RISK MANAGEMENT FOR ROADS

19 September 2007 (a.m.)

TECHNICAL COMMITTEE 3.2
RISK MANAGEMENT FOR ROADS

INTRODUCTORY REPORT

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EXECUTIVE SUMMARY

Many parts of the world are at significant risk of natural and man-made disasters. Modern industrial practices, dependencies on critical infrastructures make countries further vulnerable to not only a wide range of natural disasters but also serious man-made disasters. These factors, combined with increased population densities and property development in hazard zones, have heightened countries' disaster risks as follows:

1. Natural disasters, include typhoons, cyclones, hurricanes, flooding, tornadoes, drought, wildfires, earthquakes, volcanoes, landslides, ice storms, and dust storms that all contribute to disease epidemics.
2. Man-made disasters, include critical infrastructure threats, oil and chemical spills, building fires, mechanical equipment explosions, and terrorism.

TC 3.2 of Strategic Theme 3 lays special emphasis on integrated risk management for roads with expanded research into risk assessment, decision-making processes, reduction of risk and risk management tools. More specifically TC 3.2 has the three terms of reference:

1) Introduce risk management techniques in the road sector
2) Introduce risk management for mega-projects
3) Improve highway systems security

Since the beginning, TC3.2 has been making considerable efforts to achieve its objectives, by organizing five TC3.2 meetings in various countries and one international seminar in Ha Noi, Viet Nam. Three more meetings and the 2nd international seminar are scheduled before the World Road Congress in Paris.

To formulate and improve various risk management strategies for the future, TC 3.2 will prepare the technical session agenda for the World Congress in Paris as follows:

1. Opening Remarks
2. TC3.2 Activities for the Cycle
3. Introduction of Risk Management Techniques
    - Risk Management for Roads
    - Risk Management for Projects
    - Risk Management for Highway Systems Security
4. Workshop on Risk Management for Roads
    - Comparison of Risk Management Manuals in various countries
    - Implementation of the Hyogo Framework for Action - Risk Management for Roads
    - Practical Application of RM for Road Infrastructures threatened by natural and man-made hazards
    - Practical Application of RM for Mega-projects
    - Discussion
5. Future Activities and Resolutions
6. Closing Remarks

COMMITTEE MEMBERS WHO CONTRIBUTED TO THE REPORT

Dr. Michio Okahara, TC 3.2 chair
Hiroyuki Nakajima, TC 3.2 English speaking secretary
Line Tremblay, TC 3.2French speaking secretary

1. INTRODUCTION

Foreword

The Technical Committee on Risk Management for Roads (TC 3.2) is one of the 18 Technical Committees. TC 3.2 lays special emphasis on integrated risk management with expanded research into risk assessment, decision-making processes and security issues. More specifically TC 3.2 has the three terms of reference,

1) Introduce risk management techniques in the road sector
2) Introduce risk management for mega-projects
3) Improve highway systems security

To accomplish its mission, TC 3.2 is actively engaged in various activities such as launching an international survey, collecting good practices of risk management, developing technical toolbox for risk management and organizing international seminars.

Strategies, Outputs and Activities

According to the terms of reference for TC 3.2, there are three issues as shown in Table 1, and the three working groups that are responsible for each issue have been established. The first meeting of TC 3.2 was held in May 2004. Since the first meeting, the members of TC 3.2 have gathered twice a year from all over the world. They share their experience with each other in efforts to deepen the knowledge about risk management for roads. TC 3.2 collects good practices of risk management, and is developing a technical toolbox for risk management. In addition, an international survey on risk management for roads was carried out in 2005.

Table 1 Terms of Reference for TC 3.2

Issue 1 - Introduce risk management techniques in the road sector	
Strategies	Outputs
· Collect and analyze information about Integrated Risk Management from a strategic organizational standpoint · Collect information about the use of quantitative risk assessment/management tools and develop best practices/ lessons learned on risk based decision making · Study how security risks/vulnerability can be used to assess major transportation alternatives and impact the decision making process	· Recommendations on how risk management can be used in an organization to guide programs/projects · Report on existing practices · Model Integrated Risk Management Framework that can be used as a Guide · Quantitative risk assessment toolbox of techniques and methodologies which can be applied to the transportation community
Issue 2 - Introduce risk management for mega-projects	
Strategies	Outputs
· Study the use of risk assessment tools on mega-projects and assess their success	· Guidance on better use of risk management on mega-projects to maintain public trust and confidence
Issue 3 - Improve highway systems security	
Strategies	Outputs
· Investigate the application of risk management principles to the reduction of risk for the highway system	· Vulnerability assessment model for critical transportation infrastructures

2. INTERNATIONAL SURVEY AND SEMINARS

2.1. First International Survey of Risk Management

TC 3.2 planned an international survey to understand the current status of risk management techniques and practices, and thus to complement the expertise of the committee members. This international survey is two-fold, and the first survey was characterized as the first step to obtain more detailed information through the second survey.

The first questionnaire of the international survey was prepared in three languages (English, French and Spanish) and TC3.2 had received 25 answers of their first International Survey from 23 countries (2 answers from Canada and Norway) by April 04, 2006. The results of the survey are summarized below.

a) General

The percentage of the countries, which use risk management in the organization's decision-making system, is 76% (19/25), 53% have RM policies or guidelines (13/25), and 60% have general models for risk management (15/25). Canada (Quebec, New Brunswick), Italy, Norway (Eastern Region), Romania, and Switzerland have risk management policies or guidelines, but they don't have general models for RM. Argentina, Finland, Mexico, Netherlands, Norway (Region Midt), Quebec, and USA have general models for risk management, but they don't have risk management policies or guidelines.

After the survey, we learned that the US government has SAFETEA-LU "Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users" enacted August 10, 2005 as policy and guidelines.

It was expected that countries would develop first risk management policies or guidelines and then general models for risk management. In reality there are more countries that have general models for RM than countries that have developed risk management policies or guidelines.

b) Risk Management for networks

The percentage of countries, which use risk management for road network projects at the general planning stage is 68% (17/25), 32% have specific risk management models for road networks (8/25).

c) Risk Management for projects

The percentage of the countries, where risk management is used for infrastructure projects, is 80% (20/25). The percentage of countries, which have specific risk management models to achieve Total Time-Quality-Budget is 36% (9/25). Further, the percentage of the countries, which have specific risk management methods for detailed studies in environment, transportation of dangerous goods, road/tunnel/bridge construction is 68% (17/25).

d) Highways securities

76% of the countries take into account the security aspects during the design stage of a project (19/25). For the planning stage of a network this percentage is 72% (18/25), in the operating stage it is 76% (19/25).

Italy and Sweden take into account the security aspects during the operating stage of a network, but not during the planning stage. Argentina takes into account the security aspects when planning a network, but not when operating it.

Events considered as a hazard for roads are natural hazards and man-made hazards below Fig. 1. and Fig. 2.

Figure 1 Natural Hazards

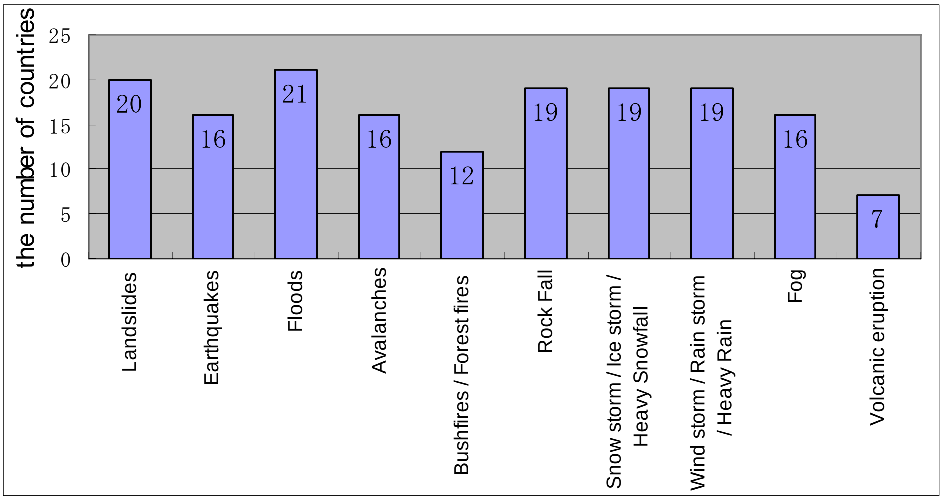
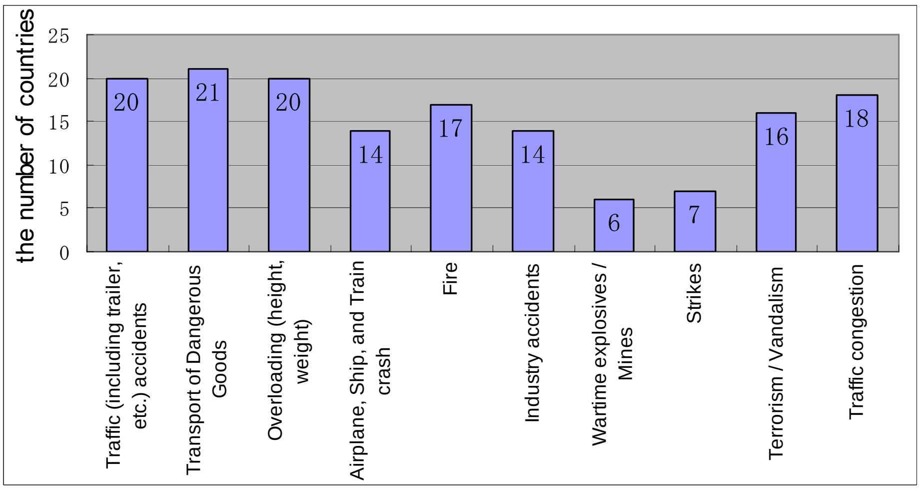


Figure 2 Man-made (human, social, technical) Hazards



2.2. Seminars

The 1st PIARC international seminar jointly organized by TC3.2 and the Ministry of Transport, Viet Nam was held from the 26th to 28th of April 2006.180 participants gathered (50 from overseas including Japan, Canada, New Zealand, France, Sweden, Norway, Switzerland, Spain, Italy, Malaysia, India, Sri Lanka and Indonesia +130 from Viet Nam) and 22 papers were presented (9 from TC3.2 International Committee Members and 13 are Invited) regarding the risk management for roads.

The seminar consisted of four sessions and one workshop: (Fig.4.)
Session 1: Introduction of RM Techniques
Session 2: RM of Natural Hazards
Session 3: RM of Man-made Hazards
Session 4: RM for Projects and Organization
International Workshop on Tsunami

In the seminar, the status of Viet Nam on risk management for roads was introduced. Regarding natural-hazard, natural disasters (typhoon, torrential rain, flooding) always bring great difficulties to Viet Nam. Proactive technologies (Landslide protection, continuous reinforcement of concrete pavement) were presented as countermeasures to mitigate damages of transport infrastructures in Viet Nam. Regarding man-made disasters, traffic accidents and negative impacts on environment have increased. Enhancement of the road user's compliance with traffic rules has the first priority because users' bad behaviour is the main cause of most accidents. In addition there are needs for establishment of the legal system and better coordination among relevant ministries.

The Seminar provided an ample opportunity for all the participants to share the knowledge and new ideas on about the risk management for roads and the Vietnamese culture.

Figure 3 Opening Remarks by TC3.2 Chairman, Dr. Michio Okahara

Figure 4 The view of the seminar

The report of this seminar can be found on the PIARC web site. (refer to http://www.piarc.org/en/). The 2nd PIARC international seminar will be held in Colombia in April 2007.

3. INTRODUCTION OF RISK MANAGEMENT TECHNIQUES

3.1. Risk Management for Roads in New Zealand, Mr. Roly Frost, Transit New Zealand. A transport system that builds a better New Zealand

Many parts of the world are at significant risk of natural and technological (man-made) disaster. New Zealand is a country of approximately 269,000 sq/km set in the Pacific Ocean and as such is vulnerable to a wide range of natural disasters, which are a major source of risk. The country has a range of weather extremes and a topography ranging from sea level to mountains of over 3,500 meters. The coastline is extensive with deep fiords and glaciers in the south to protected bays in the north. For a country so beautiful to visit and live in, it has many natural hazards such as extreme wet weather events, earthquakes and volcanic eruptions.

Transit New Zealand is a Crown Entity roaring authority managing the state highway network of New Zealand. Transit's approach to RM is to provide and encourage the use of a set of risk management tools with the purpose of minimizing unplanned occurrences and maximizing chances of success through greater risk awareness and proactive management. Risk management has become part of the organization's culture.

The paper discusses Transit's approach to reduce risks and examines in detail specific areas of risk to the transportation system from natural hazards. In particular the paper shows mitigation effects put in place for the following:

a) Lahar Management Risk Process

Mt. Ruapehu is an active volcano situated in the centre of the North Island. On Christmas Eve 1953 the Crater Lake breached creating a Lahar of water, mud, rock and debris to flow down the mountainside. The Lahar struck a railway bridge causing collapse. 151 people died as the majority of the carriages were swept downstream in the Lahar. In 1995/96 the mountain erupted again with ash spread over a wide sector of the North Island. The crater's lake refilling from rain and snow created a situation where water was retained by a relatively unstable dam, creating the probability of a Lahar. The paper discusses the mitigation that has been put in associated with this risk.

b) Seismic Risk to Bridges

The paper describes a systematic assessment of the seismic security of approximately 2,500 state highway bridges. The paper highlights the many variables that influence the results of a structural analysis and the significant amount of judgment required both in deciding the input parameters for the analysis and in interpreting the results.

C) Avalanches

An example of best practice gained from visits to Canada and Europe is highlighted in the paper as an example of mitigation measures taken to protect one of New Zealand's most scenic routes from avalanche damage.

The paper also details the application of risk management to vulnerable parts of the network, both in terms of the asset and the operation. It discusses the responsibility placed on the road authority in providing a road system that builds a better New Zealand within a sustained funding environment.

This risk management process is described in Risk Management Process Manual produced by Transit.

3.2. Risk Management for Projects, Mr. Johan Hansen, Sweden

Risk management for projects involves the components planning, design and construction of the management process for road networks. The operational aspects have to be considered in the phases planning and design. Sweden has guidelines for risk management in the following sub areas: balanced scorecard, project, network management, internal safety, and crisis management.

The risk management process consists of the following steps: risk identification, risk evaluation, and execution of measures. Risk identification and evaluation includes the aspects of time, cost, function, property (owned by the project or external), human (staff, road user, and third party), intangible assets (image, human resources, etc), and environment. The risk evaluation is based on a matrix considering the probability and the consequences of the risks. Evaluating risk, all aspects mentioned before need to be considered and balanced.

A case study of risk management for projects is the Southern Link in Stockholm. Based on this example, the interfaces of risk management with the project sponsor, the project management, the product, and external stakeholders has been illustrated. A checklist for project risk management has been provided:

- Decide on a plan for the project's risk management
- For larger projects appoint a coordinator for risk management
- Best qualified to deal with the risk should undertake it
- Project's top 10 ranking risks delivered to the next phase with suggestions for measures
- Requirements in the contract for the contractor's own risk management
- Perform risk analysis based on the 2 perspectives
    - Contractor phase
    - Road using phase
- During construction always prioritize safety, working environment, and environment along time-cost-function
- Keep the analysis up to date

The key conclusion is that risk management needs active support from management to be successful.

3.3. Risk Management for Highway Systems Security, Mr. Michel Cloutier, Canada

This part focuses on the operation of road networks. It deals with risk management principles related to Highway Systems Security.

Following the terrorist events of September 2001 matters related to Highway Systems Security have become increasingly important over the last few years as the level of awareness has, itself, become more widespread. Therefore many organizations have become increasingly involved in this area of expertise and several methodologies and approaches were developed to assist responsible authorities in the assessment of vulnerabilities of their infrastructure and the identification of critical assets.

This part consisted in a summary of interesting approaches. It appears that they have all been elaborated in North America. Even if most of the other countries in the world are exposed to terrorism actions too, the level of awareness seems not to be the same. The identified targets for terrorism are:

- Public transportation: Automobiles, trucks, buses, trains, subways, aviation, ships, etc.
- Infrastructures Highways and roads, bridges, tunnels, etc.

Based on the “Blue Ribbon Panel Document” the speaker gave a definition of risk and an overview of the RM principles related to the Highway Systems Security:

- Risk is the product of Occurrence, Vulnerability and Importance:
  R = O x V x I
- RM principles related to the Highway Systems Security:
  - Identify critical assets
  - Assess vulnerability/consequences
  - Identify countermeasures
  - Estimate countermeasures costs
  - Implement and review emergency plans

4. BEST PRACTICES FOR RISK MANAGEMENT

4.1. Risk Management of Natural Hazards

SH73 SPRINGFIELD TO ARTHUR's PASS SLOPE STABILITY EVALUATION, Mr. Terry Brown, Transit New Zealand

State Highway 73 runs 255 km between Christchurch and the West Coast on the South Island of New Zealand. The route includes the Arthur's Pass alpine pass through the Southern Alps. The mountains rise to some 2,200 m in this area and the road reaches an elevation of 920 m. The alternative route is 332 km long on SH7, the Lewis Pass and point to point, is 77 km longer than SH73.

A review process included a comprehensive assessment and prioritisation of the risks due to slope instability. The main objectives of the project included:

- To determine a cost optimal preventive maintenance programs at various detritus cleanup sections of SH73 between Springfield and Arthur's Pass; and
- To provide a procedure for demonstrating an appropriate standard of highway care where road users are subject to risk from slope instability hazards.

For SH 73 the risks have been identified for different slope instability events that could pose a threat to road users, Transit and the wider community. The types of events considered range from small-scale debris events that would impact on only part of a single lane, up to large-scale instability that would involve the overall slope both above and below the highway. The risk to life as well as financial risk to Transit and the wider community were identified for 55 highway cuttings. The risks have been prioritised and various mitigation options evaluated. The methodology used allows the economic consequences of various geotechnical events to be incorporated into the calculations, which were used to develop benefit cost ratios for the various mitigation options.

On an updated risk assessment there are 26 cuttings where the level of calculated annualised lives risk (ALR) exceeds an international recognised Intolerable Limit of 1 in 1000 (equivalent to 0.001 chance of fatality per year). This Intolerable Limit for ALR of 0.001 is currently used within the dams industry in Australasia and has been ratified by the New South Wales Coroners Court in recent proceedings relating to societal lives risk from potential events that cannot be managed by the general public.

Current trends in the application of lives risk criteria for hazardous industry and dams, where the risk receptors cannot manage the level of risk that they are exposed to, are adopting a level of risk above which is unacceptable (the Intolerable Limit). Below this threshold the decision on whether or not the risk is tolerable is being made based on the ALARP(ALARP stands for **A**s **L**ow **A**s **R**easonably **P**racticable) principle. In essence, risk reduction measures should be implemented until no further reduction is possible without very significant capital or other resource expenditure that would be grossly disproportionate to the amount of risk reduction achieved.

QUANTITATIVE RISK ESTIMATION OF ROAD SLOPE DISASTER,
Mr. Kohashi, Tsuneoka, Tanaka, Takahara, Hamada, Japan

Because of topographical conditions, many roads in Japan are built in the proximity of slopes that are unstable and susceptible to collapses and failures. Although the progress in protection measures has significantly reduced the frequency of road slope disasters, an enormous number of road slopes still remain dangerous. Furthermore, disasters such as slope failures induced by torrential rains and large-scale rock mass collapses, which are difficult to protect, have been conspicuous in recent years. Under these circumstances, road administrators are required to implement effective risk management against slope failure disasters under limited financial resources and to explain to the public the actual slope disaster risk and the cost-effectiveness of mitigation measures.

The proposed method applies a concept of risk curve developed in the field of disaster insurance to quantifying the level of risk in road slope disasters (Fig.5.).

First, the fragility curve is calculated based on the data such as past records of failures, precipitation records and results of slope stability inspection. Then the risk, defined as the socio-economical damages and losses, is estimated in the form of a risk curve based on the data such as the estimated scale of failures and the amount of traffic. This quantitative risk estimation method could help road administrators undertake the effective and efficient risk management.

A loss excedance probability curve, which is called a risk curve, depicts the probability that a certain level of loss will be exceeded on an annual basis. The procedure for creating the risk curve for an individual slope along a roadway section is shown in Fig. 5. The risk curve for a road section is developed by summing up the risk curves for all slopes within this section. This procedure is explained below using a case study. The case study was conducted for a 32.5 km road section from Nichinan City to Miyazaki City of National Route 220 in Miyazaki Prefecture, Japan (Fig. 6.).

Figure 5 Procedure for developing a risk curve

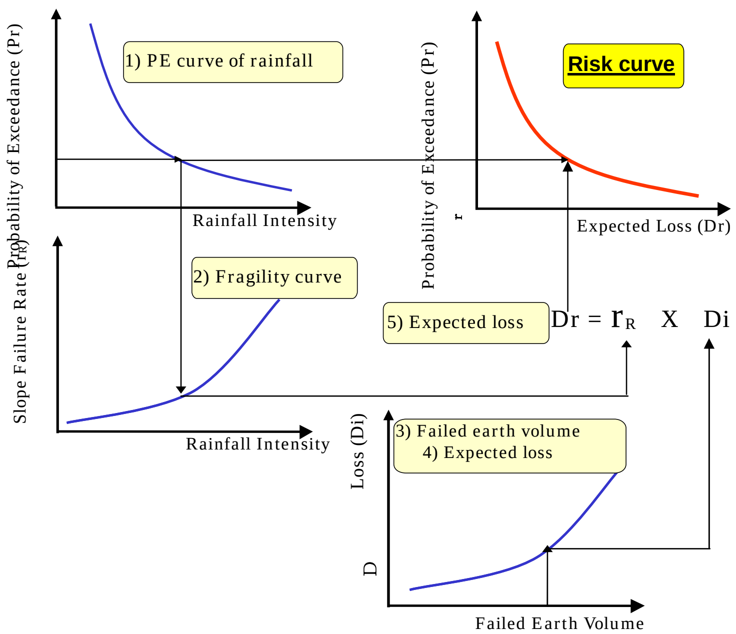
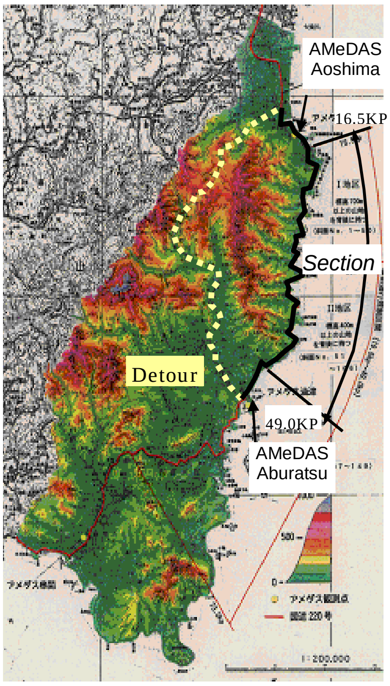


Figure 6 Section for case study



4.2. Risk Management of Man-made Hazards

Example of a risk management process in Italy: ”THE FREJUS TUNNEL”
Robert ARDITI SINA, Joel FAURE SFTRF , Ugo JALLASSE SITAF, Italy

The Fréjus motorway tunnel, opened on July 12th 1980, connects the city of Bardonecchia in Italy to the city of Modane in France through a bidirectional tunnel, 12.985 m long(Fig.7.). The Fréjus alpine tunnel in the first six months of 2005 recorded an average daily traffic of 5.360 vehicles. Since its opening in July 1980, traffic has constantly and proportionately increased according to trade flows crossing the Alps.

Fréjus is an Italian/French international tunnel and it is part of the trans-European network. In 2001 the Intergovernmental Commission decided to assess the technical and natural risks related to the operation of the Fréjus tunnel, in order to define any corrective and compensation action aiming to the reduction of the risks.

According to this instruction the tunnel operators SITAF and SFTRF performed a “Risk analysis on the Frejus tunnel and the relevant plazas” in order to assess all the risks related to the operation of this motorway tunnel.

Traffic flow has also been taken into account, as well as the relevant split in terms of light and heavy vehicles, coaches, vehicles carrying dangerous goods and exceptional convoys.
The operation of the tunnel has then been analyzed in terms of human resources, organizational structure, safety installations and equipment and relevant criteria of use.

The chart here below Fig.8 shows a methodological overview of the risk scenarios study, where the interactions of the various traffic anomalies into consideration have been taken into consideration, as well as the effects of a possible fire and human reactions to emergency situations.

Figure 7 The Fréjus Tunnel

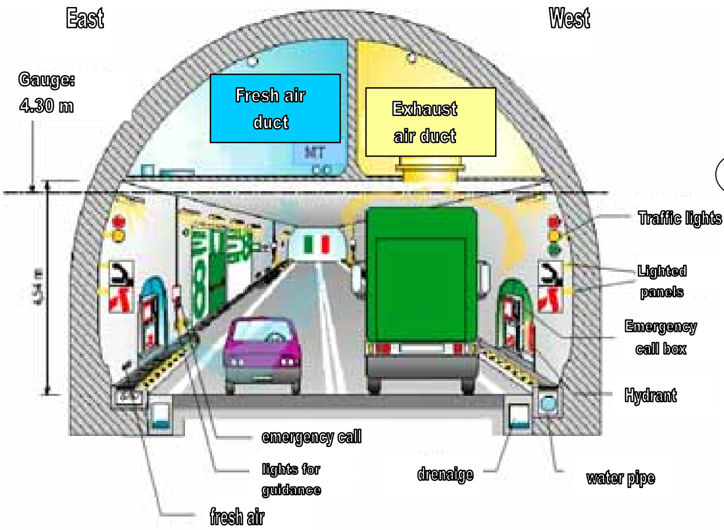
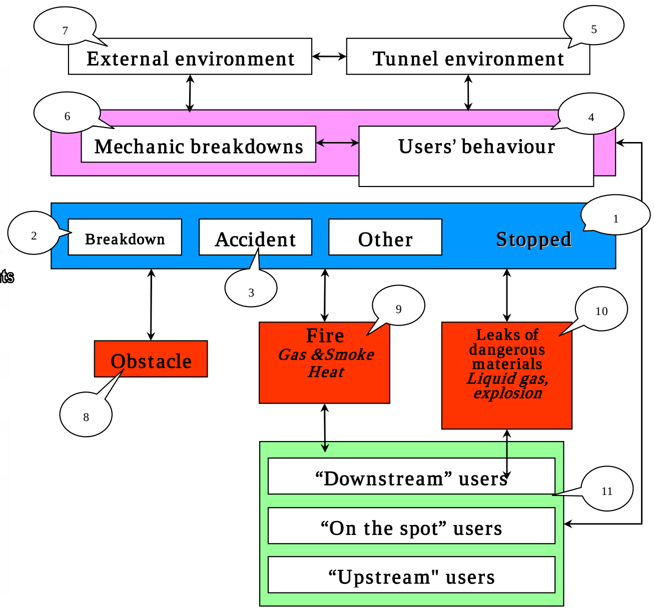


Figure 8 The chart of overview of the risk scenarios study



The consequences of risks have been classified according to the following Table 2:

Table 2 Classification of the consequences of risk

G	Class	Description
I	Minor	No additional damages with respect to the same external situation.
II	Significant	Light injuries, or severe injuries for the most vulnerable tunnel users, generated in the tunnel environment.
III	Critical	Severe injuries (irreversible), or death for the most vulnerable tunnel users, generated in the tunnel environment.
IV	Catastrophic	Death of people regardless of their physical ability, generated in the tunnel environment.
V	Severe catastrophy	Death of a high number of people (>50), regardless of their physical ability, generated in the tunnel environment.

4.3. Risk Management for Mega-projects

RISK MANAGEMENT ON MEGA PROJECTS AN EXAMPLE OF AN OPERATIONAL RISK ANALYSIS, Mr. Plovgaard Anders, Denmark

Several new Danish mega projects have applied systematic risk management in various forms to qualify decisions and to significantly improve engineer's decisions. The use of these techniques has shown that potential problems can be clearly identified such that appropriate risk reduction initiatives can be implemented in time. The most recent Danish (Swedish/Danish) mega project using risk management throughout the organization is the Oresund Link tunnel and bridge project connecting Sweden and Denmark (Fig.9.).

The Oresund Link (bridge and tunnel) opened on 1 July 2000; it includes 8 km of bridge and 4 km of immersed tunnel, joined by a 4 km long artificial island. As an integrated part of the Oresund Link Risk Management System the Operational Risk Analysis (ORA) was compiled. The purpose of the ORA is to summarize the risk facilities and major disruptions in the operational phase of the Oresund Link, to compare the risk with the acceptance criteria outline and if possible and/or required to take reducing measures.

In this report, followings elements are introduced as the practical examples for the management of risk proactively and consistently throughout the project.

- Hazard Identification
- Risk Acceptance Criteria on the ALARP (As Low As Reasonably Practical) domain (Table 3)
    for road : less than 33 fatalities per 1 billion passages of the Link
    for rail : less than 4 fatalities per 1 billion passages of the Link
- User Risk as individual risk and societal risk (Fig.10)
- Risk reducing measures (Assumption)

Vehicles and trains should be stopped in case of a collapse of the Tunnel or the Bridge.

Ventilation in the road tunnel tubes is working in case of an accident with dangerous goods or toxic materials and so on.

Figure 9 Possible hazards on the Oresund Link

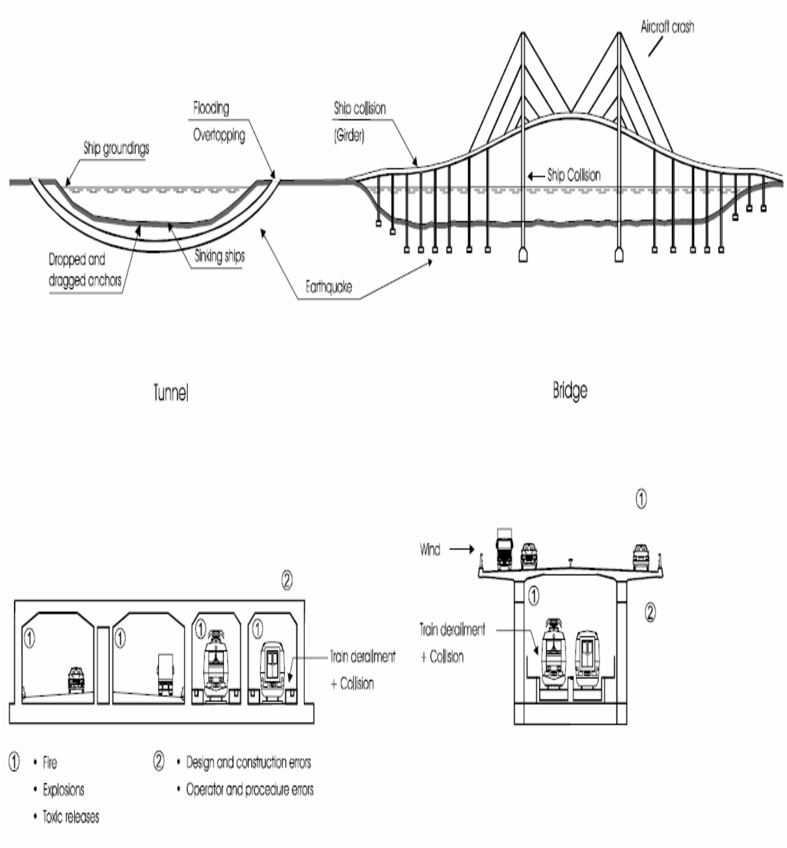


Figure 10 Contributions to the individual risk for road and railway users

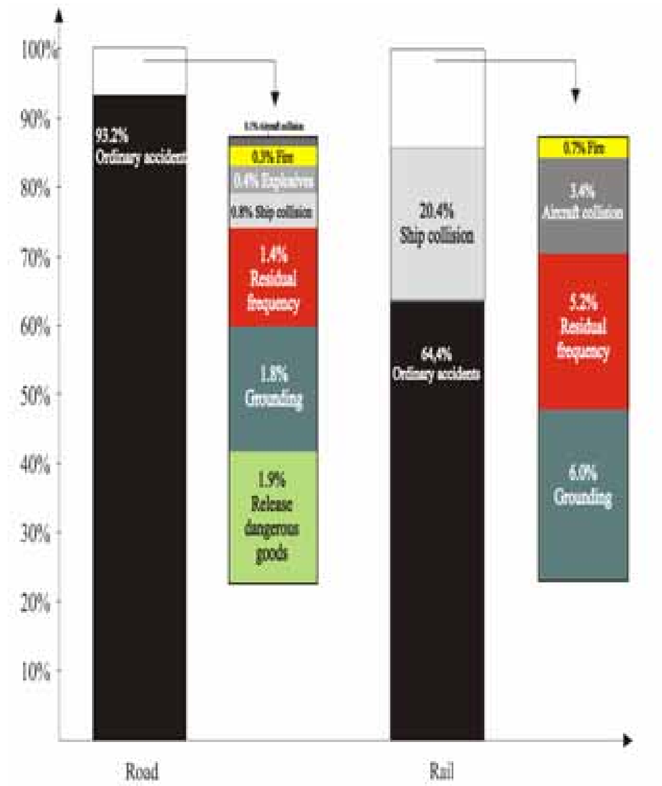


Table 3 Individual risk for road and railway users (i.e. the number of fatalities per billion passages of the Link)

Road / Rail	Yearly average number of fatalities	Individual risk	Acceptance criteria
Road	0.1871	21.3	33
Rail	0.0451	4.6	4

4.4. List of papers regarding risk management for roads

There are a lot of papers regarding risk management for roads in the meetings, seminars and journals as shown in the following Table 4.

Table 4 List of papers regarding risk management for roads

Title	Authors	References
The repercussions of Katrina storm in Quebec	Line Tremblay, French Speaking Secretary of PIARC TC 3.2, Canada-quebec	Routes/Roads 2006-N 329
Quantitative risk estimation of road slope disaster	H.KOHASHI, N.TSUNEOKA, M.TANAKA, H.TAKAHARA, T.HAMADA, Public Works Research Institute, Japan	Routes/Roads 2006-N 329
Risk management on mega projects an example of An operational risk analysis	Anders PLOVGAARD, Head of design, Road, Directorate, Denmark, Member of PIARC TC3.2	Routes/Roads 2006-N 329
Example of a risk management process in Italy " The Fréjus tunnel"	Robert Arditi, Member of PIARC TC3.2, Italie	Fourth Meeting of TC 3.2, PIARC in Tokyo
SH73 Springfield to, ARTHUR'S PASS SLOPE,STABILITY EVALUATION	Terry Brown, Transit NZ, for the PIARC, Member of PIARC TC3.2	Fourth Meeting of TC 3.2, PIARC in Tokyo
PIARC risk management technical committee	MICHIO OKAHARA, KEIICHI TAMURA, KEI TESHIMA, SHINJURO KOMATA,AKIRA SASAKI, HARUHIKO UETSUKA, Japan	2^{nd} International Symposium on Tunnel Safety & Security ,March 15-17,2006 Madrid, SPAIN
The report of 1^{st} PIARC international seminar	MICHIO OKAHARA, HIROYUKI NAKAJIMA, KEI TESHIMA,AKIRA SASAKI, Japan	Road Engineering & Management Review, July ,2006, Japan

PIARC/TC3.2 Risk Management for Roads Presentation List	
Title	COUNTRY
The 2nd International Committee Meeting in TORINO (2004.10.13 - 15)	
Advanced methods for the knowledge of the environment – objectives for the management of risk for roads	Italy
Gestion des risques des routes, façon pour mesurer l'urgences, exploitation et processus innovateurs	Italy
Johan Hansen's presentation	Sweden
Highway Systems Security	Canada
TRAMP project - Telematic control for dangerous goods on road	Italy
The relationship between infrastructures and wildlife: problems, possible solutions and interventions performed in Italy	Italy
The management of risk for road, the operator point of view	Italy
The 3rd International Committee Meeting in VALENCIA (2005.4.12 - 15)	
Examples of good practices	France
Practice of a mega-project considering RM – Using the Great Belt fixed Link tunnel as the case	Denmark
Risk Management in making decisions: The West Ring of Bergen	Norway
Sismoa, Seismic Vulnerability Assessment of Existiob Bridges	France
Civil protection at the Ministère des Transports du Québec	Canada-Quebec
Assessment and Proposal of an Action Plan – Multi-Partner Committee on Control of Dangerous Substances	Canada-Quebec
The 4th International Committee Meeting in TOKYO (2005.10.25 - 26)	
A landslide triggered by typhoons at UI, Nara	Japan
Prospect of Risk management in Road slope Disaster	Japan
Risk Management Study on Transportation Blockage Countermeasures for Scenario Earthquake	Japan
Risk Management for the Swiss National Highway System and its Bridge Stock	Switherland
The Millau Viaduct(from risks management perspectives)	France
Mt Ruapehu – a Unique Risk	New Zealand
The Southern Link in Stockholm – Successful "High-risk Project"	Sweden
The 5th International Committee Meeting in Ha Noi (2006.4.24 - 25)	
Presentation on road administration and risk management in Viet Nam	Viet Nam
Risk management for a major project	Japan
Technical toolbox for risk managementrf	Japan
State of the Art in Risk Management	Canada
Risk management techniques in the road sector	NEW ZEALAND
Risk management for mega-project	SWEDEN
Highway systems security	Canada
Viet Nam Seminar	
Risk Sharing in International Projects: In View of Incomplete Contracts	Japan
Introduction of RM for roads	New Zealand
Introduction of RM for projects	Sweden
Introduction of RM for Highway Systems Security	Canada
PIARC activities and results of international survey	Japan
Climate Change and Its impacts on Infrastructures, The GeRiCi Project	France
Earthquake and Risk Management	Japan
Seismic Risk Assessment Tool for Road Networks	France
Development of Road Slope Risk Management System Focusing on an Evaluation of Optimum Maintenance and Repair Plan	Japan
One Example of Road Tunnel Rout Modification Caused by Landslides	Japan
Recent damages on roads from the natural disasters and proactive and prevent measures to mitigate the damages in Viet Nam	Viet Nam
Emergency Response Guidebook	Canada
Traffic Management Special Scheme for Nuclear Transportation	Spain
"Risk Management in Road Transportation and Measures	Viet Nam
The Artificial Road Accident Rate Prediction Along Ayer Hitam-Batu Pahat Johor	Malaysia
Civil Protection Risk Management and Assessment	Canada-Quebec
Risk Management in the Planning Process for a Long Subsea Road Tunnel in Norway	Norway
South East Asia Community Access Programme (SEACAP) A New Approach	Canada
The National Training Program on Rural Road Management (SEACAP 11) -The achievements and lessons learnt	Viet Nam
Keynote Lecture regarding Risk Management	Japan
Current Status of Indonesian Tsunami Warning System	Indonesia
Recent Tsunami Disaster Stricken to Sri Lanka and Recovery	Sri Lanka
Others	
RISK MANAGEMENT STUDY ON TRANSPORTATION BLOCKAGE COUNTERMEASURES FOR A SCENARIO EARTHQUAKE	JAPAN
RESEARCH ON THE QUANTITATIVE RISK ESTIMATION METHOD OF ROAD SLOPE DISASTER	JAPAN
THE RESEARCH ON THE MONITORING SYSTEM OF ROAD SLOPE FAILURES WITH OPTICAL FIBER SENSORS	JAPAN
A REPORT ON RISK MANAGEMENT IN THE DESIGN-BUILD METHOD	JAPAN
A CASE STUDY OF RISK MANAGEMENT FOR PUBLIC WORKS	JAPAN

5. RISK MANAGEMENT TECHNICAL TOOLBOX

TC 3.2 is developing a technical toolbox, which is a database of useful technologies for risk management in each road management phase, i.e., planning, design, construction, operation and reconstruction in order to transfer technologies for risk management to developing countries. The completion of this new toolbox leads to effective and efficient contribution for the international cooperation.

What is Technical Toolbox for Risk Management?

The technical toolbox for risk management is a database of policy, techniques and operation (maintenance) technologies / tools with inspection facility for road management, which consists of the inventory sheets and their appendix. Purposes of technical toolbox for risk management are:

- Introduction of risk management techniques to the road sector systematically.
- Dissemination of the road risk management technology.
- Utilization of the technology as a common property by the participating countries.

What are Inventory Sheets?

The inventory sheets are prepared to introduce the risk management technology used mainly in Japan to the developing countries, and the risk management technology/tools from different countries will be added to them. The inventory sheets aim to assist budgeting and road management with easy application of risk management technologies/tools.

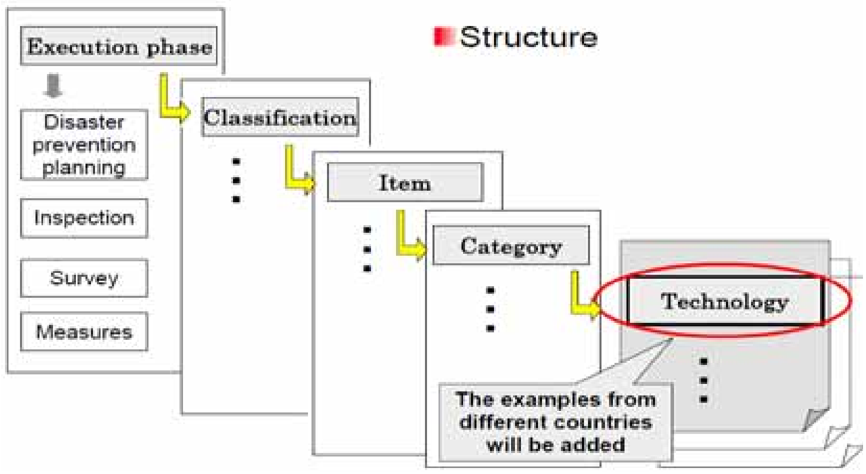
The inventory sheets record the applicability (e.g. effectiveness and cost) of used individual technologies/tools of risk management and the perspective of technologies/tools for future use. They are divided into natural hazards management and man-made hazards management. Every inventory sheet is structured in shown as Fig. 11 according to the execution phases of road management: planning, inspection, investigation, design, construction, maintenance, management and administration. All sheets are classified according to risk management process: risk analysis, risk assessment, risk treatment, risk communication and risk management.

The appropriate inventory sheet (refer to Fig.12) can be selected as shown in Table 5:

1) Choose the corresponding inventory sheet numbers according to natural or man-made hazard management;
2) Refer to the corresponding phase of project-execution and to risk management process;
3) Look up for the appropriate inventory sheet.

Advantages of the inventory sheets are 1) Provision of general idea of technologies/tools, precedents, cost, etc., 2) Easy decision-making to adopt best technologies/tools for risk management process according to the summary in each sheet, 3) Easy revision and expansion based on their development in electrical availability, 4) Usage as an effective tools of technology transfer to developing countries, and 5) Linkage to their appendix for further references.

Figure 11 Structure of Inventory Sheet



Inventory Sheets for the Natural Hazards Management

Natural hazards prone to road disasters are flood, earthquake, landslide, windstorm, wave/surge, tsunami, snow damage, and others (settlement, volcano eruption). Presently 109 inventory sheets for the natural hazard management are available.

Inventory Sheets for Man-made Hazards Management

Man-made hazards prone to road disasters are classified into the direct hazard (traffic accidents, dangerous goods transport, overloading vehicles and tunnel fire) and the indirect hazard (accidents near roads not caused by traffic users, such as fire, effect of nuclear accident, explosion in the factories, terrorism and war). Presently 11 inventory sheets for man-made hazard management are available.

Figure 12 Example of Inventory Sheet
(Tunnel inspection using a laser scanner)

Inventory Sheet 35

Project phase	Survey
Classification	Detailed survey
Item	Structural survey
Category	Surface survey
Technology	Optical scanning

Technical summary

Optical scanning is carried out in tunnels and other structures important for road disaster prevention management to detect surface degradation and deformation in the structure by optically scanning the concrete surface.

Effect

As this is a non-destructive method, it does not harm the structure and can be easily carried out.

Considerations

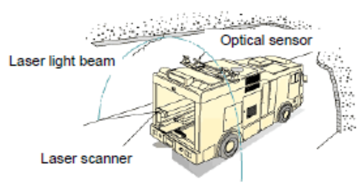
The equipment for scanning can be expensive. Also, there is a limit to the depth that degradation can be detected, so it is necessary to combine it with other inspection methods.

Cost/resources

	Chief engineer	Engineer	Technician	Total	Units
On site	0.0	1.0	1.0	2.0	Person.day
Reporting	0.0	1.0	1.0	2.0	Person.day
Total	0.0	2.0	2.0	4.0	Person.day

* Per 100㎡

Cost basis: Calculated based upon the results from within Japan



Inspection within a tunnel using a laser scanner

Inspection of road surface by laser scanner and scan image

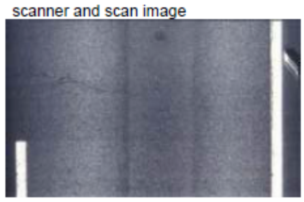


Table.5. Use of Inventory Sheets for Risk Management

Risk Management		General			Natural Hazard																								Anthropogenic (Man-made) Hazard						Maintenance					
					Natural Disaster Overall)				Flood		Earthquake		Slide: rockfall, slope failure, landslide and debrisflow					Wind storm		Wave/ surge/ tsunami		Snow damage		Others (Settlement, Volcano eruption)					Direct Hazard (traffic accidents, dangerous goods transport and overloading			Indirect Hazard (not caused by traffic user: fire and industry accidents along			Bridge			Tunnel		
Risk Assessment / Risk Analysis / Data Collection	Topographic and geologic conditions	1	4	9	1	4	9	14	14	16	14	16	14	16	17	18	19	16		14	16	14	16	14	16	17	18	19							10	13	14	11	13	14
		17	23	24	16	17	18	19			18	23	20	21	22	23	26							20	23	26	29								34	36	37	34	35	36
		25			20	22	23	24					29																						19	20	23	19	20	23
					25	26	50																												29	38		37	38	
	Conditions of surface sediments, tectonics and groundwater	1	4		1	4	9	14			14	23	14	23	24	27	29			103				14	23	24	28	29							10	21	29	11	21	
					23						57	58	30	31	32	33	45							30	31	32	33	45												
																								46	56															
	Weather and climate conditions	1	2	4	1	2	4	9	12				12	49				12	49	12		12		12	49															
		12			12	49																																		
	Disaster history	1	2	4	1	2	4	9	4	12	4	9	4	9	12	15		4	12	4	12	4	12	4	12	15									10	15		11	15	
		9	12	15	12	15			15		15							15		15		15																		
	Use of roads: daily traffic, traffic accidents																												m6	m10	m11				13					
Risk Assessment / Risk Analysis / Identi fication	Source of Natural and Man-made Hazards Situation of road facilities and structures (Pavement, slope etc.)	1	3	4	1	3	4	6	1	3	1	3	1	3	6	8	9	1	3	1	3	1	3	1	3	4	6	8	2			2			10	13	34	11	13	21
		6	7	8	7	8	9	15	4	6	6	8	15	17	18	19	20	4	6	4	6	4	6	9	15	17	18	19	m6	m10	m11				36	37	38	34	35	36
		9	13	20	16	18	19	20	8	9	9	15	23	24	25	26	27	8	9	8	9	8	9	20	23	24	25	26							21			37	38	40
		23	24	25	21	22	23	24	15		18	23	39	40	41	42	45	15		15		15		39	40	41	42	43										52		
					25	26	50				57	4	47	48	50	51	4							44	45	46	47	48												
													21	22										50	51	55	56	57												
																								58																
Risk Assessment / Risk Analysis / Risk Estimation	: Event, Consequence and Probability	3	7	111	3	7	12	111	3	12	3	15	3	12	15	39	40	3	12	3	12	3	12	3	15	39	40	41	m6	m10	m11				10			11		
									15		57		41	42	45	47	50	15		15		15		42	43	44	45	46												
													52	53										50	54	55	56	57												
																								58																
Risk Evaluation	: Risk Criteria, Risk scenario and Cost Evaluation	1	2	3	1	2	3	4	1	4	1	4	1	4	8	9	12	1	4	1	4	1	4	1	4	8	9	39	2			2			10			11	40	
		4	9	112	8	9	12	15	8		8	57	39	40	41	42	45	8		8		8	9	40	41	42	43	44	m6	m10	m11									
		113	114		50	109	111	112					47	50	51	52	53							45	46	50	51	54												
					113								109											55	56	57	58													
Risk Treatment / Risk Optimization	: Planning, design, construction and operation (maintenance) of countermeasure s								88	89	31	57	28	29	30	31	32			103	104	87		43	44	56	73	82	m1	m2	m3	m9	m10		m9			m8		
									90		58	92	33	39	40	41	42			105	106			96	97	98			m4	m6	m7									
											93	95	62	63	64	65	66												m8						36	37	91	35	36	37
											98		67	68	69	70	71																		92	93	94	99	100	101
													72	73	74	75	76																		95					
													77	78	79	80	81																							
													82	83	84	85	86																							
													88	89	90																									
Risk Treatment / Risk Avoidance		5	12	50	1	2	12	59	1	12	1	98	1	12	39	40	41	1	12	1	103	1		1	43	44			m5			m11			10	102		11	102	
		59	60	61	60	61							42	50	102	107	108			104	105								2			2								
		102	2																																					
Risk Treatment / Risk Transfer	Insurance)	110																																						
Risk Treatment / Risk Retention		5											39	40	41	42								43	44				m6											
Risk Communication		2	5	60	2	5	12	15	15	61	15	61	15					15	61	15	61	15		15	61				5	2		5	2		5			5		
		61	109	59	59	60	61													103	104								m1	m8		m11								
																				105																				

6. CONCLUSION AND TOPICS FOR THE FUTURE

The activities of TC3.2 including meetings, seminars, international surveys, studies, and technical toolbox are summarized as follows:

1) Since the commencement, TC3.2 has been making considerable efforts to achieve our objectives, by organizing five TC3.2 meetings in various countries and one international seminar in Ha Noi, Viet Nam. Two more meetings and the 2nd international seminar are scheduled until the World Road Congress in Paris.

2) TC 3.2 conducted an international survey to understand the current status of risk management techniques and practices in PIARC member countries. This international survey is two-fold, and the first survey was characterized as the first step to obtain more detailed information through the second survey.

3) Significant number of best practices of risk management for natural hazards and technological (man-made) hazards and mega-projects and the methodologies of risk management have been introduced and studied to improve expertise of the TC3.2 members.

4) The technical toolbox has been developed for technical cooperation to developing countries.

Through the committee members' discussion, it is pointed out that TC3.2 should exert further efforts to accomplish the following subjects which could not be focused on in depth during this 4-year term.

- The development of critical infrastructures protection against a variety of hazards
- The application of risk finance including insurance policies to risk management for roads
- The development of educational method including capacity building to risk management for roads
- The development of guidelines/manuals of risk management for roads
- The creation of information sharing strategies such as networking to mitigate disasters
- The development of risk management technical toolbox for technical cooperation improvement to developing countries
- TC3.2 should function as a showcase of risk management practices of advanced countries.