Safety Ranking of Rural Curves
Based on Design Consistency Measures

Jiří Ambros*, Veronika Valentová, Peter Oríšek | CDV – Transport Research Centre, Lišeňská 33a, 636 00 Brno, Czech Republic
*jiri.ambros@cdv.cz

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):

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

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

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REFERENCES


ANALYSIS AND CONCLUSIONS

Comparison of two safety rankings of curves:

1) based on crashes

- predicted crash frequency $P_{cr} = AADT \times CCR \times e^{-EB}$
- empirical Bayes estimate $EB = w \cdot P_{cr} + (1 - w) \cdot R$
- weight $w = \frac{k}{k + P}$
- over-dispersion parameter $k = k_0 \cdot l$
- potential for safety improvement $PSI = EB_P - EB$

2) based on speed differences

- 85th percentile speed in curve ($V_{85}$)
- 85th percentile speed in tangent ($V_{85}$)
- absolute difference $\Delta V$

'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).