

## INTRODUCTION

- Roundabout = popular and safe type of road intersection
- The safety benefit of roundabout conversions recognized world-wide
- Since 2000s also built in Central Europe, but without proper safety evaluation
- Reasons: lack of relevant data and experience with safety performance functions
- It is possible to apply international models – but there are differences in design guidelines and driving behaviour

(adapted from www.youreuropeamap.com)



**The objective:**  
 To conduct comparative study of roundabout safety in four Central European countries (Czech Republic, Hungary, Poland, Slovakia) using safety performance functions.

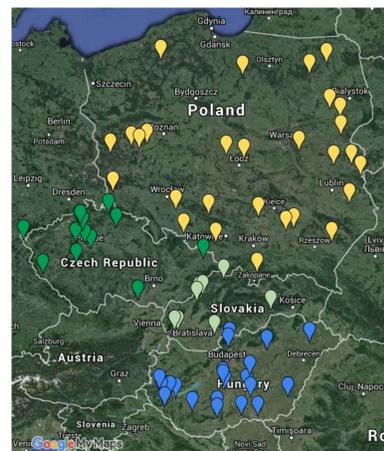
## DATA

### Sample

- Focus on the most typical settings: unsignalized, urban, 4 legs, single lane
- Traffic volumes often unavailable in cities
- Shift of focus to rural/suburban
  - 72 in total (13 CZ, 21 HU, 29 PL, 9 SK)
  - ~ perpendicular legs, no bypasses



Source: Google



Source: www.zdw.krakow.pl

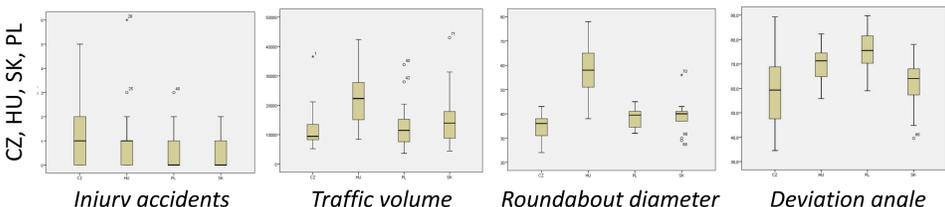
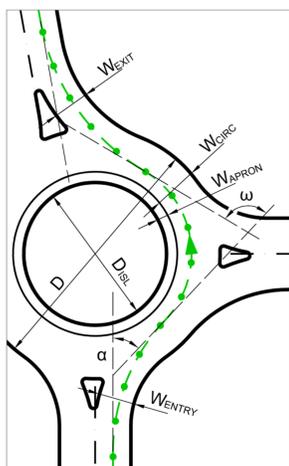
### Variables

- 5-year frequency of injury and total accidents (property-damage-only not fully available)
- AADT (total daily number of entering vehicles)

Geometrical variables collected from on-line maps:

- Deflection = trajectory changes imposed by roundabout geometry
  - Entry angle ( $\alpha$ ) – on roundabout entries
  - Deviation angle ( $\omega$ ) – between opposing legs (average from 4 legs)
- Diameter of roundabout and central island
- Average width on entering and exiting legs, circulating width and width of traversable apron
- Presence of pedestrian crossing or cycle path

(created by L. Vyskočilová, CDV)



## RESULTS

General predictive model of accident frequency ( $N$ ):

$$N = \beta_0 \cdot AADT^{\beta_1} \cdot \exp\left(\sum_{i=2}^n \beta_i \cdot x_i\right) \quad \begin{array}{l} x_i - \text{explanatory variables} \\ \beta_i - \text{estimated regression coefficients} \end{array}$$

Candidate models were tested with all accident severity categories as response variables. All explanatory variables were entered and sequentially removed, using backward elimination, to achieve statistical significance  $\leq 10\%$ .

### Individual models:

- Developed for CZ, PL, SK
- Unsuccessful with HU data
- Most of explanatory variables did not contribute to any models

Variable ranges among countries are mostly overlapping = similar safety and traffic conditions, also partial similarity of guidelines, which dictate roundabout geometry.

Therefore we attempted to develop a model for injury accidents with all data combined.

### Combined models:

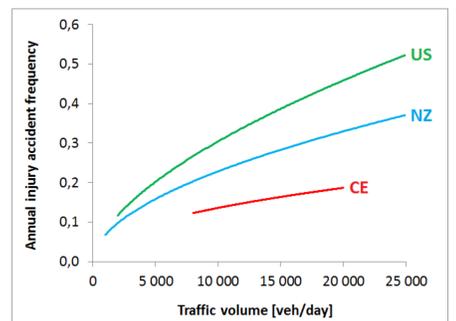
- Model with **entry angle**:  
 $N = 0.004 \cdot AADT^{0.424} \cdot \exp(0.369 \cdot W_{apron}) \cdot \exp(-0.034 \cdot \alpha)$
- Model with **deviation angle**:  
 $N = 0.001 \cdot AADT^{0.639} \cdot \exp(0.402 \cdot W_{apron}) \cdot \exp(-0.031 \cdot \omega)$

= deflection has a protective effect (lower speed, less accidents)

- Simple model:

$$N = 0.002 \cdot AADT^{0.458}$$

United States	$1.3 \cdot 10^{-3}$	0.5923
New Zealand	$1.73 \cdot 10^{-3}$	0.53
"Central Europe"	$2.16 \cdot 10^{-3}$	0.458



## DISCUSSION AND CONCLUSIONS

Limitations to the presented study and developed statistical relationships:

- Small sample size.** Typical minimal recommended sample size is 30 units: Polish sample suffices, others do not. The limitation was availability of AADT.
- Uncertainty in response variable.** At roundabouts, very rarely severe injuries occur. It would be thus beneficial to use total accident counts; unfortunately property-damage-only accidents are either underreported or not reported at all (in HU and PL).
- Incomplete explanatory variable.** Omitted variable bias, eg. vehicle speeds or sight conditions.
- International comparison.** Used samples (CE, NZ, US) may not be simply comparable (differences in locations, speed, accident reporting rates, etc.).

### Conclusions:

- CE samples are relatively comparable and may thus be combined.
- The combined models show the importance of deflection, which is often not adequately considered in design guidelines.
- Further improvements of sample size and data collection should lead to new findings for future updates of roundabout design guidelines.

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