Development of a speed-based surrogate roundabout safety measure

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The study

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Roundabout types

- Single-lane
- Multi-lane
- Turbo-roundabouts with dividers
- Turbo-roundabouts without dividers
- Various shape of roundabouts (eight)

How to assess road safety?

- Low occurrence of accidents
- Variables at accident prediction models (traffic exposure, variables reflecting geometric features, and speed features)
- Accident prediction models based on speed:

$$Acc = e^{-16.61} \cdot Q_e^{0.47} \cdot Q_c^{0.26} \cdot S_C^{2.13}$$ [Turner et al., 2009]

$$Acc = e^{-12.80} \cdot Q_e^{0.81} \cdot e^{0.34 \cdot IAS}$$ [Persaud et al., 2011]

where:

Acc = annual number of crashes
Q_e = entering flow
Q_C = circulating flow
S_C = free-flow circulating speed
IAS = inside average speed

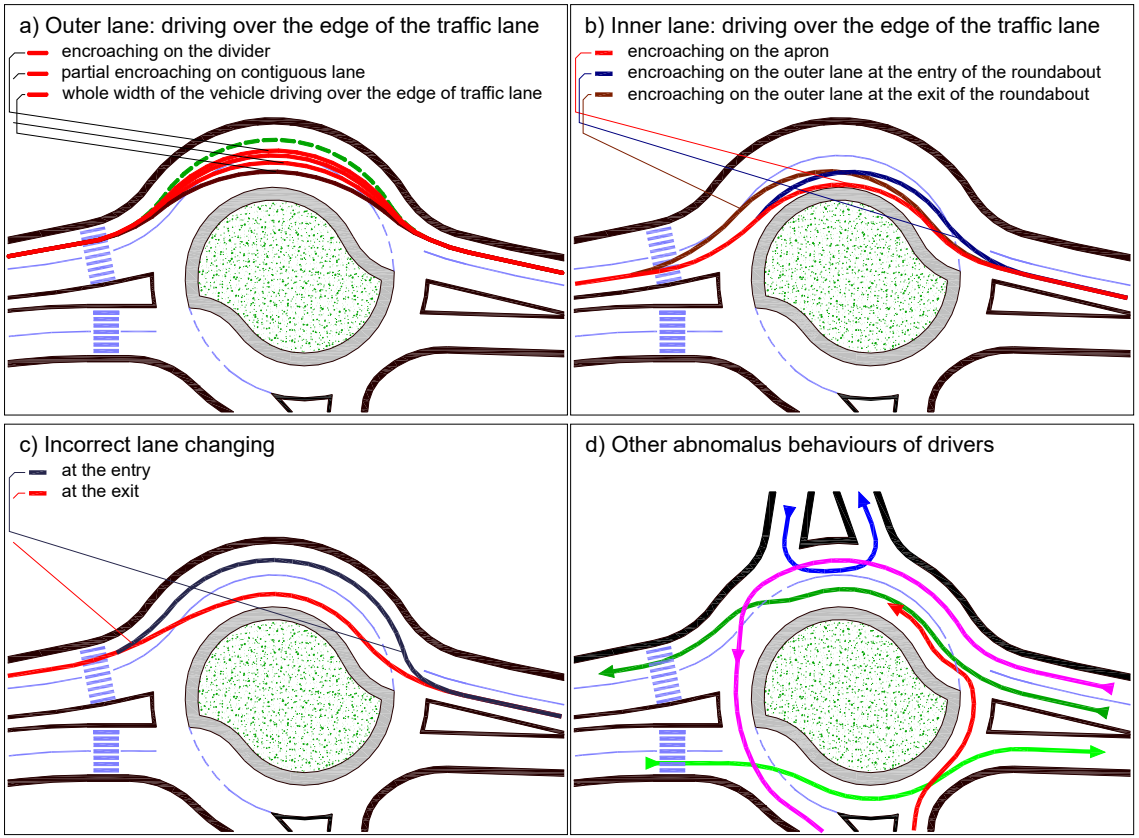
- Speed through roundabouts = f (deflections, radii, geometric features)
- How to assess geometrical parameters for turbo-roundabouts?

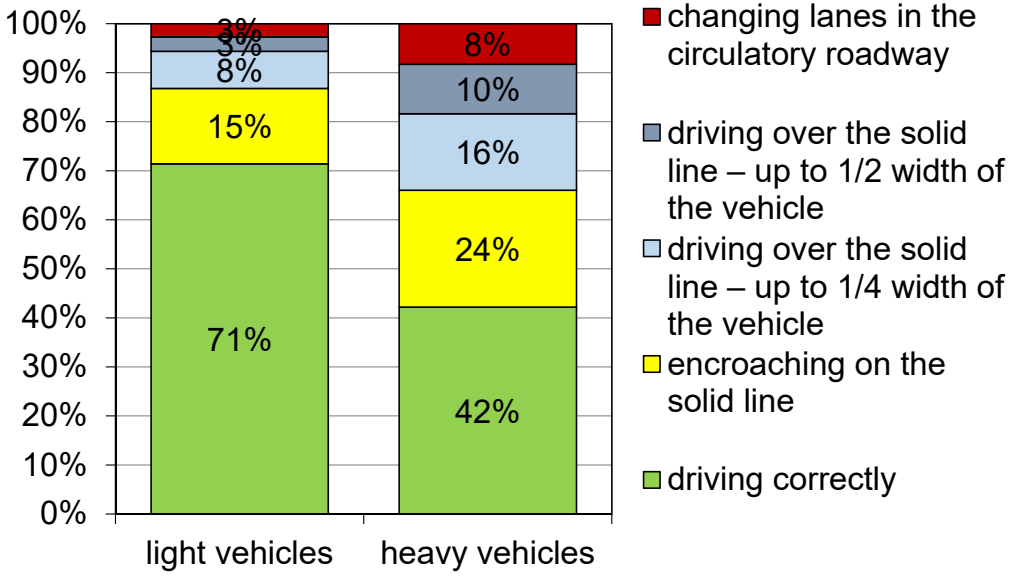
Turbo-roundabouts

- without dividers (trajectory changes are possible)

- with dividers (no trajectory changes)

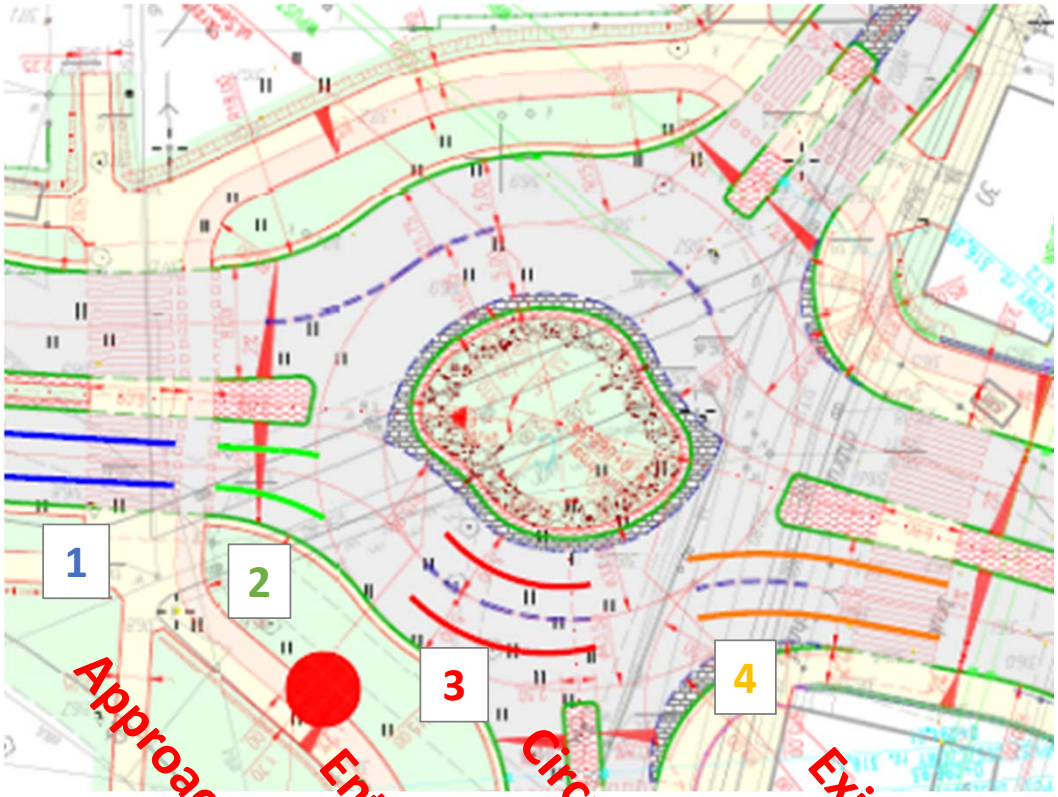
Surrogate measures based on driver behaviour



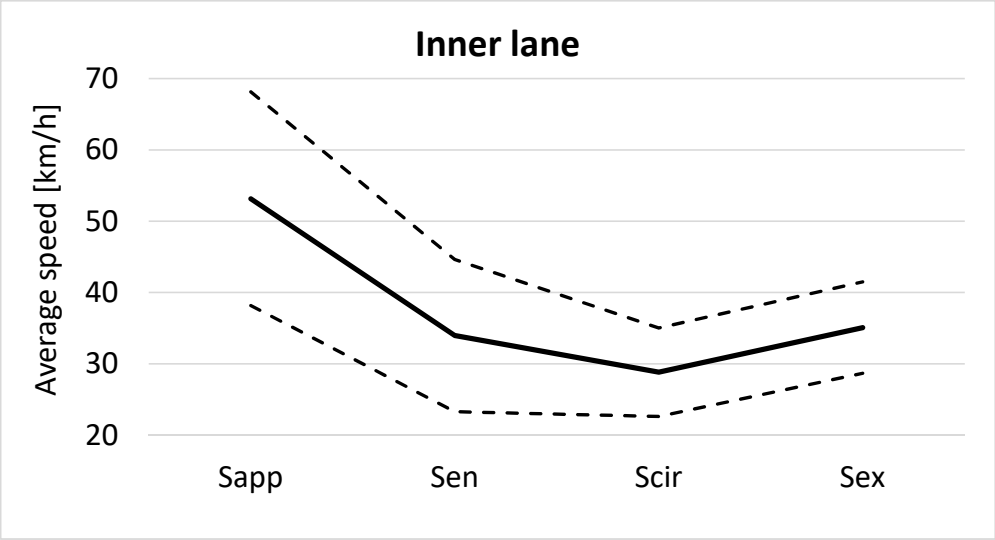


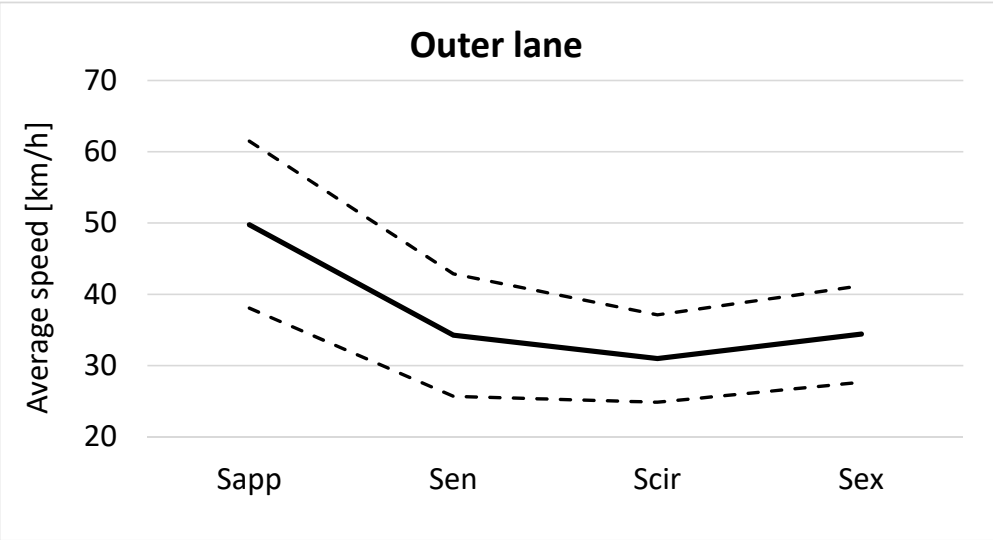
[Chodur and Bąk, 2016]

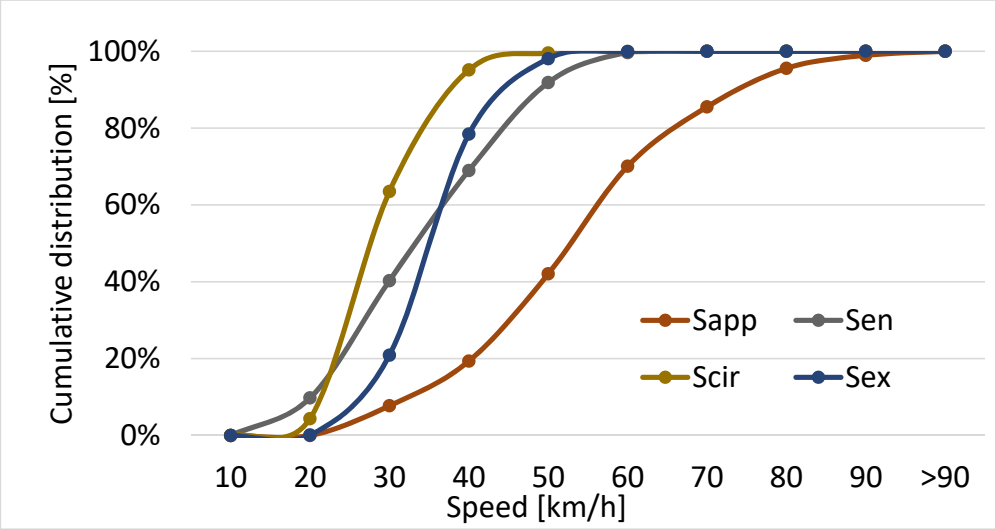
Data collection on 15 turbo-roundabouts

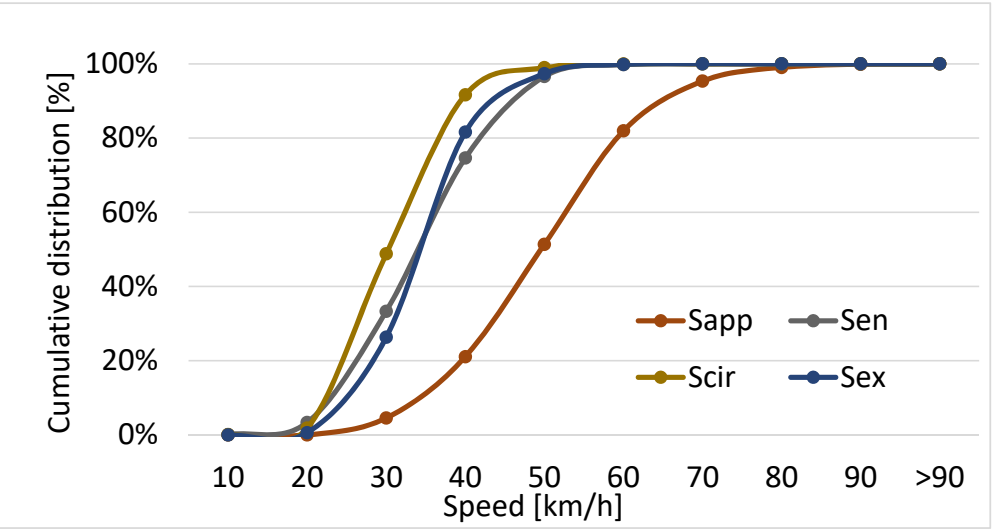


Speed results (1): turbo-roundabouts with dividers

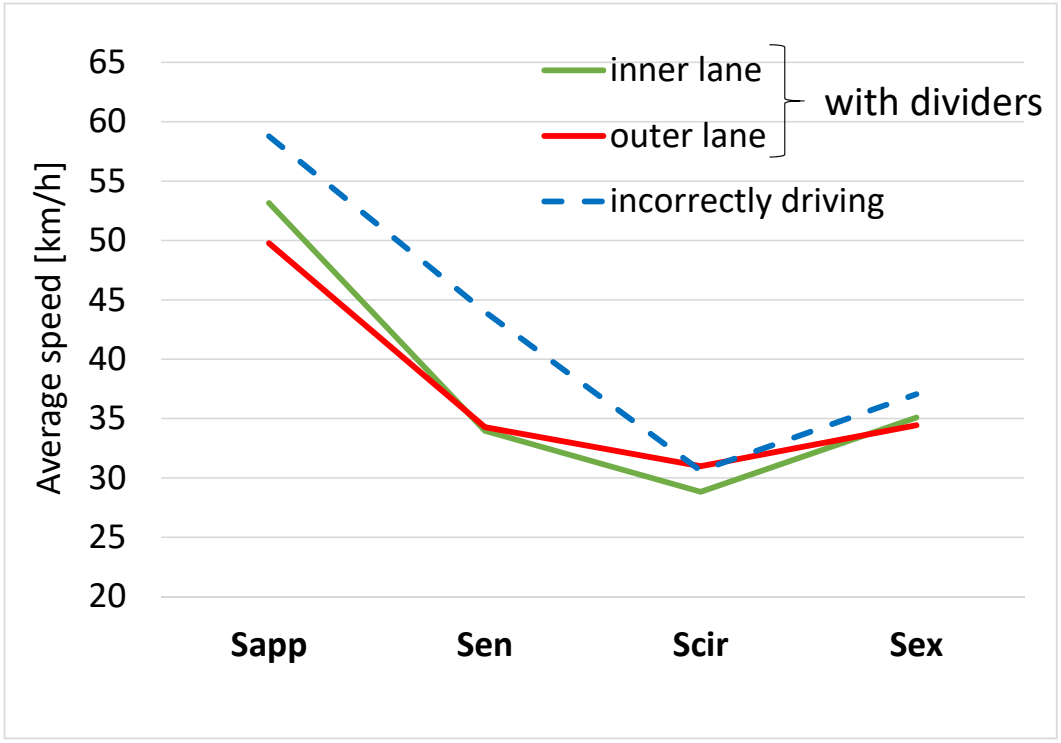


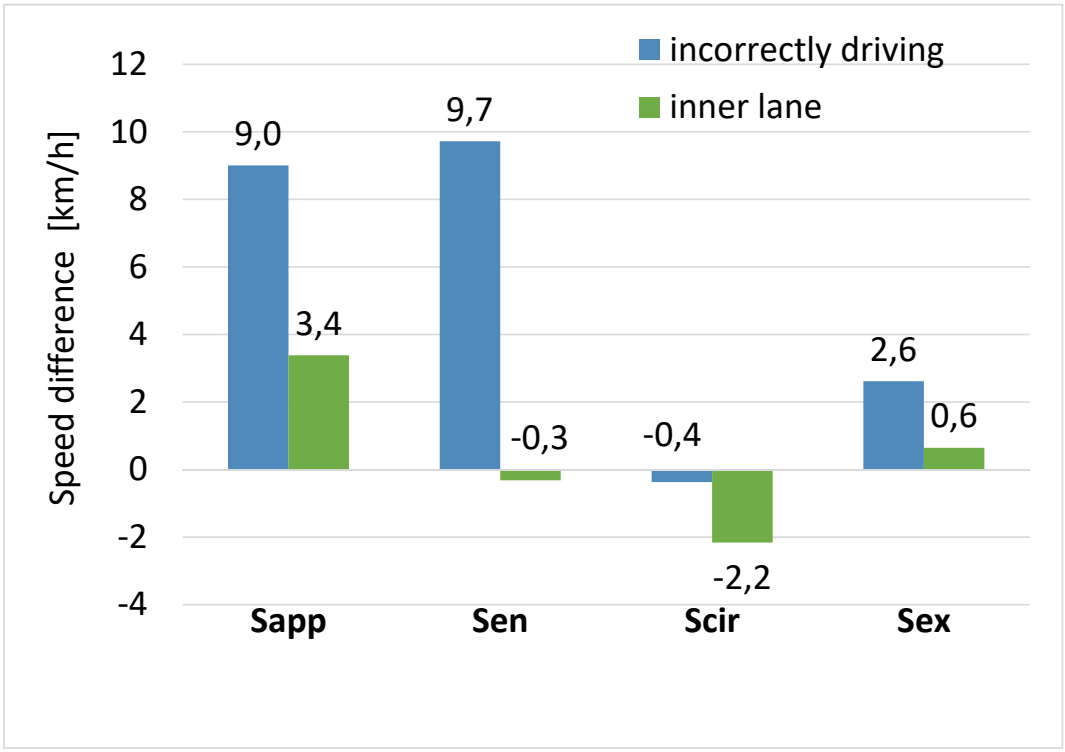






Speed results (2): turbo-roundabouts without dividers





Speed-based surrogate roundabout safety measure

- Section speed

  S_{en}=5,54+0,485·S_{app}+0,432·R_{en} R^2=0,74 (R_{min}=12m, R_{max}=32m)

  S_{cir}=22,2+0,358·R_{cir} R^2=0,36 (R_{min}=11m, R_{max}=34m)

  S_{ex}=27,28+0,384·R_{ex} R^2=0,24 (R_{min}=12m, R_{max}=30m)

- Turbo-roundabouts <u>with</u> dividers

  IAS_d – inside average speed [km/h] (IAS_{min}=25 km/h, IAS_{max}=42 km/h)

  IAS_d=-6,87+0,334·S_{en}+0,394·S_{cir}+0,482·S_{ex} R^2=0,98

- Turbo-roundabouts <u>without</u> dividers

  IAS_{nd} – inside average speed with improper driving [km/h]

  IAS_{nd}=IAS_d+3,66+0,021·P_{impdrv} R^2=0,81

  P_{impdrv} – percent of improper driving [%] (min=15%, max=40%)

Conclusions

- The method allows to evaluate the relative changes in road safety based on observed or calculated speed.
- The use of observed speed, as a surrogate safety measure, allowed to estimate road safety on turbo roundabouts with and without dividers, including driver behaviour.
- Estimation of speed could be improved by using floating car data (speed profiles and trajectories).
- It will be necessary to develop and validate accident prediction models.

Thank you for your attention

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