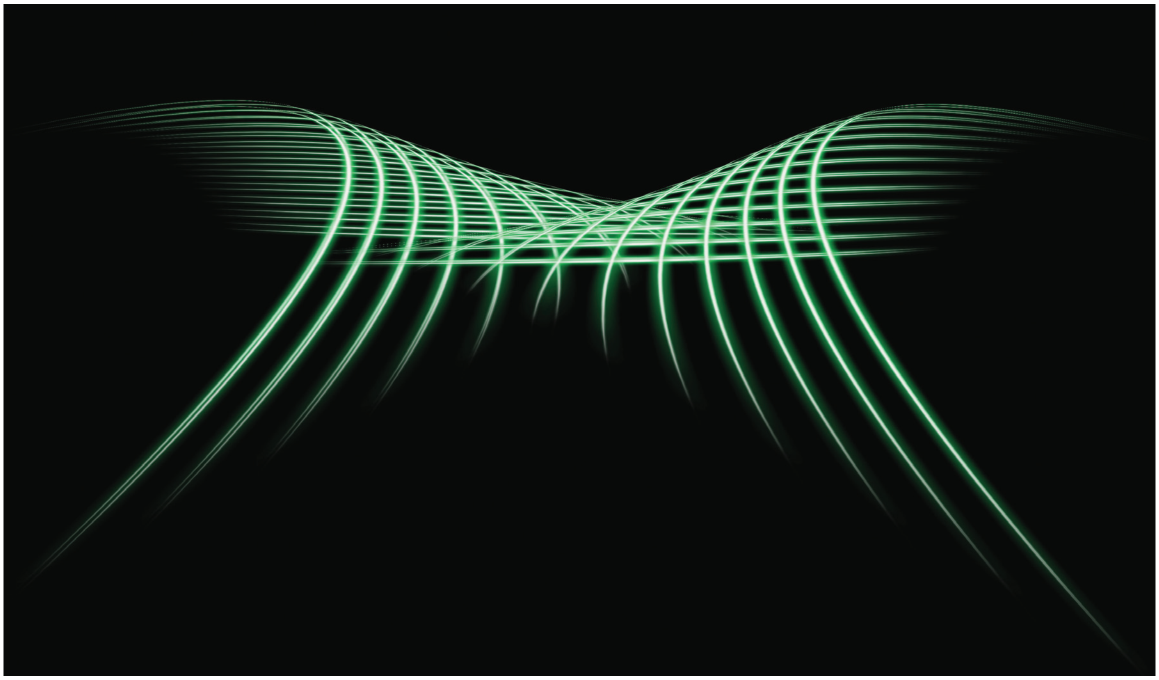
HCM2010

HIGHWAY CAPACITY MANUAL



CHAPTER 33

ROUNDABOUTS: SUPPLEMENTAL

TRB TRANSPORTATION RESEARCH BOARD
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HCM2010

HIGHWAY CAPACITY MANUAL

The HCM 2010 significantly enhances how engineers and planners assess the traffic and environmental effects of highway projects by

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CHAPTER 33
ROUNDABOUTS: SUPPLEMENTAL

CONTENTS

LIST OF EXHIBITS

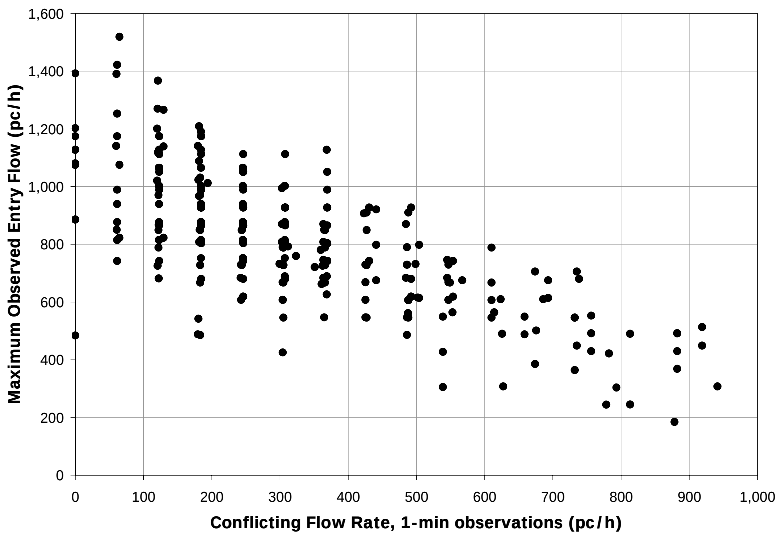
1. SUPPLEMENTAL GUIDANCE

This section presents supplemental guidance on the methodology provided in Chapter 21, Roundabouts.

VARIABILITY AND UNCERTAINTY

The analyst should be aware of the large observed variation in driver behavior at roundabouts. Exhibit 33-1 shows observed combinations of entry flow and conflicting flow during 1-min periods of constant queuing and demonstrates the wide scatter of measured entry flows during capacity conditions. Part of this variation can be explained by the instability of 1-min measurements. The remainder of the variation is attributable primarily to variations in driver behavior, truck percentage, and exiting vehicles. Since there is no external control device regulating flow interactions at roundabouts, driver interactions govern the operation, and they are highly variable by nature.

Exhibit 33-1
Observed Combinations of Entry Flow and Conflicting Flow During 1-min Periods of Continuous Queuing at Single-Lane Roundabout Entries



Source: Data from *NCHRP Report 572* (*1*).

LANE-USE ASSIGNMENT

Lane-use assignment is best determined by measuring lane use in the field under the conditions being analyzed. In the absence of this information, default values or estimates can be used. This section provides background on the process by which an analyst can make an appropriate selection of a lane utilization factor.

There were few instances in the database used to develop the multilane model (*1*) in which a steady-state queue existed on all lanes of a multilane entry. Most commonly, for the two-lane entries, the outside lane had a sustained queue while the inside lane only had sporadic queuing. In general, several factors contribute to the assignment of traffic flow to each lane:

Turning movement patterns greatly influence lane assignments.

1. The assignment of turning movements to each lane (either as exclusive lanes or as shared lanes) directly influences the assignment of traffic

volumes to each lane. This is generally accomplished through the use of signs and pavement markings that designate the lane use for each lane. Multilane entries with no lane-use signing or pavement markings may be assumed to operate with a shared left-through lane in the left lane and a shared through-right lane in the right lane, although field observations should be made to confirm the lane-use pattern of an existing roundabout.

Dominant turning movements may create de facto lanes. A de facto lane is one designated for multiple movements but that may operate as an exclusive lane because of a dominant movement demand. A common example is a left-through lane with a left-turn flow rate that greatly exceeds the through flow rate.

2. Dominant turning movements may create de facto lane assignments where there is no advantage for drivers in using both lanes assigned to a given turning movement. For example, at an entry with left-through and through-right lanes and a dominant left-turn movement, there may be no advantage for through drivers in using the left lane. In addition, a lack of lane balance through the roundabout (e.g., two entry lanes but only one downstream circulating lane or one downstream exit lane) can create de facto lane-use assignments for a particular entry.

Downstream destinations may influence lane assignment.

3. Destinations downstream of a roundabout may influence the lane choice at the roundabout entry. A downstream destination such as a freeway on-ramp may increase use of the right entry lane, for example, even though both lanes could be used.

Poor geometric alignment of the entry may cause drivers to avoid the left lane.

4. The alignment of the lane relative to the circulatory roadway seems to influence the use of entry lanes where drivers could choose between lanes. Some roundabouts have been designed with rather perpendicular entries that have a natural alignment of the right entry lane into the left lane of the circulatory roadway. Under this design, the left entry lane is naturally aimed at the central island and is thus less comfortable and less desirable for drivers. This phenomenon, documented elsewhere (*2*, *3*) as *vehicle path overlap*, may result in poor use of the left entry lane. Similarly, poorly aligned multilane exits, where vehicles exiting in the inside lane cross the path of vehicles exiting in the outside lane, may influence lane use on upstream entries. In either case, the effect is most readily measured in the field at existing roundabouts and should be avoided in the design of new roundabouts.

Unfamiliar drivers may incorrectly select lanes for the intended movements.

5. Drivers may be uncertain about lane use when they use the roundabout, particularly at roundabouts without designated lane assignments approaching or circulating through the roundabout. This may contribute to the generally incorrect use of the right entry lane for left turns, for example, because of a perceived or real difficulty in exiting from the inside lane of the circulatory roadway. Proper signing and striping of lane use on the approach and through the roundabout may reduce this uncertainty, although it is likely to be present to some extent at multilane roundabouts.

Of these items, the first three factors are common to all intersections and are accounted for in the assignment of turning-movement patterns to individual lanes. Of the remaining two factors, both of which are unique to roundabouts, the fourth factor should be addressed through proper alignment of the entry relative to the circulatory roadway and thus may not need to be considered in the analysis of new facilities. However, existing roundabouts may exhibit path overlap, resulting in poor lane utilization. It may be possible to reduce the fifth factor through proper design, particularly through lane-use arrows and striping. These collectively make accurate estimation of lane utilization difficult, but it may be measured at existing roundabouts.

Multilane roundabouts generally exhibit a bias to the right lane except where a double left-turn movement is present.

For entries with two through lanes, limited field data suggest that drivers generally have a bias for the right lane. For entries with two left-turn lanes (e.g., left-turn-only and shared left-through-right lanes), limited field data suggest that drivers have a bias for the left lane. Although no field observations have been documented for entries with two right-turn lanes, experience at other types of intersections with two right-turn lanes suggests that drivers have a bias for the right lane.

CAPACITY MODEL CALIBRATION

As discussed in Chapter 21, Roundabouts, the capacity model can be calibrated by using two parameters: the critical headway t_c and the follow-up headway t_f. One example application of this calibration procedure was performed for roundabouts in California (*4*).

Field-measured values for critical headway and follow-up headway were determined as follows:

- Critical headway:
  - Single-lane roundabouts: 4.8 s
  - Multilane roundabouts, left lane: 4.7 s
  - Multilane roundabouts, right lane: 4.4 s
- Follow-up headway:
  - Single-lane roundabouts: 2.5 s
  - Multilane roundabouts, left lane: 2.2 s
  - Multilane roundabouts, right lane: 2.2 s

By using these values and the expressions in Equation 21-21 through Equation 21-23, the capacity equation for single-lane roundabouts can be expressed as follows:

$$A = \frac{3{,}600}{t_f} = \frac{3{,}600}{2.5} = 1{,}440$$

$$B = \frac{t_c - (t_f/2)}{3{,}600} = \frac{4.8 - (2.5/2)}{3{,}600} = 1.0 \times 10^{-3}$$

$$c_{pce} = Ae^{(-Bv_c)} = 1{,}440e^{(-1.0\times10^{-3} v_c)}$$

Therefore, the model resulting from the use of California-specific data for critical headway and follow-up time has a higher intercept, and thus higher capacity, over its entire range than does the model based on the national study. These equations replace the equations in Step 5 of the Chapter 21 methodology.

2. REFERENCES

Many of these references can be found in the Technical Reference Library in Volume 4.

1. Rodegerdts, L., M. Blogg, E. Wemple, E. Myers, M. Kyte, M. P. Dixon, G. F. List, A. Flannery, R. Troutbeck, W. Brilon, N. Wu, B. N. Persaud, C. Lyon, D. L. Harkey, and D. Carter. *NCHRP Report 572: Roundabouts in the United States.* Transportation Research Board of the National Academies, Washington, D.C., 2007.
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