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Research article

Safety impact of application of auxiliary lanes at downstream locations of Thai U-turns☆

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ABSTRACT

To assess the safety impact of auxiliary lanes at downstream locations of U-turns, the Traffic Conflict Technique was used. On the basis of the installed components at those locations, four types of U-turns were identified: those without any auxiliary lane, those with an acceleration lane, those with outer widening, and those with both an acceleration lane and outer widening.

The available crash data is unreliable, therefore to assess the level of road safety, Conflict Indexes were formulated to put more emphasis on severe crashes than on slight ones by using two types of weighting coefficients. The first coefficient was based on the subjective assessment of the seriousness of the conflict situation and the second was based on the relative speed and angle between conflicting streams.

A comparatively higher Conflict Index value represents a lower level of road safety. According to the results, a lower level of road safety occurs if two components apply or if a location is without any auxiliary lane. The highest level of road safety occurs if the layout includes only a single component, either an acceleration lane or outer widening.

1. Introduction

1.1. Road traffic crash trends in Thailand

Road traffic crashes in developing as well as emerging countries tend to be one of the major reasons for fatalities and disabilities. Middle-income countries, which are motorizing rapidly, are the hardest hit. The economic growth in Thailand has resulted in an expanding network of roads and an increased number of drivers. The growing number of vehicles on the road in turn has contributed to a significant increase in road crashes annually. In Thailand, the road traffic crash problem is regarded as one of the most serious social problems. There were 13,766 reported road traffic fatalities in Thailand in 2010, and the estimated GDP loss was approximately 3% due to road traffic crashes [1].

1.2. Road safety at median openings in Thailand

Median openings (including U-turns) are considered the most road traffic crash–prone locations after straight and curved sections of Thai highways, as illustrated in Fig. 1.

Charupa [3] stated that U-turns are frequently located near the entrances and exits of villages and towns. Often, the various types of U-turns confound unfamiliar drivers. In many areas, U-turns are situated close to each other in order to service local residents. However, in some areas, U-turns are located far from each other, causing illegal driving such as driving in the wrong direction to reach the closest U-turn point.

1.3. Function of U-turns on Thai highways

Median at-grade U-turns on divided Thai highways are provided for U-turning to allow drivers to join the traffic stream in the opposite direction. The basic functions of median at-grade U-turns on Thai highways are shown in Fig. 2. U-turns are also constructed to reduce the number of at-grade T- and X-junctions [to avoid direct right turns from highways onto minor roads and from minor roads to highways (for left-hand traffic)]. Other purposes to use U-turns include to reduce travel time for emergency services and to provide for efficient law enforcement and highway maintenance.

☆ Fully documented templates are available in the elsarticle package on CTAN.

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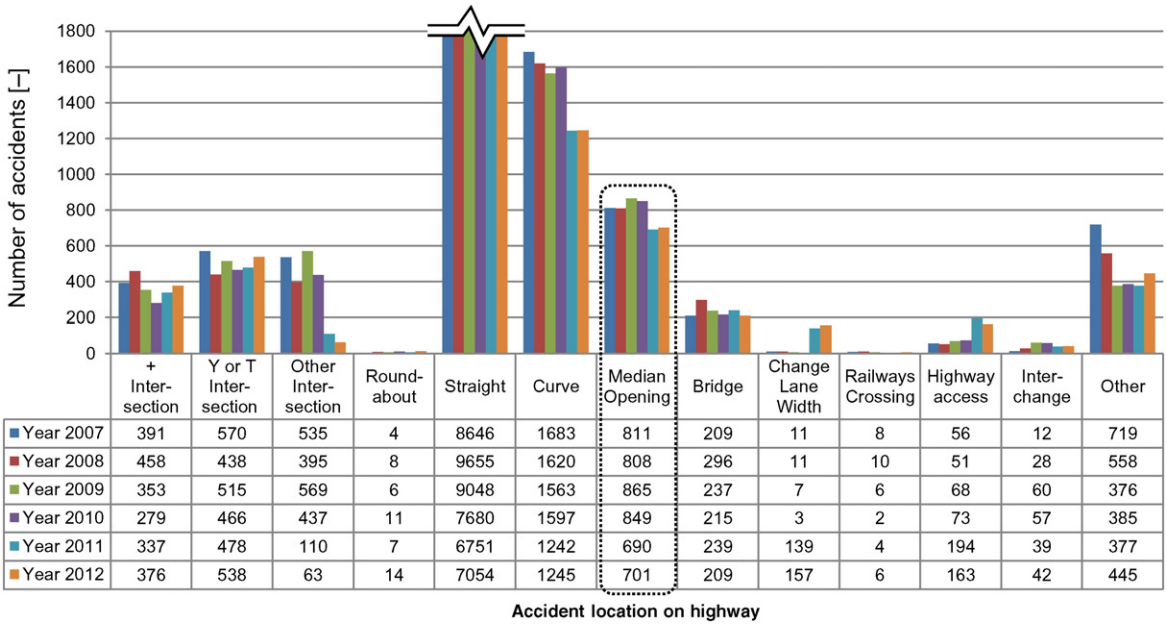

	+ Inter-section	Y or T Inter-section	Other Inter-section	Round-about	Straight	Curve	Median Opening	Bridge	Change Lane Width	Railways Crossing	Highway access	Inter-change	Other
Year 2007	391	570	535	4	8646	1683	811	209	11	8	56	12	719
Year 2008	458	438	395	8	9655	1620	808	296	11	10	51	28	558
Year 2009	353	515	569	6	9048	1563	865	237	7	6	68	60	376
Year 2010	279	466	437	11	7680	1597	849	215	3	2	73	57	385
Year 2011	337	478	110	7	6751	1242	690	239	139	4	194	39	377
Year 2012	376	538	63	14	7054	1245	701	209	157	6	163	42	445

Fig. 1. Crash frequency by location on Thai highways [2].

1.4. Interaction between U-turning and through-traffic streams

In theory, through-traffic should get priority over U-turn traffic all the time. However, midblock U-turn junctions interrupt the through-traffic movement. There are therefore interactions between through-traffic streams and U-turning traffic streams. After arriving at a mid-block median opening, the U-turning vehicle waits for a gap in the on-coming through-traffic stream large enough to complete the U-turn manoeuvre. As traffic volume increases on the through-traffic streams, the U-turning traffic has trouble finding a sufficient gap to enter the other side of the carriageway, and thus a queue is formed at the deceleration lane, which affects the through-traffic movement in the same direction and, as a result, drivers experience longer delays. The U-turning vehicles also affect through-traffic movement in the opposite direction when they merge. The U-turning vehicles often do not wait for an acceptable gap in the on-coming through-traffic. They gradually move onto the conflicting lane to show their intention to go. Through-traffic vehicles sometimes do not allow for a U-turn by increasing speed, changing lanes, honking the vehicle's horn, or flashing their headlights (visual equivalent of blowing the horn). Eventually, the through-traffic stops and allows the U-turn traffic to move. According to field observations at U-turn junctions, when the U-turn traffic is in a long queue or has waited for a long time, the drivers of U-turning vehicles tend to be more aggressive in making U-turns. At the same time, the conflicting through-traffic tends to be willing to stop and allow the U-turn traffic to go.

1.5. Design consistency of U-turns, road safety, and driver behaviour

Numerous layout design practises of U-turns are followed in Thailand. Some are standard (as per the design guidelines of the Department of Highways) and the remaining are non-standard (based on local design practise). The U-turn layout design varies with the application and dimensions of its components, such as auxiliary lanes (acceleration, deceleration, and loons). The length of these auxiliary lanes is not uniform at most U-turns. The shorter length of some of these auxiliary lanes does not provide enough space to make a comfortable lane change; this may result in safety problems in terms of weaving traffic and queue formation. The numerous types of U-turn layouts produce inconsistent design characteristics of the road infrastructure. For study purposes, U-turns were classified according to their layout components (acceleration lane and outer widening).

In practical terms, inner through-lanes of divided highways are used for passing; they are also dedicated to vehicles moving at high speeds. At U-turns, acceleration (merging) lanes and deceleration (diverging) lanes are provided along the inner lanes of divided highways. So,

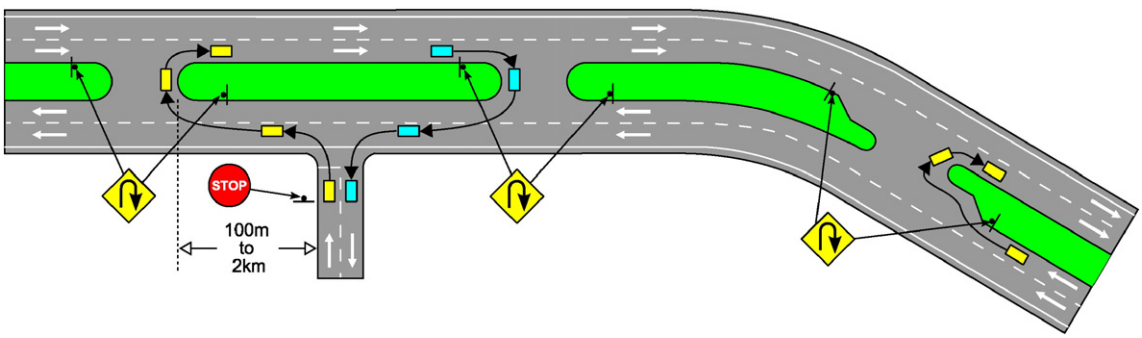

Fig. 2. Basic functions of median at-grade U-turns.