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HAZARDSCRC

BNHCRC: RESEARCH ADVISORY FORUM

PROJECT B8: ENHANCING RESILIENCE OF CRITICAL ROAD STRUCTURES: BRIDGES, CULVERTS AND FLOOD WAYS UNDER NATURAL HAZARDS

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An Australian Government Initiative



OUTLINE

- 1) Research Partners
- 2) Challenge faced by road authorities
- 3) Research Program
- 4) Deliverables
- 5) Some preliminary work
- 6) Way forward
- 7) Feedback/Comments

RESEARCHERS & END USERS



Strand 1: Lead strand and project management. Road structures vulnerability modelling – all hazards – flood, fire, climate change (except earthquake). Development of prototype tool for maintenance optimisation for resilience.

Strand 2: Study effect of damage to road structures on community resilience, determine community adaptation measures.

Strand 3: Analysis of road structures due to earthquakes and contribution to flood and bush fire loading estimates as input for modelling.

Strand 4: Analysis of design standards for all road structures. Work with other streams to determine thresholds and update design standards.



PEOPLE

- 1) Prof. Sujeeva Setunge (RMIT)
 - 2) Prof. Chun-Qing Li (RMIT)
 - 3) Prof. Darryn McEvoy (RMIT)
 - 4) A/Prof. Kevin Zhang (RMIT)
 - 5) Prof. Priyan Mendis (Melb. Univ.)
 - 6) Dr. Tuan Ngo (Melb. Univ.)
 - 7) A/Prof. Karu Karunasena (USQ)
 - 8) Dr. Weena Lokuge (USQ)
 - 9) Prof. Dilanthi Amaratunge (Salford, UK)
- Dr. Ross Prichard (TMR Qld)
 - Mr. Nigel Powers (VicRoads)
 - Prof. Wije Ariyaratne (RMS NSW)
 - Dr. Neil Head, Attorney General Dept.
 - Dr. Matt Hayne, Geo Science Aust.
 - Mr. Myles Fairbairn, Locker Valley regional Council

2011 FLOOD IN QUEENSLAND

- 9170 road network,
- 4748 rail network,
- 89 severely damaged bridges and culverts,
- 411 schools
- 138 national parks
- 18000 residential and commercial properties were significantly affected in Brisbane and Ipswich



2013 FLOOD IN LOCKYER VALLEY REGION



LOCKYER VALLEY REGION



2013 FLOOD IN LOCKYER VALLEY



WORST FLOOD IN AUSTRALIA

- 1) Sealed roads (est: \$137 million)- 80 km of replacement road, 200 000m² patching and 128 km of repairs to shoulders and drains
- 2) Unsealed roads (est: \$8.5 million)- Replace pavement, bulk earthworks and shoulder repairs
- 3) Bridges (est \$11 million)- Replacement and repair (likely to change with more structural assessment)
- 4) Major culverts (est: \$5 million- Replacement and repair
- 5) Minor culverts (est: \$1.4 million)- Replacement and repair
- 6) Floodways (est: \$13.1 million)- Replacement and repair

- 43 out of 46 bridges were damaged!

RESEARCH PROGRAM

Vulnerability Assessment of Road Infrastructure

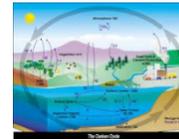
Bushfire



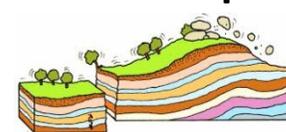
Flood



Climate Change



Earthquake



Images have been adopted from Google Images

Analysis of case studies and possible scenarios

- Failure of bridges / culverts / floodways
- Gathering required data from project's stakeholders
- Extraction of data and analysis of design codes
- Possible earthquake scenarios



Failure Mechanisms Identification and Rationalisation of the Effects Using Engineering & Scientific Knowledge

- Hydrodynamic studies
- Debris effects
- Fire & heat analysis
- Earthquake effects



Threshold Identification & Hardening Optimisation

+ Failure Consequences

- Engineering
- Economic
- Social/ / Environmental

RESEARCH PROGRAM

Vulnerability Assessment of Road Infrastructure

Failure Mechanisms Identification and Rationalisation of the Effects Using Engineering & Scientific Knowledge

- Hydrodynamic studies
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Failure Consequences

- Engineering
- Economic
- Social/ / Environmental

Direct Impact on Structures

- Likelihood of Structural Failure based on
 - Hazard Type
 - Structure Type
 - Location



Direct & Indirect Consequences on Community

- Environmental Impact
- Economic Impact
- Social Impact

Measures to Enhance Resilience of Critical Road Infrastructure

- Threshold Identification
- Innovative and Fast Strengthening Methods
- Hardening and Maintenance Regime Optimisation

Recommendations for Engineering Design Standards

Generic Methodology for Vulnerability Modelling of Infrastructure

Prototype Tool for Hazard Modelling on Infrastructure

OUTPUT – CONTRIBUTION TO KNOWLEDGE

- Advancement in understanding input hazard parameters for quantifying impact of hazards on road structures
- Understanding failure mechanisms under different hazard types and vulnerable structural forms – clustering of structural forms
- Quantifying community impact of failure of critical road structures
- Earthquake vulnerability profile for road structures in case study regions
- Road infrastructure retrofitting options and optimisation strategies
- Generic framework for vulnerability assessment of infrastructure

OUTPUTS – END USER DELIVERABLES

- Design guide for flood ways
- Earthquake vulnerability profile
- Road infrastructure retrofitting options and optimisation strategies
- Providing information to relevant Austroads code committees
- A prototype software tool to model effects of natural hazards on bridges, culverts and floodways