Circumstances of Traffic Accidents on Curves in Metropolitan Expressways and Prediction of the Accident Reduction Impact on AHS

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Outline of this paper

Our Subjects:

10% of the total length of the Metropolitan Expressway in Tokyo is made up with 270 curve sections (radius of curvature 200 m or less) where 20% of traffic accidents (approximately 3,000 accidents per year) were happened in 2002 year.

And economic losses by congestion have been estimated at 7.0 billion yen per year.

These problems are now spreading throughout other highway road.
Solution of Subjects:

Therefore traffic safety countermeasures are effective to not only Safety, but also Economy. We learned the installation of congestion information boards and other measures is effective to this subjects.

Our study; To develop the detection algorithm of dangerous conditions using infrastructure side sensors (obstacles, road surface condition, etc.), communications (DSRC) and to determine the unexpected accidents at curvature, and inform to driver to avoid accidents. We did the tests at real road and proved the algorithm (Vehicle-Highway Cooperation System) is effective to the safety and the reduction of the loss time.
The Flow Chart of AHS Research Process

AHS research process

Accident analysis

Determine seven service area

Joint tests (Demo 2.0)

Establish proving test systems

Proving Tests
  * Test track tests
  * Driving simulator tests
  * Actual road tests

Judgment on Development
  * Legal issues
  * Cost effectiveness
  * Measures to promote widespread implementation

Deployment

Evaluation and verification

• Feasibility study of systems and key-element technologies on the test course
• Make AHS widely known among concerned people in Japan and overseas

• Baseline evaluation of sensors and road-to-vehicle communication on test track and actual roads

• Evaluation and verification aimed at practical application
AHS for road section of uninterrupted flow field

Support system for provision of information on stationary and slow vehicles ahead

Detect danger at roadside

Transmit detected information to vehicle

Road condition detection sensor

Stopped vehicle

Information Antenna

Starting Antenna

Information board

Vehicle Provides Information to Driver
Support system for prevention of over-shooting on curve
Table 1 Dangerous situations on expressway curves

<table>
<thead>
<tr>
<th>Accident</th>
<th>Related to <strong>rear-end collisions</strong> with stationary vehicles ahead</th>
<th>Related to <strong>single-vehicle accidents</strong> (Collision with side wall, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rear-end collisions with stationary vehicles / rearmost congestion Collision with side wall when swerving to avoid obstacle ahead</td>
<td>Single -vehicle accidents (Collision with side wall, overturning, etc.)</td>
</tr>
<tr>
<td>Dangerous behavior (Close call)</td>
<td>Sudden braking swerving</td>
<td>Sudden braking occurs the deviation from the lane</td>
</tr>
</tbody>
</table>
This Curve Feature: Highway Curve and so sharp. Curvature is 88m radius. Drivers want to keep high speed to turn this curvature. In a year accidents volume: 140 accidents were occurred in 2002 year. Accidents were almost rear end crashes.
Equipments Configuration on the Sangu-bashi Section

Test equipments | No.
---|---
Base beacon | 1
Information beacon | 1
Road condition detection sensor | 4

Starting beacon

Information beacon

Starting point of incident detection

Distance to the starting point of incident detection: 375m

Incident detection range 138m

Road condition detection Sensor 1

Road condition detection Sensor 2

Road condition detection Sensor 3

Road condition detection Sensor 4

An up line

Traveling direction of the test vehicle

To Hachioji

A down line

To Miyakezaka junction
### The Classified accidents on the Sangu-bashi Section

<table>
<thead>
<tr>
<th>Cause of accident</th>
<th>Accident type</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rear end collision</td>
<td>Collision with side wall, etc.</td>
</tr>
<tr>
<td>Rearmost congestion ahead</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Stationary vehicle ahead</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Excessive speed</td>
<td>-</td>
<td>19</td>
</tr>
<tr>
<td>Total</td>
<td>4</td>
<td>26</td>
</tr>
</tbody>
</table>

| Reported to Metropolitan Expressway Public Corporation | 3 | 9 | 12 |
Distribution of speed on entering curve of vehicles involved in accidents

Figure 5  Distribution of speed on entering curve of vehicles involved in accidents

- **Caused by forward obstacle** (N=11)
- **Caused by excessive speed** (N=19)
- **Caused by forward obstacle**
- **Caused by excessive speed**

<table>
<thead>
<tr>
<th>Speed at entry to curve (km/h)</th>
<th>Number of vehicles</th>
<th>Total percentage %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Caused by forward obstacle (N=11)**
- **Caused by excessive speed (N=19)**
After analyzed the accidents, driver if he can received “the low speed vehicle information”, he can avoid the rear end crash.

The occurrence of the accident stop car

This accident happened on 11/10 22:03

The curve penetration speed of the accident car is 51.7km /h.

It is counted backward from car speed, and beacon passage time is estimated.

At this time, System was Informed with the low speed vehicles was being

• This example is rear end crash which front car was stopped in an accident
• At the time of concerned vehicle pass the beacon, the system already detected and informed the low speed vehicle was being
### Table 4  Potential for information provision by AHS

<table>
<thead>
<tr>
<th>Traffic situations about which AHS was able to provide information</th>
<th>Number of vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information can be provided with present system</td>
<td>10</td>
</tr>
<tr>
<td>Slow -moving vehicles</td>
<td>2</td>
</tr>
<tr>
<td>Stationary vehicles</td>
<td>2</td>
</tr>
<tr>
<td>Rearmost congestion</td>
<td>6</td>
</tr>
<tr>
<td>Information can be provided with modifications to the system</td>
<td>10</td>
</tr>
<tr>
<td>No situation*</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>11</strong></td>
</tr>
</tbody>
</table>

At the time the vehicle passed the antenna, the situation ahead had not developed; presentation of information will be enabled by positioning an antenna directly before the commencement of the curve, etc.
Sensors were set up on sections of functioning roads to enable proving tests of the AHS under real traffic conditions.

The test of Sangu-bashi section is one of these trials. By the way of analysing the sensor data, it enables to understand the status of accidents.

This indicates that AHS also could be practical to know dangerous areas from data.

The trials were carried out using only particular vehicles able to receive particular information, but because the system was able to provide information immediately in advance to vehicles involved in accidents and to vehicles braked suddenly, the service can be predicted to be effective.
Thank you for your kind attention