TECHNICAL COMMITTEE SESSION

29 September 2011 (am)

TECHNICAL COMMITTEE D.3
ROAD BRIDGES

INTRODUCTORY REPORT

CONTENTS

EXECUTIVE SUMMARY

Road bridges are fundamental infrastructure in all national, regional or local road networks. In many developed countries, significant budgets were invested in road infrastructure including road bridges during the economic growth after World War II. Due to this situation, many developed countries are facing a problem related to aging of road bridges. Developing countries have devoted their investment to infrastructure in more recent times and will face similar aging network issues in the future.

Various damages to reinforced concrete slabs, fatigue cracks on steel bridges, chloride attack on concrete bridges, and ASR in concrete bridges are among the more prevalent issues to have been reported. In addition, some countries have an urgent task associated with seismic retrofit against large-scale earthquakes.

To take care of these problems, road administrators provide a bridge inspection system. Under this inspection system, periodic inspections are conducted based on a predetermined interval. As a part of bridge inspection, bridge condition is assessed and corrective actions are decided. The inspection results are recorded within a bridge management system containing structural and environmental characteristics as well as a history of both repairs and strengthening. The inspection system begins the asset management process with the aim to provide appropriate maintenance and strengthening at the appropriate time to extend bridge life. In addition, the system permits effective allocation of limited funds for repair and reconstruction of bridges constructed during the period of rapid economic growth.

In light of the above, inspector accreditation, non-destructive testing and condition assessment for bridges, innovative maintenance techniques, and management of the bridge stock are important tasks for road administrators.

To further complicate bridge asset management, many countries are facing additional problems due to climate change. It is important to identify aspects of road bridges potentially affected by climate change. The technical committee TC D.3 has researched impacts to road bridges and identified adaptation strategies that are currently developed.

The work of the TC D.3 Committee during the last four years has been based on information collected from different countries in the world through questionnaires. Three groups were established by the Technical Committee TC D.3. Five issues assigned by PIARC were dealt with by these three groups and have been summarized in four reports. The work program followed by TC D.3 is presented in Figure 1.

Based on the four reports prepared by three groups, the session organized by the Technical Committee of Road Bridges will be four parts and will include the following:

- Inspector Accreditation, Non-Destructive Testing and Condition Assessment for Bridges
- Large road bridges, management, assessment, inspection and innovative maintenance techniques
- Management of the bridge stock
- Adaptation to climate change

Year / Work Item	2008			2009												2010												2011				
	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5
Meeting	x							x					x							x					x							x
Seminar													x																			
Development of work plan	x																															
Preparation of table of contents		x	x	x	x	x	x																									
Sourcing information								x	x	x	x	x	x																			
Prepare first draft														x	x	x	x	x	x	x												
Review period																				x	x	x	x	x								
Final draft																									x	x						
Translation																											x	x				
Review of translation for accuracy with original																													x			
Submission to PIARC General Secretariat																														x	x	x

Figure 1: Work Program

In addition, to exchange knowledge and ideas all around the world, those interested in inspection and assessment of the condition of road bridges, innovative maintenance/repair techniques, and management of the bridge stock are invited to present their information during the session organized by TC D.3.

45 abstracts were received to the technical session. All abstracts were reviewed by the TC D.3, finally 32 abstracts were nominated to submit a full paper.

This Introductory Report attempts to give a vision of the main topics to be presented and discussed in the session TC D.3 of Road Bridges.

These instructions are for the preparation of Introductory Reports for the XXIVth PIARC World Road Congress 2011. To ensure timely and efficient production of the congress proceedings that are in a consistent and easily readable format, authors must submit their manuscripts in strict conformity with these instructions. Your cooperation in adhering to these instructions is greatly appreciated.

COMMITTEE MEMBERS AND COUNTRIES WHO CONTRIBUTED TO THE REPORT

Committee members and countries having contributed to the activities are as follows:

Satoshi KASHIMA, Japan	Chair
Pierre GILLES, Belgium	Secretary (French)
Brian HICKS, Canada	Secretary (English)
Pablo DIAZ SIMAL, Spain	Secretary (Spanish)

Group 1

Leader	
Borre STENSVOLD, Norway	Member
Alessandro Contin, Italy	Corresponding Member
Brian HICKS, Canada	Member (Secretary)
Gediminas VIRSILAS, Lithuania	Member
Malcolm T. KERLEY, USA	Member
Philipp STOFFEL, Switzerland	Member
Ravi RONNY, South Africa	Member
Timo TIRKKONEN, Finland	Member
Toma IVANESCU, Romania	Member
Victor POPA, Romania	Member

Group 2

Leader	
Erica SMITH, Australia	Member
Alberto ASCENZI, Italy	Corresponding Member
Alvaro NAVARENO ROJO, Spain	Member
Andres TORRES ACOSTA, Mexico	Member
Dimitrios KONSTANTINIDIS, Greece	Member
Geraldine VILLAIN, France	Member
Henrik NIELSEN, Denmark	Member
Janos KARKUS, Hungary	Member
Kiyohiro IMAI, Japan	Associate Member
Louis-Marie BELANGER, Canada-Quebec	Member
Maurizio LIEGGIO, Italy	Member
Pierre GILLES, Belgium	Member (Secretary)
Vaclav HVIZDAL, Czech Republic	Member

Group 3

Leader	
Thierry KRETZ, France	Member
Masahiro YANAGIHARA, Japan	Corresponding Member
Pablo DIAZ SIMAL, Spain	Member (Secretary)

Countries having responded to the questionnaires prepared by Group 1:
Issue 3.4 :
Canada (New Brunswick, Ontario), Finland, Germany, Italy, Japan, Lithuania, South Africa, Switzerland, USA

Issue 3.5 :
Belgium, Finland, Germany, Italy, Japan, Lithuania, Norway, Slovenia, South Africa, Switzerland

Countries having responded to the questionnaires associated with Issue 3.1 and Issue 3.2 prepared by Group 2 :
Australia (Queensland, South Australia, Victoria, Western Australia), Belgium, Canada (Alberta, New Brunswick, Ontario), Canada-Quebec, Denmark, Finland, France, Greece, Hungary, Italy, Japan, Mexico, Norway, South Africa, Spain, USA (Virginia)

Countries having responded to the questionnaires associated with Issue 3.1, Issue 3.2, and Issue 3.3 prepared by Group 3 :
Australia, Belgium, Canada, Denmark, France, Germany, Greece, Japan, Sweden, USA

1. INTRODUCTION

1.1. Program of the Session

The session is intended for any bridge owners, engineers, and technicians related to bridge inspection, non-destructive testing, condition assessment, and innovative maintenance techniques including normal and large scale bridges. In addition, management of bridge stock and adaptation to climate change from the point of view of road bridge maintenance are included. To exchange knowledge and ideas all around the world, those interested in inspection and assessment of the condition of road bridges, innovative maintenance/repair techniques, and management of the bridge stock are also invited.

The session is structured in three parts:

- Presentation of the work of Committee TC D.3

Report 1: Inspector Accreditation, Non-Destructive Testing and Condition Assessment for Bridges
Report 2: Large road bridges, management, assessment, inspection and innovative maintenance techniques
Report 3: Management of the bridge stock
Report 4: Adaptation to climate change

- Individual contributions

To exchange knowledge and ideas all around the world, those interested in inspection and assessment of the condition of road bridges, innovative maintenance/repair techniques, and management of the bridge stock are also invited.
32 abstracts from all around the world have been selected to submit full papers .

2. COMMITTEE'S WORK

2.1. Inspector Accreditation, Non-Destructive Testing and Condition Assessment for Bridges

The goal of PIARC, Theme D is to improve the quality of road infrastructure through the effective management of assets in accordance with user expectations and managers' requests. While new technologies, social and environmental developments are expanding the sphere of interest for road authorities, infrastructure and management of assets remains their core business. The need for more efficient use of funds requires constant improvement in techniques in terms of the design, management and maintenance of assets.

The report was written to satisfy the following Technical Committee D.3 strategic plan issues:

- Issue D.3.1 – Inspections and non-destructive condition surveys; and
- Issue D.3.2 – Assessment of the condition of road bridges.

The first issue relates to the non-destructive testing techniques utilized throughout the world, their uses, advantages and disadvantages to form a best practice guideline for publication. The aim was to produce an assessment of the most effective regimes for structural inspections, identifying the key elements of the inspection process and report on the most effective techniques for non-destructive testing of different structural elements, taking account of costs, complexity and safety.

The second issue relates to the assessment procedures based on the detailed inspection process and qualification and accreditation regimes for bridge inspectors to ensure both consistency of results and safety of inspectors. The aim was to summarise the information on accreditation courses available to ensure that two different inspectors performing an inspection of the same bridge will give similar results and to document the different bridge condition assessment procedures.

Data was collected using literature research and the results of a questionnaire sent to bridge authorities in all member countries of PIARC Technical Committee D.3 – Road Bridges. A questionnaire was sent by working group 2 to identify the different inspector accreditation programs, non-destructive testing techniques and condition assessment approaches used by various road authorities.

A total of 22 responses from local road administrations in 15 different countries were received to the questionnaire. The data collected during the study are grouped, summarised, analysed and evaluated as presented in the final report.

Group 2 of Technical Committee D.3 has completed a study which presents and compares the qualification process for the inspection of road bridges, the types of non-destructive testing techniques utilised to determine key characteristics for different bridge materials and the condition assessment of road bridges in different countries or regions. These are all important components of an overall bridge management system to ensure appropriate asset management and bridge management activities.

The inspector education and qualification programs are compared using a number of criteria including admission requirements, duration and content of specific courses and requalification standards.

Non-destructive tests are categorised for different material types and further by the specific problem they are trying to address (e.g. detection of broken cables, crack detection or hardness). The purpose of the test is explained with images from the test itself or output results from the test. Comparison is made between the possible tests with recommendations on the most appropriate non-destructive test technique to adopt to reliably, economically and safely derive the specific material characteristic.

Condition assessment activities are compared using a number of factors including damage catalogues, condition assessment procedures, element ratings/scores, overall bridge or global ratings/scores and use of these ratings.

2.2. Large road bridges, management, assessment, inspection and innovative maintenance techniques

In order to deal with the specific problems of large bridges management, Group 3 has prepared a questionnaire that has been disseminated between PIARC members, with the specific objectives:

- to get information on large bridges maintenance and condition assessment ; a special attention was given to cable stayed and suspension bridges ;
- to get specific information on innovative maintenance and rehabilitation techniques ;

The aim of the questionnaire was to collect data on individual large bridges, The questionnaire was addressed to owners of large bridges, or to responsible persons or companies in charge of maintenance or to companies involved in large rehabilitation works.

Group 3 has received ten answers concerning the management of specific large bridges plus one answer concerning a large suspension bridge rehabilitation works. This information has been analysed and synthesised, and group 3 report on large bridge management includes:

- a presentation of the general principles of large bridge management
- case studies as examples of good practices
- more detailed information on innovative maintenance and rehabilitation techniques6. Conclusions

2.3. Management of the bridge stock

Bridges are valuable and costly elements of a country's inventory of transportation infrastructure. Some countries manage their inventory at the national level, others at the state on provincial level while others have introduced Public Private Partnerships (PPP's) for this purpose. Some countries have extensive networks of bridge infrastructure while others have a more limited number of bridges under their responsibility. Of the countries surveyed, the majority of the bridges are concrete in design whereas the United States and Japan have substantial steel bridges in their inventory.

Regardless of the number of bridges in a country's inventory, it appears that most have developed bridge management systems. These systems include bridge inspection, maintenance, rehabilitation and sometimes design. Some countries maintain the data input themselves while others employ external consultants. Most jurisdictions use their Bridge Management System (BMS) to prioritize their maintenance and rehabilitation program.

The work of the Issue D.3.4 “Management of Bridge Stock” Group 1 of TC D.3 “Road Bridges” was to assess the different approaches used to prioritise management action of bridges for a range of road administrations. Group 1 developed a working plan, prepared a detailed questionnaire, analysed the responses and documented its findings, including small and large scale structures, with comments on costs and skills required for management.

Responses from the countries surveyed also highlight several measures that could help in the prioritization of bridge projects. The experience and training of the inspectors are critical to a successful implementation as well as the ease of understanding and usage by decision makers.

2.4. Adaptation to climate change

Climate change has now become a global issue of concern and it is for this reason that PIARC has incorporated it into the strategic themes and technical committees for the term 2008-2011. Higher levels of carbon-dioxide as part of greenhouse gas emissions are being released resulting in heat being trapped in the atmosphere, which over time will result in a rise in the earth’s air temperature. This rise in temperature will filter into the oceans causing sea water to expand and therefore raise sea levels. There are already signs of extreme weather occurring in certain parts of the world resulting in events like drought, flooding, typhoons, earthquakes and tsunamis. The frequencies of some of these events are also increasing.

At the Copenhagen Summit held in December 2009, a global agreement on climate change could not be reached and therefore it is most likely the current carbon-dioxide emissions will continue. Under Strategic Theme D (Quality of Road Infrastructure), issues of concern of the extreme weather impacting on design and management on assets are being addressed. With regard to road bridges, of concern are the extreme day and night air temperatures causing expansion and contraction of bridge superstructures, frequency and intensity of rainfall (causing major flooding). Therefore, there is a need to review existing design codes about flood return periods, extreme wind patterns that effect the design return periods, intensity and frequency of earthquakes with the secondary effects as landslides or tsunamis. Scour control is also another aspect that needs consideration.

The study was therefore to investigate how the various countries define climate change and policies they may have in place, any cases of extreme weather conditions experienced and whether this has resulted in a change in design methodology of bridge stock. Responses were received via a questionnaire that was circulated to the various countries. The responses will assist in understanding the impact of climate change and its effect on design, construction and maintenance of bridge infrastructure.

Thirteen countries or states from five continents responded to this study, whose networks range from a few hundred kilometres to tens of thousands of kilometres and with substantial number of bridges. In general, there are extreme natural events being experienced in many countries resulting in loss of lives and loss or damage to infrastructure. Importantly however, most countries cannot qualify that these events are as a result of climate change.

The data collected during the study are summarized and comments on the developments from the various countries are given.

3. INDIVIDUAL CONTRIBUTIONS

45 abstracts associated with inspection and assessment of the condition of road bridges, innovative maintenance/repair techniques, and management of the bridge stock were received to the technical session. All abstracts were reviewed by the TC D.3 Committee, 32 abstracts were selected to submit a full paper as follows:

Structures management system on Croatian Highways

Application of a vulnerability model for bridges over stream beds against floods in 100 cases of the Spanish road network

The rehabilitation of bridges and the bridge management of a road network, results of current implementations, future development

Efficiency improvement applied to bridge management system of the state road network video in Spain

Introduction of non-destructive highway inspection methods using high definition video and infrared technology

Results of the long term surveillance researches of road bridges

Upgrading of Reinforced Concrete Bridges Utilizing FRP

Study on reduction of vibration control devices for Akashi-Kaikyo Bridge

Behaviour of hyperestatic beams corroded and repaired with mortar

Displacements and earth pressure at integral bridges and comparison of different constructions for the backfill area

Finnish Bridge Life-Cycle-Cost Guideline

Application of the Composite Materials on the structures of bridges

A case of measures for improving the long-term durability of a prestressed concrete bridge using high-strength concrete.

Strengthening methods for composite concrete bridges in longitudinal shear

Underwater pile repair using FRP – State of the art

Web Site of the Argentinean Bridge Management System

William R Bennett Bridge - a floating structure across Okanagan Lake

Design of orthotropic bridges with viscous bituminous surfacings: laboratory and in-situ testing, modelling and finite element calculation

Monitoring integrity and corrosion damage on stay cable bridge system in Mexican Highways

Electrochemical Corrosion Testing in Two Piers

Network monitoring of highway bridges in Spain

Performance of reinforced bitumen sheets for waterproofing of concrete bridge decks according to the European product standard.

Stonecutters and Forth Bridges - Holistic Approach to Design of Long Span Cable Stayed Bridges

Baluarte Bridge

Investigation of Bridge Formulas

Structural reliability analysis of a cable stayed bridge using Monte Carlo Simulation

Design and strategy for the monitoring center for bridges and intelligent structures of Mexico

Technology of optic fiber for bridge monitoring with application to the dynamic traffic loads in Mexican bridges

Comparison of the strain of the superstructure of a bridge with an analytical model and field test using monitoring equipment based fiber optic sensors

Rio Papaloapan Bridge: Design and successful application of special non destructive inspection techniques

Maintenance Plans for Highway Bridges

Inspection pf prestressed road bridges by ultrasound 3D tomographer

DRAFT CONCLUSIONS

Regarding the work developed by the committee in the five issues, some draft conclusions can be presented according to four reports:

- Regarding Inspector Accreditation, Non-Destructive Testing and Condition Assessment for Bridges

The report produced by Group 2 was researched and written to satisfy strategic plan issues related to inspections and non-destructive condition surveys and assessment of the condition of road bridges. Both issues are intrinsically linked to the PIARC goal of Theme D to improve the quality of road infrastructure through the effective management of assets in accordance with user expectations and managers' requests. Infrastructure and management of assets remains core business for all road authorities and the need for more efficient use of funds requires constant improvement in techniques in terms of the design, management and maintenance of assets.

Inspector Accreditation

Recognising and understanding that the detailed inspection process is the key to gathering information about the condition of the bridge network, a training course is considered essential for qualification of inspectors. This educational process, a theoretical course with some practical training is seen as an essential requirement to achieve consistent inspection data collected by diverse personnel.

It is recommended that detailed bridge inspection be the responsibility of an experienced civil engineer, with use of specialised technicians and external resources with appropriate bridge experience employed as needed. The course itself should be a minimum of 2 days, incorporating practical inspection training on actual bridge sites. To complete full accreditation it is recommended that inspection of a certain number of bridges, of different types, be completed and certified by the responsible bridge authority. A requalification procedure is considered a mandatory component of any training and accreditation system to ensure the continued quality of the inspection process.

In an ideal world, the detailed bridge inspection process should be performed in an apprenticeship manner. Perhaps this is possible in some circumstances, but with the speed and the constraints of the actual world, the growing and ageing bridge stocks and declining bridge maintenance funding, it is not often feasible. This is why a quality detailed inspection training program combined with a continuous quality control process (as an audit) and a requalification process are all essential. It is imperative to trust or to have a high degree of confidence in the initial technical data generated in the management process, and on which other human resources will count on afterwards in the analysis and decisional activities.

Non-Destructive Testing

Further inspection data, beyond that provided in the detailed visual inspection, is essential in order to know the condition of the bridge network and to plan judicious interventions in order to improve condition. Non-destructive testing (NDT) is one tool for the bridge inspector to provide reliable, quantitative information on the current bridge condition.

Recommended NDT methods have been proposed for each main bridge material to solve the various problems encountered in bridges of their construction. However, it should be noted that the range of problems may be very wide and it is difficult to propose a best method to cover all problems and situations. Although these recommendations are based on assessment of 22 questionnaire responses and aim to reflect the most effective techniques for non-destructive testing of different structural elements, each organisation must consider their own needs in relation to costs, complexity, laboratory testing facilities, reliability of data, access to technical experts and specialist technologies, portability of equipment and direct application of results.

Irrespective of the recommendations and the choice made by each individual organisation based on an assessment of their needs, it is important to bear in mind that most NDT methods do not measure aspects directly but rely on calibration and validation in order to make structural conclusions. Successful implementation of any NDT technology requires management support, extensive training, calibration and technology transfer. These implementation considerations must be addressed effectively if any NDT is to be used successfully. Further, it must be recognised that many NDT methods are useful only in mapping a bridge for identification of defects with specific recommendations for further destructive testing.

Condition Assessment

Condition assessment of bridges is an essential part of an overall system of bridge management. Understanding that the detailed inspection process is the key to gathering information about the condition of the bridge network, the rating of bridge elements is considered essential for determination of overall bridge condition. A standardised approach to condition assessment then provides a logically consistent framework for management decision support and communication of bridge inventory performance.

Organisations need to devise a condition assessment procedure to suit their uses of the information but certain recommendations have still been made. Damage catalogues are considered the most effective means to ensure unambiguous assignment of condition states. Condition states should only be assigned to the major structural elements with element scores considering the extensiveness and severity of the damage as well as the progression of the damage (deterioration) and the performance of the element in service. It is recommended that one element rating system be adopted for all elements with at most five scores for condition assessment. An overall rating calculated according to the weighted sum of the individual rated elements is considered to be the best approach for determination of the global condition rating.

In the current environment of limited funds for bridge replacement and maintenance, it is important to have objective data to be able to demonstrate decline in bridge health and support the fact that timely maintenance intervention over a long period is most cost effective. The use of condition assessment ratings helps fill these needs. Condition assessment also forms the basis for the estimation of possible interventions and for estimation of costs for possible remedial work.

However, it is important to realise that the inspection data compiled in thousands of reports are the results of human judgement. Bridge inspectors judge the performance, stability and the structural performance of critical elements for the assignment of condition states. For this reason, it needs to be kept in mind that although the overall score determined by calculation appears objective it is in fact made up of many subjective elemental scores.

The principles behind condition assessment provide a solid foundation to advance the state of the art in maintenance management. However, the use of condition assessment element or global ratings should always be considered a tool only with individual and expert engineering judgment applied to the results in the determination of the most effective bridge management activities.

- Regarding Large road bridges, management, assessment, inspection and innovative maintenance techniques

The report is based on the answers received to a questionnaire disseminated through PIARC TC D3 members to owners and managers of large bridges. It describes the management organisation of 10 large bridges, located in several countries and representing different structural types: cable stayed bridge, suspension bridge, large steel truss of different shapes (arch, cantilever beam), large prestressed concrete box girder, steel or concrete beams.

It appears that for most large bridges, a Specific Authority is in charge of the management and that safety, serviceability and durability requirements are more stringent than on standard bridges. Concerning safety, it appears that a risk analysis is done implicitly or explicitly to foresee and mitigate the risks. Concerning serviceability and durability requirements, it appears convenient to introduce the terms of "Conditional Preventive Maintenance" and "Maintenance for durability" to explain how these requirements are taken into account.

In order to act preventively and to achieve the serviceability requirements, it is necessary to have a precise knowledge of the bridge health. Then, specific assessment procedures and monitoring systems are used on large bridges, in order to cheek continuously or at given intervals the constitutive materials, components and the structure behaviour.

Large bridges are very expansive assets that are built for a sustainable future. The very notion of life cycle is inappropriate for theses structures. In fact, we should assume that they are built forever. Recent progress in steel and concrete materials and in the knowledge of their ageing processes make it possible to consider a one thousand life span, rather than the usual one hundred life span.

But three conditions are to be met:
- Very careful design of the structure and choice of materials, based on an risk analysis and on the integration of the management constraints, including the replacement of all components whose life span is limited
- Good execution
- A modern asset management approach, based on the concept of preventive maintenance as described in this article and on the usage of intelligent monitoring techniques to provide accurate information on materials, components and structural health and on their ageing.

- Regarding Management of the bridge stock:

Bridges are valuable and costly elements of a country’s inventory of transportation infrastructure. Therefore, a systematic and comprehensive approach for managing the assets is essential for both owner and user.

Twelve countries, states or agencies from five continents participated in the study, which included responses to the questionnaire developed by the committee. Regarding the funding and based on international experiences a value of about 1 to 1.5% of the replacement value of the bridge infrastructure is recommended for yearly bridge maintenance and inspection activities. This common value could not be proven by the answers of the questionnaire.

The survey showed also that Bridge Management Systems (BMS) are currently used in all countries responding to the questionnaire although they manage very different sizes of bridge inventories. It can therefore be concluded that a BMS is an important management tool to facilitate cost effective decision making in preservation of bridge assets.

An effective use of a BMS has to be based on the quality of the inspection method and updating the data. Therefore, the experience and training of the inspectors are critical to the successful implementation as well as the ease of understanding and usage by decision makers.

As possible future work, the committee recommends to study the existing reports on BMS especially whether there has been any development in the direction of asset management. Prepared by Group 1

- Regarding Adaptation to climate change:

Climate change is related to big time relations (i.e. decades, centuries). It seems to be clear that both natural (“internal”) and human activity-based (“external”) forces influence the range of the effects mainly linked with climate change. The present result of the classical question and answer framework showed that for more or less “new” issues new ways in gaining information should be tested. Workshops in collaboration with international experts promise better findings.

To provide a capability of bridges to adapt to the effects of climate change is certainly the goal of bridge owners worldwide, although the different age within the bridge stock makes it very difficult to decide how to act on existing bridges and how to design new ones. Deficiencies of existing structures are almost never caused by effects of climate change only, whereas design rules for new construction often do not treat effects of climate changes separately. Preventive measures for new construction to adopt them seem to be easier to develop.

Nevertheless, the exposure of climate change will certainly lead to a need of a deeper understanding of different effects caused by climate change on bridge structures. This could be a further work to be investigated in the next PIARC term 2012-2015.