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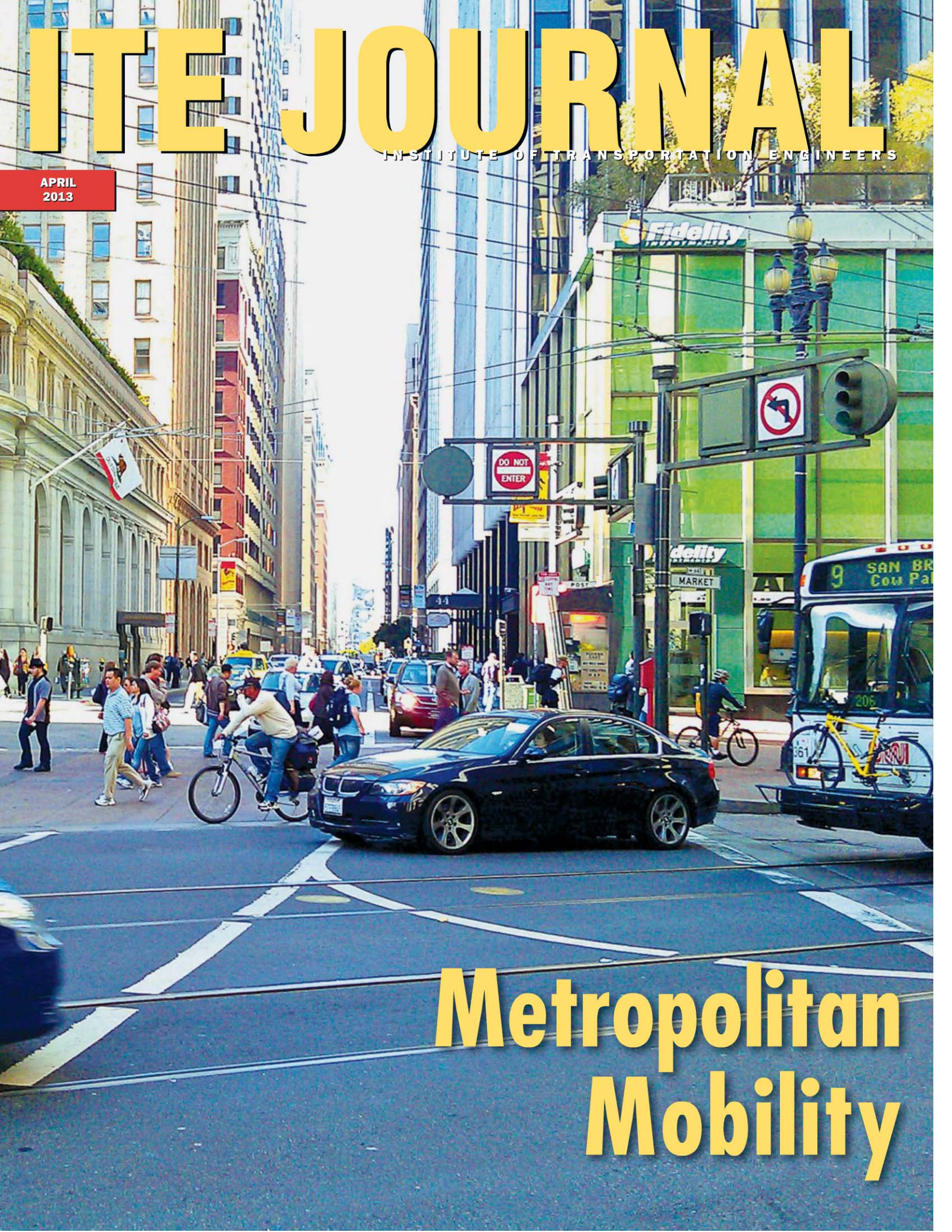

Metropolitan Mobility

Intersection Crossing Based on a Pedestrian Time Gap

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This article discusses how the critical time gap, or minimum time to cross an unsignalized intersection, for a pedestrian priority route should be based on pedestrian rather than automobile travel times to encourage walking and ensure safety. This pedestrian-based time gap impacts other intersection safety measures, such as intersection sight distance (ISD) and the gap size, or allowable crossing window for pedestrians. The time gap should provide sufficient time for a pedestrian to cross without having to wait an exceptionally long time to cross safely between cars.

Introduction

Traditional automobile-focused designs and intersection facilities do not always provide sufficient safety to travelers using other modes. The critical time gap determines intersection design safety for all modes, not simply for automobiles. Though critical time gap varies depending on intersection type, in the context of this article, it is considered to be the minimum time window needed to cross safely at an intersection from a complete stop at the cross street at a two-way stop (AASHTO Case III).[1] This gap is currently based on reaction times, speeds, lengths, travel, and visual distances for the automobile traveler. The critical time gap is particularly important as one of the few valid determinants of intersection safety without actual traffic data, and therefore is critical for intersection design. Other determinants are based on this factor, such as intersection sight distance and crossing gap size, essentially the window or headway between oncoming vehicles. However, a pedestrian—assuming a walking speed of 3.5–4.5 ft. per second (1.0–1.5 m per second) or 2.5–3.0 mph[2–4] (4–5 kph)—takes significantly longer to cross that intersection than a car. The goal of this study was to determine whether pedestrians can safely cross a given intersection, using the traditional automobile-based critical time gap, and what impact this determination would have on traditional warrants for traffic control intervention.

A neighborhood environmental study[7] in Indianapolis analyzed a proposed pedestrian priority route,[8] but the route uses a street that crosses an intersection with a borderline intersection sight distance. A separate traffic analysis[10] found that the warrants from the Indiana Department of Transportation (as mentioned in the *Indiana Design Manual*)[11] that would satisfy the requirements for installing the recommended all-way stop were not met using automotive indicators alone. This finding led to disagreement as to how to treat this intersection. The traffic analysis found no warrants that would explicitly indicate the proper walkability requirements for the intersection. This article will consequently examine corresponding warrants that would ensure the proper pedestrian performance for this intersection.

Description of the Intersection

The proposed pedestrian priority route follows 56th Street in Indianapolis connecting two major pedestrian destination clusters. The problematic intersection is located at the crossing of Central Avenue and 56th Street within an extensively landscaped residential area with abundant trees and regular curb cuts for driveways. The speed limit is 35 mph (56 kph) along Central Avenue and 30 mph (48 kph) along 56th Street. The intersection has a curb-to-curb distance of 44 ft. across Central Avenue and 30 ft. across 56th Street. There are sidewalks on all approaches. The intersection is currently controlled by stops on 56th Street, but there were no stops on Central Avenue. There is an all-way stop with a flashing signal one block north adjacent to the schools on 57th Street. There is an all-way stop with a flashing signal two blocks south at 54th St. (~1,000 ft. [305 m] away). There is one travel lane in each direction for each street. There were no marked crosswalks or static advanced warning signs for pedestrians. Otherwise, the vehicular traffic flow on Central Avenue was unimpeded.

There is a significant vertical crest curve along Central Avenue cresting about 300 ft. (92 m) north of the intersection obscuring the approach of southbound traffic. The intersection sight distance (ISD) along that viewing line is 400 ft. or 122 m (10 ft. or 3 m greater than the minimum for the automobile ISD warrant)[9] from within the intersection at the speed limit (see Figure 2). There are parking lanes and abundant vegetation that can also obstruct sight distances, particularly from the street corners, but otherwise the ISDs are unimpeded.

Existing Guidelines and Warrants

Consideration was given for existing guidelines and warrants in the *Manual on Uniform Traffic Control Devices* (MUTCD) and *ITE Traffic Engineering Handbook*. The only guideline or warrant that came close to applying was MUTCD Warrant 4 (Pedestrian Volume)[12] for a traffic signal. This intersection did not meet the minimum volume of pedestrian crossings at the time. However, the observed condition is a safety consideration, not a traffic consideration. If a minor public road had a vehicular volume of 300 vehicles per day, this intersection would still be required to meet the safety requirement for ISD. (ISD is one of the few intersection considerations that does not consider traffic volume.[13])

Figure 1. Pedestrian view from street corner of a car approaching over the study's vertical crest curve. Position 1—car at 390 ft. (119 m) from intersection—car not visible.

Figure 2. Position 2—car at just under 300 ft. (92 m) from intersection, beginning to be visible through the windshield of the parked car.

Figure 3. Position 3—car at 200 ft. (61 m) from intersection.

Physical Observation of Conditions at the Intersection—Warrant Based on ISD

From the curb (rather than from mid-intersection), the ability for cars to be seen north of the rise is somewhat less than the 390 ft. (119 m) warrant minimum. It is closer to 300 ft. (92 m). A car was positioned at three distances from the intersection: 390 ft. (119 m), 300 ft. (92 m), and 200 ft. (61 m) {marked in yellow on Fig. 3}. A car 390 ft. (119 m) from the intersection could not be seen even from a height of 64 in. (1.63 m). (A height of 42 in. [1.07 m] is the standard height of a driver's eye used for ISD calculations[14] and was considered a conservative estimate of pedestrian height as well.) The car starts to become visible in position 2. The car traveling at 35 mph (56 kph), from position 2, arrives at the intersection in 6 seconds, consistent with the *Indiana Design Manual*[15] calculations for traditional ISD. Unfortunately, as the calculations below would indicate, the pedestrian would have insufficient time to cross the intersection.

However, in the *Indiana Design Manual*, which is based on American Association of State Highway and Transportation Officials (AASHTO) guidelines, the warrant analysis explicitly considers only the ability/safety of cars to cross the intersection. The question is whether pedestrians can safely cross the intersection under these conditions. It would take a pedestrian (assuming a walking speed of 3.5 ft. [1 m] per second) significantly longer to cross that intersection than a car. The true equivalent safe crossing for a pedestrian on a major pedestrian route should be based on the ability of a pedestrian to cross, with crossing time becoming the proper critical time gap (t_g) for the ISD calculation.

Pedestrian Crossing—Critical Time Gap

The intersection has a 44 ft. (13 m) crossing distance, and calculations suggest a crossing time of ~12.5 seconds.* This time gap would suggest that the proper ISD should be as follows using the calculations from the *Indiana Design Manual 46-10*,[17] "[F]or other conditions, the time gap should be adjusted and the required ISD recalculated using the formula:

$$ISD = 1.47\ V_{major}\ t_g\ (English)\quad ISD = 0.278\ V_{major}\ t_g\ (Metric)$$

Where t_g is the time gap in seconds, V_{major} the speed (mph, kph) of the major road and ISD (ft., m), the intersection sight distance (the value to determine). This formula yields an ISD of 640 ft. (195 m) for a 44 ft. (13 m) crossing distance."

Thus, the intersection is not controlled

**This suggestion does not include the decision time to cross, or "gap acceptance," normally allocated for a car whose driver must engage the accelerator after having come to a complete stop. The reaction time of a walker to make a decision and start walking is less, so this study will conservatively assume that it will not add a significant amount to crossing time. A more in-depth study of these factors is recommended.*

properly for pedestrian crossing based on ISD. Recommended additions to the ISD Table in the *Indiana Design Manual* (IDM fig. 46-10G)[17] that could account for pedestrians at this type of intersection are shown in the table above as an example.

Pedestrian Crossing Gap Size

A second pedestrian warrant to determine whether pedestrians can safely cross this intersection, based on critical pedestrian time gap, involves the gap size or availability of time windows that allow pedestrians to cross. If the new ISD and its conditions are considered, the criterion for determining a safe crossing gap size is not met. For instance, in the case of 56th and Central from 5 to 6 p.m., there are 408 vehicles per hour on Central, the current major street, traveling at 35 mph (56 kph). Even if it is assumed that the minimum automotive-based ISD of 390 ft. (119 m) is valid, it would take 7.8 seconds for a car to get from that visible point to the intersection and on average there are 8.8 seconds between cars during that hour. Whereas automobiles can negotiate the crossing in fewer than 7 seconds,[17] a pedestrian, as asserted earlier, would require a time gap (t_g) of 12.5 seconds. It would thus be rare to have a safe crossing window for a pedestrian. ■

Editor's Note: Reference numbers refer to the full paper, which can be viewed by visiting the ITE Community at http://bit.ly/14c7YK8.

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