An Integrated R & D Program for the Railway Safety Improvement in Korea

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(Received from the Guest Editor on July 31, 2006)

Abstract: The railway safety in Korea is threatened due to the restructuring of the railway industries, introduction of the Korea Train eXpress (KTX) and electrification of the conventional lines. Many technical arrangements are to be improved to control railway accidents as low as reasonably practicable, such as a railway safety act, safety standards, and safety assessment infrastructures.

With the support of the Korean government the Korea Railroad Research Institute (KRRI) is conducting an integrated R&D program for improvement of the railway safety, of which the target is to reduce the accident fatalities by half. The program is composed of three parts; the safety system engineering and the program management, the establishment of a safety management system, and the development of techniques for assessing and preventing major railway accidents. Details of the research programs are explained in this paper, where risk is used as the major control measure.

Key Words: railway safety, major train accident, risk assessment, system safety

1. Introduction

In 105 year history of Korean railway operation, non-precedent changes are occurring in recent 5 years. These changes, including setting up Railway Safety Act, railway industry restructuring, electrification of the conventional lines, Korea Train eXpress (KTX, 300km/h speed train) operation, and the North and South Korean railway connection, are increasing railway hazards. As a result number of railway accidents and fatalities are increasing in recent years.

After the Daegu subway train fire accident, the Korean government has been trying to prepare a nation-wide railway safety program, a safety organization, and a Safety Act. Currently, a railway Safety Act and an accident investigation board are partially organized [1-3]. In order to support the establishment of the safety standards, many areas of technology are required. The Ministry of Construction and Transportation (MOCT) and KRRI drove the requirements for safe operation of the railways as follows.

1. Construction of a nation-wide railway safety management program and the execution of safety regulations.

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2. Establishment of safety technologies for the hazard analysis, the risk assessment and the risk control
3. Establishment of a long-term safety goal for the improvement of safety cultures.
4. Establishment of a basis for technical exchanges with other countries for securing the safety technology and a safety assurance system
5. Construction and utilization of an integrated safety database for the safety improvement
6. Establishment of a basis for the efficient execution of the “Railway Safety Act”

A number of safety experts were gathered together for planning a Korean Railway Safety Program in 2004, and benchmarked safety programs of European Countries and safety management systems of safety related industries such as nuclear and aircraft[4-8]. As results, 34 research topics in four areas were selected for improvement of the rail safety.

An integrated R&D program was planned for systematic control of the railway safety and for active response to accidents. The goal of the R&D program was set to reduce fatalities by half the current level. Among the 34 researches in four areas, 15 research topics in three areas were selected to proceed because of limited research funds and time. The selected three areas are as follows: 1) safety system engineering and project management; 2) establishment of a safety management system; 3) and development of assessing & preventing techniques for major accidents. Research results could be utilized for construction of safety standards, development of aptitude test system for railway employees, and development of training manuals and other management rules. Due to the lack of background research, the integrated R&D program will be carried out as a rolling plan until 2010.
2. Contents of Master Plan

Details of the integrated R&D program are explained in this section. Fifteen research topics in three areas are shown in table 1.

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<td>Techniques for assessing and preventing major accidents</td>
<td>11. Development of test and evaluation techniques for the fire resistance of rolling stocks and infrastructures</td>
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<td>15. Development of intelligent level crossing and the improvement of safety performances</td>
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The third research category, “Techniques for assessing & preventing major accidents” is the base studies for the second category, “Safety management system”. Techniques to be developed will be utilized for execution of the Railway Safety Act and railway safety regulations, and for construction of rail safety standards and procedures. Relationships between the research topics are schematically shown in figure 1.

2.1 System Engineering and Project Management

System engineering for the interface control among the research topics and the construction of safety testing infrastructure are included in this research area. This
program will interface the results of the research with the safety management program & safety regulation.

Many types of equipments are required for testing fire/collision/derailment performances of railway systems. For the efficiency of installation of the equipments, system engineering will be carried out in this part.

A system engineering study has resulted in national railway safety management system architecture as shown in Figure 2.

![Fig. 2: National Railway Safety Management System Architecture](image)

2.2 Hazard Analysis and Risk Assessment for Safety Management

In Korea risk based regulation is first tried in nuclear industry but it is still review stage in nuclear industry where railway industry has many opportunities in risk based regulation. In order to support Korean government’s risk based safety regulation on railway, basic research are carried out in this program.

For the risk based regulation many basic techniques and data are required. Standard risk assessment techniques and data analyses are carried in this program. As results, risk assessment model and quantified risks for major train accidents will be determined. These include hazard analysis and classification of the identified hazards. The risk of each
hazard can be derived in connection with the accidents database. The results will be incorporated into the safety investment plan as well as resource allocation.

2.3 Establishment of a Management System for the Human Factors

Human factors are difficult to quantify although they are one of major reasons for train accidents. As a start, studies for human factors control, aptitude analysis, worker allocation guideline, man-machine interface, correlation analysis for fatigue and stress, work planning, and emergency action plan will be carried out. The results of these basic researches will be incorporated into the training program. Human factor control techniques and requirements will be developed in this study.

2.4 Development of a Training System for Safety Critical Worker

Training program for safety critical workers has been developed by train operating companies. These training programs have to be improved as the train operation environment changes. A simulator for evaluating the deriver’s work competency will be developed in this research. In some training program, such as the safety critical worker, simulator will be used for a proper emergency action.

2.5 Establishment of Safety Standards for Rolling Stock, Infrastructure, Critical S/W and Dangerous Freight

Currently, existing safety standards are only for urban subway rolling stocks. In order to extend safety standard to all types of trains, infrastructures and safety critical S/W, systematic studies including testing equipments installation will be preceded. Safety standards for level crossing are included in this study. For setting up the rolling stock safety standards, fire/collision/derailment tests will be carried out, and related assessment equipments will also be installed. After verification of these safety standards, results of this study will be incorporated into regulations or rules for railways.

2.6 Development of Emergency Action Guidelines for Designed Accident Scenarios

Proper actions in case of train accidents can be very helpful to reduce fatalities. Those also prevent accidents from propagating into disastrous results. In order to prevent the propagation of accidents to disasters, accident scenarios will be prepared, and proper emergency action plans will be derived in this study. Response actions for terrorism, interface between emergency rescue organizations and transportation of dangerous products are included in this part.

2.7 Design and Construction of a Safety Management Information System

Various DBMS (DataBase Management System) are under operation for various purposes, such as operation, construction, research, and accident inspection. In this reason, prompt estimation is difficult for the data gathering and verification time. For the efficiency interface between other research topics such as risk assessment, cost benefit analysis, decision-making, safety assessment, an automatically linked DBMS is required. Automated data gathering DBMS will be developed in this study. Developed database will be connected to other programs such as system engineering tools and risk assessment S/W.
2.8 Development of Test and Evaluation Techniques for Train Fire, Collision, and Derailment

Many technical research and supporting tests are required for setting up the standards. In accordance with system engineering for testing infrastructure installation program, various tests on collision, derailment and fire will be carried out.

For fire resistance of rolling stock and infrastructures, guidelines for materials and detailed criteria for measuring these materials will be developed. For collision and derailment safety, safety performance evaluation techniques will be developed and required test equipments will be installed.

2.9 Development of Intelligent Level Crossing

Level crossing is still one of the major reasons for train accidents, so many level crossings are replaced with overhead crossings now and car detection and warning system is installing now. But some level crossings could not be replaced due to many limitations. In order to reduce accidents regarding level crossings, intelligent level crossing system will be developed such as connection techniques between train control devices and road traffic controller, image processing and RF communications, and information supply techniques for road drivers and train drives.

3. Conclusion

A brief introduction of an integrated R&D program for railway safety in Korea is presented in this paper. This R&D will setup the basis for efficient execution of the risk based Rail Safety Act, and for constructing rail safety regulations and procedures, and eventually contribute greatly to the reduction of railway accidents of Korea in near future.

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