

EMPIRICAL ANALYSIS OF THE CHARACTERISTICS OF UNDISCIPLINED CROSSING PEDESTRIANS OVER MULTILANE ROADWAY OF URBAN STREETS

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Abstract: Although the number of pedestrian fatalities by road traffic accidents is declining, the percentage reduction is relatively low compared to a car accident in Japan. Therefore, the share of pedestrian related accidents has increased in recent years. Numbers of pedestrians are killed in traffic accidents when they cross the roadway outside the crosswalk; such behavior is so called as 'undisciplined crossing'. The installation of a median with crossing deterrent fences is believed to be the most effective measure to prevent such 'undisciplined crossing' in Japan. However, there is no technical guidelines or standards to install such median, to have opening of it, and to evaluate the effects of installation of such median quantitatively for serving as a measure used in cost-benefit analysis. In this study, a verification analysis was made as a basis for quantitatively determining the conditions under which people cross a road without using a crosswalk.

Keywords: Undisciplined Crossing Pedestrians, Arterial road of urban streets, characterization

1. INTRODUCTION

The percentage reduction of pedestrian fatalities is lower than that of vehicular fatalities, although the number of pedestrians killed in traffic accidents is declining. Recently, more pedestrians are being killed than vehicle occupants. Approximately 30% of pedestrian deaths in 2011 occurred when people violated crossing rules. In most such cases, pedestrians crossed the road without using a crosswalk.

To encourage pedestrians to use crosswalks, installing a fence in the center of the road to dissuade them from crossing the road in non-crosswalk areas is considered effective—even if the structure fails to meet the requirements for median strips.

The Large City Subcommittee of the Regional Traffic Safety Committee of the Japan Society of Traffic Engineers has been studying the question of guidelines to cover the installation and removal of traffic-safety devices including median strips. This study was conducted as part of the studies of the subcommittee, which is chaired by Prof. Hisashi Kubota of Saitama University.

First, we present the results of investigations into pedestrians crossing streets not using a crosswalk, called “undisciplined crossing,” one of the main causes of pedestrian accidents. Second, we present the results of the analysis of undisciplined crossing under hazardous conditions, focusing on vehicular movement, based on the investigation results. Finally, we

report the ongoing analysis.

2. OUTLINE OF INVESTIGATION

2.1 Investigation sections

Investigations were performed in two sections of roadways with different regional characteristics to identify undisciplined crossing on routes under different roadside and road conditions. The investigation sections are outlined in Table 1.

Table 1 Section outline

	Roadside condition	Road condition
Section (i)	Downtown housing area	Four-lane, two-way arterial road
Section (ii)	Commercial area	Six-lane, two-way arterial road

2.2 Investigation method

Video cameras were installed at high elevations from where a panoramic view of the investigation section could be obtained. The behavior of pedestrians who crossed the road and road traffic conditions at the time of crossing were monitored. The locations of the video cameras and their angles of view are shown in Figure 1.

In the areas that could not be monitored by the video cameras, researchers made visual verifications wherever possible.

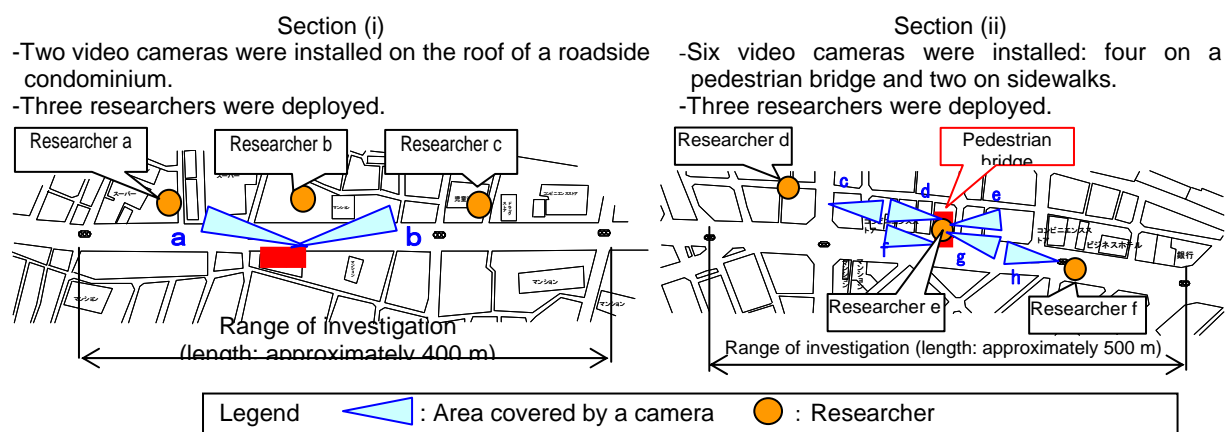


Figure 1. Locations of video cameras and angles of view

2.3 Investigation details

The following parameters were investigated.

- (i) Crossing of the road not using a crosswalk (number of pedestrians, locations, and routes)
- (ii) Traffic count (pedestrians, bicycles, and automobiles)
- (iii) Signal indication

3 Results of investigation

3.1 Section (i) Four-lane, two-way arterial road running through a downtown housing area

(1) Road traffic conditions

The four-lane, two-way arterial road runs through a downtown housing area. An analysis of a 400-m-long section with four intersections controlled by signals was conducted. The section has seven tributaries that are connected to the arterial road at intersections without signals.

Residences such as apartment blocks coexist with commercial facilities including a supermarket and convenience stores along the road. A railway station is located to the south of the section.

The traffic count during 12 hours in the daytime (7:00 through 19:00) on the day of the investigation included 25,904 automobiles, 2,752 bicycles, and 1,163 pedestrians. Large vehicles accounted for 16.1%.

(2) Crossing without using a crosswalk

A total of 1,313 people crossed the road without using a crosswalk during the 15-hour period between 7:00 and 22:00. This included 689 pedestrians, 603 bicyclists, and 21 non-classified subjects. The percentage of people aged 60 or older was estimated to be approximately 30% based on external observation, higher than in that in Section (ii) (Figure 2). The number of pedestrians who did not use a crosswalk peaked between 7:00 and 17:00. However, the peak ratio was lower than that in Section (ii) (Figure 3). This may be because there were pedestrians around throughout the day, as the road is in a downtown housing area.

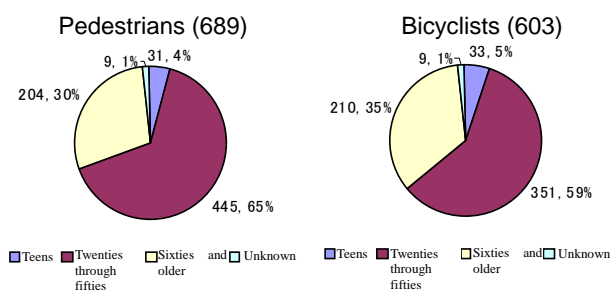


Figure 2—Number of pedestrians and bicyclists not using a crosswalk by age group

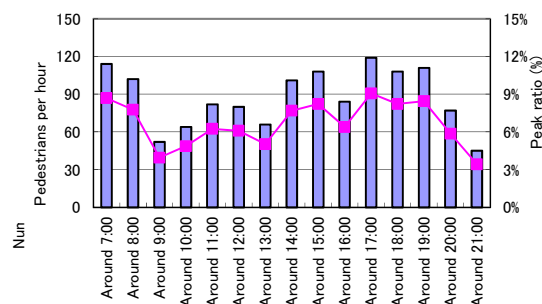


Figure 3—Number of people crossing without using a crosswalk by time of day

(3) Routes taken while crossing without using a crosswalk

The routes taken by people crossing the road in non-crosswalk areas are shown by time of day in Figure 4. The routes taken while they were within the angle of view of a video camera were recorded for 15-minute periods in the morning, afternoon, and evening.

In any period, people frequently crossed the road at right angles to the road alignment. Hence, the crossing distance was relatively short.

In the morning, people crossed from one tributary to another on numerous occasions. Most moved toward the station and were considered to be commuters.

In the afternoon, many headed for the supermarket. In the evening, people behaved as they did either in the morning or in the afternoon. However, the direction in which more

people moved from one tributary to another across the road was reversed, with people moving from the station to their home including commuters.

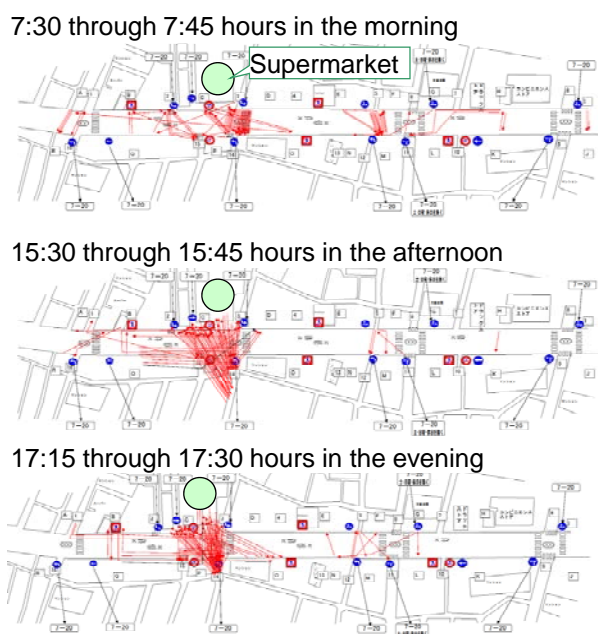


Figure 4. Routes of crossing the road without using a crosswalk by time zone

(4) Occurrence of accident-causing incidents due to crossing without using a crosswalk

Accident-causing incidents were visually monitored in the 15-minute periods in the morning, afternoon, and evening, as mentioned in (3) above. These incidents are defined as events that include the risk of the paths of a person crossing the road and of a vehicle traveling along the road colliding. Judging from the disaster-averting behavior of vehicles and people crossing the road, both were assumed to be close to each other for 10 seconds or less.

Four accident-causing incidents were confirmed out of 224 cases of undisciplined crossing. In three incidents, the pedestrians crossed the road near a vehicle or near a vehicle in front of a line of vehicles. The vehicles were traveling at a relatively high speed. In another incident, the pedestrian was close to a bicycle traveling along the driveway.

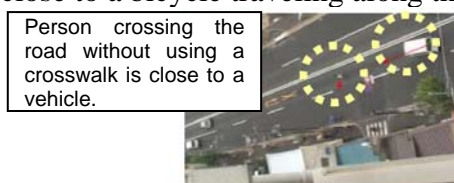


Figure 5. Incident likely to cause an accident (example)

The traffic signal indications when people crossed the road are listed in Table 2. The table lists the signal indications upstream of the lane that was closest to the person who crossed the road without using a crosswalk. In 221 out of the 224 cases of undisciplined crossing, the person crossed the road when the upstream signal turned red. In most cases, there were no vehicles traveling from upstream. People tended to cross the road in front of the vehicles that had stopped at the traffic signal. Thus, there was marginal danger.

investigation included 31,483 automobiles, 2,520 bicycles, and 3,485 pedestrians. Large vehicles accounted for 11.7%.

(2) Crossing without using a crosswalk

A total of 772 people crossed the road without using a crosswalk during the 15-hour period between 7:00 and 22:00; this number included 381 pedestrians and 391 bicyclists. The percentage of people in their 20s through 50s was nearly 90% based on external observation. The percentage of people aged 60 or older was 4%, lower than in that in Section (i) (Figure 7). More people crossed the road without using a crosswalk around 8:00, 12:00, and 19:00 than at any other time of the day (Figure 8). This may be because people crossed the road without using a crosswalk during commuting time or break, as the road is in a commercial area.

People frequently crossed the road to visit roadside stores. Some people parked their vehicles on one side of the road and visited a store on the other side of the road. Numerous bicyclists crossed the large intersection on the west side of the study section.

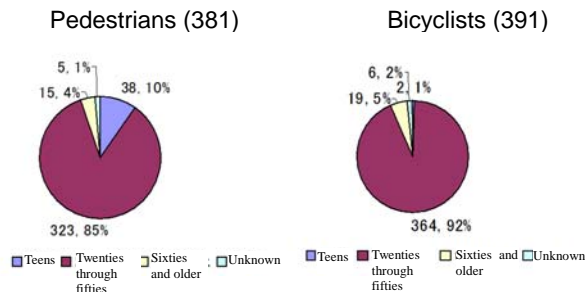


Figure 7. Number of pedestrians and bicycle users not using a crosswalk by age bracket

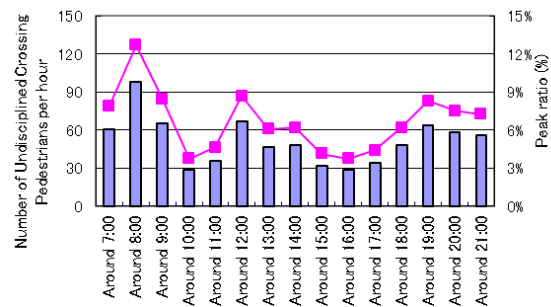


Figure 8. Number of people crossing without using a crosswalk by time zone

(3) Routes taken while crossing without using a crosswalk

The routes taken by people crossing the road in a non-crosswalk area are shown by time of day in Figure 9. The routes taken while they were in the angle of view of a video camera were recorded in a 15-minute period each in the morning, afternoon, and evening.

The largest number of people crossed the road without using a crosswalk in the morning. People frequently crossed the road diagonally to the road alignment regardless of the time of day. Hence, the crossing distance was relatively long.

In the morning, numerous people crossed an offset intersection from one tributary to another. In the afternoon, numerous people headed for a tributary. In the evening, people behaved as they did either in the morning or in the afternoon. However, the direction in which more

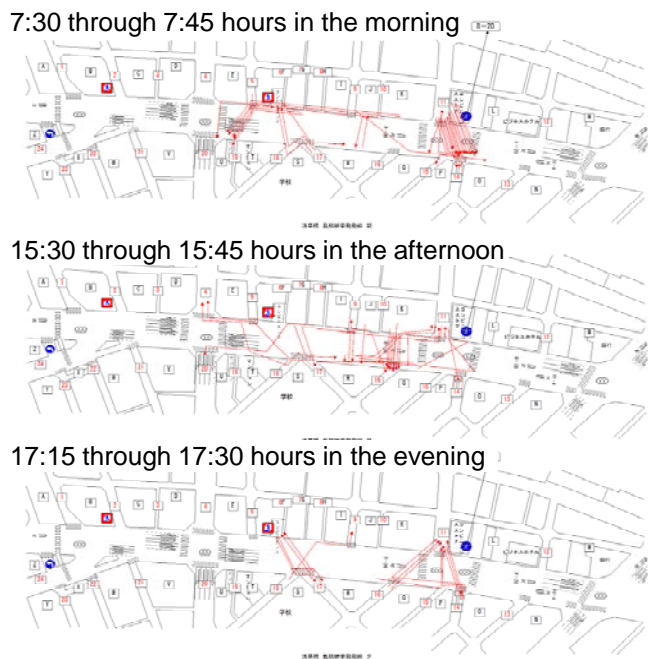


Figure 9. Routes of crossing the road without using a crosswalk by time zone

people crossed the offset intersection was reversed.

(4) Occurrence of accident-causing incidents caused by not using a crosswalk

Accident-causing incidents were visually monitored in the 15-minute periods in the morning, afternoon, and evening, as discussed in (3) above. Fourteen accident-causing incidents were confirmed out of the 65 cases of undisciplined crossing. Pedestrians crossed the road while vehicles were passing or temporarily stood waiting in the zebra zone in the center of the road and waited for the moment to cross (Figure 10).



Figure 10. Incident likely to cause an accident (example)

Approximately 80% of pedestrians crossed the road when the upstream traffic signal turned red (Table 3). More pedestrians crossed the road irrespective of signal indications than that observed in Section (i).

Table 3 – Signal indications when a person crosses the road without using a crosswalk
Signal indication while crossing the road Number of people/vehicle during 15-minute period

Time zone	Red	Red/green	Green	Green /yellow/red	Yellow/red	Right red arrow	Total
Morning	25	2	1	1		1	30
Afternoon	20	1	1				22
Evening	8				2	3	13
Total	53	3	2	1	2	4	65

(5) Risk assessment of undisciplined crossing with focus on vehicular arrival pattern

The traffic counts on the main road in the time period during which more people crossed without using a crosswalk than in any other time period are shown in Figure 11. Out of the 785 vehicles in the 15-minute period in the study section, approximately 30% entered from tributaries, unlike in Section (i), which had few entries from tributaries.

Vehicles arrived in the section where people frequently crossed the road without using a crosswalk even when the upstream traffic signal was red, because numerous vehicles entered from tributaries. Hence, there occurred a small gap. Thus, more people crossed the road under hazardous conditions than in Section (i).

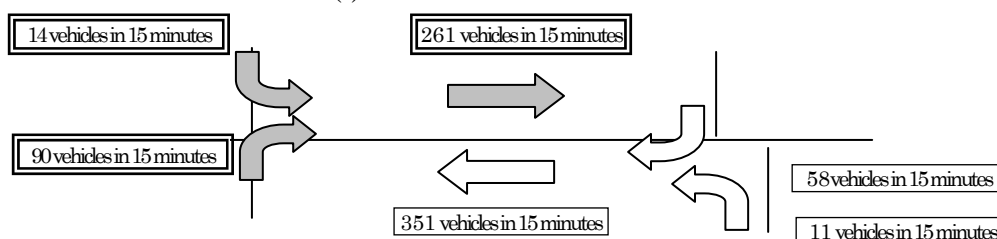


Figure 11 – Traffic counts on the main road

Time-series data on the pattern of vehicular arrival and the timing of crossing without using a crosswalk in cross sections in which people frequently cross without using a crosswalk is shown in Figure 12. Figures 12-a and -b show the data at the times of the day with heavy and light automobile traffic volumes, respectively. Periods exist regardless of the time of the day in which no vehicle arrives. People crossing the road without using a crosswalk take the timing. In this section in particular, people crossed the road after a group of vehicles passed.

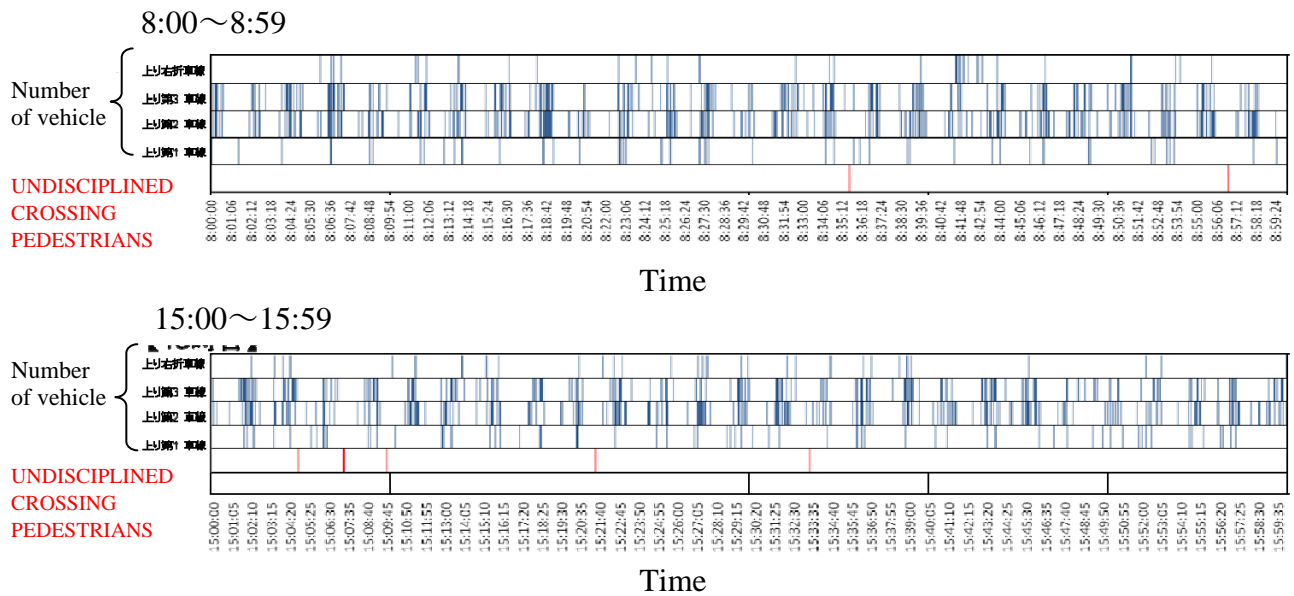


Figure 12 Pattern of vehicular arrival and crossing of the road without using a crosswalk

In order to quantify the period with no vehicular arrival, a distribution of headways was organized (Figure 13). It is evident that people crossed the road without using a crosswalk when the headway was ten seconds or longer. It was also found that the frequency of timing of crossing the road without using a crosswalk relatively safely depended on the traffic volume level. A few people crossed the road without using a crosswalk even when the headway was short, causing accident-causing incidents. Accident-causing incidents here mean the incidents with a possibility of the paths of a person crossing the road and of a vehicle crossing each other. Judging from the disaster averting behavior of the vehicle and people crossing the road, both were assumed to be close to each other for ten seconds or less.

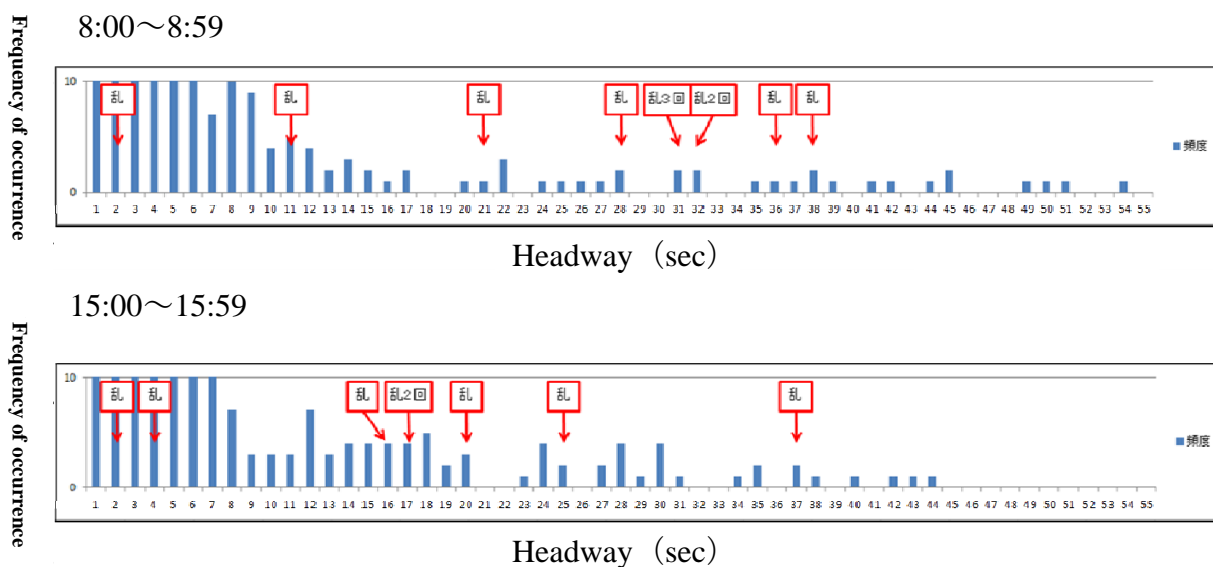


Figure13 Distribution of headways

4. Conclusion remark

Modeling the people’s behavior of crossing a road without using a crosswalk is expected to help explain the locations where people can easily cross the road without using a crosswalk and the conditions for preventing people from crossing the road without using a crosswalk. If the conditions have been identified, it will become possible to propose appropriate locations where intersections and new facilities for crossing the road including two-step crosswalks should be placed.

In the sections near a signalized intersection in urban areas, “myakuryu”, or the flow in which the volume changes periodically, occurs and “gaps” occur in which no vehicle exists on the road. People cross the road without using a crosswalk using the “gap”. If it is assumed that “gaps” occur when the headway is ten seconds or longer, people cross the road without using a crosswalk under the same condition. People cross the road without using a crosswalk in approximately 20 % of the “gaps”. People cross the road without using a crosswalk in other locations than gaps in 3 cases. In these cases, accident-causing incidents occur.

The frequency with which “gaps” occur is nearly the same regardless of the number of people crossing the road without using a crosswalk. The number of people is governed by demand. There is no correlation between the traffic volume and the number of people crossing the road without using a crosswalk in any time zone on the day of investigation. The period of occurrence of “gaps” is approximately 120 seconds. People cross the road without using a crosswalk in the case where the period is shorter than the time lost in getting around the location.

5. Closing remark

In this study, the characteristics of the crossing of roads by pedestrians without using a crosswalk were investigated at two sites under different roadside and road conditions, and the observed hazardous incidents were analyzed. As a result of the investigations, the attributes of people crossing the road without using a crosswalk, locations at which people crossed the

road, routes that people took, and hazardous incidents were identified.

The percentage of hazardous incidents (accident-causing incidents) was approximately 2%, relatively low, in Section (i), although there were many cases of undisciplined crossing, and people crossed the road relatively safely. On the other hand, in Section (ii), the percentage of hazardous incidents was approximately 20%, higher than that in Section (i).

In Section (i), lines of vehicles are formed at traffic lights, and a large gap is easily created. Thus, people can cross the road somewhat easily, and the risk is low. People crossed the road at right angles to the road alignment and exclusively at certain points.

In Section (i), numerous elderly people cross the road without using a crosswalk, and the risk of accidents was high in the view of the behavior of the aged to avoid danger, although hazardous incidents occurred infrequently. Measures such as encouraging crossing at limited points and planning the timing of crossing the road will be discussed, and future policy measures and installation of median strips will be examined in a later study.

In Section (ii), the percentage of undisciplined crossing was high, and people frequently crossed the road diagonally over a long distance. The mechanism of deciding to cross the road without using a crosswalk—even under hazardous conditions, the relationship between the structure of consciousness and road environment, and the disadvantage of preventing people from crossing by installing a median strip and the effects on roadside pedestrians will be analyzed in a later paper.

6. REFERENCES

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