PROBLEM OF TRANSPORT OF DANGEROUS MATTERS BY ROAD TRANSPORT IN TERMS OF ROAD SAFETY IN CZECH REPUBLIC

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Abstract: The paper is focused on the questions of road transport of dangerous matters, with an accent on traffic accidents. The accident frequency is one of the key elements influencing transport reliability. For that reason it is necessary to analyse the places of accident occurrence for minimizing accident frequency. It is possible to identify critical places on the road infrastructure of the Czech Republic with using the analysis of accident frequency. All of these factors will improve safety by this risk type of transport of matters. The safety of road transport of dangerous matters is influenced not only by characteristics of a utilized vehicle and by personality characteristics and knowledge of a driver, but also by a selected transport route.

Keywords: ADR agreement, accidents, dangerous matters, risk.

1. Introduction

The transport of dangerous matters is one of the key security issues which greatly affects the security of critical transport infrastructure. Because this is a high risk for road traffic, the major impact of this issue must be given due attention. An integral part of this special issue is to determine the risks of transport, i.e. the risk of unacceptable impacts caused by the disaster.

It is a fact that may arise or with some probability arise event or set of events that completely changes the original estimated state and evolution of interests protected by law (life and health, property, environment, society, state) in a given place at a given time interval. The risk is proportional to the threat, technical vulnerabilities and vulnerability due to the number of people (Policie ČR., 2010).

2. Accident Rate of Road Vehicles Carrying Dangerous Matters

Accidents, which frequently happen, pose the greatest risk to the transport of dangerous goods, while the escape of dangerous things can cause permanent damage to health, property and environment.

2.1. Traffic Accidents Involving Vehicles Carrying Dangerous Matters

As seen from Table 1, in the years 2002-2009 there was a total of 1473 accidents involving vehicles transporting dangerous goods. Almost every 10th accident was transported to the release of dangerous goods.

In other words, the escape of dangerous things occurred in 10.73% of the total

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number of 1473 traffic accidents. Since this is a very high value, it is necessary to prevent such accidents and strive to effectively eliminate them. Note that traffic accidents in which there was a leakage of dangerous goods are marked red.

Table 1
List of the number of traffic accidents related to the leakage of dangerous substances from 2002 to 2009

Year	Number of traffic accidents involving dangerous substances			
	(accident occurred when the leakage of dangerous substances)			
	solid	liquid	gaseous	total
2002	91 (1)	139 (82)	25 (6)	255 (89)
2003	84 (3)	118 (7)	16 (0)	218 (10)
2004	13 (1)	146 (10)	17 (0)	176 (11)
2005	31 (3)	163 (15)	15 (2)	209 (20)
2006	12 (0)	149 (5)	25 (0)	186 (5)
2007	17 (1)	131 (9)	24 (0)	172 (10)
2008	25 (0)	124 (5)	17 (1)	166 (6)
2009	5 (1)	72 (5)	14 (1)	91 (7)

Source: (Policie ČR, 2010), author

In terms of state missed 3.6% of all transported solids, 13.2% of all liquids and 6.5% of all gases. Although 13.2% figure represents a relatively large value, it is necessary to point out that liquid substances are mostly involved in the transport of dangerous goods.

(Note: There are 1042 road accidents involving liquid dangerous goods in all 1473 traffic accidents, i.e. 70.7%)

3. General Presumptions for Establishing Critical Places of Dangerous Articles' Transportation on Czech Roads

It is necessary to examine the accident's volume of cargo vehicles, which carry dangerous articles. The examination is based on the records of a traffic accident in a given time period. It is necessary to have information about a place of a traffic accident, time of the accident's origin, reasons of the origin and about participants of the traffic accident (Brožová and Buliček, 2008).

3.1. Place of Traffic Accident Origin

A place of the origin of a traffic accident is the most important point in the assessment of critical places on transport infrastructure. It is important to have the information about the road, where an accident happened, for the assessment. This information should be detailed for high-exact of partial results. That information include road category, road kilometres, but also the direction in which the accident has happened.

3.2. Time of Traffic Accident Origin

Another point in the assessment of critical places is time, which is important for the assessment of the traffic accident's reason. Every day has its specificity which reflects in the risks of traffic accidents. It is possible to mention changes in traffic intensity during the day (the week), variable sight-rate at different day periods, but also in different seasons. Weather conditions and technical conditions of roads also play a role. Places with increasing traffic congestion influence places of traffic accidents' origin and process of quest.

3.2.1. Reason of Traffic Accident Origin

It is necessary to know the reasons of a traffic accident for critical section problem solving. The reasons could be driver's failure, and other reasons (such as dangerous articles, defects on the road, etc.). It enables the survey about traffic accidents classification and utilizes reasons for probability calculation of the generation of traffic accidents.

3.2.2. Participants of Traffic Accidents

A category and a technical condition of all vehicles, which participate in an accident, information about other people (pedestrians), are all inherent pieces of information for the risks elimination during this special transportation.

The mentioned dates (place, time, origin reasons and participants of traffic accident) have to be analysed. The analysis says which of the accidents will be counted in and which not and why.

4. Criterion for Dangerous Articles Transportation - Exclusion from a Given Section

The Law about Traffic on the Roads no 361/2000 Sb. in valid wording knows the traffic restrictions (it means traffic signs "Prohibition of Entry", and "Prohibition of Entry for Vehicles with Dangerous Load, which can cause water pollution"). The missing maps of the Czech roads and highway network are great embarrassment.

Each section of the transport network has to be explored from the point of view of dangerous articles transportation accessibility.

Factors which influence the accessibility are:

a) Road category
b) Traffic intensity in relation to section capacity
c) Engineering characteristics of roads
d) Accident frequency on a given section
e) Other characteristics of section (rural area/urban area, number of inhabitants who live in proximity, schools, health care institutions, etc.).

5. Proposal of Reduction of Road And Highway Sections for Dangerous Articles Transportation – With Critical Places and Imposing of Traffic Restrictions

Having **cognisance about the location of traffic restrictions** (prohibition signs relevant for dangerous articles transportation) is important for the reduction of road and highway sections in the Czech Republic. The author made a map with transportation routes (Fig. 1). The map is based on the reliability couched in the self-probability enumeration of traffic accident nascency in road transport. The map originates from the elimination of the riskiest section. The transport modelling software tools enable us to compile the distant matrixes on generalized cost base. The costs can be set by a formula. The minimum cost road can be searched from the matrixes, Eq. (1):

$$GC_{ij} = \alpha D_{ij} + \beta T_{ij} + \gamma C_1^{ij} + \delta C_2^{ij}, \text{[money]} \quad (1)$$

where:

- GC_{ij} *are generalized costs [money]*
- D_{ij} *is the distance between places (zones) i and j [km]*
- T_{ij} *is the journey time between places (zones) i and j [min]*
- C_1^{ij} *are additional costs (risks costs) between places (zones) i and j [money]*
- C_2^{ij} *are additional costs gained from previous assignments (previous iterations of calculations of ssignment of the traffic flow to a given net's section) between places (zones) i and j [money]*
- $\alpha, \beta, \gamma, \delta$ *are weighted and transfer coefficients (determine weigh of each criterion and transmit different parameters on similar base, e.g. for expression in money units).[1/km; 1/min ; - ; -]*

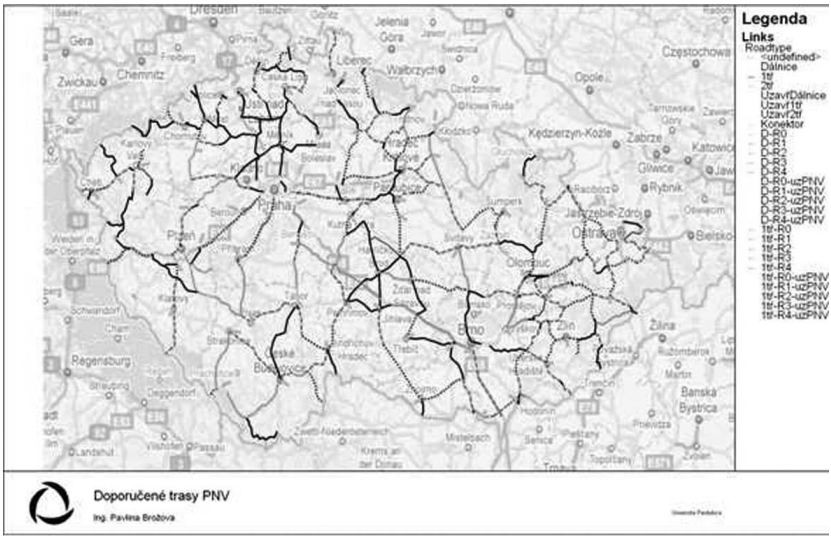

Fig.1.
The suggestion of transportation routes – the author's self elaboration
Source: (author)

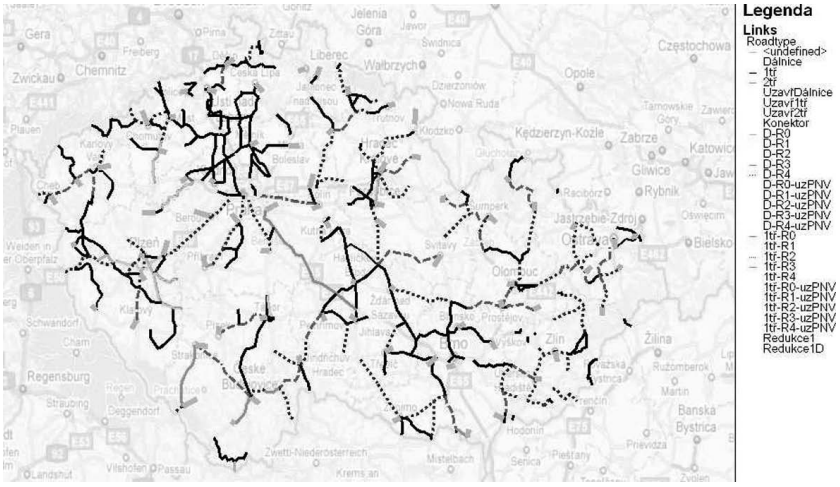

Fig. 2.
The reduced net by using OmniTRANS
Source: (Author)

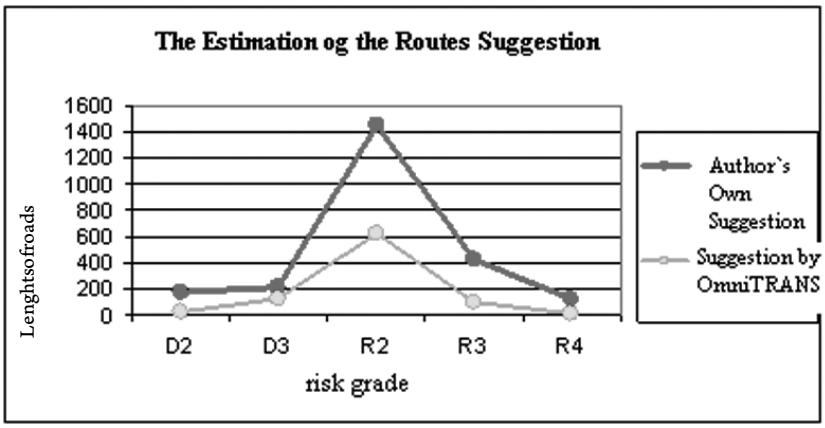

Fig.3.
The estimation of the routes suggestion *Source: (Author)*

The generalized costs can be couched in minutes, but those gained times doesn't correspond with real time of transportation. Nevertheless they included the risk factor. It constitutes a mathematical means for the calculation of the shortest road with regard to risks on the sections. The OmniTRANS software has compiled the next map with transportation routes. The author used SQL inquiries to create this map (Fig. 1). As we can see, routes are more reduced against the suggestion in Fig. 2. The author's map includes 2 396 km of transport routes with risks 2 – 4. The OmniTRANS compiled a map with only 892 km of transport routes with risks 2 – 4. The biggest number of routes with risks 2 was left out in both examples (see Fig. 3).

6. Conclusion

The most problematic sections from the point of view of dangerous articles transportation were chosen for the critical section analysis of roads in the Czech Republic base. The established sections were recognized in two proposals of transportation lines. The first proposal has been created by analytic methods; the second one has been created with modelling software support. Owing to this fact the usability of this equipment for this kind of problem has been proved, because the demand of transportation has been investigated during the risks assessment.

Acknowledgements

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PROBLEM DRUMSKOG PREVOZA OPASNIH MATERIJA U ODNOSU NA BEZBEDNOST DRUMSKOG SAOBRAĆAJA U REPUBLICI ČEŠKOJ

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Sažetak: Ovaj rad je usredsređen na pitanja drumskog prevoza opasnih materija, sa posebnim osvrtom na saobraćajne nezgode. Učestalost nezgoda je jedan od ključnih elemenata koji utiče na pouzdanost transporta. Usled ovog razloga, neophodno je analizirati mesta na kojma se događaju nezgode radi smanjenja njihove učestalosti. Moguće je identifikovati kritična mesta na putnoj infrastrukturi Republike Češke sa primenom analize učestalosti nezgoda. Svi ovi faktori će unaprediti bezbednost prevoza opasnihh materija. Na bezbednost drumskog prevoza opasnih materija utiču ne samo karakteristike korišćenih vozila i odlike ličnosti vozača, kao i njegovo znanje, već i odabrana transportna ruta.

Ključne reči: ADR sporazum, nezgode, opasne materije, rizik.