Analysis of the bicycle space to avoid crossing conflict between bicycles and vehicles at the small intersection

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1 Introduction

Recently bicycles are getting more common by having eco-friendly advantages in many developed countries. However, traffic accidents related to bicycle are increasing in Japan. The number of traffic accidents between bicycles and pedestrians is increasing up to 4 times in the past 10 years. And traffic accidents between bicycles and vehicles remain in high counts. There are many opinions that the problem might come from the usage of pedestrian road, and so on. In Japan, many bicycles could run in the pedestrian road. There are a few bicycles that run in the roadway. Therefore, it is important to install the effective countermeasures, and needed to reconsider the road spaces for bicycles. Aim of this study is to propose the design of pedestrian road for bicycle from the safety point of view.

In order to understand the spatial characteristics of the black spots of bicycle accidents, accident data of municipal police in Akita, that population is almost 300 thousands, was collected and analyzed. Based on the bicycle related accident data for 3 years, 46 black spots were selected for the study. By the result of the survey for each black spot, characteristics were summarized into 3 categories, such as inflow to the arterial roads with the smaller intersection (21), right-turn situation at the signalized intersection (21), and entrance of parking lot (4). It is able to understand that inflow to the arterial road shares almost half. Traffic accidents of the categories "right-turn situation at the signalized intersection" and "entrance of parking lot" are influenced by the traffic volume. However, there exist many traffic accidents at the inflow to the arterial road at the situation of the low traffic volume from the smaller road.

2 Modeling the risk at the intersection

In order to evaluate the risk at the intersection, risk rate was defined as the probability of accident occurrence between bicycles and motor vehicles, and risk rate was evaluated for intersection. Percentage that the driver could not stop at the conflict point after recognizing the other subjects and making a sudden brake for both bicycle and motor vehicle was used to evaluate the risk ratio. Risk ratio (D) would be evaluated by multiplying these two percentages (Figure 1). P_b shows the percentages that bicycle could not be stopped with remaining certain spaces in front of the conflict point, and P_c shows the percentages that motor vehicle could not be stopped with remaining certain spaces in front of the conflict point. According to the running path of the bicycle, conflict point is classified into 3 parts ("building path", "center path" and "roadway path").

$$D = P_b \times P_c$$

D : *risk rate*

P_b : *percentage of impossibility to stop in front of the conflict point (bicycle)*

P_c : *percentage of impossibility to stop in front of the conflict point (motorcar)*

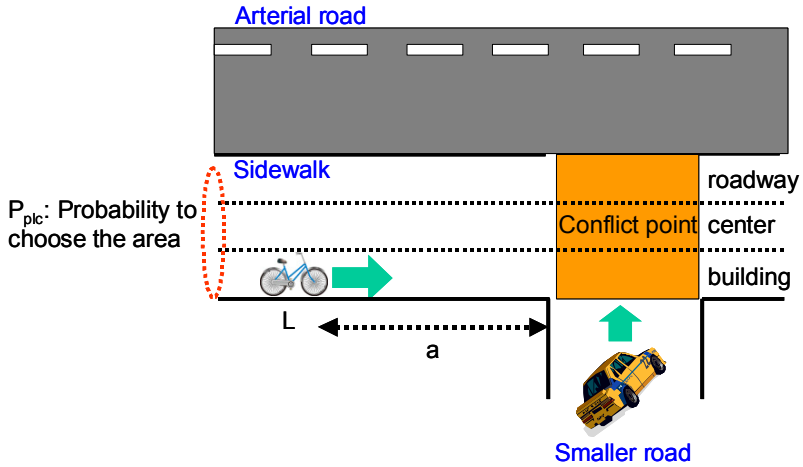

Figure 1 Spatial features of the intersection

P_b in each conflict point is evaluated by multiplying the probability (P_{plc}) to choose the running path and the probability (P_{ns}) of impossibility to stop in front of the conflict point through the distribution of the travel speed of the bicycle at each point (Figure 2). P_{ns} could be calculated every 1 meter from the conflict point.

$$P_b = P_{plc} \times P_{ns}$$

P_{plc} : *probability to choose the area*

P_{ns} : *impossibility to stop in front of the conflict point*

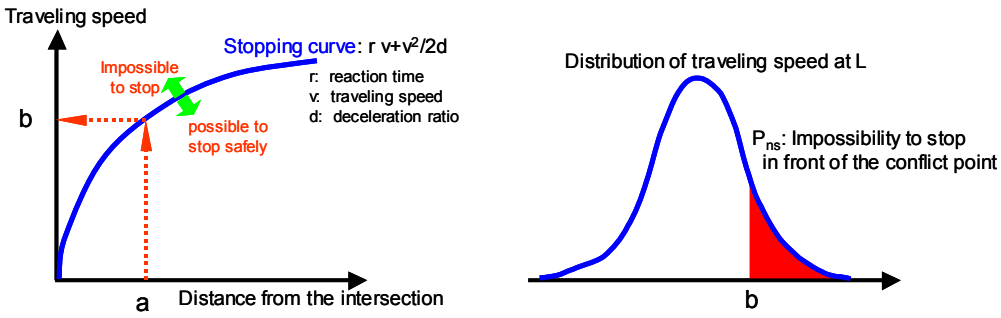

Figure 2 Concept to calculate the risk rate

P_c could be evaluated by utilizing the same concept as calculating P_b. In calculating P_c, distribution of the travel speed of motor vehicle and distribution of the stopped position of motor vehicle at the intersection were used to show the risk of traffic accident.

3 Evaluation of the risk

Results of the risk analysis shows that the risk is higher in the "building path" and lower in the "roadway path". Furthermore, there exists a risk less than 5 meters away from the conflict point and there exists fewer risks in the "roadway path". The reason of this result might come from the higher travel speed of bicycle and the conscious mind to stop closely to the conflict point. From the result of risk evaluation, it could be understood that higher travel speed and worse running path of the bicycle might be the cause of traffic accident from the viewpoint of bicycle. Therefore, the effect of countermeasure is analyzed as how does the risk rate would be decreased if the moving behavior of the bicycle is controlled for several cases.

3.1 Effect of decreasing the traveling speed of the bicycle

Higher travel speed of the bicycle is focused as the countermeasure to decrease the risk of traffic accident. Effect of decreasing the travel speed of the bicycle is analyzed. As a result, risk rate of decreasing 5km/h for all bicycles was calculated. This means that all bicycle should decrease their speed up to 2/3, because average travel speed of bicycle is about 15km/h. From this results, it could be understood that the effect of decreasing the travel speed of bicycle is large, and installing this countermeasure would contribute to decrease the risk of traffic accident.

3.2 Effect of controlling the running path of the bicycle

Controlling the running path of the bicycle is focused as the countermeasure to decrease the risk of traffic accident, because there exists higher risk in the "building path". Therefore,

changing the bicycle route to the "roadway path" could be one countermeasure to decrease the risk. Risk rate with changing the bicycle route to run the "roadway path" at the position of 4 meters away from the conflict point was calculated. In this situation, it is assumed that all bicycles must take "roadway path" whenever the bicycle approach to the conflict point. From this results, it could be understood that the risk rate is significantly decreased.

3.3 Desirable countermeasure

In order to compare the effect of countermeasures shown in the former section, risk rate is summarized as representative value that is a total of each risk rate in the all field of calculated area. By comparing the risk rate, it is easily understood that changing the route of the bicycle could decrease the risk more than 90 percent, while decreasing the travel speed of the bicycle could decrease the risk about 40 percent. Therefore, by taking countermeasures to control the path of the bicycle route could be most effective for decreasing the risk of traffic accident, and it is important to install the countermeasure to change the bicycle route at this situation.

In installing the countermeasure, making the relatively higher grade level to the edge of intersection in the "building path" might be effective to control the route of bicycle. There is higher grade level in "building path" and lower grade level in "roadway path". Bicyclists tend to dislike the bump in moving. Therefore, by installing this countermeasure, bicycle would naturally take the "roadway path" in passing through the intersection. This could be considered to avoid the traffic accident between bicycle and motor vehicle.

References

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