Headway Acceptance Decisions on Single-Lane Roundabouts in Spain: Critical and Follow-Up Headway

Marilo Martin-Gasulla, University of Florida (US), mmgasulla@ufl.edu
Alfredo Garcia, Universitat Politècnica de València (Spain), agarciag@tra.upv.es
Carlos Llorca, Technical University of Munich (Germany), carlos.llorca@tum.de

Background and Objectives

Introduction

Critical and follow-up headways relevant impact on roundabouts' operation and capacity analysis:

- Critical gap (Hc):
  - Unobservable value, different for each driver, time and conditions.
  - Depends on sampling criteria. ↑ dispersion.
  - Strong impact when conflicting flow (Qc) is high.
  - Widely studied.
- Follow-up headway
  - Less researched.
  - Strong impact when conflicting flow (Qc) is low.

Research motivation

There is a need to document headway acceptance on Spanish roundabouts:

- Large number of roundabouts in Spain (more than 38,000).
- Driver behavior: more used to roundabouts and/or aggressive.
- High demands.
- Not balanced demands.

Lack of further studies on follow-up headway influence on capacity and its variation with demand.

Objectives

The aim of the research is to analyze the main parameters at roundabouts: critical and follow-up headway.

- To collect data of both parameters in one Spanish single-lane roundabout.
- To calculate the discrete value and/or distribution of the critical headway from the most widely used models.
- To calibrate and validate VISSIM for the observed scenarios.
- To study the follow-up headway variation for different critical headway values and increasing traffic demand conditions
- To discuss the results with previous research.

State of the Art

Critical headway estimation

Method	Data requirements	Other input or factors	Output	Estimation procedure	Follow up headway
Harwood et al. (1996)	Headways under maximum rejected headway	no	Mean critical headway	Numeric or graphic calculation	no
Siegloch (1973) [*14*]	Accepted lags and headways under saturated conditions	no	Mean critical headway	Linear regression	yes
Lag Method [*15*]	Only lags	no	Mean critical headway	Numeric calculation	no
Raff (1950)	No specific requirements	no	Median critical headway	Numeric or graphic calculation	no
Greenshields (1947)	No specific requirements	no	Mean critical headway	Numeric calculation	no
Ashworth [*16*]	Only accepted headways	no	Mean critical headway	Numeric calculation	no
Harders	Headways of drivers which rejected at least one headway	no	Distribution of critical headways (empirical)	Numeric calculation	no
Logit	No specific requirements	May include geometrical variables or driver characteristics in a linear formula	Distribution of critical headways (logistic)	Model coefficients estimation	no
Probit	No specific requirements	May include geometrical variables or driver characteristics in a linear formula	Distribution of critical headways (normal distribution)	Model coefficients estimation	no
Maximum Likelihood	Accepted headways and the maximum rejected headway (if there are not rejected headway it is assumed equal to 1)	no	Distribution of critical headways (in general a lognormal distribution)	Model coefficients estimation	no
Wu (2012) Empirical distrib. (Weibull distrib.)	No specific requirements	no	Distribution of critical headways (choice among empirical, normal, weibull, etc).	Numeric calculation	no

Methodology

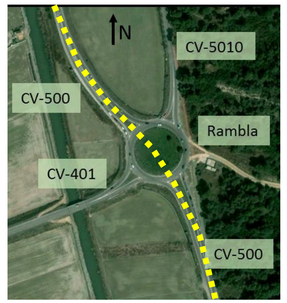
Field study

- 80 m diameter sub-urban roundabout in Valencia, Spain
- 5 approaches (Rambla is a local access, very low traffic demand)
- 8 m roundabout circle width - only one effective lane
- Most important demand on CV-500 (northbound and southbound)
- 305 min video recording

Roundabout location

Peak hour conditions:

- 1400 to 1700 vph
- No pedestrians or cyclists
- 0.5% trucks



Roundabout layout – yellow dashed line shows the major road

Surveillance camera. Traffic Management Center

Headway acceptance criteria. End of a lag or headway on the circle

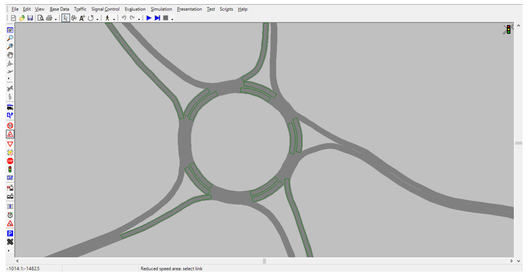
Sample size

Accepted headways	2702
Rejected headways	295

Microsimulation study (VISSIM)

Calibration parameters in VISSIM:

- Stop lines and conflict markers position.
- Reduced speed area length.
- Dynamic queue condition.
- Number of observed vehicles, from the Wiedemann car-following model.
- Look ahead distance, from the Wiedemann car-following model.



Calibration results:

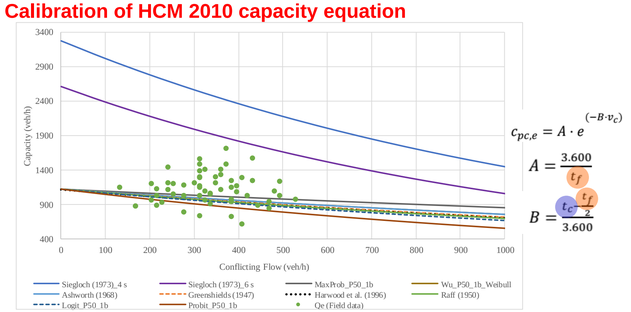
✓ Comparison between observed and simulated queue length
✓ less than 15% of error

Acknowledgments

PTV VISSIM the mind of movement
GOBIERNO DE ESPAÑA MINISTERIO DE FOMENTO DGT Dirección General de Tráfico
GENERALITAT VALENCIANA CONSELLERIA DE VIVIENDA, OBRAS PÚBLICAS Y VERTEBRACIÓN DEL TERRITORIO
AJUNTAMENT DE VALÈNCIA

Analysis and Results

Calibration of HCM 2010 capacity equation

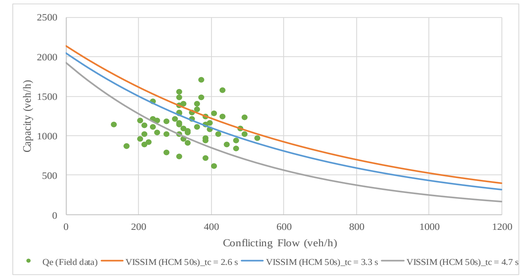


$$c_{pc,e} = A \cdot e^{(-B \cdot v_c)}$$

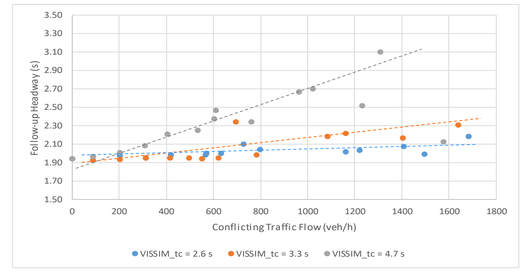
$$A = \frac{3.600}{t_f}$$

$$B = \frac{t_c - \frac{t_f}{2}}{3.600}$$

VISSIM capacity estimation (for LOS F HCM)



Follow-up headway distribution vs. conflicting flow



Conclusions

Critical headway estimation:

- Differences up to 2 s depending on method or sampling criteria.
- Methods based on congested conditions leads to higher values.
- For large Qc (>800 vph), critical gap affects capacity.
- For low Qc (<500 vph), critical gap effect is not decisive.

Follow-up headway:

- Major contributing parameter when Qc are low.
- Cannot be considered uniform at every Qc level – increases with Qc.

Microsimulation tools represent a useful method to avoid the absence of follow-up estimation procedures.