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GUIDELINES FOR QUANTIFYING THE INFLUENCE OF AREA TYPE AND OTHER FACTORS ON SATURATION FLOW RATE

PROBLEM STATEMENT

The procedures in Chapter 16 of the 2000 Highway Capacity Manual (HCM) recognize that area demographics influence the capacity of a signalized intersection. Factors such as area population, average age, average income, and average trip distance are likely correlated with intersection capacity. The procedures in the HCM use a common base saturation flow rate (i.e., the theoretical capacity of a signalized intersection approach when it stays green 100% of the time) that is unaffected by the number of lanes on the intersection approach. However, measurements of saturation flow rate in Florida indicate that flow rate tends to increase with the number of approach lanes. The HCM procedures indicate that right-turning vehicles have a lower saturation flow rate than those on a through movement. However, the HCM adjustment factor for right turns does not reflect the effect of turn radius.

The effect of area demographics, number of lanes, and right-turn radius have been reported in the literature but have not been sufficiently researched to the extent that they are suitable for practical application. The HCM authors recommend that analysts capture these effects by conducting field studies to calibrate the HCM procedures for use in their jurisdictions. While this recommendation is rational, it is not often implemented in practice because it is time consuming and expensive. Research is needed to develop saturation flow rate adjustment factors that can be used to estimate the effect of area demographics, number of lanes, and right-turn radius on flow.

OBJECTIVES

The objectives of this research project are to (1) quantify the base saturation flow rate for through movements, and (2) develop adjustment factors that account for the effects of area type, number of lanes, and the presence of right-turn vehicles..

FINDINGS AND CONCLUSIONS

The findings from a review of the literature indicate that some areawide influences and local conditions have been found to be correlated with saturation flow rate but are not included in the HCM. Areawide influences reflect differences between drivers in small towns and those in large cities (e.g., drivers in rural environments tend to demonstrate less aggressive behavior in congested traffic). Local conditions reflect differences between drivers during off-peak and peak traffic hours. Local conditions also reflect the effect of constraints on the driving environment, as may be characterized by the number of approach traffic lanes or speed limit.

Saturation flow adjustment factors reflecting the effect of population, traffic pressure, number of lanes, and speed limit were developed for this research. An examination of factor trends indicates that saturation flow rate is lower in lightly populated (e.g., rural) areas.

Traffic pressure reflects the presence of aggressive drivers who are anxious to minimize their travel time in otherwise high-volume conditions (e.g., rush hour). They achieve their goal by accepting relatively short headways during queue discharge. The traffic pressure adjustment factor indicates that saturation flow rates increase as traffic queues increase.

The curb lane of a through lane group typically has a lower saturation flow rate than that of the adjacent through lanes. This lower rate is likely due to various sources of “friction” associated with the edge of the roadway (e.g., driveways, pedestrians, signs, poles, and other street furniture) and its proximity to moving traffic. When this effect is averaged across all lanes in the through lane group, saturation flow rate is found to increase with increasing number of lanes.

The physical elements of the urban street environment tend to be correlated with the posted speed limit. These elements include driveway density, roadside development, sidewalks, on-street parking, and street segment length. When these elements are present in the vicinity of the intersection, they are likely to influence saturation flow rate. This influence was observed in field measurements of saturation flow rate at intersections on streets having a range of speed limits. Specifically, lower saturation flow rates were found on lower-speed streets.

Saturation flow rate adjustment factors for lanes with right-turn movements and for those with heavy vehicles were also developed. Saturation flow rate was found to decrease with an increase in right-turn vehicle percentage and with an increase in heavy-vehicle percentage. Right-turn radius was not found to be correlated with saturation flow rate. A comparison with similar factors reported in the HCM indicates that right-turn vehicles and heavy vehicles have less of an effect on saturation flow rate than suggested by the HCM factors.

A base saturation flow rate of 1950 passenger cars/hour/lane (pc/h/ln) was estimated from the data collected at numerous Florida intersections. This rate is slightly higher than the 1900 pc/h/ln value currently used in FDOT’s Quality/Level of Service Handbook (Handbook). The base rate of 1950 pc/h/ln and the aforementioned adjustment factors are recommended for inclusion in the next edition of the Handbook.

BENEFITS

The products of this research will be implemented through their incorporation in the Handbook. The Handbook is used by engineers, planners, and decision makers on a statewide basis in the development and review of roadway users’ quality/level of service at planning and preliminary engineering levels. The implementation of the research products will improve the accuracy of the level of service estimates, which should translate into a more cost-effective distribution of construction project resources and a more equitable cost-share distribution among developers. That is, FDOT will be better able to assess the street system to know where improvements are needed, which will allow for effective prioritization of resources, how much of the cost burden should be borne by developers, relative to their participation in the project. Additional benefits of the research include improved ability to manage signal timing (i.e., for equal distribution of green light time) by considering demand and capacity.

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