Calibration of the HCM 2010 Roundabout Capacity Equations for Georgia

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INTRODUCTION

Roundabouts provide operation and safety benefits over traditional intersection designs. When examining alternative intersection designs, the ability to accurately predict capacity is important. The current method for determining roundabout capacity in the United States is found in the 2010 Highway Capacity Manual (HCM) drawn primarily from the National Cooperative Highway Research Program (NCHRP) Study 3-65. The default capacity equations can be calibrated to local conditions using locally determined values of critical headway, t_c ,and follow-up headway, t_f

The purpose of this study is to calibrate the HCM 2010 model to driving conditions in Georgia by determining the critical headway and follow-up headway at single-lane roundabout in Georgia.

BACKGROUND

HCM 2010 SINGLE LANE ROUNDABOUT CAPACITY EQUATION

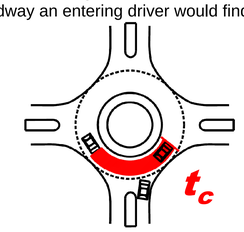
$$c_{pce} = Ae^{(-Bv_c)}$$

$$A = \frac{3600}{t_f} \quad B = \frac{t_c - \frac{t_f}{2}}{3600}$$

$c_{pce} = entry\ capacity, \frac{pcu}{h}$
$v_c = conflicting\ vehicle\ traffic\ volume\ rate, \frac{pcu}{h}$
$t_c = critical\ headway, s$
$t_f = follow-up\ headway, s$

CRITICAL HEADWAY, t_c

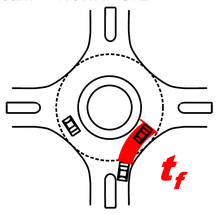
➢"The minimum headway an entering driver would find acceptable" – NCHRP 572



➢Estimated from accepted and rejected gaps
➢NCHRP 572 presents three different methods for determining critical gap:
(1) Inclusion of all observations of gap acceptance, including rejected lags
(2) Inclusion of only observations that contain a rejected gap; and
(3) Inclusion of only observations where queuing was observed during the entire minute and the driver rejected a gap
➢**Gap:** the time between the passing of the rear of the leading vehicle and the front of the following vehicle in a traffic stream
➢**Lag:** the time between when a vehicle arrives at the entrance point and the next circulating vehicle

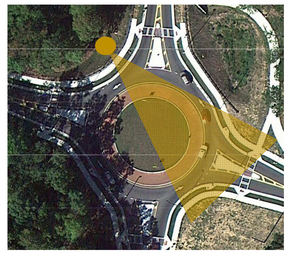
FOLLOW-UP HEADWAY, t_f

➢"The headway maintained by two consecutive entering vehicles using the same gap in the conflicting stream" – NCHRP 572



DATA COLLECTION

CAMERA PLACEMENT



CAMERA VIEW

➢Recorded 36 approaches over 14 roundabouts
➢Collected 65+ hours of video

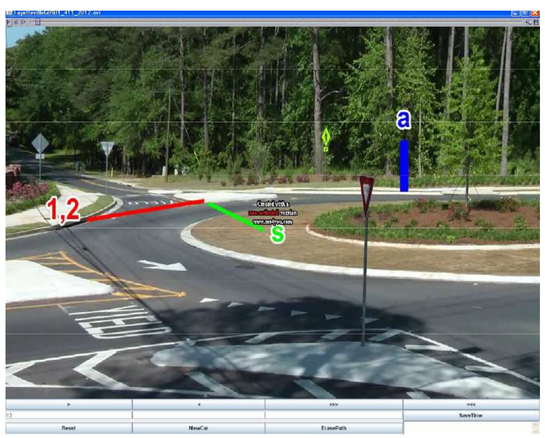
SITES:

- Alpharetta
- Covington
- Columbus
- Duluth
- Douglasville
- Emory
- Fayetteville
- Hinesville
- Marietta
- Newnan
- Roswell
- St. Simons

DATA EXTRACTION

➢ Developed in-house computer-assisted program to record timestamps
➢ Collected timestamps via keystroke entry at reference lines
➢ Output: set of all timestamps of circulating, entering, and exiting vehicles

Keystroke	Event
1	Vehicle arrives at the entry point
2	Vehicle arrives at the circular roadway
a	Vehicle exits the roundabout
s	Vehicle circulates in front of the approach of interest
x	Beginning of queue on the approach
z	End of queue on the approach
q	Errors in the data collection file



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RESULTS

FOLLOW-UP HEADWAY

➢ Found by subtracting the timestamp of the following vehicle at the entrance point from the leading vehicle at the entrance point
➢ Used a move-up time threshold of 4.0 seconds to expand the number of follow-up headway observations because few sites were under consistent capacity constrained conditions
➢ **Average follow-up headway: 3.269 seconds**

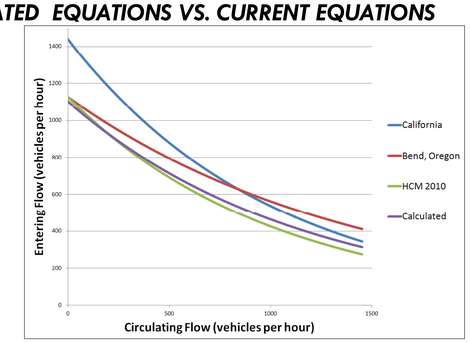
Follow-up Headway Without Exiting Vehicles		Queued		Move-up Time < 4 s	
		t_f (s)	n	t_f (s)	n
Calculated Results	Average (weighted)	3.502	2,886	3.269	8,172
NCHRP 572 Results	Average (weighted)	3.400	2,996	3.200	7,859

CRITICAL HEADWAY

➢ Found NCHRP 572 Method 2 to be most appropriate
➢ Used the Maximum Likelihood Method
➢ Inflection point on the logistic curve is the critical headway
➢ **Average critical headway: 4.747 seconds**

Critical Headway Without Exiting Vehicles		NCHRP Method 1			NCHRP Method 2			NCHRP Method 3		
		t_c (s)	n (% of NCHRP Method 1)	std. dev.	t_c (s)	n (% of NCHRP Method 1)	std. dev.	t_c (s)	n (% of NCHRP Method 1)	std. dev.
Calculated Results	Total		6724			1344 (20 %)			333% (5%)	
	Average (weighted)	5.503		1.916	4.747		1.922	4.922		1.562
NCHRP 572 Results	Total		11581			3322 (29%)			558 (5%)	
	Average (weighted)	4.500		1.000	5.000		1.200	5.510		1.300

CALIBRATED EQUATIONS VS. CURRENT EQUATIONS



FINDINGS

Results indicate that calibrating the HCM 2010 single-lane roundabout capacity equation to Georgia conditions generally increases the predicted capacity.

IMPACT OF EXITING VEHICLES

➢ The NCHRP 572 capacity equations did not account for exiting vehicles in the final model
➢ Results of this study indicate the inclusion of exiting vehicles decreases critical headway