Lessons learned from one of New Zealand’s most challenging civil engineering projects: rebuilding the earthquake damaged pipes, roads, bridges and retaining walls in the city of Christchurch 2011 - 2016.

Seismically Induced Shear of a Concrete Reservoir in the February 2011 Christchurch Earthquake: Investigations and Response

Story: Huntsbury Reservoir
Theme: Design

A PowerPoint presentation prepared for the Australia New Zealand Geotechnical Engineering Conference.

This document has been provided as an example of a tool that might be useful for other organisations undertaking complex disaster recovery or infrastructure rebuild programmes.

For more information about this document, visit www.scirtlearninglegacy.org.nz
Seismically Induced Shear of a Concrete Reservoir in the February 2011 Christchurch Earthquake: Investigations and Response

ANZ 2015 // 22-25 February 2015

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Huntsbury No. 1 Reservoir

- Circa 1954
- 36,000 m³ capacity
- Reinforced concrete
- $M_w 6.2$ EQ 22 February 2011
- Damage → complete functional failure
Structural Damage
Crack Mapping

- Zone 20-25 m wide
- Oriented 280° - 300°
- Full depth of slab
- S moved ~50 mm NW
Tunnel Observations
Observations Beyond the Reservoir
Geotechnical Investigation

Legend

- Floor Cracks
- Borehole
- Trench
- Evidence of shear zone within core
- Evidence of shear zone within trenches
- Evidence of shear zone within Tunnel
- Significant core loss
Geotechnical Investigation
Interpreted cross-section of shear zone

Maximum Extent of Floor slab cracking (~33m)

Legend
- Ash
- Basalt
- Fracture Inclinations
  - Most Likely
  - Unlikely
- Clay lined fractures
- Inferred fault trace
- No recovery

Interpreted cross-section of shear zone
Inferred concentrated zones of movement 65-85° ± 10° S-SW
Apparent extent of shear zone 20-25m
Assessment of Geological Risk

- Expect further displacement during seismic events
- Not possible to forecast seismic events or movement.
- Potential 50-150mm of movement along shear zone over next 50 years
-Extent and width of shear zone 20-25m
- Principles of MfE ‘Planning for Development of Land on or Close to Active Faults’
Remedial Options

• Alternative site – not viable

• Reinstatement solutions:
  - Option A: Reinstate existing
  - Option B: Single new reservoir
  - Option C: Multiple new reservoirs

• Considered a range of technical solutions

• Materials: Reinforced Concrete Steel, HDPE liner
Selected Repair Solution

Legend

- Floor Cracks
- Borehole
- Trench
- Evidence of shear zone within core
- Evidence of shear zone within trenches
- Evidence of shear zone within Tunnel
- Significant core loss
- New Structures

Legend:

- BH3
- BH1
- BH2
- NE Reservoir
- SW Reservoir
- Existing Reservoir
Construction
Completed Repair
Conclusions

• Observations and investigation confirmed presence of 20-25m wide previously unknown shear zone

• Geotechnical design criteria - based on recorded evidence and judgement

• Assessment of risk, site viability and technical solutions

• Solution: modification of existing structure providing setback

• Highlights importance of integrated engineering, geological and geotechnical assessments when designing critical infrastructure.