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Derivation of a Risk-Based Level of Service Index for Surface Street Network Using Reliability Analysis

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Abstract : Current Level of Service (LOS) index adopted in Highway Capacity Manual (HCM) for signalized intersections on surface streets is based on the intersection average delay. The delay thresholds for defining LOS grades are subjective and is unrelated to critical traffic condition. For example, an intersection delay of 80 sec per vehicle for failing LOS grade F does not necessarily correspond to the intersection capacity. Also, a specific measure of average delay may result from delay minimization, delay equality, or other meaningful optimization criteria. To that end, a reliability version of the intersection critical degree of saturation (v/c) as the LOS index is introduced. Traditionally, the level of saturation at a signalized intersection is defined as the ratio of critical volume sum (per lane) to the average saturation flow (per lane) during all available effective green time within a cycle. The critical sum is the sum of the maximal conflicting movement-pair volumes in northbound-southbound and eastbound/westbound right of ways. In this study, both movement volume and saturation flow are assumed log-normal distributions. Because, when the conditions of central limit theorem obtain, multiplication of the independent, positive random variables tends to result in a log-normal distributed outcome in the limit, the critical degree of saturation is expected to be a log-normal distribution as well. Derivation of the risk index predictive limits is complex due to the maximum and absolute value operators, as well as the ratio of random variables. A fairly accurate functional form for the predictive limit at a user-specified significant level is yielded. The predictive limit is then compared with the designated LOS thresholds for the intersection critical degree of saturation (denoted as X

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