BNHCRC: RESEARCH ADVISORY FORUM

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

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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:** Community impact: Study effect of damage on 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.
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3) Prof. Darryn McEvoy (RMIT)
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6) Dr. Tuan Ngo (Melb. Univ.)
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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
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

**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

**Failure Consequences**
- Engineering
- Economic
- Social / Environmental

**Climate Change**

**Bushfire**

**Flood**

**Earthquake**

Threshold Identification & Hardening Optimisation

Images have been adopted from Google Images
RESEARCH PROGRAM

Vulnerability Assessment of Road Infrastructure

Failure Mechanisms and Rationalisation of the Effects Using Engineering & Scientific Knowledge
- Hydrodynamic studies
- Debris effects
- Fire & heat analysis
- Earthquake effects

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

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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