PIARC Strategic Plan - 2020-2023

TECHNICAL COMMITTEE 4.2 – BRIDGES

4.2.1. Measures for increasing adaptability to Climate Change

Strategies / Objectives

• Collect case studies of damage resilient measures in different countries to climate change.
• Establish criteria for the design and construction of more resilient bridges.
• Search for innovative solutions to extend the service life of the bridges and rehabilitate them in the most-effective way:
    o Advancement of inspection techniques/technologies and bridge management systems
    o New rehabilitation materials and technologies.
• Encourage coordination with other TCs and TFs, such as *T.C.1.4 – Climate change and resilience of road networks, T.F.3.1 – Road Infrastructure and Transport Security, T.C. 4.3 – Earthworks, T.F.4.1 – Road Design Standards,* and *T.C.3.3 – Asset Management.*

There are already signs of extreme weather in certain parts of the world resulting in events heavy rain, flooding and typhoons. The frequencies of some of these events are also increasing.

In general, there are extreme natural events being experienced in many countries resulting in loss of lives and loss or damage to infrastructure.

Climate change has become a global issue of concern and it is for this reason that PIARC has incorporated it into the strategic themes and technical committee bridges for the terms of 2008-2011 and 2012-2015.

PIARC's International Climate Change Adaptation Framework for Road Infrastructure was produced by PIARC *T.C E.1 - Adaptation Strategies and Resiliency* (SP 2016-2019). Outputs associated with the issue "Measures for increasing resilience to climate change" will be expected to provide several measures which will be options for road owners within this Framework.

With regard to road bridges, concerns associated with climate change are the extreme day and night air temperatures causing expansion and contraction of bridge superstructures, frequency and intensity of rainfall (causing major flooding), and so on.

Importantly, however, most countries cannot qualify that these events are as a result of climate change. Furthermore, there is very limited information about the effects of climate changes on bridge design and maintenance.

Because of that, it is important first to clear and define the climate change for bridges in order to collect proper information and case studies associated with measures for increasing resilience to climate change.

Based on the above recognition, the scope of this study was first to investigate how the various countries define climate change and policies through literature review and questionnaires, and second to collect case studies with respect to the defined climate change impact, which are applied as measures for increasing resilience to climate change. The main findings would be included in a Briefing note.

Outputs	Expected Deadlines
• Literature review	• April 2021
• Collection of case studies	• April 2022
• Briefing note	• October 2023

4.2.2. Forensic engineering for structural failures

Strategies / Objectives
• Investigate current approaches to forensic engineering in order to ensure safety of the bridges and improve bridge standards.   ○ Identify good practices in managing all data and documentation obtained from failure captures in order to produce actionable information • Encourage coordination with other TCs and TFs, such as *T.C.1.5 – Disaster Management*, *T.C.3.1 – Road Safety*, *T.C.3.3 – Asset Management*, *T.F.3.1 – Road Infrastructure and Transport Security*, *T.C. 4.3 - Earthworks* and *T.F. 4.1 – Road Design Standards.*

Despite modern inspection methods and approaches, there are still bridge collapse disasters due to deteriorated materials or systems, construction defects, overloads, and poor design. Recent examples include the collapse of the I-35W Bridge over the Mississippi River in Minnesota as well as the Genova Bridge in Italy.

When a bridge collapse occurs, engineers investigate the cause of collapse to identify how design, materials, workmanship, and/or overloading affected structural performance.

In this meaning, Forensic engineering plays an important role in improving the safety of bridges. Engineers learn from the results of the Forensic engineering investigations and make improvements to the requirements of design, construction and maintenance in order to prevent these tragedies from reoccurring.

Laboratory experimental techniques and computer simulations have become highly developed to analyze material and system failures.

Expert witness testimony is commonplace to determine criminal and civil liabilities. Strategically placed cameras and data recording systems can often capture failures as they occur, greatly reducing the uncertainty of conflicting eyewitness reports.

An understanding of how to best capture all of this data and documentation to produce actionable information would be of value to the bridge engineering community and lead to the improved safety of bridges. Therefore, it is required to investigate the current approaches to forensic engineering in order to improve the safety of bridges and to include the findings in a report.

Outputs	Expected Deadlines
• Full report	• June 2022

4.2.3. Advancement of inspection techniques / technologies and bridge management systems

Strategies / Objectives
• Including electronic inspection techniques, drones, structural health monitoring/bridge instrumentation, Lidar, Radar, Thermography, big data analysis, machine learning – AI, BIM modeling, scour monitoring) • Encourage coordination with other TCs and TFs, such as *T.C 3.3 - Asset management*, *T.F. 3.1 – Road Infrastructure and Transport Security*, and *T.F.4.1 – Road Design Standards.*

Bridge inspections form an essential basis for the maintenance management of bridges and engineering structures. New technologies such as remote sensing and the use of a variety of sensors have the potential to significantly improve the quality of the results of structural inspections, but due to a lack of experience on the part of owners and operators they are not yet being used comprehensively.

The aim of the topic is to collect and process experience on the use of these new technologies on the basis of case studies and thus to make these technologies more readily available.

Outputs	Expected Deadlines
• Collection of case studies	• March 2021
• Briefing note	• October 2021

4.2.4. New rehabilitation materials and technologies

Strategies / Objectives
• Analyze the use of new materials and technologies such as steel (new combinations of strength and ductility), concrete (new cement, high performance shotcrete), composite, 3D printing for bridge repair. • Encourage coordination with other TCs and TFs, such as *T.C 3.3 - Asset management, and T.F.4.1 – Road Design Standards.*

Aging infrastructure with only limited functional capacity pose a major problem in terms of maintaining the mobility of people and the transport of goods. Bridges and other engineering structures are particularly important here because of their bottleneck function.

Within the framework of this topic, solutions are to be identified which can be used to accelerate and improve the repair and structural upgrade of bridges under traffic. In addition to new high-performance materials, the focus is also on the use of new technologies and construction methods with the focus on "Construction under Traffic".

Outputs	Expected Deadlines
• Collection of case studies including TC members comments	• April 2022
• Briefing note	• November 2022

4.2.5. Bridges damage-resilient in seismic areas

Strategies / Objectives
• Evaluation of the effectiveness of different retrofit techniques to enhance seismic resilience of highway bridges. • Comparison of different measures to improve the seismic resistance. • Encourage coordination with other TCs and TFs, such as *T.C.3.3 – Asset Management*, *T.C.4.3 – Earthworks*, and *T.F.4.1 – Road Design Standards*.

Seismic events caused severe damage on road bridges in seismic areas. It had resulted in closing of road networks.

Bridge damage causes not only bridge repair and restoration, but also produces indirect economic losses due to network disruption as well as traffic delay.

Therefore, it is always desirable to minimize these negative consequences from extreme events and to maximize disaster resilience of highway infrastructures.

Seismic retrofitting of road bridges is one of the most common approaches accepted by bridge owners to enhance system performance during seismic events.

In this relation, this issue evaluates the effectiveness of different retrofit techniques to enhance seismic resilience of highway bridges.

Seismic resilience of bridges can be represented as a combined measure of bridge seismic performance and its recovery after the occurrence of seismic events.

Comparison of different measures to improve the seismic resistance will be a good example for road owners to make decisions. They could be analyzed by a collection of case studies.

Hence, results obtained from this study would be drafted in a report that helps in educated decision-making for selecting efficient and cost-effective seismic design and/or retrofit strategies for highway bridges.

Outputs	Expected Deadlines
• Collection of case studies	• June 2022
• Full report	• December 2022