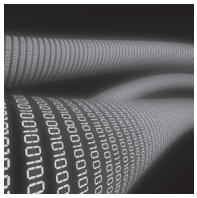

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Different measures for load securing create barriers in international road freight transport

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ABSTRACT

The purpose of this article is to present measures related to the load securing on European level. The road transport plays significant role in Europe. With the increasing volume of goods carried by road the number of vehicles are increasing and also the number of accidents involving trucks. The appropriate load securing increases the safety of road freight transport. European Best Practice Guidelines on Cargo Securing for Road Transport issued by European Commission are the first document on European level offering the load securing information.

There is also a lack of load securing training for truck drivers in most of the EU member states. In most member states the load securing is not the part of the training to obtain truck driving licence. The directive 2003/59/EC on the initial qualification and periodic training of drivers of certain road vehicles for the carriage of goods or passengers shall improve the situation. The education of truck drivers from load securing began since September 2009.

The standard EN 12195-1 offers calculation base to design load securing arrangements. There were cases when it has created unreasonable demands for load securing. The standard has been revised and finally published in May 2011. However, still the differences between the designs according to the EN 12195-1, methods using in Nordic countries, Germany and according to the IMO/ILO/UN ECE Guidelines on packing of cargo transport units exists. European Best Practice Guidelines on Cargo Securing for Road Transport are need to be revised to reflect the development in the area of load securing.

KEYWORDS: load securing, road freight transport, safety action

Road Safety Action Programme and Load Securing

The traffic safety is crucial with the increasing number of vehicles on European roads. The EU bodies monitor accidents in road transport and accept necessary measures to achieve required level of safety. In terms of **Road Safety Action Programme** the European Commission prepared **European Best Practice Guidelines on Cargo Securing for Road Transport** with the active participation of the authors of this paper. **[4]**

These guidelines should be the help for legislation changes in most of EU member states with only general and insufficient legislation (mainly the goal of legislation is: the load may not endanger) covering load securing without methods how to achieve the goals of legislation including problems with load securing controls by authorities.

Mr. Jacques Barrot, Vice-President of the European Commission, which was the Commissioner in charge of transport introduces these guidelines and says:

"It has been estimated that up to 25% of accidents involving trucks can be attributable to inadequate cargo securing. Rules on cargo securing exist in several Member States, but they often differ in content and scope, making it very difficult for international transporters to know what the minimum cargo securing requirements are for a given cross-border transport operation." [4]

Faults usually occurred in traffic in relation to the load securing

Present situation in traffic shows that there are following mistakes usually occurred in traffic in relation to the loading and load securing.

The load carried in inappropriate vehicle is usual way how the load is carried. Usually the load does not fit to the vehicle or the vehicle superstructure is not design for blocking of load as it should be according to the EN 12642 [22]. Typical example is the curtainsider semi-trailer with sidewalls not designed for load securing. The load must be lashed. However, if the load is not permitted to lash because of soft edges, than the vehicle is not suitable for transport.

The bad condition of the vehicle superstructure is the second problem where structural faults or missing parts of the superstructures e.g. wooden laths exist.

The lashing points on a platform are crucial if the cargo need to be lashed. Sufficient number, strength and position are important. Standard EN 12640 [23] defines basic requirements but minimum 12 pairs of lashing points per 13,6 m length of semi-trailer does not fit to the 17 sections of pallets loaded. Also minimum strength of 2000 daN is not suitable when common lashing straps of lashing capacity 2000 or 2500 daN are used more than one in same direction of load movement.

Appropriate loading is crucial point how to load the vehicle safely and in easy way to secure and not to overweight. It there is a lot of space between the load units then the load securing is difficult and costly.

Load on open vehicles is clearly visible by all road users. When the load is not secured, which is clearly seen, this is very dangerous to road users. On the other hand, unsecured load in closed vehicles presents hidden danger to the road users.

Top-over lashing (tie-down) is the most frequent lashing method but not suitable to secure heavy loads not blocked forwards. When the load is settling the effect of the tie-down is lost. Therefore retensioning recommended by the EN 12195-1 is important [20].

The type and condition of securing devices plays important role by load securing. Polyester lashing straps wear our more quickly than steel lashing equipment [18].

Manufacturing companies tend to save costs on packing and the safety of the load has to be assured by securing equipment provided by the carrier. Here the discrepancy between the securing equipment specified in the carriage order and equipment necessary to secure the load correctly occurs. Here the carrier can relieve of liability for correct load securing. There are also companies with internal load securing guidelines but presented load securing is not efficient and road carriers refuse to secure the load according to these guidelines.

Convention on the Contract for the International Carriage of Goods by Road (CMR)

This convention stipulates the responsibilities of the parties participated in international carriage of goods by road.

According to Article 17:

"1. The carrier shall be liable for the total or partial loss of the goods and for damage thereto occurring between the time when he takes over the goods and the time of delivery, as well as for any delay in delivery."(Convention CMR, 1956)

This means, if the carrier takes over the shipment, he also takes over the full responsibility for the shipment where load securing plays significant role to prevent any loss or damage on shipment. However, CMR Convention doesn't stipulate who is obliged to do the load securing.

According to the Article 17 sec. 4: *the carrier shall be relieved of liability when the loss or damage arises from the special risks as according to the letter b) the lack of, or defective condition of packing in the case of goods which, by their nature, liable to wastage or to be damaged when not packed or when not properly packed.*

Responsibility of the driver for loading and securing of a cargo

In many EU countries the driver of the vehicle is usually directly responsible for appropriate load securing in a way not to endanger traffic safety by the load on the vehicle. However, the driver meets a broad range of carrying goods and often doesn't have sufficient information about the load parameters as the weight, the dimensions, the position of the centre of gravity and behaviour of the load during carriage. Sometimes he is not allowed to be present during the loading and the vehicle is sealed after the loading. The driver does not perform load securing.

There is usually only general legislation defining the goal – safety. But in many EU countries there is a lack of procedures to achieve the safety of a load. This means how to secure the load in a correct way. There are also exceptions in countries as Germany and Nordic countries with load securing legislation and standards with 30 years tradition and also with effective load securing controls.

The truck drivers in most of the EU countries have a minimum knowledge from the load securing because this is not a part of the education to obtain a driving licence.

European Directive requiring education of professional drivers from loading and securing of a cargo

The European commission published the **Directive 2003/59/EC on the initial qualification and periodic training of drivers of certain road vehicles for the carriage of goods or passengers** to increase the traffic safety and the level of knowledge of professional drivers. The directive stipulates responsibility for EU member states to create the system of the initial qualification of professional drivers and periodic trainings. Knowledge from loading and securing of a cargo is a part of the List of subjects in ANNEX 1 of the directive 2003/59/EC as follows:

"1.4. Objective: ability to load the vehicle with due regard for safety rules and proper vehicle use:

forces affecting vehicles in motion**, use of gearbox ratios according to vehicle load and road profile, **calculation of payload of vehicle or assembly, calculation of total volume, load distribution, consequences of overloading the axle, vehicle stability and centre of gravity, types of packaging and pallets;

***main categories of goods needing securing, clamping and securing techniques, use of securing straps, checking of securing devices, use of handling equipment, placing and removal of tarpaulins.*"** (Directive 2003/59/EC)

In order to establish that the driver complies with the obligations of the directive, Member States should issue the driver with a certificate of professional competence. Member States shall apply these measures from **10 September 2009** as regards the initial qualification required to drive vehicles in licence categories C1, C1+E, C and C+E.

The general aim specified by the directive must be more specified in national teaching syllabuses for load securing. European Best Practice Guidelines ([4] sec. 8.14) also specifies the content of the load securing training.

Loading and securing of dangerous goods

By transport of dangerous goods significant measures are taken in Europe because these goods are danger for health and life of the persons, animals and plants or for the environment. This is covered in Europe by **European Agreement Concerning the International Carriage of Dangerous Goods by Road – ADR Agreement.**

Part 7.5.7 Handling and stowage describes general requirements for securing of dangerous goods:

„7.5.7.1 Where appropriate the vehicle or container shall be fitted with devices to facilitate securing and handling of the dangerous goods. Packages containing dangerous substances and unpackaged dangerous articles shall be secured by suitable means capable of restraining the goods (such as fastening straps, sliding slatboards, adjustable brackets) in the vehicle or container in a manner that will prevent any movement during carriage which would change the orientation of the packages or cause them to be damaged. When dangerous goods are carried with other goods (e.g. heavy machinery or crates), all goods shall be securely fixed or packed in the vehicles or containers so as to prevent the release of dangerous goods.

Movement of packages may also be prevented by filling any voids by the use of dunnage or by blocking and bracing. Where restraints such as banding or straps are used, these shall not be over-tightened to cause damage or deformation of the package (Guidance on the stowage of dangerous goods can be found in the European Best Practice Guidelines on Cargo Securing for Road Transport published by the European Commission. Other guidance is also available from competent authorities and industry bodies.). [2]

Load securing guidelines for road transport

Even if the professional driver has general knowledge about loading and load securing still there are organisations distributing specific load requiring special securing. Some organisations solve this problem by internal **load securing guidelines**. They offer basic aid for drivers and loading staff. These organisations lay stress on work safety. Mainly they define priorities: **„superior product requires superior carriage and the customer needs our product damage free and in time"**. The sender should also specify load securing aids the carrier should have and the aids there are available for the carrier at the loading site. He should choose the right vehicle, correctly perform the loading and offer specific load securing aids. Usually the responsibility of the driver is to distribute the load in regard to axle loads and secure it with the close cooperation of the sender.

The driver must be aware of the load carried e.g. in case the load settles he checks the tension in lashings and retighten them during carriage.

In table 1 there are companies in Slovakia with **Load Securing Guidelines for Road and Sea carriage.** The Department of Road and Urban Transport, University of Zilina worked up the guidelines for their load based on calculations and tests in years 2007 -2011.

In table 2 there are load securing situations of dangerous palletized goods in five cargo transport units for road and sea transport according to the load securing guidelines of one chemical company in Slovakia distributing these goods on trailers in Europe and in containers world wide. The stowage and the type of cargo transport unit have significant influence on load securing inside the unit. Also the type of packaging plays important role to fit well into the cargo transport unit. [19]

Load securing controls

Even if the directive 93/59/EC and the system of the education of professional drivers bring a general knowledge of loading and load securing there is still

Table 1. Load securing guidelines prepared in Slovakia – 2007 - 2011

Company	Type of load distributed	Calculation of load securing arrangements performed	Measurement of coefficients of static friction performed	Static inclination tests performed	Dynamic driving tests performed
1	Steel • sheets › bundles › coils › coil-strips • pipes	YES	NO	NO	NO
2	Steel • profiles packed in bundles › square profile › rectangular profile › circular profile	YES	YES	YES	NO
3	Paper • sheets › A4, A3 office paper › offset paper • reels	YES	NO	NO	NO
4	Aluminium • extrusion billets › long extrusion billets › short extrusion billets • ingots Chemical cargo • dangerous goods packed in big-bags	YES	YES	YES	YES
5	Chemical cargo – dangerous goods • bags on a pallet stabilized by a foil • big-bags • Steel drums • Intermediate Bulk Container	YES	YES	YES	YES
6	Copper • wire • anodes in bundles Chemical cargo – dangerous goods • bags on a pallet stabilized by a foil • big-bags	YES	YES	YES	NO

Table 2. Loading and securing of palletized cargo loaded in two layers – upper layer incomplete in different cargo transport units in one company according to the Load securing guidelines

Cargo transport unit	Number of pallets Weight of the load	Transport mode	Load securing aids
Semi-trailer with sideboards (cf. Figure 1)	46 pallets 22 tones	Road transport	2x europallet 11x web-lashing with tensioner 2x long corner protectors
Semi-trailer open or curtainsider (cf. Figure 2)	46 pallets 22 tones	Road transport	2x europallet 18x web-lashing with tensioner
Curtainsider certified according to EN 12642 Code XL (cf. Figure 3)	46 pallets 22 tones	Road transport	2x europallet 6x web-lashing with tensioner

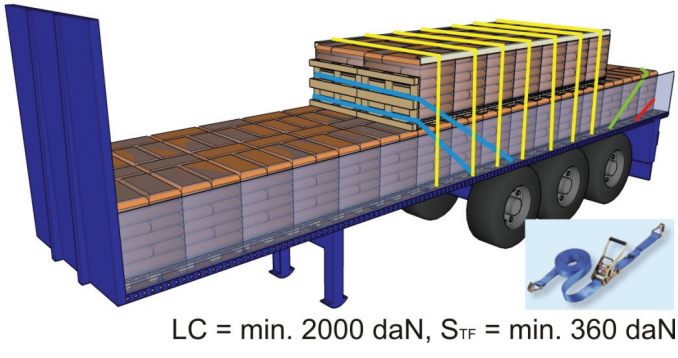

Fig. 1. Load securing of palletised load in semi-trailer with sideboards (cf. Table 2)

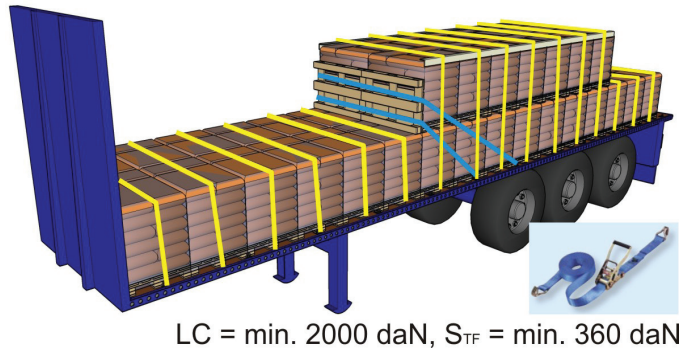

Fig. 2. Load securing of palletised load in open semi-trailer or curtainsider (cf. Table 2)

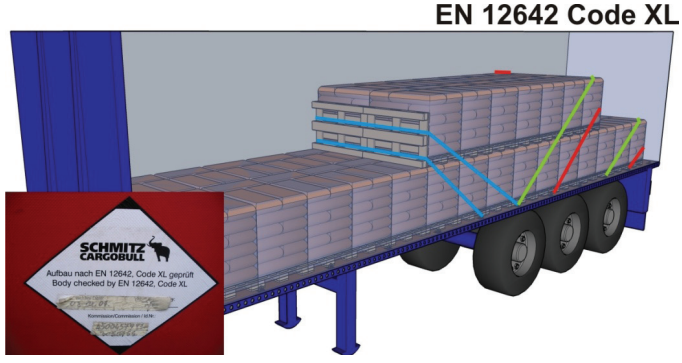

Fig. 3. Load securing of palletised load in curtainsider certified according to the standard EN 12642 Code XL (cf. Table 2)

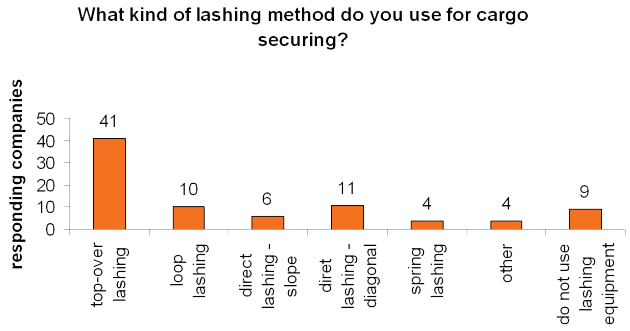

Fig. 4. Results from survey among 55 transport and distribution companies in Slovakia in 2005

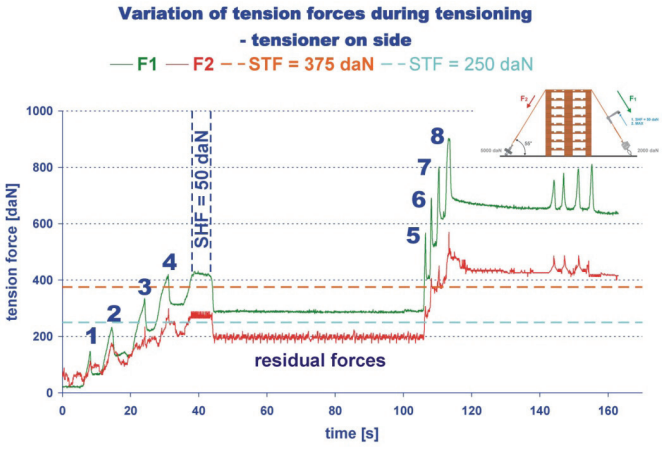

Fig. 5. Variation of tension forces during ratchet tensioning for top-over lashing with tensioner placed on side of the load

a lack of base how to design and perform the load securing and how to check it by controlling authorities. Germany and Sweden have well trained inspectors to perform load securing checks. The problem is that "sufficient load securing" is different in Sweden and Germany and according to the EN 12195-1:2011. The level of load securing is different. The Czech Republic started to perform controls according to the EN 12195-1:2011 since 1st of July 2011.

Sec. 8.14 of European Best Practice Guidelines also specifies that:

"It is recommended that road side checks are carried out using the same standards which are used for training for drivers and other staff. Road side checks should be carried out by specifically trained staff. All members of enforcement bodies concerned with traffic supervision should receive at least training about the basic issues of cargo securing, as mentioned above. Staff members carrying out dedicated supervision measures for heavy goods vehicles should be trained as experts also in all the other fields mentioned above."[3]

How many lashing aids do we need, is often a big issue when it comes to cargo securing. There are met various demands for cargo securing in European countries. The demand for the number of lashings is really confusing for international road haulers. The lorry driver travelling through different countries of Europe is often afraid of how many lashing straps or other equipment the controlling authorities and consignors at loading sites will want to see and if the straps are proper to use and fulfil the demands of standards or guidelines.

Top-over lashing, as the most frequent lashing method

Top-over lashing is used everywhere when it comes to cargo securing by lashing. If the driver secures general load by lashing he uses top-over lashing in about 90 % of all cases. The results from survey among 55 transport and distribution companies in Slovakia in 2005 are showed in the figure 4.

But what the effectiveness of top-over lashing is each driver must take into consideration. The driver should know what the friction and acceleration are and he also should know that usually the force on the opposite side without a tensioner is lower when compared to the tensioner side [6] , [8], [10].

Variation of tension forces during real tensioning of the usually used web-lashing by a ratchet tensioner is shown in the figure 5.

F1…force on tensioner side, F2…force on opposite side without tensioner, SHF – standard hand force of 50 daN applied on hand of the ratchet [8], [16]

It is clearly seen the force increase during tensioning. The numbered force peaks present the tightening through the teeth of the ratchet spindle. It is also seen that the force on the tensioner side (F1) is higher than the force on the opposite side (F2). This force difference depends on corner friction. If the corner friction is low the forces are almost equal. In some cases when the opposite line do not slip back during the tensioning the F2 > F1.

Main views on load securing in EU

Friction and forces in top-over lashing are the main points influencing top-over lashing and these points create controversy between the standard **EN 12195-1 Load restraint assemblies on road vehicles – Safety - Part 1: Calculation of lashing forces** and **IMO/ILO/UN ECE Guidelines for packing of cargo transport units (CTU's)** which are the two main basis for load securing design in Europe. The discussion was opened during the work on **European Best practice guidelines on cargo securing for road transport** and led after some years to the revision of European standard EN 12195-1 which has

Table 3. Basic parameters to design cargo securing arrangements

Parameter	CTU Guidelines IMO Model course 3.18	Standard EN 12195-1:2004	Standard EN 12195-1:2011
Acceleration coefficients			
Road transport – forwards - c_x	1 g	0.8 g	0.8 g
Road transport tilting sideways - c_y	0.5 g	0.7 g	0.6 g
Friction for frictional lashing method			
friction parameter– μ	static - μ_S	dynamic - μ_D	$0.925 \times \mu_S$
Friction for direct lashing methods			
$\mu \times f_\mu$	$f_\mu = 0.7$	$f_\mu = 0.7$	$f_\mu = 0.75$
k – factor for frictional lashing with 1 tensioner only			
k-factor	2	1.5	2
Safety factor for frictional lashing - f_S			
f_S	0	0	1.1 1.25 only road transport forwards
Static inclination tests and dynamic driving tests as an equal measure for cargo securing arrangements as theoretical calculations based on load and transport types			
	YES–stat. ; NO–dyn.	NO	YES
Frictional lashing against sideways tilting F_T…tension force in the lashing line, S_{TF} = standard tension force based on measurement procedure, LC…lashing capacity			
Equations calculate with following parameters	$c_y = 0.5$ $F_T = S_{TF}$	$c_y = 0.7$ $F_T = S_{TF}$	MAXIMUM FROM $c_y = 0.5$; $F_T = S_{TF}$ OR $c_y = 0.6$; $F_T = ½$ LC
Frictional lashing against sideways tilting for rows of identical units			
Equations	YES - tables	NO the same equation as for one unit	YES
Equations for loop lashings and spring lashing			
Equations	YES - tables	NO – the same equation as for slope and diagonal lashings	YES
Defined measurement procedures to obtain static and dynamic friction coefficients			
	YES - static	YES – static NO - dynamic	YES
Friction value for sawn wood – fabric base laminate/plywood			
m	$\mu_S = 0.5$; $\mu_D = 0.35$	$\mu_S = 0.5$; $\mu_D = 0.35$	m = 0.45

been successfully revised. The standard is, as national standards, implemented in EU but not obligatory in all the member states. In several states the standard is only on a voluntary base (in Czech republic obligatory since 1st of January 2011, in Germany since is valid). The discussions of experts showed that the standard stipulates very high and costly demand on cargo securing when it comes to top-over lashing. Therefore it has been called for the revision.

The main points of discussions were about friction (static or dynamic), acceleration sideways and k-factor. K-factor was always the biggest problem during the discussions. The standard defines it as the *"coefficient which allows for the loss of tension force due to friction between lashing and load"*. (Standard EN 12195-1:2004) [8]

Because of the friction on the corners the force on the opposite side is usually lower then the force on the tensioner side. This is presented in the calculation by k-factor with value 1,5 for top-over lashing with a tensioner on one side of the lashing only. The value 1,5 means that on the side without a tensioner there is only half of the force of the tensioner side. Of course, this value is very conservative and measurements showed that also the values more than 2 are possible to measure. The value of k-factor mainly depends on the corner friction. [10]

The issue is clear. The use of k-factor lower than 2 influences the number of lashings. The situation in EN 12195-1:2004 led also to infinite number of lashings for top-over lashing of unstable loads against tipping. [17]

The following table gives basic design parameters according to the CTU Guidelines, the standard EN 12195-1:2004 and the new standard EN 12195-1:2011.

Monitoring of shipments

To monitor the accelerations during carriage various monitoring devices are available where accelerations in three axis and rotations are recorded together with GPS position, speed and climatic conditions. This equipment can also be used during dynamic driving tests of load securing (cf. Fig. 6).

Conclusion

The Directive 2003/59/EC on the initial qualification and periodic training of drivers of certain road vehicles for the carriage of goods or passengers is applied in all member states for truck drivers from September 2009 but not at the same level. There must be national teaching syllabuses reflecting current demands on load securing. The different demands on load securing means also the training and controls are performed in different way in member states. For international road freight transport and multimodal transport it is necessary to unify EU requirements on load securing.

These means the drivers should be educated according to the relevant legislation, standards and guidelines and use them in EU**.** Here teaching sylabusses must reflect the results of securing methods according to the IMO/ ILO/UN ECE Guidelines on Cargo Transport Units, EN 12195-1:2011 and German guidelines VDI 2700.

European Best Practice Guidelines are need to be updated according to the EN 12195-1:2011 because the current specification of load securing design is not valid anymore. It Germany wants also to specify the calculation results in the guidelines according VDI 2700 Sheet 2 than these option should be also taken into consideration.

Acknowledgements

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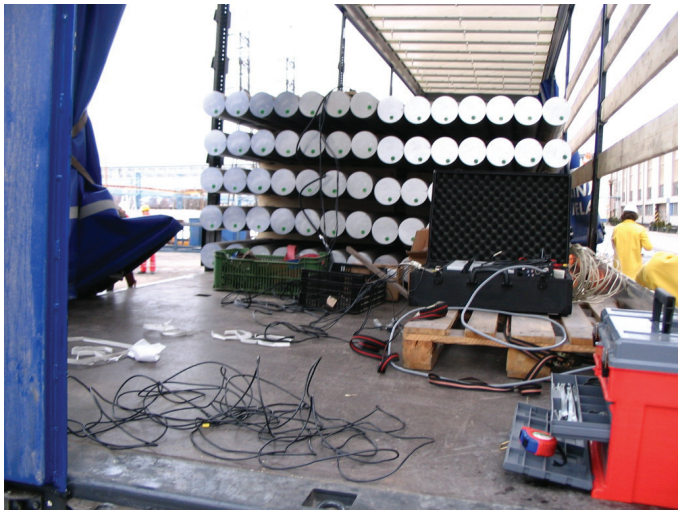

Fig. 6. Dynamic driving tests of load securing of aluminium extrusion billets using monitoring equipment

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