TRAFFIC SAFETY MEASURES ON HANSHIN EXPRESSWAY

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ABSTRACT

This study reports the measures of the Hanshin Expressway to reduce traffic accidents. The Hanshin Expressway Company Limited (HECL) , managing the Hanshin Expressway , has accomplished a reduction of more than 1,000 accidents per year, which was the targeted goal of the Traffic Safety Measures Action Program which implemented measures to reduce traffic accident on the expressway over the course of three years beginning in 2007. The authors have analyzed the effectiveness of the measures implemented through this program. Based on the discussions regarding how to reduce accidents even further through the analysis of causal factors of traffic accidents, the HECL is continuing the effort by instituting the Second Traffic Safety Measures Action Program.

1. INTRODUCTION

Hanshin Expressway is an urban highway system serving the Kansai region in Japan(Figure 1). Since it began operation in 1964, the system has evolved to now the total length of 242km. Although, at first the number of vehicles as well as the number of traffic accidents on the Expressway increased as the highway system grew, the trend has been stagnant and even started slightly declining since 1998. As of FY2009, the number of daily traffic volume on the Expressway is approximately 900,000 vehicles, and the number of accidents is 6,072 per year.

The number of traffic accidents on the Expressway network did not increase significantly for over 20 years since 1980s, mainly due to the fact that a number of measures to reduce accidents have been implemented. Still, as of FY2005, the numbers of accidents on the Expressway network have been approximately 7,300 per year, which is equivalent to 20 accidents on a daily basis(Figure 2). Hence, the demand for further reduction of accident is considerable. Therefore, the HECL instituted “Hanshin Expressway Traffic Safety Measures Action Program [1] ” (AP) in 2007 to realize a safer, securer and more comfortable highway,reducing the annual number of accidents by 1,000 over the course of three years until FY2009.

With the objective to build foundational literature on the accident reduction effort and promotion of constant implementation of traffic safety measures, this study will analyze performance and achievements of the AP, and hence, extend the discussion on the factors that cause traffic accidents , and introduce the new AP instituted in 2010 , based on the analysis. The remainder of this study is structured as follows:

- An analysis of the accomplishments of the AP and identification of potential improvements
- Discussion on new safety measures toward the new AP
- Institution of the new AP

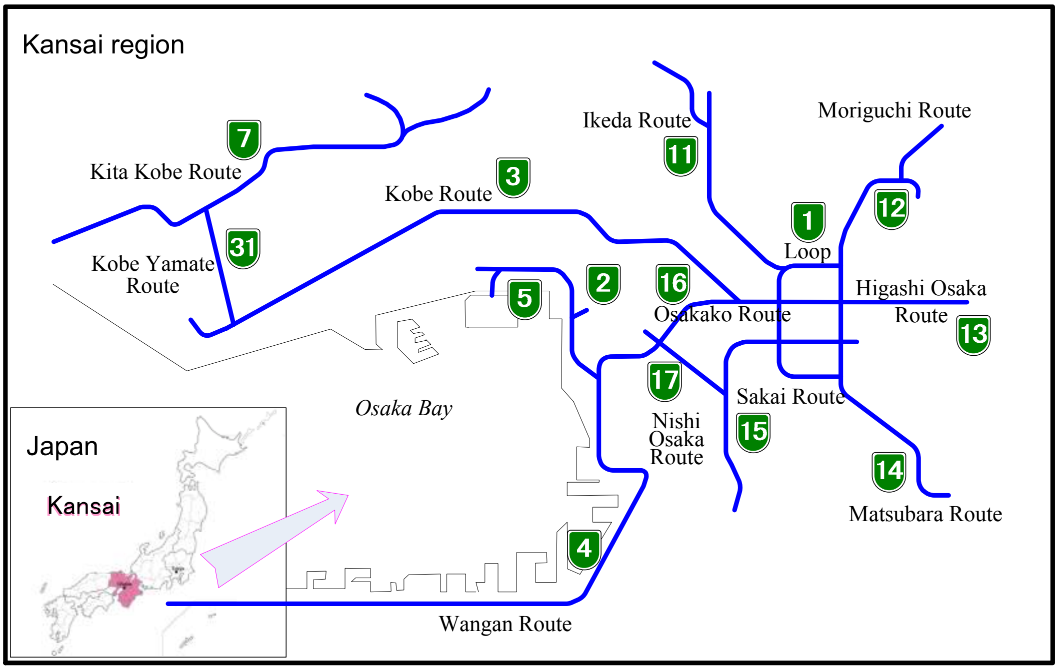


Figure 1 - Hanshin Expressway Network

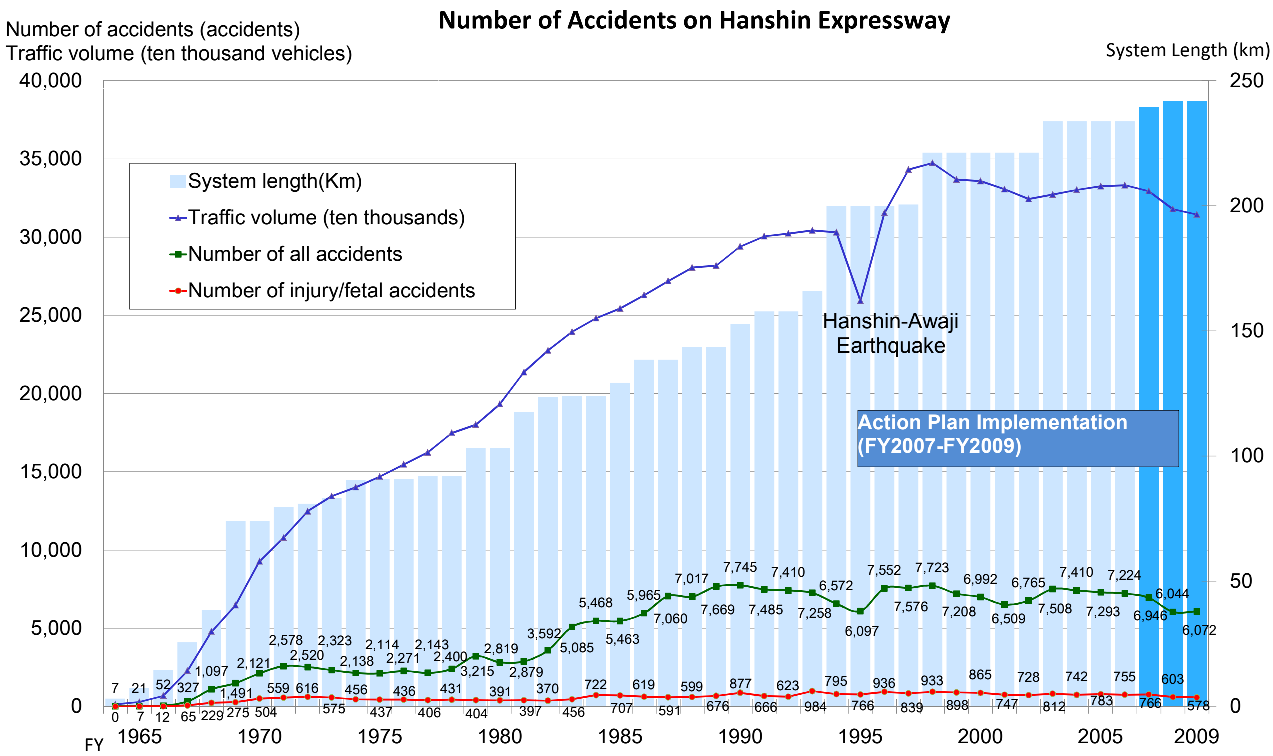


Figure 2 - Traffic Accidents on Hanshin Expressway

2. TRAFFIC SAFETY MEASURES ACTION PROGRAM (AP)

2.1. An Overview of the AP

The AP identified 30 locations with the worst accident occurrences with the share of 20% of all accidents on the Expressway network during the fiscal year 2005. Targeting a reduction of 1,000 accidents (13%) over three years until the end of FY2009, the HECL implemented a series of reduction measures. Figure 3 is a summary of the safety measures on a promotion material prepared for the program, and Figure 4 summarizes the concept employed in the AP.

Figure 3 – Hanshin Expressway Traffic Safety Measures Action Program (Promotion Material)

Objective	1. Reduction of 4 targetted accident types - Curved sections; merge/diverge sections; toll plazas; debris 2. Effective measures for the worst 30 locations
Goal	**Reduction Target : over 1,000 accidents (13%) as a base line**
Implementation Period	**from FY2007 to FY2009**

Figure 4 – Hanshin Expressway Traffic Safety Measures Action Program Concept

2.2. An Analysis of AP Achievements

The number of accidents, which before the AP implementation was 7,293 in FY2005, decreased to 6,072 in FY2009, which accounts for a reduction of 1,221 accidents. Effectively this is equivalent to a reduction in the monetary loss of $2.3 million (losses involving injuries and casualties, property damages and time losses due to congestions trigerred by the accidents). Further, the CO_2 emissions due to the congestions also declined by approximately 1,320ton (20%).

A closer look at the statistics of the accident reduction reveals those measures which were effective and others which were not. Table 1 shows the accident reduction of 4 targetted accident types. Safety measures implemented on curved sections and toll plazas reduced accidents by a considerable extent. On the other hand, the numbers of accidents at merging/diverging sections and those involving debris did not achieve significant reduction. The following section will discuss following aspects of the AP: description, effect, and potential improvements.

Table 1 – Accident Reduction Target and the Results

	Location	FY2005	FY2009	Δ	Target
AP measures Implemented	Curve	929	397	-532	-500
	Merge/diverge	347	389	42	
	Toll plazas	700	245	-455	-300
	Debris	676	567	-109	-200
	Total	2,652	1,598	-1,054	-1,000
No measure		4,641	4,474	-167	-
Grand Total		7,293	6,072	-1,221	-1,000

2.2.1. Safety Measures on Curved Sections (Single Vehicle Collisions)

A large number of single vehicle collions happened at curved sections, especially under: low traffic volumes (free traffic flow); during night time (low visibility); and under wet conditions. As a part of the AP, the HECL implemented such safety measures as anti-slip coating on pavement to increase the slip resistance value, and LED delineators to improve visibility on curved sections. As a result of these measures, the HECL was able to achieve a significant reduction of accidents at these locations. The anti-slip coating on pavement was especially effective, reducing the number of accidents by over 80%. Also, LED delineator (multi-type) contributed to reduce accidents during the night time (Figure 5).

While the measures on the curved sections accomplished a substantial reduction of accidents on the Expressway, the analysis revealed possible improvements for further reduction. For example, anti-slip coating on pavement have relatively low durability. Also, the number of accidents at curved sections where the AP measures were not implemented experienced rather increases of accidents. As such, there is a need to continue implementing these safety measures at more locations, and still to expand the scope of the program by implementing speed reduction measures at sections before the curves.

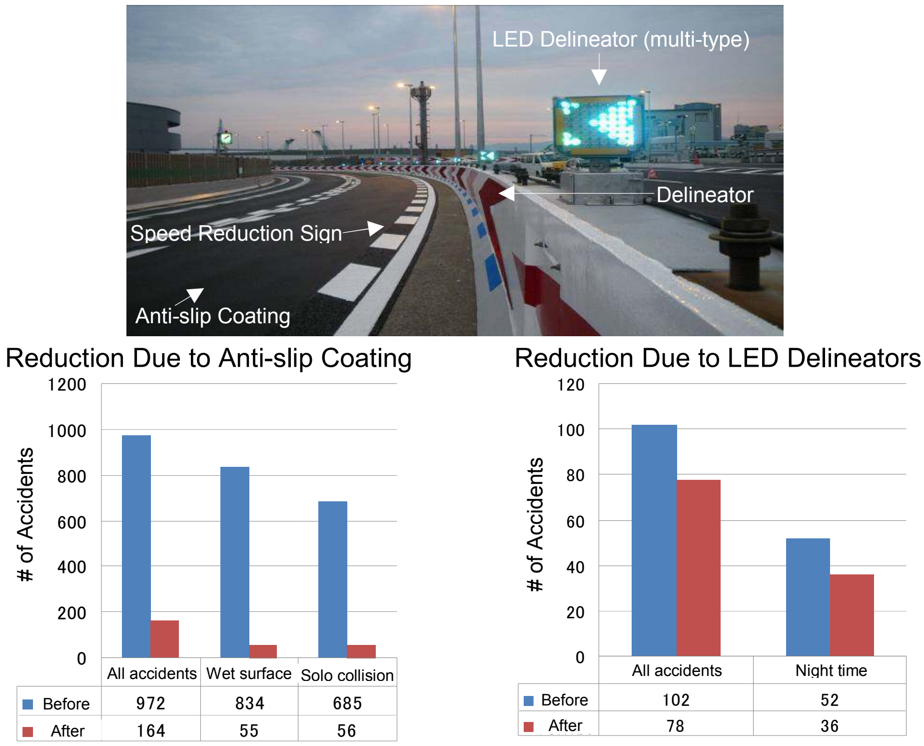
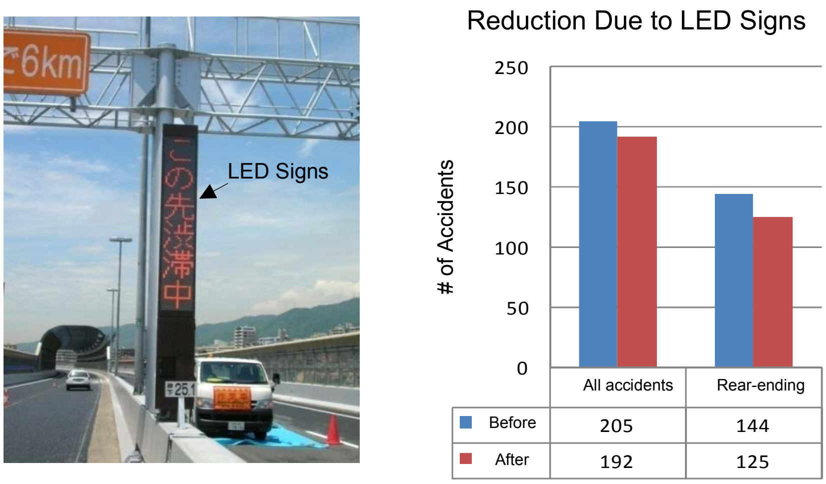


Figure 5 –Measures to Address Single Vehicle Collisions at Curved Sections and Accident Reduction
(Note: Accident reduction is a comparison of # of accidents per year before and after implement.)

2.2.2. Safety Measures on Curved Sections (Rear-ending Collisions)

Notorious characteristics of those curved sections where rear-ending accidents frequently occurred include: many happened during the day-time under congested flows; and many were minor accidents under congestions rather than at the tails of congestions. As such, the HECL installed LED traffic information boards at or before the curved sections where the number of rear-ending was high, so that drivers could be aware of the risk of rear-ending and also whether there is congestion ahead(Figure 6).

While there were reduction effects on the number of accidents at just the locations where the LED information boards were installed, rear-ending accidents under congestion happen not only at the curved sections but also throughout the congested flows. Thus, it became evident that installing the LED information boards at only some locations would not necessarily reduce the number of entire accident population. This result suggests that raising drivers' awareness of the risk of rear-ending under congestion might be effective.



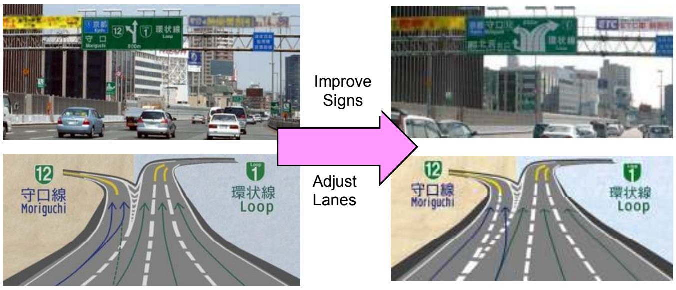
	All accidents	Rear-ending
Before	205	144
After	192	125

Figure 6 - Measures to Address Rear-ending Accidents at Curved Sections and Accident Statistics
(Note: Accident reduction is a comparison of # of accidents per year before and after implement.)

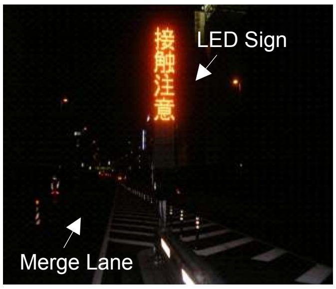
2.2.3. Safety Measures at Merging/Diverging Sections

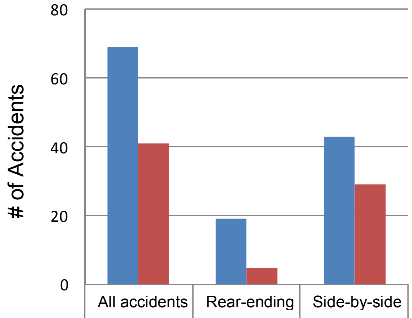
While typically merging sections observe rear-ending accidents, diverging sections demonstrate a considerable frequency of minor accidents where vehicles hit another from their sides ("side-by-side). To address the accidents at merging sections, the HECL implemented such measures as installations of LED traffic information boards to raise the drivers' awareness, reducing the accidents effectively at some of the locations. And to address the accidents at diverging sections, the HECL also simplified information signs and altered the lane-dividing lines to reduce drivers' confusions, which turned out to be effective (Figure 7).

But it should be noted that the analysis of the causal factors of the accidents during the AP implementation were far from sufficient, and the safety measures remained only at the level of experiment. Further, the accident reduction was not comprehensive among the entire population of accidents. Therefore, discussions on the effectivity of safety measures, based on detailed understandings of accidents mechanisms, are desired.



Measures at diverging





	All accidents	Rear-ending	Side-by-side
Before	69	19	43
After	41	5	29

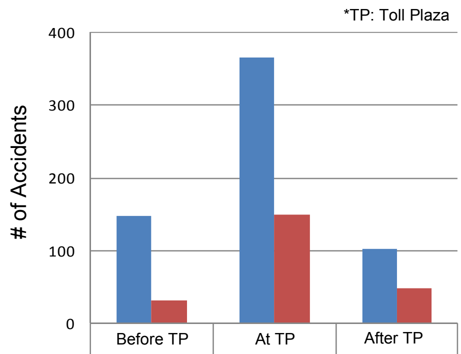
Measures at merging

Figure 7 - Measures to Address Accidents at Merging/Diverging Sections and Accident Statistics
(Note: Accident reduction is a comparison of # of accidents per year before and after implement at Sakai Rte to Loop Rte Merging.)

2.2.4. Safety Measures at Toll Plazas

A descriptive statistical analysis of accidents occurring at toll plazas show that the largest number of accidents occurred at or around those facilities, rather than before or after the facilities. Notably, a large number of accidents took place at Electronic Toll Collection (ETC)/Cash mixed lanes, typically of which were ETC vehicles rear-ending to vehicles paying tolls by cash. Further, a number of minor, side-by-side collisions and rear-ending collisions took place at areas where ETC lane and cash payment lanes are next to each other.

The HECL implemented such safety measures as removing mixed payment lanes (taking into consideration the ETC usage rate) and multi-color painting indicating the ETC lanes. Yet, the numbers of minor collisions before and after toll plazas and rear-ending while passing the toll gates are still substantial. There is a need to continue enhancing these measures to reduce these types of accidents.



	Before TP	At TP	After TP
FY2005	148	365	103
FY2009	31	149	48

Figure 8 - Measures to Address Accidents at Toll Gates and Accident Statistics

2.2.5. Safety Measures for Debris-related Accidents

The demand for continuous implementations of safety measures that address accidents caused by debris is large, due to the fact that debris could potentially lead to serious accidents. The HECL has implemented such measures to prevent or quickly address debris as: increased law enforcement activities against over-weight commercial trucks and; advocacy activities (banners, promotional DVDs, flyers, websites, newsletters, radio announcements and events at parking areas). Furthermore, the HECL has also reached out to the Japan Trucking Association to ask for their support in promoting compliance with the weight regulation and notifying the management in case of finding/dropping debris on the Expressway. Despite such extensive effort, the reduction in the number of accidents under this category did not reach the target.

Promotional DVD Image

Banner

Figure 9 - Measures to Address Debris-related Accidents

2.2.6. Action Program Safety Measures Summary

As a result of the measures implemented onto the Expressway facilities through the AP, the number of accidents decreased by more numbers than the program target. Yet, there are still as many as 6,000 accidents on the Expressway network per year, and the accidents did not achieve reduction, such as at merging / diverging sections, remain to be in need of further actions. The authors recognize the need to continue the discussion on the potential measures to address the unsolved challenges to even further reduce accidents on the Expressway network.

3. ADDITIONAL SAFETY MEASURES PROPOSED BASED ON THE ANALYSIS

3.1. Analyzing the Safety Measures at Merging / Diverging Sections

Most of the locations where the accidents at merging / diverging sections were occurred were located on the Route 1 Loop Line, which has the highest traffic volumes in the entire network and consists of one-way four lanes (Figure 10). It is reasonable to attribute the high occurrence of the accidents to the high traffic volume and also the fact that the Loop Route repetitively merges and diverges with other routes.

It is imperative to understand and recognize the factors that contribute to accidents at merging/diverging sections to reduce accidents. Such degrees of understanding would, however, necessitate analysis of not only the physical attributes of the road (i.e. liner, signs, and information boards) but also behavioral analysis of drivers with regards to their psychological conditions and the physical attributes of the roads. As such, the HECL conducted a series of driving tests using eye-mark recorder for the drivers on the Loop Route between Sakai Rte to Loop Rte Merging and Nishi-Senba Junction, to obtain a detailed data of behavior of drivers to accident factors. The following section, due to space limitation, will discuss the results of the analysis rather than reviewing the detailed contents of analysis.

3.2. Safety Measures Based on the Analysis at Merging / Diverging Sections

The results of the driving test indicated that one of the major factors leading to rear-ending and minor side-by-side accidents at merging/diverging sections is frequent lane-changing, which is indispensable to drive on a complex system like the Loop Route. Specifically, a typical distance between a merging entrance and a diverging exit is very short, while the number of lanes is as large as four. There is a significant volume of traffic that enter the Loop Route and proceed to the folloing diverging exit on the other side of the Expressway. A significant proportion of the drivers demonstrated a tendency to change lanes as soon as they enter the Loop Route, perhaps because they tend to have a desire to save some room of changing lanes before it’s too late. The concentration of changing lanes at merging on the Loop Route triggered side-by-side minor collisions. In addition, driving on the Loop Route, which is a uniquely complex route (e.g. exits on both sides and continuously), drivers experience higher risks to lose attention of the front of the vehicle by excessively focusing on the information signs and to change lanes just before diverging, eventually causing a rear-ending accident.

These findings suggest potential measures in merging to alert the merging to drivers, and to suppress the conflicting in the lane, to encourage lanes changes, by installing sign warning merging in front. And the authors plan to change some lines not to change lanes, to disperse the position of changing lanes (Figure 11).

And similarly, potential measures in diverging are to minimize the risk of drivers to lose attention to the front or to change lanes in an unsafe manner: improvement of the information provision. More precisely, the authors proposed to encourage reasonable lane changes of the drivers through installing multiple information boards with the colors specific to each route to exit to, and hence, painting the lanes with their destination colors (Figure 12).

Figure 10 - Expressway Section under the Analysis

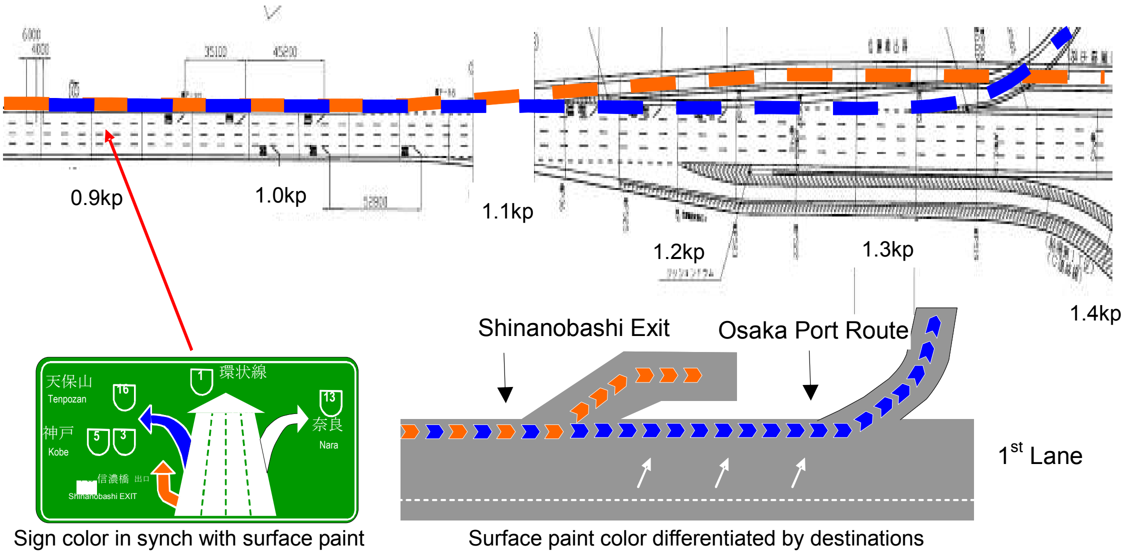


Figure 11 - An Example of Safety Measure at a Diverging Exit Section

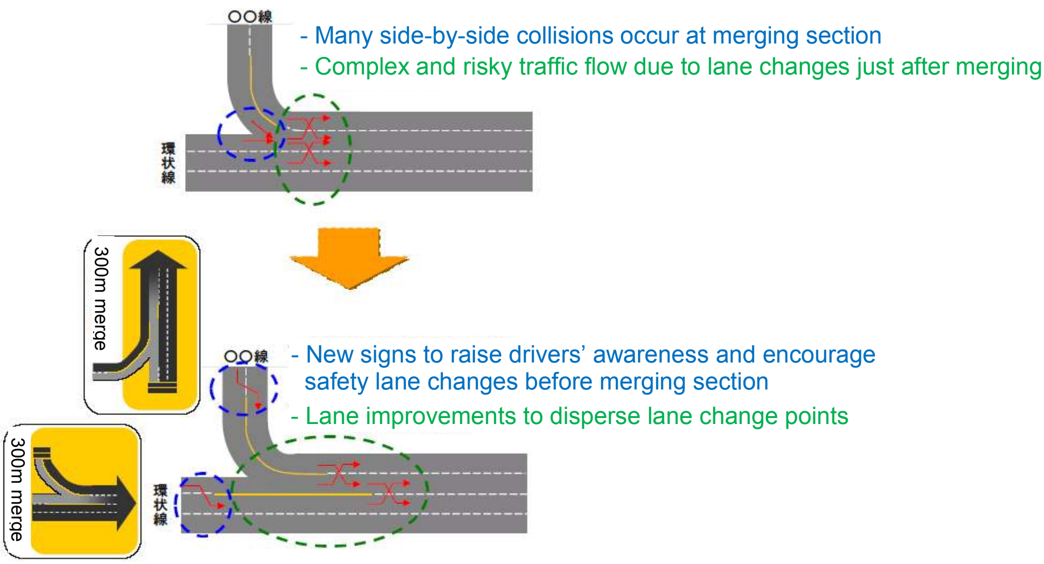


Figure 12 - An Example of Safety Measure at a Merging Section

3.2. A More Comprehensive View on Safety Measures and Proposal for Improvement

The AP achieved a substantial decline in the number of accidents through investing in the measures to address issues particular to locations with higher accident frequencies. To achieve even further reduction, however, the HECL would need to improve or even alter their approaches of the measures that did not generate desirable outcomes. Hence, it would also be necessary to identify measures that are comprehensible to the entire network (i.e. not just accident-prone zones). Therefore, the authors continued with the analysis of the accident factors in order to expand the scope of the project to contributing to the traffic safety in a broader context.

3.2.1. Constructing a New Accident Database

Previous analysis of accident factors have been conducted using only an accident dabatase that consisted of variables including: time; location; driver characteristics (e.g. age, gender, driving experience and frequency of the Expressway usage) and; accident characteristics (i.e. rear-ending, single vehicle accidents, and side-by-side collisions).

As the discussions in the previous sections indicate, accidents are caused by various factors including road characteristics, traffic environments and the characteristics of the drivers. Therefore, the existing database is only partial in analyzing the characteristics of accidents at a deeper level. The authors attempted to address this issue by constructing a more comprehensive accident database. The additional variables in the database are: traffic data (traffic volume, average speed, and presence/absence of congestion); road characteristics (linear, direction, and the history and type of pavement); weather (precipitation) and; previous implementation of the AP measures. The following sections will refer to this new database as “accident DB.” The records in the accident DB are the 26,181 accidents that occurred between April 2005 and December 2008. This database enabled statistical analysis of accident factors, from a wholistic perspective with numerous independent variables.

3.2.2. Obtaining a Standardized Accident Frequencies for Each Highway Section

As the accident DB is constructed by matching the original accident data and other datasets, the records needed to be standardized. This was done by constructing a accident rate for each Expressway section, which is defined by the interval of vehicle detectors located every 500 meters throughout the Expressway network. This processing enabled a comparison of accident occurrence rates under different conditions, such as characteristics of the drivers, weather and road structure, which used to be impossible because of the differences in the values of denominators of the samples.

3.2.3. A Comparative Analysis of Accidents among Distinct Drivers Characteristics

Figure 13 compares the characteristics of the drivers primarily responsible for the accidents. Apparently, drivers of certain characteristics consist higher shares: below the age 20 and above 70 years old and; occasional drivers, in terms of driving frequency. The authors could argue, based on the analysis using the accident DB and the section accident rates, that the characteristics of the drivers, under various road conditions and traffic conditions demonstrate distinct propensities of causing accidents (Figure 13, Table 2). The authors labeled a few of the groups with different attribute: “youth,” “senior,” “female,” “truck,” and “light users.” To these drivers, providing information and safety education individual is also very effective, the authors think, not only contributing level of entire traffic safety up, because “light users” often causes accident on the Hanshin Expressway.

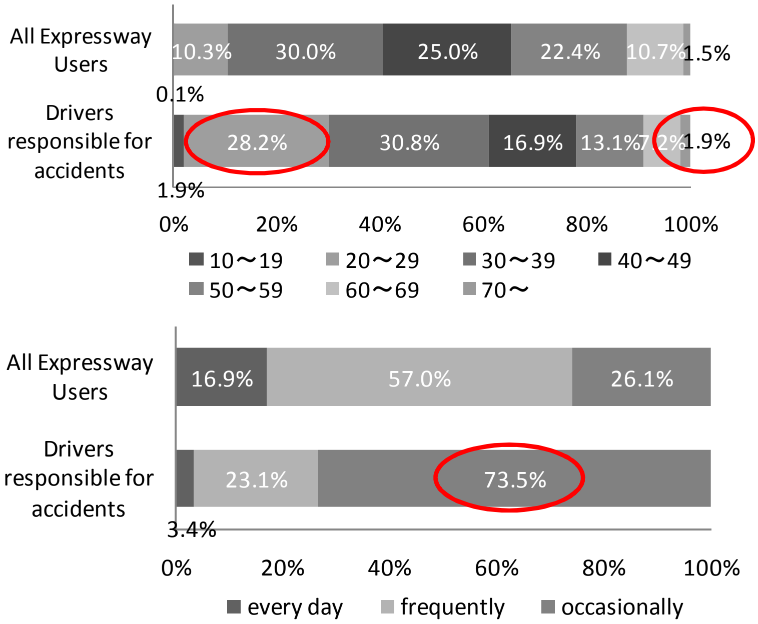


Figure 13 - Characteristics of Expressway Users and Drivers Responsible for Accidents, Comparison

Table 2 - Accident Proclivity Based on Driver Characteristics, Summary

Characteristic	Accident Proclivity
Youth	-Single vehicle collisions -Collisions at curved sections under free traffic flows
Senior	-Side-by-side collisions under congestions/heavy traffic -Rear-ending under congestions
Female	-Vehicle collisions at merging/diverging sections -Accidents on weekends/holidays
Truck drivers	-Relatively frequent occurrence of vehicle collisions at merging/diverging sections under heavy traffic
Light users	-Frequent accidents regardless of road structure and traffic conditions -Particularly high frequency of single vehicle collisions

3.3. Safety Measures through Directly Approaching Drivers

3.3.1. Traffic Safety Measures through Directly Approaching Drivers

While appropriate provision of safety information might have been effective to a certain extent, it is unrealistic to communicate to the drivers the massive amount of information, such as the knowledge derived from accident analysis and know-hows of safety driving long accumulated until today. Also, although the HECL has engaged in promotion activities such as websites, posters, flyers and banners to encourage safety driving, these messages target the entire driver population: to all people; the content of all common; one-directional. So, the authors could assume that there is limitation in such approaches to influence drivers to take these messages as their own issues.

For these reasons, the authors discussed alternative means to provide information to the drivers, taking into consideration their characteristics and the accidents that they are prone to cause. The objective here is to improve the efficiency of information provision and the effectiveness to change their driving behavior, through reaching out with such emphases as being: individualized; specific and; dual-directional. In other words, the proposed measure will provide information useful for driving specifically in certain traffic conditions on the Hanshin Expressway, relevant to his/her respective characteristics as a driver, and through participatory programs.

It should be noted that the number of daily trips on Hanshin Expressway network is approximately 900,000, however, and it is difficult to reach out to each single driver one by one. Therefore, the authors initiated a safety driving assistance project to provide safety information simulataneously to many drivers, through a website "HANSHIN EXPRESSWAY SAFETY NAVI [2] (Hanko Safety Navi ; http://safetynavi.jp/)." An unique educational program was constructed to be the main contents of the website, referring to the driving aptitude test and the hazard susceptibility test, is well-known. (Figure 14).

The Hanko Safety Navi consists of five main contents, representative three of which will be discussed in the following sections: Safety Driving Test Program; Safety Driving Support Program and; Safety Caution Map.

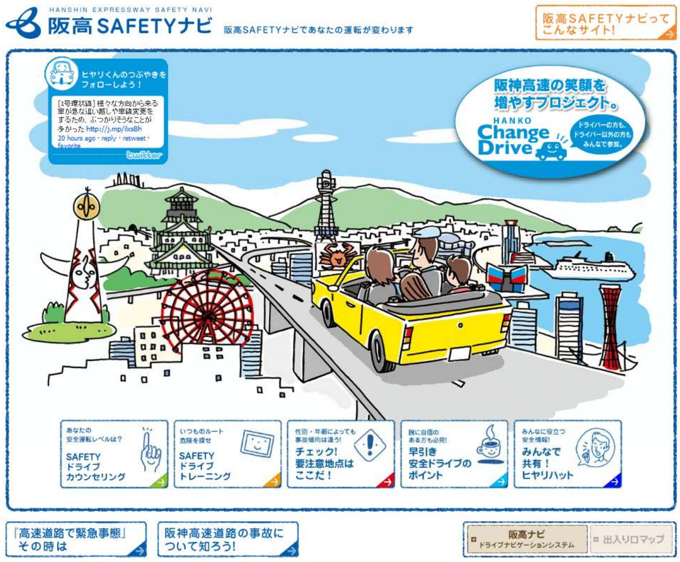


Figure 14 - "HANSHIN EXPRESSWAY SAFETY NAVI" Website Homepage

3.3.2. Building Safety Driving Test Program

One of the component of the Hanko Safety Navi is a Safety Driving Test Program, which is designed to enable drivers to recognize his/her own driving characteristics in terms of driving safety consciousness, attitude and the level of judgement. The objective of this program is to raise the drivers' awareness for driving safety through providing advice based on the respective driving characteristics.

While the contents of this test program is based principly on the driving aptitude test, which is the national standard, the specifics of the test is specialized on the context of Hanshin Expressway. As such, drivers are able to gain knowledge and advice on the driving safety that is necessary and specific to the Hanshin Expressway through this program (Figure 15). Furthermore, the advices in this program is carefully designed to draw the attention of drivers by avoiding typical phrases such as "slow down well before curves on rainy days" but provide concrete numbers such as "on rainy days, accidents happen x times more on curves than straight sections." This is so that drivers will recognize the level of risk they face under those conditions. These advices, convincing with numerical values, have become possible because of the newly developed database from which the authors could estimate the accident rates for Expressway sections. Finally, the program features that the visitors of the website are required to input their personal characteristics and driving history (i.e. accident history) so that further analysis and comparison with the accident DB will be possible.

Figure 15 - “HANSHIN EXPRESSWAY SAFETY NAVI” Safety Driving Test Program Image (Driving Aptitude Test)

3.3.3. Building Safety Driving Support Program

The next component of the Hanko Safety Navi is Safety Driving Support Program, which was developed with the objective to enhance drivers’ risk perception and decision making ability. The program first, based principly on the hazard susceptibility test, provides a movie clip with real driving conditions on the Hanshin Expressway (i.e. curve, merging, diverging, and congestion) and tests the drivers’ perception of latent risk when driving(Figure 16).

After the test, this program leads the drivers to a simulation plan of safety driving on the Expressway routes of the drivers’ arbitrary choice, letting the drivers to develop a habit of safety driving on the routes that they drive in their real lives (Figure 17).

Figure 16 - “HANSHIN EXPRESSWAY SAFETY NAVI” Safety Driving Support Program Image (Risk Perception Test)

Figure 17 - "HANSHIN EXPRESSWAY SAFETY NAVI" Safety Driving Support Program Image (Safe Driving Plan Simulation)

3.3.4. Providing Safety Caution Map

Through the Hanko Safety Navi, customized maps were provided to the drivers. The authors constructed "Safety Caution Map" based on the characteristics of drivers (youth, male, female, seniors and truck drivers) and the types of accidents they are prone to cause (Figure 18). The map provides detailed advises for each cautionary locations, articulating the types of accidents that tend to happen for the each location.

Figure 18 - "HANSHIN EXPRESSWAY SAFETY NAVI" Safety Caution Map Image (Cautionary Locations Map)

3.3.5. Future Development of the Program

As mentioned above, Safety Driving Test and Safety Driving Support Program require that the users input their own characteristics. These input data, along with their answers to the questions on the tests, are stored in the database, so that the test and support programs can maintain their reliability by continuous analysis of the population. Therefore, the authors plan to continue analyzing the data to update the program on a periodical basis, so that the program evolves to serve its objectives.

4. THE SECOND TRAFFIC SAFETY MEASURES ACTION PROGRAM

The AP achieved a substantial outcome in reducing the accidents through implementation of safety measures onto the Expressway facilities. Yet there remains the unsolved issues of accidents at merging/diverging sections on the complex highway networks. Also, further reductions of accidents would demand implementations of safety measures to address proclivities of drivers of certain characteristics.

Based on the above considerations, "Hanshin Expressway the Second Traffic Safety Measure Action Program [3] " (the 2nd AP) was established in 2010 with the following three focus areas:

- Safety improvement of driving environment
- Improvement of information signs
- Promotion of safety driving

The 2nd AP aims at reducing the number of accidents by 1,000 per year, and reduce the number of injury/casualty accidents by 100 per year, through implementing the measures with the following enhancements.

4.4.1. Safety Improvement of Driving Environment

The safety measures in AP to improve driving environment, such as increasing the slip resistance values, were considerably effective. The 2nd AP, therefore, will enhance the implementation of such measures as installation of anti-slip coating on pavement and LED delineators (multi-type).

4.4.2. Improvement of Information Signs

One of the challenges that the AP was unable to effectively address was the frequent lane-changes on complex networks such as the Loop Route, and the number of accidents at merging/diverging sections still remains high. Since a large proportion of drivers to cause accidents at these locations are so-called light users, improvements can be expected through facilitating safety driving environment to minimize their sense of insecurity while driving through these Expressway sections. The 2nd AP will implement appropriate traffic control measures such as improving the information signs and lane realignment, so that light users could travel through merging/diverging sections more safely with less anxiety.

4.4.3. Promotion of Safety Driving

While the above two focuses of the 2nd AP primarily address accident prone sections of the Expressway, more comprehensive approaches, including improvements of measures that were ineffective in the previous AP, are necessary to further reduce accidents. Aiming at increasing the drivers' safety knowledge and awareness of safety driving, the 2nd AP will focus its attention on the distinct accident patterns for different characteristics of the drivers. The 2nd AP implements an additional measure to utilize the website to provide information and driving advice to drivers, catering the appropriate and specific information for respective individual's characteristics, based on the analysis of the abundant data.

5. CONCLUSION

The HECL instituted the AP in 2007 to implement safety measures focusing on accident prone sections of the network, effectively reducing the number of accidents to a considerable degree. The HECL intends to continue investing in further reduction of accidents by revealing unaddressed safety risks through analyzing the data that became available through the AP. Specifically, the HECL initiated additional safety measures such as enhancing information signs and opening a web-based service to cater safety training to drivers based on respective characteristics. The authors could argue that the most valuable achievement of the AP is the scientific process by which specialists and management came together to analyze the result of an initiative, identify possible improvement and proceed to implement the additional measures.

As taffic accidents occur typically as a result of multiple factors, a single safety measure virtually is insufficient to eliminate the risk of accidents. As such, it is imperative to repeat the cycle to implement a measure, not just to be satisfied but also to analyze the results, to identify possible improvements, and to implement additional measures to continue evolving the traffic safety standard of the Expressway network. Therefore, the AP and the 2nd AP plays a significant role in the attempt of the HECL to proceed with the cycle for safety standard evolution.

It is the intent of the authors to report the program outcomes and analysis results of the 2nd AP at an appropriate occasion.

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REFERENCES

1. Hanshin Expressway Traffic Safety Measures Action Program ; http://www.hanshin-exp.co.jp/company/torikumi/jutai/img/actionprogram.pdf (April 2007, in Japanese)

2. HANSHIN EXPRESSWAY SAFETY NAVI ; http://safetynavi.jp/ (May 2011, in Japanese)

3. Hanshin Expressway the Second Traffic Safety Measure Action Program ; http://www.hanshin-exp.co.jp/company/torikumi/2011-0601-1133.pdf (July 2010, in Japanese)