Field Measurements of Capacity and Delay at Unsignalized Intersections

BY TIAN ZONGZHONG, MICHAEL KYTE AND JAMES COLYAR

Capacity and delay are two major parameters for evaluating intersection operations. While models and procedures are available to estimate these parameters given some other easily obtainable traffic flow parameters, traffic engineers often have to conduct field measurements to verify the results given by available models and procedures. Capacity and delay models are provided by the 1994 update of the Highway Capacity Manual (HCM), which is used by most traffic engineers and jurisdictions. However, these models and procedures often have limitations when applied to some unusual conditions. The models were either developed based on simplified assumptions or a limited source of field data. The 1994 HCM update provides models for estimating capacity and delay at unsignalized intersections, including two-way stop-controlled (TWSC) and all-way stop-controlled (AWSC) intersections. The procedures for TWSC intersections do not account for certain conditions, such as the effect of platoons on the major street when an upstream signal exists, or the effect of median storage where minor street vehicles can proceed through the intersection in a two-step process, namely two-stage gap acceptance process. The procedures for AWSC were developed based on empirical studies of a limited number of intersections. Both procedures could provide invalid results when an intersection has unusual geometric or traffic flow conditions. It is important for traffic engineers to conduct field measurements to verify the model results under such circumstances, so that reasonable recommendations can be provided when determining an intersection control type.

Directly measuring capacity and delay in the field is a difficult task. To maintain the acceptable accuracy of the measurement, one option is to videotape an intersection and extract the data from the videotapes. However, this time-consuming method may not be practical for most engineers.

The purpose of this article is to introduce a practical method for measuring capacity and delay at unsignalized intersections. A model relating average total delay and average queue length is introduced based on queuing theory, and the model was verified based on a comprehensive database established during the research project “Capacity and Level of Service at Unsignalized Intersections,” sponsored by the National Cooperative Highway Research Program (NCHRP). By conducting field measurements of queue length and volume, the delay is obtained. Using the delay models of the 1994 HCM update, capacity can then be calculated.

Available Methods for Measuring Capacity and Delay

Kyte et. al. uses the following equation to estimate approach capacity at unsignalized intersections:

Tian ZongZhong
works for Kittelson and Associates Inc. in Portland, Ore. He earned his B.Eng. and M.Eng. from NJIT in Beijing, China, and his M.S. in transportation engineering from the University of Idaho. He is an Associate of ITE.

Michael Kyte
is Director of the National Center for Advanced Transportation Technology at the University of Idaho. He is Chair of TRB’s Unsignalized Intersection Subcommittee. Kyte is a Member of ITE.

James Colyar
is a Transportation Analyst with Kittelson and Associates Inc. in Portland, Ore. He received a B.S. in civil engineering at the University of Idaho. Colyar is an Associate of ITE.