The Resilience of Road Access in the Wellington Region

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Acknowledgements
Outline

- What is Resilience?
- How Resilient is Road Access?
- Will Transmission Gully scheme help?
- Questions?
“the ability to recover readily and return to its original form from adversity”

RESILIENCE
Why Resilience?

- Transportation networks are vital lifelines.
- We live in a country prone to many natural hazards.
- We rely on a few transportation corridors.
Resilience

- Quality
- Vulnerability or Loss of Service
- Time for Recovery
- Time

• Resilience
(Smaller the area the greater the resilience)
Research

Resilience based approach
Performance

- **Damage State** - severity of damage
- **Availability State** - level of access after event
- **Outage State** - duration of reduced access

Diagram showing:
- Level of Service
- Vulnerability or Loss of Service
- Time for Recovery
- Resilience (Smaller the area the greater the resilience)
# Resilience States

## Availability State

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## Outage State

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Resilience of Road Networks

- **Level 1**
  - National Strategy
    - (Ministry of Emergency Management and NZ Transport Agency)

- **Level 2**
  - Regional Transportation Risk Management Strategy
    - (Regional Councils, Local Authority RCAs & NZ Transport Agency)

- **Level 3**
  - Road Network Asset Risk Management
    - (Road Controlling Authorities)

- **Level 4**
  - Emergency Management
    - (Road Controlling Authorities)

- **Level 5**
  - Project Development & Design
    - (Road Controlling Authorities & Designers)
Resilience of Access

- Likely to take more than 6 months to restore access
- Remain vulnerable to aftershocks
- Major impact on response and recovery
• National Strategy
  • (Ministry of Emergency Management and NZ Transport Agency)

• Regional Transportation Risk Management Strategy
  • (Regional Councils, Local Authority RCAs & NZ Transport Agency)

• Road Network Asset Risk Management
  • (Road Controlling Authorities)

• Emergency Management
  • (Road Controlling Authorities)

• Project Development & Design
  • (Road Controlling Authorities & Designers)
Pre-planning for Post – Earthquake Response

- Identification of critical areas
- How to restore access
- What resources required
- What prior engagement required?
Key Issues for Route Security

- Road form – cuttings, embankments, walls, viaducts
- Active fault crossings
- Performance of cut and fill slopes
- Geotechnical uncertainties
- Cost of solutions
Performance

- **Damage State** - severity of damage
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**Resilience**

(Smaller the area the greater the resilience)
Route Security Philosophy

- *Highway open for full access in small hazard events*

- *Continued access or reopens after short closure (12 hrs to 3 days) in moderate hazard events*

- *Limited access can be restored within reasonable period (say 3 days to 2 weeks) after long return period event*
Active Faults

- Ohariu Fault 1,500 - 2,200 years
- Moonshine Fault > 11,000 years
- Active splinter of Ohariu Fault ~ 2,500 years
Road Forms Considered

- Benched cuttings with rock fall barriers
- Reinforced soil embankments
- Reinforced soil walls
- Half Bridges
- Viaducts
- Tunnel options
Highway alignment

- Avoid steep hillsides with thick colluvium on Eastern flank
- Avoid inferred landslide on Eastern flank of valley
- Use wider valley floor through Battle Hill
- Restricting Ohariu Fault crossings to one
- Crossing fault on earthworks road form, NOT viaducts
Cut Slopes

- Precedent cut slopes and natural slopes in the region
- Historical earthquake induced landslides
- Dominant shear / crush / fault defects in rock
- Rock mass failures in rock
Dominant Defects
Cut Slope Design Philosophy

- Cut Slope Stability
- Integrated Cut Slope Design
- Earthquake Performance
- Cost Effectiveness
- Rock Fall Management
Integrated Cut Slope Design

Cut slope angle

30  40  50  60  70  80  90

- Rock mass cut slope stability
- Earthquake performance
- Rock defect kinematic stability
- Rockfall management

Proposed cut slope

• low risk
• medium risk
• high risk
Cut Slope Configuration
Cut Slopes

- Adopted 40° to 50° slopes to 60 m height

- 35° slopes in higher 70 m to 75 m high cuts in sheared rock

- Avoided eastern flank of valley with higher cut slopes

- Provision for cut slope stabilisation where necessary
Wenchuan Earthquake, 2008
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Expected Performance

- Remains open in moderate earthquake and storm events, or small sections closed can be quickly opened.

- Highway closed in large earthquake events at some sections, particularly if Ohariu Fault rupture event . . . but can be opened for limited access in 3 days to 2 weeks.

- This will significantly improve access into Wellington, including after a major earthquake.
Project Cost

- Preferred Scheme ~ $1 billion
- Some $300 Million savings over original scheme
Conclusions

- Resilience is a useful concept for understanding the security of our road network.

- The access into Wellington is likely to be unavailable for a long time after a major earthquake.

- Understanding resilience expectations within wider network is important.
Conclusions

- Transmission Gully highway will significantly enhance resilience of access for Wellington
- Resilience can be enhanced by early focus on route security
- Resilience doesn’t necessarily cost more!