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CARGO SECURING AND ACCIDENT RATE IN THE ARMY OF THE CZECH REPUBLIC

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Abstract: *The article analyses the evolution of the accident rate in terms of the Army of the Czech Republic during last 6 years (2010-2015) and examines selected causes of vehicle accidents. In the context of the comparison of selected methods of cargo securing an analysis of potential risks in cargo securing on trucks of the Army of the Czech Republic has been done. A simple model of cargo securing on selected truck was created for these purposes. The model takes into account values measured in the field in comparison to conventional transport performed on highway and 2nd class road. Statistical analysis of the evaluation values of the coefficients of acceleration, which serves as a data source of the presented model, is included.*

Keywords: transportation, cargo security, modelling, accident rate

1. Introduction

Accident rate in road transport has been a major problem for a long time. In the Czech Republic (CR), despite of preventive measures the number of accidents is not decreasing. Such measures may include e.g. the appropriate setting of the transport system, better information for drivers, as well as measures to reduce the risks of injury or killing of road users – especially technical measures for vehicles and the traffic infrastructure.

The total number of accidents in the Czech Republic was 25,239 accidents in 2005 and only 19,676 accidents in 2010. However, in 2015 it increased again to 21 561 accidents [1,2,3,4].

Increasing of the number of accidents is certainly also caused by increasing number of vehicles in the long term (see Table 1 and Figure 1).

The article will focus primarily on trucks in context of the examined segment in terms of the Army of the Czech Republic (ACR).

The issue of accidents in the ACR has been recorded and evaluated by ACR Military Police in long term. Basic area that is assessed is whether the accident culpable, respectively non-culpable. It also includes monitoring of other aspects (death or injury, extent of damage, type of vehicle, etc.). Interesting facts include the statistics of causes of accidents (see below).

Table 1 Accident rate development in road transportation and number of vehicles in chosen segment.

Quantity/year	2000	2005	2010	2015
Accidents	25,445	25,239	19,676	21,561
Passenger vehicles	3,438,870	3,958,708	4,496,232	5,115,316
Cargo trucks	275,617	415,101	584,921	646,792

** Vehicles registered in the CR*
Source: [1,2,3,4].

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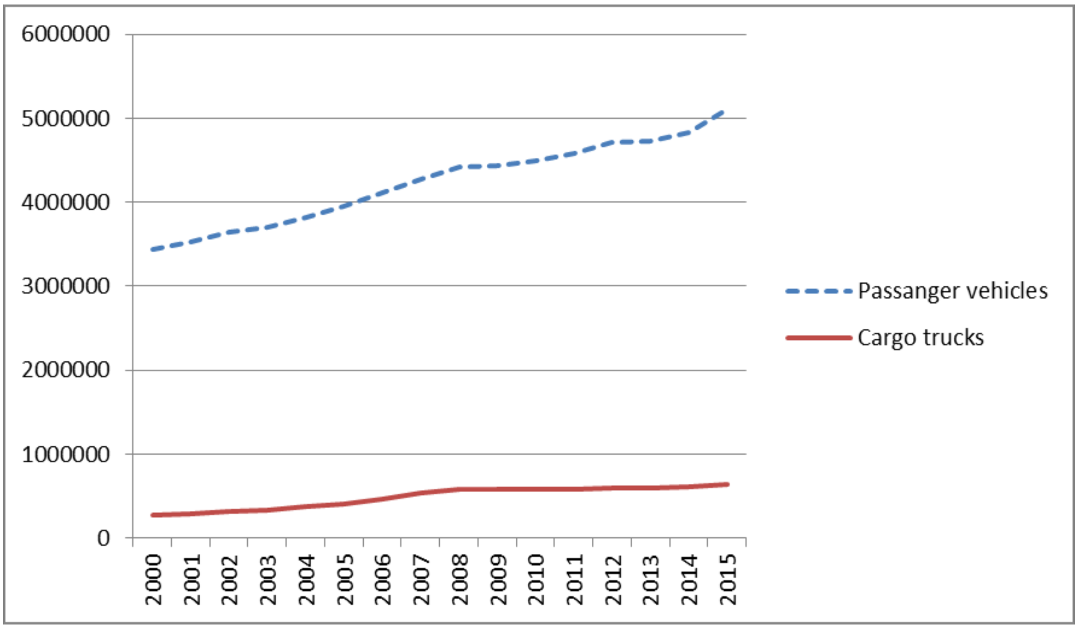
Table 2 Number of persons killed or injured during vehicle accidents

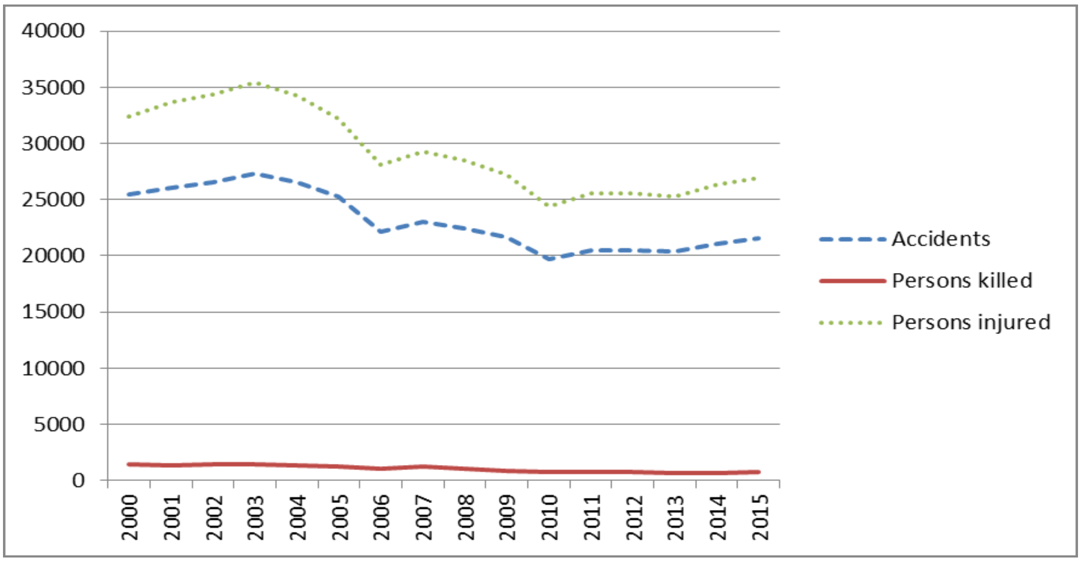
Quantity/year	2000	2005	2010	2015
Persons killed	1,486	1,286	802	738
Persons injured	32,439	32,211	24,384	26,966

** The number of persons killed during vehicle accidents – within 30 days since the day of the accident*
Source: [1,2,3,4].



** Vehicles registered in the CR*
Source: [1,2,3,4].

Figure 1 – The number of vehicles in the CR in years 2000-2015



** The number of persons killed during vehicle accidents – within 30 days since the day of the accident*
Source: [1,2,3,4].

Figure 2 – Accidents and the number of persons killed and injured in the CR in years 2000-2015

2. Accident rate in the CR

From Table 1 it is obvious that although there was a slight increase in the number of accidents between 2010 and 2015 (less than 9.6%), the increase in the number of vehicles registered in the CR stood more strongly in both major segments (cars and trucks). The increase is, between the years when there has been an increase in the number of accidents (2010 – 2015), nearly 13.8% for passenger vehicles, 10.6% for cargo trucks respectively. In comparison with the year 2000 the increase is very significant: almost 49% for passenger vehicles and 138% for cargo trucks respectively.

There is a positive trend in the number of persons killed within 30 days from the date of the accident, which has been steadily declining since 2000 (with minor exceptions in 2002, 2007 and 2014) and declined to one half of the level of 2000 in 2015 (see Table 2 and Figure 2).

The number of people injured is also significantly decreasing (nearly 16.9%) between the years 2000 – 2015, but in recent years the trend is rather increasing. Among the years 2010 – 2015there is an increase of almost 10.6%.

A certain insufficiency of statistics on the national level is the lack of resolution of technical causes of accidents and possibly specific type of technical glitches. Section 6.2.1. of transportation yearbooks classifies accident by location and type, but it does not identify technical causes of the accidents. Some carriers file these statistics in their information systems. Unlike the aggregated statistical data on the CR these statistics are not publicly available and thus serve only to traffic and fleet control of the carrier.

3. Accident rate in ACR and its causes

The situation in the ACR is different from the situation in the CR. The accident rate during the past 6 years in the ACR oscillates around the mean values (arithmetic averages during 6 years): 93 culpable accidents, 88 non-culpable accidents respectively. Mean values are not markedly different and even overall numbers do not show significant differences (555 resp. 528 accidents).

The number of persons injured and killed is also interesting, the number is significantly higher for non-culpable accidents (see Table 3).

The situation is reverse for property damage, the damage caused by culpable accidents are almost 2.8 times higher than in the case of non-culpable accidents.

The reason is undoubtedly much higher number of culpable accidents of cargo trucks which is almost double compared to non-culpable accidents.

For use of other statistical tools, the sample is relatively small and mainly the segment of persons injured and killed because of to traffic accidents is relatively negligible.

A very interesting is observing partial information on injuries, as well as monitoring of selected causes of accidents in the ACR.

Injuries are divided standardly into groups of slight and serious injuries. Persons killed during vehicle accidents are mentioned separately.

The causes of accidents are categorized into alcohol, speeding, not giving right of way, dangerous overtaking, driving style and technical causes.

A certain shortcoming is the lack of identification of technical reasons, which can also include accidents caused by improper securing of the cargo. More frequently, the release of the load, damage, and injuries respectively happen without causing a traffic accident. Such cases are not recorded in the ACR in relation to logistics, but only with respect to compensation, or legal liability respectively. Regarding the absence of this category the number of accidents caused by technical reason can be considered as an insufficient indicator that could testify about the method of cargo securing.

Table 3 Culpable and non-culpable vehicle accidents in the ACR

	CULPABLE ACCIDENTS					NON-CULPABLE ACCIDENTS				
Year	**Trucks**	**Injuries**	**Dead**	**D** (CZK)**	**Total***	**Trucks**	**Injuries**	**Dead**	**D** (CZK)**	**Total***
2010	24	2	0	1,453,100	91	21	8	0	1,025,500	101
2011	18	1	0	6,207,000	75	9	2	0	1,314,000	85
2012	16	0	0	507,000	78	10	0	1	513,000	106
2013	30	1	0	1,546,100	108	21	9	1	651,050	84
2014	24	0	0	624,600	93	8	2	0	384,879	83
2015	35	1	0	1,059,500	110	10	0	0	227,500	69
Total	**147**	**5**	**0**	**11,397,300**	**555**	**79**	**21**	**2**	**4,115,929**	**528**

** Total number of vehicle accidents in the ACR, incl. cargo trucks*
*** Damage to property in CZK*
Source: [5].

Based on the above mentioned analysis of available statistical data, it is important to ask the following question: What should be monitored with regard to repressive measures, and in particular to preventive measures?

What should be evaluated subsequently in relation to the accidents is mentioned above, the basis is primarily a detailed elaboration of technical reasons. The part of the evaluation should be also problems which cause injury during e.g. loading/unloading or damage to property (cargo, fastening device, vehicle, etc.).

In terms of precautionary measures may be considered desirable to know besides the nature of the cargo and technical means also conditions of transport. Transport conditions can be only assumed before initiation of transportation, however, that assumption should be qualified and should be based on empirical studies. The key factor is then measured and statistically processed values of acceleration coefficients, which are an essential component of the calculations of relevant inertial forces acting on the cargo during transportation. The presented model of cargo securing illustrates the importance of examining of the size of the acceleration coefficient (inertial forces) in relation to the cargo securing which may have a negative impact on accident rates in the ACR.

4. Model of cargo securing

For the purpose of the model following data was measured – acceleration coefficient values in the selected section of D1 highway (Brno – Vyškov) and II. class road no. 430 (Vyškov – Brno) on 14th October 2016. For measuring of the values 4 pieces of accelerometers OMEGA (OM-CP-ULTRASHOCK-5) [6] were used and mounted in cargo space of the military truck – Middle Cargo Terrain Tatra T-810. The vehicle was left during the transport experiment without cargo. For both experiment sections of route Brno – Vyškov and back the same vehicle driven by the same driver was used [7,8].

Measured values for transportation on route Brno – Vyškov are presented in Figure 3, for transportation on route Vyškov - Brno in Figure 4. Values of the acceleration coefficient for each axis are: x – longitudinal axis, y – transverse axis and z – vertical axis.

The aim is the comparison of differences in extreme values for the transportation on the highway and the II. class road, including a comparison with the values of the acceleration coefficients which are set in the standard EN 12195-1 (the "Standard"). The Standard identifies empirically obtained – estimated values of the acceleration coefficients for the particular axes in the basal vector c = (0.80, 0.60, 1.00) [9]. In both data sets there are significant differences in comparison with normatively set values of the acceleration coefficients.

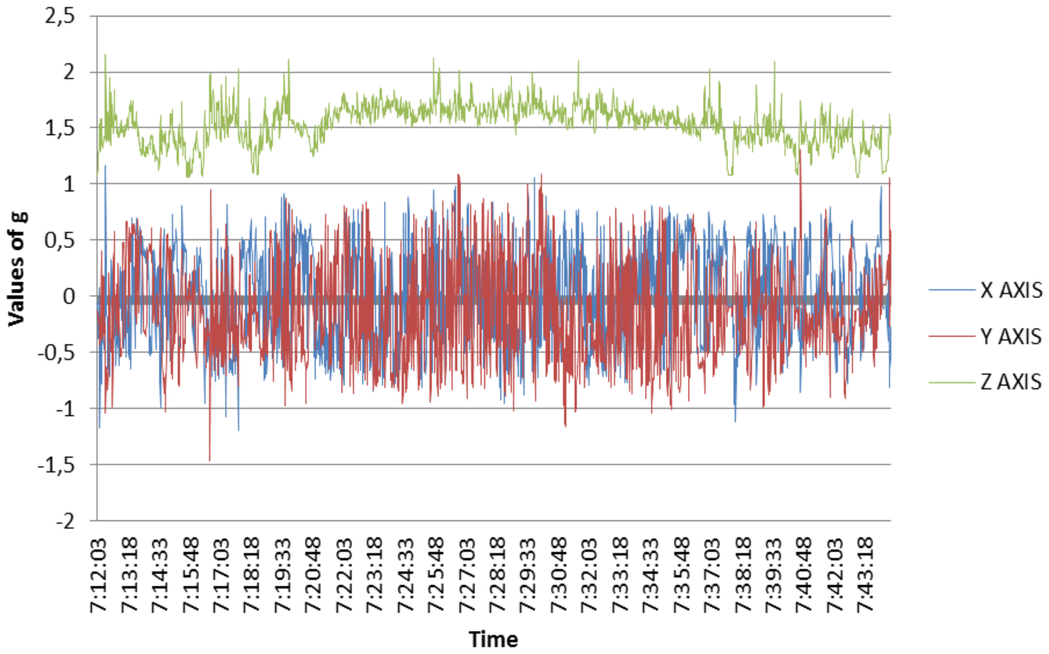
From a total of 5,817 values 483 values are outside the norm, which represents 8.30% of the values on route Brno – Vyškov (highway). That means the acceleration coefficient (in absolute value) of the particular axis exceeds the normatively set values of the basal vector (see above). Only a negligible number (two values) exceeds a normatively set baseline vector twice, so more than c_2 = (1.60, 1.20, 2.00), which represents only 0.03% of values.

On the route Vyškov – Brno (II. class road) there is a total of 6,276 values 897 values outside the norm, which represents 14.29% of the values. Relatively insignificant number (77 values) exceeds the baseline vector twice, which represents 1.23%.

In the context of the results it can be said that there are significantly more acceleration function extremes on the II. class road, although the size of both data sets is different. Above all, the absolute number of values that exceed the value of the basal vector twice should be considered as risky.

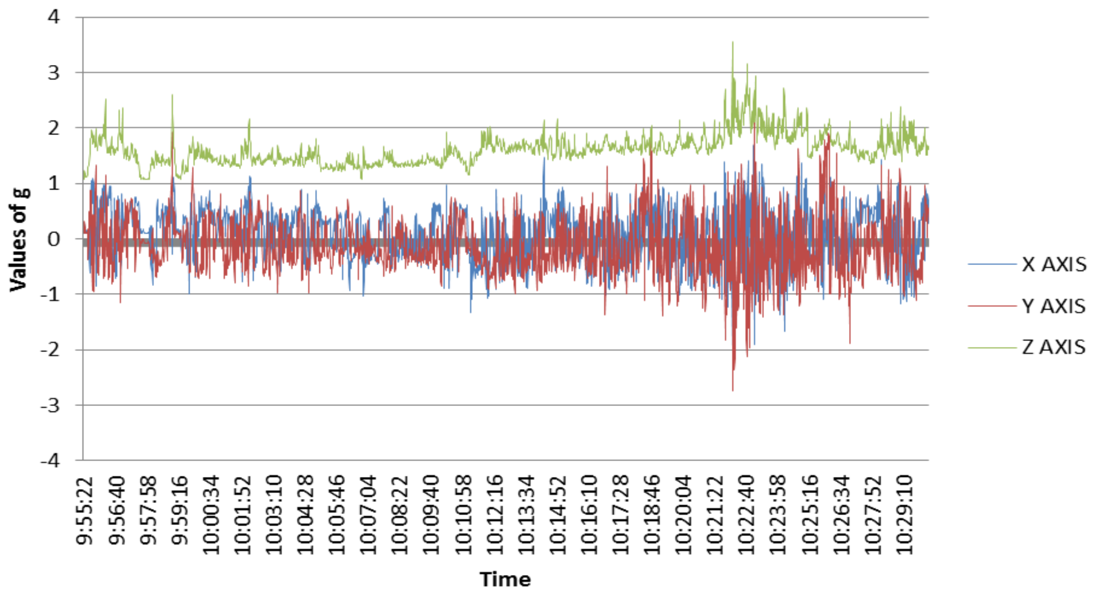
In such a situation it can be expected that the securing method, including the choice of a suitable securing mean (e.g. lashings strap), does not correspond with the conditions set in the Standard. For example, value of capacity of lashing strap 1,000 daN for the load, which has weight of 1,000 kg can be considered insufficient. With acceleration coefficient values more than twice the load will behave as heavier (over 2,000 kg).

The mean values of both data sets are not much different, as well as the most of other basic descriptive characteristics. Significant fluctuations were seen only in kurtosis value, which is for the second dataset (II. class road) almost 17 times higher (0.2449 in the first dataset, 4.0687 in the second dataset respectively).



Note: The values in z-axis needs to be lower by 1g because of measuring from the value of 1g, not 0g.
Source: own.

Figure 3 – Model transport Brno – Vyškov (highway)



Note: The values in z-axis needs to be lower by 1g because of measuring from the value of 1g, not 0g.
Source: own.

Figure 4 – Model of transportation on route Vyškov – Brno (II. class road)

5. Conclusions

The presented model illustrates the need to monitor not only the number of accidents but also causes and in terms of logistics and transportation the basic parameters of the technical causes of accidents in particular. An important advantage would also be monitoring the losses not only associated with the accident, but also caused during the loading, unloading and associated with the transportation itself.

In case of incorrect or insufficient cargo securing those losses may be significant, regardless the fact that there is no accident. Related to above mentioned is also the potential legal liability for damage to state property caused in culpable accidents, as well as for damage caused by improper cargo securing. Another issue is use of mathematical methods and models for purposes of evaluation of accidents [10].

Suitability of cargo securing (among others) depends on the size of the inertial forces that are assumed to act on cargo during transportation.

The basic component of determining the size of the inertial forces in each axis are relevant acceleration coefficients.

From the above mentioned case study, it is obvious that differences between different routes (highways and II. class roads) and Standard which, based on empirical studies reports values of these coefficients, are significant. Existence of significant fluctuations (extremes) of acceleration function is also demonstrated by significantly higher kurtosis of the second dataset (II. class road) in comparison with the first dataset (the highway) and points out to the sharper distribution of values in comparison with a standard normal distribution.

Prerequisite for further research is to perform a deeper statistical analysis or to use other methods (approaches) [11,12] , including the use of a larger data sample [13]. It seems advisable in the military conditions to include an assessment of the acceleration coefficient of off-road vehicles [8]. Additionally, more specifics can be included, such as the transport of dangerous goods (e.g. ammunition [14]), where the safety aspect of cargo securing is even more important.

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