# Safety Ranking of Rural Curves Based on Design Consistency Measures

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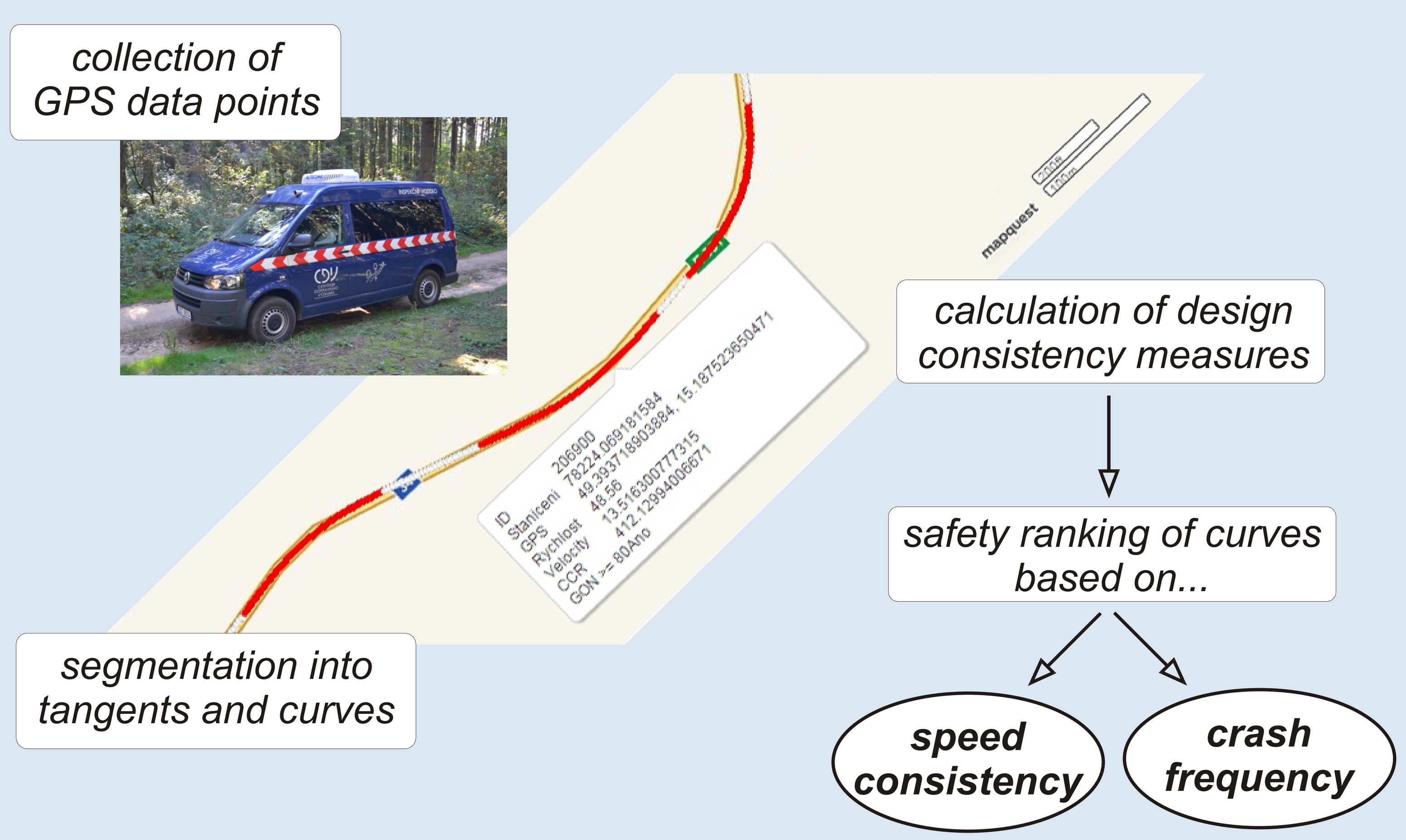
## INTRODUCTION

Road horizontal alignment has a significant impact on driving and safety. 25 to 30% of all fatal crashes world-wide occur on curves (*1*). In the Czech Republic this amount is even higher. The most critical settings is: **curves on rural sections of national roads**, related to fatalities due to **speeding.**

The reasons include the lack of design consistency - road geometric features should conform to driver expectations. **Consistent operating speeds are the product of consistent design** (*2, 3*). Several measures are used in this regards; the most common is **magnitude of speed reduction between successive design elements** (*4*).

We want to apply this concept in practice
(not depending on low-quality/non-existent designs):




***Is there a valid relationship?***
***Does speed consistency help explain safety performance?***

## DATA COLLECTION

Czech region (*Kraj Vysočina*), the most trafficked national roads No. 19 and 34.

– paved, 2-lane, undivided, approx. 7 m wide roads
– approx. AADT 5,000 to 10,000 vpd
– general speed limit 90 km/h

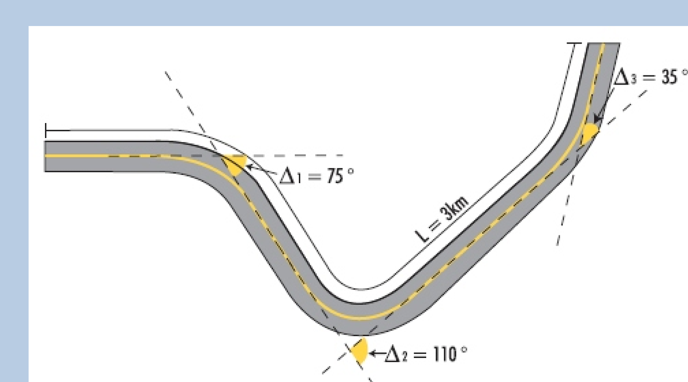
(in total 100 km, with more than 200 curves)

– driven through in two weekdays, in one direction, as close as possible to free-flow speed
– GPS @ 10 Hz (equals 2.5 m @ 90 km/h)
– segmented into tangents and curves (details in *5*)

For each segment **two consistency measures** were determined:

– 85th speed percentile

– curvature change rate



$$CCR = \frac{75° + 110° + 35°}{3\ \text{km}} = 73°/\text{km}$$

Further data for validation:

– **Crash frequency:** 5-year period, all severities, only single-vehicle crashes = related to alignment

– **AADT** from the National Traffic Census

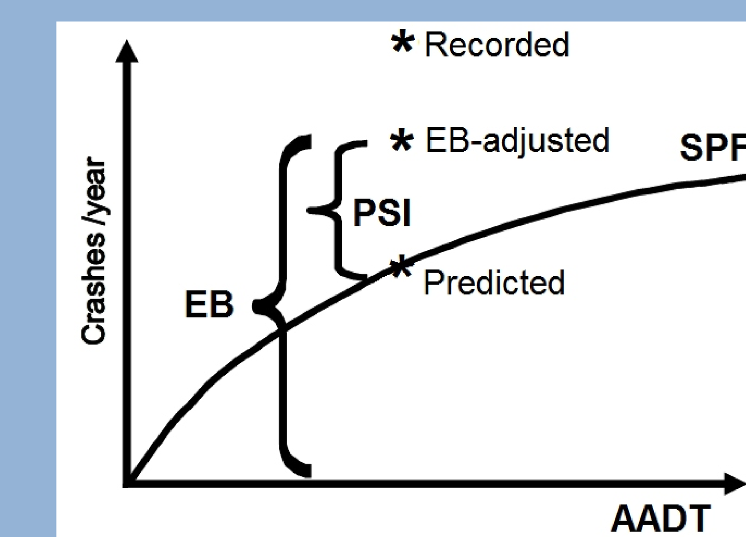
– **Curve lengths** obtained from GPS points

## ANALYSIS AND CONCLUSIONS

### Comparison of two safety rankings of curves:

### *1) based on crashes*

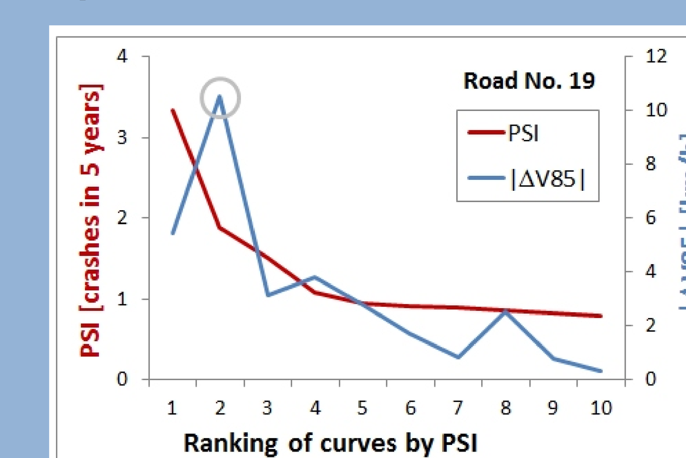
– predicted crash frequency
$P_i = a \,.\, AADT_i^b \,.\, CCR_i^c \,.\, e^{d\,.\,Li}$
– empirical Bayes estimate
$EB_i = w_i \,.\, P_i + (1 - w_i) \,.\, R_i$
– weight
$w_i = k_i / (k_i + P_i)$
– over-dispersion parameter
$k_i = k \,.\, L_i$
– potential for safety improvement
$PSI_i = EB_i - P_i$

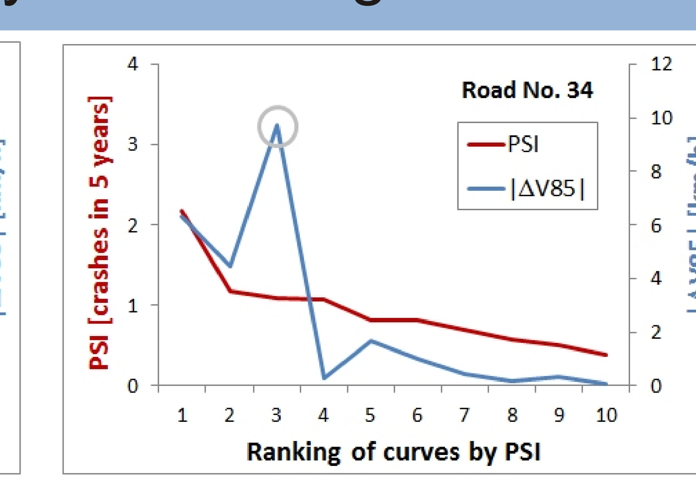



### *2) based on speed differences*

– 85th percentile speed in curve ($V_{85,\,i}$)
– 85th percentile speed in tangent ($V_{85,\,i+1}$)
– absolute difference $|\Delta V_{85}|$

'Top' 10 curves ranked by descending PSI values:




There is general relationship between the trends of both safety rankings. An outlying speed value in both graphs = uphill driving.

Limitations:
– *Data collection*: 1 ride in 1 direction provides only rough estimate of common speed behaviour.
– *Crash sample*: low frequencies, on average 0.5 crash per curve
– *Other uncontrolled influences* on speed and crashes: vertical curvature, cross section, or local speed restrictions

***Nevertheless the results show that speed consistency is related to actual safety and may serve as a surrogate measure.***

***Further research will aim at improving the methodology and enlarging the sample (using vehicle fleet data from larger road network).***

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