XVI WORLD WINTER SERVICE AND ROAD RESILIENCE CONGRESS
CALGARY, CANADA - 7-11 FEBRUARY 2022

Session Report

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TECHNICAL SESSION R 15.1, INCORPORATING RESILIENCE INTO ASSET MANAGEMENT MONDAY, FEBRUARY 7, 09:00 AM TO 10:30 AM

1. KEYWORDS

road asset management, asset management system, resilience, performance-based and data-driven approach, accountability, quantitive risk, performance and optimization, disaster recovery, climate change adaptation, Infrastructure management, Decision Support Tool (DST).

2. PRESENTATION OF THE SESSION

The section presents a series of approaches and case studies for incorporating resilience into the Asset Management business processes. Resilience is becoming a key consideration in Asset Management as agencies strive to identify risk associated with extreme events and develop robust, data-driven, risk-based decision support frameworks and tools for managing the road infrastructure. The session presents (1) a methodologies for assessing the benefits of possible maintenance activities in terms of discounted risk reduction illustrated with a case study in the Santarem region of Portugal, (2) the use of data-driven decision making, asset condition assessment, and identification of vulnerabilities and resilience implementation actions in Canada, and (3) the plans to establish a modern, effective and sustainable road Asset Management framework that incorporates resilience in Poland.

3. PROGRAMME OF THE SESSION

Session Chair: Gerardo FLINTSCH, Chair of PIARC TC 3.3, USA
Session Organiser: Gerardo FLINTSCH, Chair of PIARC TC 3.3, USA
Session Secretary: James SMITH, English Speaking Secretary of PIARC TC 3.3, Canada
Session Moderator: Matthew HAUBRICH, Member of PIARC TC 3.3, USA

Person	Organization, Position…	Title of the presentation
Rade HAJDIN	Infrastructure Management Consultants LLC, Switzerland	Decision Support Tool for Improving Resilience of Transportation Infrastructure (IP0040)
David HEIN	Independent Consultant, Canada	Asset Management Contributions to Road System Resilience in Canada (IP0011)
Andrzej MACIEJEWSKI	National Roads and Motorways, Warsaw, Poland	Resilience in Road Asset Management in Poland (IP0025)

4. TECHNICAL FINDINGS AND DEBATE

Decision Support Tools for Improving Resilience of Transportation Infrastructure
Rade HAJDIN (Switzerland)

- Condition assessment and periodic visual inspections cannot mitigate failures due to sudden events.
- Limitations to the current risk-based approaches and decision support tools.
    - Gradual deterioration of assets and sudden events are not treated concurrently.

    - Multimodal and multi-asset classes are not considered.
    - Analysis does not include the recovery process.
- Resilience evaluation methodology.
    - Identify threat scenario(s), failure mode(s), the consequences of failure(s), and the quality of service restored/improved.
    - Threat reduction and redundancy can be achieved through preventative maintenance.
    - Early/advanced warnings initiate contingency measures to aid the recovery phase.
- No unified approach to evaluating the benefit of resilience.
    - Monetization is a viable solution.
        - Model timing as a Poisson process (annual rate of occurrence).
        - Ranking of maintenance strategies using Cost (C) / Resilience (Re) ratio.
- Resilience-based Decision Support Tool (DST)
    - Web-based app for cost-effective decisions on maintenance to maximize network resilience
    - Allows risk and resilience analysis based on "what-if" scenarios (events, maintenance strategies, recovery delays, etc.)
    - Types of input data required: threat scenarios, asset exposure, and network details.
    - Failure scenario.
        - Probabilities can be calculated using Monte Carlo analysis or defined as a single magnitude.
        - Consequences based on traffic disturbances and socio-economic and ecology.
    - Visualization of consequences and risk.
    - Resilience assessment and recovery planning optimized C/Re ratio to account for recovery delays, maintenance strategies, budget, etc.
- DTS use in the Infrastructure Portugal road and rail project (SAFEWAY) identified the benefits of timely maintenance and the effectiveness of recovery activities based on a 100-year flooding event.

Asset Management Contributions to Road System Resilience in Canada
David HEIN (Canada)

- Canada's focus has primarily been reactionary as opposed to resilience and prevention of risks
- Challenges.
    - Large county, extensive road network, and relatively small population.
    - Temperature variations +27^{o}C to -25^{o}C with extremes as low as -50^{o}C and Artic areas covered in snow and ice for most of the year.
    - No federal authority is responsible for road infrastructure.
- Case study - Sea to Sky Highway (Public-Private Partnership with a 25-year concession contract)
    - Highway on the side of a mountain.
    - Forty-eight bridges, 219 mechanically stabilized retaining walls and 2.4 million cubic meters of earthworks.
    - Challenges: rockfalls.
    - Risk management and recovery program include:
        - Inspections following significant natural events (earthquakes, rainstorms and snow)
        - Identification and prioritization of mitigation procedures to reduce rockfall and debris risks.
- Case Study - Ice Roads
    - Limited year-round access to northern communities; most have access only through ice roads in the winter (seasonal) to move goods and services (mineral deposits, gold, diamonds, etc.).
    - Canada maintains over 5,500km of seasonal ice roads that are constructed and deconstructed yearly.
    - The ice roads behave like a flexible pavement (they will deflect and bend under load).
        - Safety factor (risk) for the ice strength (A) and thickness (h).
    - Use of ground-penetrating radar (GPR) for monitoring ice thickness and quality.

    - Mitigation measures have been developed for identified hazards (dry cracks, wet cracks, snowbanks, thermal contraction/expansion cracks, warming ice, high winds, and water level changes).
    - Additional mitigation methods: limit speeds (less than 25km/h), vehicle spacing, and no passing (travelling the same direction).
- Case Study - Road building in the Arctic.
    - Challenge to maintain the permafrost in a frozen condition.
    - Techniques – no cut designs (build-up), use of air convection embankments, heat drains, and light coloured aggregates

Resilience in Road Asset Management in Poland
Andrzej MACIEJEWSKI (Poland)

- Significant investment in road infrastructure has occurred over the last 15 years in Poland ($10+ Billion).
- Focus on resilience due to the EU Court of Justice decision to allow HV (11.5 tons/axle) on the entire public road network.
- The RAM4PL research project addresses the adaptive and technical challenges of the HV (overweight) demand.
    - Potential risks include: an increase in precipitation, an increase of HV traffic volumes, an increasing number of overweight vehicles, and accelerated loss of structural resilience and surface resilience indicators.
    - Development of a value governance framework that assessed impacts, services, assets, interventions and decisions, activities, and resources based on identified objectives, risk, planning, delivery, monitoring, and assessment to align aspirations and capacity.
    - Refinement of the planning process, following the Deming Cycle approach, Plan-Do-Check-Act (Adjust).
    - Enhancements were made to the optimized decision-making model to account for the network's resilience.
    - Identified risks – increased precipitation, increased HV traffic volumes, HV on all public roads, decreases in structural and surface resilience indicators.
    - New IT architecture was required to support the project (data warehouse, models, and business intelligence platform)
    - Output, optimized solutions based on identified objectives and constraints
- The methodology used in the RAM4PL project allows for smarter decisions ensuring the resilience of the whole network.
    - The development of dashboards assists decision-makers with key summary information.

5. RECOMMENDATIONS FOR DECISION-MAKERS, FOR PIARC OR FOR INTERNATIONAL ORGANISATIONS

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6. PREPARATION OF THE SESSION

The session was planned by PIARC TC 3.3 Asset Management Working Group #2, Measures for Improving Resilience of Road Network, led by Rade HAJDIN. Working Group members volunteered to share projects and experiences from their countries. Congress abstracts and papers were reviewed by volunteers of the TC.