September 13, 2018

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Ms. Jennifer E. Reczek, P.E.
Project Manager
New Hampshire Department of Transportation
7 Hazen Drive / P.O. Box 483
Concord, NH 03302-0483

Re: Walpole, NH – Rockingham, VT
Bridge Street (Vilas Bridge) over the Connecticut River
Bridge No. 062/052
Bridge Load Rating Letter Report
Hoyle, Tanner Project No. 092590.07

Dear Ms Reczek:

Hoyle, Tanner and Associates, Inc. (Hoyle, Tanner) is pleased to submit this Bridge Load Rating letter report presenting the initial load rating results for the Vilas Bridge carrying Bridge Street over the Connecticut River between Walpole, New Hampshire and Rockingham, Vermont. The purpose of this structural analysis and load rating was to determine the live load capacity of the existing arch ribs and spandrel columns. Replacement of the bridge deck, floorbeams, and spandrel arches, as part of a future rehabilitation project, was assumed for this analysis based on their current poor condition. Therefore, these members were not load rated. The load rating results will aid the New Hampshire Department of Transportation (NHDOT) in determining the need for further structural analysis and for the evaluation of rehabilitation alternatives. Rehabilitation alternatives evaluation was not included in this assignment.

This letter report includes the following enclosures:

- Load Rating Locations Figure
- Load Rating Results for HS20 Live Load Figure
- Load Rating Results Table

Since the load rating was based on an assumed rehabilitation concept and was completed to aid in further evaluation of rehabilitation alternatives of the Vilas Bridge, the NHDOT Form 4 is not included in this letter report.

Bridge Description

The existing bridge, constructed circa 1930, is a two-span, 216’ long, reinforced concrete open spandrel arch structure which remained in service until its closure to vehicular and pedestrian traffic in the spring of 2009. Each span has a clear distance of 107’-6¾”. The arch ribs are spaced at 20’-0” and the spandrel columns are spaced at 12’-2¾”. The floor system consists of a 9” thick reinforced concrete bridge deck supported by 14” wide by 2’-9” deep reinforced concrete floorbeams spaced at 12’-2¾”. The floorbeams span between the spandrel columns near the ends and the arch ribs at the center of each span. The bridge deck is 32’–6” wide and supports a 24’-0” roadway and a 4’-9” wide sidewalk on the south side. The reinforced concrete bridge rail has open windows and pilasters spaced with each spandrel column or floorbeam. The reinforced concrete abutments and pier are founded on bedrock.

Based on a review of the 2010 Wiss, Janney, Elstner Associates, Inc. (WJE) Vilas Bridge (NHDOT Bridge No. 062/052) Condition Assessment report, dated November 10, 2010, the last significant repairs to the bridge were performed in 1974. These repairs included shotcrete added to the underside of the deck as well as some of the floorbeams. Additional concrete patch repairs to the arches and spandrel columns of various age and condition are also present on the bridge.

Load Rating Assumptions and Criteria

The load rating was performed using the Load Factor Rating (LFR) method in accordance with the American Association of State Highway and Transportation Officials (AASHTO) Manual for Bridge Evaluation (MBE), 2011 (including interims through 2016), the AASHTO Standard Specifications for Highway Bridges, 17th Edition, and the NHDOT Bridge Design Manual. The AASHTO HS20-44 live load served as the basis for the load rating calculations. The arch rib and spandrel columns were rated for both multiple and single lane loading configurations. Sidewalk live loading in conjunction with the AASHTO HS20-44 vehicular live load is considered operating level. A utility load of 250 pounds per foot acting on each arch rib was included in this analysis.

A two-dimensional analysis model was utilized to determine the force effects due to dead loads, live loads, and uniform thermal loads. The MIDAS Civil 2018, Version 2.2, computer software program developed by MIDAS Engineering Software was used for the structure modeling. Multiple load cases considering live load positioning, sidewalk live load, and dead load associated with the sidewalk and other components was used to determine the force effects. Transverse force, wind loading, shrinkage and rib shortening and second order analysis effects were not considered. Excel spreadsheets, the MathCAD computer program, and hand calculations were utilized to calculate loads and the load rating factors.

Hoyle, Tanner performed a routine visual inspection of the Vilas Bridge for the NHDOT on July 21, 2017 to collect field observations to develop an updated condition assessment of the bridge and to compare it to the last inspection report. Prior to the 2017 inspection report, the last inspection and condition assessment was completed by Wiss, Janney, Elstner Associates, Inc. (WJE) in April 2010. The bridge is considered to be in fair to poor condition based on observations made during previous NBIS routine inspections. The arch ribs and spandrel columns exhibit varying degrees of deterioration and section losses which affect the live load capacity. Since detailed existing condition measurements are not available, the Load and Resistance Factor Rating condition factor of 0.85 was utilized to account for member deterioration and section losses.

Since replacement of the bridge deck, floorbeams, and spandrel arches, as part of a future rehabilitation project, was assumed, an increase in the structure width from 32’-6” to 33’-0” to accommodate a 6’-0” sidewalk was considered for this analysis.

The following material strengths were used in the calculations:

- Reinforced Concrete Arch Ribs: f'_c=3000 psi
- Reinforced Concrete Spandrel Columns: f'_c=4000 psi
- Reinforcement Yield Strength: F_y=33 ksi

Load Rating Results

The arch rib controlling inventory and operating ratings for the HS20-44 live load are HS23.5 and HS39.3, respectively. The controlling operating rating with sidewalk live load considered is HS43.7. The controlling operating rating with uniform thermal load considered is HS26.2.

The spandrel column controlling inventory and operating ratings for the HS20-44 live load are HS6.4 and HS10.7, respectively. The controlling operating rating with sidewalk live load considered is HS11.9. The load rating analysis and calculations yielded operating level rating factors less than zero for the second interior spandrel column with thermal force effects considered. These results may be due to simplifying assumptions made during the original design to deal with the complexity of the analysis. Based on Hoyle, Tanner's design assumption and methodology research for this bridge type, the columns may have been considered to be hinged and that the deck and arch rib were independent structures. This assumption simplified and allowed the columns to be designed for axial loads only. The spandrel columns are reinforced with a reinforcing steel area of 1% of the gross area, which was the minimum requirement. The use of the minimum required reinforcing steel area and the load rating results indicate the simplified design approach may have been used for the columns.

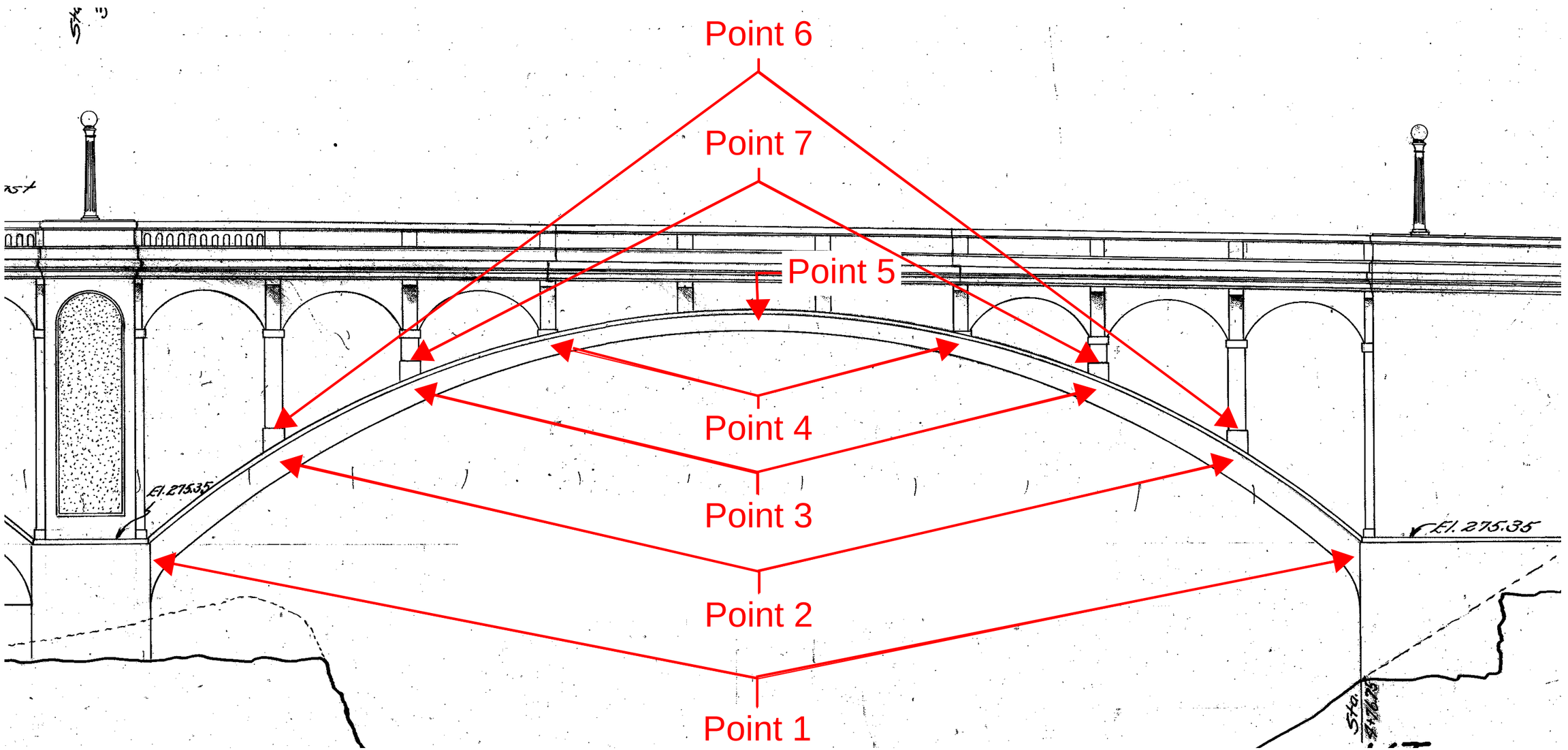
Please refer to the Vilas Bridge Load Rating calculations for additional information.

We trust that this submittal will meet with the Departments approval. Please feel free to contact me should you need any additional information or if you have any questions during your review of this submittal.

Sincerely,
Hoyle, Tanner & Associates, Inc.

Sean T. James, P.E.
Project Manager

Enclosures



LOAD RATING LOCATIONS

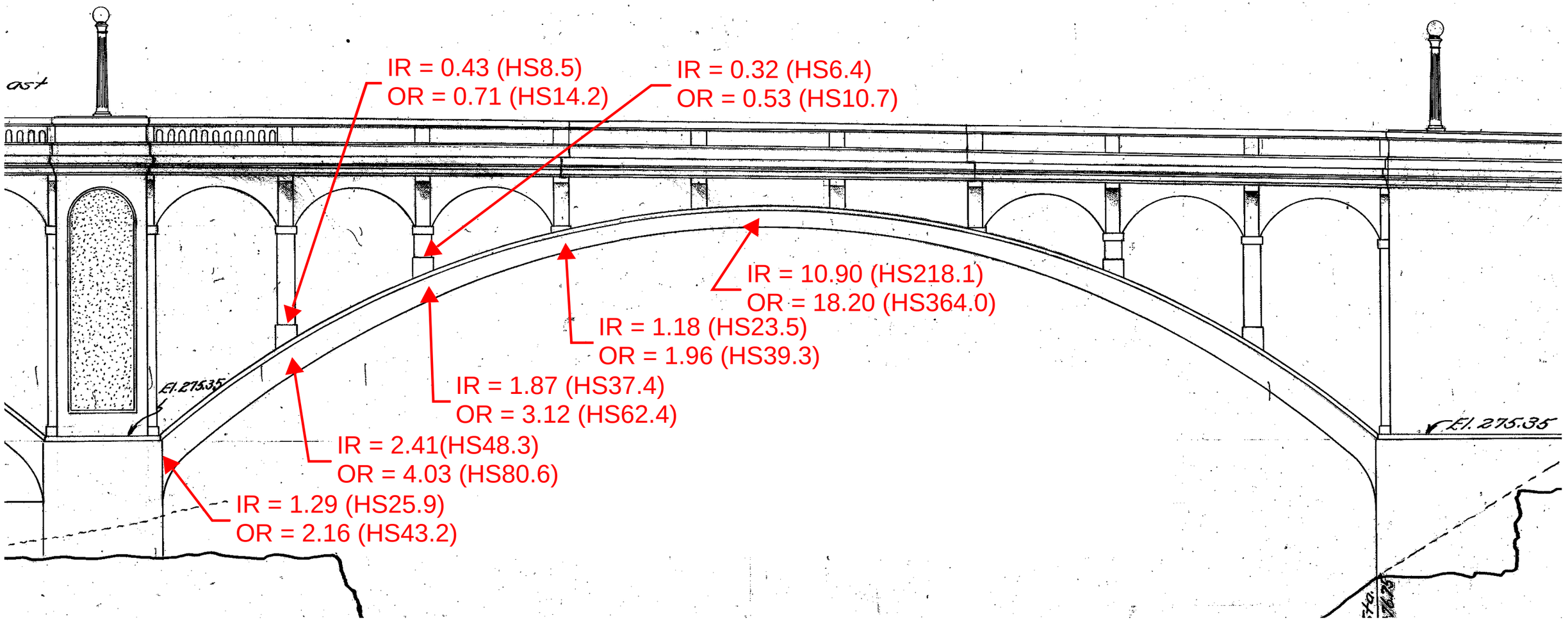
Walpole, NH - Rockingham, VT

Load Rating of the Vilas Bridge over the Connecticut River (Bridge No. 062/052)

July, 2018

New Hampshire DOT Department of Transportation

Hoyle, Tanner & Associates, Inc.



LOAD RATING RESULTS FOR HS20 LIVE LOAD

Walpole, NH - Rockingham, VT

Load Rating of the Vilas Bridge over the Connecticut River (Bridge No. 062/052)

July, 2018

New Hampshire DOT
Department of Transportation

Hoyle, Tanner & Associates, Inc.

Hoyle, Tanner & Associates, Inc.
150 Dow Street
Manchester, NH 03101

Required Capacity and Available Capacity Summary Tables

Maximum Live Load Moment with Concurrent Thrust

			Required Capacity (HS Tons)																	
			Current	Certified Vehicles		Multiple Lanes Loaded								Single Lane Loaded							
		Span	Legal	Single	Multiple	Inventory		Operating		Opr. w/ SW		Opr. w/ TU		Inventory		Operating		Opr. w/ SW		Opr. w/ TU	
Location	Point	Length	Loads	Unit	Unit	RF	Avail. Cap.*	RF	Avail. Cap.*	RF	Avail. Cap.*	RF	Avail. Cap.*	RF	Avail. Cap.*	RF	Avail. Cap.*	RF	Avail. Cap.*	RF	Avail. Cap.*
Arch	US 1	45.6	19.8	23.1	22.3	1.29	25.9	2.16	43.2	2.40	48.0	1.23	24.5	1.81	36.2	3.02	60.5	3.02	60.5	1.72	34.3
	US 2	34.9	19.5	23.9	21.3	2.41	48.3	4.03	80.6	4.48	89.6	3.85	77.0	3.38	67.6	5.64	112.8	5.64	112.8	5.39	107.8
	US 3	41.2	19.7	23.4	21.8	1.87	37.4	3.12	62.4	3.47	69.3	2.57	51.5	2.62	52.3	4.37	87.4	4.37	87.4	3.60	72.1
	US 4	39.7	19.7	23.5	21.5	1.18	23.5	1.96	39.3	2.18	43.7	1.31	26.2	1.65	33.0	2.75	55.0	2.75	55.0	1.84	36.7
	US 5	81.9	20.1	22.2	25.4	12.72	254.5	21.24	424.8	23.60	472.0	19.46	389.2	17.81	356.2	29.73	594.6	29.73	594.6	27.24	544.8
Spandrel Column	US 6	45.6	19.8	23.1	22.3	0.43	8.5	0.71	14.2	0.79	15.8	0.25	5.0	0.60	11.9	1.00	19.9	1.00	19.9	0.35	7.1
	US 7	47.3	19.8	23.0	22.6	0.32	6.4	0.53	10.7	0.59	11.9	-0.21	-4.3	0.45	9.0	0.75	15.0	0.75	15.0	-0.30	-6.0
Arch	DS 1	45.6	19.8	23.1	22.3	2.25	44.9	3.75	75.0	4.01	80.2	2.11	42.3	2.57	51.3	4.28	85.7	4.10	82.0	2.41	48.3
	DS 2	34.9	19.5	23.9	21.3	4.18	83.7	6.99	139.7	7.63	152.5	6.63	132.6	4.78	95.7	7.98	159.7	7.83	156.5	7.58	151.5
	DS 3	41.2	19.7	23.4	21.8	3.23	64.6	5.39	107.8	5.84	116.9	4.43	88.7	3.69	73.8	6.16	123.1	5.99	119.8	5.07	101.3
	DS 4	39.7	19.7	23.5	21.5	1.98	39.6	3.31	66.1	3.54	70.8	2.16	43.2	2.26	45.3	3.78	75.6	3.62	72.4	2.47	49.4
	DS 5	81.9	20.1	22.2	25.4	21.91	438.3	36.58	731.5	40.31	806.2	33.47	669.3	25.04	500.9	41.80	836.1	41.42	828.5	38.25	765.0
Spandrel Column	DS 6	45.6	19.8	23.1	22.3	0.72	14.4	1.20	24.0	1.19	23.8	0.40	7.9	0.82	16.4	1.37	27.4	1.20	24.1	0.45	9.1
	DS 7	47.3	19.8	23.0	22.6	0.48	9.6	0.81	16.1	0.74	14.8	-0.50	-10.0	0.55	11.0	0.92	18.4	0.74	14.8	-0.57	-11.5

Maximum Live Load Thrust with Concurrent Moment

			Required Capacity (HS Tons)																	
			Current	Certified Vehicles		Multiple Lanes Loaded								Single Lane Loaded							
		Span	Legal	Single	Multiple	Inventory		Operating		Opr. w/ SW		Opr. w/ TU		Inventory		Operating		Opr. w/ SW		Opr. w/ TU	
Location	Point	Length	Loads	Unit	Unit	RF	Avail. Cap.*	RF	Avail. Cap.*	RF	Avail. Cap.*	RF	Avail. Cap.*	RF	Avail. Cap.*	RF	Avail. Cap.*	RF	Avail. Cap.*	RF	Avail. Cap.*
Arch	US 1	109.4	20.2	22.7	26.0	9.90	198.0	16.52	330.5	18.36	367.2	13.42	268.4	13.86	277.2	23.13	462.7	23.13	462.7	18.79	375.8
	US 2	109.4	20.2	22.7	26.0	9.15	183.0	15.28	305.5	16.97	339.5	15.03	300.5	12.81	256.3	21.39	427.7	21.39	427.7	21.04	420.7
	US 3	109.4	20.2	22.7	26.0	8.19	163.7	13.66	273.3	15.18	303.6	13.33	266.6	11.46	229.2	19.13	382.6	19.13	382.6	18.66	373.3
	US 4	106.4	20.2	22.8	25.9	7.14	142.8	11.92	238.4	13.25	264.9	11.41	228.2	10.00	200.0	16.69	333.8	16.69	333.8	15.97	319.4
	US 5	88.0	20.1	22.1	25.6	10.90	218.1	18.20	364.0	20.22	404.4	16.68	333.5	15.26	305.3	25.48	509.6	25.48	509.6	23.35	467.0
Spandrel Column	US 6	54.7	19.9	22.8	23.5	0.67	13.4	1.12	22.4	1.24	24.8	0.45	9.1	0.94	18.7	1.56	31.3	1.56	31.3	0.64	12.7
	US 7	96.0	20.1	22.1	25.8	0.75	15.1	1.26	25.2	1.40	28.0	-0.34	-6.7	1.06	21.1	1.76	35.3	1.76	35.3	-0.47	-9.4
Arch	DS 1	109.4	20.2	22.7	26.0	16.87	337.5	28.17	563.3	30.95	619.0	22.77	455.5	19.28	385.7	32.19	643.8	31.81	636.2	26.03	520.6
	DS 2	109.4	20.2	22.7	26.0	15.55	310.9	25.95	519.0	28.47	569.5	25.51	510.2	17.77	355.3	29.65	593.1	29.24	584.9	29.16	583.1
	DS 3	109.4	20.2	22.7	26.0	13.91	278.1	23.21	464.3	25.47	509.5	22.63	452.7	15.89	317.8	26.53	530.5	26.16	523.2	25.86	517.3
	DS 4	106.4	20.2	22.8	25.9	12.15	243.0	20.28	405.7	22.27	445.4	19.39	387.7	13.89	277.7	23.18	463.6	22.88	457.5	22.16	443.1
	DS 5	88.0	20.1	22.1	25.6	18.78	375.6	31.35	626.9	34.54	690.7	28.68	573.6	21.46	429.3	35.83	716.6	35.49	709.9	32.78	655.7
Spandrel Column	DS 6	54.7	19.9	22.8	23.5	1.15	23.0	1.92	38.5	1.96	39.3	0.78	15.7	1.32	26.3	2.20	43.9	2.00	40.0	0.90	17.9
	DS 7	96.0	20.1	22.1	25.8	1.21	24.3	2.02	40.5	2.17	43.4	-0.74	-14.7	1.39	27.7	2.31	46.3	2.21	44.1	-0.84	-16.9

* Available Capacity in HS Tons