Estimation of critical and follow-up headways at roundabouts

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Motivation

Roundabout capacity analysis in Portugal is based on the UK regression method. This method has some limitations, which has recently motivated research in Portugal into the use of capacity methods based on gap-acceptance theory.

Objectives

- Estimation of critical and follow-up headways at Portuguese roundabouts
- Comparison of the main estimation methods
- Comparison with results from other countries

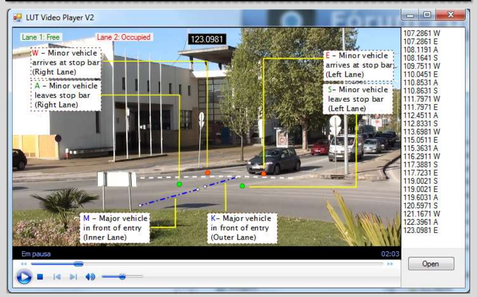
Data collection

- Methodology consistent with the NCHRP Report 572
- Based on video recordings
- 6 roundabouts in Portugal with
  - Periods of continuous queuing
  - simple operations
  - standard geometric design
- Observation time: 53 – 99 minutes per entry
- Data conversion: LUT|$_{VP2}$ tool and Excel VBA

Estimation methods

- Siegloch, Raff, Wu, Troutbeck (ML), Logit

The semi-automatic LUT|$_{VP2}$ tool was developed to facilitate the data conversion task (VB.NET)



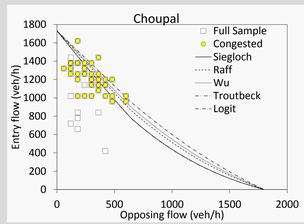
Roundabout	Entry	Lane	Sample data: Length (min)	Entries (veh)	Oppos. (veh)	Method / Sample Set: Siegloch / A, MUT*: 4 s, t_c (s)	t_f (s)	MUT*: 6 s, t_c (s)	t_f (s)	Raff B, t_c (s)	Wu B, t_c (s)	Trout. C, t_c (s)	Logit B, t_c (s)
Choupal	N	--	54	1053	246	3.76	2.18	4.27	2.08	3.90	3.75	4.28	3.54
R. Santa	E	--	99	1181	1245	3.37	2.20	4.15	2.17	3.65	3.56	3.73	3.54
Nelas	W	L	53	524	756	3.14	1.94	3.72	1.99	3.40	3.55	3.63	3.26
Nelas	W	R	53	721	756	3.11	1.95	3.33	2.11	3.11	3.22	3.31	3.07
Pedrulha	W	L	76	819	553	2.95	2.42	4.46	2.33	3.09	3.98	3.88	3.59
Pedrulha	W	R	76	1137	553	2.52	2.32	3.19	2.42	3.57	3.68	3.75	3.31
Nelas	S	L	54	489	664	3.06	2.25	3.78	2.26	3.28	3.30	3.37	3.11
Nelas	S	R	54	671	664	3.02	2.16	3.38	2.64	3.39	3.46	3.60	3.33
Palmeiras	S	L	59	252	977	2.96	2.35	3.55	2.78	3.65	3.68	3.56	3.49
Palmeiras	S	R	59	421	977	2.62	2.36	3.12	2.56	3.30	3.20	3.29	3.07
VR Taveiro	W	L	73	1198	931	3.19	2.16	3.43	2.13	3.03	3.15	3.25	2.75
VR Taveiro	W	R	73	1165	931	2.69	2.37	2.88	2.38	2.97	3.02	3.19	2.56

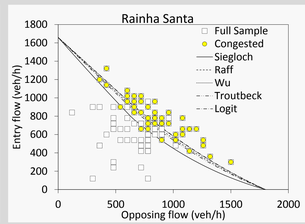
Sample sets: **A**: all gaps (saturated conditions); **B**: accepted gaps and largest rejected gap of each minor vehicle; **C**: accepted gap and largest rejected gap of drivers that rejected at least one headway.
(*) MUT: move-up threshold

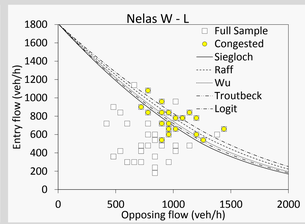
Country	Critical headway, t_c (s)	Follow-up time, t_f (s)	Observations
AUSTRALIA			Model based on conflicting
1-lane	1.4 – 4.9 (2.9)	1.8 – 2.7	flow, number of lanes, diameter, and
2-lane (dominant lane)	1.6 – 4.1 (2.9)	1.8 – 2.2	entry width
2-lane (subdominant lane)	--	2.2 – 4.0	(*21*) (cited in (*6*))
DENMARK			Parameters estimated by regression
1-lane, urban	5.1	3.0	(*22*)
1-lane, rural	4.7	3.0	
2-lane, rural	4.0	2.6	
GERMANY			[x/y]: number of lanes: entry/circle;
[1/2] 40 = DCI = 60 m	5.6	2.5	In the original only final capacity
[2/2] compact 40 = DCI = 60 m	5.2	2.2	formulas are provided. These are the
2/2 large DCI > 60 m	4.4	2.9	parameters that provide the best fit
			using Siegloch's capacity formula
			(*23*)
ISRAEL	4.0		Logit method with waiting time as
1-lane, urban/sub-urban			independent variable. Value for a 10
			s. waiting time
			(*17*)
POLAND			Parameters estimated by regression
Medium 2-lane (L)	4.3	3.3	(*24*)
Medium 2-lane (R)	4.6	3.6	
Large 2-lane (L)	3.8	2.6	
Large 2-lane (R)	4.2	2.9	
Semi 2-lane	4.7	2.8	
PORTUGAL	3.2 – 3.7	2.1 – 2.3	Maximum Likelihood, Raff , other
			methods (from current limited
			observations)
SPAIN	3.3 – 3.5	¯ t_c / 2	(*25*)
SWEDEN			Maximum Likelihood method
2-lane roundabouts (L)	4.4 – 4.6		generalized for multilane
2-lane roundabouts (R)	4.0 – 4.3		roundabouts (*14*)
UNITED STATES			(*) Maximum Likelihood method
HCM 2000	4.1 – 4.6	2.6 – 3.1	(6)
NCHRP 572 (*)			
1- lane roundabouts	4.2 – 5.9	2.6 – 4.3	
2- lane roundabouts (L)	4.2 – 5.5	3.1 – 4.7	
2- lane roundabouts (R)	3.4 – 4.9	2.7 – 4.4	

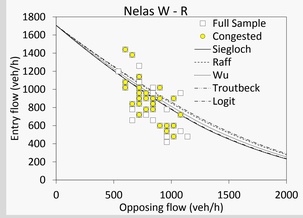
Validation

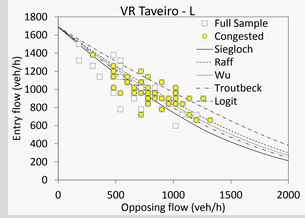
- Comparison of observed and predicted capacities using Hagring's capacity formula (generalization of Tanner's model)

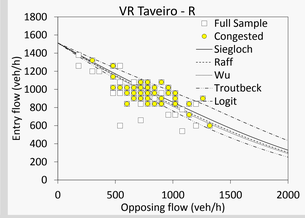












Main conclusions

- Siegloch's estimates are very dependent of the move-up time threshold used to classify the saturation periods;
- Maximum Likelihood method overestimates the critical headway when the opposing flows are very low;
- Wu and ML methods produce very similar estimates;
- The Logit method allows the explicit use of independent variables other than the headway; the waiting time at the stop bar was not statistically significant;
- The critical headway is usually smaller at the right-lane entry;
- Portuguese (and Spanish) drivers are more aggressive than northern/eastern European drivers;
- The comparison between estimated and observed capacities suggests that Raff, Wu and Troutbeck methods are the more reliable.