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

Session Report

Date: 11/02/2022
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TECHNICAL SESSION 13.1. RESILIENCE OF EARTHWORKS. PART 1
FRIDAY, FEBRUARY 11, 09:45 PM TO 11:15 PM

1. KEYWORDS

Resilience, earthworks, natural hazards, case studies, landslides, etc.

2. PRESENTATION OF THE SESSION (RESILIENCE OF EARTH STRUCTURES TO NATURAL HAZARDS – PART 1)

Part 1 presented a series of approaches and case studies for incorporating resilience into Earth Structures. Resilience is becoming a key consideration in the design, operation and maintenance of Earth Structures as asset owners strive to identify risk associated with extreme events and develop robust earthworks solutions to support road infrastructure. The session presented (1) a definition of resilience in relation to Earth Structures (2) Measures for increasing resilience of Earth Structures on the road networks of Spain and Mozambique and (3) methods for measuring the Health of Earth Structures in Portugal.

3. PROGRAMME OF THE SESSION

Session Chair: Patrick Boisson
Session Organiser: TC 4.3
Session Secretary: Paul Nowak

Person	Organisation, Position…	Title of the presentation
Enrico Mittiga	ANAS, Italy	Definition of resilience
Felipe Collazos-Arias	Ministerio de Transportes, Spain	Increasing Resilience of Earth Structures on a Road in Northern Spain
Iracema Mascarenhas	National Roads Agency, Republic of Mozambique	Climate Resilience in the Road Sector in Mozambique Canada
Alexandra Ferreira	ASCENDI, Portugal	Geotechnical Infrastructure Observation and Health

4. TECHNICAL FINDINGS AND DEBATE

Patrick Boisson (chair of TC 4.3) introduced the first speaker, Enrico Mittiga who talked about the Case Studies collected by TC4.3, Working Group 1 for their Report on Resilience of Earth Structures. 16 case studies had been received from a variety of countries. The presentation began with an overview of the form of earth structures and to emphasize the fact they provide the foundations to infrastructure. These structures (embankment/cuts) need to adapt to natural hazards for a rapid recovery to an extreme event. This makes resilience is an interesting methodology base on many combinations: (1) structures need to be adaptable and easily repairable, (2) the structure must be designed to a well-known intensity of a hazard.

Felipe Collazos-Arias from Spain, presented an overview of hazards and failures of earth structures in northern Spain. The cases studies presented provided a number of different techniques as solutions including rock netting, water management biological engineering and embankment stabilisation. Most solutions were required to remediate failures that occurred due to high volume of surface water flow.

Iracema Mascarenhas from Mozambique was unable to present so Patrick Boisson presented a quick summary of her work and invited the attendees to download her paper, which received a PIARC Award. Roads in Mozambique are classified from 1 to 4 according to the needs of adaptation against climate change. The map that results of this analyse can greatly help the stakeholder in the reinforcements each roads need.

The last presentation was by Alexandra Ferreira from Ascendi, a private company in Portugal. They described their methodology for inspection and asset management of earth structures called SUSTims. The inspection is provides a grading for each structure from which either monitoring or specific maintenance is scheduled, as required. Alexandra identified that visual inspection is a cheap technique, close to the field.

To finalize the session, many questions were posed to Alexandra. Someone wanted to know if the SUSTims guide was already published. Alexandra answered that it is not yet published. Someone asked if the inspectors were trained and Alexandra responded that a formal training regime was required by all those undertaking filed inspections.

Patrick Boisson closed the session saying that it was an excellent session in which many case-studies were presented and invited the attendees to join the poster session and the second session.

30 persons attended this session.

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

In the session, many case-studies were presented. It is worth mentioning that the solutions can be considered to see if they can be utilized in other countries.

We saw in some case-study that many failures that happened in the last 20 years due to natural hazards, may be as a result of climate change. The repair technique can vary and must adapted to the problem. Resilience is greatly **improved with inspection of each earth structure** (Alexandra Ferreira). Even if it is mandatory in Portugal, Alexandra from Ascendi evaluated that **the cost for inspection and maintenance is cheaper than repairing the collapse when they happen**. Inspection needs tools for mapping and notation of the health state of each structure.

6. PREPARATION OF THE SESSION

This session was planned, designed and organised as follows.

Patrick Boisson, Natalia Perez, Yasmina Boussafir, Paul Nowak, Jason Hastings, Alexandra Ferreira (TC4.3)