TEXAS SOUTHERN UNIVERSITY

Project Summary Report 0-4273-S
Project 0-4273: Yellow and Red Intervals to Improve Signal Timing Plans for Left-Turn Movement

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PROJECT SUMMARY REPORT

Summary Report on Yellow and Red Intervals to Improve Signal Timing Plans for Left-Turn Movement

Signal intervals have long been used at intersections for clearing one traffic movement before allowing another conflicting movement to proceed. Among the signal intervals, a yellow change interval, the yellow signal period, is adopted for a driver approaching the intersection to make the decision to either stop or proceed into the intersection after the green signal turns to yellow. A red clearance interval, the all red signal period, is used to clear the intersection before the green signal for the conflicting traffic movement starts.

For the left-turn movement, shown in Figure 1, the determination of the yellow change and red clearance intervals is more complicated than for the through movement. However, the yellow change and red clearance intervals for left-turn movements are not yet fully understood in either theory or practice. In practice, the yellow change and red clearance intervals for the through movement are simply used for the left-turn movement. The lack of an appropriate method for determining the left-turn yellow change and red clearance intervals may result in inappropriate signal timings, which are either unsafe for left-turn vehicles or inefficient for the intersection.

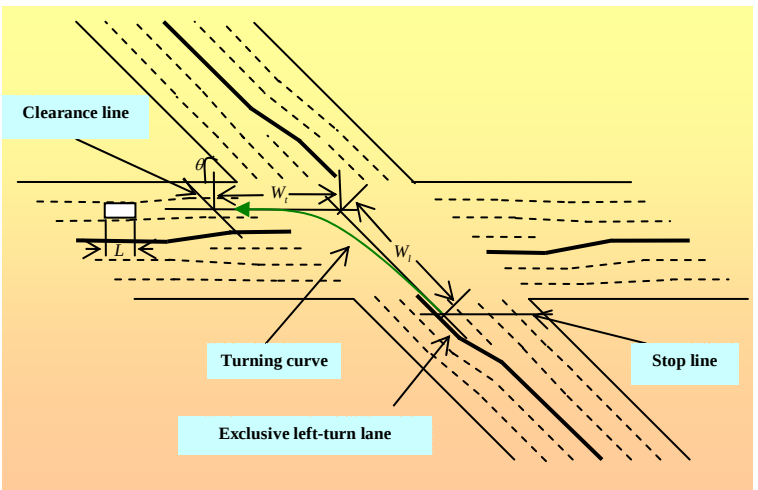

FIGURE 1 A Schematic Drawing of the Left-Turn Movement at a Signal-Controlled Intersection.

What We Did…

In this research project, we (1) prioritized the parameters potentially affecting the yellow change and red clearance intervals for the left-turn movement; (2) established the framework; (3) developed the approach to calibrate the parameters in the framework; and (4) conducted field tests at 21 intersections in Texas.

Prioritized parameters potentially affecting the yellow change and red clearance intervals

A survey of transportation engineers, researchers, and executives was conducted to identify

and prioritize the parameters that potentially affect the yellow change and red clearance intervals for the left-turn movement. A review of the top 10 prioritized factors reveals that the number one concern was related to accidents. Others include geometric design, visibility and impeding factors, speed, traffic laws, perception-reaction time, and signal phasing.

Established the framework determining the yellow change and red clearance intervals

Based on the survey, a framework was proposed, which was designed to incorporate a comprehensive set of factors related to the determination of the change intervals for the left-turn movement.

Figure 2 and Figure 3 describe the framework for determining the yellow change and red clearance intervals, respectively. From these two figures it is shown that many parameters are taken into consideration in the developed framework.

Developed the approaches calibrating the parameters of the proposed framework

Calibration of the framework was developed as well. The purpose was to ensure that the results from the framework be consistent with the field observations. The first step was to conduct a preliminary calibration to the parameters and calculate the change intervals for the surveyed intersections. The second step was to further calibrate the framework to extend the results to any target intersections.

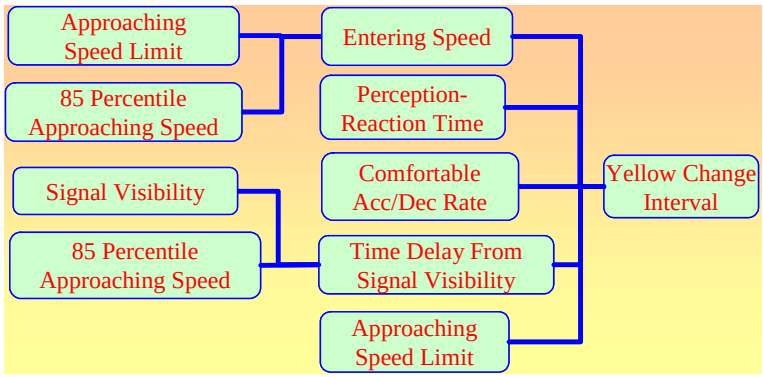

FIGURE 2 Description of Framework for Yellow Change Interval.

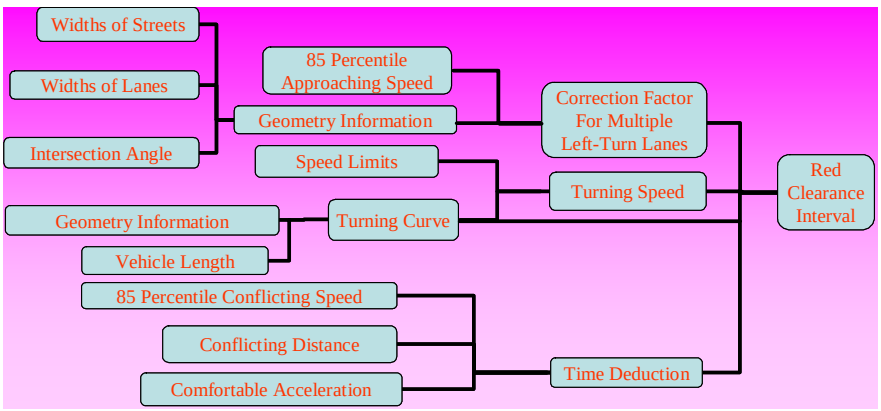

FIGURE 3 Description of Framework for Red Clearance Interval.

Conducted field tests at 21 intersections in Texas

In order to compare the calculated versus observed yellow change and red clearance intervals, field tests were conducted at 21 Texas intersections. Comparison results were used to examine the effectiveness of the proposed framework. Historical accident data from these intersections were used to identify the problem intersections for further examination.

What We Found…

Existing yellow change intervals for left-turn movements are longer than those calculated

By comparing the calculated yellow change intervals from the framework with the existing intervals at the 21 surveyed intersections, it is found that the existing yellow change intervals are longer than those calculated. The dashed and solid blue lines in Figure 4 show this kind of comparison.

Existing red clearance intervals for left-turn movements are shorter than those calculated

Also plotted in Figure 4 are the existing red clearance intervals (dashed red line) and the calculated red clearances (solid red line) for the 21 Texas intersections. For most of the intersections, the existing red clearance intervals are shorter than those calculated.

Existing total change intervals are close to those calculated

Although the existing yellow change and red clearance intervals are different from the calculated intervals, the existing total change intervals for the 21 Texas intersections are close to the calculated total change intervals. These are shown as the dashed and solid green lines in Figure 4.

This fact implies that the adjustment of yellow change and red clearance intervals by the proposed framework will not reduce the total green time, and thus will not decrease the efficiency of the intersection.

The Researchers Recommend

The researchers recommend further testing and implementation of the proposed framework. Table 1 summarizes the calibration results for a wide range of intersection configurations.

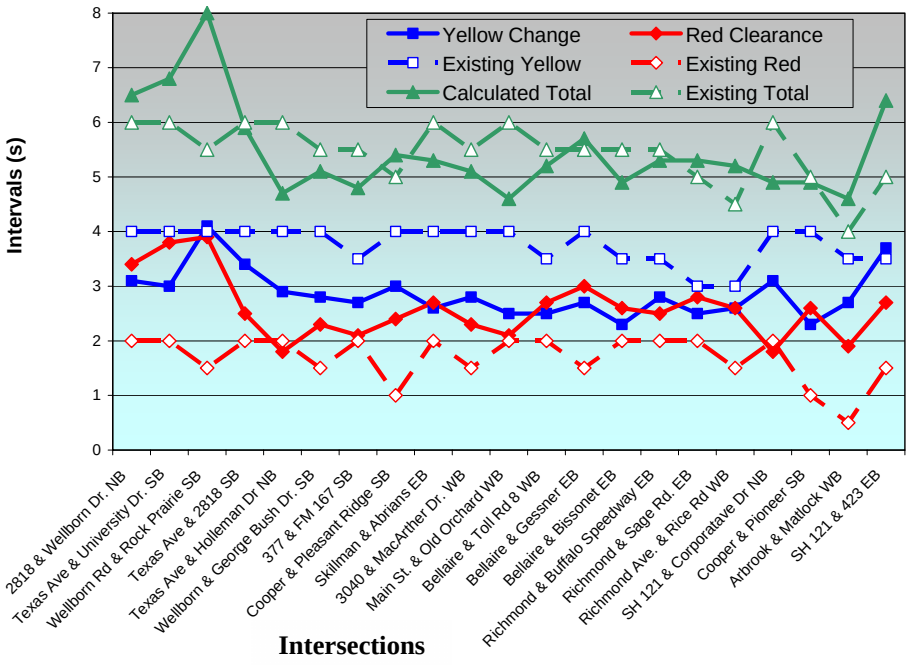

FIGURE 4 Comparison of Calculated and Existing Yellow Change and Red Clearance Intervals.

Approach Speed	No of Lanes		Depth							
			70ft		90ft		110ft		130ft	
			Yellow	Red	Yellow	Red	Yellow	Red	Yellow	Red
30	1	PT	3.0	2.2	3.0	2.9	3.0	3.6	3.0	4.3
		PM	3.0	2.2	3.0	2.8	3.0	3.5	3.0	4.2
	2	PT	3.0	2.5	3.0	3.2	3.0	3.9	3.0	4.6
		PM	3.0	2.4	3.0	3.1	3.0	3.8	3.0	4.5
40	1	PT	3.0	2.4	3.0	2.9	3.0	3.6	3.0	4.3
		PM	3.0	2.6	3.0	2.8	3.0	3.5	3.0	4.2
	2	PT	3.0	2.6	3.0	3.2	3.0	3.9	3.0	4.6
		PM	3.0	2.8	3.0	3.1	3.0	3.8	3.0	4.5
50	1	PT	3.0	2.9	3.0	3.1	3.0	3.6	3.0	4.3
		PM	3.0	3.1	3.0	3.3	3.0	3.5	3.0	4.2
	2	PT	3.0	3.1	3.0	3.2	3.0	3.9	3.0	4.6
		PM	3.0	3.3	3.0	3.5	3.0	3.8	3.0	4.5
55 or above	1	PT	3.0	3.1	3.0	3.3	3.0	3.6	3.0	4.3
		PM	3.4	3.5	3.3	3.7	3.3	3.9	3.2	4.2
	2	PT	3.3	3.5	3.2	3.6	3.1	3.8	3.1	4.5
		PM	3.4	3.7	3.3	3.8	3.2	4.0	3.2	4.2

Note: for trucks, yellow change remains same, red clearance increases 0.1s for 5%-10% trucks in the traffic; 0.3 for 10%-15% trucks; 0.4s for 15%-20% trucks; and 0.5s for 20% or above trucks.
PT: Protected; PM: Protected/Permitted

TABLE 1 Recommended Intervals for Right Angle Intersections.

For More Details . . .

This research is documented in reports 0-4273-1 and 0-4273-2, *Yellow and Red Intervals to Improve Signal Timing Plans for Left-Turn Movement*

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To obtain copies of a report: CTR Library, Center for Transportation Research, (512) 232-3138, email: ctrlib@uts.cc.utexas.edu

TxDOT Implementation Status — June 2004

The objective of this research project was to develop a comprehensive framework for determining the yellow change and red clearance intervals for left-turn movements at intersections with various geometric configurations and protected/permissive signal phases. One product was required for this project – a Guidebook containing guidelines for determining yellow changes and red clearance intervals for left-turn movement. The Guidebook will help facilitate the implementation of the proposed framework on Texas highways at signalized intersections with left-turn phases.

For more information, contact Mr. Wade Odell, P.E., RTI Research Engineer, at (512) 465-7403 or e-mail wodell@dot.state.tx.us.

Your Involvement Is Welcome!

TTI0501.0405.525 TSU PSR 0-4273-S

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