6th Annual International Cycling Safety Conference
21-22 September 2017, Davis, California, USA

Study on Traffic Accidents Involving Bicycle Carrying Children: Analysis of Traffic Accident Data in Japan and Experimental Study for Accident Reconstruction

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Keywords: children, traffic accident, bicycles, head injury.

1 INTRODUCTION

In recent years, bicycles are widely used due to changes in social conditions, such as rising concern for environmental problems and health in Japan. Bicycles that can carry children are popular among parents who have preschool children. With the increase of the use of bicycles, the traffic accidents involving bicycles become the problem, and various studies and measures to prevent traffic accidents, such as maintenance of bicycle use environments, are being carried out by administrative agencies[1]. Meanwhile, the decrease in the number of children is a serious problem in Japan[2]. Under such circumstances, studies and measures to prevent traffic accidents involving bicycles carrying children are also necessary. Therefore, in this paper, we analyzed the accident involving bicycles carrying children and the injury patterns using traffic accident data. In addition, we carried out the car-bicycle crash test using dummies.

2 TRAFFIC ACCIDENT DATA

Traffic accident database that is collected by the police from all over Japan were used in this study. We investigated the traffic accidents that children carried on bicycles were killed or injured. As a result of analysis, the number of casualties of children decreased year by year, but in recent years the rate of decrease was low, and it was around 1,000 per year. In addition, there were many accidents with normal cars and mini cars (K-cars), and a lot of accidents were crossing collisions at intersections. In accidents, many children carried on bicycles were injured in heads and faces. On the other hands, many cyclists carrying children were injured in legs and arms.

3 CRASH TEST

3.1 METHOD

Typical real-world accident, such as a crossing collision at an intersection, was reconstructed in order to understand the behavior of cyclists and children in the accidents. We performed a crash test that the front of the car hit the left side of the bicycle (Figure 1). An adult female dummy (Hybrid-Ⅲ AF 05) and a child dummy (Hybrid-Ⅲ 3 YO) rode on a bicycle (Figure 2). The child dummy was placed on a rear child seat without a seat belt. The test car was sedan type, and its gross weight was 1,226 kg. The crash velocity of the car was 30 km/h, and that of the bicycle was 15 km/h. The car braked immediately after the collision with the bicycle.

The behavior of the dummies was captured by high-speed video cameras (1,000 fps). We analyzed the high-speed videos, assuming that the influence of the motion in the screen depth direction was small. An external optical speed sensor was used to obtain the impact velocities of the car and the bicycle. An accelerometer with a 20 kHz sampling rate was attached in the head of the child dummy.

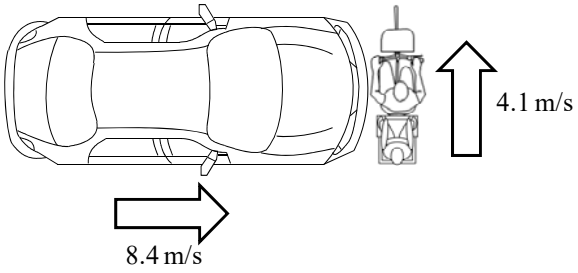

Figure 1: Crash test condition

Figure 2: Bicycle

3.2 BEHAVIOR OF DUMMIES

Figure 3 shows high-speed video images of the dummies. First, the footrest of the rear child seat contacted the car, and then left leg of the child dummy contacted the front of the car. The upper body started to the rotate because the left leg was pushed by the car, then the left side of the head collided with the hood at 145 ms. After that, the child dummy was thrown above the car and rotated in the air, the target mark on the left side of the pelvis reached the highest position (height: 1.6 m) at 391 ms. After the left foot collided with the window shield, the target mark on the top of the head reached the highest position (height: 1.8 m) at 608 ms. Finaly, the child dummy dropped on the road surface from the side of the left front fender.

First, the left leg of the adult dummy contacted the front of the car, and the upper body started to rotate. After that, the left hand of the adult dummy contacted the hood at 102 ms, then the left side of the head collided with the hood at 200 ms. After the adult dummy was pushed out forward of the car, dropped on the road surface from the side of the left front fender.

Both the child dummy and the adult dummy started to rotate because the left legs were pushed by the front of the car, and the behavior of making the heads collide with the hood was the same. However, the behavior of dummies after being thrown from the hood after the head collision was different. The child dummy was thrown upwards than the adult dummy. This is thought to be due to the relationship between the directions of the reaction force at the time of head collision and the positions of the center of gravity of the dummies.

3.3 CHILD DUMMY HEAD RESULTANT ACCELERATION

There were several peaks in the head acceleration of the child dummy (Figure 4). Peak A was caused by the collision of the head with the hood of the car, and Peak B was caused by the collision of the head with the road surface. The maximum value of the acceleration in collision with the road surface was approximately 16 times that in the collision with the hood. The reason for this is thought that the road surface is harder than the hood and that the child dummy dropped on the road surface from a high position due to the child dummy being thrown upwards by the collision with the hood.

4 CONCLUSIONS

· Traffic accident data

A lot of bicycles carrying children had accidents with normal cars and mini cars (K-cars), and many accidents were crossing collisions at intersections. In accidents, many children carried on bicycles were injured in heads and faces. On the other hands, many cyclists carrying children were injured in legs and arms.

· Crash Test

It was suggested that the child dummy could be thrown upwards than the adult dummy by the collision with the car. The maximum value of the head acceleration of the child dummy in collision with the road surface was much higher than that in the collision with the hood.

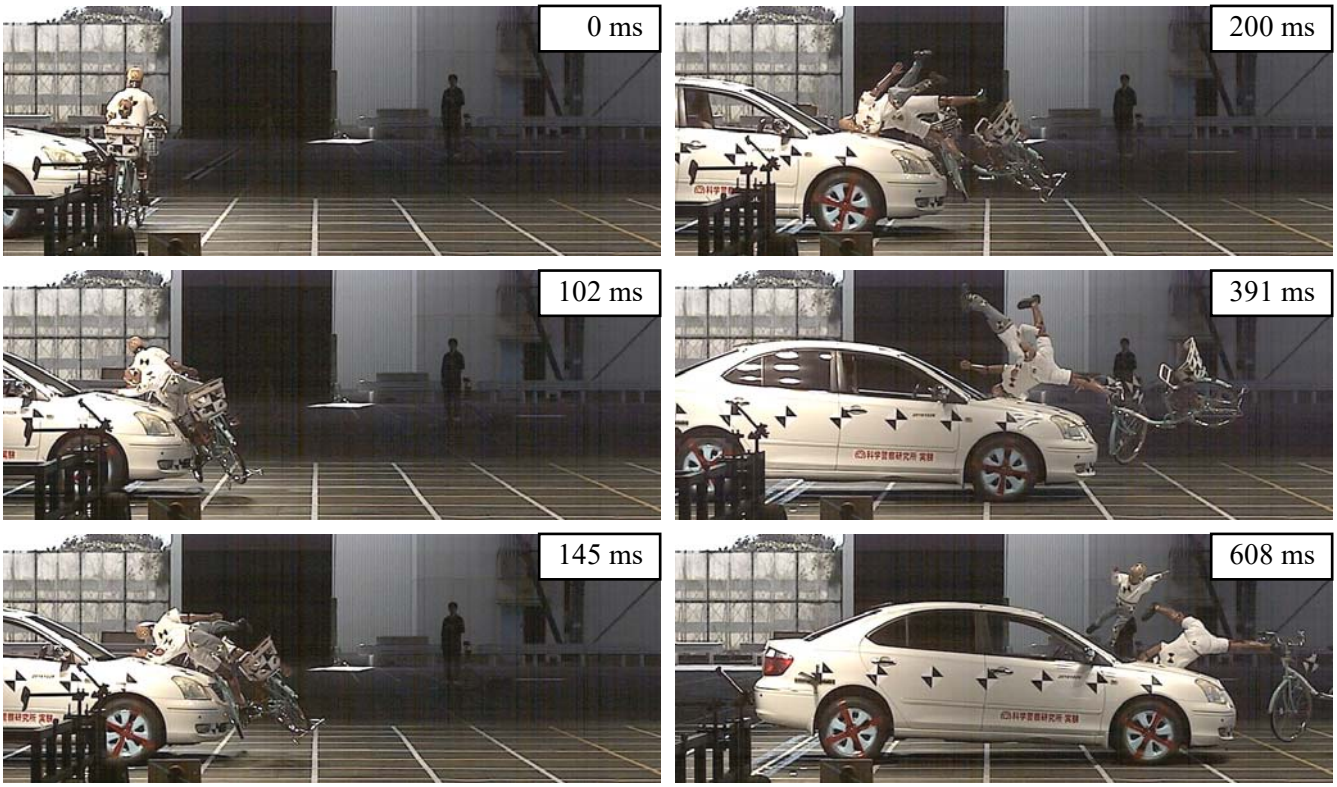

Figure 3: Behavior of dummies in crash test

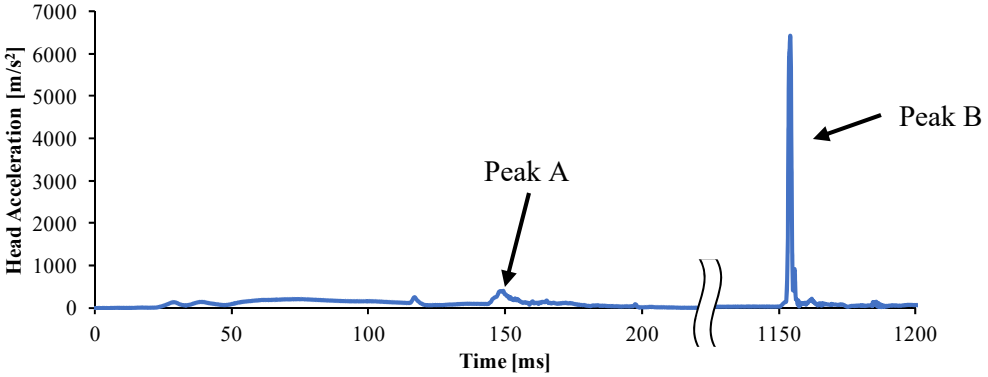

Figure 4: Child dummy head resultant acceleration

5 ACKNOWLEDGMENT

This work was supported by JSPS KAKENHI Grant Number JP15K21637.

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