

Main North Line Resilence – Kaikoura Earthquake

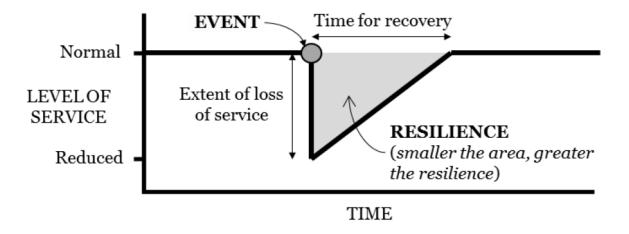
15 November 2018



SiwiRail

What is Resilience?

Using the NCTIR Resilience Study



Resilience = Robustness + Redundancy + Response

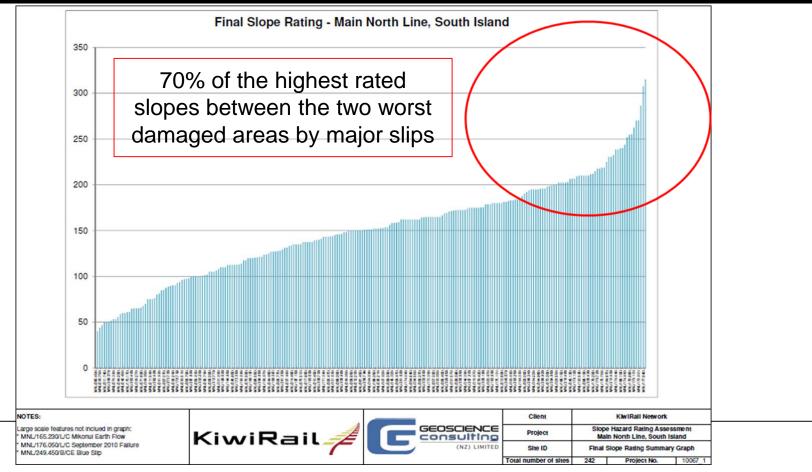


2

State of Asset Knowledge pre EQ?



Key Asset Knowledge pre EQ



Damage – where it happened



Safety Considerations

- KiwiRail set client safety requirements for train running.
- Assets such as bridges are more binary they either meet "code" or not.
- Assets such as slopes require a greater degree of engineering judgement and utilise comparative scoring systems.
- KiwiRail made use of So Far as is Reasonably Practical for its Assurance Process for defining "safety" in opening of the MNL.
- A key feature of this is operational rail controls used in addition to engineering ones – rainfall forecasting, remote monitoring, speed restrictions.



Reliability Considerations

- A weakened state around assets, particularly slopes, will exist for some years.
- Compared to pre earthquake, outages from storm events are going to higher.
- Likewise heightened seismic activity will likely cause additional outages.



NCTIR undertook a study in mid July 2017 to answer this. There were three time horizons considered:

- August target for re-opening for commissioning trains
- December 2017 target for SH1 re-opening
- End of NCTIR and Reinstatement Works

In broad terms:

- Resilience improves as time moves on and permanent repairs are completed
- Risk management controls increasingly moved to engineering controls rather than the high levels of operational controls that were used initially
- There will be outages when bad weather is forecast and some clean up work may be required after an event but the length of outage is important!



Mapping the Corridor

9

_							o NS								Sout																			Rakau		-
Rail Kilometr	age		203.500	203.650	203.950	204.100 204.250	204.400	204.700	204.850 205.000	205.150	205.300	205.450	205.750	205.900	206.050 206.200	206.350	206.500	206.650	206.800 206.950	207.100	207.250	207.400	207.700	207.850	208.000	208.150	208.300	208.450	208.750	208.900	209.050	209.200	209.350	209.650	209.800	209.950
Performance	e/Dam	age																																		
Asset Slopes				П			П	Т						<u> </u>	-	Т								Т	—				Т	1		П	Т	Т	П	_
										T						T																	╈	+		-
									ò	P1A	S2	P1B			ន	3		į	8	Б		Ľ	S S	8 5			88			S9						
Bridges				\square			\square	+				\square		\square													+						_			_
															113		114																	GLL		
Tunnels																												\top							\square	_
																15		16		17																
Coastal Prot	tection	1																																		
CP ID																																				
Fill Slopes,	Ret Wa	alls																																		
Fill, RW ID									T	Т			Т	Π	T	Г			Т	T	Π	T	Т	Ţ				Τ								
•	S	lopes - Key																			Ri	sk	-)	SI	op	e	R	ati	ng	g			'	'		
	1	Closed Tran	spor	t Co	Corridor																	le	less than 200										Τ			
	2	Affected TC										art	hqu	uake cl		lo	sure)					be	∋tv	ve	en	20	00	00 and 2			50		Ť			
	3	Did not affeo		· ·																		ar	ea	ate	r t	ha	n	25	0				\dagger			
	3 4	Did not affect		-					un	de	rsto	າດດ	1		+	+	+			3.							Ī				†_					
	5	Did not affect		· · · · ·				· ·		-							-	+						-				-	+		_		+			
	5					Kely					_	_	_				_	+	_				_	-		_		-	_	_	_		+			
	6	TC in tunnel	, no a	affe	Ct																															

Heat Maps

	1	NS:	22	(Pa	pa	roa	Po	int)	to	Cla	rer	nce		(Sou	Jth			١	Nal	papa	8	Γ		Γ	Γ	Γ	Г	Г
		215.500	88	3 8	8	20	8	20	8	88	2	88	20	8	2	8	88	3 5	38	8	8	3	8	8	8	8	8	8	8
Rail Kilometrage		20	0.0	15.9	18	16.2	16.4	16.5	19.7	16.8		12	17.4	2	1.1	6	18.0	10.2	18.5	18.6	18.8	18.9	6	19.2	19.4	19.5	19.7	19.8	R
Performance/Damage		<u>i si i</u>	яļć	4 64	ιė	Ŕ	Ŕ	ĠI.	ġЦ	910	غل	1 ÓI	Ŕ	Ġ.	ġ.	N I	N C	4 6	4 Ġ4	i è	là	Ó	Ŕ	ġ.	Ŕ	Ň	Ŕ	Ŕ	6
Asset			_	_		_	_	_	-	_		_	_	-	-		_	_	_		_		-	-		-		_	
Slopes	1		Т	Т	Т	Г				Т	Т	Т		Т			Т	Т	Т	Г	Т	Г	Г	Г		Г	Г	Т	Г
· ·		H			T				-		T		Н			T		+	+	t		t							t
		~		2			4	P8; S24	5	e								0			0			S30, P9		P9, S31		8	
		82	8	8			834	ŝ	S25	S	8					8	ŝ	8			88			ñ	x	8°		S 32	
								_																Ĩ		Ĩ			
																													L
Bridges		_																											L
					112										1	2	118												
Tunnels	+	++	+	+	f	+	H	\vdash	-		+	+	Н	+	ſ	-	-	+	+	⊢	+	⊢	+	⊢	⊢	⊢	⊢	⊢	\vdash
	<u> </u>	H	+	+	┢	+	H	H			+	+	H	+	┥	+	+	+	+	┢	+	t	\vdash	\vdash	\vdash	\vdash	t	+	t
		\square								8						\downarrow						L							
Coastal Protection		\prod	\perp						\downarrow	+					\downarrow	4	\downarrow	+											L
CP ID																										1			
Fill Slopes, Ret Walls		┺							┥										+						\vdash	\vdash	t	+	t
Fill, RW ID		ΠŤ	T		Γ				1	T	T					1	T	1	T	Г		F		T	F	T	t	t	T
Profile	-	1.4	uai	IST	201	7			+	-	÷	+	H	-	+	÷	÷	÷	+	+	h	h	-	-	-	-	-	-	┢
Triggering Event					-	_	_						_				_	_			_							_	
	Risk	Т	Т	Т	Γ	Γ			Τ		Т	Т			Т	Т	Т	Т	Т	Γ	Т	Γ	Γ	Γ	Γ	Γ	Γ	Г	Г
1/5 Rainfall																													
1/25 Rainfall	Resilience	Ц																				L							
1/100 Rainfall	<u>∦</u>										4				4	4	4	+		L									
					-	-			_						_	4	+			L .							_		-
	, ž				t	E					+	+	-							+	+-	L							
	Å										+				-	-	+	+											E
Aftershock (MM V) Earthquake (MM VII+) Profile	ž	15.1	Dec	20.02	bo	- 20															ł								
Earthquake (MM VII+) Profile	Re	15 (Deo	em	be	r 20	17									1	ł												
Earthquake (MM VII+)	Risk	15 [Dec	em	be	r 20	17												T										
Earthquake (MM VII+) Profile	Risk	15 (Dec	em	be	r 20	17																						
Earthquake (MM VII+) Profile Triggering Event	Risk	15 (Dec	em	be	r 20	17																						
Earthquake (MM VII+) Profile Triggering Event 1/5 Rainfall	Risk	15 1	Dec	em	be	r 20	17																						
Earthquake (MM VII+) Profile Triggering Event 1/5 Rainfall 1/25 Rainfall	Risk	15 (Dec	e m	be	r 20)17																						
Earthquake (MM VII+) Profile Triggering Event 1/5 Rainfall 1/25 Rainfall 1/100 Rainfall			Dec		be	r 20	117																						
Earthquake (MM VII+) Profile Triggering Event 1/5 Rainfall 1/25 Rainfall 1/100 Rainfall Aftershock (MM V) Earthquake (MM VII+)	Risk					20 7 20	117																						
Earthquake (MM VII+) Profile Triggering Event 1/5 Rainfall 1/25 Rainfall 1/100 Rainfall Aftershock (MM V) Earthquake (MM VII+) Profile	Risk					7 20																							
Earthquake (MM VII+) Profile Triggering Event 1/5 Rainfall 1/25 Rainfall 1/100 Rainfall Aftershock (MM V) Earthquake (MM VII+) Profile	Risk					20																							
Earthquake (MM VII+) Profile Triggering Event 1/5 Rainfall 1/25 Rainfall 1/100 Rainfall Aftershock (MM V) Earthquake (MM VII+) Profile Triggering Event	Risk																												
Earthquake (MM VII+) Profile Triggering Event 1/5 Rainfall 1/25 Rainfall 1/100 Rainfall Aftershock (MM V) Earthquake (MM VII+) Profile Triggering Event 1/5 Rainfall	Risk 8 Ueijise 2 Risk					200 r 200																							
Earthquake (MM VII+) Profile Triggering Event 1/5 Rainfall 1/25 Rainfall 1/100 Rainfall Aftershock (MM V) Earthquake (MM VII+) Profile Triggering Event 1/5 Rainfall 1/25 Rainfall	Risk 8 Ueijise 2 Risk																												
Earthquake (MM VII+) Profile Triggering Event 1/5 Rainfall 1/25 Rainfall 1/100 Rainfall Aftershock (MM V) Earthquake (MM VII+) Profile Triggering Event 1/5 Rainfall 1/125 Rainfall 1/100 Rainfall 1/100 Rainfall	Risk 8 Ueijise 2 Risk																												
Earthquake (MM VII+) Profile Triggering Event 1/5 Rainfall 1/25 Rainfall 1/100 Rainfall Aftershock (MM V) Earthquake (MM VII+) Profile Triggering Event 1/5 Rainfall 1/25 Rainfall	Risk																												

■ 50-120 days ■ >120 days

Outage duration Open <1 day 1-5 days 5-14 days 14-50 days



Slopes are Key Assets

	1	Expec	ted p	erfor	man			
Location / Identifier	1/2 HI ST	1/5 ST	1/25 ST	1/100 ST	MMVEQ	MMVII EQ	Aerial	Hillshade
Road RS 118 14.840 15.120 280	No closure	No closure	Single lane for <1 day due to slips			Closed for 2-3 weeks due to landslides		
Rail 211.120 210.820 300	No dosure	No dosure	Closed for <12 hours	Closed for 5 days from slips	No dosure	Closed for >5 days due to landslides		
Road RS 118 14.340 14.840 500	cingre rarre or sow ror <1 day due to debris	Single lane for <1 day due to debris flow	Closed for 1-2 days due to debris flow/slips	Closed for 3-5 days due to debris flow/slips	No closure	Closed for ~2 months due to land slides		
Rail 211.620 211.120 11 ⁵⁰⁰	Short outage due to low volume debris flow	Closed for <12 hours due to debris flow/slip	Closed for ~1 day due to debris flow/slip	Closed for 3-5 days by debris flow/slip	No closure	Closed for >5 days due to landslides		

Response Planning is Critical



Conclusions

- Knowing your assets
- Knowing your network
- Limits to how "robust" you can be
- Planning for response







Stronger Connections. Better New Zealand.

Questions



INIRA

Kingkail #