Memo

Date: Monday, February 05, 2018

Project: Load Rating for Short Span Prefabricated Bridge County Standards

Subject: Rating Summary

INTRODUCTION

This memo summarizes the load ratings for the precast prestressed box beams with span lengths of 30', 40', 50', 60' and 70' and for the reinforced concrete box beams with spans of 30', 40' and 50'. These standards are referred to as the B24 and B30 Standards.

These beams have been load rated for the following live loads:

- Design Live Load
  - HL-93 Vehicle (See the AASHTO Manual for Bridge Evaluation, Figure C6A-1)
- Legal Loads
  - Routine Commercial Traffic (See Iowa DOT Bridge Rating Manual, Figure 5.4.1-1)
    - Type 4
    - Type 3S3A
    - Type 3-3
    - Type 3S3B
    - Type 4S3
  - Specialized Hauling Vehicles (SHV's) (See Iowa DOT Bridge Rating Manual 5.4.1-2)
    - SU7
    - SU6
    - SU5
    - SU4
  - Emergency Vehicles (EV's) (See FHWA Memorandum titled, "Load Rating for the FAST Act's Emergency Vehicles, dated November 3, 2016)
    - EV2
    - EV3

ASSUMPTIONS

- Ratings were performed utilizing the 2nd Edition of the AASHTO Manual for Bridge Evaluation (MBE), 2011 Interims and the Iowa DOT's current Bridge Rating Manual dated September 30, 2013 using the Load and Resistance Factor Rating (LRFR) methodology.
- ½" integral wearing surface was included in the dead load, but not used for structural capacity.
- 50 psf non-composite future wearing surface or gravel present on the bridges.
- Condition Factor = 1.0 (assuming the bridge condition is "good" or "satisfactory").
- System Factor = 1.0

- All live loads include a 1.33 impact factor on the truck portion of the live load.
- Bridge spans rated for worst case skew of 30 degrees.
- Ratings performed for flexure and shear.
- Serviceability ratings only performed for the prestressed concrete box beams per the MBE.
- In accordance with the Iowa DOT Bridge Rating Manual, with regards to unknown ADTT, the most conservative Load Factor from the tables in the MBE was utilized.
- Leap Bridge software (Version 16.01.00.10 Dated 2016) was used to rate the prestressed concrete box beams.
- Leap Bridge is not capable of rating reinforced concrete box beams. Therefore, Leap Bridge (Version 16.01.00.1) was used to determine moments and shears and spreadsheets were utilized for the rating.
- **Live Load Distribution Factors - Prestressed Concrete Boxes**
  Live load distribution factors used for the flexural design and rating of the beams were based on past studies conducted by Iowa DOT. However, AASHTO equations including skew effects were used for determining the live load distribution factors for shear. Controlling live load distribution factors are:
  - 30’ Span
    - Moment = 0.50 Lanes / Beam
    - Shear = 0.69 Lanes / Beam
  - 40’ Span
    - Moment = 0.50 Lanes / Beam
    - Shear = 0.69 Lanes / Beam
  - 50’ Span
    - Moment = 0.50 Lanes / Beam
    - Shear = 0.69 Lanes / Beam
  - 60’ Span
    - Moment = 0.50 Lanes / Beam
    - Shear = 0.69 Lanes / Beam
  - 70’ Span
    - Moment = 0.50 Lanes / Beam
    - Shear = 0.67 Lanes / Beam
- **Live Load Distribution Factors - Reinforced Concrete Boxes**
  AASHTO Equations were used for determining the live load distribution factors for design and rating of the beams. Skew effects were included in the live load distribution factors for shear and conservatively ignored for the live load distribution factors for moment. Controlling live load distribution factors are:
  - 30’ Span
    - Moment = 0.39 Lanes / Beam
    - Shear = 0.70 Lanes / Beam
  - 40’ Span
    - Moment = 0.37 Lanes / Beam
    - Shear = 0.69 Lanes / Beam
  - 50’ Span
    - Moment = 0.35 Lanes / Beam
    - Shear = 0.67 Lanes / Beam

PRECAST PRESTRESSED BOX BEAMS RATINGS

Prestressed Concrete Box Beam Rating Summary								
Span (ft)	Rating Vehicle	Bending		Shear		Controlling RF_{op}		
		RF_{inv}	RF_{op}	RF_{inv}	RF_{op}	RF_{op}	Response	Location
30	HL-93	1.53	1.99	1.43	1.88	**1.43 (INV)**	Shear	Near Support
	Type 4	--	2.18	--	1.95	**1.95**	Shear	Near Support
	Type 3S3A	--	2.18	--	2.15	**2.15**	Shear	Near Support
	Type 3-3	--	2.62	--	2.25	**2.25**	Shear	Near Support
	Type 3S3B	--	2.17	--	2.08	**2.08**	Shear	Near Support
	Type 4S3	--	2.18	--	1.98	**1.98**	Shear	Near Support
	SU4	--	2.26	--	2.12	**2.12**	Shear	Near Support
	SU5	--	2.09	--	1.97	**1.97**	Shear	Near Support
	SU6	--	1.91	--	1.98	**1.91**	Bending (Service III)	Midspan
	SU7	--	1.84	--	1.98	**1.84**	Bending (Service III)	Midspan
	EV2	--	2.31	--	2.44	**2.31**	Bending (Service III)	Midspan
	EV3	--	1.52	--	1.64	**1.52**	Bending (Service III)	Midspan
40	HL-93	1.33	1.72	1.17	1.54	**1.17 (INV)**	Shear	Near Support
	Type 4	--	1.79	--	1.69	**1.69**	Shear	Near Support
	Type 3S3A	--	1.94	--	1.72	**1.72**	Shear	Near Support
	Type 3-3	--	2.06	--	1.74	**1.74**	Shear	Near Support
	Type 3S3B	--	1.90	--	1.90	**1.90**	Shear	Near Support
	Type 4S3	--	1.82	--	1.71	**1.71**	Shear	Near Support
	SU4	--	1.79	--	1.87	**1.79**	Bending (Service III)	Midspan
	SU5	--	1.69	--	1.70	**1.69**	Bending (Service III)	Midspan
	SU6	--	1.52	--	1.65	**1.52**	Bending (Service III)	Midspan
	SU7	--	1.43	--	1.62	**1.43**	Bending (Service III)	Midspan
	EV2	--	1.83	--	2.16	**1.83**	Bending (Service III)	Midspan
	EV3	--	1.18	--	1.44	**1.18**	Bending (Service III)	Midspan
50	HL-93	1.23	1.60	1.55	2.04	**1.23 (INV)**	Bending (Strength I)	Midspan
	Type 4	--	1.74	--	2.36	**1.74**	Bending (Strength I)	Midspan
	Type 3S3A	--	1.92	--	2.16	**1.92**	Bending (Strength I)	Midspan
	Type 3-3	--	1.82	--	2.19	**1.82**	Bending (Strength I)	Midspan
	Type 3S3B	--	1.92	--	2.60	**1.92**	Bending (Strength I)	Midspan
	Type 4S3	--	1.77	--	2.36	**1.77**	Bending (Strength I)	Midspan
	SU4	--	1.72	--	2.59	**1.72**	Bending (Service III)	Midspan
	SU5	--	1.59	--	2.33	**1.59**	Bending (Service III)	Midspan
	SU6	--	1.43	--	2.21	**1.43**	Bending (Service III)	Midspan
	SU7	--	1.32	--	2.12	**1.32**	Bending (Service III)	Midspan
	EV2	--	1.73	--	3.00	**1.73**	Bending (Service III)	Midspan
	EV3	--	1.12	--	1.99	**1.12**	Bending (Service III)	Midspan
60	HL-93	1.24	1.61	1.41	1.86	**1.24 (INV)**	Bending (Strength I)	Midspan
	Type 4	--	1.76	--	2.21	**1.76**	Bending (Service III)	Midspan
	Type 3S3A	--	1.81	--	1.90	**1.81**	Bending (Service III)	Midspan
	Type 3-3	--	1.73	--	1.92	**1.73**	Bending (Service III)	Midspan
	Type 3S3B	--	1.99	--	2.19	**1.99**	Bending (Service III)	Midspan
	Type 4S3	--	1.78	--	2.18	**1.78**	Bending (Service III)	Midspan
	SU4	--	1.74	--	2.47	**1.74**	Bending (Service III)	Midspan
	SU5	--	1.59	--	2.21	**1.59**	Bending (Service III)	Midspan
	SU6	--	1.42	--	2.06	**1.42**	Bending (Service III)	Midspan
	SU7	--	1.31	--	1.95	**1.31**	Bending (Service III)	Midspan
	EV2	--	1.72	--	2.87	**1.72**	Bending (Service III)	Midspan
	EV3	--	1.12	--	1.89	**1.12**	Bending (Service III)	Midspan
70	HL-93	1.19	1.54	1.75	2.32	**1.19 (INV)**	Bending (Strength I)	Midspan
	Type 4	--	1.73	--	2.84	**1.73**	Bending (Service III)	Midspan
	Type 3S3A	--	1.69	--	2.34	**1.69**	Bending (Service III)	Midspan
	Type 3-3	--	1.58	--	2.36	**1.58**	Bending (Service III)	Midspan
	Type 3S3B	--	1.98	--	2.56	**1.98**	Bending (Service III)	Midspan
	Type 4S3	--	1.75	--	2.55	**1.75**	Bending (Service III)	Midspan
	SU4	--	1.71	--	3.20	**1.71**	Bending (Service III)	Midspan
	SU5	--	1.55	--	2.84	**1.55**	Bending (Service III)	Midspan
	SU6	--	1.39	--	2.63	**1.39**	Bending (Service III)	Midspan
	SU7	--	1.27	--	2.46	**1.27**	Bending (Service III)	Midspan
	EV2	--	1.68	--	3.71	**1.68**	Bending (Service III)	Midspan
	EV3	--	1.10	--	2.45	**1.10**	Bending (Service III)	Midspan

PRECAST REINFORCED BOX BEAMS RATINGS

Reinforced Concrete Box Beam Rating Summary										
Span (ft)	Rating Vehicle	Bending		Shear (@ support)		Shear (@ transition)		Controlling RF_{op}		
		RF_{inv}	RF_{op}	RF_{inv}	RF_{op}	RF_{inv}	RF_{op}	**RF_{op}**	**Response**	**Location**
30	HL-93	1.66	2.16	1.27	1.64	1.29	1.68	**1.27 (INV)**	Shear	Near Support
	Type 4	--	2.35	--	1.70	--	1.46	**1.46**	Shear	Stirrup Transition
	Type 3S3A	--	2.35	--	1.87	--	1.61	**1.61**	Shear	Stirrup Transition
	Type 3-3	--	2.83	--	1.91	--	1.69	**1.69**	Shear	Stirrup Transition
	Type 3S3B	--	2.34	--	1.83	--	1.55	**1.55**	Shear	Stirrup Transition
	Type 4S3	--	2.35	--	1.72	--	1.48	**1.48**	Shear	Stirrup Transition
	SU4	--	2.53	--	1.85	--	1.58	**1.58**	Shear	Stirrup Transition
	SU5	--	2.34	--	1.72	--	1.48	**1.48**	Shear	Stirrup Transition
	SU6	--	2.14	--	1.72	--	1.48	**1.48**	Shear	Stirrup Transition
	SU7	--	2.06	--	1.72	--	1.48	**1.48**	Shear	Stirrup Transition
	EV2	--	3.16	--	2.12	--	1.81	**1.81**	Shear	Stirrup Transition
	EV3	--	2.10	--	1.45	--	1.24	**1.24**	Shear	Stirrup Transition
40	HL-93	1.35	1.75	1.03	1.34	1.10	1.42	**1.03 (INV)**	Shear	Near Support
	Type 4	--	1.80	--	1.47	--	1.30	**1.30**	Shear	Stirrup Transition
	Type 3S3A	--	1.95	--	1.47	--	1.33	**1.33**	Shear	Stirrup Transition
	Type 3-3	--	2.07	--	1.49	--	1.34	**1.34**	Shear	Stirrup Transition
	Type 3S3B	--	1.92	--	1.65	--	1.44	**1.44**	Shear	Stirrup Transition
	Type 4S3	--	1.83	--	1.49	--	1.31	**1.31**	Shear	Stirrup Transition
	SU4	--	1.97	--	1.62	--	1.42	**1.42**	Shear	Stirrup Transition
	SU5	--	1.86	--	1.47	--	1.30	**1.30**	Shear	Stirrup Transition
	SU6	--	1.68	--	1.43	--	1.38	**1.38**	Shear	Stirrup Transition
	SU7	--	1.57	--	1.40	--	1.36	**1.36**	Shear	Stirrup Transition
	EV2	--	2.43	--	1.86	--	1.63	**1.63**	Shear	Stirrup Transition
	EV3	--	1.59	--	1.26	--	1.11	**1.11**	Shear	Stirrup Transition
50	HL-93	1.50	1.95	1.15	1.49	1.09	1.42	**1.09 (INV)**	Shear	Stirrup Transition
	Type 4	--	2.13	--	1.70	--	1.38	**1.38**	Shear	Stirrup Transition
	Type 3S3A	--	2.32	--	1.56	--	1.29	**1.29**	Shear	Stirrup Transition
	Type 3-3	--	2.24	--	1.58	--	1.30	**1.30**	Shear	Stirrup Transition
	Type 3S3B	--	2.36	--	1.83	--	1.51	**1.51**	Shear	Stirrup Transition
	Type 4S3	--	2.17	--	1.72	--	1.40	**1.40**	Shear	Stirrup Transition
	SU4	--	2.36	--	1.89	--	1.53	**1.53**	Shear	Stirrup Transition
	SU5	--	2.18	--	1.71	--	1.39	**1.39**	Shear	Stirrup Transition
	SU6	--	1.96	--	1.62	--	1.39	**1.39**	Shear	Stirrup Transition
	SU7	--	1.81	--	1.55	--	1.33	**1.33**	Shear	Stirrup Transition
	EV2	--	2.89	--	2.18	--	1.77	**1.77**	Shear	Stirrup Transition
	EV3	--	1.88	--	1.47	--	1.19	**1.19**	Shear	Stirrup Transition