Value for Money
Value
Value
Risk and Value
Tunnel Description

Tunnel description
• 1.27km long
• Unlined rock
• 3.8m high
• 6 to 7m wide
• 10% gradient
• No power supply - On site generator is only power supply
Tunnel Traffic

Traffic demand is primarily unidirectional flow:

• Going in in the morning, and
• Out in the evening
Background

- 12% buses
- Steep climb uphill from Milford to the tunnel
- Several bus fires.
- Fire life safety risk
- Tunnel study
Tunnel Study

Initial Findings

- A new duplicate tunnel.
- Ventilation.
- Deluge.
- Egress.
Quantitative Risk Assessment (QRA)

PIARC Definition

Definition of all fire events.

Decision tree of probabilities and consequences.

Options:
• Do Nothing
• Various improvements
Key Findings

Primary risk is old buses uphill.

Consequences for uphill traffic!

Bi directional operation increases consequences.

Operational measures provide major improvements.

- Bus checks
- Uni directional flow
- Cameras
- etc
## Summary Results

<table>
<thead>
<tr>
<th>Option</th>
<th>Lives/100M V.km</th>
<th>Years to fatality</th>
<th>NPV Cost</th>
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<tbody>
<tr>
<td>Do Nothing</td>
<td>630</td>
<td>10</td>
<td>$0</td>
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<tr>
<td>Operational</td>
<td>75</td>
<td>85</td>
<td>$3M</td>
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<tr>
<td>Deluge</td>
<td>65</td>
<td>100</td>
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<tr>
<td>Egress</td>
<td>130</td>
<td>50</td>
<td>$15M</td>
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<tr>
<td>Ventilation</td>
<td>130</td>
<td>50</td>
<td>$20M</td>
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<td>New Tunnel</td>
<td>40</td>
<td>165</td>
<td>$160M</td>
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<td>Benchmark</td>
<td>0.07 (10)</td>
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</table>
EQ – Low Probability / High Consequence
CHCH CCTV Building – Design Issue
Christchurch Masonry
Christchurch Liquefaction
Christchurch Bridges

Footbridges damaged.

SH Bridges minor damage only.

Continuous bridges most at risk.

No loss of life on bridges.

No major traffic disruption

Abutment rotation.
Christchurch Bridges

Liquefaction resulted in the banks “flowing” towards the river.

Abutment piles rotated and probably yielded.

The question then arises – what do we do now?

• Live load test
• Fixed up approaches.
• Monitor
NZ EQ Prone Buildings Policy

1931 Napier EQ 256 people died.

Building improvements reduced Christchurch deaths by ???

95%

EQ Prone building < 33% NBS.

Schools & hospitals 15 yrs to retrofit.

Other buildings much longer.

Bridges exempt EQ prone rules.
EQ Lessons Learned

Bridges are resilient generally.

We can live with damage.

Main problem is design “flaws”? 

Seismic retrofit programme revised and curtailed.

Seismic design criteria being revisited.

Value based on risk to life 1st
MacKays to Peka Peka Project

New expressway on SH1.

High seismic zone.

Poor foundations.

Susceptible to liquefaction.

Reduced seismic performance saved $30M.

• Specific assessment
• Incremental costs and risks
• Subjective value choice by NZTA
Maximise freight productivity.

Minimise infrastructure costs.

VDAM Rule 2010.

Maximise the safe live load capacity.
Freight Network

Business case for HPFN

792 bridges on HPFN

Screened to 159 for Assessment

64 bridges strengthened.

$30M for first tranche

5% of network = 50% freight km
Maximising Live Load Capacity

Material testing.
Sophisticated analysis.
Canadian shear standard.
Compromise on serviceability
Load management through WiM
Structural response monitoring
Special inspection monitoring.
Reduced live load factors:
• Route restriction.
• Accurate deterioration.
• Ductile failure mode
• 6 month inspection.
• Early replacement feasible
Rakaia Bridge

Longest bridge in NZ

Theoretically under capacity for HPMV

WiM station to measure loads.

Instrumentation to measure response.

Good research (play) opportunity.
Live Load Risk

Failure due to live load is another low probability high consequence event.

On the one hand we know that most bridges have significant reserves of capacity.

On the other hand there are some that don’t and we can’t afford a failure.
Actual Risks Realised

Newmarket Viaduct ($240M)

Auckland harbour bridge extensions ($80M)

Kaituna bridge ($1M)

Kawerau Truss ($1M)

Waitaki Bridge ($3M)

Mohaka truss bridge
Bridge Inspection

Bridge Inspection Engineer
- Inspection and maintenance skill and experience
- Structural understanding
- Inquisitive and logical
- Thrifty
- Slow and steady
Mohaka Bridge

Minnesota Bridge

https://www.youtube.com/watch?v=C31lOHNzbM
Questions