

Yellow light dilemma zone researches: a review

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Abstract: The yellow light dilemma zone is widely known as an area on the high-speed intersection approach, where vehicles neither safely stop before the stop line nor proceed through the intersection during amber interval. Within such an area, a vehicle might be involved in a right-angle crash or rear-end collision. This issue has been extensively discussed over five decades in traffic engineering field, covering from theory to practice. However, few comprehensive review literatures on the amber signal dilemma zone problems can be found. The objective of this paper is to summarize the evolution of yellow light dilemma zone researches. Basic definition and boundary of dilemma zone followed by driver behavior and dilemma zone hazard measurement are depicted. At last, the future directions of yellow light dilemma zone research are discussed.

Key words: yellow light; dilemma zone; driver behavior; signalized intersection

1 Introduction

When a yellow light is on at high-speed signalized intersections (i. e., posted speed limit is 60 km/h or greater), one important question for drivers is the decision to go or stop. There is a zone, known as dilemma zone, on the intersection approach, where vehicles at the onset of yellow phase neither safely stop before the stop line nor proceed through the intersection by the start of red light. Within dilemma zone, a decision to pass through the intersection might result

in a right-angle crash, whereas a decision to stop might produce a rear-end collision. Such dangerous area has attracted lots of attentions of traffic safety researchers since 1960. A substantial number of studies have been conducted to figure out the best way to prevent approaching vehicles from being trapped in dilemma zone.

Liu et al. (1996) discussed the setting of a yellow light duration based on the GHM model so as to eliminate the dilemma zones. They also reviewed the existed various ways to determine the yellow light inter-

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val. Most recently, Li et al. (2013) briefly introduced the notion of yellow light dilemma zone and explained why such a zone existed in reality. However, these two aforementioned studies did not provide a full description of research status and progress of yellow light dilemma zone over the years. The intent of this paper is therefore to present a comprehensive review of yellow light dilemma zone related investigations and practices, highlighting the advances on this topic and identifying future research directions.

2 Definition and boundary of dilemma zone

2.1 Definition of dilemma zone

Urbanik and Koonce (2007) termed dilemma zone as type I dilemma zone defined by Gazis et al. (1960) and type II dilemma zone identified in a technical committee report produced by Southern Section of ITE (Parsonson 1974). Based on GHM model, type I dilemma zone is defined as a zone within neither stopping safely nor proceeding the intersection before the end of yellow indication (Gazis et al. 1960), which is shown in Fig. 1.

In Fig. 1, X_c is the minimum distance from the stop line, a vehicle can safely stop before the stop line; X_0 is the maximum distance from the stop line, a vehicle can cross and clear the intersection by the end of

yellow signal. According to GHM model, X_c and X_0 are expressed as follows, respectively (Gazis et al. 1960)

$$X_c = v_0 \delta_1 + \frac{v_0^2}{2a_1} \quad (1)$$

$$X_0 = v_0 \tau + 0.5 a_2 (\tau - \delta_2)^2 - W - L \quad (2)$$

where v_0 is approaching vehicle's speed (ft/s); δ_1 and δ_2 are driver's perception reaction time for stopping and crossing (s), respectively; a_1 and a_2 are the maximum vehicle's deceleration and acceleration rates (ft/s²), respectively; τ is yellow signal duration (s); W is intersection width (ft); L is vehicle length (ft).

When $X_c > X_0$, the zone between X_c and X_0 is type I dilemma zone, as shown in Fig. 1. When $X_c < X_0$, the zone between X_c and X_0 is termed as option zone (Fig. 1). A vehicle within option zone can either pass through the intersection or stop before the stop line at the onset of yellow indication.

In 1974, a technical committee report produced by Southern Section of ITE formally identified the type II dilemma zone (Parsonson 1974), as shown in Fig. 2. The type II dilemma zone is actually an option zone (Parsonson 1992), where the drivers decide whether to stop or go. This option zone is therefore regarded as "decision zone" or "indecision zone", because the driver may experience indecisiveness upon seeing the yellow indication (Parsonson 1992; Gates et al. 2007; Li 2011).

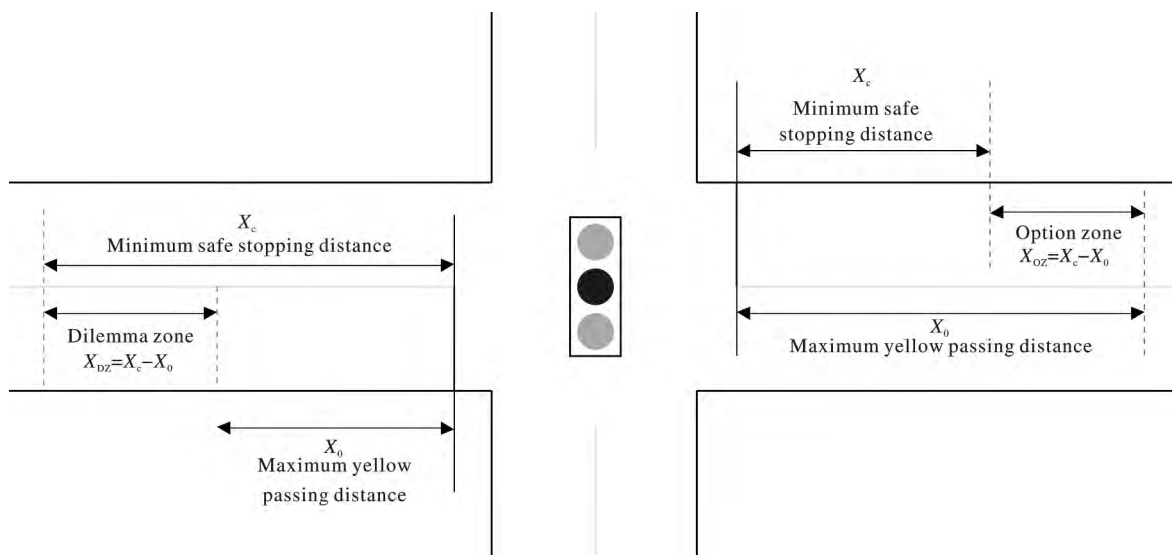


Fig. 1 Formation of type I dilemma zone

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