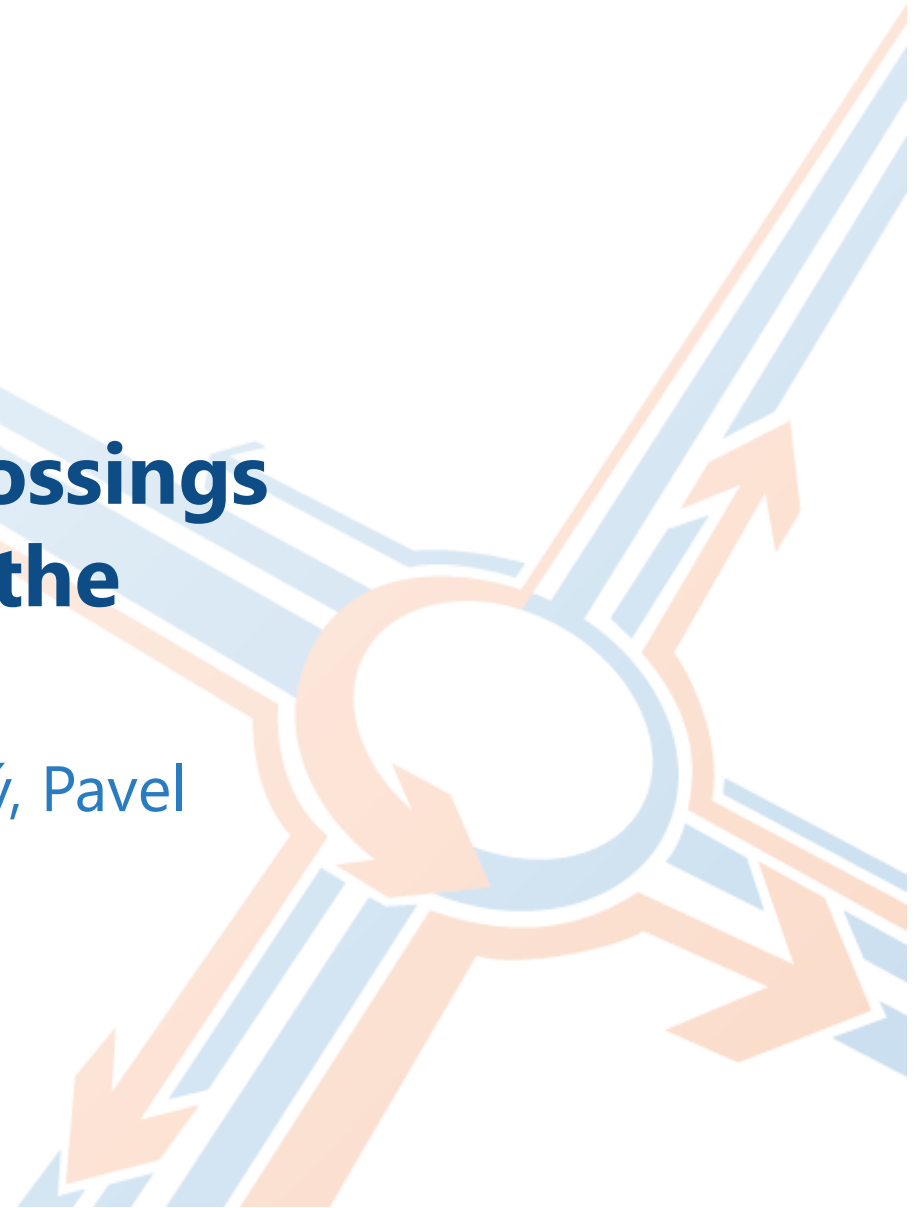


Risk factors at level crossings with flashing lights in the Czech Republic

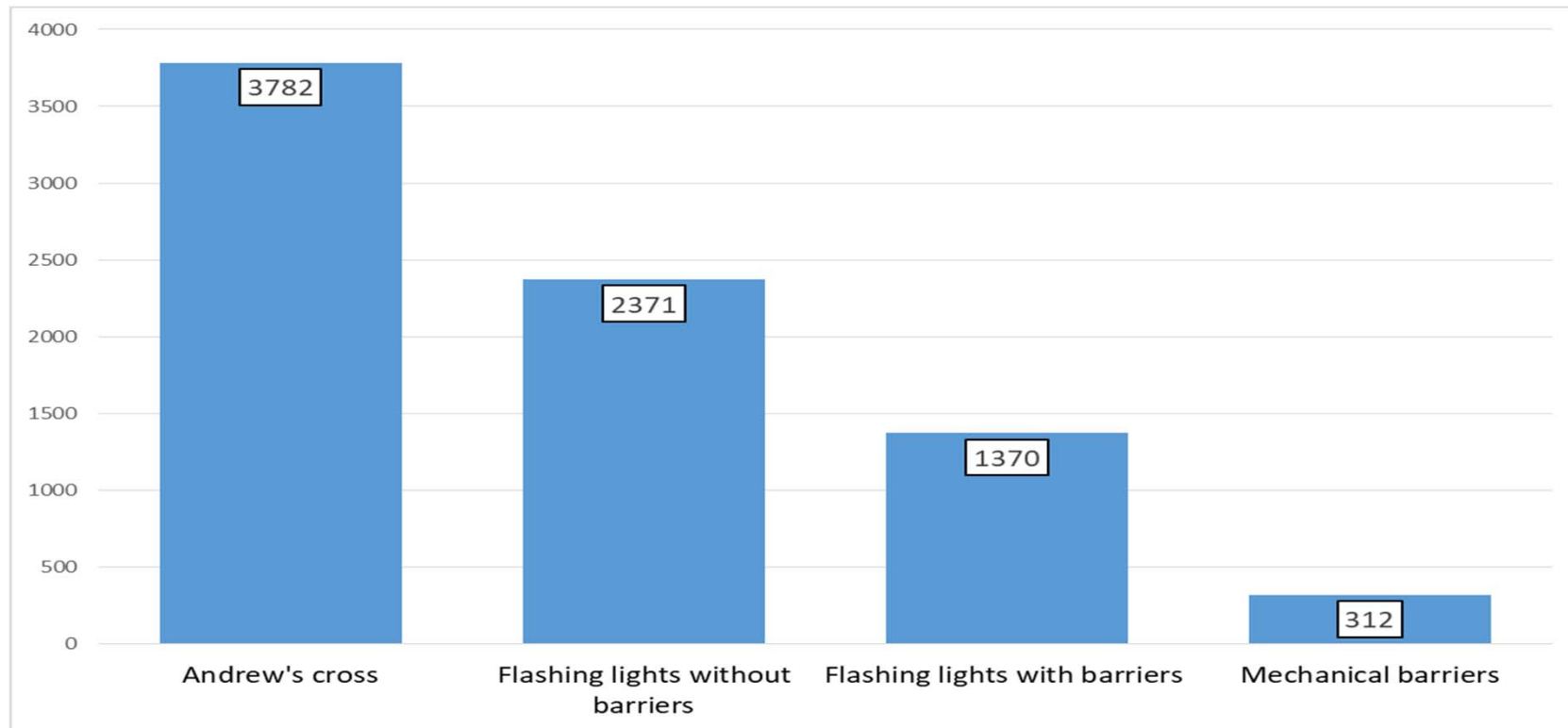
Pavλίna Skládaná, Pavel Skládaný, Pavel
Tučka, Jiří Ambros

Centrum dopravního výzkumu, v. v. i.



Level crossings and accidents in the CR

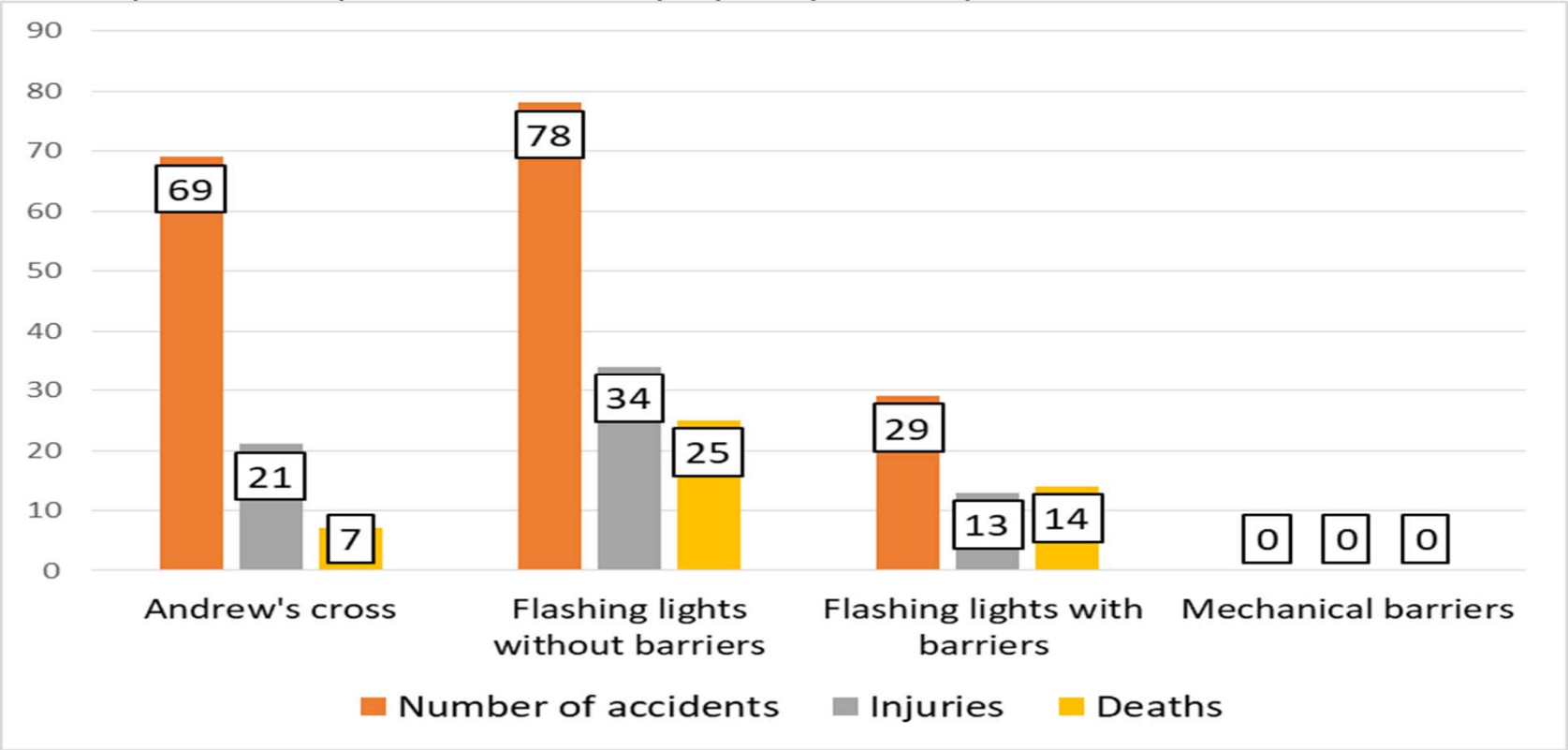
Data 2017: 7870 registered level crossings, of which 3782 with Andrew's cross; **2371 with lights**; 1370 with lights and barriers, 312 with mechanical barriers, 35 other (source: SŽDC).



Level crossings and accidents in the CR

Number of accidents and casualties is the highest (both absolutely and relatively) at level crossings with flashing lights without barriers.

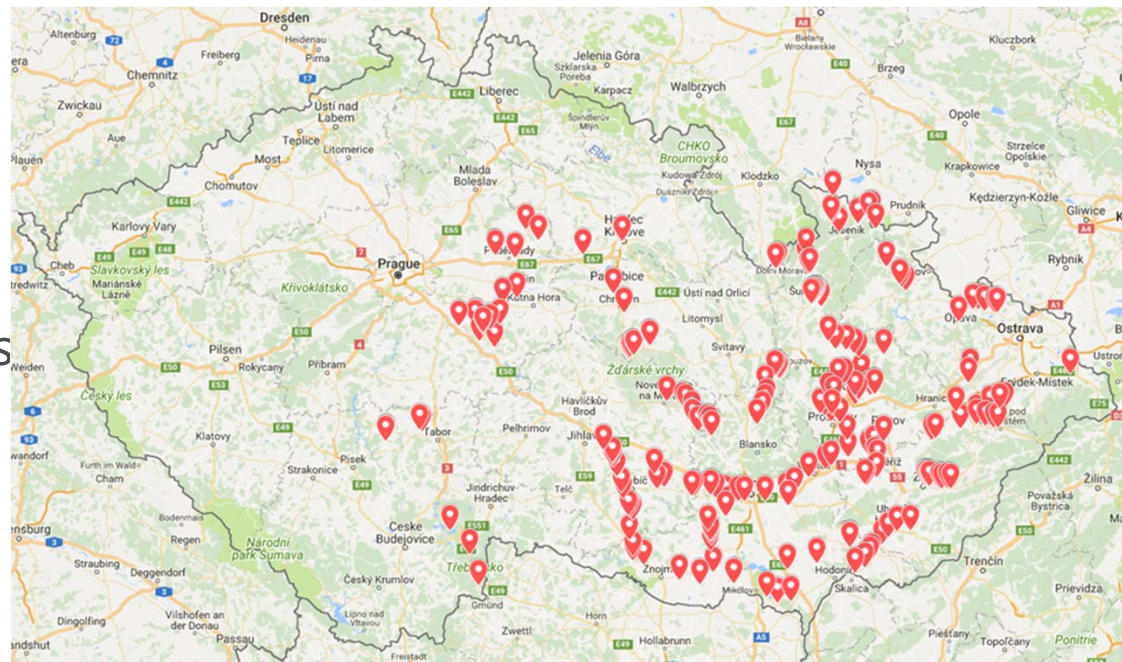
Example 2016 (source: Rail Safety Inspection):



Research project ISPROFOND

(Statistical quantification of the impact of risk factors at railway level crossings using the prediction models of accidents)

The goal of the project was statistical assessment of the importance of factors that contribute to accidents, to facilitate decision making in the area of financing safety measures. The project included observation and measurements at 206 level crossings with flashing lights (sample of total 2371 crossings equipped only with flashing lights without barriers).



Method

Variables followed:

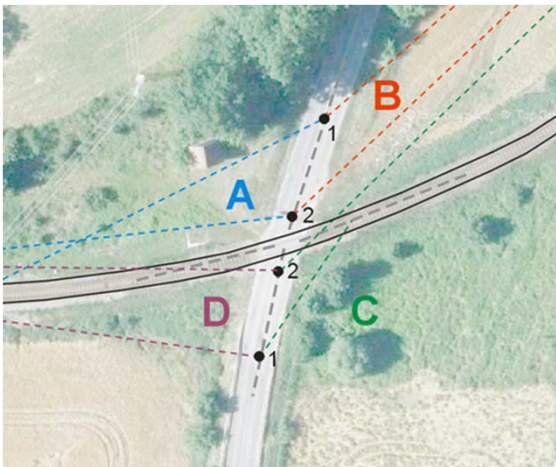
- Exposure (both rail and road traffic volumes)
- Speed (road vehicles and trains)
- Infrastructural characteristics (number of tracks, crossing angle, horizontal and vertical alignment,...)
- Warning lights (type, design, number,...)
- Road marking and signing
- Sight conditions
- Accidents during last 10 years



Method

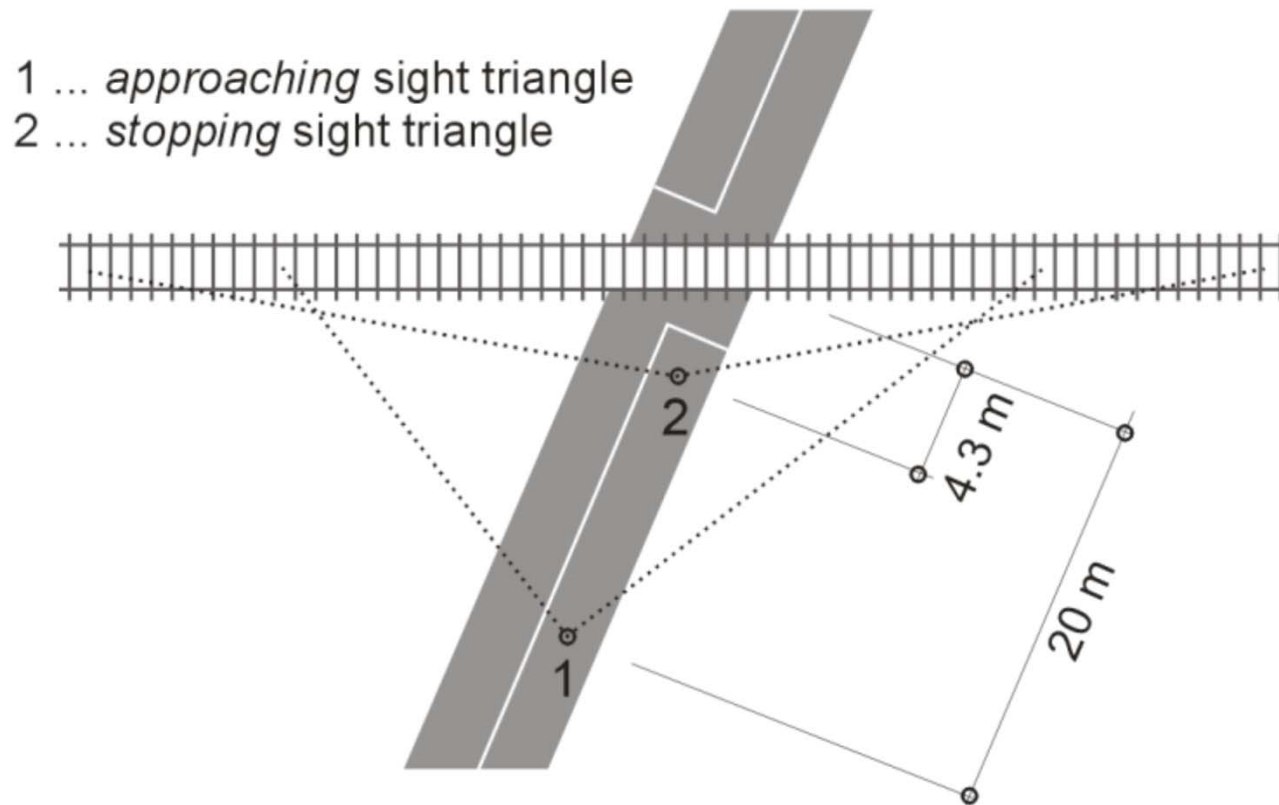
Train volumes and speeds were provided by Railway Infrastructure Administration, other data was collected from maps and in the field:

- observing current state of RLC infrastructure, flashing lights, road marking and signing, etc.
- taking photographs to enable later checks of observations and measurements
- collecting road vehicles' volumes and speeds by roadside radars
- measuring sight distances by digital distance meter in each quadrant



Method

Sight distances were assessed from two positions in each quadrant.



Data collection

Příloha 2

Příklad formuláře:

Rokogostkova železničního přejezdu č. P 3342
 Lokalita: Trnová 02
 Poloha přejezdu: km 746,036
 Dne: 20. 11. 2016
 Jméno: PAVLINA, TUDLA

PARAMETRY


Tržba rychlost (km/h)	
Intenzita drážního / silničního provozu (pod. vozidel za 24 hod.)	
Podle km	
Delka neobjezdného zábrna most kolébkový (m)	45,0
Bližší radlaň a zastávka (na, ano - popište)	ne
Výstražníky (typ, bílé světlo, počet, svítilny ...)	2x bílé světlo, 2x zvuková, 2x světelná
Výstražníky (rychlejší výstražníky, pozadí ...)	ne
Delka mostu nadjezdem výhledy a příjezdem vjezd (m)	30 m od železničního přejezdu, 30 m od silničního přejezdu
Šířka vozovky na přejezdu, příjezd a ze něm (m)	3,0 m
Druh a kvalita povrchové plochy, směry sklonů, apod.	asfalt, 0,5% sklon
Možnost odbočení / výhledu / výhledu podél železničního přejezdu, na, ano - popište	ne
Delky SÚZ a VÚZ	ne
Chodník	ne
Nejvyšší dovolená rychlost na ŽP	50
Intenzita silničního provozu (jediných objezdů)	52
Faktory ovlivňující provoz	ne
Možnost odbočení sklonů	ne
Jiný	ne

Číslo přejezdu ... **Typ vozidla** ... **Číslo přejezdu** ... **Typ vozidla** ...

0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100		
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Příloha 3

Příklad přehledu výstupů z radarového měření:

P6967	Klnice u Boskovic		
	49° 32' 06.48138" N 16° 41' 20.71277" E km 21,131 (Skalice n/Sv. – Chornice) x silnice II/374		
Měřeno dne: 28. 11. 2016			
Silniční doprava			
	Osobní vozidla	Nákladní vozidla	Celkem
Intenzita přepočtená na RPD	5288	525	5813
85. percentil rychlosti	52	48	
Překračování rychlosti 30 km/h			94,0 %
40 km/h			61,9 %
50 km/h			16,7 %
60 km/h			1,2 %
Drážní doprava			
Intenzita	6		
Průměrná rychlost	34		
Nejvyšší traťová rychlost	50		



Model

Safety performance function was built using generalized linear modelling procedure in IBM SPSS, with a negative binomial error structure and logarithmic link function. Using backwards elimination approach, optimal variant was tested, based on statistical significance of predictors and SPF overdispersion parameter.

$$N = \beta_0 \cdot (I_{cars})^{\beta_1} \cdot (I_{trains})^{\beta_2} \cdot \exp\left(\sum (\beta_i \cdot x_i)\right)$$

Number of accidents in the quadrant 10 years

Intensity of road and rail traffic

Other risk factors



Results

Out of 30 detected risk factors, 7 were identified as statistically significant; some obvious (traffic volumes, speeding), some need more attention:

- Sight distance from stopping position (4,3 m)
- Sight distance from approaching position (20 m)
- Conspicuousness (observability) of level crossing surface
- „Short“ level crossing



Results: sight distance

Approaching and stopping sight distances proved to have opposite impacts at level crossings with flashing lights.

- Long approaching sight distance contributes to safety; together with warning lights, good sight enables „double control“ and driver can see approaching train even in situation when warning lights are difficultly visible or perceptible (strong sunlight, light disguised by other vehicle).
- Long stopping sight distance appears to be less useful; good sight from this point may take driver's attention away from warning lights, that are in this moment crucial.



Results: level crossing surface

Observability of the level crossing proved to be very important factor. Inconspicuous or even invisible crossing makes driver's perception of the situation difficult, and missing road marking that should highlight the boundary of the crossing makes it difficult for users to decide where optimal stopping point is.



Results: short level crossing

Very frequent and very serious risk factor. In most cases, solution is very hard to find. Coordination of the signal systems of the railway level crossing and neighbouring intersection proved to be efficient technical solution.



Limitations of the model and other risk factors

Using the regression model, other existing risk factors recorded during field inspections did not appear to be statistically significant, although their impact on safety is evident (missing warning lights for some of approaching roads, confusing signing, uneven terrain causing the risk of getting stuck, etc.).

The main limitation of the model was small sample size, but also small frequencies across categories for some variables. Possibly some inputs needs to be modified (e.g. measurement of luminance of warning lights could bring better results then following the lights' design).





For more information

- About the model: Jiří Ambros (jiri.ambros@cdv.cz)
- About risk factors: Pavel Skládany (pavel.skladany@cdv.cz)

The study was conducted with the financial support of Czech Ministry of Education, Youth and Sports under the National Sustainability Programme I project of Transport R&D Centre, using the research infrastructure from the Operation Programme Research and Development for Innovations.



SAFER LC, Madrid, October 2018
Risk factors at level crossings with flashing lights in the CR



Thank you for your attention.

Pavλίna Skládána

pavlina.skladana@cdv.cz

phone: +420 541 641 711

Centrum dopravního výzkumu, v. v. i.

Líšeňská 33a, 636 00 Brno, Czech Republic

www.cdv.cz/en/

