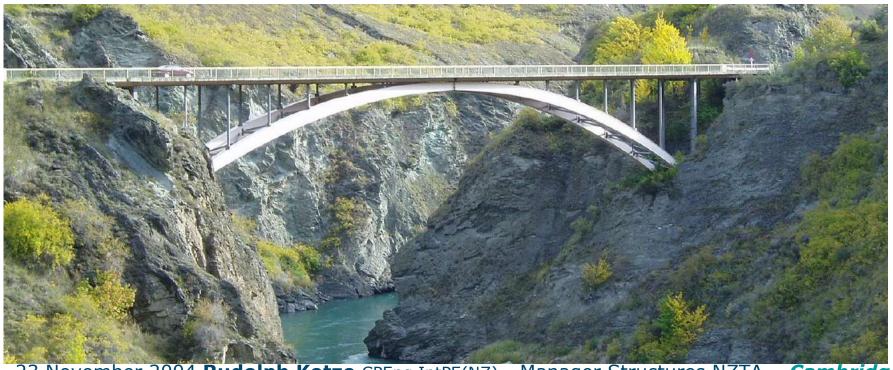
Bridges 2020: Management for Long Term Performance



23 November 2004 Rudolph Kotze CPEng IntPE(NZ) - Manager Structures NZTA Cambridge September 2009



2011 Rugby World Cup



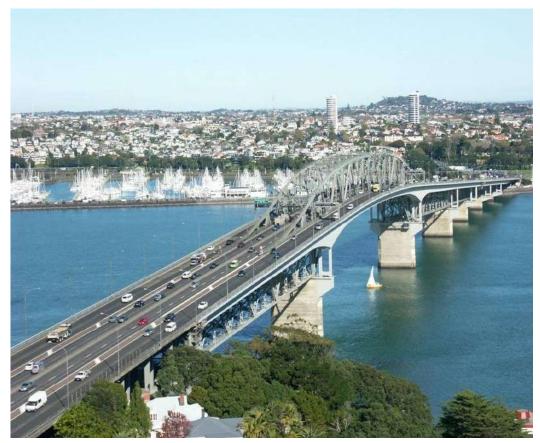


New Zealand Government

2

Risk-based Bridge Asset Management in New Zealand

- Asset description
- Funding priorities
- Asset management
- Risk management
- The future.....





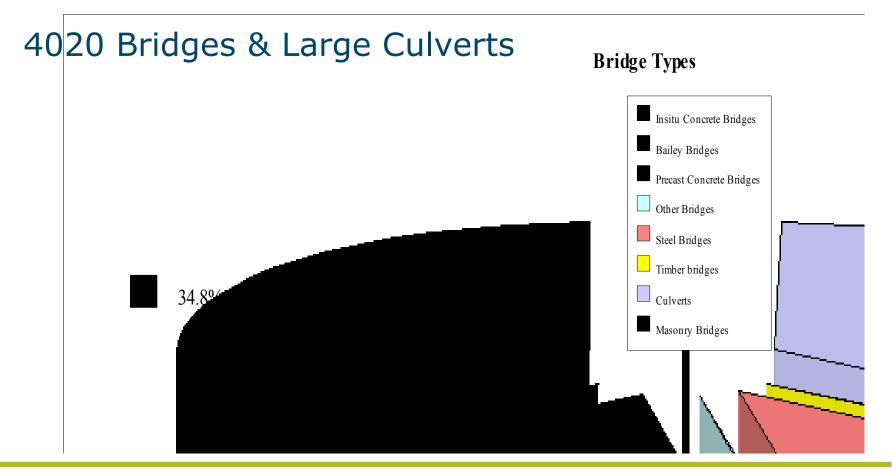
State Highway Network

- 4,020 bridges and large culverts (>3.5m²)
- Bridge stock equivalent to average Australian State
- Replacement ~NZ\$6.0B
- Depreciated ~NZ\$3.7B





Asset description





New Zealand Government

5

Asset Performance Criteria

Load Capacity

- All bridges \geq Class I
- 4 bridges "One at a time"
- 17 reduced speed

Height Clearance

- 13 bridges < 4.55m
- 7 tunnels < 4.55m

Bridge Width



• 327 bridges < LOS width thresholds

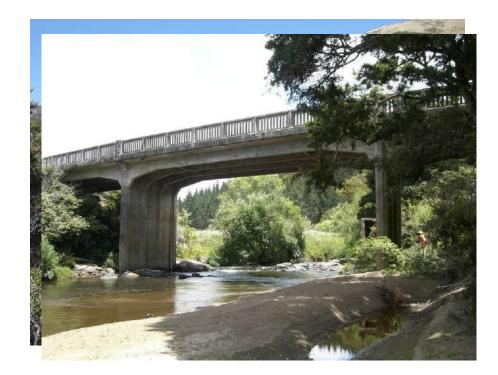


- Precast concrete
- In-situ concrete
- Steel beam
- Steel truss
- Stone arch
- Suspension
- AHB





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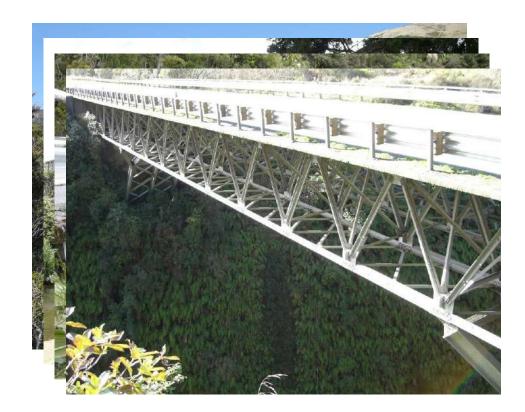


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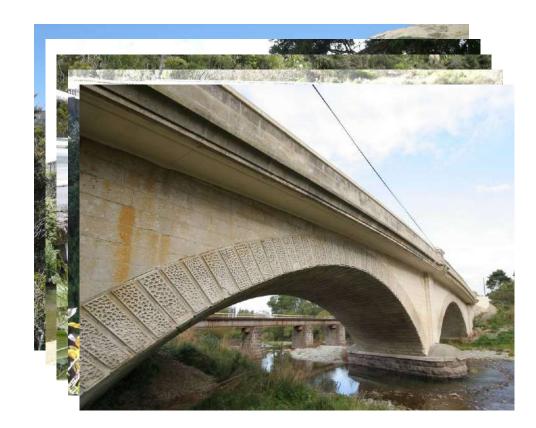


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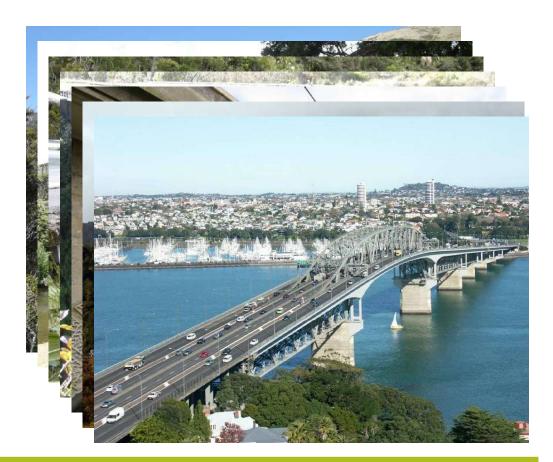


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- Mt Victoria
- Terrace
- Lyttelton
- Homer
- Johnstone's Hill





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- Lyttelton
- Homer
- Johnstone's Hill



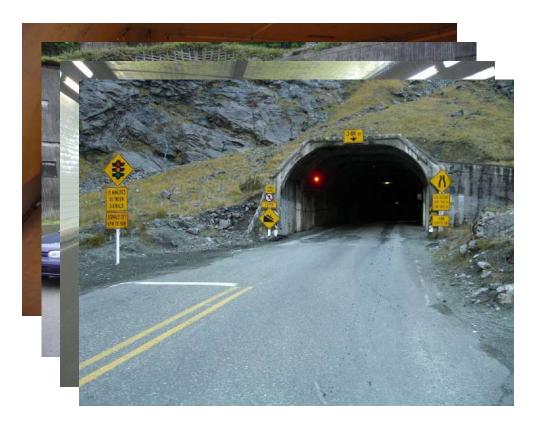


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- Mt Victoria
- Terrace
- Lyttelton
- Homer
- Johnstone's Hill





- Retaining walls
- Sea walls
- Gantries & large signs
- Culverts





- Retaining walls
- Sea walls
- Gantries & large signs
- Culverts





- Retaining walls
- Sea walls
- Gantries & large signs
- Culverts





- Retaining walls
- Sea walls
- Gantries & large signs
- Culverts





- Footbridges
- Overbridges
- Redundant bridges
- Historic bridges
- Stock underpasses
- Shared bridges
- Bailey bridges





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- Otira Viaduct
- Upper Harbour
- Meeanee Road
- Waiwera Viaduct
- Dowse Interchange





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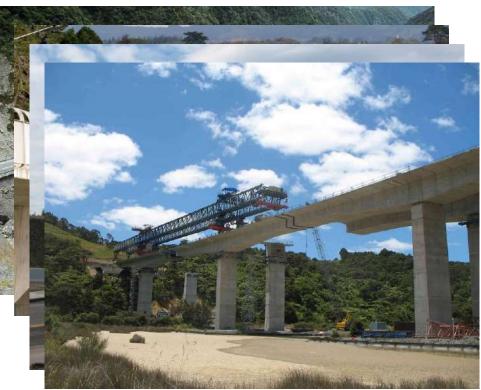


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Funding Government Policy Statement

- Issued by the Minister of Transport every 3 years
- Sets out short to medium term objectives
- Can be amended by the Minister at anytime
- NZTA must `give effect to it'
- New government amended GPS (May 2009)
 - Targets replaced with impacts
 - Strong focus on economic growth and productivity

Investment Strategy



GPS – Impacts

- Economic growth and productivity impacts
- Improvements in the provision of infrastructure and services that enhance transport efficiency and lower the cost of transportation through:
 - improvements in journey time reliability
 - easing of severe congestion
 - more efficient freight supply chains
 - better use of existing transport capacity.
- Better access to markets.

A secure and resilient transport network.



Effectiveness – strategic fit

Low

Minimum

- Meets LTMA objectives
- Affordable
- Considers appropriate alternatives and options
- Considers adverse effects or impacts
- Appropriate scale

Medium

Low criteria PLUS

- Part of a strategy, package or plan
- Enduring benefits
- Considers land use strategies and implementation plans
- Significantly effective in achieving 'strategic fit' assessment potential

High

Low + Med PLUS

- Integrated between transport modes
- Integrated with land use and other infrastructure
- Supports networks from national perspective
- Is an optimised transport solution



Economic efficiency

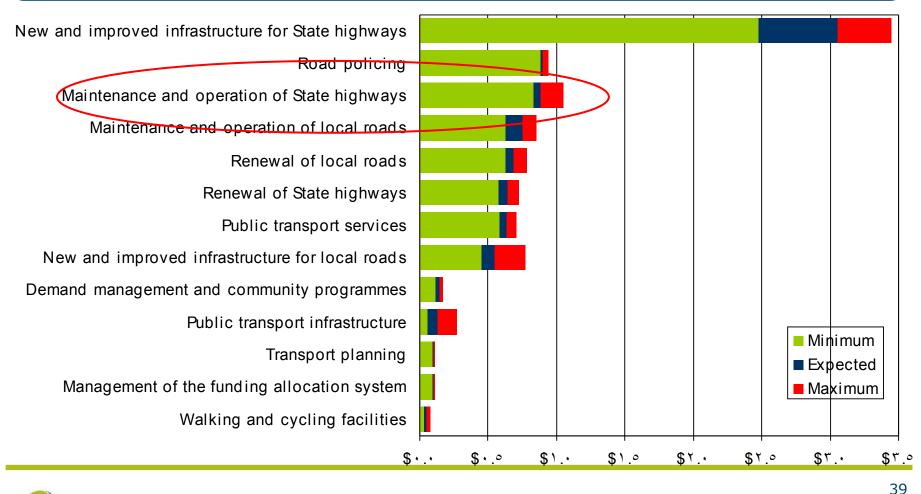
• For improvements the primary measure of economic efficiency is benefit cost ratio

Low	Medium	High
BCR \geq 1 and < 2	BCR \geq 2 and < 4	BCR > 4

 BCR < 1 only considered in exceptional circumstances and at discretion of Board

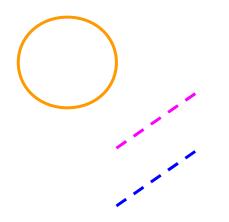


2009/10 to 2011/12 expenditure ranges



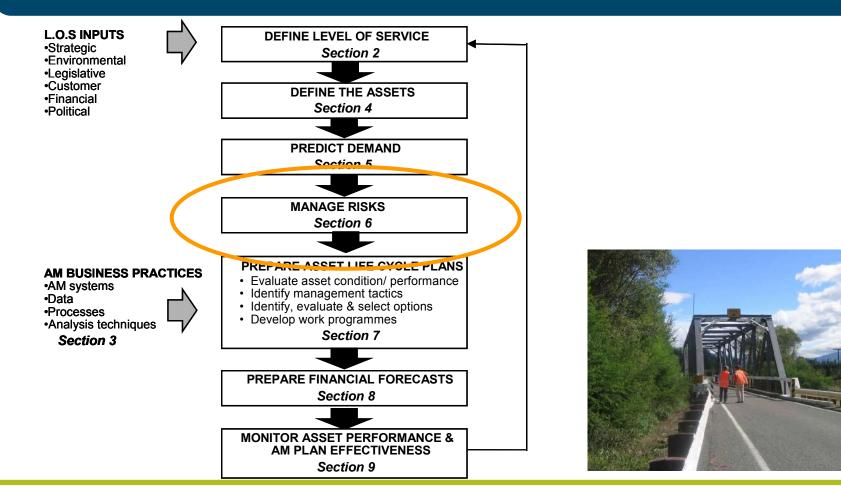


Funding forecast -maintenance





Asset Management Framework







Solutions
Risks
Cost

Bridge Consultant

Network Consultant (Roads)

NZTA

Regional Bridge Consultants

Region 1 – Northland • Opus Whangarei

Regions 3&4 – Waikato & Bay of Plenty

BBO Hamilton

Regions 7&8 – Taranaki. & Manawatu-Wanganui

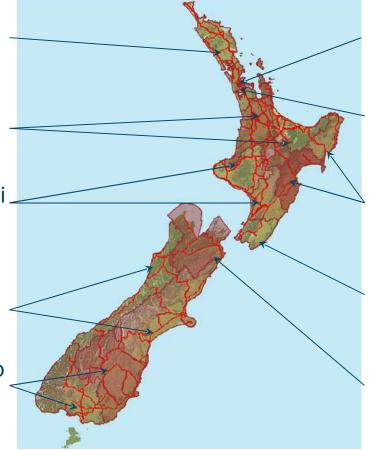
BBO Hamilton

Regions 11&12 – Canterbury & W Coast

• Opus Christchurch

Regions 13&14 – Otago & Southland

Opus Dunedin



PSMC003 – Auckland Harbour Bridge Total Bridge Services Region 2 – Auckland • Auckland MA Regions 5&6 – Gisborne & Hawkes Bay Opus Napier Region 9 – Wellington Opus Wellington Region 10 – Nelson-Marlborough

Opus Blenheim



Inspection Regime

Inspections undertaken in accordance with NZTA S6 Bridges & Other Structures Inspection Policy:

Inspection type	Frequency	Undertaken by
Superficial	Monthly	Network Consultant
General	2 years	Bridge Consultant
Detailed	6 years	Bridge Consultant
Special	When required	Bridge Consultant



New Zealand Government

Bridge Inspection

		tion Report			Transit Network I	Transit Office: <u>Wanganui</u> Management Area: <u>West Wanganui</u>	API-M6
	Highway:		A) W/	E 215A Rou	utine Bridge Component Replaceme	ant [Includes Hybrid's & PSMC's]	
					Contract Area:		1
Type of Bridge:	Restrictions: Date: / / Reviewed By:	Data: / /	Network	Maintenance	Contract Area:		
Inspected by		ection Engineer)	Network	k Maintenance	Contract Area:		
neck List	(Bridge insp	ection Engineer)	Specific	Projects>\$15,	,000:		
neral	Superstructure Steel		Highwa	av RP	Bridge Name	Work Description	
Appearance	Nain Sec.	dations and Substructure		-			1
Approach adequacy	Nember Member 26	Settlement					
Approach adequacy Signs Vibration	15 Condition of Paint 27 16 Corrosion 28	Cracking			1		
Bearings		Spalling Abrasion					
H.D Bolts and Linkages		Corrosion of Steel	[Extend	table as require	d	Subtotal W/E 21	15A \$
Expansion Joints		Other defects					
Footways	Superstructure Timber Scou	r and Waterway	B) W/	E 215B Stru	uctural Bridge Component Replacer	ment	
Road safety barriers and/or handralis Deck drainage		River aggrading	Highwa	ay RP	Bridge Name	Work Description	Budget
	21 Warping and Cracking 33	River degrading	a) High	Priority Projec	-		
perstructure Concrete	22 Deck wear 34	Waterway adequate	47			Deck Joint Nosing angle broken loose	\$ 15,0
Deck Main Sec.	23 Bolts and Spikes 35 24 Other defects 36	Erosion of abuts/ approaches	4	127/2.91	Mangaturuturu	Deck Joint repair	\$ 20,0
Cracking Nember Member	25 Date of last boring 37	Embedment of foundations Other erosion or scour risks					
Spaling	27 Date of last boring	other erosion or sedar risks					
Rein'.	Marking Code						_
Corrosion		nance (provide comment) 3 tenance (provide comment) 4					_
defects	Monitor next inspection 2 Not Applicable	N	(Extend)	table as require		High Priority - Subto	otal \$ 35.00
medial work recommended last inspection has		overleaf if anower is NO)	b) Media	um Priority Pro	ojects		¢ 00,00
TA Database Changes Required	and the second	hange (f answer is YES)	4		Makatote River	Repaint	\$ 80,00
on personal changes required		menge it without to reav	4		Waimarino	Repaint	\$ 40,00
		(Continue over if required)		176/4.05		Repaint	\$ 40,00
			4	206/0.00		Repaint Repaint	\$ 100,00 \$ 40.00
mments and Recommendations fo	r Maintenance/Repairs		43	130/0.00		Repaint Deck Joint Repair	\$ 40,00
Item Brief Description o	f Fault and Recommendations for Repair and Urgenc	cost Estimate		258/2.07		Longitudinal Deck Joint Repair	\$ 7,50
			RAMP' 🗄	258/2.68		Longitudinal Deck Joint Repair	\$ 10.00
				258/3.7		Longitudinal Deck Joint Repair	\$ 10,00
			[Extend:	table as require	.d]	Medium Priority - Subto	
						Subtotal W/E 215B (Med + Hig	
						Desired W/C 215B Funding. (Please state desired funding	ng) \$ 372,5
				E 24 EC 044	ner Structures Component Replacen	nont	
				(Specify)	er orractares component Replacen	1	
				(Specily) ire/Dismantling	(Specify)		-
				ructures (Specif			1
						•	
			[Extend	table as require	d	Subtotal W/E 21	15C \$
10 contracts and 10 contracts						ements [Includes Hybrid's & PSMC's]	
(Continue over if required)		I			Contract Area:		
mments and Basemmendations Bi	elating to Future Management (Transfer to	Current Benert)			Contract Area: Contract Area:		_
		Part on (Pridea		table as require		Subtotal W/E 21	15D \$
Item	Defect/Strategy	Inspection Engineer) Date	[Extend	unic as require	<u></u>	Subiotal W/E 21	*
			E) W/	E 215E Profi	essional Services for Component R	Replacements [Includes Hybrid's & PSMC's]	
					Contract Area:	BBO Regional Bridge Consultant	\$ 40.97
			Network	. mannænnande	o difficiented.	DDD regional bridge Consultant	\$ 40,97
							_
		1 1 1					



Routine works

- Clear vegetation
- Clean joints
- Clean drainage
- Scour repairs
- Guardrail repairs





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Structural works

- Painting
- Strengthening
- Concrete repairs
- Replace joints
- Steel repairs
- Guardrail upgrades





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Structural works

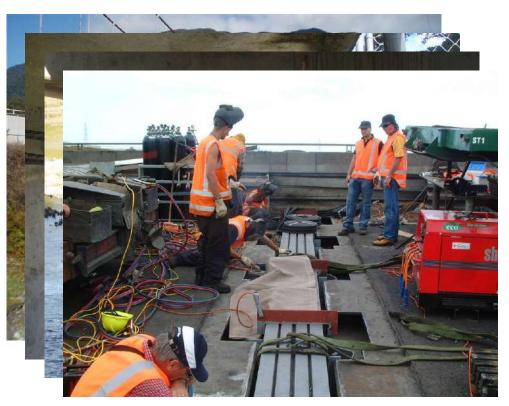
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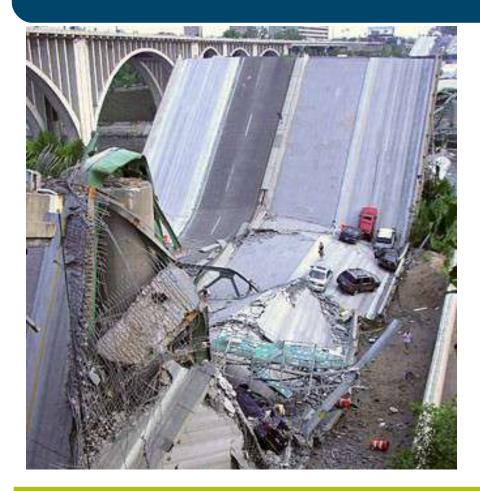
Structural works

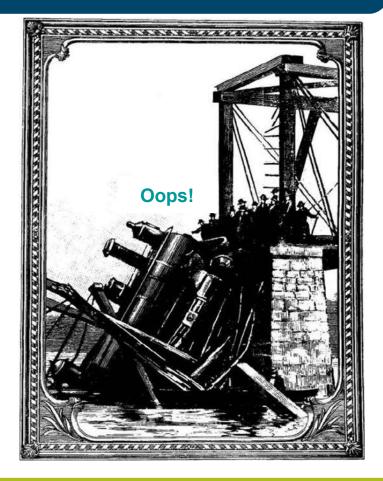
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- Guardrail upgrades





Risk Management







New Zealand Government

Risk Management

Identification Assessment Decision Criteria Reduction & Control Monitoring and Review Transfer

MARCH PRO

Risk Management

Emergency Management and Response Planning

Civil Defence & EM Act requires NZTA to;

- Identify and understand hazards and risks
- Prepare plans to manage hazards and risks
 NZTA has developed;
- Contingency Plans
- Disaster Recovery Plans
- Emergency Procedure Manuals
- Bailey Bridges







Risks faced by structures

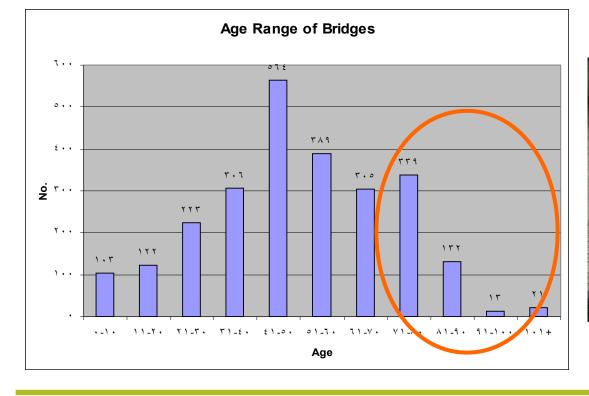
- Condition
- Loading
- Environmental
- Construction (Quality)
- Design Standards
 Whole-of-Life





Condition Risks

The average age of SH bridges is 50 years





Historical overview



Asset Condition

Condition is relatively good:

- Average age of 50 years
- Climate is moderate: no de-icing salts used
- History of effective inspection and maintenance programmes





Condition



80 years

less than 30years





SH6 Kawarau River Bridge

Built 1963 Fatigue cracks found 2008





New Zealand Government

SH6 Kawarau River Bridge

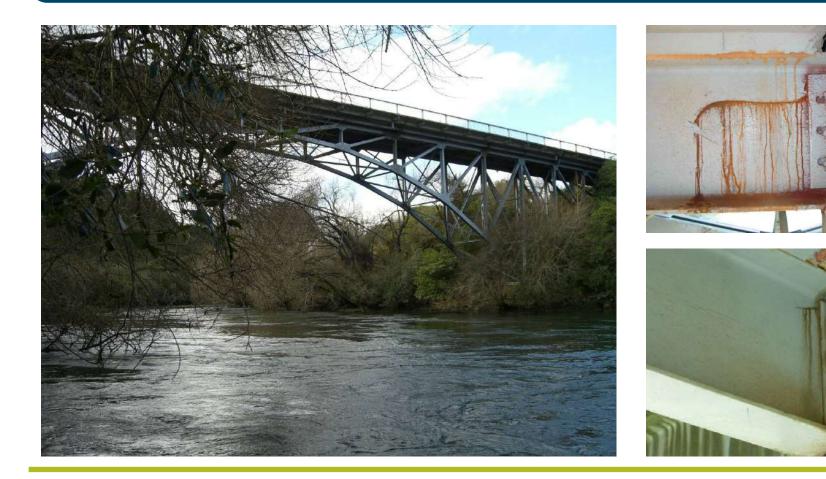


Transom cracks





Atiamuri SH1 - fatique

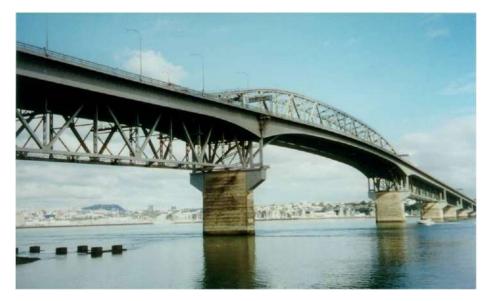




New Zealand Government

Box Girder Extensions

Completed 1969







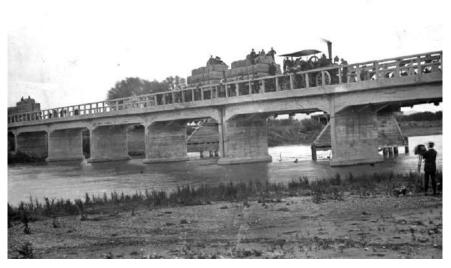
1970 to date....

- Early 70's box girders first strengthened
- 1985 HCV's banned for 4 years -strengthened
- 1987 live load upgrade
- 1990's ongoing fatigue repairs
- 1995 Poly-urathane road surfacing started
- 2000 seismic upgrade completed
- 2002 onwards traffic/structural assessments
- 2007 strengthening/upgrade (live load)



Loading Risks

The loads that bridges need to carry have changed beyond recognition





Traction Engine 1912

Volvo 2009



New Zealand Government

Overweight Permitting

Overloads

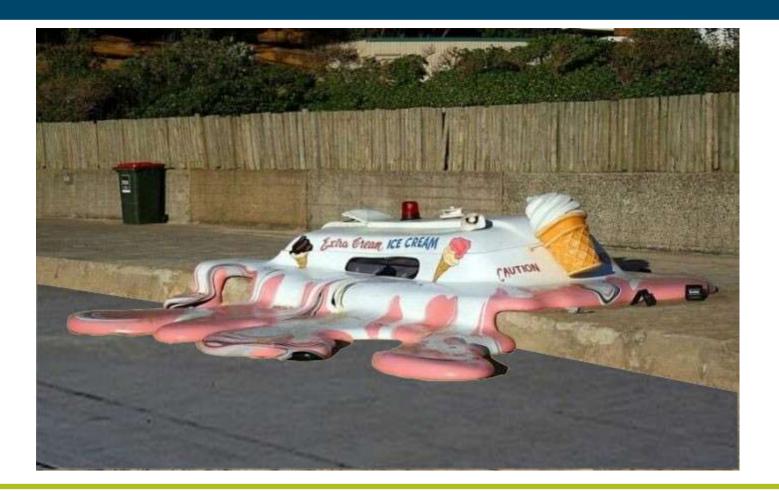
OPERMIT





New Zealand Government

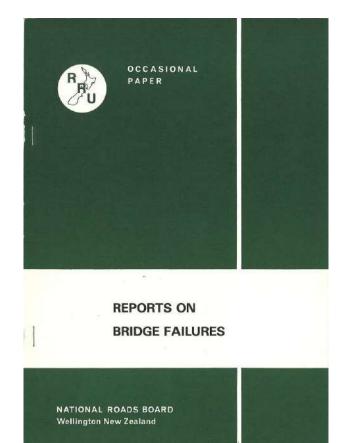
Environmental risks





New Zealand Government

Environmental Risks – Scour



A survey of 108 bridge failures between 1961 and 1984

CAUSE OF FAILURE	NUMBER	PERCENTAGE	
Approach/Abutment Scour	29	26.8	
Pier Scour	34	31.5	
General Scour	5	4.6	74%
Aggradation	2	1.9	
Insufficient Waterway	10	9.3	
Earthquake	6	5.6	1968 Inangahua
Structural Failure	14	13.0	
Falsework Failure	3	2.8	
Settlement	2	1.9	
Landslide	3	2.8	







Environmental risks







SH82 Waitaki River Bridge No.1

Built 1881
 History of scour problems







SH54 Jamiesons Bridge

Built 1932
 Pier dropped in 2004 flood







New Zealand Government

BRIDGE NAME:

SITE INSPECTION OBSERVATIONS

	N = No, U = Unkno			own, Y = Yes
LOCAL SCOUR AT PIERS / ABUTMENTS				Hazard Rating
E vidence of woody debris accumulation on piers	N	ы	\sim	1 - 5
(identify location of debris accumulation)		0	•	(1 = low
E vidence of pier scour	И		\sim	5 = high)
(identify location of scour)	14		•	
Evidence of pier foundation tilt / movement	N	U	Ŷ	
(identify location of tilt / movement)	14		•	
Piers skewed at angle to direction of river flow	N	U	Ŷ	
(estimate angle of skew)		0	•	
One or more piers sited in deepest part of channel	N	U	Y	
One ormore piers sited dose to confluence of two braid channels	N	U	Y	
E vidence pf woody debris accumulation on abutment	N	ы	\sim	
(identify location of debris accumulation)			•	
Evidence of abutment scour	N	U	\sim	
(identify location and nature of scour)	13		•	
Abutments skewed to direction of river flow	И	U	Y	
(estimate angle of skew)	14	0		

HAZARD SUMMARY					
Hazard Rating	Key Hazard Factor				
	Hazard Rating				

GENERAL COMMENTS / RECOMMENDATIONS FOR MONITORING / MAINTENANCE ETC.

Hazard rating		Bridge location / Waterway adequacy	Channel Cross-section shape / Bed Degradation and Aggradation	Bank Stability / Approach Embankment Integrity	Local Scour at Piers / Abutments
5	Widespread deforestation of catchm		bed.	Extreme bank erosion upstream impinging on	Extensive debris raft on piers / abutments.
	Widespread catchment erosion.		butment foundations.	bridge abutment or piers.	Evidence of extreme scour at piers /
			Manager of Landson and State	Extreme abutment / approach embankment	abutments.
	Dam located upstream cutting off see supply.		bymmetric ide ent.	erosion.	Evidence of pier tilt / movement.
			bed.		One or more piers sited close to confluence of two braid channels.
					Piers / abutment skewed at more than 45 degrees to direction of river flow.
4	1. C.		ka apartant	Severe bank erosion upstream impinging on	Piers / abutments skewed at more than 30
	the second			bridge abutment or piers.	degrees to direction of flow.
			100 23	Severe abutment / approach embankment erosion.	Severe debris raft formation on piers / abutments.
					Severe scour at piers / abutments.
		and the second second	A CARLE		
3	Partial deforestation of catchment.	Bridge sited on moderate bend.	Moderate degradation of bed.	Moderate bank erosion.	Piers skewed at more than 15 degrees to
	Moderate landslide activity in catchment.	Bridge sited on moderately meandering	Moderately exposed piles / abutment	kindemite abritment (annunach embandement	direction of flow.
		channel.	foundations.	and the second sec	ins /
	Channel bed infested with large willow trees or other vegetation.	Bridge sited at moderate channel constriction.	Channel shape slightly asymmetric		And a second second second
	Severe st	the second second second second	lightly deeper to one side.		
	river/str	Mar.	derate aggradation of bed.	A CONTRACT OF A CONTRACT OF	
	The Party of the Party of the Party of the	A CONTRACTOR OF			
	The Property of the Party of the Party of the	A DECEMBER OF A			
	Markey Strengthered	Alternative Contraction of Contracti		A CONTRACTOR OF A CONTRACTOR OFTA CONTRACTOR O	
2	Catchme	The state of the second second	19		sto
					and the second sec
	Occasion				
	Natural a				
	Moderate				
	river / str				and the second
	Channel •				
1	Catchme		ective channel degradation	and the second	11/10/2005
	Channel :	AND AN A PARA	intermeasures downstream.	the second s	
		and the state of t	ective channel aggradation	panks weil protected.	
	Extensive structure.		ntermeasures upstream.		No scour evident at piers / abutments.
			14 C		
	Low gradient over stream.				
	Tidal or lake influence on water levels.				
			1	1	









ALSO, THE BRIDGE IS OUT AHEAD



Environmental Risks – Seismic

Screening from 1996



Response to significant events in US and Japan





Bridge Seismic Screening

Programme	Total	P1	Р2	Р3
Detail Assessments	335	192	72	71
Linkages	173	92	45	36

Linkage Retrofit Completed **Detailed Assessments** Re-prioritise 50 completed assessments **Detail Design & Construction** Target 3 to 5 bridges/annum Funding \$5 to \$10million pa



Seismic Retrofits

SH6 Kawarau River – retrofit
 SH26 Waihou River - linkages





New Zealand Government

Design Standards / LoS Risks

Risks associated with Standards and Levels of Service:

- Construction & Design
- Narrow bridges
- Low headroom (bridge strikes)
- Guardrails



Construction & Design

Newmarket Viaduct 1965 Continuous prestressed concrete box -girder

Replacement started 2009





New Zealand Government

Levels of Service

Level of Service	Current LOS	Desired LOS
Load Capacity	Class I	HN-HO-72
Height Clearance	4.55m	6.0m
Bridge Width		
Motorway	8.0m	10.0m
Urban	8.0m	10.0m
>10,000 vpd	8.0m	10.0m
4,000 - 10,000 vpd	8.0m	10.0m
1,000 - 4,000 vpd	6.8m	10.0m
<1,000 vpd (2 lane)	6.0m	8.5m
<1,000 vpd (1 lane)	3.0m	4.7m
Bridge Barriers	varies	varies



New Zealand Government

Narrow Bridges

- 324 bridges defined as narrow
- 61 of these are single lane
- 124 non-deficient single lane bridges (AADT<1000)





Narrow Bridges

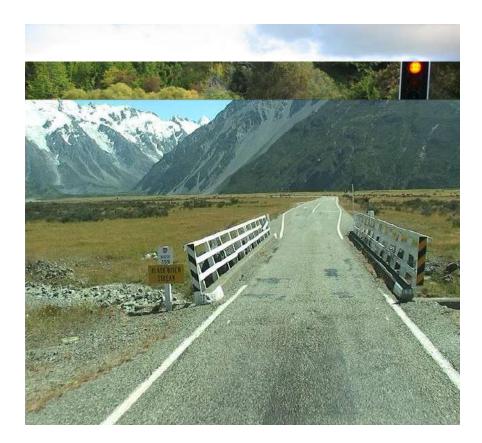
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Narrow Bridges

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Low Headroom Bridges

- 13 bridges have headroom less than desired minimum (4.55m)
- Bridge strikes are a significant issue in Auckland
- Not just in Auckland





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Low Headroom Bridges

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- Tombstone guardrails
- Post and rail
- Retrofit Guidelines





- Tombstone guardrails
- Post and rail
- Retrofit Guidelines





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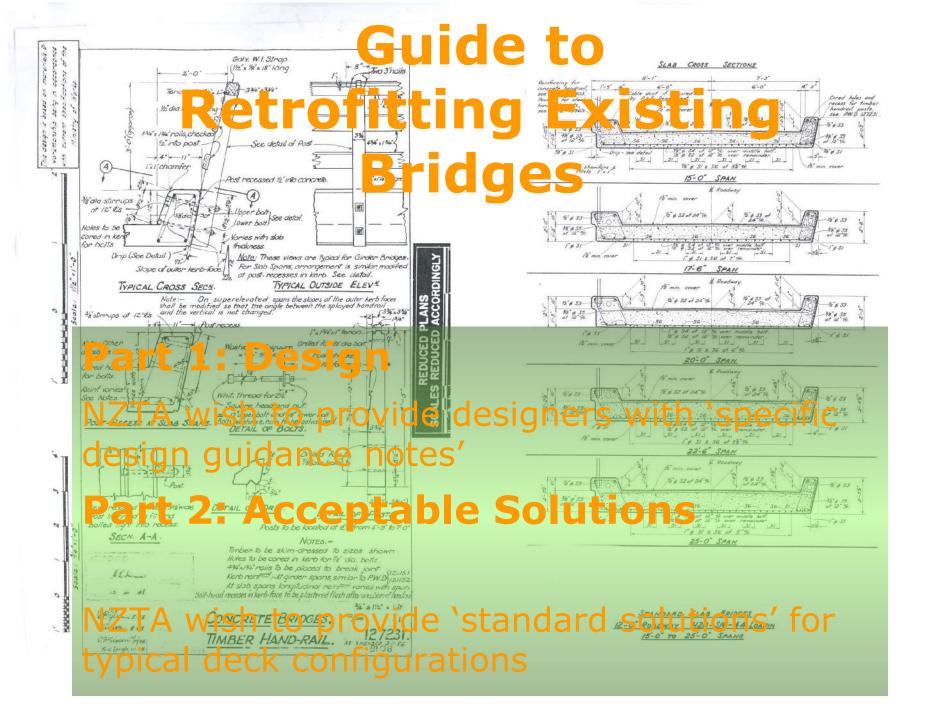




- Tombstone guardrails
- Post and rail
- Retrofit Guidelines







Bridge Replacement Programme

Bridges on programme for

- Levels of Service
- Condition all risks
- Road alignment



Tell compelling Risk Story

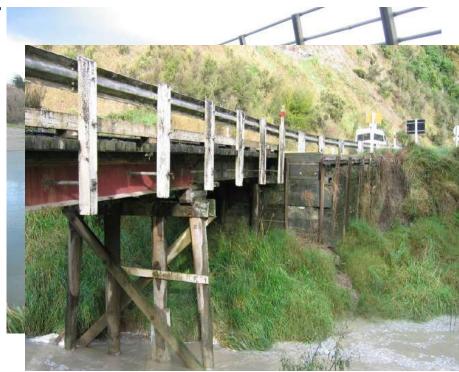


New Zealand Government

Bridge Replacement Programme

Bridges on programme for

- Levels of Service
- Condition all risks
- Road alignment



Tell compelling Risk Story

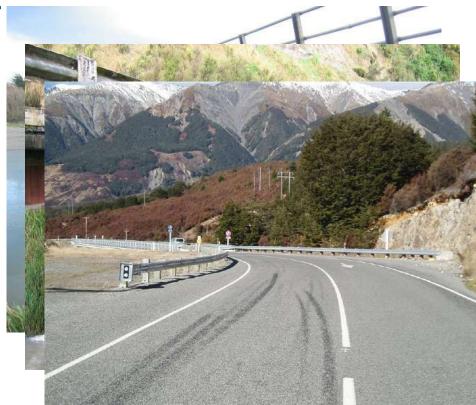


New Zealand Government

Bridge Replacement Programme

Bridges on programme for

- Levels of Service
- Condition all risks
- Road alignment



Tell compelling Risk Story





Tunnel Management





Tunnels

Biggest risk associated with SH tunnels:

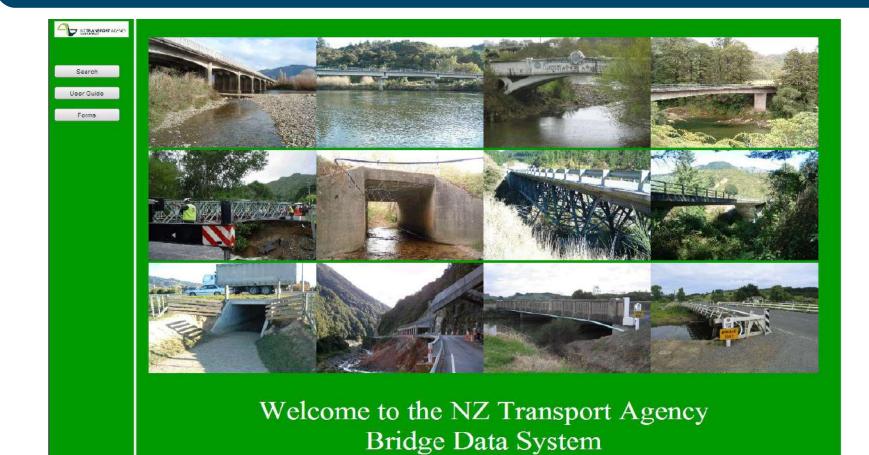
Funding secured \$60million





New Zealand Government

Bridge Data System





New Zealand Government

Bridge Information System

- Bridge Inventory
 - Inspection & Forward Work Category Lists
- Maintenance Records History & Costs
- Construction Details
- Condition Rating
- Overweight Vehicle Management
- Access to As-Builts and GPS system



New Zealand Government

KISS

Future Demand

Key factors

- Average traffic growth of 4% per annum
- Very high growth in Auckland
- Pressure to increase vehicle weight and dimension limits
- Quality systems

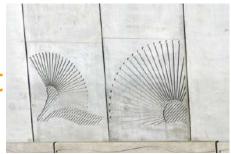




New Zealand Government

Future challenges

- **People** passionate about bridges!
- Funding GPS
- Climate Change Sustainability Durability
- Retrofitting & replacing existing structures
- Heavier loads 50t plus
- Sensitivity to communities
- Increased Research & Development





Bridge Management Vision: "NZTA Centre of Excellence - Bridges"

Best Practice Systems - BIS
 Effective Maintenance of Existing Assets
 Effective input in Capital Works - 100+ years life
 Overweight Vehicle Management
 Resource in-house skills

Conclusions



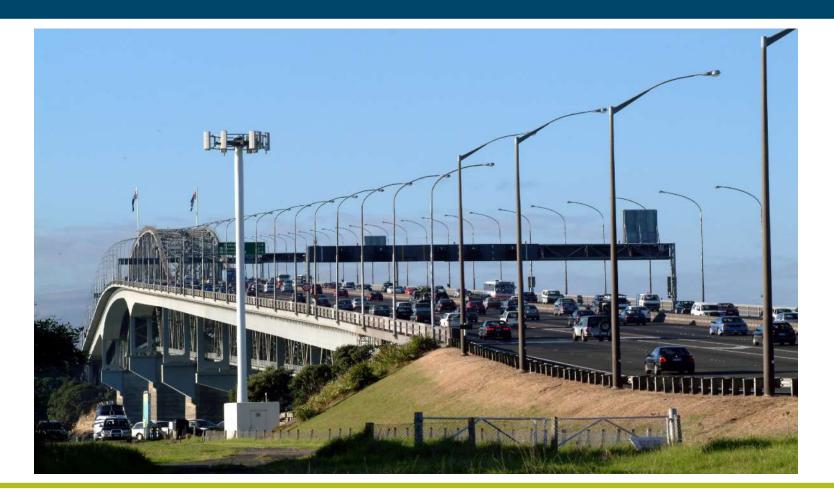
1000's years design life





New Zealand Government

Discussion





New Zealand Government