Bridge No:	N/A	Owner:	VAOT
Town/City:	Rockingham	Maintainer:	
Route Carried:	VT Route 121	Year Built	2015
Crosses:	Saxtons River	Year(s) Rebuilt/Rehab:	

SUMMARY OF BRIDGE RATING

VEHICLE TYPE		RF	RT (TONS)	POSTING LOAD (TONS)	
HL-93	INVENTORY	1.06	47.57		Interior Shear
	OPERATING	1.37	61.65		Interior Shear

Group 1 Posting Analysis (Configuration 1)

Governing Posting: N/A

Governing Load Model: N/A

Group 2 Posting Analysis (Configurations 2 - 5)

Governing Posting: N/A

Governing Load Model: N/A

Group 3 Posting Analysis (Configurations 6 - 8)

Governing Posting: N/A

Governing Load Model: N/A

Please check all the boxes that apply:

LRFR Evaluation Factors: LL Rating

Live Load Distribution Factor:	0.83	Positive Moment Flex	
	0.83	Negative Moment Flex	
	1.09	Shear Dist. Factor	
Live Load DF Special Hauling:	N/A		
Impact Factor:	33%		
Governing Condition Factor, ϕ_c:	1		
System Factor, ϕ_s:	1		
ADTT :	3700		

Bridge load rating is:

- [ ] governed by substructure rating
- [ ] Connections control the load rating
- [x] Exterior girder controls load rating
- [ ] As-built load rating
- [ ] As-inspected load rating
- [ ] One Lane Loaded
- [ ] Advanced Analysis Used
- [ ] Actual Measurements Taken
- [ ] Finite Fatigue Life 75 years*

STATE OF VERMONT
ERIC T. CALDERWOOD
NO. 8711
Structural
LICENSED
PROFESSIONAL ENGINEER

BREAKDOWN OF BRIDGE RATING

Town/City: Rockingham
Bridge No: N/A

Route Carried:
Crosses:

LOAD RATING POINTS OF INTEREST

Bridge Component	HL-93			
	Inv 72.0 kip	Oper 72.0 kip		
Exterior Beam Strength I Positive Moment	2.27	2.94		
Exterior Beam Strength I Negative Moment	1.34	1.73		
Exterior Beam Strength I Shear	1.15	1.49		
Exterior Beam Service 2 Positive Moment	2.89	3.75		
Exterior Beam Service 2 Negative Moment	4.57	5.93		
Interior Beam Strength I Positive Moment	2.32	3.00		
Interior Beam Strength I Negative Moment	1.21	1.56		
Interior Beam Strength I Shear	1.06	1.37		
Interior Beam Service 2 Positive Moment	2.95	3.82		
Interior Beam Service 2 Negative Moment	4.16	5.40		
CONTROLLING RATING FACTORS	1.06	1.37		

VT Route 121

Saxtons River

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Rockingham, VT
BRF-0126(12)
Load Rating per 2011 Manual for Bridge Evaluation (with 2013 Interim Revisions)

General Equation (per 6.4.2.1-1)

Capacity for Strength Limit States: per (6A.4.2.1-2)

$\varphi_c := 1$ satisfactory condition

$\varphi_s := 1$

lower limit applies, if >0.85, OK $\varphi_c \cdot \varphi_s = 1$ per (6A.4.2.1-3)

Capacity for Service Limit States: per (6A.4.2.1-4)

Distribution Factors

$D.F._{moment} := 0.830$ (Both Interior and Exterior Sheet 6 of 64 Steel Design)

$D.F._{Shear} := 1.09$ (Controlling Shear D.F. 7 of 64 Steel Design)

Table 6A.4.2.2-1

$\gamma_{DCSTR1} := 1.25$ $\gamma_{DWSTR1} := 1.50$ $\gamma_{INVSTR1} := 1.75$ $\gamma_{OPSTR1} := 1.35$

STRENGTH 1 Positive Moments

$\gamma DC_{STR1PosMint} := 629.06\ kip \cdot ft$
$\gamma DW_{STR1PosMint} := 206.89\ kip \cdot ft$
$\gamma LL_{STR1PosMint} := 1751.86\ kip \cdot ft$

(P.17 of 64 Steel Design Comps.)

$\gamma DC_{STR1PosMext} := 529.44\ kip \cdot ft$
$\gamma DW_{STR1PosMext} := 137.93\ kip \cdot ft$
$\gamma LL_{STR1PosMext} := 1751.86\ kip \cdot ft$

STRENGTH 1 Shear

$\gamma DC_{STR1Vint} := 74.31\ kip$
$\gamma DW_{STR1Vint} := 24.37\ kip$
$\gamma LL_{STR1Vint} := 205.61\ kip$

(P.40 of 64 Steel Design Comps.)

$\gamma DC_{STR1Vext} := 62.91\ kip$
$\gamma DW_{STR1Vext} := 16.05\ kip$
$\gamma LL_{STR1Vext} := 205.61\ kip$

STRENGTH 1 Negative Moments (@ Pier)
(P.18 of 64 Steel Design Comps.)

$\gamma DC_{STR1NegMint1} := 847.83\ kip \cdot ft$
$\gamma DW_{STR1NegMint1} := 278.84\ kip \cdot ft$
$\gamma LL_{STR1NegMint1} := 1720.70\ kip \cdot ft$

$\gamma DC_{STR1NegMext1} := 713.58\ kip \cdot ft$
$\gamma DW_{STR1NegMext1} := 185.9\ kip \cdot ft$
$\gamma LL_{STR1NegMext1} := 1720.70\ kip \cdot ft$

STRENGTH 1 Negative Moments (@ 0.1L From Pier)
(P.19 of 64 Steel Design Comps.)

$\gamma DC_{STR1NegMint2} := 444.91\ kip \cdot ft$
$\gamma DW_{STR1NegMint2} := 146.33\ kip \cdot ft$
$\gamma LL_{STR1NegMint2} := 1089.38\ kip \cdot ft$

$\gamma DC_{STR1NegMext2} := 374.46\ kip \cdot ft$
$\gamma DW_{STR1NegMext2} := 97.55\ kip \cdot ft$
$\gamma LL_{STR1NegMext2} := 1089.83\ kip \cdot ft$

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Exterior Beam, Positive Flexure, Strength 1

Moment Capacity $C_{Str1PosMext} := 4641.36\ kip \cdot ft$ (Exterior Beam Positive Moment Capacity P.24 of 64)

$$invRF_{STR1PosMex} := \frac{C_{Str1PosMext} - \langle \gamma DC_{STR1PosMext} + \gamma DW_{STR1PosMext} \rangle}{\gamma LL_{STR1PosMext}} = 2.268$$ Controls

$$opRF_{STR1PosMex} := \frac{\gamma_{INVSTR1}}{\gamma_{OPSTR1}} \cdot invRF_{STR1PosMex} = 2.941$$ Controls

Exterior Beam, Negative Flexure (@ Pier), Strength 1

Maximum Factored Stress $F_{bSTR1NegM} := 50\ ksi$ (Exterior Beam Negative Stress Capacity P.29)

$S_{bfnm} := 768.32\ in^3$ (Bottom Flange Section Modulus Negative Moment P.3)

$C_{STR1NegM1} := F_{bSTR1NegM} \cdot S_{bfnm} = 3201.333\ kip \cdot ft$

$$invRF_{STR1NegMex1} := \frac{C_{STR1NegM1} - \langle \gamma DC_{STR1NegMext1} + \gamma DW_{STR1NegMext1} \rangle}{\gamma LL_{STR1NegMext1}} = 1.338$$ Controls

$$opRF_{STR1NegMex1} := \frac{\gamma_{INVSTR1}}{\gamma_{OPSTR1}} \cdot invRF_{STR1NegMex1} = 1.734$$ Controls

Exterior Beam, Negative Flexure (@ 0.1L from Pier), Strength 1

Maximum Factored Stress $F_{bSTR1NegM} := 39.4\ ksi$ (Exterior Beam Negative Stress Capacity P.30)

$S_{bfnm} := 768.32\ in^3$ (Bottom Flange Section Modulus Negative Moment P.3)

$C_{STR1NegM2} := F_{bSTR1NegM} \cdot S_{bfnm} = 2522.651\ kip \cdot ft$

$$invRF_{STR1NegMex2} := \frac{C_{STR1NegM2} - \langle \gamma DC_{STR1NegMext2} + \gamma DW_{STR1NegMext2} \rangle}{\gamma LL_{STR1NegMext2}} = 1.882$$

$$opRF_{STR1NegMex2} := \frac{\gamma_{INVSTR1}}{\gamma_{OPSTR1}} \cdot invRF_{STR1NegMex2} = 2.439$$

Exterior Beam, Shear, Strength 1

Shear Capacity $V_r := 315.91\ kip$ $C_{STR1V} := V_r = 315.91\ kip$

$$invRF_{STR1Vex} := \frac{C_{STR1V} - \langle \gamma DC_{STR1Vext} + \gamma DW_{STR1Vext} \rangle}{\gamma LL_{STR1Vext}} = 1.152$$ Controls

$$opRF_{STR1Vex} := \frac{\gamma_{INVSTR1}}{\gamma_{OPSTR1}} \cdot invRF_{STR1Vex} = 1.494$$ Controls

Interior Beam, Positive Flexure, Strength 1

Moment Capacity $C_{Str1PosMint} := 4893.98\ kip \cdot ft$ (Interior Beam Positive Moment Capacity P.27 of 64)

$$invRF_{STR1PosMint} := \frac{C_{Str1PosMint} - \langle \gamma DC_{STR1PosMint} + \gamma DW_{STR1PosMint} \rangle}{\gamma LL_{STR1PosMint}} = 2.316$$ Controls

$$opRF_{STR1PosMint} := \frac{\gamma_{INVSTR1}}{\gamma_{OPSTR1}} \cdot invRF_{STR1PosMint} = 3.003$$ Controls

Interior Beam, Negative Flexure (@ Pier), Strength 1

Maximum Factored Stress $F_{bSTR1NegM} := 50\ ksi$ (Exterior Beam Negative Stress Capacity P.29)

$S_{bfnm} := 768.32\ in^3$ (Bottom Flange Section Modulus Negative Moment P.3)

$C_{STR1NegM1} := F_{bSTR1NegM} \cdot S_{bfnm} = 3201.333\ kip \cdot ft$

$$invRF_{STR1NegMint1} := \frac{C_{STR1NegM1} - \langle \gamma DC_{STR1NegMint1} + \gamma DW_{STR1NegMint1} \rangle}{\gamma LL_{STR1NegMint1}} = 1.206$$ Controls

$$opRF_{STR1NegMint1} := \frac{\gamma_{INVSTR1}}{\gamma_{OPSTR1}} \cdot invRF_{STR1NegMint1} = 1.563$$ Controls

Interior Beam, Negative Flexure (@ 0.1L from Pier), Strength 1

Maximum Factored Stress $F_{bSTR1NegM} := 39.4\ ksi$ (Exterior Beam Negative Stress Capacity P.30)

$S_{bfnm} := 768.32\ in^3$ (Bottom Flange Section Modulus Negative Moment P.3)

$C_{STR1NegM2} := F_{bSTR1NegM} \cdot S_{bfnm} = 2522.651\ kip \cdot ft$

$$invRF_{STR1NegMint2} := \frac{C_{STR1NegM2} - \langle \gamma DC_{STR1NegMint2} + \gamma DW_{STR1NegMint2} \rangle}{\gamma LL_{STR1NegMint2}} = 1.773$$

$$opRF_{STR1NegMint} := \frac{\gamma_{INVSTR1}}{\gamma_{OPSTR1}} \cdot invRF_{STR1NegMint2} = 2.298$$

Interior Beam, Shear, Strength 1

Shear Capacity $V_r := 315.91\ kip$ $C_{STR1V} := V_r = 315.91\ kip$

$$invRF_{STR1Vint} := \frac{C_{STR1V} - \langle \gamma DC_{STR1Vint} + \gamma DW_{STR1Vint} \rangle}{\langle \gamma LL_{STR1Vint} \rangle} = 1.057$$ Controls

$$opRF_{STR1Vint} := \frac{\gamma_{INVSTR1}}{\gamma_{OPSTR1}} \cdot invRF_{STR1Vint} = 1.370$$ Controls

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SERVICE II

Table 6A.4.2.2-1

$\gamma_{DCServ3} := 1.00$ $\gamma_{DWServ3} := 1.00$ $\gamma_{LLINVServ3} := 0.80$ (P.17 of 64 Steel Design Comps.)

Service II Positive Moments (Check both Flanges, Apply Steel and Deck Fluid Load to Girder Section, Rail Loads to LT Composite Section and Live Loads to ST Composite Section) Note: Bot Flange will control by inspection

$\gamma DC_{SvcIIPosMint} := 461.92\ kip \cdot ft$
$\gamma DC_{SvcIIPosMintcs} := 41.32\ kip \cdot ft$ (Rail Load Carried by LT Comp Section)
$\gamma DW_{SvcIIPsoMint} := 137.93\ kip \cdot ft$ (P. 38)
$\gamma LL_{STvcIIPosMint} := 1301.38\ kip \cdot ft$

$\gamma DC_{SvcIIPosMext} := 361.57\ kip \cdot ft$
$\gamma DC_{SvcIIPosMextcs} := 61.99\ kip \cdot ft$ (Rail Load Carried by LT Comp Section)
$\gamma DW_{SvcIIPsoMext} := 91.95\ kip \cdot ft$ (P. 37)
$\gamma LL_{STvcIIPosMext} := 1301.38\ kip \cdot ft$

$S_{bf} := 679.9\ in^3$ (P.2) $S_{tf} := 679.90\ in^3$ (P. 2)

$S_{exbfLT} := 945.29\ in^3$ $S_{exbfST} := 1153.77\ in^3$ (P. 20)
$S_{extfLT} := 3119.87\ in^3$ $S_{extfST} := 15601.21\ in^3$

$S_{inbfLT} := 990.05\ in^3$ $S_{inbfST} := 1239.02\ in^3$ (P. 21)
$S_{intfLT} := 4295.47\ in^3$ $S_{intfST} := 36842.66\ in^3$

Exterior Beam, Positive Moment, Service II

Service 3 Capacity $C_{svcII} := 47.5\ ksi$

$$invRF_{svcIIMexbf} := \frac{\left(C_{svcII} - \left(\frac{\gamma DC_{SvcIIPosMext}}{S_{bf}} + \frac{\left(\gamma DC_{SvcIIPosMextcs} + \gamma DW_{SvcIIPsoMext}\right)}{S_{exbfLT}}\right)\right)}{\frac{\gamma LL_{STvcIIPosMext}}{S_{exbfST}}} = 2.893$$ Controls

$$opRF_{scvIIMexbf} := \frac{\gamma_{INVSTR1}}{\gamma_{OPSTR1}} \cdot invRF_{svcIIMexbf} = 3.751$$ Controls

$$invRF_{svcIIMextf} := \frac{\left(C_{svcII} - \left(\frac{\gamma DC_{SvcIIPosMext}}{S_{tf}} + \frac{\left(\gamma DC_{SvcIIPosMextcs} + \gamma DW_{SvcIIPsoMext}\right)}{S_{extfLT}}\right)\right)}{\frac{\gamma LL_{STvcIIPosMext}}{S_{extfST}}} = 40.486$$

$$opRF_{scvIIMextf} := \frac{\gamma_{INVSTR1}}{\gamma_{OPSTR1}} \cdot invRF_{svcIIMextf} = 52.482$$

Interior Beam, Positive Moment, Service II

Service 3 Capacity $C_{svcII} := 47.5$ ksi

$$invRF_{svcIIMinbf} := \frac{\left(C_{svcII} - \left(\frac{\gamma DC_{SvcIIPosMint}}{S_{bf}} + \frac{\left(\gamma DC_{SvcIIPosMintcs} + \gamma DW_{SvcIIPsoMint}\right)}{S_{inbfLT}}\right)\right)}{\frac{\gamma LL_{STvcIIPosMint}}{S_{inbfST}}} = 2.949$$ Controls

$$opRF_{scvIIMinbf} := \frac{\gamma_{INVSTR1}}{\gamma_{OPSTR1}} \cdot invRF_{svcIIMinbf} = 3.823$$ Controls

$$invRF_{svcIIMintf} := \frac{\left(C_{svcII} - \left(\frac{\gamma DC_{SvcIIPosMint}}{S_{tf}} + \frac{\left(\gamma DC_{SvcIIPosMintcs} + \gamma DW_{SvcIIPsoMint}\right)}{S_{intfLT}}\right)\right)}{\frac{\gamma LL_{STvcIIPosMint}}{S_{intfST}}} = 91.647$$

$$opRF_{scvIIMintf} := \frac{\gamma_{INVSTR1}}{\gamma_{OPSTR1}} \cdot invRF_{svcIIMintf} = 118.801$$

Service II Negative Moments Check Top Flange Non-Composite (Bot Flanges will have the same RF)

$\gamma DC_{SvcIINegMint} := 676.25\ kip \cdot ft$
$\gamma DW_{SvcIINegMint} := 184.84\ kip \cdot ft$ (P. 38)
$\gamma LL_{STvcIINegMint} := 408.37\ kip \cdot ft$

$\gamma DC_{SvcIINegMext} := 572.56\ kip \cdot ft$
$\gamma DW_{SvcIINegMext} := 121.72\ kip \cdot ft$ (P. 37)
$\gamma LL_{STvcIINegMext} := 408.37\ kip \cdot ft$

$S_{bf} := 768.32\ in^3$ (P.3) $S_{tf} := 768.32\ in^3$ (P. 3)

Exterior Beam, Negative Moment, Service II

Service 3 Capacity $F_A := 40\ ksi$ $C_{svcIINeg} := F_A \cdot S_{tf} = 2561.067\ kip \cdot ft$

$$invRF_{svcIINegMext} := \frac{\left(C_{svcIINeg} - \left(\gamma DC_{SvcIINegMext} + \gamma DW_{SvcIINegMext}\right)\right)}{\gamma LL_{STvcIINegMext}} = 4.571$$ Controls

$$opRF_{scvIINegMext} := \frac{\gamma_{INVSTR1}}{\gamma_{OPSTR1}} \cdot invRF_{svcIINegMext} = 5.926$$ Controls

Note: Both top and Bot. Flange have the same section

Interior Beam, Negative Moment, Service II

Service 3 Capacity $F_A := 40\ ksi$ $C_{svcIINeg} := F_A \cdot S_{tf} = 2561.067\ kip \cdot ft$

$$invRF_{svcIINegMint} := \frac{\left(C_{svcIINeg} - \left(\gamma DC_{SvcIINegMint} + \gamma DW_{SvcIINegMint}\right)\right)}{\gamma LL_{STvcIINegMint}} = 4.163$$ Controls

$$opRF_{scvIINegMint} := \frac{\gamma_{INVSTR1}}{\gamma_{OPSTR1}} \cdot invRF_{svcIINegMint} = 5.396$$ Controls

Note: Both top and Bot. Flange have the same section