Calibration of the HCM 2010 Roundabout Capacity Equations for Georgia Conditions

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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 Highway Capacity Manual (HCM) 2010 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 roundabouts in Georgia.

BACKGROUND

HCM 2010 CAPACITY EQUATION – SINGLE LANE ROUNDABOUT

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

$$A = \frac{3{,}600}{t_f} \qquad B = \frac{t_c - \frac{t_f}{2}}{3{,}600}$$

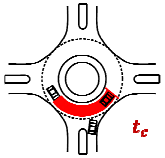
$c_{pce} = entry\ capacity, \frac{pcu}{h}$

$t_c = critical\ headway, s$

$t_f = follow-up\ headway, s$

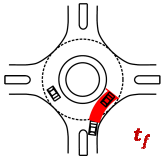
$v_c = conflicting\ circulating\ traffic\ flow\ rate, pcu/h$

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 accepted 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 vehicles arrives at the entrance point and the next circulating vehicle

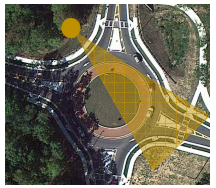
FOLLOW-UP HEADWAY, t_f



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

DATA COLLECTION/EXTRACTION

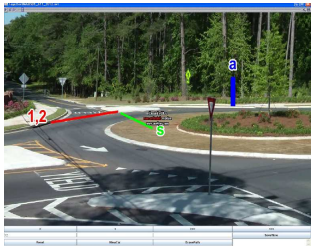
CAMERA PLACEMENT



CAMERA VIEW

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

- 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

FINDINGS

Preliminary results of this study 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 did not account for exiting vehicles in the final model
- Preliminary results of this study indicate the inclusion of exiting vehicles decreases critical headway

GAP AND LAG DATA

Lags were included in the initial data analysis because of lack of gap data at some roundabout sites. However, after data processing the results indicate that collecting lag data is subjective based on the person collecting the data. Data collectors are instructed to press keystroke "1" when the entering vehicle stops or significantly slows down on the approach. The lag inconsistencies are a result of the data collector's perception of when a vehicle slows down.

Data analysis for critical headway will further investigate the use of including both gap and lag data. In addition, critical headway will be calculated using only gap data. These two methods are consistent with the NCHRP 572's recommended methods one and two for determining critical headway.

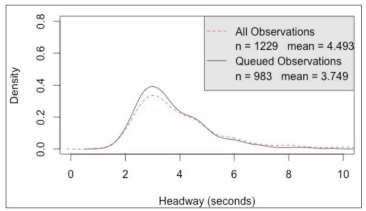
This research is sponsored by the Georgia Department of Transportation under contracts RP11-14. Opinions expressed here are those of the authors and not necessarily those of the Georgia Department of Transportation.

PRELIMINARY RESULTS

(CURRENT RESULTS INCLUDE LAG DATA)

FOLLOW-UP HEADWAY

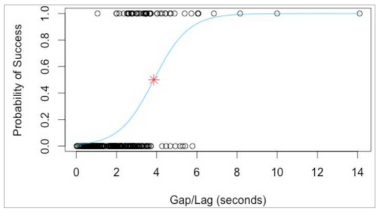
- Found by subtracting the timestamp of the following vehicle at the entrance point from the leading vehicle at the entrance point



CRITICAL HEADWAY

- Used the Maximum Likelihood Method
- Inflection point on the logistic curve is the critical headway

$$E(Y_i|X_i) = \pi_i = \frac{e^{\beta_0+\beta_1 X_i}}{1+e^{\beta_0+\beta_1 X_i}}$$



CALIBRATED EQUATIONS VS. CURRENT EQUATIONS