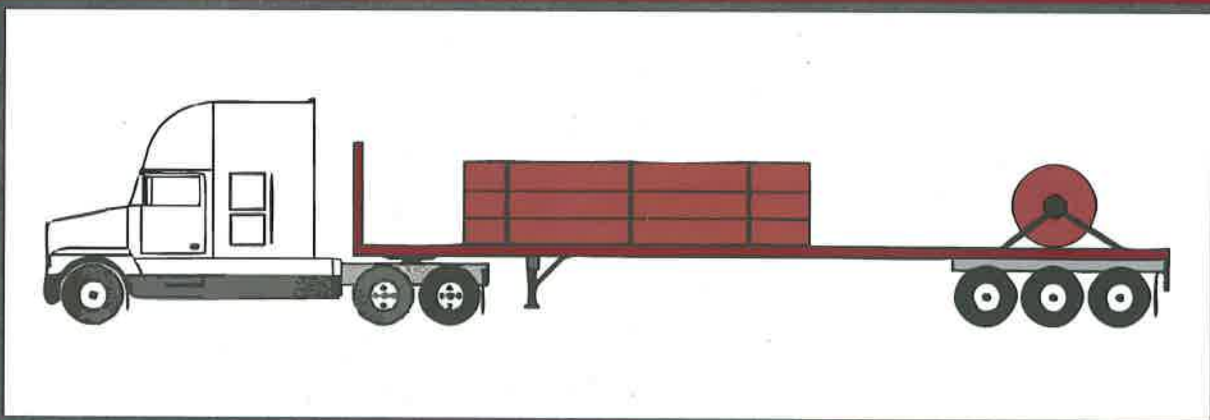
CCMTA Load Security Research Project

Report # 3

SLIPPAGE TESTS WITH ANTI-SKID MATS



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CANADIAN COUNCIL OF MOTOR TRANSPORT ADMINISTRATORS
CONSEIL CANADIEN DES ADMINISTRATEURS EN TRANSPORT MOTORISÉ

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Report # 3

SLIPPAGE TESTS WITH ANTI-SKID MATS

Prepared for

Canadian Council of Motor Transport Administrators
Load Security Research Management Committee

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North American Cargo Securement Standard

CCMTA is serving to coordinate the development of a revised North American Cargo Securement Standard. To this end the research results in this report are being reviewed and discussed by interested stakeholders throughout North America.

Those readers interested in participating in the development of the North American Cargo Securement Standard through 1997 are invited to visit the project Web site at www.ab.org/ccmta/ccmta.html to secure additional project information.

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The dressed lumber used in the tests was provided by Gestofor Inc., load cells were provided by the Ontario Ministry of Transportation, and Daishowa Forest Products Ltd. provided the use of their pitch table and supplied the paper rolls during the testing.

Background

In 1993, the Canadian Council of Motor Transport Administrators formed a load security research management committee to address the lack of a sound technical basis for the existing rules. Based on an extensive consultation, the Ontario Ministry of Transportation prepared a report on the types of testing that would be required to fill in this knowledge gap. The results could then be used as the basis for a new national standard on load security.

The extensive body of research necessary to meet the committee's objectives was divided up among various research agencies. The Forest Engineering Research Institute of Canada (FERIC) was contracted by the Ministère des Transports du Québec to perform the portion of the tests that related to the security of dressed lumber. Nisymco Inc. was subcontracted by FERIC to assist in the research. The results of this research were documented in the contract report "Dressed Lumber Tiedown Tests" (Hay et al. 1996).

One of the principal conclusions of the latter report was that friction along the surfaces of contact between the load and its supports appears to be the main factor that affects load security. As a result, the research team extended the tiedown test program to conduct **limited** tests with rubber anti-skid mats designed to increase the coefficient of friction under the load. This report summarizes these supplementary tests.

Test Equipment and Methodology

The tests evaluated the effects of two different rubber anti-skid mats on the load security in pitch (along the longitudinal axis) of both dressed lumber and paper rolls. The anti-skid mats were furnished by separate suppliers; one (mat A) was somewhat thicker and spongier than the other (mat B). Samples are provided in the Appendix.

The test methodology in the pitch tests was as described in Hay et al. (1996). Spring-loaded probes sensed the movement of the load, and inclinometers recorded the inclination angles of the trailer deck. Figure 1 shows a typical example of the computer output of the results (dressed lumber, low tension, mat A). The tests of load stability in pitch were conducted on a wood chip discharge table at Daishowa Forest Products Limited's facilities in Quebec City (Figure 2). The table's hydraulic system created shock loads at around 14°, 29° and 44° of inclination. **As such, any slippage that occurred around these angles may have been premature**.

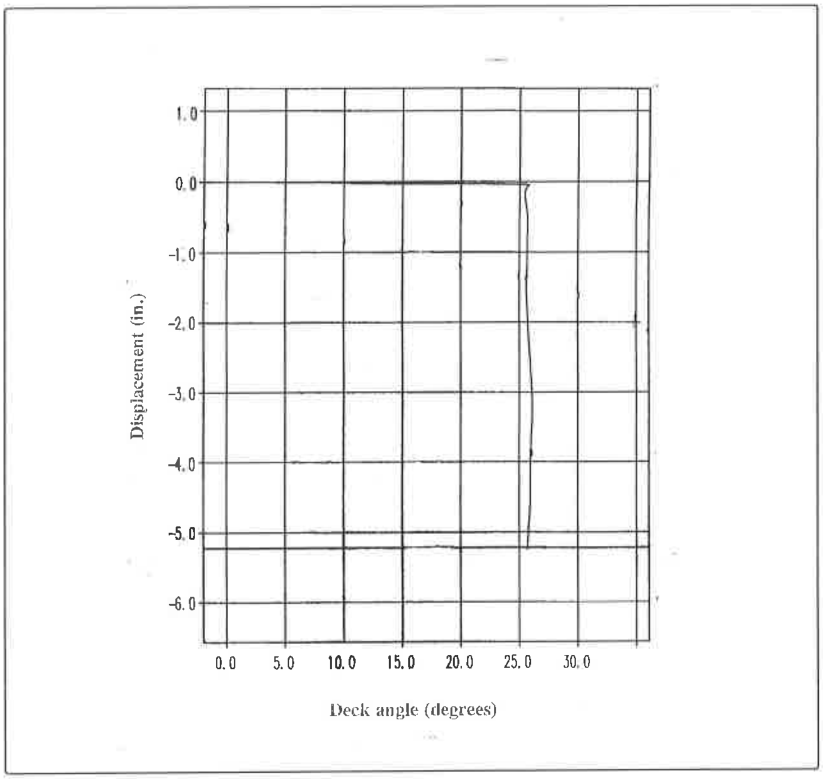

Figure 1. Example of typical computer output.

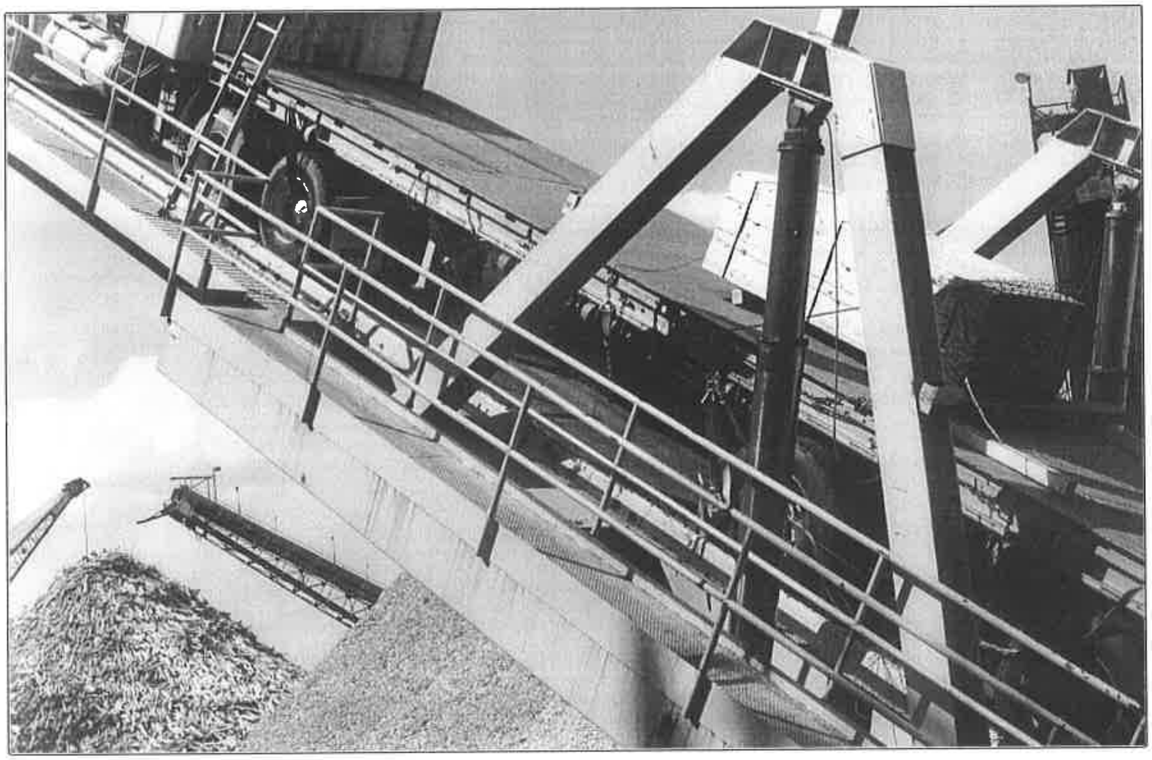

Figure 2. Testing the load stability of dressed lumber on the Daishowa chip discharge table.

Tests with Dressed Lumber (single 8-ft bundle)

The dressed-lumber stability tests were conducted with a single strapped bundle of 8-ft softwood lumber (approx. 995 lb) secured by a single overwrap-webbing tiedown under various levels of tension. The wood bundle sat on two square wooden skids (4 in. x 4 in.). The thicker anti-skid mat (mat A) was wrapped around the skids (Figure 3) or cut strips of mat were fitted underneath and above the skids (Figure 4). The results presented in Table 1 are those when strips of mat were used, but there was no difference in performance between the two techniques. Table 1 also provides comparative data for the same load configuration tested without anti-skid mats (from Hay et al. 1996). No tests were performed with anti-skid mat B for this load configuration.

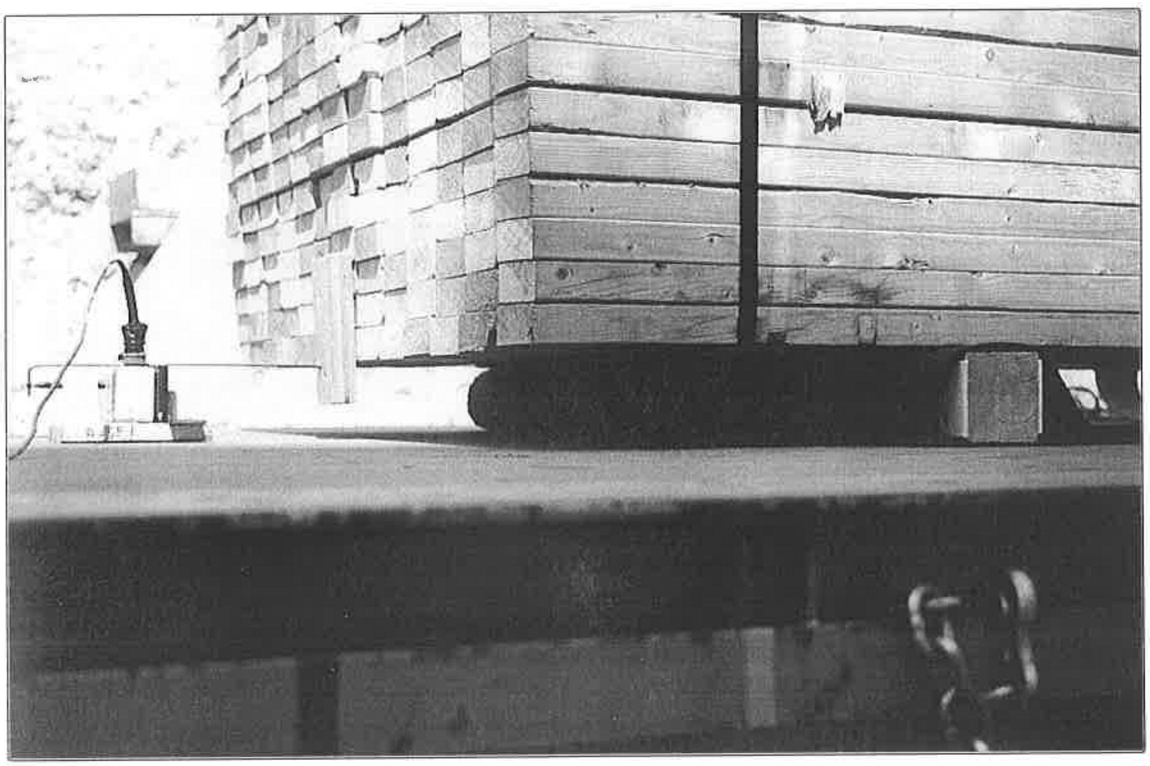

Figure 3. Anti-skid mat wrapped around a wooden skid. Note the motion sensor to the left.

Figure 4. Strips of anti-skid mat fitted above and below the skid.

Table 1. Pitch test with 8-ft lumber bundle

	No anti-skid mat			Anti-skid mat A		
	Tiedown tension (lb)	Slip angle	g-force at slip	Tiedown tension (lb)	Slip angle	g-force at slip
Nominal tiedown tension						
Zero	0	31°	0.52	0	30°	0.50
Low	240	31°	0.52	220	29°	0.48
				220	26°	0.44
Medium	545	45°	0.71	500	45°	0.71

Under zero or low tiedown tension, the anti-skid mat provided no benefit, and the bundle actually shifted at a slightly lower angle than with no mat. With the mat, load displacement did not occur as a result of true slippage but instead resulted from the skids rolling over (Figure 5). The exact cause of this is not certain, and the results are clouded by the fact that displacement occurred at or near an angle where the tilt table's hydraulics imposed a shock on the system. One possibility is that the skids sunk into the rubber under the weight of the load, thereby rounding the corners of the skids and increasing their propensity to roll. This problem could be resolved by using wider, rectangular skids or possibly by using the mats only on the upper surface of the skids, since there was never any slippage between the skids and trailer deck in the earlier tiedown tests (Hay et al. 1996).

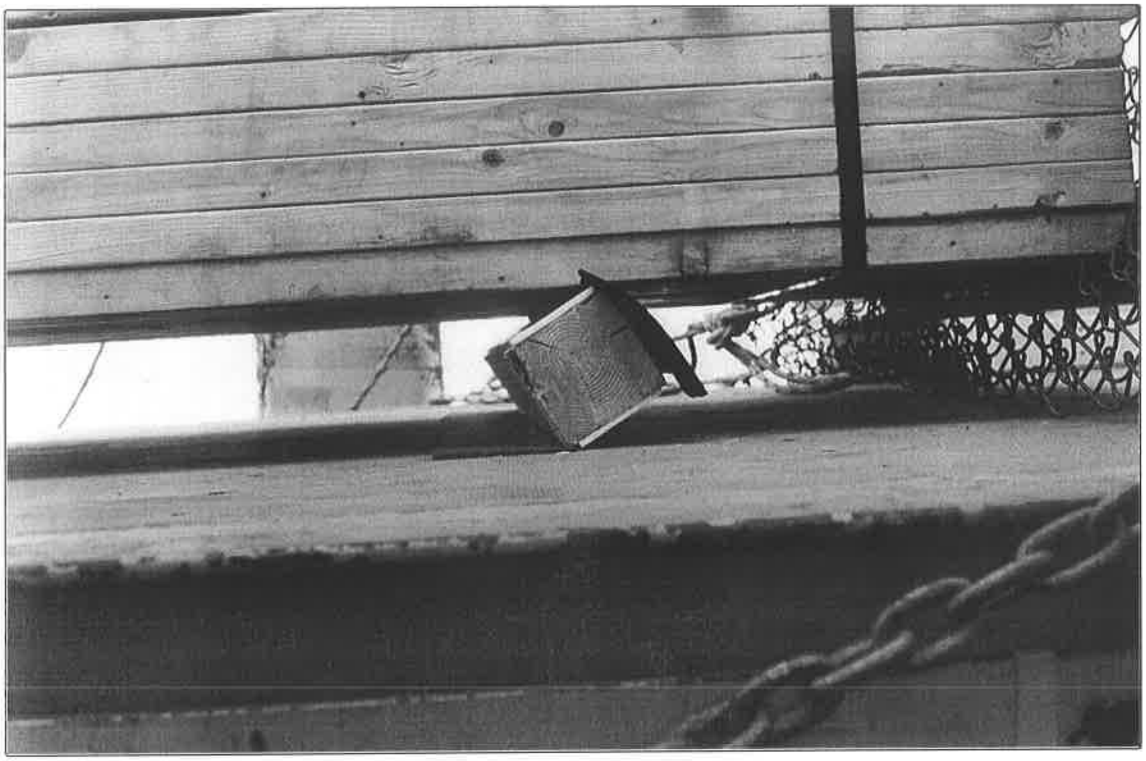

Figure 5. The skids rolled under zero or low tiedown tension.

At medium tiedown tension, which represents levels typical of normal onroad usage, the mat provided comparable results to those observed with no mat, though the slippage did appear somewhat less sudden and of smaller magnitude. Without the mat, the bundles of wood slipped completely at 45°. In contrast, wood bundles on mats began slipping at 45° and continued slipping up to 54° but in a series of small increments rather than a sudden slippage. This observation would need to be verified through further testing. Again, slippage occurred at one of the table's "shock" angles, which may have triggered premature movement.

Tests with Paper Rolls

Two paper rolls were furnished by Daishowa for pitch testing on different friction surfaces with no tiedowns (Figure 6). The specifications of these rolls were:

	Diameter	Height	Weight
Roll A	1.242 m	1.108 m	902 kg
Roll B	1.030 m	1.380 m	720 kg

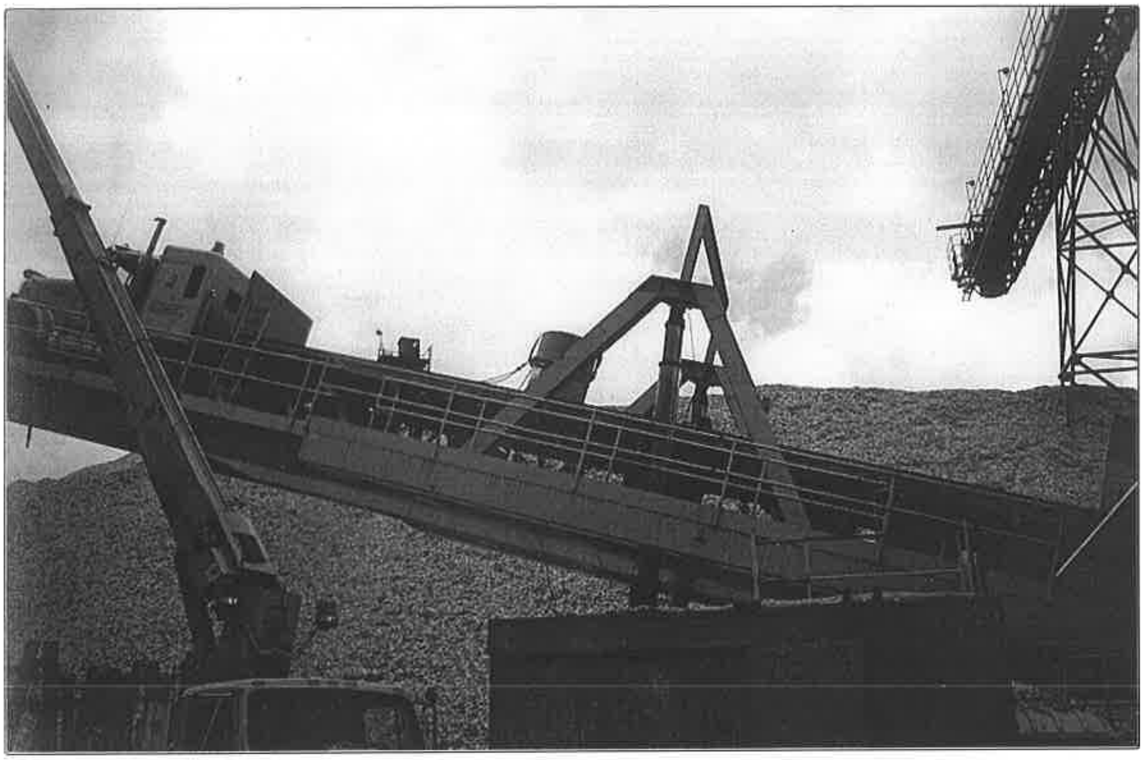

Figure 6. Pitch tests with paper rolls. The chains on the paper roll served as a safety measure, not as a tiedown.

The stability in pitch of both rolls was assessed while the rolls rested directly on the trailer's deck (Transdeck® laminated-fiberboard surface coated with phenolic resin), on the thicker anti-skid mat (mat A) and on the thinner anti-skid mat (mat B) (Figure 7). The comparative results are presented in Table 2.

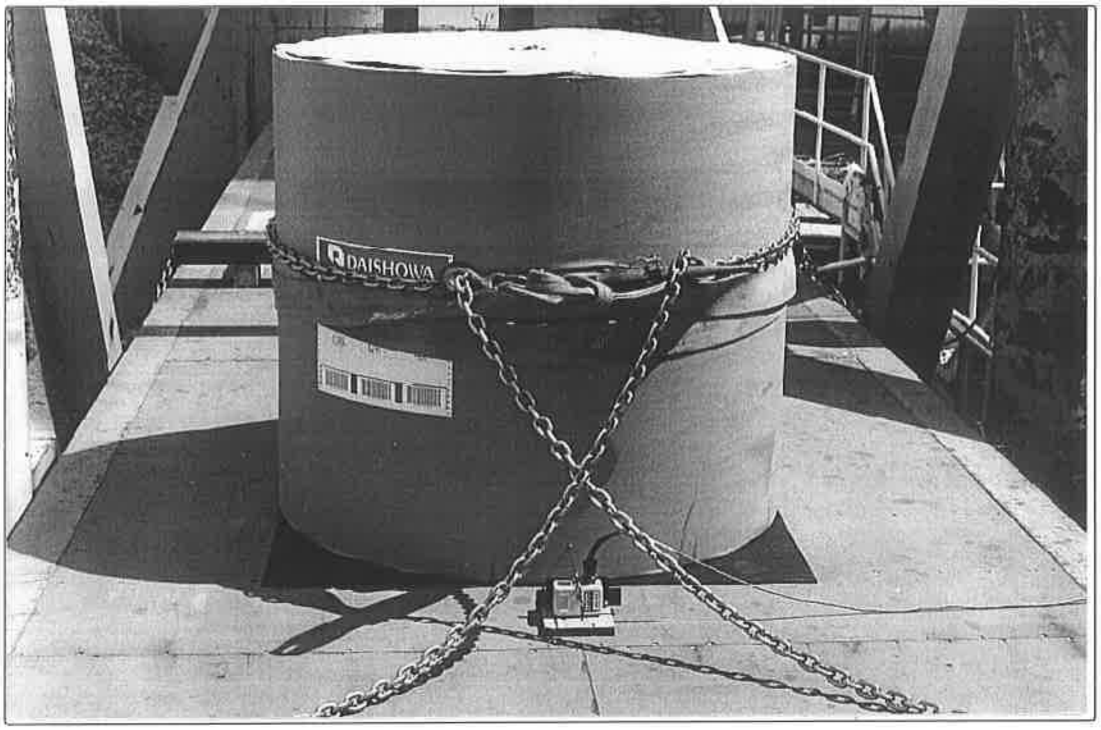

Figure 7. Paper roll A on the thicker anti-skid mat. Note the motion sensor in the foreground.

Table 2. Pitch test with paper rolls

	Transdeck®		Mat A		Mat B	
	Slip angle	g-force at slip	Slip angle	g-force at slip	Slip angle	g-force at slip
Roll A	28°	0.47	39°	0.63	37°	0.60
Roll B	30°	0.50	32°[a]	0.53	30°	0.50

[a] Movement resulted from an initial minor slip followed by tipping of the roll.

Both anti-skid mats appeared to provide a significant benefit in preventing slippage, especially under paper roll A which had a larger contact area. Of the two, the thicker mat (mat A) performed somewhat better. Again, the results should be viewed with caution as slippage in several tests occurred at or near a "shock" angle. Furthermore, mat B showed obvious signs of damage after a single test (permanently deformed mat, signs of friction burns due to load slippage), which rendered the mat unsuitable for further use. On the other hand, mat A showed no signs of deformation or breakage after load slippage.

Conclusions

The mats provided no benefit in securing a single bundle of 8-foot lumber resting on wooden skids. This result is not surprising, since earlier testing (Hay et al. 1996) had demonstrated that such a load configuration was secure under medium or high tiedown tension. However, the same tests also demonstrated that securing a load on icy surfaces (simulated using Teflon® surfaces on the skids) was very problematic. Anti-skid mats may provide some benefit under such conditions, thus further tests are warranted. The effect of changing the skid dimensions in conjunction with the use of anti-skid mats should also be investigated.

The mats did provide significant benefits in preventing slippage of paper rolls resting directly on the trailer deck. It should be noted that the reference deck surface (Transdeck®) exhibits relatively good anti-slip properties (Billing 1996), and thus the anti-skid mats **may** provide an even greater advantage under more critical (e.g., icy, wet) conditions. This subject warrants further study.

The reader is cautioned that the study results are based on very limited testing and, as such, should only be considered as indicators of performance. Moreover, the potential influence of the shocks created by the test equipment suggests additional caution. Nevertheless, the use of anti-skid mats to improve load security appears to hold enough potential to warrant further investigation. Other factors to consider include the type of anti-skid mat and its relative properties, the mat's working life, and changes in mat properties over time and as a result of usage.

References

Billing, J.R. 1996. Personal communication. Ont. Min. Transp., Toronto, Ont. [Report in preparation.]

Hay, E.; Williams, W.; Heidersdorf, E. 1996. Dressed lumber tiedown tests: CCMTA load security research project, section 11. Min. Transp. Qué., Quebec City, Que. 28 p.

Appendix

(Sample no longer available)

Mat A

(Sample no longer available)

Mat B

North American Load Security Research Project Reports

[1] Billing J.R., Mercer W.R.J. and Cann W., "A Proposal for Research to Provide a Technical Basis for a Revised National Standard on Load Security for Heavy Trucks", Transportation Technology and Energy Branch, Ontario Ministry of Transportation, Report CV-93-02, November 1993.

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[2] Rakheja S., Sauvé P. and Juras D., "Experimental Evaluation of Friction Coefficients of Typical Loads and Trailer Decks under Vertical Vibration", North American Load Security Research Project, Report 2, Canadian Council of Motor Transport Administrators, Ottawa, Ontario, 1997.

[3] Heidersdorf E. and Hay E., "Slippage Tests with Anti-skid Mats", North American Load Security Research Project, Report 3, Canadian Council of Motor Transport Administrators, Ottawa, Ontario, 1997.

[4] Hay E., Williams W. and Heidersdorf E., "Dressed Lumber Tiedown Tests", North American Load Security Research Project, Report 4, Canadian Council of Motor Transport Administrators, Ottawa, Ontario, 1997.

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[5] Mercer W.R.J. and Billing J.R., "Effect of Cargo and Tiedown Characteristics on Equalization of Tension in the Spans of Tiedowns", North American Load Security Research Project, Report 5, Canadian Council of Motor Transport Administrators, Ottawa, Ontario, 1997.

[6] Mercer W.R.J. and Billing J.R., "Effect of Binder Type and Chain Length on Tension in Chain Tiedowns", North American Load Security Research Project, Report 6, Canadian Council of Motor Transport Administrators, Ottawa, Ontario, 1997.

[7] Billing J.R. and Lam C.P., "Friction Coefficients between Typical Cargo and Truck Decks", North American Load Security Research Project, Report 7, Canadian Council of Motor Transport Administrators, Ottawa, Ontario, 1997.

[8] Mercer W.R.J. and Billing J.R., "Load Capacity of Nailed Wood Blocking", North American Load Security Research Project, Report 8, Canadian Council of Motor Transport Administrators, Ottawa, Ontario, 1997.

[9] Billing J.R. and Lam C.P., "Effect of Cargo Movement on Tension in Tiedowns", North American Load Security Research Project, Report 9, Canadian Council of Motor Transport Administrators, Ottawa, Ontario, 1997.

[10] Billing J.R. and Leung D.K.W., "Evaluation of the Strength and Failure Modes of Heavy Truck Cargo Anchor Points", North American Load Security Research Project, Report 10, Canadian Council of Motor Transport Administrators, Ottawa, Ontario, 1997.

[11] Mercer W.R.J. and Billing J.R., "Tests on Methods of Securement for Thick Metal Plate", North American Load Security Research Project, Report 11, Canadian Council of Motor Transport Administrators, Ottawa, Ontario, 1997.

[12] Mercer W.R.J. and Billing J.R., "Tests on Methods of Securement for Large Boulders", North American Load Security Research Project, Report 12, Canadian Council of Motor Transport Administrators, Ottawa, Ontario, 1997.

[13] Mercer W.R.J. and Billing J.R., "Bending Strength of Trailer Stakes", North American Load Security Research Project, Report 13, Canadian Council of Motor Transport Administrators, Ottawa, Ontario, 1997.

[14] Mercer W.R.J. and Billing J.R., "Effect of Tiedowns on Wood Blocks Used as Dunnage", North American Load Security Research Project, Report 14, Canadian Council of Motor Transport Administrators, Ottawa, Ontario, 1997.

[15] Billing J.R. and Lam C.P., "Tests on Methods of Securement for Metal Coils", North American Load Security Research Project, Report 15, Canadian Council of Motor Transport Administrators, Ottawa, Ontario, 1997.

[16] Mercer W.R.J. and Billing J.R., "Tests on Methods of Securement for ISO Containers", North American Load Security Research Project, Report 16, Canadian Council of Motor Transport Administrators, Ottawa, Ontario, 1997.

[17] Billing J.R. and Leung D.K.W., "Analysis of Heavy Truck Cargo Anchor Points", North American Load Security Research Project, Report 17, Canadian Council of Motor Transport Administrators, Ottawa, Ontario, 1997.

[18] Billing J.R. and Couture J., "North American Load Security Research Project Summary Report", North American Load Security Research Project, Report 18, Canadian Council of Motor Transport Administrators, Ottawa, Ontario, 1997.

---

[19] Grandbois J., "Assessing a Securement Method for the Transportation of Heavy Machinery Using a Combination of Highway Vehicles", North American Load Security Research Project, Report 19, Canadian Council of Motor Transport Administrators, Ottawa, Ontario, 1997.
