

## DIFFERENCES IN CARGO SECURING REGULATIONS. HOW COULD WE ACHIEVE HARMONIZATION?

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### Abstract

This paper provides a study of existing cargo securing regulations applied for road transport by different national regulations, standards and guidelines. Since no universal standard has been globally accepted yet, differences in cargo securing requirements may lead to complexity, especially when multimodal transports are to be performed. Such barriers may potentially affect the development of free trade.

A case study has been executed in order to demonstrate the effect of different regulations on cargo securing for road transport. In the paper a proposal is presented on how to harmonization can be achieved.

The results are supposed to attract a wide range of stakeholders, aiming to define a common vision and legislative structure on forthcoming regulations in the cargo securing field. The result will also be used as an input to the present work in the UNECE expert group working with the revision of the IMO/ILO/UNECE Guidelines for Packing of Cargo Transport Units to prepare an international Code of Practice for Packing of Cargo Transport Units.

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**Keywords:** Cargo Securing, National and international regulations, Guidelines, Standards, Road transport, Road safety, Harmonization

## **1. Introduction**

Transportation is one of the most expanding industries, based and supported by both globalization and economic growth. With increased demand for transport services, more cargo will be out for transit during sea, land and air transports in the future. When the amount of traffic increases accidents due to inadequate cargo securing may more frequently lead to severe consequences. Accidents can, however in many cases, be prevented by the knowledge of risks associated to the specific transport mode. Having this in mind, special attention must be taken for the evaluation of routines for ensuring that cargo securing procedures are performed in accordance with applicable regulations, in order to minimize the risk of accidents. This is however obstructed by the non-confirmative or even conflicting regulations that apply in different regions and for different modes of transport.

## **2. Background**

The majority of transport companies as well as industries generating goods, frequently transport cargo between different countries and sometimes also between different parts of the world. Regarding cargo securing, especially for road transports, this has during a long period of time led to confusion since the harmonization of regulations between different states, is lacking. The result of inaccurate harmony in the legal field of the transport sector has a lot of disadvantages and in many cases companies are not fully aware of how they should arrange their cargo securing routines for compliance with all concerned regulations. It has also been shown that countries like Sweden and Germany has completely different views on what to be considered as “safe” cargo securing. According to the Swedish Road Regulation TSVFS 1978:10 and VVFS 1998:95, the cargo securing needed for a specific transport is a lot more sparse than for example the German standard series VDI 2700. What is interesting in this comparison is also that this represents an example including two member states of the European Union, a union based on visions of unrestricted mobility and free trade between member states. Since transports are essential for the development of such a union, the lack of harmonization should be considered as a barrier for the potential of achieving the initial purpose the union is intended for.

Even though non-harmonized regulations have political effects it is important to point out the additional costs associated with an overly ambitious level of cargo securing requirements not significantly increasing road safety, both in terms of administration and actual cargo securing work. In an overall perspective this may affect the competition between companies and since the globalization give rise to establishment and growth of manufacturing companies in developing countries, ineffective legislation may potentially harm the European competitiveness.

Currently, regulations regarding cargo securing may become legal either by national legislation, enforcement of applicable standards by the national authority or by a court judgment, alternatively by referring to applicable guidelines in national regulations. Universally valid regulations should on the other hand improve the efficiency in both regional and global transports.

## **3. Research method**

As a part of the lack of an overall perspective for cargo securing globally, MariTerm AB has been contracted by several industries for compiling documents by which the majority of international regulations have been described and analysed. The compilations were aimed at determining a minimum level of cargo securing efforts needed for legal compliance with all

the selected regulations, saving administrative work for the intended industries. For this purpose, a number of factors considered being important for the facilitation of internal cargo securing routines, were chosen. Another analysis of regulations and their comparison was made in (Jagelcak, 2004) and (MariTerm, 2004).

**3.1 Cargo type**

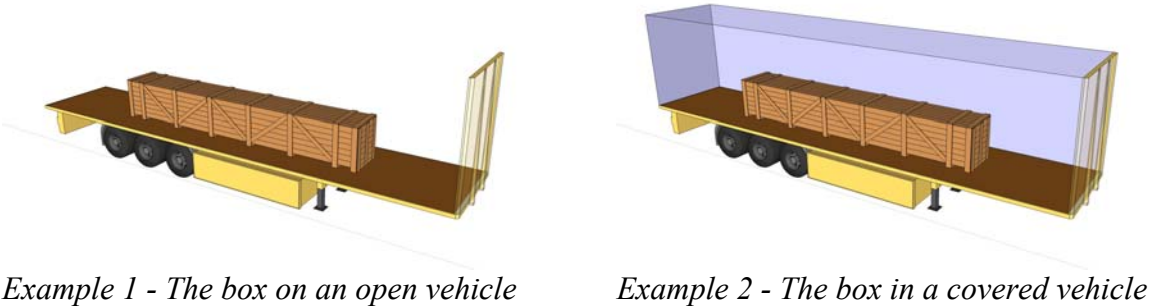
In order to illustrate the findings of these studies, top over cargo securing arrangements for a rather simple cargo, a wooden box of 10 ton, have been worked out for different conditions in accordance with the requirements found around the world.

**Table 1 – Weight and dimensions of the wooden box**

<b>Weight</b>	10 ton	<b>Centre of gravity</b>	
<b>Length</b>	7.8 m	longitudinal	3.9 m
<b>Width</b>	1.1 m	transverse	0.55 m
<b>Height</b>	1.1 m	vertical	0.65 m

**3.2 Vehicle types**

In the examples, securing arrangements are designed for two different vehicle types. The vehicles are supposed to be equipped with typical plyfa (plywood) floors as well as sufficiently strong headboards. One vehicle is open and in this the contact surface between the box and the vehicle floor is supposed to be wet and somewhat dirty. The other vehicle is covered and for this the surface is supposed to be dry and clean.



*Example 1 - The box on an open vehicle*

*Example 2 - The box in a covered vehicle*

**Figure 1 – examples of analysed vehicle types**

The influence of the use of anti-slip mats for different regulations has also been investigated.

**3.3 Regulations**

Most countries do not have any other requirements for cargo securing than that the cargo may not fall off during transport. For the following countries and regions more detailed cargo securing requirements have been found:

**Global**

*IMO/ILO/UNECE Guidelines for Packing of Cargo Transport Units.* These guidelines contain design accelerations for cargo securing arrangements but no other technical design criteria.

*IMO Model Course 3.18 – Safe Packing of CTUs* contains instructions for the design of cargo securing arrangements for sea and road transports as well as quick lashing guides.

### **Regional**

Europe – the non-mandatory *European Best Practice Guidelines on Cargo Securing for Road Transport*. According to this document cargo securing arrangements can be based either on the CEN method (the European Standard EN 12195-1) or the IMO method (IMO Model Course 3.18).

Europe – *CEN standard EN 12195-1 – Load restraining on road vehicles – Safety – Part 1: Calculation of securing forces*. An old version from 2003 is superseded by a revised version from 2010. Both versions contain detailed instructions for the design of cargo securing arrangements.

*North America - Cargo Securement Standard 10* contains detailed instructions for the design of cargo securing arrangements.

### **National**

USA - *The United States Federal regulations 49 C.F.R. 393* contains basically the same requirements as the North American Cargo Securement Standard.

Canada – *National Safety Code Standard – Cargo Securement* contains basically the same requirements as the North American Cargo Securement Standard.

Australia – *Load Restraint Guide* contains instructions for the design of cargo securing arrangements.

New Zealand – *Truck Loading Code* with instructions on the design of cargo securing arrangements.

Germany - *22 StVO (Road Traffic Regulations)* states that for the design of cargo securing arrangements the state of art should be used. Before the revision of the European standard EN 12195-1 the version from 2003 was regarded as state of the art. After the revision it is unsure whether German courts will regard the revised European standard from 2010 as state of the art or if the national German standard VDI 2700 will be applied. In part 2 this standard contains design criteria for cargo securing arrangements.

Sweden - *TSVFS 1978:10 – Regulations on Cargo Securing on Vehicles*. These regulations were complemented in 1998 with detailed instructions on the design of cargo securing arrangements and the design criteria are basically identical to the criteria in the IMO Model Course 3.18.

Great Britain - *Code of Practice – Safety of Loads on Vehicles* contains design accelerations but no other details for the design of cargo securing arrangements.

Belgium - *Federale Overheidsdienst Mobiliteit en Vervoer* with reference to the European Best Practice Guidelines.

Luxemburg, Czech Republic and Belarus refer to the European Standard EN 12195-1 in their legislations.

Norway and Finland have national regulations containing design accelerations but else vague design criteria for cargo securing arrangements.

### 3.4 Cargo securing equipment

For the study in this paper it has been decided to use a 50 mm web lashing labelled with the following data:

Breaking load: 4 000 kg (daN) (40 kN) from hook to hook

Lashing Capacity LC: 1 600 daN (kg) (16 kN) according to the CEN standard EN 12195-2

Standard Tension Force  $S_{TF}$ : 400 daN (kg) (4 kN) according to the CEN standard EN 12195-2 (The measurements of  $S_{TF}$  of certain webbings and the background for  $S_{TF}$  is described by Jagelcak and Rievaj (2009).)

Such a lashing will have a Working Load Limit - WLL of 1 300 kg (13 kN) in the USA.

### 3.5 Parameters influencing the cargo securing arrangement

As top over lashing arrangements is the most frequently used lashing method on vehicles, such arrangements have been taken as the basis for the description of the difference in the different cargo securing regulations.

The required number of top over lashings preventing the wooden box of 10 ton from sliding have been determined by the requirements in the following regulations, guidelines and standards:

- The principles in the IMO Model course 3.18 – Safe Packing of CTUs (IMO)
- European standard EN 12195-1:2003 - Load restraint assemblies on road vehicles - Safety - Part 1: Calculation of lashing forces (EN 2003)
- European standard EN 12195-1:2010 - Load restraining on road vehicles - Safety - Part 1: Calculation of securing forces (EN 2010)
- VDI Guideline 2700 Part 2- Securing of loads on road vehicles. Tie down forces (VDI)
- North American Cargo Securement Standard (NACSS)
- Australian Load Restraint Guide (ALRG)
- New Zealand Truck Loading Code (NZTLC).

### 3.6 Design philosophy

In the different regulations different design philosophies are used for the determination of required number of top over lashings to prevent cargo from sliding.

#### *IMO method*

According to the IMO method the static friction is used for the design of top over lashing arrangements. Friction values for typical material contacts are given in the table of IMO Model course 3.18. These values may be used if the surfaces are dry and clean, and if not the friction 0.3 shall be used. Friction values verified by other means may, however, be used in the design. It is assumed that the pretension in the lashings is equal on both sides of the cargo and thus the k-factor is 2, see below. No extra safety factor is used. For securing arrangements where there is no sliding risk, at least one top over lashing per 4 ton of cargo shall be used to avoid the cargo from moving due to vibrations.

#### *CEN method from 2003*

According to the CEN method from 2003 the dynamic (sliding) friction is used for the design of top over lashing arrangements. Friction values for typical material contacts are given in Annex B of the standard. Friction values verified by other means may, however, be used in the design. It is assumed that the tension force in the lashing on the non-tensioner side is 50%

of the tension force on the tensioner side of the lashing and thus the k-factor is 1.5. No extra safety factor is used. There are also no instructions on a minimum number of lashings to be used.

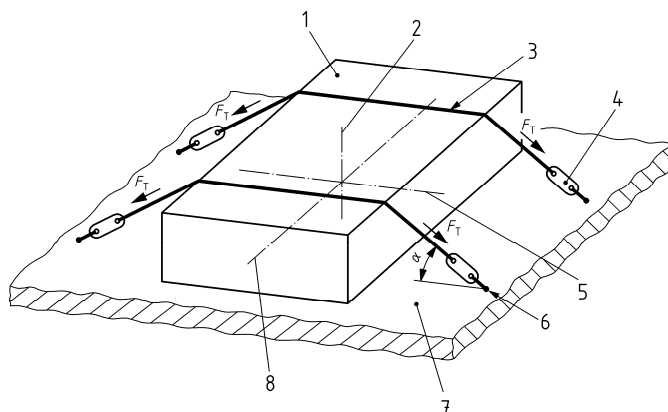
### **CEN method from 2010**

According to the CEN method from 2010 a friction factor of 92.5% of the static friction or 103% of the dynamic friction is used for the design of top over lashing arrangements. Friction factors for typical material contacts are given in Annex B of the standard. Friction values verified by other means may, however, be used in the design. It is assumed that the pretension in the lashings is equal on both sides of the cargo and thus the k-factor is 2. Extra safety factors are used for avoiding sliding in the design of top over lashing arrangements and a safety factor of 1.1 is used in all horizontal directions, except for road transport in forward direction, where a safety factor of 1.25 is used. It is mentioned in the standard that even for cargo with no risk of sliding or tilting, measures (e.g. blocking or lashing) shall be taken to avoid them to be significantly displaced due to vibrations. The required number of lashings can be calculated by the following formula:

$$n \geq \frac{(c_{x,y} - \mu \times c_z) m \times g}{k \times \mu \times \sin \alpha \times F_T} f_s \quad (1)$$

In this equation the following parameters are used:

- $n$  number of lashings required to prevent sliding
- $c_{x,y}$  the horizontal acceleration expressed in parts of the gravity acceleration  $g$
- $c_z$  the vertical acceleration expressed in parts of the gravity acceleration  $g$
- $g$  the gravity acceleration =  $9.81 \text{ m/s}^2$
- $m$  the weight of the cargo in ton
- $\mu$  the coefficient of friction between the cargo and the platform
- $\alpha$  the angle between the lashing and the platform in degrees
- $F_T$  the pretension in the lashing in kN
- $f_s$  safety factor
- $k$  factor due to vertical pressure difference on tensioner and non-tensioner side



### **Key**

- 1 load
- 2 vertical axis
- 3 lashing device
- 4 tensioning device
- 5 transverse axis
- 6 lashing point
- 7 horizontal plane
- 8 longitudinal axis

**Figure 2 — Frictional lashing of a load (Source: EN 12195-1:2010)**

### ***VDI method***

According to the VDI method the dynamic friction is used for the design of top over lashing arrangements. A range of friction values for some material contacts are given in tables. One table is given for dry conditions and one for wet conditions [cf. sec. 3.2 of VDI 2700 Sheet 2 (2002)]. Friction values verified by other means may be used in the design. It is assumed that the pretension in the lashings is equal on both sides of the cargo and thus the k-factor is 2. However, it is mentioned *“In the case of vertical lashing using tensioner on one side only, it may be advantageous to increase the pretension force on the pre-tensioned side within the limits of the permissible lashing force, taking into account the initial difference in the pretension force due to encircling losses”* [cf. sec. 4.1, note 1 of VDI 2700 Sheet 2 (2002)]. No extra safety factor is used. There are no instructions on a minimum number of lashings to be used.

### ***North American method***

The requirements on lashing arrangements in North America are solely based on the length and weight of the cargo as well as the Working Load Limit of the lashings. Dimensioning accelerations are given but no guidance is offered for technical calculations. For cargo with a length exceeding 3.04 meters, one tie-down is to be used for each 3.04 meter length of cargo. If blocking is not achieved in the forward direction, one additional tie-down should be applied. Additionally, it should be checked that the aggregated Working Load Limit of the tie-downs is at least one-half of the cargo weight. One top over lashing or a pair of either loop or straight lashings qualifies as a tie-down. Friction mats are considered to provide resistance to horizontal movement equal to 50% of the cargo weight.

### ***Australian method***

According to the Australian method the static friction is used for the design of top over lashing arrangements. Friction values are given for steel cargo but not for wooden boxes. Friction values verified by other means may, however, be used in the design. It is mentioned in the guide that there may be differences in the pretension on the tensioner and non-tensioner sides of the lashings up to 4:1. However, a k-factor of 2 is used in the calculated examples in the Australian guide and thus this value is also used in the comparison in this paper. It is mentioned in the guide that for a 50 mm web lashing a pretension of 3 kN may be used for a push up ratchet and 6 kN for a pull down type. As the push up type is the most commonly used a pretension of 3 kN is used in the calculations. It is further mentioned in the guide that to maintain the friction force during normal driving the tiedown lashings must be pre-tensioned to provide a minimum clamping force of 20% of the weight of the load. [cf. Section C and F of Load Restraint Guide (2004)].

### ***New Zealand method***

The following is valid for the design of top over securing arrangements for rigid cargo weighing 0.5 tonne or more in New Zealand:

- *“Cargo that are to be transported on a vehicle platform must be secured by securing devices that pass from the deck on one side of the vehicle over the load to the anchor point on the other side of the deck.*
- *Cargo that are not loaded against a headboard, the securing devices must have a combined rated strength of at least twice the weight secured.*
- *Cargo that are loaded against a headboard so that the top packets are supported by at least 150 mm. The securing devices must have a combined rated strength of at least the weight secured.*

- *For webbings and other ropes, the rated (assembly) strength must be equivalent to not more than half the breaking strength.*
- *When webbing is used, the vehicle should have at least one lashing every 1.5 metres along the length of the load.” [The official New Zealand truck loading code (2010)]*

These requirements are also supplemented by Annex C of the Truck Loading Code where there is a theoretical method for the determination of load securing by calculation or by practical tests. A simple formula for top over lashing combined with blocking is given.

$$P = Q \times a - (10 \times Q + S) \times \mu \quad (2)$$

Where:

- $Q$  the mass of the load (kg).  
 $P$  force which acts on the restraint equipment such as headboards, side post, etc (Newtons, N).  
 $a$  design acceleration level ( $\text{m/s}^2$ ). In the forward direction  $a = 10 \text{ m/s}^2$  approximately, in the rearward and sideways direction  $a = 5 \text{ m/s}^2$  approximately.  
 $S$  the sum of the tensile forces exerted by the vertical parts of the lashings (Newtons, N).  
 $\mu$  static friction coefficient for the contact surface between the load and its support. It may be assumed for these calculations that the coefficient of friction is 0.2. If a higher value is used, it must be justified by evidence, for example, a result obtained in a practical experiment.

It is not clear how  $S$  shall be taken into account in terms of k-factor but the factor has been set to 2 in the calculations.

### 3.7 Parameters for comparison

The wooden box with the given dimensions is not sensitive for tilting in any direction according to any of the regulations. The parameters influencing the design of the top over cargo securing arrangement according to the different regulations are shown in the table below.



**Table 2 - Parameters used in the analysis of required number of lashings**

	<b>IMO Model Course 3.18</b>	<b>EN 12195-1 (version 2003)</b>	<b>EN 12195-1 (version 2010)</b>	<b>German VDI 2700-2</b>
<b>DIMENSIONING CRITERIA</b>				
Accelerations				
- Longitudinal forward	→ 1 g / ↓ 1 g	→ 0.8 g / ↓ 1 g	→ 0.8 g / ↓ 1 g	→ 0.8 g / ↓ 1 g
- Longitudinal rearward	← 0.5 g / ↓ 1 g	← 0.5 g / ↓ 1 g	← 0.5 g / ↓ 1 g	← 0.5 g / ↓ 1 g
- Transverse	↔ 0.5 g / ↓ 1 g	↔ 0.5 g / 0.7 g <sup>1</sup> / ↓ 1 g	↔ 0.5 g / 0.6 g <sup>1</sup> / ↓ 1 g	↔ 0.5 g / 0.7 g <sup>1</sup> / ↓ 1 g
- Vertical upward	Not applicable	Not applicable	Not applicable	Not applicable
Coefficient of friction - Sawn timber against wood	Actual may be used	Actual may be used	Actual may be used	Actual may be used
- Dry and clean surface	$\mu = 0.5$	$\mu = 0.35$	$\mu = 0.45$	$\mu = 0.35$
- Wet surface	$\mu = 0.3$	$\mu = 0.2$	$\mu = 0.2$	$\mu = 0.2$
- With anti-slip mat	$\mu = 0.6$ if tested	$\mu = 0.6$ if tested	$\mu = 0.6$	$\mu = 0.6$ if tested
<b>CARGO SECURING EQUIPMENT</b>				
- Strength	MSL <sup>2</sup> Not applicable	LC <sup>4</sup> Not applicable	LC <sup>4</sup> Not applicable	LC <sup>4</sup> Not applicable
- Pretension	4 kN <sup>3</sup>	4 kN <sup>4</sup>	4 kN <sup>4</sup>	4 kN <sup>4</sup>
<b>CARGO SECURING METHOD</b>				
Top over lashing	Allowed	Allowed	Allowed	Allowed
- k-factor <sup>5</sup>	k = 2	k = 1.5	k = 2	k = 2
- Friction	$\mu = \mu_{\text{static}}$	$\mu = \mu_{\text{dynamic}}$	$\mu = \mu_f$ <sup>6</sup>	$\mu = \mu_{\text{dynamic}}$
- Lashing angle	$\alpha = 59.4^\circ$	$\alpha = 59.4^\circ$	$\alpha = 59.4^\circ$	$\alpha = 59.4^\circ$
- Safety factor	$f_s = 1$	$f_s = 1$	$f_s = 1.1$ sideways and backward $f_s = 1.25$ forward	$f_s = 1$
<b>CARGO – WOODEN BOX</b>				
- Weight	m = 10 ton	m = 10 ton	m = 10 ton	m = 10 ton
- Length	Not applicable	Not applicable	Not applicable	Not applicable

<sup>1</sup> This value is to be used when there is tipping risk sideways

<sup>2</sup> MSL = 50% of Breaking Load for Web Lashings

<sup>3</sup> PT ≈ 10% of Breaking Load

<sup>4</sup> LC and S<sub>TF</sub> measured according to EN 12195-2

<sup>5</sup> Difference in tension forces in lashing lines used for uneven distribution of lashing forces

<sup>6</sup> Friction factor  $\mu_f = 0.925 \times \mu_{\text{static}}$  or  $0.95 \times \mu_{\text{tested}} / 0.925$  or  $\mu_{\text{dynamic}} / 0.925$

**Table 2 - (continued)**

	<b>North America Cargo Securement Standard</b>	<b>Australia</b>	<b>New Zealand</b>
<b>DIMENSIONING CRITERIA</b>			
Accelerations			
- Longitudinal forward	→ 0.8 g / ↓ 1 g	→ 0.8 g / ↓ 1 g	→ 1.0 g / ↓ 1 g
- Longitudinal rearward	← 0.5 g / ↓ 1 g	← 0.5 g / ↓ 1 g	← 0.5 g / ↓ 1 g
- Transverse	↔ 0.5 g / ↓ 1 g	↔ 0.5 g / ↓ 1 g	↔ 0.5 g / ↓ 1 g
- Vertical upward	↑ 0.2 g	↑ 0.2 g	↑ 0.2 g
Coefficient of friction Sawn timber against wood	Not applicable	Actual may be used	Actual may be used
- Dry surface	Not applicable	$\mu = 0.5$ if tested	$\mu = 0.5$ if tested
- Wet surface	Not applicable	$\mu = 0.2$ if tested	$\mu = 0.2$
- With anti slip mat	50% of cargo weight to be used in calculations	$\mu = 0.6$ if tested	$\mu = 0.6$ if tested
<b>CARGO SECURING EQUIPMENT</b>			
- Strength	WLL = 13.3 kN	Not applicable	Rated strength 20 kN
- Pretension	Not applicable	3 kN	4 kN
<b>CARGO SECURING METHOD</b>			
Top over lashing	Allowed	Allowed	Allowed
- k-factor	$k = 2$	$k = 1.5$	( $k = 2$ )
- Friction	Not applicable	$\mu = \mu_{\text{static}}$	$\mu = \mu_{\text{static}}$
- Lashing angle	$\alpha = 59.4^\circ$	$\alpha = 59.4^\circ$	$\alpha = 59.4^\circ$
- Safety factor	Not applicable	$f_s = 1$	$f_s = 1$
<b>CARGO – WOODEN BOX</b>			
- Weight	10 ton	10 ton	10 ton
- Length	7.8 m	Not applicable	7.8 m

#### **4. Required number of top over lashings for the analysed cargo**

Required number of lashings is calculated for the wooden box; un-blocked in all directions as well as for the box blocked forward by a H-bracing in forward direction against a sufficiently strong headboard. Calculations have been made for a contact surface between the box and the platform that is wet and somewhat dirty, dry and clean as well as clean (dry or wet) with rubber in between.

Even though the basic design accelerations are similar according to all the studied regulations, guidelines and standards, the required number of top over lashings differs considerable due to influence of other parameters as can be seen from the table and figures below.

**Table 3 - Required number of top over lashings for a wooden box of 10 ton**

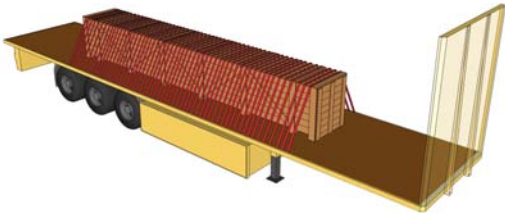
Regulations, standards or guidelines	Wet & dirty		Dry & clean		Rubber & clean	
	Blocking		Blocking		Blocking	
	None	Fwd	None	Fwd	None	Fwd
IMO Model Course 3.18 (IMO)	34	10	15	3	10	3
EN 12195-1:2003 (EN 2003)	57	29	25	9	6	0
EN 12195-1:2010 (EN 2010)	54	24	14	2	6	2
VDI 2700 part 2 (VDI)	43	22	19	7	5	0
North American standard (NACSS)						
- established from length	4	3	4	3	4	3
- established from WLL	4	4	4	4	2	2
- vertical (k=2, WLL=13 kN, $\alpha=59.4$ deg)	3	3	3	3	3	3
- maximum of the above requirements	4	3	4	3	4	3
Australian Load Restraint Guide (ALRG)						
- horizontal	57	29	12	0	7	0
- vertical (k=2, $F_T=3$ kN, $\alpha=59.4$ deg)	6	6	6	6	6	6
- maximum of the above requirements	57	29	12	6	7	6
New Zealand Code (NZTLC) – method 1						
- established from length	6	6	6	6	6	6
- established from rated strength	10	5	10	5	10	5
- vertical (k=2, $F_T=4$ kN, $\alpha=59.4$ deg)	3	3	3	3	3	3
- maximum according to method 1	10	6	10	6	10	6
New Zealand Annex C – method 2						
- (k=2, $F_T=4$ kN, $\alpha=59.4$ deg)	59	22	15	0	10	0
- minimum of method 1 and 2	10	6	10	0	10	0
Maximum of the above requirements	57	29	25	9	10	6
Minimum of the above requirements	4	3	4	0	4	0

In the two last rows of the table the maximum and minimum requirements for each condition is shown. In reality more than about 10 top over lashings would never be used as other lashing methods like spring and loop lashings would have been used. The intention with the presented values is to show the difference in the basic philosophy of the regulations.

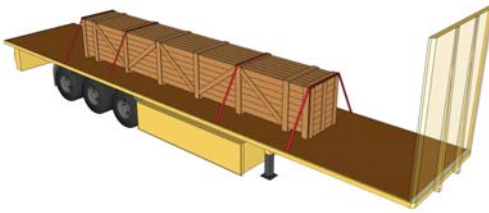
It can be concluded that the highest requirements in several cases are found for the European standard from 2003. It is obvious that the requirements in New Zealand are significantly diverging if the design is based on annex C or if it is based on length and weight of the cargo. It can also be seen that when rubber is used for an arrangement not blocked in forward direction the largest requirements can be found for the IMO and New Zealand methods. The reason for this is that a forward acceleration of 1 g is applicable for these methods, while 0.8 g is applicable for the others.

For many of the conditions the North America standard gives the lowest requirement. The only exemption from this is when rubber is used for an arrangement that is blocked in forward direction where zero lashings can be used according to some regulations.

In the sketches below the highest and lowest requirements for each condition are shown.

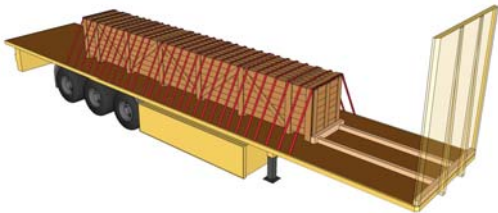


*Highest requirement, 57 lashings (EN 2003/ALRG)*

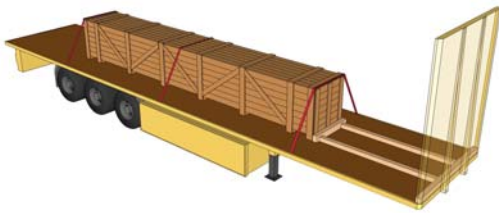


*Lowest requirement, 4 lashings (NACSS)*

**Figure 3 – Highest and lowest requirements for wet & dirty surface without blocking**

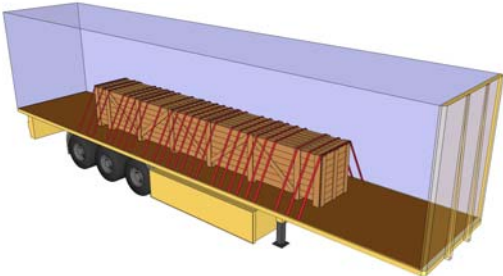


*Highest requirement, 29 lashings (EN 2003/ALRG)*

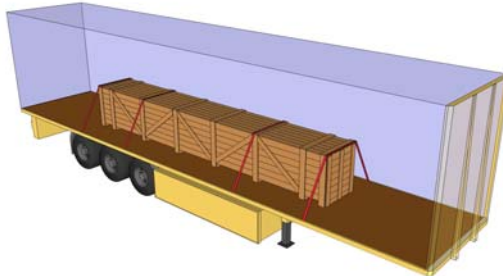


*Lowest requirement, 3 lashings (NACSS)*

**Figure 4 – Highest and lowest requirements for wet & dirty surface with blocking forward**

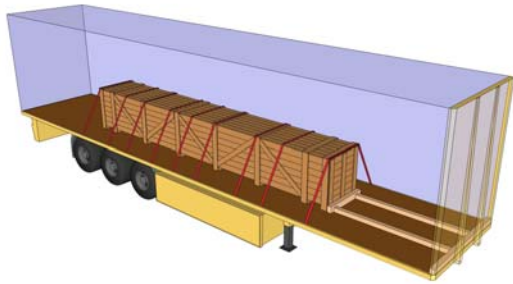


*Highest requirement, 25 lashings (EN 2003)*

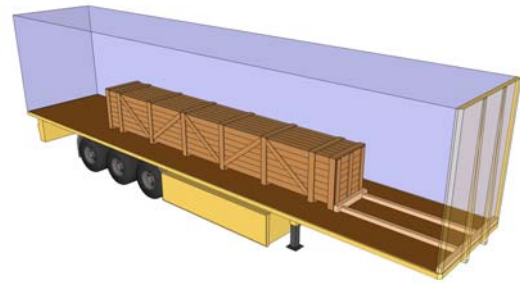


*Lowest requirement, 4 lashings (NACSS)*

**Figure 5 – Highest and lowest requirements for dry & clean surface without blocking**

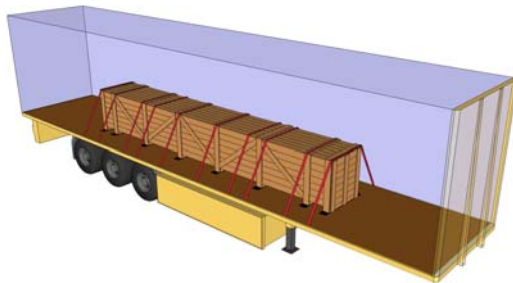


*Highest requirement, 9 lashings (EN 2003)*

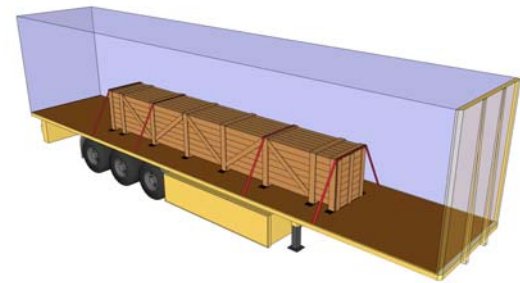


*Lowest requirement, 0 lashings (NZTLC)*

**Figure 6 – Highest and lowest requirements for dry & clean surface with blocking forward**

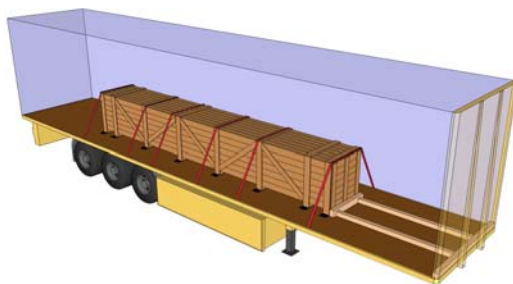


*Highest requirement, 10 lashings (IMO/NZTLC)*

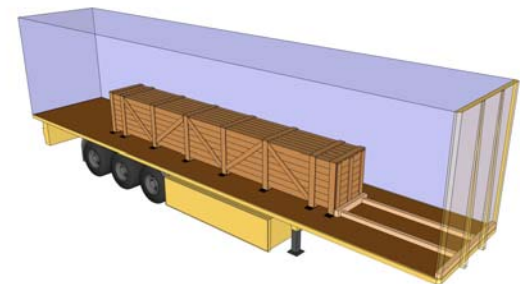


*Lowest requirement, 4 lashings (NACSS)*

**Figure 7 – Highest and lowest requirements for clean surface with rubber without blocking**



*Highest requirement, 6 lashings (ALRG)*



*Lowest requirement, 0 lashings (EN2003/VDI/NZTLC)*

**Figure 8 – Highest and lowest requirements for clean surface with rubber and blocking forward**

## 5. Conclusions and recommendations

In a long term perspective, divergent regulations on cargo securing will not be sustainable without affecting the transport industry negatively. In a general perspective, barriers preventing free trade between countries may potentially also affect the economic growth, whether it is regional or global.

This study has shown that few steps have been taken against harmonizing cargo securing regulations for road transports globally. It should be pointed out that if also combined transports by sea and rail were to be considered, the level of complexity would be even greater. Especially during rail transports the principles for cargo securing are completely different for those applicable on the road. As when the transport sector becomes further intermodal, differing regulations greatly impose the transport efficiency since additional administration has to be performed by the company responsible for the specific cargo securing arrangement. In a long term perspective, this may decrease the level of competitiveness in regions where foreign countries are dependent on transports performed in a transitional country characterized by high cargo securing requirements.

Since the IMO/ILO/UNECE organizations have initiated a revision of their Guidelines for Packing of Cargo Transport Units, this may be an efficient entrance for the development of more universal cargo securing regulations suited for transports on a regional as well as global basis.

### *Recommendations*

As a basis for harmonization of cargo securing regulations globally it is proposed to take the IMO and EN 2010 methods as these give the most reasonable required number of lashings. In these regulations different arrangements as blocking forward, frictional conditions as well as the use of anti-slip mats also show clear effect on the required number of lashings.

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