

Analysis of a Curved Steel Plate Girder Bridge with BrR

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Introduction

Introduction



- The function of the curved steel plate girder rating analysis was introduced in V6.5 including diaphragms.
- Lateral bracing members were added in V6.6.
- Many issues in LFR analysis engine have been resolved since then.
- Only main girders are rated.



Structure Description

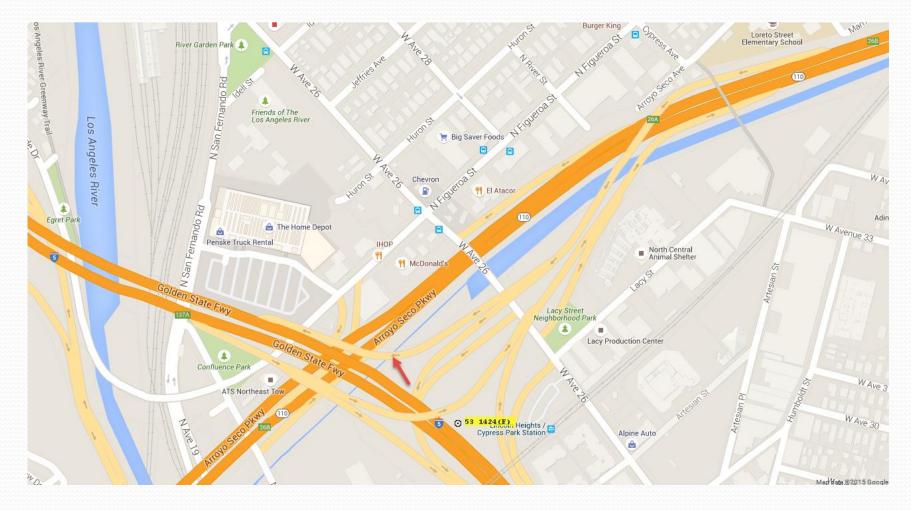


Structure Description

- Built in1962, connecting highway 110 to I-5.
- Curved Steel Plate Girders for Span 8 10
- Spans 8 9 are 2-span (92.5'-92.5') continuous structure with curved alignment
- Span 10 is a simple span (97.5') with curved and tangent alignment
- The RC deck with four steel girders spacing at 9'-3".
- 400 ft radius is used for the curved alignment line.
- Maximum super elevation is 12%

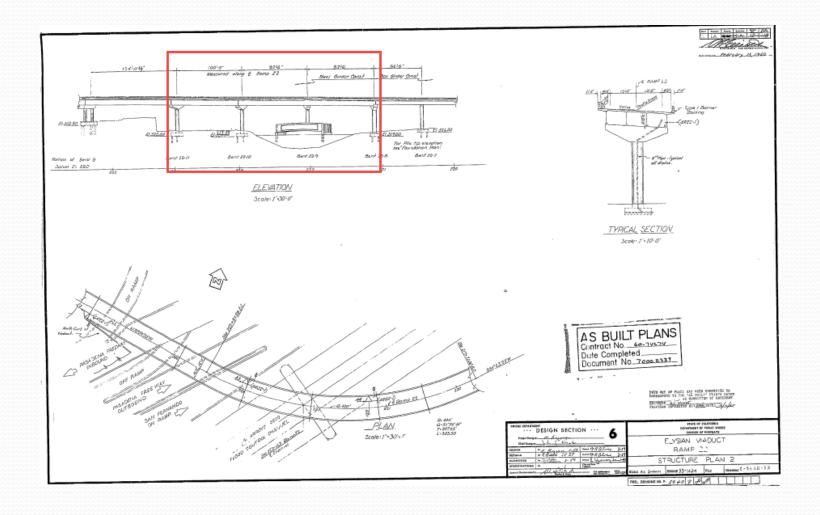


Bridge Location



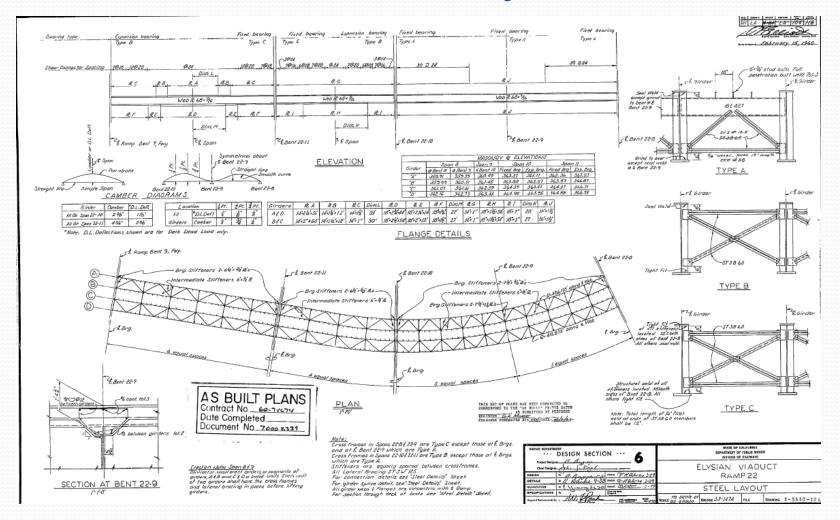


Structure Plan





Steel Layout





Top View





Side View





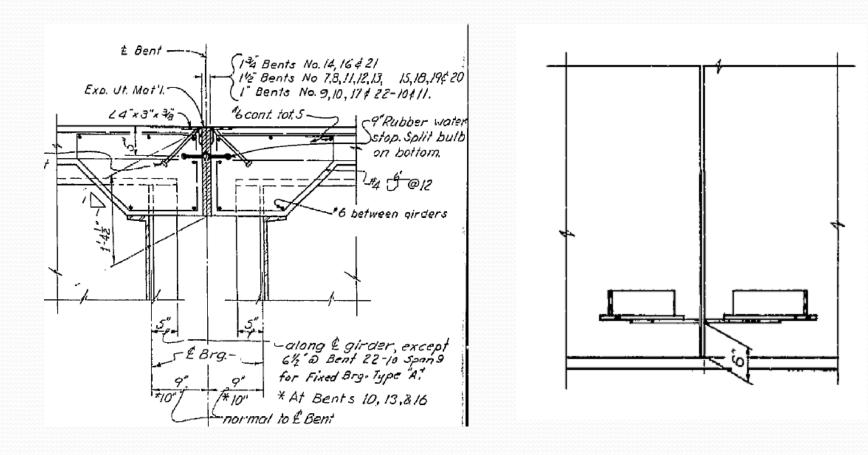
Bottom View





Girder End Details

Lateral Bracing Connection (6" above bottom flange)





Girder Details

- Span 8-9: Web: 68" x 7/16"; Flanges: 16" x 1-1/2" Equal shear stiffener spacing: 53.1" to 56.9" Non-composite section near Bent 9 Fixed bearings at all supports
- Span 10: Web: 68 x 7/16, Stiffener Space: 47.5" to 51" Top Flange: 14 x 1 Bottom Flange: 18 x 1-1/2 and 18 x 1 Composite Section Expansion and fixed bearings used



Bridge Modeling



Superstructure Definition

- Curved alignment
- Radius
- Superelevation
- Design speed:
 50 mph

Girder System Superstructure	Definition	
Definition Analysis Specs Er	gine	Â
Name: Span 8	-	Frame Structure
		Simplified Definition
	ort: pinned at middle and rollers at ends. shear capacity override at girder ends.	Deck type: Concrete
		·
Default Units: US Cu	stomary Enter Span Lengths Along the Reference	For PS only
Number of spans: 2	Line:	Average humidity:
Number of girders: 4	Span Length	%
	1 91.67 2 91.67	Member Alt. Types
		P/S R/C
Horizontal Curvature Along Ref	erence Line	
I Horizontal curvature	Distance from PC to first support line:	
Superstructure Alignment	Start tangent length: 0.000000 ft	
Curved Towney award toward	Radius: 400 ft	
 Tangent, curved, tange Tangent, curved 	Direction: Right -	
Curved, tangent	End tangent length: 0.000000 ft	
	Distance from last support line to PT: ft	
	Design speed: ⁵⁰ mp	h
	12	
	Superelevation:	
	III	1.1 ·



Structure Framing (Span 8-9)

A Structure Framing Plan Details	5		- • •
	Number of spans =	= 2 Number of girders = 4	
Layout Diaphragms Lateral Br	acing Ranges		
	Girder Spacing Orientation Perpendicular to girder	Distance from superstructure definition reference line to the leftmost girder: -13.875 ft	:
Support Skew (Degrees)	Along support	Default Member Bearing Alignment Girder Rad	tii
1 0 2 0		Support Girder Bearing Alignment Type (December 2017)	Radius (ft)
3 0	Girder Spacing	1 Tangent ▼ (Degrees) G1 (D/t> G2 (D/t	
	Girder (ft) Bay Start of End of	2 Tangent G3 (d/t>	<u> </u>
	Girder Girder 1 9.25 9.25	3 Tangent G4	386.125
	2 9.25 9.25		
	3 9.25 9.25		
		Apply to all members	
		OK Apply	Cancel



Diaphragms (Span 8-9)

			Number of	f spans = 2	Numbe	er of girders =	4					
Layout Diaphragms L	Lateral B	Iracing Ranges										
Girder Bay: 1		▼ Co	ру Вау То	Diapł Wiza	iragm ird							
	upport	Start D (f	istance t)	Left Diaphragm	Right Diaphragm	Number	Left Length	Right Length		istance (ft)	Load	Diaphragm
Туре	umber	Left Girder	Right Girder	Spacing (ft)	Spacing (ft)	of Spaces	(ft)	(ft)	Left Girder	Right Girder	(kip)	- april agri
				C Leftmost	ine Line girder	e Suj In Number o Equal Spac) Enter equal spa) Enter groups of opport diaphragm I terior diaphragm I f es 5 4	f equal spaces p acing per span equal spacing oad:	er span kip kip Help			



Diaphragms (cont.)

ayout Diaph	ragms L	ateral Bracing Ra		ber of spans = 2	2 N	lumber of gird	lers = 4						
Girder Bay:	1	•	Copy Bay To.		Diaphragm Wizard								
Spacing Reference	Support		istance ft)	Left Diaphragm	Right Diaphragm	Number	Left	Right	End Dist (ft)		Load	Dischar	
Туре	Number	Left Girder	Right Girder	Spacing (ft)	Spacing (ft)	of Spaces	Length (ft)	Length (ft)	Left Girder	Right Girder	(kip)	Diaphra	Igm
Both Gir 💌	1 💌	0	0	0	0	1	0	0	0	0		Type A	-
Both Gir 💌	1 💌	0	0	18.9699606	18.5459869	4	75.8798424	74.1839476	75.8798424	4.1839476		Type C	-
Both Gir 💌	1 💌	75.879842	74.183947	18.9699606	18.5459869	1	18.9699606	18.5459869	94.8498026	2.7299339		Type A	-
Both Gir 💌	1 💌	94.849803	92.729934	18.9699606	18.5459869	4	75.8798424	74.1839476	170.7296454	6.9138816		Type C	-
Both Gir 👻	2 🔻	75.879842	74.183947	18.9699606	18.5459869	1	18.9699606	18.5459869	94.8498026	2 7299339		Type A	-

Lateral Bracing Ranges

3

Girder Bay:

Copy Bay To...

Diaphragm Wizard...

Spacing Reference	s	upp	ort		istance t)	Left Diaphragm	Right Diaphragm	Number	Left Length	Right Length	End Dist (ft)	ance	Load	Diaphra	
Туре	N	lumt	ber	Left Girder	Right Girder	Spacing (ft)	Spacing (ft)	of Spaces	(ft)	(ft)	Left Girder	Right Girder	(kip)	Diapriraj	gm
Both Gir 👻		1	-	0	0	0	0	1	0	0	0	0		Туре А	-
Both Gir 💌		1	Ŧ	0	0	18.1220131	17.6980394	4	72.4880524	70.7921576	72.4880524	0.7921576		Туре С	•
Both Gir 💌		1	•	72.488052	70.792157	18.1220131	17.6980394	1	18.1220131	17.6980394	90.6100651	8.4901964		Туре А	•
Both Gir 💌		2	-	0	0	18.1220131	17.6980394	4	72.4880524	70.7921576	72.4880524	0.7921576		Туре С	-
Both Gir 💌		2	•	72.488052	70.792157	18.1220131	17.6980394	1	18.1220131	17.6980394	90.6100651	8.4901964		Туре А	-



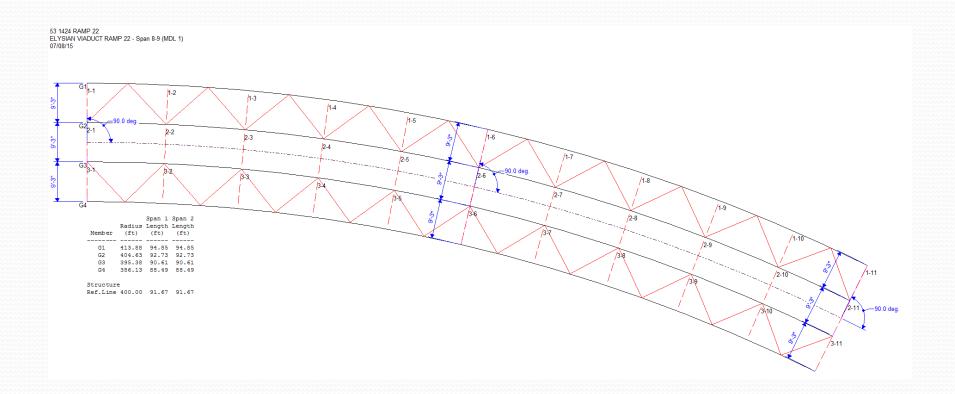
Lateral Bracing (Span 8-9)

L	ayout Diaphragms	Lateral	Bracing Ranges									
	Girder Bay: 1		• Co	opy Bay To								
	Lateral	Support		istance ft)) Length ft)	Number	Lateral		ngth ft)		stance ft)
	Bracing Pattern	Number	Left Girder	Right Girder	Along Left Girder	Along Right Girder	of Braces	Bracing	Left	Right	Left	Right
	Alternating A 💌	1 💌		0		9.273	20	LB_ST 🔻	0	185.46	0	185.46

La	yout Diaphragms	s Lateral	Bracing Ranges										
G	iirder Bay: 3		•	opy Bay To									
	Lateral	Support		istance ft)	-) Length ft)	Number	Lateral		ngth ft)		stance ft)	
	Bracing Pattern	Number		Right Girder	Along Left Girder	Along Right Girder	of Braces	Bracing	Left	Right	Left	Right	
	Alternating V 💌	1 💌	0		9.061		20	LB_ST 🔻	181.22	0	181.22	0	

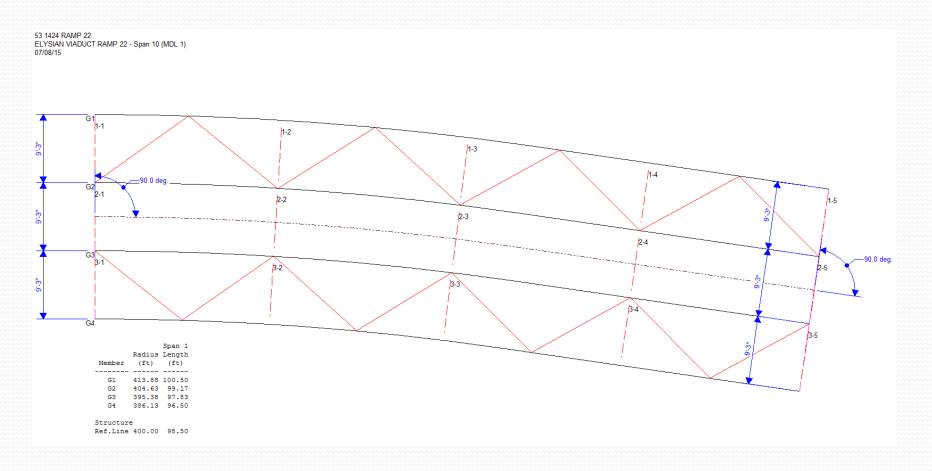


Framing Details: Span 8-9



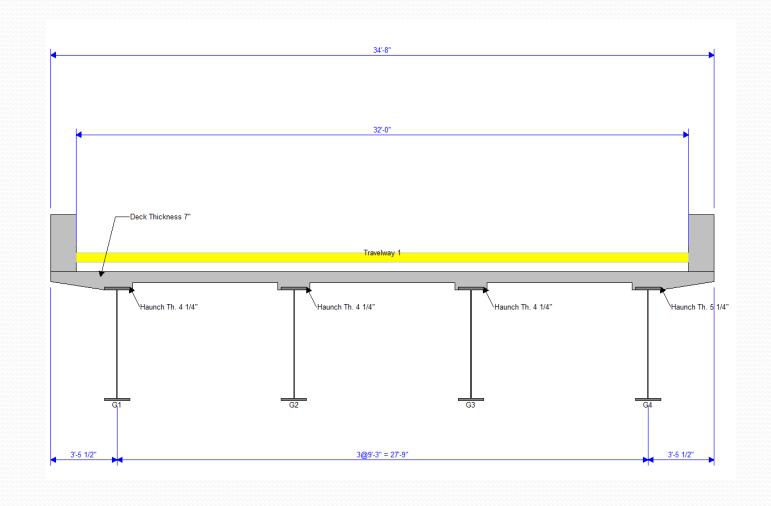


Framing Details: Span 10





Typical Section





Shear Capacity



Shear Capacity

LFD (2003 Guide Spec)

LRFD (7th Ed. 2014)

- At simple support (end panel) At end panel: $d_0 \le 0.5D$ $d_0 \le 1$
- At interior panel:

 $d_0 \le D$

Shear capacity at all location:

 $V_{cr} = CV_p$

where:

- $V_p = 0.58F_yDt_w$
- C = ratio of the elastic-shear-buckling strength to the shear-yield strength

At end parlel. $d_0 \le 1.5D$ $V_n = V_{cr} = CV_p$

At interior panel:
$$d_0 \le 3D$$
 (no LS

$$V_n = V_p \left[C + \frac{0.87(1-C)}{\left(\sqrt{1 + \left(\frac{d_o}{D}\right)^2} + \frac{d_o}{D}\right)} \right]$$



Shear Capacity in BrR (LFR)

- With LFR, shear stiffener is ignored in BrR when d₀>0.5D at end support.
- For this bridge, d_o is constant along the girder and the ranges from 0.7D to 0.84D.
- For this analysis, the shear capacity override is used at span ends.
- The override capacity is calculated ignoring 0.5D limit, or the capacity at internal panel.



Shear Capacity Comparison

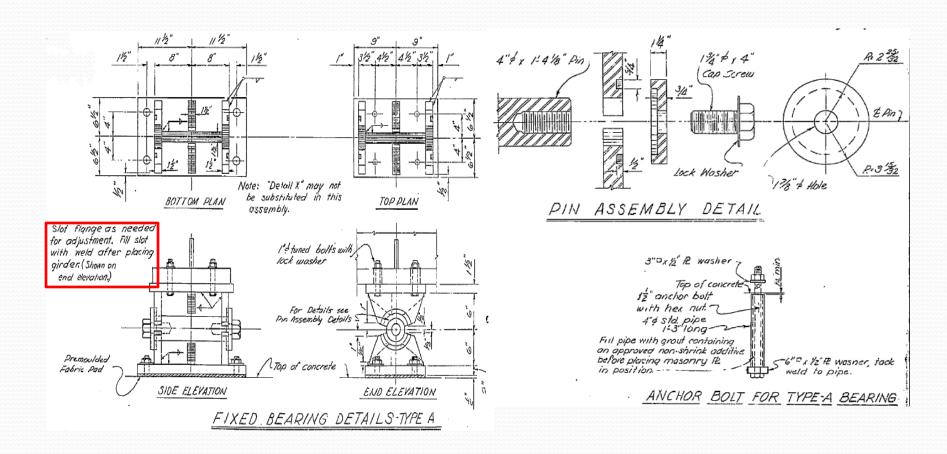
Unit: Kips	LFR	LFR	LRFR
Span 8-9	BrR	Override	BrR
G1 (Exterior D)	157.42	382.18	394.75
G2 (Interior C)	157.42	392.57	405.48
G3 (Interior B)	157.42	403.70	416.98
G4 (Exterior A)	157.42	415.64	429.31



Boundary Conditions

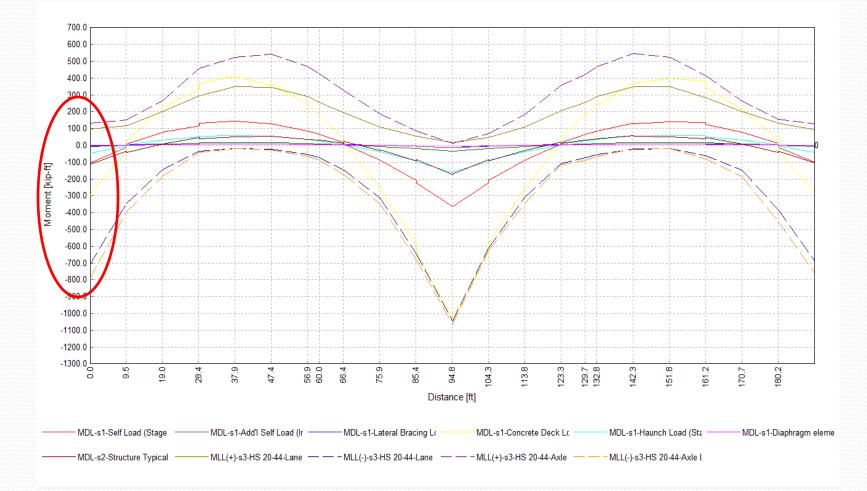


Fixed(Pinned) Bearing (Span 8-9)



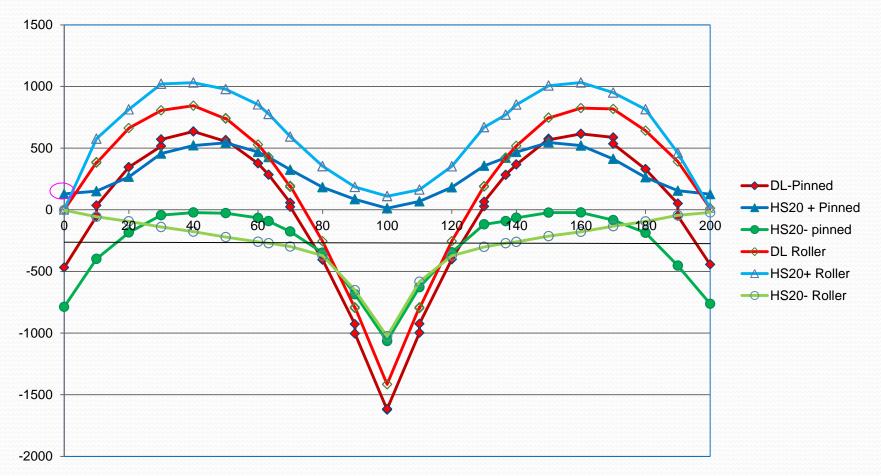


Moments (Span 8-9, G1)





Moments with Different Supports (Span 8-9, G1)





Moments Comparison (Span 8-9)

G1		M+ (max)			M- (max)		G2		M+ (max)			M- (max)	
	DL (S1)	ADL (S2)	HS20	DL (S1)	ADL (S2)	HS20		DL (S1)	ADL (S2)	HS20	DL (S1)	ADL (S2)	HS20
Roller	843.64	85.84	1031.45	-1416.66	-186.6	-1027.53	Roller	744.25	55.01	965.35	-1311.66	-73.15	-913.61
Pinned	634.92	48.6	521.48	-1622.21	-174.58	-1065.56	Pinned	523.94	27.9	530.92	-1406.45	-67.72	-986.52
Ratio	1.33	1.77	1.98	0.87	1.07	0.96	Ratio	1.42	1.97	1.82	0.93	1.08	0.93
G3		M+ (max)			M- (max)		G4		M+ (max)			M- (max)	
	DL (S1)	ADL (S2)	HS20	DL (S1)	ADL (S2)	HS20		DL (S1)	ADL (S2)	HS20	DL (S1)	ADL (S2)	HS20
Roller	646.28	45.97	879.96	-1166.97	-54.43	-811.05	Roller	523.72	72.88	811.6	-994.53	-139.38	-883.21
Pinned	507.36	24.36	527.93	-1242.73	-56.4	-913.35	Pinned	342.24	45.89	431.94	-949.19	-140.15	-888.47
Ratio	1.27	1.89	1.67	0.94	0.97	0.89	Ratio	1.53	1.59	1.88	1.05	0.99	0.99



Ratings: Pinned Supports Coltrans (Span 8-9)

Live Load	Live Load	Rating	Rating	Load Rating		Location	Location	Limit State	Impact	Lane
S 20-44	Type Lane	Method LFD	Level Inventory	(Ton) 45.69	Factor 1.269	(ft) 94.85	Span-(%)	Design Flexure - Steel	•	As Requested
S 20-44	Lane	LFD	Operating	76.22	2.117	94.85		Design Flexure - Steel		As Requested
S 20-44	Axle Load	LFD	Inventory	45.37	1.260	94.85	·····	Design Flexure - Steel	•••••••••••••••••••••••••••••••••••••••	As Requested
S 20-44	Axle Load	LFD	·····	75.41	2.095	94.85	·····	Design Flexure - Steel	•••••••••••••••••••••••••••••••••••••••	·····
/pe 3	Axle Load	LFD	Operating	74.26	2.970	94.85		Design Flexure - Steel	•••••••••••••••••••••••••••••••••••••••	·····
pe 3-3	Axle Load	LFD	Operating	88.81	2.220	94.85		Design Flexure - Steel	•••••••••••••••••••••••••••••••••••••••	·····
pe 3S2	Axle Load	LFD	Operating	81.92	2.275	94.85		Design Flexure - Steel		·····
5 Split (LFD -48kips)	Axle Load	LFD	Permit Ope	99.98	1.425	94.85	· · · · · ·	Design Flexure - Steel	•••••••••••••••••••••••••••••••••••••••	·····
7 Split (LFD -48kips)	Axle Load	LFD	Permit Ope	109.59	1.121	94.85	1 - (100.0)	Design Flexure - Steel	As Requested	As Requested
9 Split (LFD -48kips)	Axle Load	LFD	Permit Ope	124.25	0.991	94.85	1 - (100.0)	Design Flexure - Steel	As Requested	As Requested
1 Split (LFD -48kips)	Axle Load	LFD	Permit Ope	144.71	0.946	94.85	1 - (100.0)	Design Flexure - Steel	As Requested	As Requested
3 Split (LFD -48kips)	Axle Load	LFD	Permit Ope	166.71	0.923	94.85	1 - (100.0)	Design Flexure - Steel	As Requested	As Requested
SHTO LFR 3D Engine Vers alysis Preference Setting: N										



Ratings: Rollers at Ends (Span 8-9)

ating Results Summary	▼ O As	Requeste	ed 🔘 De		gie raung	level per ro	w •	J		
Live Load	Live Load Type	Rating Method	Rating Level	Load Rating (Ton)	Rating Factor	Location (ft)	Location Span-(%)	Limit State	Impact	Lane
S 20-44	Lane	LFD	Inventory	51.65	1.435	94.85	1 - (100.0)	Design Flexure - Steel	As Requested	As Requested
S 20-44	Lane	LFD	Operating	86.25	2.396	94.85	1 - (100.0)	Design Flexure - Steel	As Requested	As Requested
S 20-44	Axle Load	LFD	Inventory	59.05	1.640	94.85	1 - (100.0)	Design Flexure - Steel	As Requested	As Requested
S 20-44	Axle Load	LFD	Operating	98.61	2.739	94.85	1 - (100.0)	Design Flexure - Steel	As Requested	As Requested
/pe 3	Axle Load	LFD	Operating	97.48	3.899	94.85	1 - (100.0)	Design Flexure - Steel	As Requested	As Requested
rpe 3-3	Axle Load	LFD	Operating	114.26	2.856	94.85	1 - (100.0)	Design Flexure - Steel	As Requested	As Requested
pe 3S2	Axle Load	LFD	Operating	106.25	2.951	94.85	1 - (100.0)	Design Flexure - Steel	As Requested	As Requested
5 Split (LFD -48kips)	Axle Load	LFD	Permit Ope	119.89	1.709	94.85	1 - (100.0)	Design Flexure - Steel	As Requested	As Requested
7 Split (LFD -48kips)	Axle Load	LFD	Permit Ope	131.08	1.341	94.85	1 - (100.0)	Design Flexure - Steel	As Requested	As Requested
9 Split (LFD -48kips)	Axle Load	LFD	Permit Ope	148.08	1.181	94.85	1 - (100.0)	Design Flexure - Steel	As Requested	As Requested
1 Split (LFD -48kips)	Axle Load	LFD	Permit Ope	170.61	1.115	94.85	1 - (100.0)	Design Flexure - Steel	As Requested	As Requested
3 Split (LFD -48kips)	Axle Load	LFD	Permit Ope	190.17	1.053	94.85	1 - (100.0)	Design Flexure - Steel	As Requested	As Requested
SHTO LFR 3D Engine Ver alysis Preference Setting: N										



End Support Choice

- With rollers at ends, there is some reduction for negative moments, but very large increase for positive moments (up to 53% for DL and 98% for LL).
- If slot holes are used in the flanges, there would be no horizontal force due to the steel weight.
- Considering actual pin location, 6" from bottom flange, will reduce horizontal force (up to 36% for DL) based on FEM analysis.
- Bearing anchor bolts may bend due to larger horizontal forces.

End Support Choice (Cont.)

- The actual end support conditions are between rollers and pinned.
- For this bridge with constant girder section and same top and bottom flanges, it would be conservative to use pinned supports.
- Considering the 1.3 load factor used and the possible slower speed of heavy permit trucks, it would be reasonable to allow all permit trucks on this structure, or simply use the results with rollers at ends.

Caltra



Rating w/o Shear Override (rollers at ends)

Analysis Results - Exterior Girder _ D										
Report Type Rating Results Summary		Impact Lo Requeste	oading Type ed 💿 De		olay Forma gle rating	at level per ro	w 🔻			
Live Load	Live Load Type	Rating Method	Rating Level	Load Rating (Ton)	Rating Factor	Location (ft)	Location Span-(%)	Limit State	Impact	Lane
HS 20-44	Lane	LFD	Inventory	36.26	1.007	189.70	2 - (100.0)	Design Shear - Steel	As Requested	As Requested
HS 20-44	Lane	LFD	Operating	60.56	1.682	189.70	2 - (100.0)	Design Shear - Steel	As Requested	As Requested
HS 20-44	Axle Load	LFD	Inventory	20.59	0.572	189.70	2 - (100.0)	Design Shear - Steel	As Requested	As Requested
HS 20-44	Axle Load	LFD	Operating	34.39	0.955	189.70	2 - (100.0)	Design Shear - Steel	As Requested	As Requested
Туре 3	Axle Load	LFD	Operating	33.16	1.326	189.70	2 - (100.0)	Design Shear - Steel	As Requested	As Requested
Туре 3-3	Axle Load	LFD	Operating	44.01	1.100	189.70	2 - (100.0)	Design Shear - Steel	As Requested	As Requested
Type 3S2	Axle Load	LFD	Operating	39.95	1.110	189.70	2 - (100.0)	Design Shear - Steel	As Requested	As Requested
P5Split (LFD -48kips)	Axle Load	LFD	Permit Ope	40.41	0.576	189.70	2 - (100.0)	Design Shear - Steel	As Requested	As Requested
P7Split (LFD -48kips)	Axle Load	LFD	Permit Ope	47.90	0.490	189.70	2 - (100.0)	Design Shear - Steel	As Requested	As Requested
P9 Split (LFD -48kips)	Axle Load	LFD	Permit Ope	57.54	0.459	189.70	2 - (100.0)	Design Shear - Steel	As Requested	As Requested
P11 Split (LFD -48kips)	Axle Load	LFD	Permit Ope	69.17	0.452	189.70	2 - (100.0)	Design Shear - Steel	As Requested	As Requested
P13 Split (LFD -48kips)	Axle Load	LFD	Permit Ope	81.65	0.452	189.70	2 - (100.0)	Design Shear - Steel	As Requested	As Requested

AASHTO LFR 3D Engine Version 6.7.0.3001

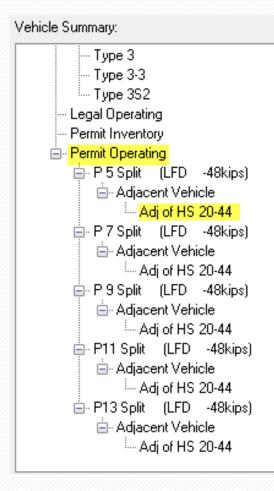
Analysis Preference Setting: None



Permit Load Setting

Vehicle Properties

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Vehicle	Tandem Train	Scale Factor	Impact	Single Lane Loaded	
HS 20-44		1			
Туре 3		1			
Type 3-3		1			
Type 3S2		1			
P 5 Split (LFD -48kips)		1.15			
P 7 Split (LFD -48kips)		1.15			
P 9 Split (LFD -48kips)		1.15			
P11 Split (LFD -48kips)		1.15			
P13 Split (LFD -48kips)		1.15			

Adjacent vehicle live load factor:

1.3

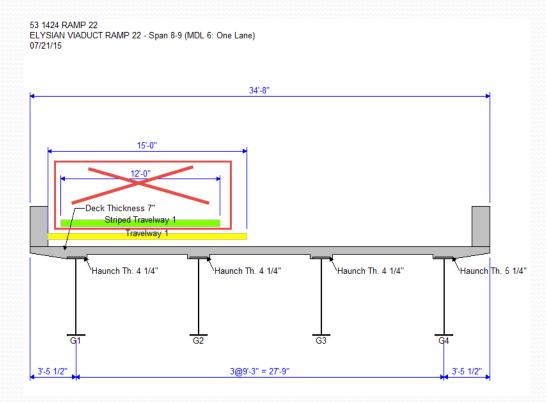


Rating for Striped Lane



One Lane Striping

- Left ETW: 1 ft from the barrier
- Traffic lane width: 12 ft
- Used 15 ft travel way width
- Do not used striped travel way function when edge stripe is less than 2 ft from barrier.





Rating with Pinned Supports

Live Load	Live Load	Rating	Rating	Load Rating	Rating	Location	Location	Limit State	Innert	1 [
Live Load	Туре М		Level	(Ton)	Factor	(ft)	Span-(%)		Impact	Lane	
S 20-44	Lane	LFD	Inventory	60.18	1.672	94.85		Design Flexure - Steel		As Requested	
5 20-44	Lane	LFD	Operating	100.39	2.789	94.85		Design Flexure - Steel		As Requested	
S 20-44	Axle Load	LFD	Inventory	60.11	1.670	94.85		Design Flexure - Steel	•		
S 20-44	Axle Load	LFD	Operating	99.90	2.775	94.85	·····	Design Flexure - Steel	•		
pe 3	Axle Load	LFD	Operating	98.44	3.937	94.85	·····	Design Flexure - Steel	•	······	
pe 3-3	Axle Load	LFD		115.97	2.899	94.85	·····	Design Flexure - Steel	•		
pe 3S2	Axle Load	LFD	Operating	107.71	2.992	94.85	·····	Design Flexure - Steel	•		
5 Split (LFD -48kips)	Axle Load	LFD	Operating	105.88	1.509	94.85	•••••••	Design Flexure - Steel	•	·····	
7 Split (LFD -48kips)	Axle Load	LFD	Operating	116.23	1.189	94.85		Design Flexure - Steel	•		
9 Split (LFD -48kips)	Axle Load	LFD	Operating	131.72	1.051	94.85		Design Flexure - Steel			
1 Split (LFD -48kips)	Axle Load	LFD	Operating	153.25	1.002	94.85	• • • • • • • • • • • • • • • • • • • •	Design Flexure - Steel	•		
3 Split (LFD -48kips)	Axle Load	LFD	Operating	176.43	0.977	94.85	1 - (100.0)	Design Flexure - Steel	As Requested	As Requested	
SHTO LFR 3D Engine Versi alysis Preference Setting: No										Close	



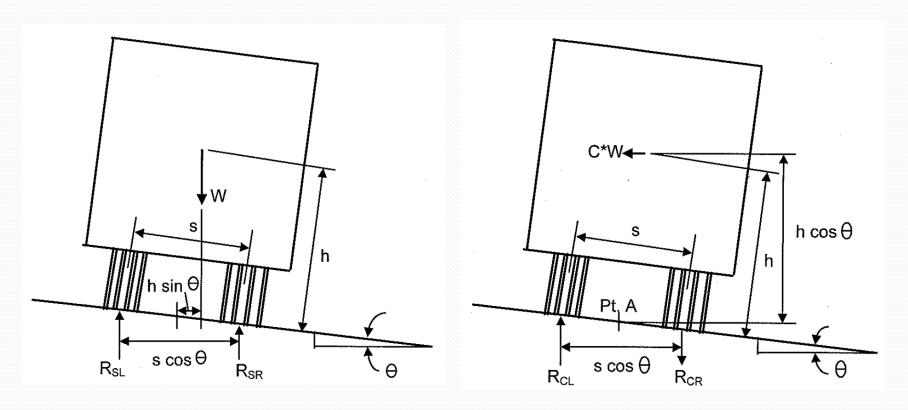
Design Speed and Centrifugal Force



Slope and Centrifugal Force

Vehicle Self Weight

Vehicle Centrifugal Force





Centrifugal Force

LFD

3.10 CENTRIFUGAL FORCES

3.10.1 Structures on curves shall be designed for a horizontal radial force equal to the following percentage of the live load, without impact, in all traffic lanes:

C = 0.00117S²D =
$$\frac{6.68S^2}{R}$$
 (3-2)

where,

- C = the centrifugal force in percent of the live load, without impact;
- S = the design speed in miles per hour;
- D = the degree of curve;
- R = the radius of the curve in feet.

LRFD

3.6.3—Centrifugal Forces: CE

For the purpose of computing the radial force or the overturning effect on wheel loads, the centrifugal effect on live load shall be taken as the product of the axle weights of the design truck or tandem and the factor C, taken as:

$$C = f \frac{v^2}{gR}$$
(3.6.3-1)

where:

- v = highway design speed (ft/s)
 - = 4/3 for load combinations other than fatigue and 1.0 for fatigue
- g = gravitational acceleration: 32.2 (ft/s²)
- R = radius of curvature of traffic lane (ft)



Centrifugal Force (cont.)

- Ratio of centrifugal forces with the same speed: $C_{LRFD}/C_{LFD}=1.33$
- Maximum design speed: $S_{max,LRFD}/S_{max,LFD}=0.867$
- This bridge: $S_{max,LRFD} = 52.5 \text{ mph}$ $S_{max,LFD} = 60.9 \text{ mph}$
- A design speed that works with LFR, may not work with LRFR.



LRFR and Refined Analysis



Permit Checks

6A.4.5.4.2c—Permit Checks Using Refined Analysis

When routine permit checks are evaluated using a refined analysis, the load factors as given in Table 6A.4.5.4.2a-1 shall be increased (by adding) 0.10 and applied on the two permit trucks placed in adjacent lanes.

<u>When escorted special permits with no other</u> <u>vehicles on the bridge are evaluated using a refined</u> <u>analysis, $\gamma_{\underline{L}} = 1.1$ should be applied to the escorted</u> <u>vehicle.</u>



Permit Checks (cont.)

<u>When special permits mixed with traffic are</u> evaluated using a refined analysis, a live load factor $\gamma_{\underline{L}} = 1.0$ shall be applied on the permit truck while a $\gamma_{\underline{L}} = 1.10$ shall be applied on the governing AASHTO legal truck placed in the adjacent lane.



LRFR 3D with Single Permit

Vehicle Summary:	Vehicle I	Properties													×
Routine Specialized Hauling Permit Load Rating		Vehicle	Tandem Train	Scale Factor	Impact	Single Lane Loaded	Legal Pair	Overrid e	Legal Live Load	riequei	су	Loading Condition	Override	Permit Live Load Factor	OK Cancel
📄 P 5 Split (LRFR-54kips)	P 5 Sp	it (LRFR -54kips)		1	0.758					Single Trip	•	Mixed with tra 🔻	V	1	
🖮 Adjacent Vehicle	P 7 Sp	it (LRFR -54kips		1	0.758					Single Trip	•	Mixed with tra 🔻	1	1	
- Adjacent Type 3-3	P 9 Sp	iit (LRFR -54kips		1	0.758					Single Trip	•	Mixed with tra 💌	V	1	
⊨ P 7 Split (LRFR -54kips)	P11 Sp	lit (LRFR -54kips		1	0.758					Single Trip		Mixed with tra 🔻		1	
🚊 - Adjacent Vehicle	P13 Sp			1	0.758					Single Trip		Mixed with tra 🔻		1	
Adjacent Type 3-3	P15 Sp	lit (LRFR -54kips		1	0.758					Single Trip	•	Mixed with tra 🔻	V	1	
🖶 P 9 Split (LRFR -54kips)															
🖻 - Adjacent Vehicle															
Adjacent Type 3-3															
🖶 P11 Split (LRFR -54kips)															
🖻 Adjacent Vehicle															
Adjacent Type 3-3															
P13 Split (LRFR -54kips)															
🖨 Adjacent Vehicle															
Adjacent Type 3-3															
□ P15 Split (LRFR -54kips)	,									_		_			
– Adjacent Vehicle	Permit I	ane load:	kip	o∕ft		Adjac	ent veh	nicle live l	oad fac	otor: 1.1					
Adjacent Type 3-3															
	Excl	ude permit lane loa	d from per	rmit vehic	cie locati	on									



Results Missing Vehicles

Analysis Results - Exterior Report Type Rating Results Summary	Lane/I	Impact Lo Requeste	ading Type d ⊘ De		olay Forma Igle rating	at i level per ro	w 🔻]			×
Live Load	Live Load Rating Rating Load Rating Rating Location Location Type Method Level (Ton) Factor (ft) Span-(%)						Limit State	Impact	Lane	=	
P15 Split (LRFR -54kips)	Axle Load	Axle Load LRFR Permit 150.21 0.744 94.85 1 - (100.0) SERVICE-II Steel Flexu A						As Requested	As Requested		
AASHTO LRFR 3D Engine Ve	ersion 6.7.0.3001										
Analysis Preference Setting: N	ione										
											-
•											► at



Conclusion



Conclusion

- LFR Engine produces all required rating results
- Ready to be used for rating production
- Will be more efficient after other issues resolved
- Would also be more efficient:
 - (1) Extend d_0/D limit for shear capacity
 - (2) Extend the 300 foot span length limit
 - (3) Consider the bearing pin location
 - (4) List lateral force at support
- LRFR Engine needs more testing



Questions?