

load clamping; load securing; metal coils transportation

**Maria CIEŚLA\***, Grażyna HAT-GARNCARZ  
Silesian University of Technology, Faculty of Transport  
Kraśińskiego 8, 40-019 Katowice, Poland  
\*Corresponding author. E-mail: [maria.ciesla@polsl.pl](mailto:maria.ciesla@polsl.pl)

## THE PROBLEM OF PROPER CARGO SECURING IN ROAD TRANSPORT – CASE STUDY

**Summary.** This paper presents the problem of improper security of cargo in trucks as the cause of about 25% of the accidents that takes place in road transport. Attention was drawn to aspects of legal liability for errors resulting from incorrect load securing according to Polish law. Article was enriched with practical examples illustrating the effects of improper cargo securing on transport unit and shows how it had to be prepared properly. When planning the proper transport protection of metal sheets rolled both calculation methods and computer applications were used.

## PROBLEM PRAWIDŁOWEGO ZABEZPIECZENIE ŁADUNKU W TRANSPORCIE DROGOWYM – STUDIUM PRZYPADKU

**Streszczenie.** W artykule przedstawiono problematykę nieprawidłowego zabezpieczenia ładunków w samochodach ciężarowych jako przyczynę około 25% wypadków, które mają miejsce w transporcie drogowym. Zwrócono uwagę na aspekty odpowiedzialności prawnej za błędy wynikające z nieprawidłowego zabezpieczenia ładunków w odniesieniu do polskiego prawodawstwa. Artykuł wzbogacono przykładem praktycznym obrazującym skutki nieprawidłowego mocowania ładunku w jednostce transportowej oraz przedstawiono jak miało ono być przygotowane prawidłowo. Przy planowaniu prawidłowego zabezpieczenia kręgów blachy wspomagano się zarówno metodami obliczeniowymi jak i aplikacjami komputerowymi.

### 1. INTRODUCTION

Today, to meet the demands of consumers and the fierce competition of the global market in TFL (transport-forwarding-logistics) companies, transport services must be carried out in direct relations (so-called door-to-door). Following the trends in ecology and in conjunction with longer growing international transport chains, for the purpose of goods movement various modes of transport are being used and integrated multimodal transport as well. However, regardless of the optimal transport mode and route, in relation "to the door" of the customer, there is always a necessity to transport goods by road, for a shorter or longer distance. Enterprises rationalizing their ecological or financial conditions, always face the dilemmas associated with security of the loads transported. After all, every company operating on the transport and courier market with their experience struggle with issues related with poor security and cargo damage during transit.

During transportation, cargo is exposed to the occurrence of different types of transport damage, affecting the quality of the services offered by the company, and thus its competitiveness in the market. It is estimated that about 25% of accidents involving trucks are caused by improper loads

fastening [1]. It is not feasible to have all road transport services done without any damage to the transported goods. It should, however, strive to ensure that the number of such disruptions in the logistics chain as small as possible. The interest in this problem applies to all market participants in basic transport services occurring on the demand side (shippers) and supply side (carriers) as well as intermediaries (e.g. agents, transport companies, trade companies, customs, insurance and others).

## 2. LEGAL LIABILITY FOR CARGO PROTECTION

For an inappropriate cargo securing it is not only the driver who is responsible as it is commonly perceived. In Poland, the law on road transport authorizes the initiation of administrative proceedings against the entrepreneur not only performing the carriage of goods, but also against the entity performing other activities related to the carriage (e.g. loading or unloading). The penalty imposed on the carrier can be up to 15 thousand. PLN ( $\approx 3600$  €) and while controlling procedures in the company it may be even 50 to 30 thousand. PLN ( $\approx 7200 - 12000$  €) - depending on the offense described [3].

Liability under Polish Law on Road Traffic [2] applied to the person securing cargo in road transport imposes on them the need to follow the guidelines under which the goods:

- must not be exceeded maximum authorized mass or maximum load capacity of the vehicle,
- on a vehicle are placed in such a way as not to cause exceeding the permissible axle loads of the vehicle on the road, not to violate the stability of the vehicle, driving is not impaired, do not impair the view of the road or not concealed lights, signalling devices, plates or other signs or characters, that the vehicle is equipped,
- should be protected from excessive noise calling or reposition (the device used to attach loads should be secured against loosening up, free sagging or falling while driving),
- which extends beyond the plane of the contour of the vehicle can be placed only on it while maintaining specific conditions.

Requirements for cargo fasteners are both in the European and national standards. An important source of information about the principles of cargo securing are also in the manuals provided by load securing equipment manufacturers. Typically, they are consistent with the content of German industry standard VDI (*Verein Deutscher Ingenieure*). These standards specify in details the methods of securing different types of loads. The guidelines set out in the standards VDI are certainly in line with national standards or European, but are extended with concrete examples and drawings.

## 3. ANALYSIS OF CARGO SECURING EXAMPLE

The success of the proper and safe transport process depends not only on the organizational factors, human, etc., which should be taken into account during the loading operations, but also appropriately selected devices and fastening equipment on the vehicle load [8]. For correct use of the safety equipment and for eliminating suggestive of the human factor, the relevant formulas, supporting procedures and computer applications are being used in decision making area, which, however, the consequences can be very serious. Determining the securing method(s) best adapted to the characteristics of the cargo (locking, blocking, direct lashing, top-over lashing or combinations of these) may be sometimes a matter of life.

### 3.1. Case study of incorrect transport protection of coiled metal sheets

The case study presents damage of cargo which was caused by sudden and rapid braking of the vehicle. Due to this transported three tons of metal sheets coils have shifted in the trucks causing damage to the goods carried. For the transport of steel coils a vehicle with universal loading trailer was used. Coils of steel were arranged horizontally on wooden crossbars, each of the coil was fastened tight with fastening belts.

Selection restraining method in this case was connected with determining the minimal number of lashing equipment. To determine the number of restraint device such equation is being used [4]:

$$n = \frac{m_L \cdot g \cdot (C_{x,y} - \mu_D)}{S_{TF} \cdot \mu_D \cdot k \cdot \sin \alpha} \quad (1)$$

where:  $n$  - number of strips required [-];  $m_L$  - load mass [kg];  $g$  - gravitational acceleration [m/s<sup>2</sup>],  $C_{x,y}$  - acceleration factor in longitudinal and transverse direction [-];  $\mu_D$  - dynamic friction coefficient [-],  $S_{TF}$  - rated belt tension force [N];  $k$  - tension power transmission coefficient ( $k = 2$  and  $k = 1.5$  if the belt is properly two or one tensioner) [-],  $\alpha$  - vertical angle of between extraction, and the plane of the floor [degrees].

Loads were placed evenly on the box, keeping the spaces in between them in order to evenly distribute the weight. During severe braking manoeuvre two coils moved forward, hitting the front shear body. There was one lashing belt cut on the sharp edges of the steel sheet, another belt slid off the load and further damage in the edge of the sheet after the tightening of security. All these damages are shown in Figure 1.

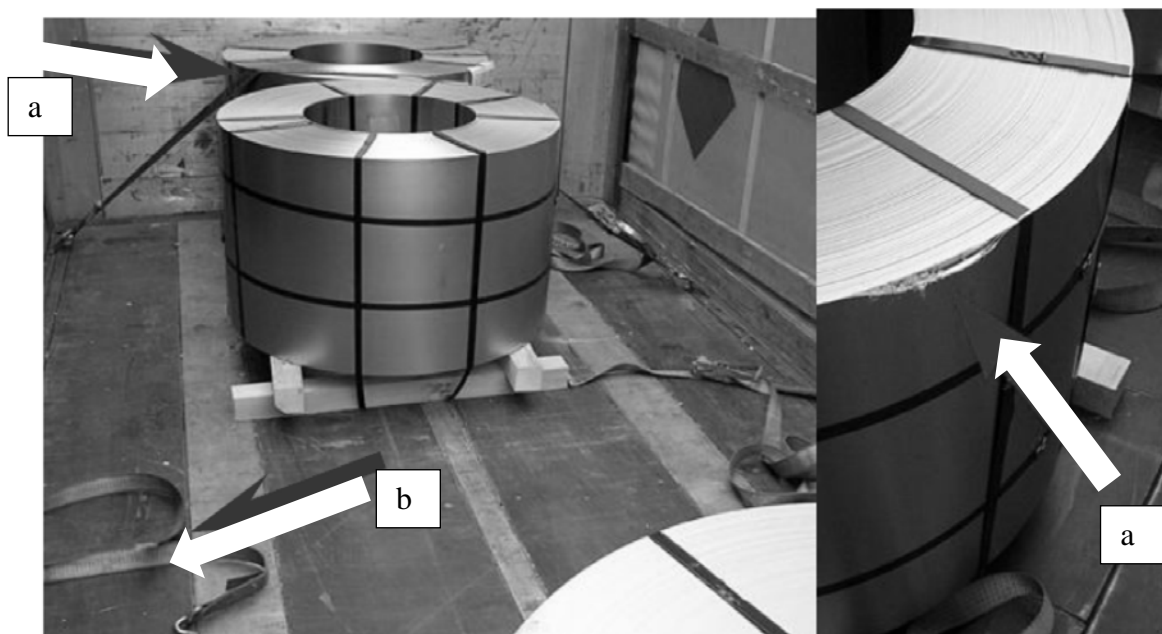


Fig. 1. The effects of improper invalid load securing: a) the damage in the edge of the sheet, b) cut lashing belt  
Rys. 1. Skutki nieprawidłowego zamocowania ładunku: a) uszkodzenie krawędzi blachy, b) przecięcie pasa mocującego

### 3.2. Planning of proper cargo securing

To transport steel roll coil fast and safe without damaging it, it is necessary that the steel roll coil has to be in stable condition [10].

In the analysed example insufficient knowledge of the proper selection of lashing equipment parameters was proved. Probably there was an incorrect technique to protect the load used, which was not able to hold heavy circles steadily. In addition, unprotected sharp edges of the load caused belt cuts and damage to the load itself. In this case, use of the plastic edge protector (blocking method) would help to avoid the problem. For more common transport of such a specific cargo, the shipper should send a special type of dump trailer adapted to the type of loads [9]. Semi-trailer through the groove in the floor protects the load from falling sideways. These coils, when loaded bore horizontal will preferably be carried on vehicles having a coil well (wedge bed) in the load platform. Also the use of protective steel frame is recommended which preserves load from moving forward in the direction of travel (Fig. 2).

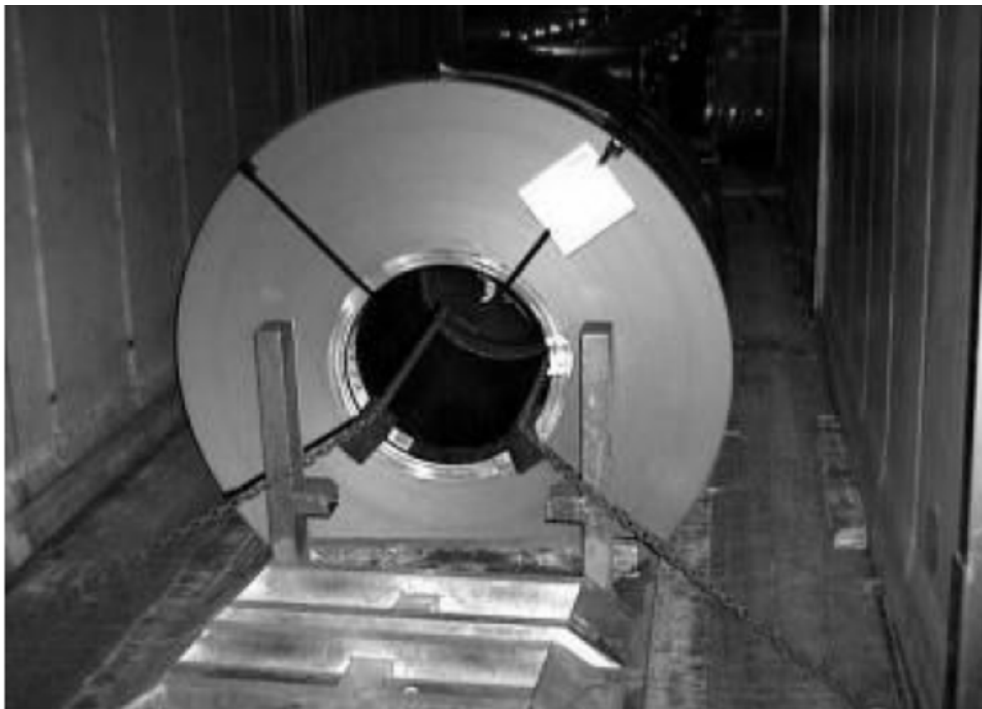


Fig. 2. Proper protection of the analysed load  
Rys. 2. Poprawne zabezpieczenie analizowanego ładunku

The groove in the floor (Fig. 3) is made of steel, therefore in order to increase the coefficient of friction between the load, and the groove and to protect the load from damage of coils surface it is recommended to line the floor with mat or non-slip synthetic material.

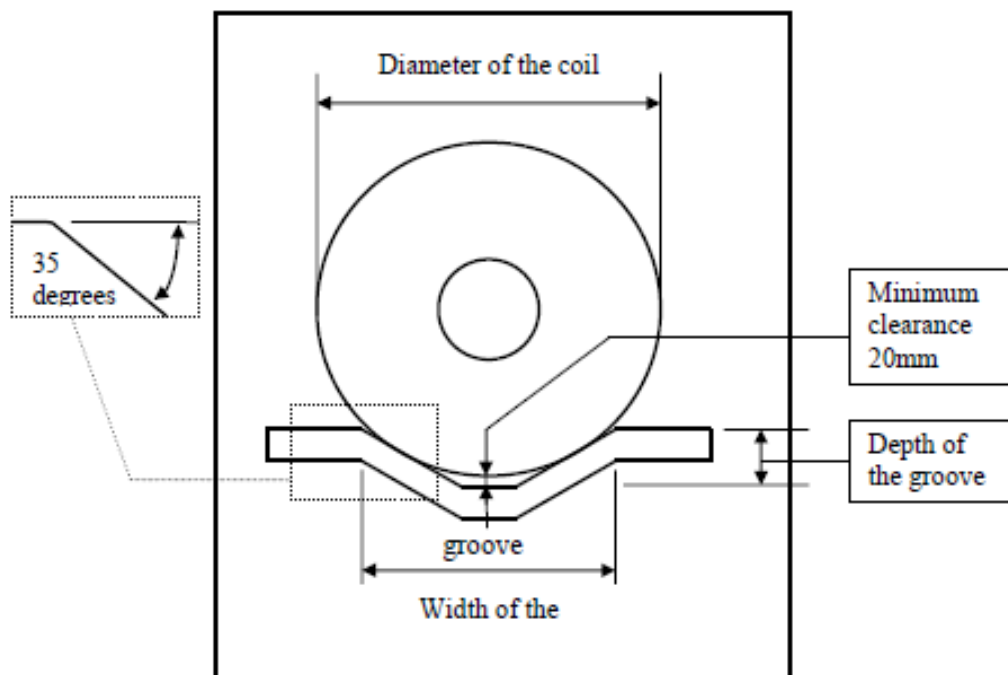


Fig. 3. Characteristics of a groove  
Rys. 3. Charakterystyka wgłębienia w podłodze

A groove is recommended for coils of four tons or more and mandatory for coils of ten tons or more. For coils of four to ten tons a wedge bed may also be used.

Requirements for a groove (see Fig. 3 [1]) are:

- the slopes should have an angle of 35 degrees to the horizontal;
- the coils, if placed in the groove, should have a minimum clearance of 20 mm to the bottom;
- the width/height ratio of the coils should not be lower than 0.7;
- if lower than 0.7, the coils have to be stowed against a support;
- rule of thumb: "width of groove = at least 60% of coil diameter";
- the contact area of the coil should clearly be below the top of the groove [1].

For a coil placed in the groove and leaning to the transverse frame should be performed lashing belts made of synthetic fiber or two steel chain protective device passing through the hole as shown in Figure 2.

The calculations performed in the Braun application [5] (Figure 4) shows that the fastening means can be used both synthetic fiber straps or chains of steel with LC (lashing capacity) of only 750 [daN]. It should be remembered to protect the edges the load from damage that can be caused by lashing equipment. In this case it is recommended to use edge beams made of wooden boards or material. Due to the very heavy weight of the cargo, special attention paid to the proper apportionment of the load on the axles.



Fig. 4. Lashing equipment adjustment with the use of Braun company application  
Rys. 4. Dopusowanie lin mocujących przy pomocy aplikacji firmy Braun

Vertical bore coils transportation with (as shown in Fig. 1) is acceptable for steel coils of up to four tons. This method however requires protection with supporting lashings. To protect the cargo from shifting are being used binders such as metal strips, strips of plastic and natural fibers to shrink covers or canvas covers, which are covered with a unit load [6]. The coil itself must be girded by two long straps as shown in Fig. 5 and with special fixing points of the vehicle [7]. Because of the bigger effort of such a cargo security it is recommended to transport coils rather in specialized trailers, as shown in Fig. 2.



Fig. 5. Protection of steel coils carried with bore vertically

Rys. 5. Zabezpieczenie kręgów blachy przewożonych osiami pionowo

#### 4. CONCLUSIONS

According to Polish law not only the transporting company is responsible for the damage of improper cargo securing but also those companies performing other activities related such as loading or unloading.

In order to meet the customer's demand and competitiveness in the market by providing high quality service, it is recommended that in large companies was at least one person who is very highly qualified in the field of cargo securing. His task would be to assist other staff involved in mounting loads, conducting internal training on lashing (for drivers, personnel involved in the loading and unloading, forwarders planning the route) and solving difficult problems that they are unable to deal with less-skilled workers. It is also a good idea to create a short guide of cargo securing that each vehicle is equipped with.

The case study of steel coils transportation has presented main problems that has been observed while invalid protection of the cargo carried horizontally. In this case, there was a damage observed of the load itself and lashing equipment. In order to avoid such problems in future it is recommended to load coils on vehicles having a coil well (wedge bed) in the load platform with protective steel frame. Lashing belts made of synthetic fiber or two steel chain protective device should be passing through

the hole of the coil. It is recommended to use special computer application to adjust the right type and number of lashing devices for cargo securing.

Vertical coils transportation with is also acceptable for steel coils that weight up to four tons. This method also requires protection with supporting lashings.

## Bibliography

1. *European Best Practice Guidelines on Cargo Securing for Road Transport*, European Commission, Directorate-General for Energy and Transport. Available at: [http://ec.europa.eu/transport/road\\_safety/vehicles/doc/cargo\\_securing\\_guidelines\\_en.pdf](http://ec.europa.eu/transport/road_safety/vehicles/doc/cargo_securing_guidelines_en.pdf)
2. Dziennik Ustaw z dnia 20 czerwca 1997 r. *Prawo o ruchu drogowym* (Dz.U. 1997 nr 98 poz. 602). [In Polish: Official Gazette of 20 June 1997. *Law on Road Traffic* (OG 1997 No. 98, item. 602)]
3. Różycki, M. Kontrola zamocowania ładunku. Co może kierowcy zrobić funkcjonariusz za nieprawidłowe mocowanie ładunków. *Truck & Business*. 2009. No. 13. P. 24-26. [In Polish: Rozycki, M. Control anchoring loads. What can to do officer for drivers if improper mounting loads. *Truck & Business*]
4. Prochowski, L. & Żuchowski, A. *Technika transportu ładunków..* Warszawa: WKiŁ. 2009. [In Polish: Prochowski, L. & Zuchowski, A. *Technology for cargo transportation*. Warsaw: WKiŁ].
5. *Braunsis*. Available at: [http://www.braun-sis.de/download/braunsis\\_v4.1.exe](http://www.braun-sis.de/download/braunsis_v4.1.exe)
6. Ładoński, W. *Podstawy towaroznawstwa ogólnego*. Wrocław: Wydawnictwo Akademii Ekonomicznej. 1991. [In Polish: Ladonski, W. *Fundamentals of general commodities*. Wrocław: Publishing of University of Economics. 1991]
7. Różycki, M. & Kędzior, J. *Zabezpieczanie ładunków. Poradnik praktyczny*. Wydawnictwo „Towary Niebezpieczne”. Wrzesień, 2007. 80 p. [In Polish: Rozycki, M. & Kedzior, J. *Securing of cargo. Practical Guide*. Publishing house „Dangerous Goods”. September, 2007]
8. Cieśla, M. & Probiez, K. Logistic planning in mass transportation process of liquid edibles. In: Sładkowski, A. (ed.) *Actual problems of logistics*. Gliwice: Wydawnictwo Politechniki Śląskiej. 2012. P. 153-171.
9. Cross, W.B. & Romick-Allen, R. & Panahshahi, N. & Hanna, S.J. Analysis of Rules and Regulations for Metal Coil Truck Transport. *Journal of Transportation Engineering*.1996. Vol. 122. No. 6. P. 475-480.
10. Kwac, L.K. & Kim, J.Y. & Kim, H.W. & Han, J.H. & Lee, Y.S. Stability analysis of dunnage for transportation of a steel roll coil. *International Journal of Modern Physics B*. 2006. Vol. 20. No. 25-27. P. 3769-3774.

Received 17.03.2012; accepted in revised form 07.12.2013