Determining Yellow Change and Clearance Intervals for Left-Turning Phases: An Evaluation of the Current Guidelines with Connected Vehicle Data

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Abstract: In March 2020, the Institute of Transportation Engineers (ITE) published new guidelines for determining traffic signal change and clearance intervals that using an extended kinematic equation for left turns. Whereas previous guidelines assumed constant speed for all vehicles approaching an intersection, this new equation accounted for left-turning vehicles needing more yellow time because they decelerate (assuming a maximum safe and comfortable rate) before making turning maneuvers. This paper evaluates these guidelines using real-world vehicle trajectories from the Ann Arbor Connected Vehicle Test Environment (AACVTE). These trajectories confirm that free-flowing left-turning vehicles decelerate, but deceleration usually starts at a moderate rate before reaching the critical distance and continues to the middle of the intersection. Vehicles then accelerate to a departure speed at the clearance point. Since the goal of the yellow change interval is to eliminate the dilemma zone such that a free-flowing vehicle can safely traverse the critical distance, these observations imply that the extended kinematic equation will overestimate the required duration for the following two reasons: 1.) the critical distance is shortened by the speed reduction before the braking point; 2.) the average traversing speed is higher as vehicles usually decelerate at a moderate rate instead of the maximum rate. The equation will underestimate the clearance interval as the average traversing speed through the intersection is slower than the intersection entry speed. We propose a new left-turn kinematic equation for determining yellow change and clearance intervals, and the results are validated from the observed vehicle trajectories.