Ruapehu District Council

RB292 Mangateitei Road Rail Overbridge
Detailed Investigation and Posting Evaluation

April 2021

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1. Summary

The Mangateitei Rail Overbridge is one of Ruapehu District Council (RDC) bridges inspected by GHD as part of the routine bridge inspection. During the inspection, it was observed that the bridge has deteriorated further, and we suspected that the bridge capacity for vehicular loadings may be less than the posted load limits. GHD carried out a live load assessment to confirm the bridge live load capacity.

Based on the results of our assessment, we conclude that the bridge has a live load capacity less than the existing posted limit with an Allowable Axle Load of 6000kg and posting "GROSS" of 60% of Class 1. (Currently 70% Class 1 with no axles limits). Both have a speed restriction for HCVs.

Due to the issues found, replacing the bridge is recommended as the existing bridge is all timber and not feasible to strengthen.

We recommend the following:

- Yearly inspections of the bridge to assess decay and deterioration.
- Update the posted limit on the bridge (as per the reassessment) within 1 month.

2. Introduction

2.1 Background

The Mangateitei Rail Overbridge was first constructed in 1908 by the NZ Government Railways (Kiwirail Bridge ID 163) and became a local road asset in the 1980s. The bridge is located along Mangateitei Road, Ohakune. Refer to Figure 1 below. It has a total length of about 17.4m consisting of three spans of which two 5.3m long simply supported end spans and a 5.4m central simply supported span. Each span comprises 6 timber beams supporting flat timbers and running boards. The deck spans are supported on reinforced concrete abutments and timber piers, which are, in turn, supported on concrete foundations.

The bridge has a carriageway width of 4.2m and carries one lane of traffic over a single rail track and an access track.

The bridge is currently posted at 70% of Class 1 and a speed restriction of 15 km/h. Axle weights are not posted.

The bridge provides road access to farms, vegetable growers and forestry with associated heavy vehicles. Due to the heavy vehicles using the bridge which could be more than the posted limit, it was observed that the bridge has started to deteriorate.

This report presents our assessment methodology, findings, and recommendation for the bridge.

Figure 1 Mangateitei Rail Overbridge Locality Plan

2.2 Scope and limitations

This report has been prepared by GHD for Ruapehu District Council and *may only be used and relied on by Ruapehu District Council for the purpose agreed between GHD and the Ruapehu District Council as set out in Section 2.2 of this report.*

GHD otherwise disclaims responsibility to any person other than for Ruapehu District Council arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Ruapehu District Council and others who provided information to GHD (including Government authorities)], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

This report excludes seismic and scour assessment and excludes a full condition report

2.3 Site Investigation

In March 2021, GHD Ltd carried out a Principal inspection on the bridge as per the bridge inspection program. The Principal Inspection is carried out on the bridge asset by rotation over six years and a general inspection is carried out every two years. These are programmed for annual completion by June each year. This is to determine the condition of the bridge and to report on defects of the bridge.

3.3.1 Measured Dimensions

The timber deck planks were measured to have a width of 200mm and depth of 100mm.

Only the timber stringers at spans 1 and 3 were observed in detail (in closeup). Measurements were recorded at Span 3 (North-East) as this has the best access to the main stringers at midspan as shown in Figure 2 below. The central span is not readily accessible and permission from Kiwirail is required as there are electrical cables below the deck.

The actual dimensions recorded for the timber stringers at Span 3 are shown in Table 1 below. The timber stringers 1 and 6 (edge beams) are located on the Eastern and Western end respectively.

Table 1 Timber Stringers Dimensions

Timber Stringers	Depth (mm)	Width (mm)
Stringer No. 1	330	230
Stringer No. 2	350	230
Stringer No. 3	340	220
Stringer No. 4	340	245
Stringer No. 5	360	255
Stringer No. 6	344	237

3.3.2 Bridge Condition

The following were observed on the bridge:

- significant wear on the running planks;
- deck planks are between fair and deteriorating condition;
- stringers are between deteriorating & seriously deteriorating (i.e. with cracks and some decay);
- crossheads/crossbeams have some longitudinal cracks; and
- piers have some deterioration (i.e., with cracks and some decay) which has been repaired in some places.

The stringers have deterioration as cracking and timber decay are primarily recorded on them. At Span 3; timber stringers No. 3 and 4 were recorded as the most deteriorated with cracks and timber decay.

On both faces of Stringer No. 3, a longitudinal crack of approximately 1 m long and 18 mm deep was observed roughly at 1.7 m from the Abutment support and about 150 mm from the top of the stringer. Also, extensive cracking was observed in the soffit, with variable depths and lengths. Refer to Figure 3 below.

On both faces of Stringer No. 4, a longitudinal crack of approximately 0.8 m long and 36 mm deep was observed roughly at 1.9 m from the Abutment support and about 200 mm from the top of the stringer. Refer to Figure 4 below.

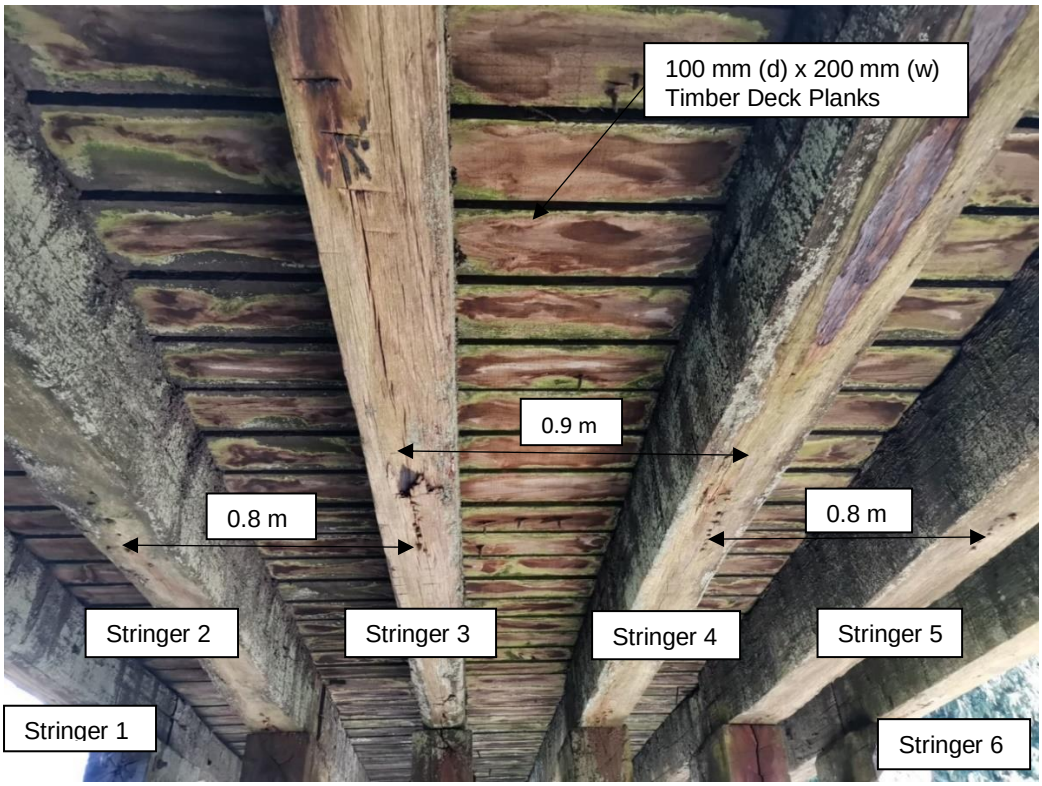

Figure 2 Deck Soffit Span 3 (North-East)

Figure 3 Timber Stringer No. 3 Defects

Figure 4 Timber Stringer No. 4 Defects

3. Posting Evaluation

Posting evaluations were carried out per Section 7 of the NZ Transport Agency Bridge Manual 3rd Edition and NZS 3603:1993.

2.4 Material Strengths

The timber properties used in the assessment were taken from NZS 3603 Table 2.2 for the timber deck planks and AS 1720.1 Table H2.1 for the timber stringers:

Timber deck planks (assuming radiata pine, no 1 framing):

- Density, γ_{td}: 550 kg/m^3
- Bending strength, f_b: 10 MPa
- Shear strength f_s: 3.8 MPa
- Compression parallel to grain, f_c: 15 MPa
- Modulus of elasticity, E: 6 GPa

Timber stringers (assuming F8 for gum, red):

- Density, γ_{ts}: 900 kg/m^3
- Bending strength, f_b: 22 MPa
- Shear strength f_s: 2.2 MPa
- Compression parallel to grain, f_c: 18 MPa
- Modulus of elasticity, E: 9.1 GPa

2.5 Section Capacity

Section capacities of the deck planks and stringers were determined from NZS 3603.

A material strength reduction factor of 0.8 was adopted.

A condition factor of 0.85 was applied to the strength reduction factor for the deck (assuming the deck is in fair to deteriorated condition) and a 0.9 condition factor was applied to the strength reduction factor for the stringers (assuming the stringer is in deteriorated condition).

2.6 Loadings and Load Factors

3.6.1 Dead Load

The dead load for the superstructure was determined assuming the unit weight of the stringers of 8.8kN/m^3 for red gum (seasoned) timber and for the deck planks 5.39kN/m^3 for radiata pine timber. The load factor for the dead load was taken as 1.25 per Table 7.4 of the Bridge Manual.

3.6.2 Vehicle Live Load

The stringers and deck plank were assessed as per Sections 7.4 and 7.5 of the Bridge Manual respectively and using the appropriate loading for Posting evaluation.

The load factor for traffic load was taken as 1.9.

A dynamic load factor of 1.1 was adopted (assuming the bridge has a speed restriction of 10 km/h).

2.7 Posting Evaluation Results

Results of the assessment are shown below:

3.7.1 Timber Deck Plank

Allowable axle load (AAL): 6000 kg

3.7.2 Timber Stringers

Posting “GROSS” for flexure: 60% Class 1 (governs)

Posting “GROSS” for shear: 160% Class 1

Refer to Appendix A for calculations.

4. Discussion and Conclusion

The above result for the stringers was determined using a grillage analysis: one stringer carries a maximum of 50% of one wheel load, with the load shared by the other stringers.

Based on the above, we conclude that the Posting “GROSS” will be 60% Class 1 with a 10 kph speed restriction.

From the investigation conducted, replacing the bridge is recommended, as the existing bridge is all comprised of timber and repairing or replacing the timbers is not recommended. The only way forward by maintaining the existing bridge is to replace individual elements and to keep it a three-span bridge which will be more expensive, where the new piers will require pier protection works, and the level of the road will need to be raised at least another 1 metre to meet Kiwirail clearances. This clearance requirement is similar for both renewal and replacing of elements.

5. Recommendations

We recommend the following:

- Ongoing assessment required at the bridge yearly to determine the extent and if deteriorating further;
- update the posted load and speed limit on the bridge within 1 month (as per the reassessment)

Appendices

Appendix A - (Rating and Posting Calculations)

GHD LIMITED

BRIDGE CAPACITY DESIGN CHECK

CLIENT:

BRIDGE NAME OR NUMBER: **B292 -- Mangateitei Rail Bridge**

BRIDGE LOCATION OR ROAD: **Mangateitei Road, Ohakune**

DESIGN SATISFACTORY FOR:

AXLES :	6,000	kg
GROSS:	60	% Class 1
SPEED:	10	kph

LIMITING BRIDGE COMPONENT:

Posting evaluations were carried out per Section 7 of the NZ Transport Agency Bridge Manual 3rd Edition and NZS 3603:1993.

Timber stringers sized used: avg.depth (d) = 340 mm and avg.width (w) = 230 mm
The above result for the stringers was analysed resulting two stringer will resist one wheel loading (i.e. the vehicle is central to the bridge and the wheel is between the stringers).
The timber properties used in the assessment were taken from AS 1720.1 Table H2.1 (assuming F8 for gum, red) and are as follows:
•Bending strength, fb: 22 MPa
•Shear strengthfs: 2.2 MPa
•Compression parallel to grain, fp: 18 MPa
•Modulus of elasticity, E:9.1 GPa

Section capacities of the deck planks and stringers were determined from NZS 3603.
A material strength reduction factor of 0.8 was adopted.
A condition factor of 0.85 was applied to the strength reduction factor for the deck (assuming the deck is in fair to deteriorated condition) and a 0.85 condition factor was applied to the strength reduction factor for the stringers (assuming the stringer is in seriously deteriorated condition).

SIGNED:  **DATE:** 29/04/2021

Chartered Professional Engineer: Alex Chisholm

Member ID 194760

Calculations

GHD Limited

CLIENT: Ruapehu District Council	JOB No:	SHEET:
JOB: Mangateitei Rail Overbridge Assessment	CALCS By: RT	DATE: 19 April 2021
SUBJECT: Determination of dead load and demands	CHECKED By:	DATE:

Description	Notation	Value	Units	Comment
density of timber (deck)	γ_{td}	5.39	kN/m^3	*assume radiata pine (550 kg/m^3)* *assume F8 (gum, red & seasoned)*
density of timber (stringer)	γ_{ts}	8.83	kN/m^3	*(900 kg/m^3)*
triburaty width per beam	b_{rp}	850	mm	*tributary width* *0.5 x (900+800)*
running planks				
thickness	t_{rp}	50	mm	
weight of running planks	w_{rp}	0.23	kN/m	*effect for one beam*
deck				
thickness	t_{deck}	100	mm	
weight of deck	w_{deck}	0.46	kN/m	*effect for one beam*
timber beams				
width	b	255	mm	*maximum*
depth	d	360	mm	*maximum*
weight of beam	w_b	0.81	kN/m	
railings	w_r	0.50	kN/m	*assumed per side*
uniform dead load on one beam	**w_b**	**1.50**	**kN/m**	
span length	**L**	**5.40**	**m**	
moment demand due to dead load for beam	**M^*_{DL}**	**5.5**	**kN-m**	$M^*_{DL} = w_b L^2 / 8$
shear demand due to dead load for beam	**V^*_{DL}**	**4.0**	**kN**	$V^*_{DL} = w_b L / 2$

Calculations

GHD Limited

CLIENT: Ruapehu District Council	JOB No:	SHEET:
JOB: Mangateitei Rail Overbridge Assessment	CALCS By: RT	DATE: 19 April 2021
SUBJECT: Determination of deck plank capacity	CHECKED By:	DATE:

Description	Notation	Value	Units	Comment
distance between supports	L_B	900	mm	*maximum distance between beams*
depth of a member in direction of flexural loading	d	100	mm	
breadth of a member perpendicular to direction of flexural loading	b	200	mm	*for planks laid flat, with running planks at least 50mm*
nominal width	b_n	650	mm	*b_n = 250 + 2 x 200*
centre to centre spacing of members	s	200	mm	
distance between points of restraint against lateral movements of the compression edge	L_{ay}	300	mm	*assume width of running planks*
bending capacity				
load duration factor	k_1	0.8		*NZS 3603:1993 Table 2.4 (duration of load taken as medium)*
parallel support factor	k_4	1.20		*NZS 3603:1993 Table 2.7 (assume 3 elements with same deformation)* $k_5 = 1 + (k_4 - 1)(1 - 2s / L_B)$
grid system factor	k_5	1.11		*but not less than 1.0*
slenderness coefficient	S	5.93		$S = 1.35\,[L_{ay} / b\,[(d/b)^2 - 1]^{0.5}\,]^{0.5}$
stability factor	k_8	1.00		*moisture condition dry*
characteristic extreme fibre stress in bending parallel to the grain	f_b	**10.0**	MPa	*assume radiata pine*
section modulus	Z	1083333	mm^3	$Z = b_n d^2 / 6$
nominal bending strength	M_{no}	11.6	kN-m	$M_{no} = k_1 k_4 k_5 k_8 f_b Z$
capacity factor	CF	1.25		*may be increased by 25% as per Section 7.5.5 a. of BM*
nominal bending strength	**M_n**	**14.4**	**kN-m**	$M_n = M_{no}$ x CF
shear capacity				
characteristic shear stress	f_s	**3.8**	MPa	*assume radiata pine*
shear plane area	A_s	43333	mm^2	$A_s = 2\,b_n\,d\,/3$
nominal shear strength	**V_n**	**175.6**	**kN**	$V_n = k_1 k_4 k_5 f_s A_s$

References: Bridge Manual and NZS 3603

Calculations

GHD Limited

CLIENT: Ruapehu District Council	JOB No:	SHEET:
JOB: Mangateitei Rail Overbridge Assessment	CALCS By: RT	DATE: 19 April 2021
SUBJECT: Determination of stringer capacity	CHECKED By:	DATE:

Description	Notation	Value	Units	Comment
distance between supports	L_B	5400	mm	
depth of a member in direction of flexural loading	d	340	mm	
breadth of a member perpendicular to direction of flexural loading	b	220	mm	
centre to centre spacing of the supporting members	s	800	mm	
distance between points of restraint against lateral movements of the compression edge	L_{ay}	200	mm	
bending capacity				
				NZS 3603:1993 Table 2.4
load duration factor	k_1	0.8		*(duration of load taken as medium)*
parallel support factor	k_4	1.00		
				$k_5 = 1 + (k_4 - 1)(1 - 2s / L_B)$
grid system factor	k_5	1.00		*but not less than 1.0*
slenderness coefficient	S	1.40		$S = 1.35 [L_{ay} / b [(d/b)^2 - 1]^{0.5}]^{0.5}$
stability factor	k_8	1.00		*moisture condition dry*
characteristic extreme fibre stress in bending parallel to the grain	f_b	**22.0**	MPa	*assumed F8 (gum, red & seasoned)*
section modulus	Z	4238667	mm^3	$Z = b d^2 / 6$
nominal bending strength	M_n	74.6	kN-m	$M_n = k_1 k_4 k_5 k_8 f_b Z$
shear capacity				
characteristic shear stress	f_s	**2.2**	MPa	*assumed F8 (gum, red & seasoned)*
shear plane area	A_s	49867	mm^2	$A_s = 2 b d / 3$
nominal shear strength	V_n	87.8	kN	$V_n = k_1 k_4 k_5 f_s A_s$

References: AS 17201.1 and NZS3603

Deck rating load				
Axle	190	kN		Table 7.7 BM
per wheel	95	kN		
load contact area	900	x	600 mm	HO Alternative (b)
nominal plank width			650 mm	
UDL			105.56 kN/m	

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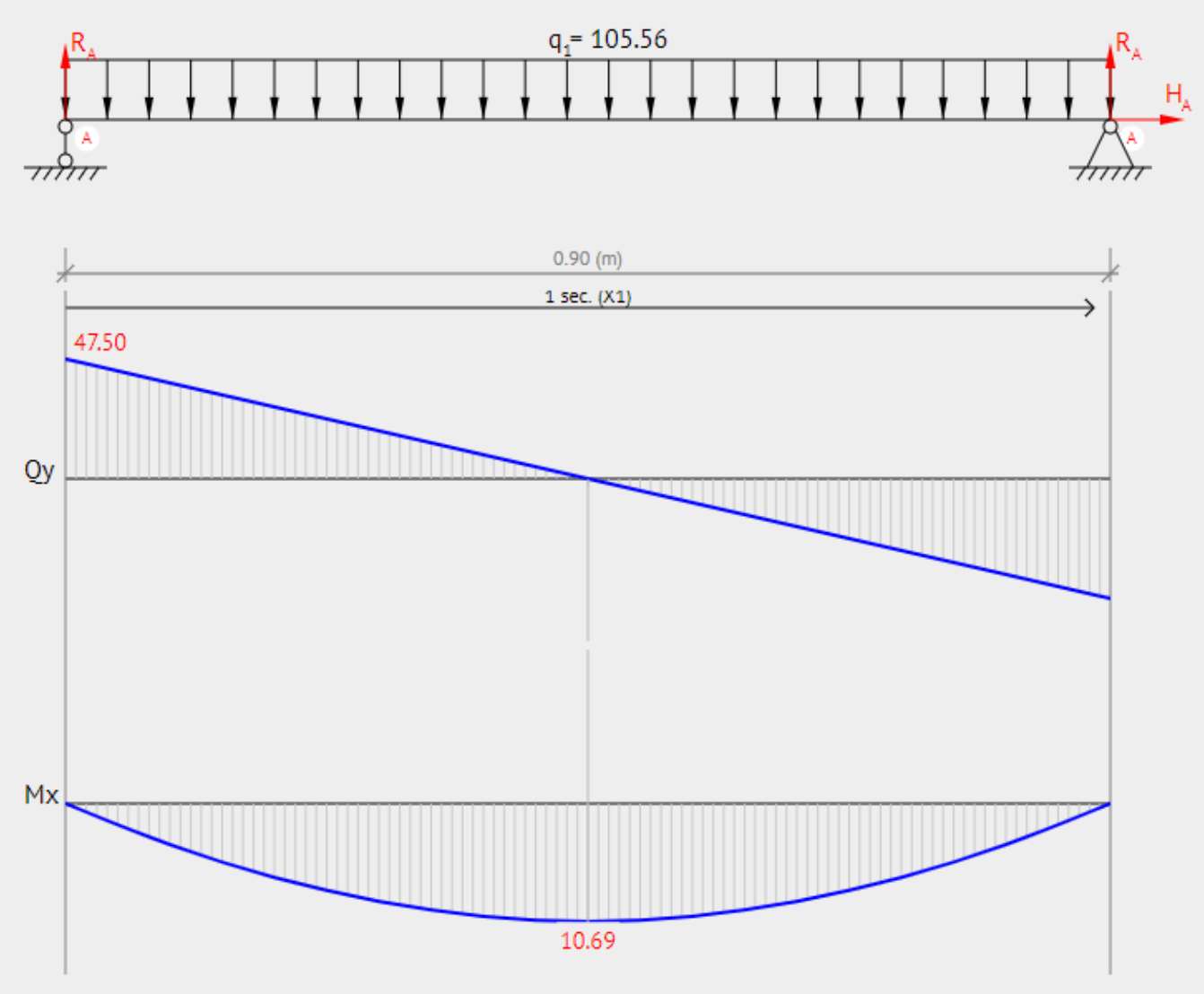
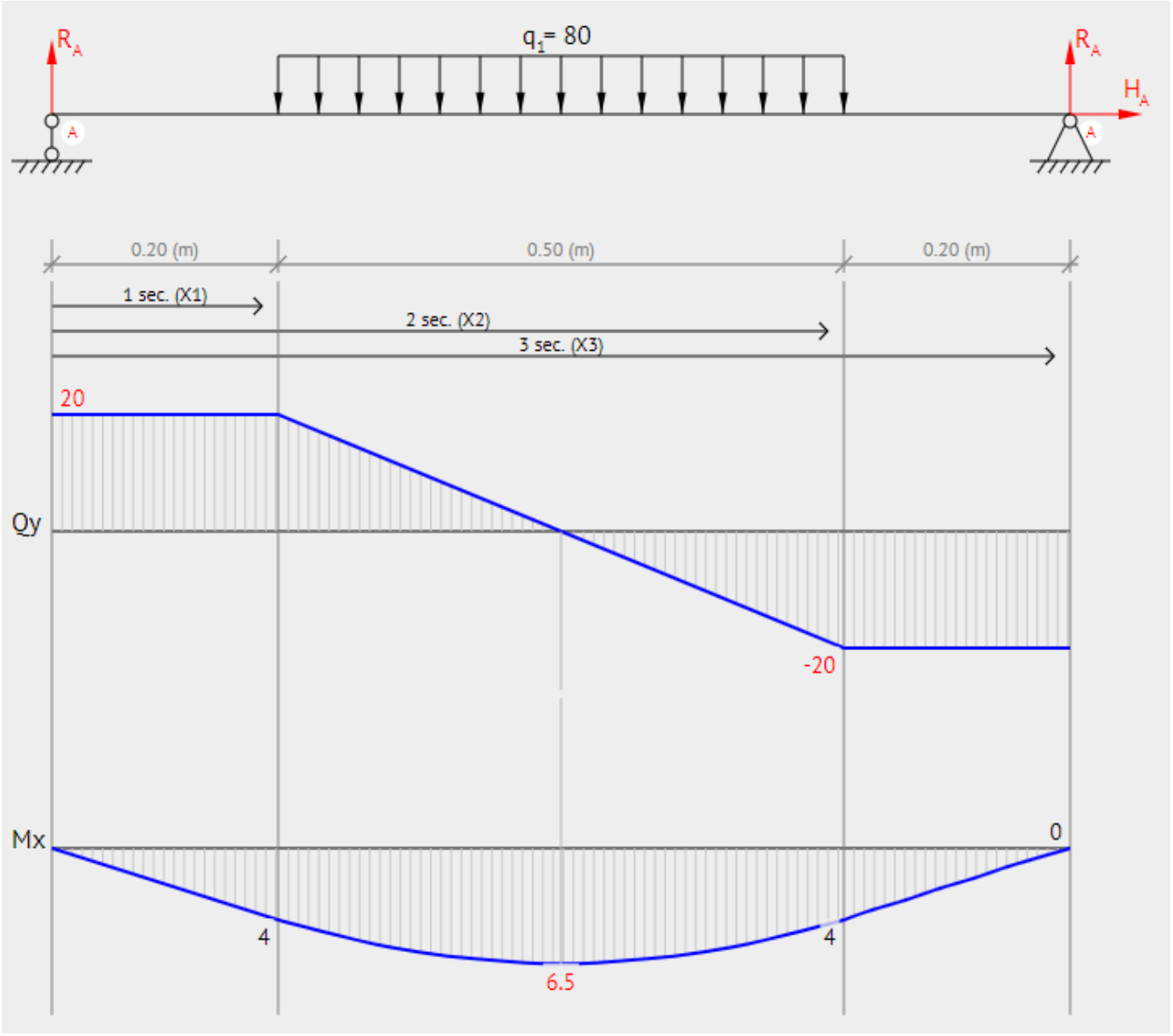


Deck Posting/50MAX evaluation load				
Axle	80	kN		Table 7.8 BM
per wheel	40	kN		
load contact area	500	x	200 mm	HN
nominal plank width			650 mm	
UDL			80.00 kN/m	

https://beamguru.com/online/beam-calculator/?save=6ff268235430f1ffa2b24f2eef652f61



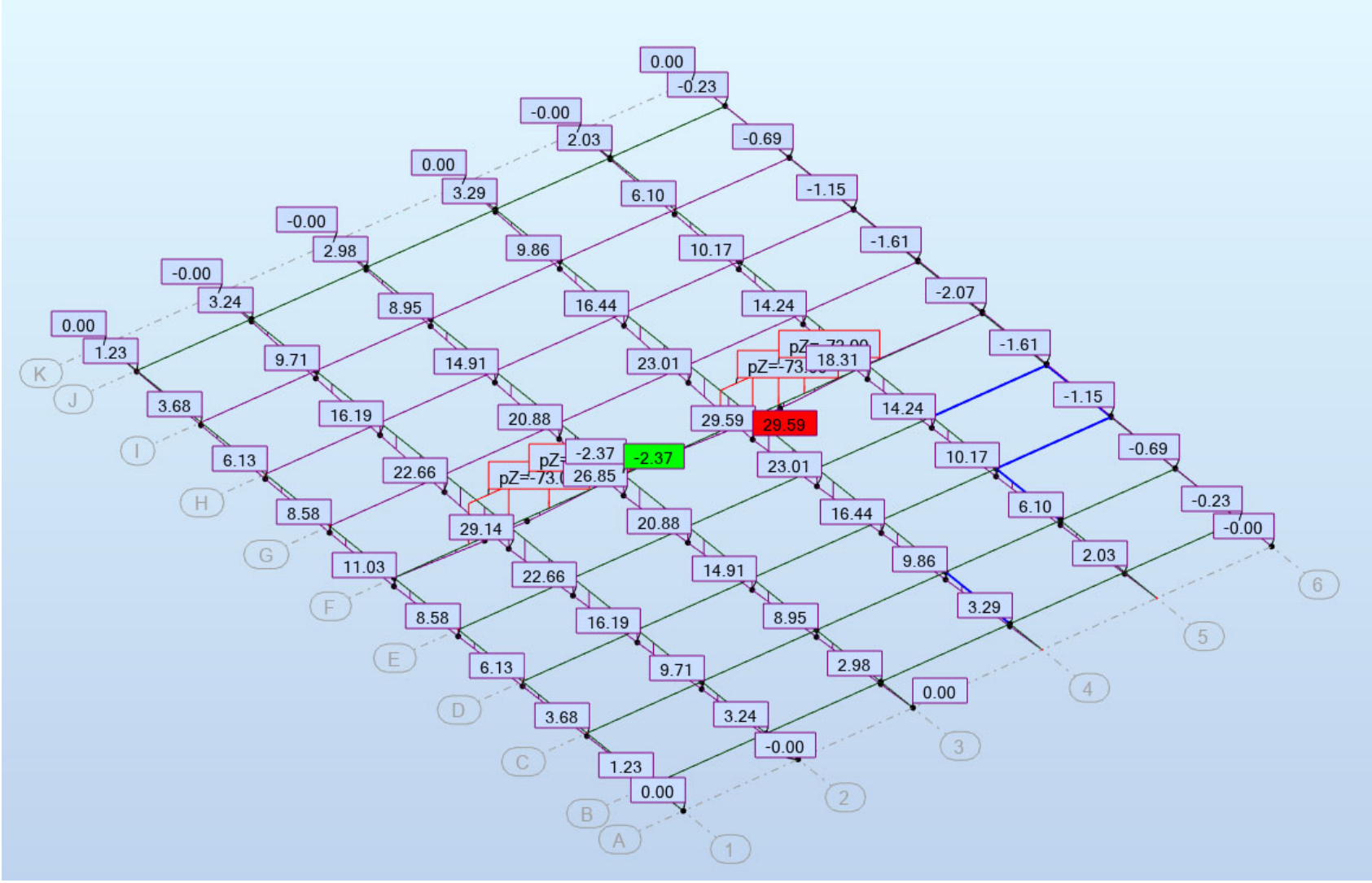
Beam Live Load from Grillage Analysis

	Axle				UDL		M*
Posting	102	beam 1	11.03	8.01%	8.925		11.03
	138	beam 2	29.14	21.16%	32.53	8.13	37.27
		beam 3	26.85	19.50%		8.13	34.98
		beam 4	29.59	21.49%		8.13	**37.72**
		beam 5	18.31	13.30%		8.13	26.44
		beam 6	-2.07	-1.50%			-2.07
			112.85	**81.95%**		32.53	
Rating	204	beam 1	22.06	8.01%	8.925		22.06
	275	beam 2	58.28	21.16%	32.53	8.13	66.41
		beam 3	53.7	19.50%		8.13	61.83
		beam 4	59.18	21.49%		8.13	**67.31**
		beam 5	36.62	13.30%		8.13	44.75
		beam 6	-4.14	-1.50%			-4.14
			225.7				

	Axle				UDL		V*
Posting	102	beam 1	4.08	8.00%	48.195		4.08
	51	beam 2	10.79	21.16%	24.10	6.02	16.81
		beam 3	9.94	19.49%		6.02	15.96
		beam 4	10.96	21.49%		6.02	**16.98**
		beam 5	6.78	13.29%		6.02	12.80
		beam 6	-0.77	-1.51%			-0.77
			41.78	**81.92%**		24.10	
Rating	204	beam 1	8.16	8.00%	48.195		8.16
	102	beam 2	21.58	21.16%	24.10	6.02	27.60
		beam 3	19.88	19.49%		6.02	25.90
		beam 4	21.92	21.49%		6.02	**27.94**
		beam 5	13.56	13.29%		6.02	19.58
		beam 6	-1.54	-1.51%			-1.54
			83.56			24.10	

Robot Grillage Analysis - Bending Moment Results of Stringers:

(2 x 60 kN wheel loads applied at mid span with one wheel load directly over stringer 2 to compare moment distribution)



Calculations

GHD Limited

CLIENT: Ruapehu District Council	JOB No:	SHEET:
JOB: Mangateitei Rail Overbridge Assessment	CALCS By: RT	DATE: 19 April 2021
SUBJECT: Results for deck	CHECKED By:	DATE:

Description	Notation	Value	Units	Comment
flexure				
nominal moment capacity	R_i	14.4	kN-m	
material strength factor	ϕ_D	**0.80**		*NZS 3603*
condition factor	CF	0.85		*between good or fair and deteriorated*
strength reduction factor	ϕ	0.68		ϕ = CF ϕ_D
dead load factor	γ_D	1.25		
overload factor	γ_O	1.49		
live load factor	γ_L	1.9		
dead load effect	DL	0.00	kN-m	*dead load may be neglected Section 7.5.5 a of BM*
deck rating load	DRL	10.7	kN-m	*from deck live load demands*
deck posting/50MAX evaluation load	DPL	6.5	kN-m	*from deck live load demands*
with speed restriction? (yes/no)		**yes**		
speed limit (30/10)		**10**		
dynamic factor	I	1.3		
corrected dynamic factor	I_M	1.10		
overload capacity of nominal width	R_O	6.6	kN-m	$R_o = (\phi R_i - \gamma_D DL) / \gamma_o$
Rating load effect	RLE	11.7	kN-m	RLE = DRL x I
Deck capacity factor	**DCF**	**0.56**		DCF = R_o / RLE
live load capacity of nominal width	R_L	5.2	kN-m	$R_L = (\phi R_i - \gamma_D DL) / \gamma_L$
Posting (or 50MAX) load effect	PLE	7.1	kN-m	PLE = DPL x I
Allowable axle load	**AAL**	**6000**	**kg**	AAL = R_L / PLE x 8200
shear				
nominal moment capacity	R_i	175.6	kN	
material strength factor	ϕ_D	0.80		
condition factor	CF	0.85		
strength reduction factor	ϕ	0.68		ϕ = CF ϕ_D
dead load factor	γ_D	1.25		
overload factor	γ_O	1.49		
live load factor	γ_L	1.9		
dead load effect	DL	0.00	kN	*dead load may be neglected Section 7.5.5 a of BM*
deck rating load	DRL	47.5	kN	*from deck live load demands*
deck posting/50MAX evaluation load	DPL	20.0	kN	*from deck live load demands*
dynamic factor	I	1.10		
overload capacity of nominal width	R_O	80	kN	$R_o = (\phi R_i - \gamma_D DL) / \gamma_o$
Rating load effect	RLE	52	kN	RLE = DRL x I
Deck capacity factor	**DCF**	**1.54**		DCF = R_o / RLE
live load capacity of nominal width	R_L	63	kN	$R_L = (\phi R_i - \gamma_D DL) / \gamma_L$
Posting (or 50MAX) load effect	PLE	22	kN	PLE = DPL x I
Allowable axle load	**AAL**	**23500**	**kg**	AAL = R_L / PLE x 8200

Calculations

GHD Limited

CLIENT: Ruapehu District Council	JOB No:	SHEET:
JOB: Mangateitei Rail Overbridge Assessment	CALCS By: RT	DATE: 19 April 2021
SUBJECT: Results for stringers	CHECKED By:	DATE:

Description	Notation	Value	Units	Comment
flexure				
span length	S	5.4	m	
nominal moment capacity	R_i	74.6	kN-m	*refer "stringer capacity" tab*
material strength factor	ϕ_D	**0.80**		*NZS 3603*
condition factor	CF	0.90		*assume deteriorated*
strength reduction factor	ϕ	0.72		
dead load factor	γ_D	1.25		
overload factor	γ_O	1.49		
live load factor	γ_L	1.9		
eccentricity	e	1.00		
dead load effect	DL	5.5	kN-m	*from dead load demands*
rating load	0.85 HO	67.0	kN-m	*from stringer LL demands*
posting load	0.85 HN	38.0	kN-m	*from stringer LL demands*
with speed restriction? (yes/no)		**yes**		
speed limit (30/10)		**10**		
dynamic factor	I_{Mo}	1.30		$I_{Mo} = 1 + (15 / (S + 38))$ *with speed restriction* for 30 km/h: $I_M = (I_{Mo} - 1) \times 0.67 + 1$ for 10 km/h:
corrected dynamic factor	I_M	1.10		$I_M = (I_{Mo} - 1) \times 0.33 + 1$
overload capacity	R_O	31	kN-m	$R_o = (\phi R_i - \gamma_D DL) / \gamma_o$
Rating load effect	RLE	74	kN-m	$RLE = 0.85HO \times I_M \times e$
Rating CLASS	**CLASS**	**43%**		$CLASS = R_o / RLE$
live load capacity	R_L	25	kN-m	$R_L = (\phi R_i - \gamma_D DL) / \gamma_L$
Posting load effect	PLE	42	kN-m	$PLE = 0.85HN \times I_M \times e$
Posting GROSS	**GROSS**	**59%**		$GROSS = R_L / PLE$

Calculations

GHD Limited

CLIENT: Ruapehu District Council	JOB No:	SHEET:
JOB: Mangateitei Rail Overbridge Assessment	CALCS By: RT	DATE: 19 April 2021
SUBJECT: Results for stringers	CHECKED By:	DATE:

Description	Notation	Value	Units	Comment
shear				
nominal moment capacity	R_i	87.8	kN	*refer "stringer capacity" tab*
material strength factor	ϕ_D	**0.80**		
condition factor	CF	0.90		*assume deteriorated*
strength reduction factor	ϕ	0.72		
dead load factor	γ_D	1.25		
overload factor	γ_O	1.49		
live load factor	γ_L	1.9		
eccentricity	e	1.0		
dead load effect	DL	4.0	kN	*from dead load demands*
rating load	0.85 HO	28.0	kN	*from stringer LL demands*
posting load	0.85 HN	17.0	kN	*from stringer LL demands*
with speed restriction? (yes/no)		yes		
speed limit (30/10)		**10**		
dynamic factor	I_o	1.30		*with speed restriction* for 30 km/h: $I = (I_o - 1) \times 0.67 + 1$ for 10 km/h:
corrected dynamic factor	I	1.10		$I = (I_o - 1) \times 0.33 + 1$
overload capacity	R_O	39	kN	$R_o = (\phi R_i - \gamma_D DL) / \gamma_o$
Rating load effect	RLE	31	kN	RLE = 0.85HO x I x e
Rating CLASS	**CLASS**	**127%**		CLASS = R_o / RLE
live load capacity	R_L	31	kN	$R_L = (\phi R_i - \gamma_D DL) / \gamma_L$
Posting load effect	PLE	19	kN	PLE = 0.85HN x I x e
Posting GROSS	**GROSS**	**164%**		GROSS = R_L / PLE

Appendix B - (Bridge Inspection Reports)

	Bridge Name: Mangateitei Rail Overbridge	Bridge No: 292	Road: Mangateitei	RP: 844

Bridge Type: Timber deck on Hardwood (HW) beams on timber piers and concrete abutments				Report Type: Principal
Piers: HW timber on concrete base	Pile Caps:	Unknown		Foundations: Concrete
Deck Type: Timber	Deck width:	4.8 m		Deck Cantilever: 0 mm
Running Planks: Full width running boards	Width (Kerb to kerb)	4.3 m		Deck Thickness: 100 timber + full width r/bs mm
Extent marking code A = No Defect B = Not > 5% C = Moderate 5 - 20% D = Wide 20 - 50% E = > 50% N = Not Applicable NI= Not Inspected	**Severity code** 1 - as new 2 = early signs of defect 3 = moderate defect 4 = severe defect 5 = element failed	Total Bridge length:	17.4 m	Map Ref (easting): 2720881.595
		Beams: 6 No. 350 x 240 avg. HW		Map Ref (northing): 6195236.034
		Spacing: 800 mm		Owner / Client: Ruapehu District Council
		Span: 3		Current Loading Sign: 70% Class 1
		Span length: 5.3, 5.4, 5.3 m		Axle: 8,200 kg Speed (km/h): 15 km/h
				Design Loading: Originally Class 1
		Height Above Water/Road: 4.806 m		Year Constructed: Unknown
Ext = Extent ; **Sev** = Severity **S** = Structural Mtce ; **R** = Routine Mtce		Inspector: Etienne du Plessis		Next Inspection Type: General
		Date: 25-Mar-2021		Date (mth/yr): 2023

Element Set	No	Description	Ext	Sev	S / R	Brief description of defect and comments
Superstructure Elements	1	Primary load carrying element	E	4	S	Timber Decay (main stringers old, cracks and decayed. Also peppered with core holes, SRF less than 0.80. Beam 3 & 4 severe weathering near abutment 1)
	2	Secondary element(s) – Transverse beams	N			
	3	Secondary element(s) – Other (incl. deck)	D	4	S	Broken Running boards (running boards badly worn)
			C	4	S	Broken Cross beams North (timber decking requires urgent replacement near abutment 1)
	4	Half joints	N			
	5	Seismic linkages/holding down bolts	N			
	6	Parapet beam or cantilever	D	3	S	Broken Kerbs
	7	Cross bracing	N			
Load-bearing Substructure	8	Foundations	A			
	9	Abutments	B	2	R	Lichen / Moss / Vegetation Abutment (lichen covering concrete surface)
	10	Head wall	A			
	11	Pier / column	B	3	S	Aged Pier (columns deteriorate / split “decayed” which in some cases have been bolted - SRF=0.80)
	12	Cross-head / capping beam	C	3	S	Crack Pier Capping beam/bearing plinth (cross head longitudinal cracks/ splitting)
			E	3	S	Crack Pier (corbels show significant splitting/ cracking)
	13	Bearings	N			
	14	Bearing plinth / shelf	C	2	R	Debris Abutment bearing plinth
Durability Elements	15	Superstructure drainage	A			
	16	Substructure drainage	A			
	17	Movement / expansion joints	N			
	18	Painting: superstructure elements	N			
	19	Painting: substructure elements	N			
	20	Painting: barriers / guardrails	B	2	R	Paint Loss Handrails
Safety Elements	21	Access / walkways / gantries	N			
	22	Guardrail / handrail / safety fences	C	3	S	Broken Handrails
			E	3	S	Loose Handrails
	23	Carriageway surfacing	N			
	24	Footway/verge / footbridge surfacing	N			
Waterway Elements	25	Invert / river bed	N			
	26	Aprons	N			
	27	River bed upstream	N			
	28	River bed downstream	N			
	29	Scour	N			
	30	River banks	N			
Retaining Element	31	Revetment / batter slope paving	N			
	32	Wing walls	A			
	33	Retaining walls	A			
	34	Embankments	A			
Other	35	Approach rails / barriers / walls	C	2	R	Missing Approach rails (both directions)
	36	Approach adequacy	C	2	R	Settlement Approach South (also reason for surface deformation and heaving)
	37	Signs	B	3	R	Missing Bridge end markers (BEM)
	38	Lighting	N			
	39	Services	A			
	40	Appearance	D	4	S	Aged Deck (all timber members exceeded their life span and bridge to be replaced)

Comments and recommendations for maintenance/repairs				
Item no.	**Element no.**	**Suggested remedial work**	**Priority (H/M/L)**	**Estimated cost**
1.	1,11,40	Investigate (bridge assessment required and may be further restricted)	H	
2.	3	Replace (running board and first couple timber cross timber boards on approach North)	H	$15,000 - $20,000
3.	6	Replace (broken kerbs - 4 off)	M	$7,500 - $10,000
4.	11,12	Monitor (pier columns, capping beams and cobbles - no change from previous inspection)	H	
5.	22	Tighten Bolts (re-nail, brace cracked timbers and fix loose handrails)	M	$5,000 - $7,500
6.	20	Clean & Repaint (all timber rails)	L	$5,000 - $7,500
7.	23,36	Regrade, New Seal (Surface) (realign approach and repair deformed surface seal)	M	$10,000 - $15,000
8.	35	Install New (approach rails where missing)	H	$2,500 - $5,000
9.	37	Install New, Capacity Check (missing BEM and update restriction sign after assessment)	H	$1,000 - $2,500
10.	40	Monitor, Install New (provide surveillance system - overweight vehicles trespassing)	H	$1,000 - $2,500
			Total Cost	

Remedial work recommended in last inspection has been completed *(comment below if NO) :*	**NO**
Bridge Database changes required *(Describe changes below if answer is yes):*	**NO**

Comments & Recommendations Relating to Future Management (Transfer to current report)

All the above items specified in the previous report were not completed - Bridge needed replacement

Other Notes

Surveillance system to be installed on the bridge as overweight vehicles been using the bridge.

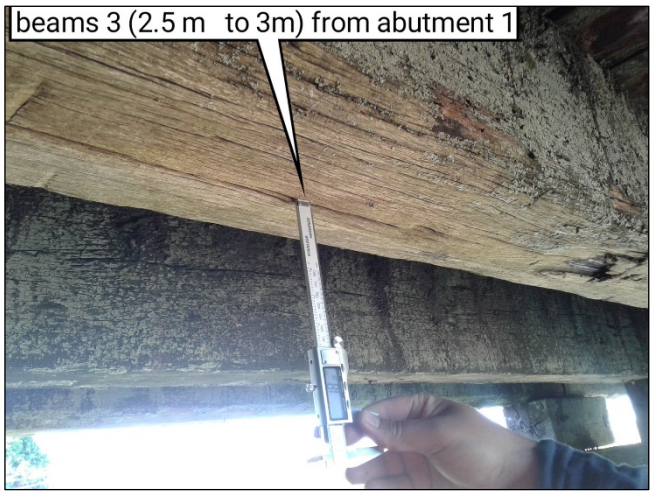
Inspection by: Etienne du Plessis	Signature:	Date: 29-Mar-2021
Reviewed by:	Signature:	Date:
Approved by:	Signature:	Date:

Bridge Overview Photo

Element Photos

1 : Primary load carrying element

Timber Decay (main stringers old, cracks and decayed. Also peppered with core holes, SRF less than 0.80. Beam 3 & 4 severe weathering near abutment 1)



3 : Secondary - Other (incl. deck)

Broken Running boards (running boards badly worn)

Broken Cross beams North (timber decking requires urgent replacement near abutment 1)

6 : Parapet beam or cantilever

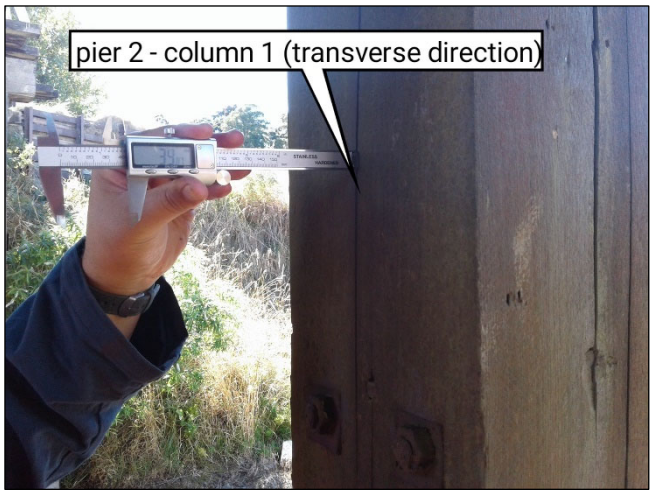
Broken Kerbs

9 : Abutments

Lichen / Moss / Vegetation Abutment (lichen covering concrete surface)

11 : Pier / column

Aged Pier (columns deteriorate / split “decayed” which in some cases have been bolted - SRF=0.80)



12 : Cross-head / capping beam

Crack Pier Capping beam/bearing plinth (cross head longitudinal cracks/ spliting)

Crack Pier (corbels show significant splitting/ cracking)



14 : Bearing plinth / shelf

Debris Abutment bearing plinth


20 : Painting : Barriers / guardrails

Paint Loss Handrails

22 : Guardrail / handrail / safety fences

Broken Handrails

Loose Handrails


23 : Carriageway surfacing


35 : Approach rails / barriers / walls

Missing Approach rails (both directions)


36 : Approach adequacy

Settlement Approach South (settlement behind abutment - also reason for surface deformation and heaving)

37 : Signs

Missing Bridge end markers (BEM)

40 : Appearance

Aged Deck (all timber members exceeded their life span and bridge to be replaced)




Supporting Photos

Approach South

Deck surface

Bridge Restriction Sign

Rail South East

Rail North West

Approach North East

Abutment 1

Pier 1

Pier 2

Abutment 2

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Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	Etienne du Plessis	Alex Chisholm		Stephen Fletcher		29/04/2021

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