Using BrR To Evaluate Bascule Bridges

2018 RADBUG MEETING – BOISE, IDAHO

AUGUST 7-8, 2018

CDOT
CHICAGO DEPARTMENT OF TRANSPORTATION

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CBiT
A Joint Venture Teaming of Alfred Benesch & Company and Collins Engineers, Inc.

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COLLINS ENGINEERS INC.

American Association of State Highway and Transportation Officials
AASHTO
The Voice of Transportation

AASHTOWare BrR Bridge Design & Rating AASHTO

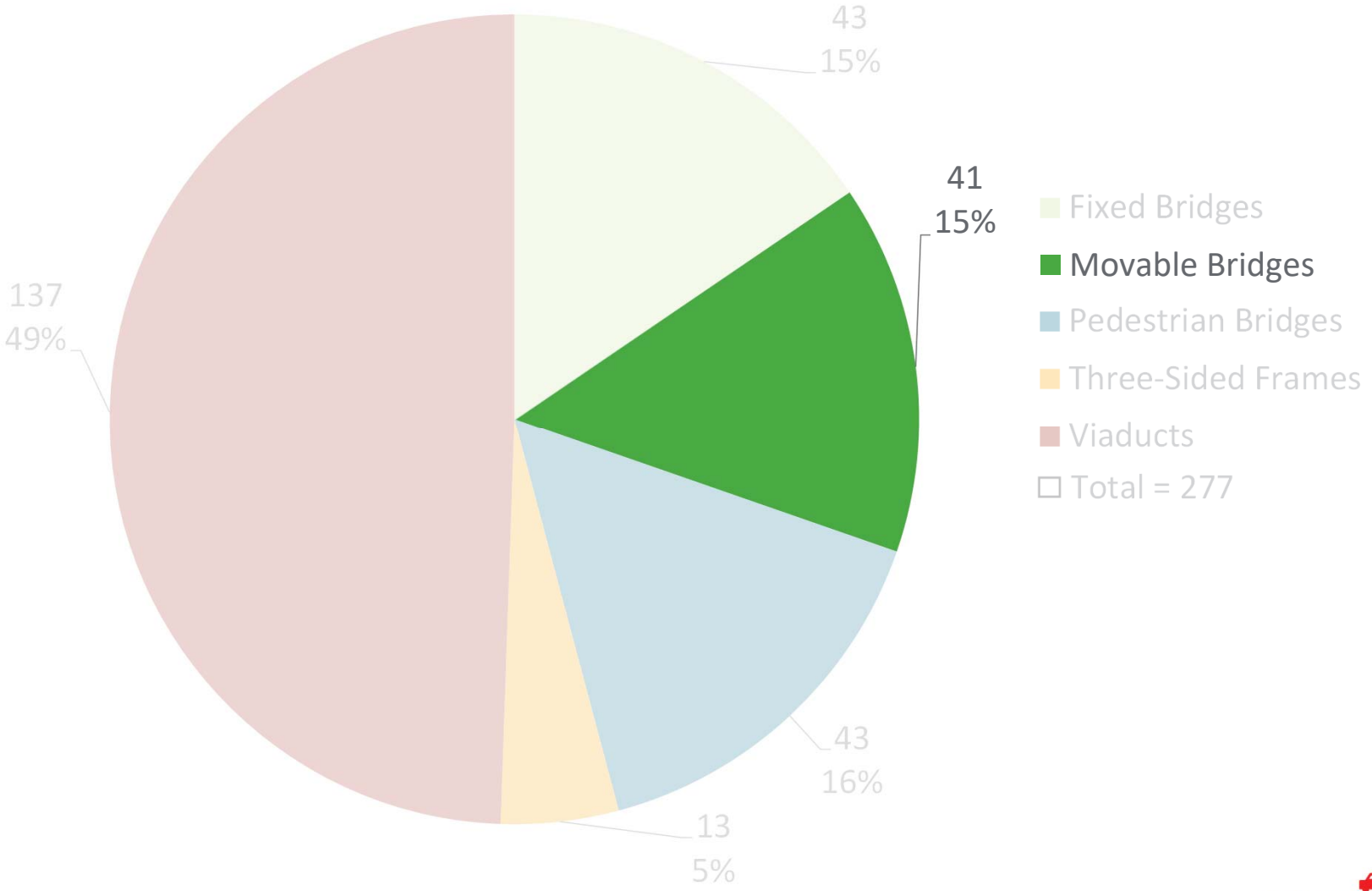
Using BrR To Evaluate Bascule Bridges

Summary of Presentation

- Background on CDOT & CBIT
- LaSalle St. and Lake St. Bascule Bridges – Carolyn Kois, P.E.
- Roosevelt Rd. and Cermak Rd. Bascule Bridges – Jim Surber, P.E, S.E.

Five Bridge Types Maintained by CDOT

CHICAGO DEPARTMENT OF TRANSPORTATION



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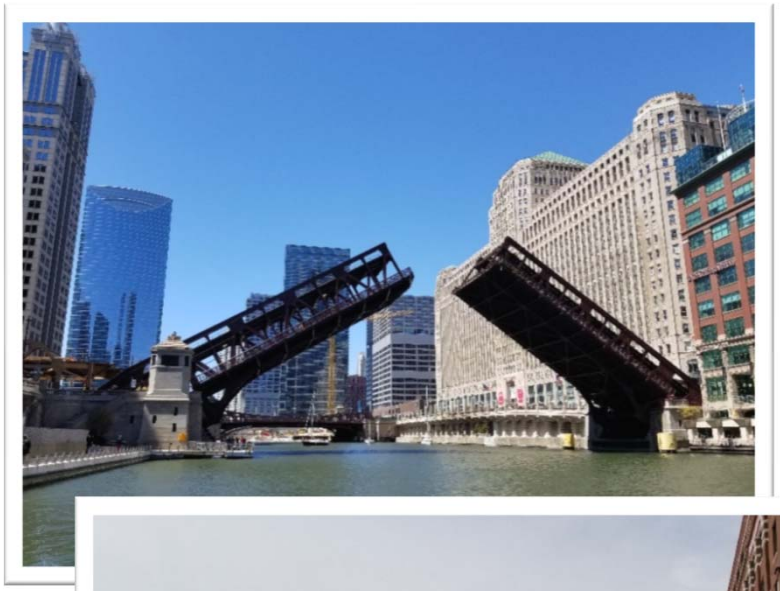
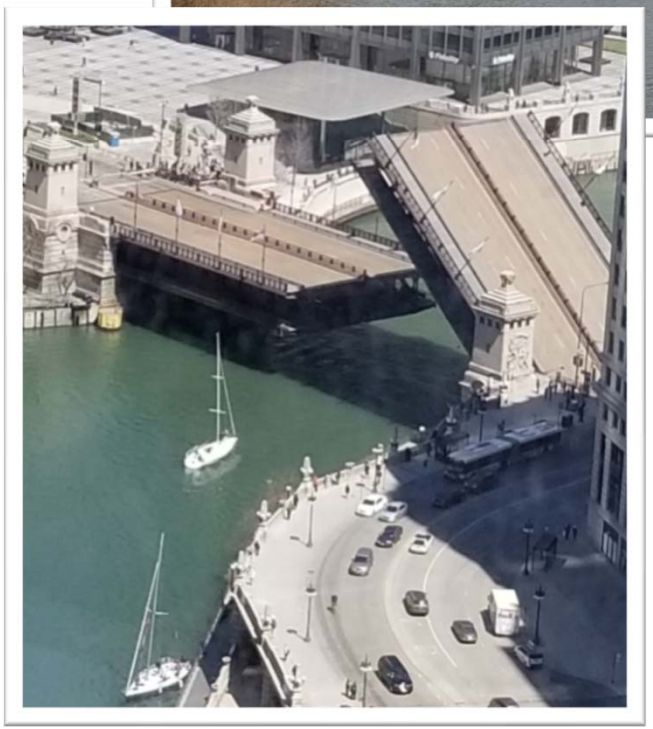
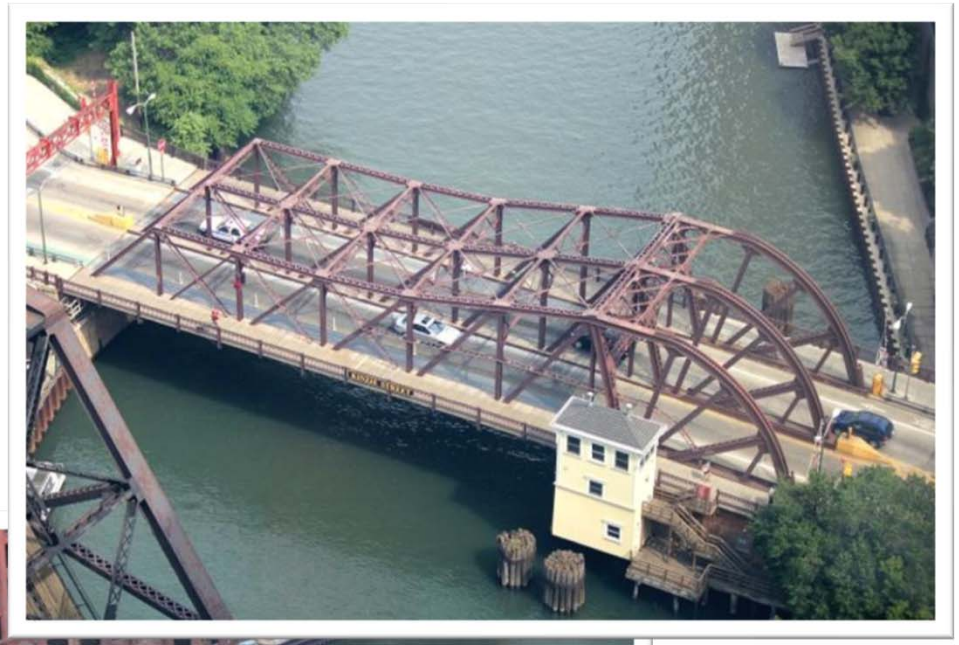
Chicago Bascule Bridges





Chicago Bascule Bridges

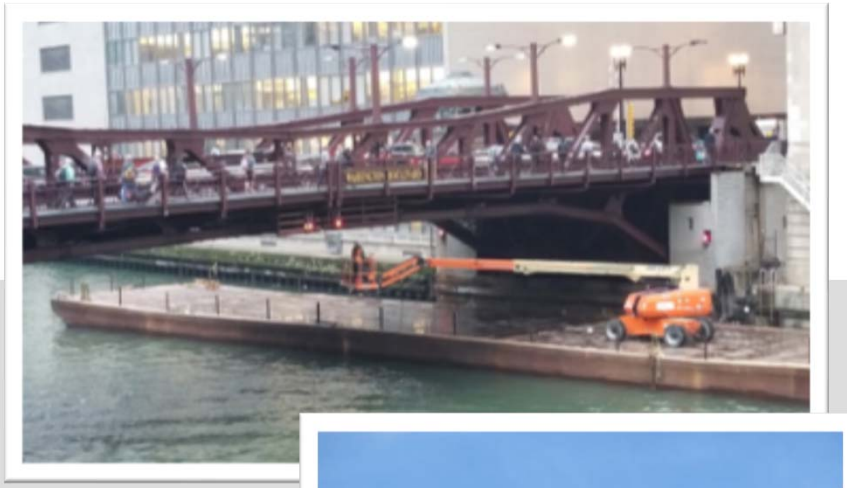


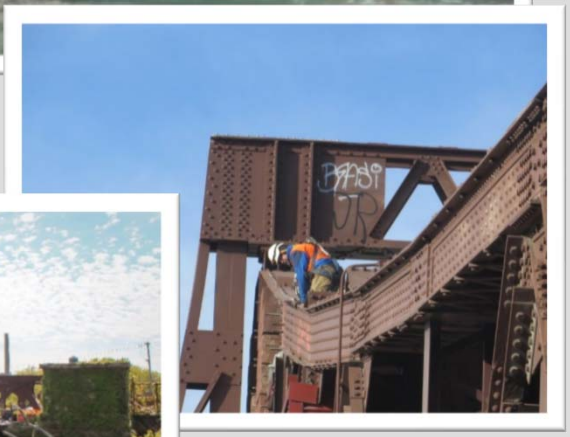
Who is CBIT?

Chicago
Bridge
Inspection
Team

A Joint Venture Teaming of Alfred Benesch & Company and Collins Engineers, Inc.

A Joint Venture Teaming of Alfred Benesch & Company and Collins Engineers, Inc.





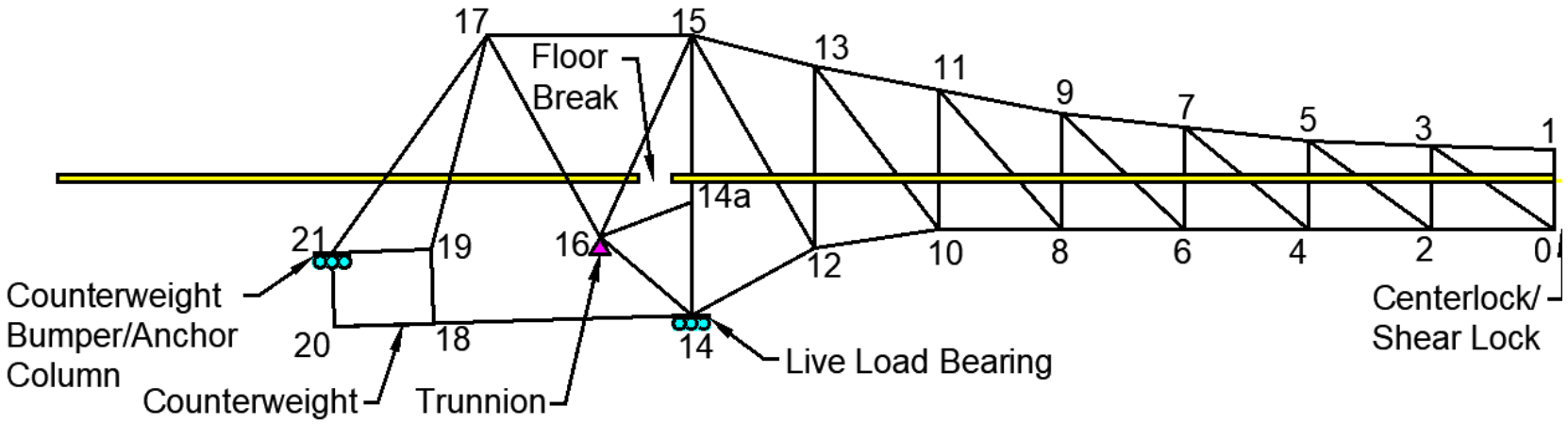
- Bridge Inspections
  - Routine, Special, Fracture Critical, Underwater and Element Level
  - Mechanical and Electrical of movable bridges
  - NDT including UT testing
  - Confined spaces
  - Rope access, barges and man-lifts
- On-Call Engineering Services
  - Bridge repairs
  - Emergency services
  - Bascule bridge balancing
- Load Rating

LaSalle St. Bascule

Single Level Double Leaf Trunnion Type Bascule

LaSalle St. Bascule

Bascule Components and Supports



LaSalle St. Bascule

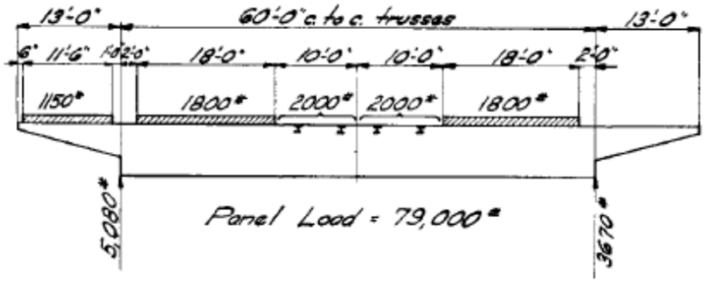
Original Construction

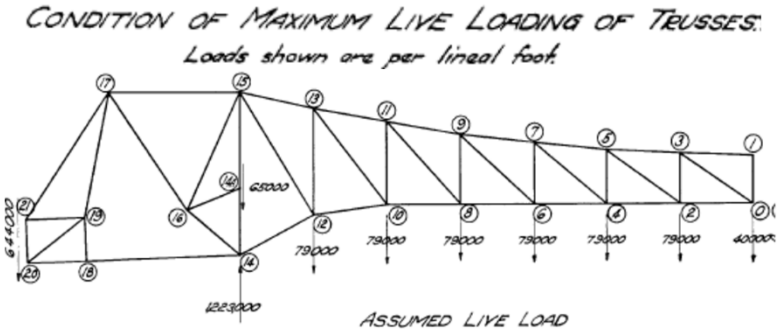
Construction/Repair History

- 1928 Original Construction
- 1969 Timber Deck Replaced with Steel/Concrete Deck rebalancing of counterweight

Historical Photo of La Salle Street Bridge
Source: Armour Engineer, Volume 22, No. 3, 1931

Design Load





Geometry

- 219’-10” between live load bearings
- 11’-6” live load bearings to trunnions
- 35”-3” trunnions to anchor columns

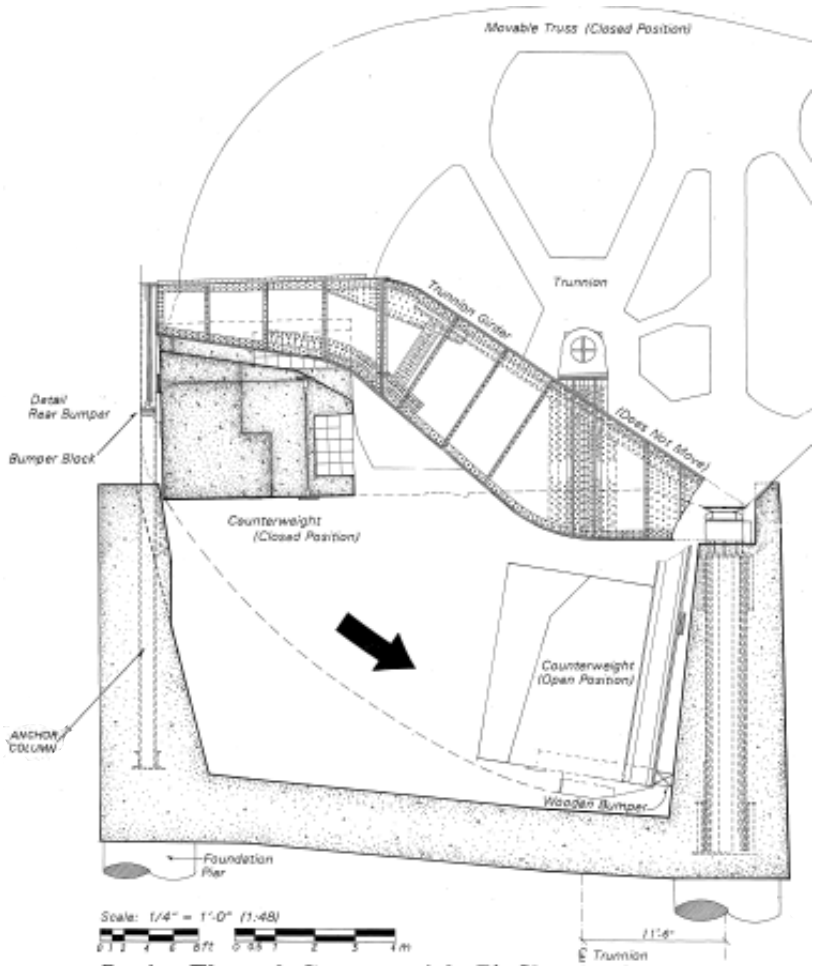
LaSalle St. Bascule

Carrying Elements

- Fixed span elements mostly rated in BrR
- Supplemental analysis required outside of BrR for some carrying elements

The concrete substructure of the bridge rests on massive concrete piers that are built down to bed rock.

Construction of Bridge
Source: Armour Engineer, Volume 22, No. 3, 1931



Section Through Counterweight Pit Showing Structural Detail

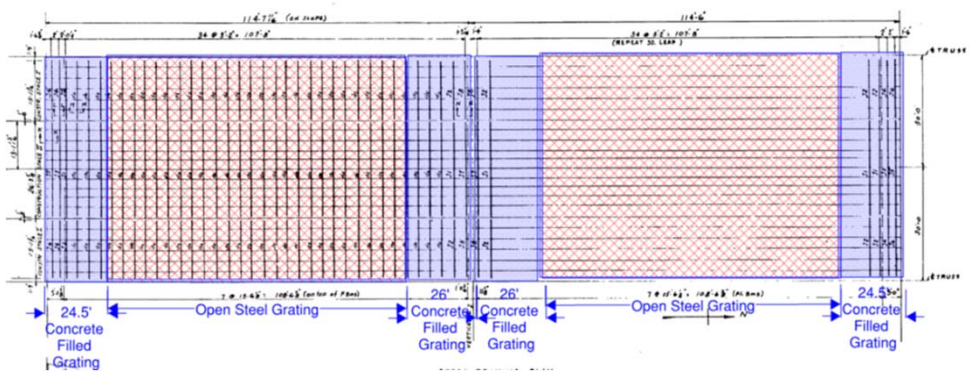
LaSalle St. Bascule

Dead Load Forces

Dead Loads

- Truss member self weight
- Floorbeams
- Stringers
- Cantilever sidewalks
- Lateral Bracing
- Deck
- Counterweight

Steel Grating Deck with Concrete Infill at Centerlock and Floorbreaks



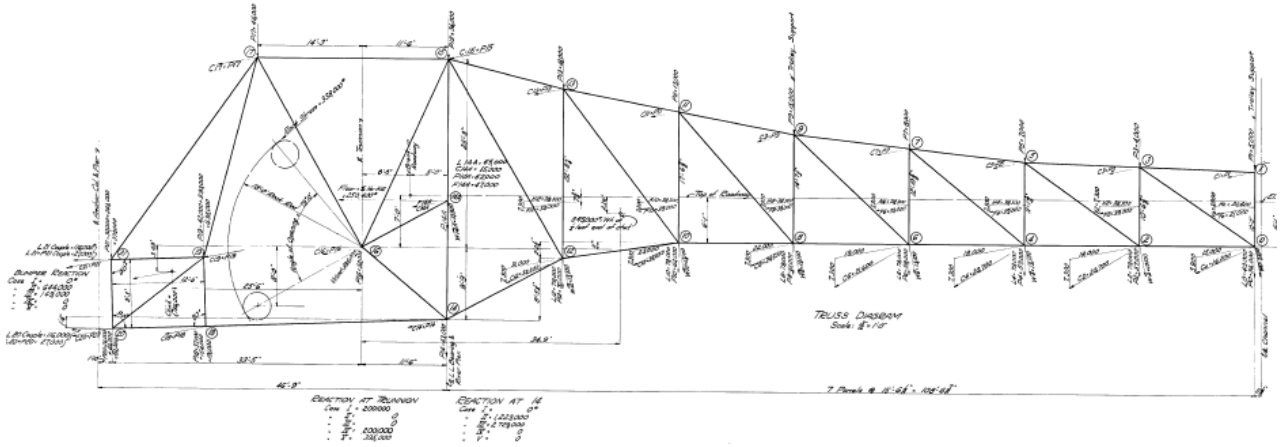
- Non-composite deck
- Deck thickness/weight adjusted to reflect weight of open steel grating
- Additional weight of concrete fill applied as distributed loads

LaSalle St. Bascule

Dead Load Balancing

Balanced Condition

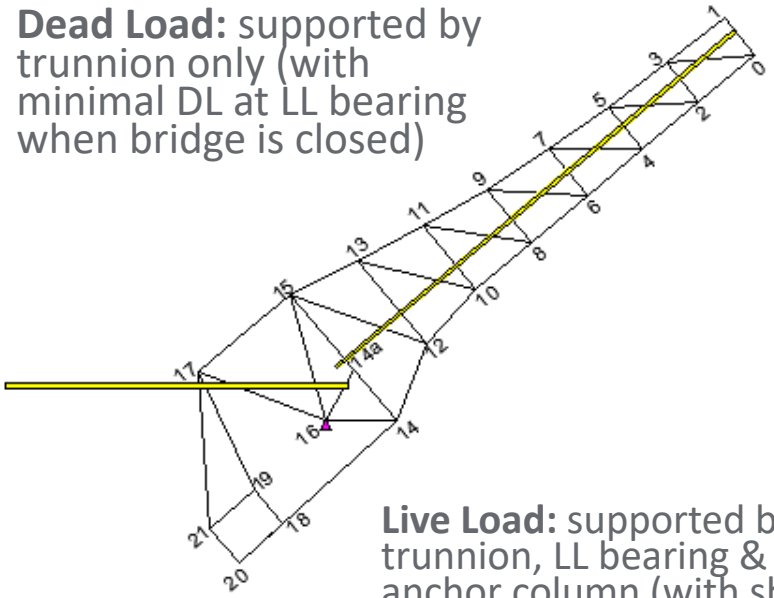
- Counterweight for DL model based on design and rehab plans
- Bascules rebalanced after repairs/alterations/maintenance
- Reaction at live load bearing is calculated for balanced condition (slightly nose-heavy)
- Counterweight is verified by comparing DL reaction at LL bearing reaction based on plan weight to LL bearing reaction calculated for balanced condition

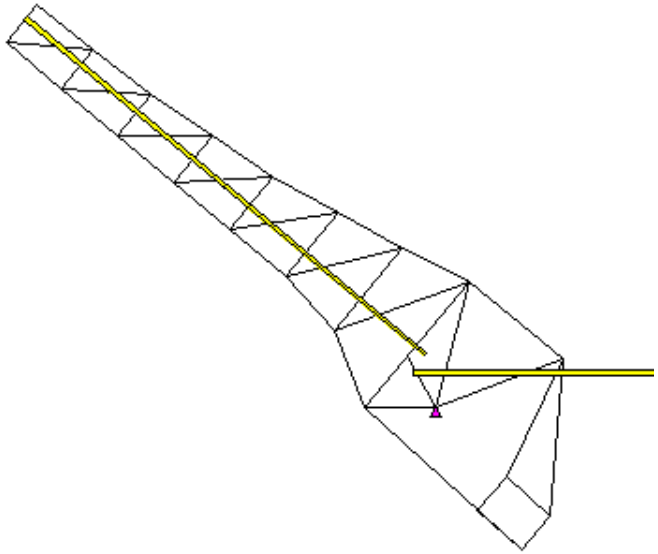


LaSalle St. Bascule

Load Stages

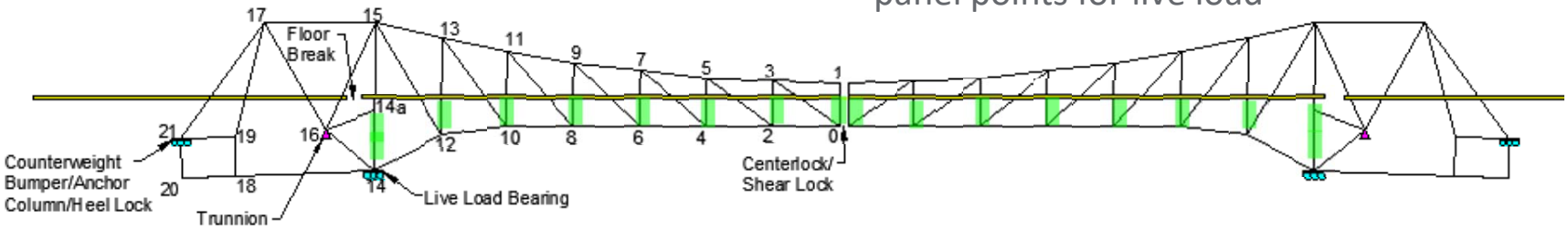
Dead Load: supported by trunnion only (with minimal DL at LL bearing when bridge is closed)





Live Load: supported by trunnion, LL bearing & anchor column (with shear transfer at centerlock)

Half deck line locations in BrR set to reflect the loaded panel points for live load



Pedestrian load included with live load

LaSalle St. Bascule

Live Load

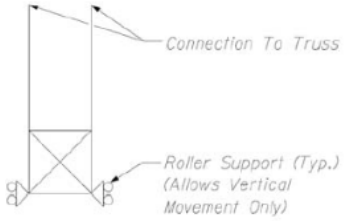
Vehicle and Pedestrian Load

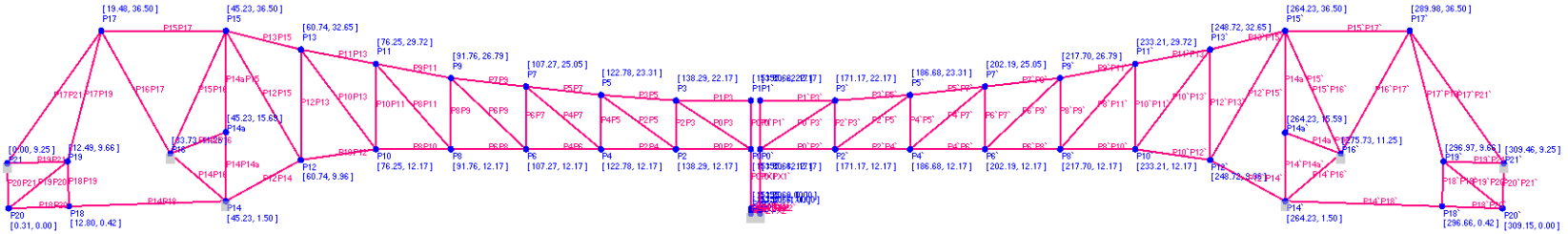
Supports

- Pin Support at Trunnion
- Roller Support at LL Bearing
- Roller Support at CW Bumper

Centerlock

- Centerlock transfers shear
- Does not transfer moment or axial load)





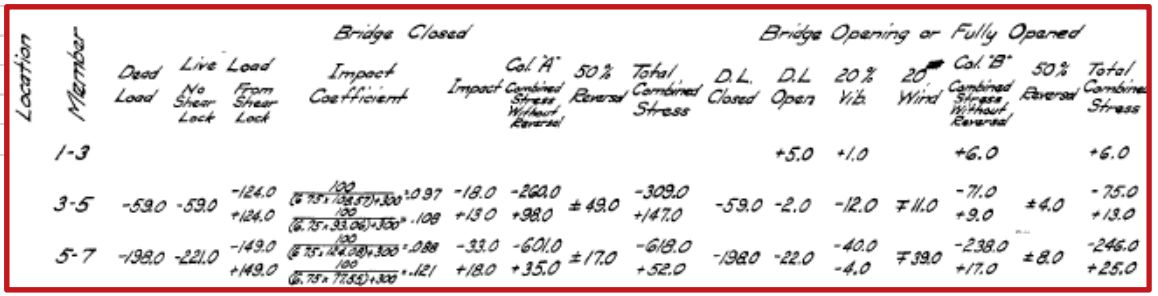
LaSalle St. Bascule

Verification of Dead Load Support Conditions

Location	Design Stress Sheet DL (k)	AASHTOWare Member	STAAD DL balance model (no centerlock or heel lock)
Top Chord		**1-3**	0
	-59	**3-5**	-72
	-198	**5-7**	-247
	-372	**7-9**	-434
	-582	**9-11**	-643
	-762	**11-13**	-803
	-866	**13-15**	-883
	-1160	**15-17**	-1128
Bottom Chord	59	**0-2**	71
	198	**2-4**	245
	371	**4-6**	431
	572	**6-8**	631
	749	**8-10**	788
	848	**10-12**	865
	856	**12-14**	862
Verticals	5	**0-1**	2
	42	**2-3**	50
	87	**4-5**	105
	132	**6-7**	141
	138	**8-9**	128
	179	**10-11**	160
	73	**12-13**	39

Location	Design Stress Sheet DL (k)	AASHTOWare Member	STAAD DL balance model (no centerlock or heel lock)
Diagonals	-71	**0-3**	-87
	-171	**2-5**	-214
	-225	**4-7**	-243
	-278	**6-9**	-277
	-266	**8-11**	-239
	-153	**10-13**	-113
	176	**12-15**	204
Rear Members	-730	**14-14a**	-738
	-801	**14a-15**	-752
		14a-16	0
	454	**14-16**	477
	405	**14-18**	393
	412	**18-20**	399
	984	**15-16**	910
	1537	**16-17**	1506
	-1179	**17-19**	-1176

Note: Numerous structure components, including the deck, have been modified since original construction. Original dead load forces are provided for information, however the dead load used for analysis was calculated based on the current structure geometry.



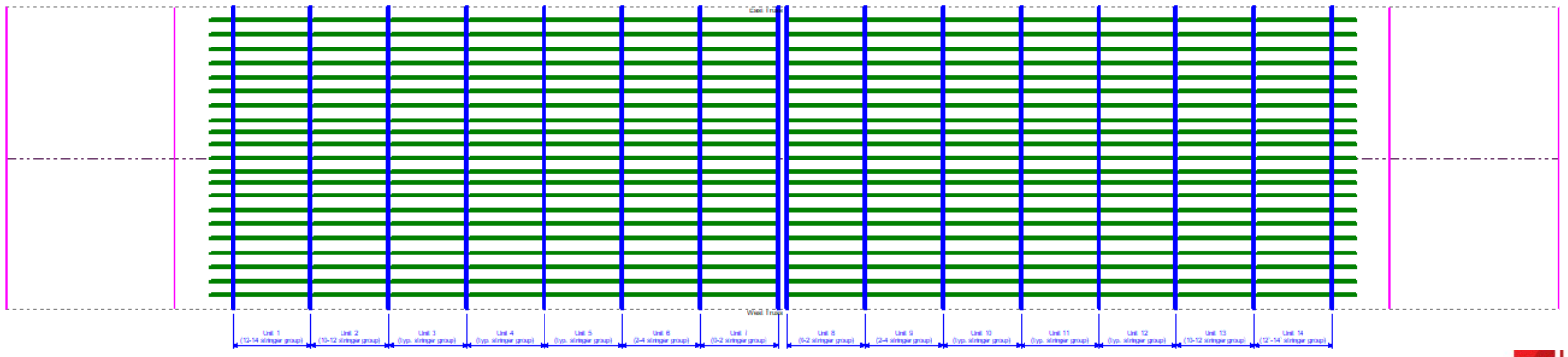
LaSalle St. Bascule

Load Rating Analysis

Floorbeams and Stringers

- Moveable portion modeled in BrR in truss superstructure definition
- Fixed spans modeled in BrR as separate superstructure alternative

Note: BrR does not model simple span floorbeams when there are more than 2 truss lines in a bridge. Floorbeams are analyzed as continuous so workaround is required to model them as simple span between trusses.



Lake St. Bascule

Double Level Double Leaf Trunnion Type Bascule

Lake St. Bascule

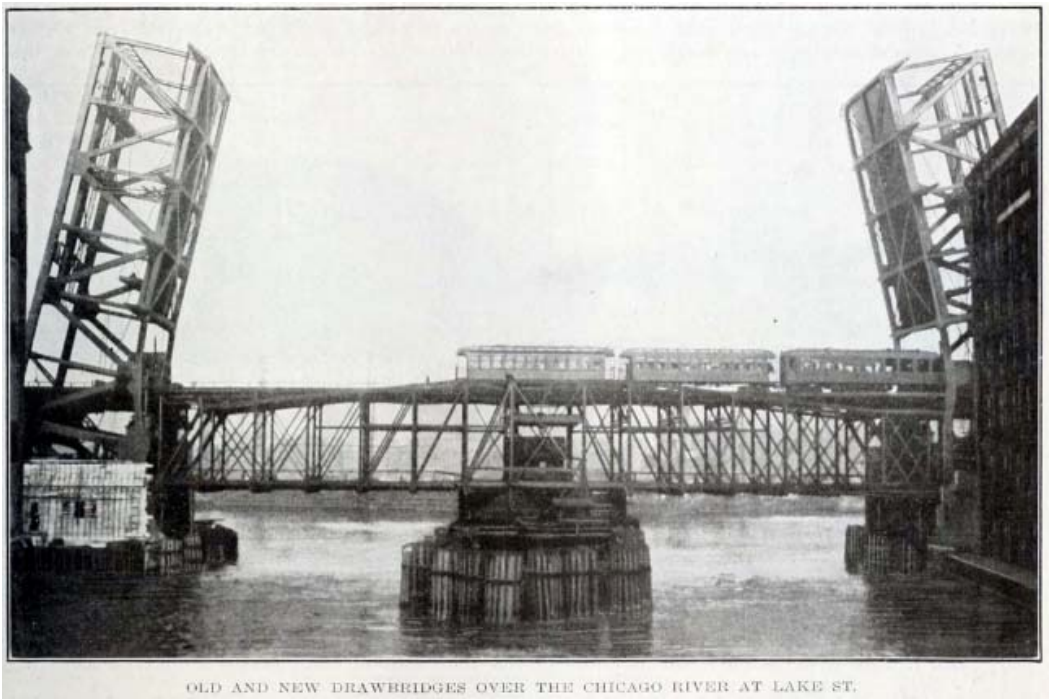
Original Construction

Construction/Repair History

- 1914 Original Construction
- 1994 lower level floor system replacement and rebalancing of counterweight
- Various other repairs over the history of the bridge

Geometry

- 245’-3” between live load bearings
- 14’-0” live load bearings to trunnions
- 37”-7” trunnions to heel locks



OLD AND NEW DRAWBRIDGES OVER THE CHICAGO RIVER AT LAKE ST.

Design Load

Live load for floor system, hangers and posts, a floor load of 100 ˜ per square foot of sidewalk and roadway combined with two 50 ton electric cars on each track, or with one 24 ton truck on any part of the roadway

25000# 25000# 7Ft 26 Ft 25000# 25000# 25000# 25000# 8Ft 7Ft 26 Ft 25000# 25000# 7Ft

2-50 Ton Cars

24000# 24000# 10Ft Wheels 5'-0" apart

24 Ton Truck

Space occupied by above loadings assumed as 10 Ft in width

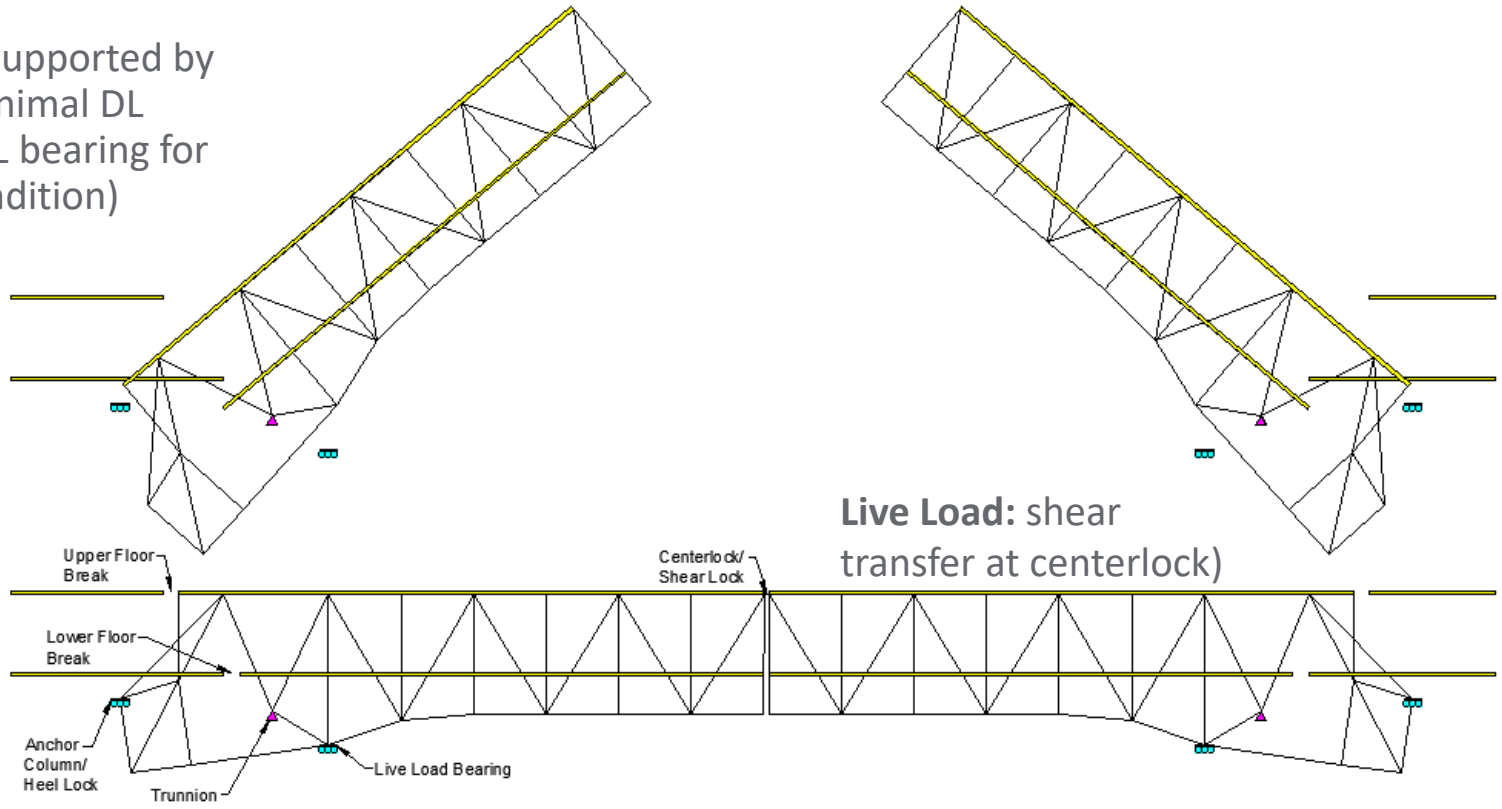
Live load for trusses, 2000# per lineal foot of each track, and 100 # per square foot of sidewalk and roadway surface not occupied by the track loads

HS 20 Design Live Load for Lower Level Floor System constructed in 1994 to replace original lower level framing

Lake St. Bascule

Load Stages

Dead Load: supported by trunnion (minimal DL reaction at LL bearing for balanced condition)



Live Load: shear transfer at centerlock)

Live Load: supported by trunnion, LL bearing & heel lock

2 Stage Load Model: Dead load force overrides are required for AASHTOWare analysis since dead load and live load have different support conditions

Lake St. Bascule

Live Load Supports

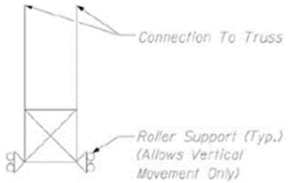
Vehicle and Pedestrian Load on Lower Level & CTA Loading on Upper Level

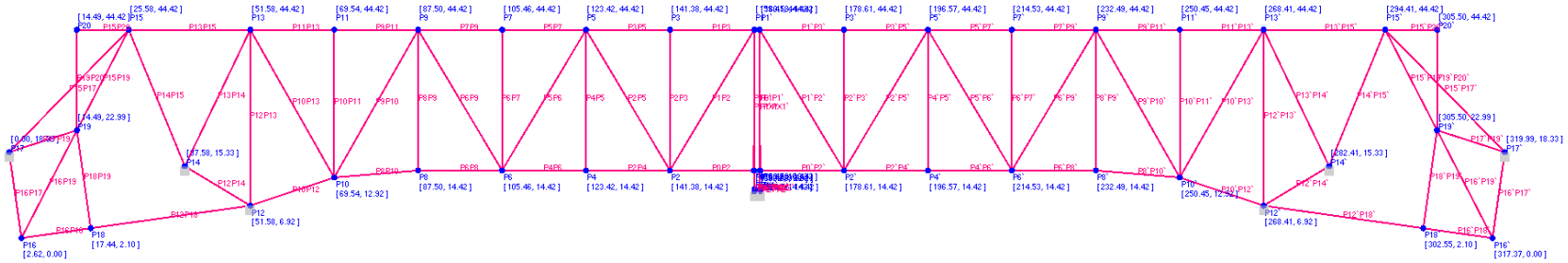
Supports

- Pin Support at Trunnion
- Roller Support at Live Load Bearing (verified no uplift)
- Roller Support at Heel Lock

Centerlock

- Centerlock transfers shear
- Does not transfer moment or axial load)

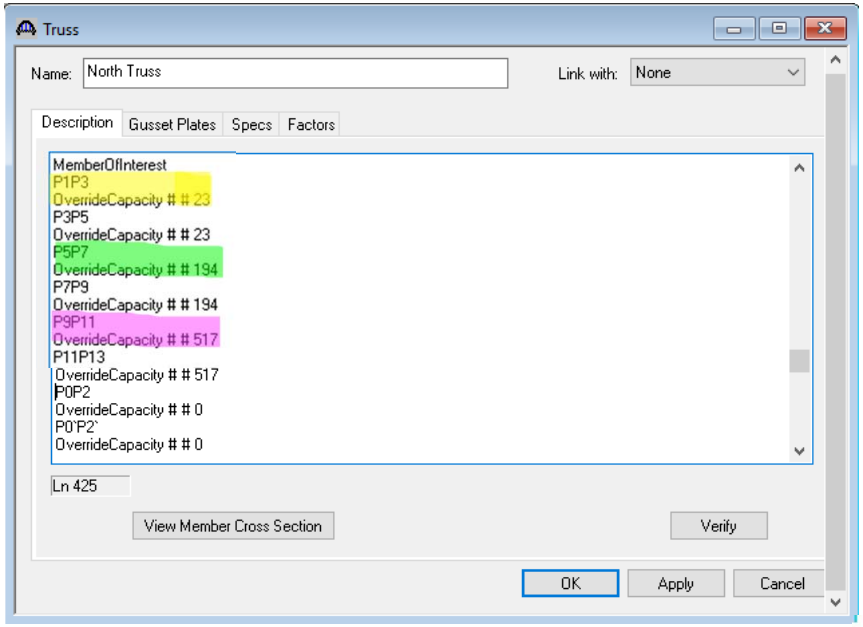




Lake St. Bascule

Dead Load Analysis

Input of Dead Load Force Overrides



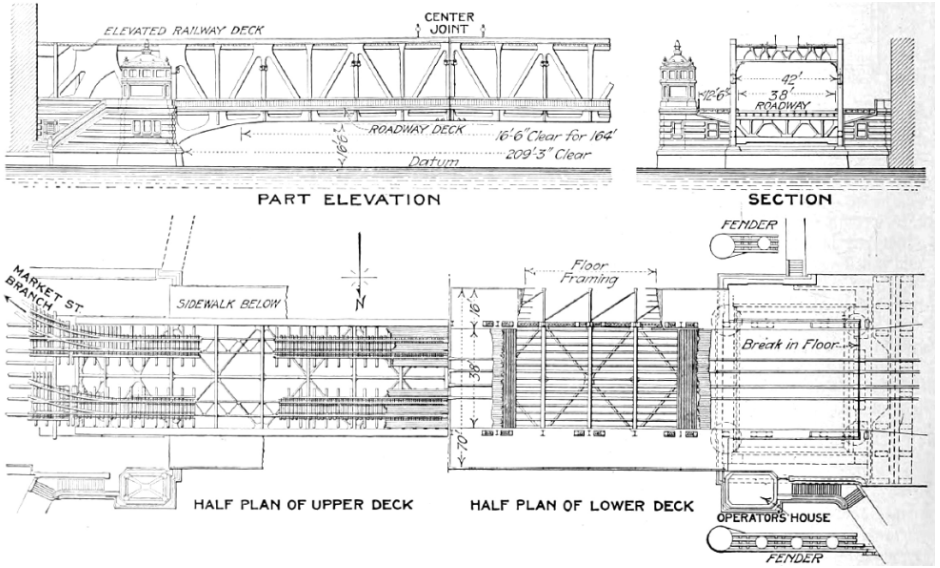
Verification of Dead Load Forces used for Analysis

Member	Truss Element	DL Force (kip)	LL Force				Capacity	
			Comp. (kip)	IF	Tens. (kip)	IF	Comp. (kip)	Tens. (kip)
P10P12	Lower-Chord	-688.00	-153.79	1.28	0.11	1.21	-2629.98	3142.80
P8P10	Lower-Chord	-346.00	-94.84	1.28	0.97	1.21	-1507.39	1805.40
P6P8	Lower-Chord	-345.00	-94.31	1.28	1.02	1.21	-1884.35	2256.60
P4P6	Lower-Chord	-88.00	-34.64	1.28	2.37	1.21	-553.48	660.00
P2P4	Lower-Chord	-88.00	-34.38	1.28	2.44	1.21	-553.48	660.00
P0P2	Lower-Chord		-0.21	1.28	0.06	1.21	-473.06	564.00
P10`P12`	Lower-Chord	-688.00	-153.49	1.28	0.11	1.21	-2629.98	3142.80
P8`P10`	Lower-Chord	-346.00	-94.59	1.28	0.97	1.21	-1507.39	1805.40
P6`P8`	Lower-Chord	-345.00	-94.05	1.28	1.06	1.21	-1507.58	1805.40
P4`P6`	Lower-Chord	-88.00	-34.53	1.28	2.40	1.21	-553.48	660.00
P2`P4`	Lower-Chord	-88.00	-34.28	1.28	2.47	1.21	-553.48	660.00
P0`P2`	Lower-Chord		-0.21	1.28	0.06	1.21	-473.06	564.00
P12P18	Lower-Chord	-413.00	-49.96	1.30	3.48	1.30	-2439.74	2502.90
P12`P18`	Lower-Chord	-413.00	-49.87	1.30	3.48	1.30	-2439.74	2502.90
P16P18	Lower-Chord	-459.00	-47.11	1.30	3.77	1.30	-2000.00	2000.00
P16`P18`	Lower-Chord	-459.00	-47.02	1.30	3.77	1.30	-2000.00	2000.00
P11P13	Upper-Chord	517.00	-0.31	1.21	128.82	1.28	-2770.65	2695.80
P9P11	Upper-Chord	517.00	-0.41	1.21	128.55	1.28	-2770.65	2695.80
P7P9	Upper-Chord	194.00	-2.27	1.21	61.46	1.28	-1204.46	1162.20
P5P7	Upper-Chord	194.00	-2.30	1.21	61.18	1.28	-1204.46	1162.20
P3P5	Upper-Chord	23.00	-2.06	1.21	14.55	1.28	-1030.56	995.40
P1P3	Upper-Chord	23.00	-2.12	1.21	14.25	1.28	-927.32	895.80

Lake St. Bascule

Combined Upper and Lower Level Live Load

- Upper Level – CTA Trains
- Lower Level – Vehicles
- Upper and loads analyzed on separate superstructure alternatives in BrR
- Truss loads combined to calculate rating factors for concurrent upper and lower level live loading



Combined Opr. RF (Comp.)	Combined Opr. RF (Tension)
1.31	99.00
1.50	30.88

LL Force (CTA)				LLDF (CTA)
Comp. (kip)	IF	Tens. (kip)	IF	
-190.89	1.28	4.62	1.21	1
-50.51	1.28	7.48	1.21	1

Member	Truss Element	DL Force (kip)	LL Force				Capacity	
			Comp. (kip)	IF	Tens. (kip)	IF	Comp. (kip)	Tens. (kip)
P6P8	Lower-Chord	-345	-139.71	1.28	2.03	1.21	-1507.58	1805.4
P4P6	Lower-Chord	-88	-59.48	1.28	4.03	1.21	-553.48	660

Roosevelt Rd. Bascule

Deck Truss Double Leaf Trunnion Type Bascule

Roosevelt Rd. Bascule
Original Construction

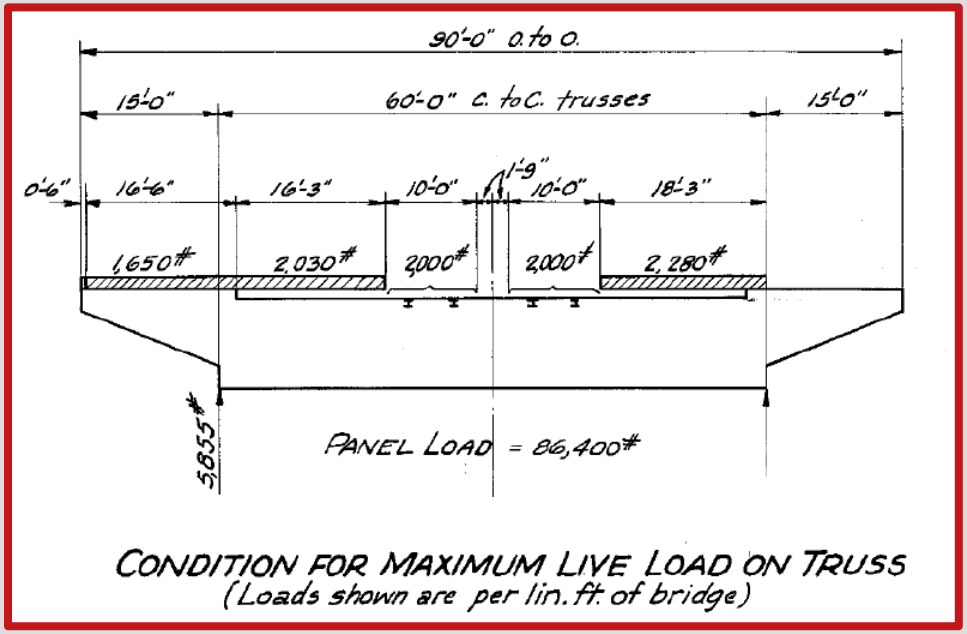
Construction/Repair History

- *1928: Original Construction*
- *1973-1975: Isolated repairs of bascule truss, deck replacement and rebalancing*
- *1994: Major rehabilitation including replacement of floorbeams, stringers and lateral bracing in movable span and rebalancing*
- *1,164 existing plan sheets*

Geometry

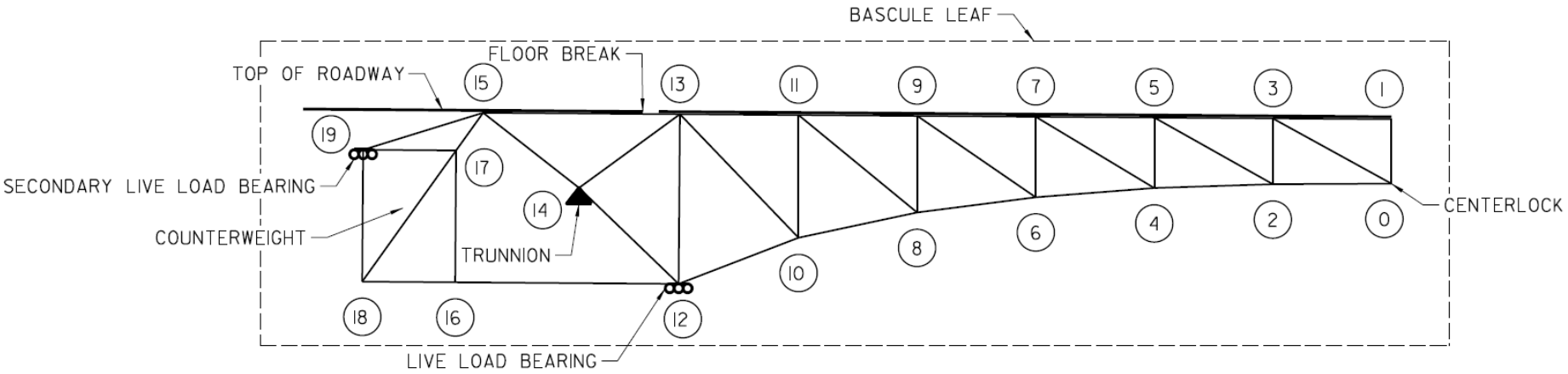
- *204'-0" CL to CL Trunnions*
- *28'-9" End Span (each side)*

- *Design Load*



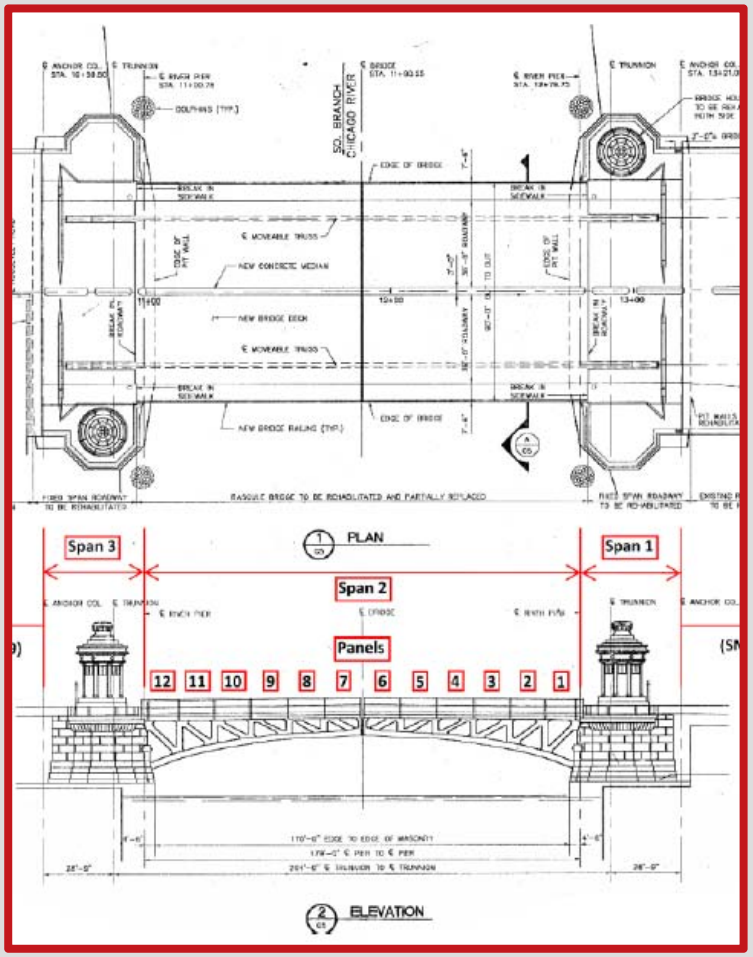
Roosevelt Rd. Bascule

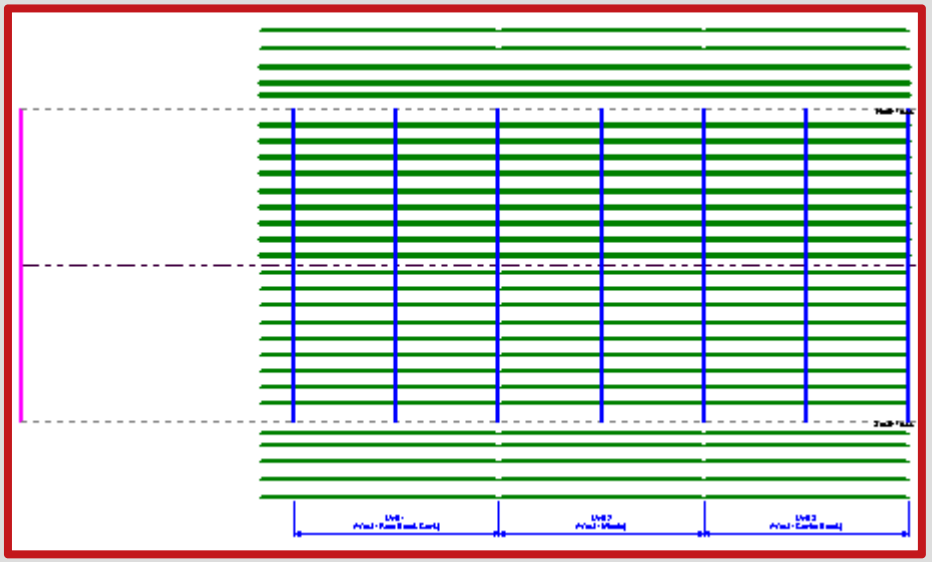
Bascule Structure Components and Supports

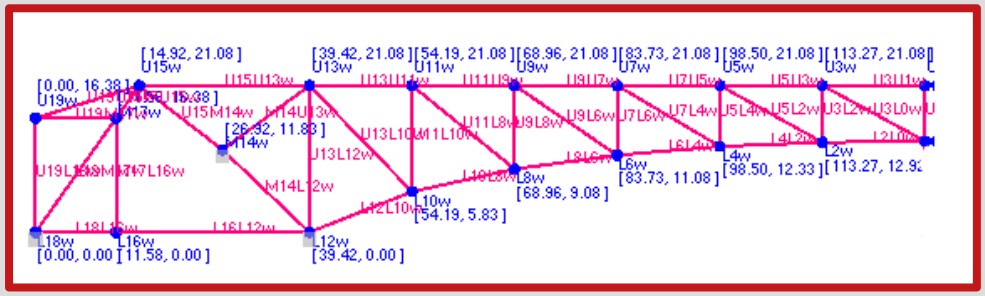


Roosevelt Rd. Bascule

Plan and Elevation

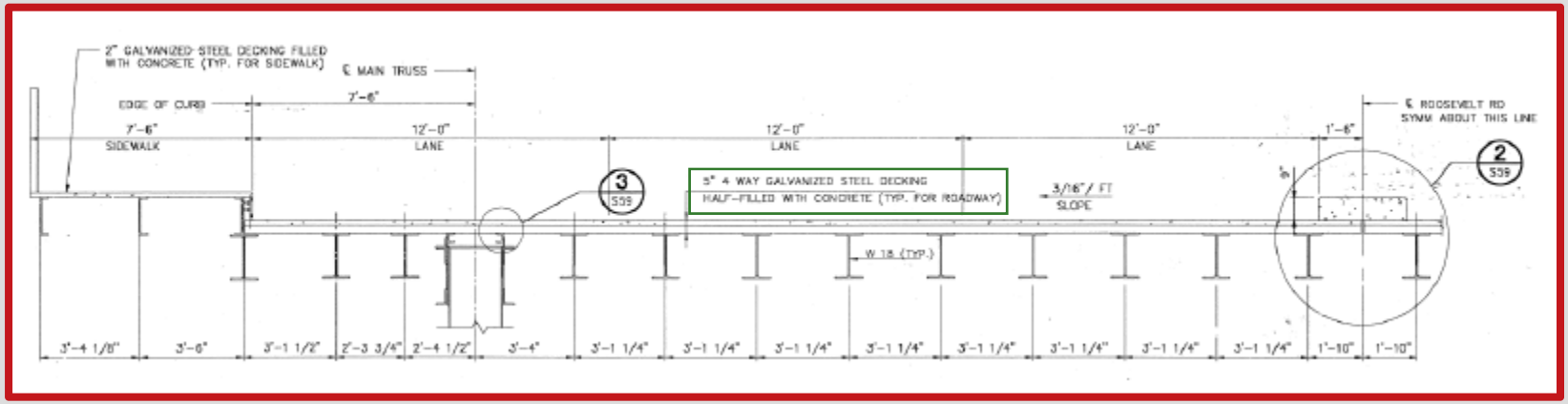


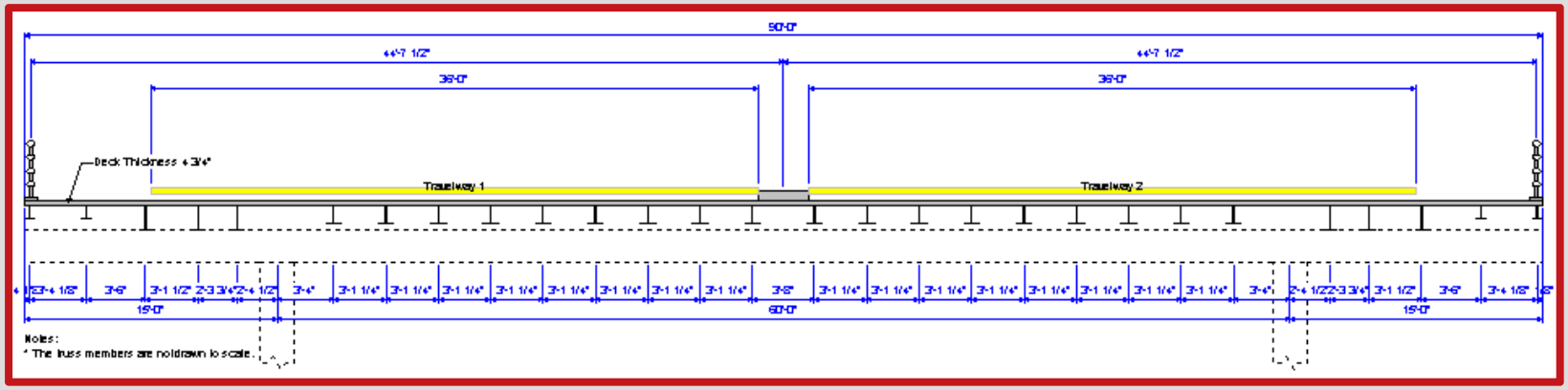




Roosevelt Rd. Bascule

Cross Section



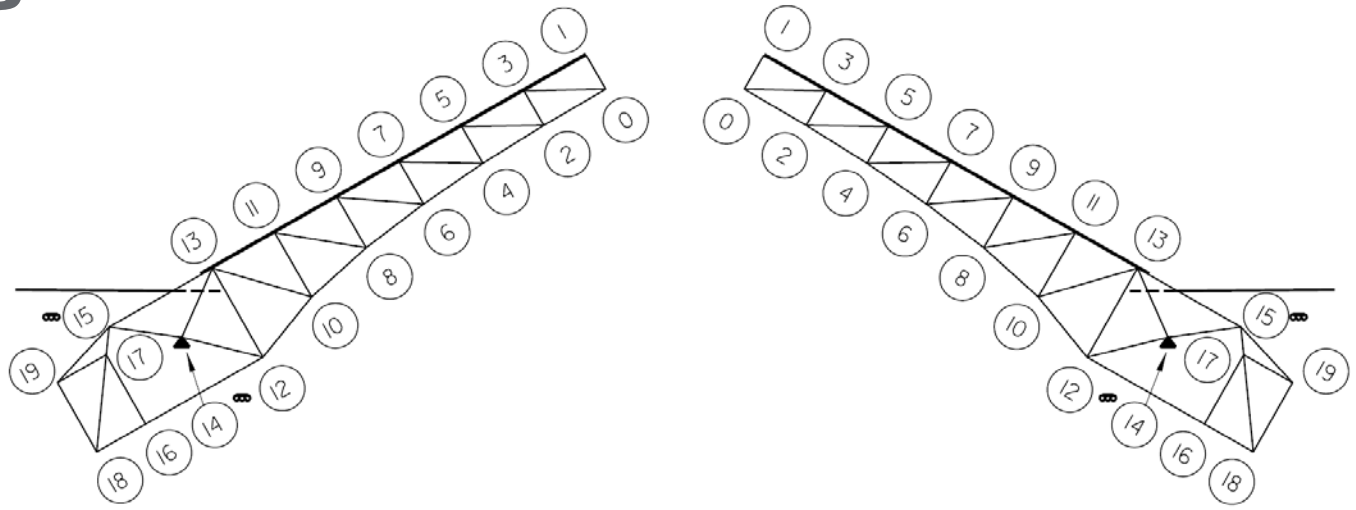


Roosevelt Rd. Bascule

Load Stages

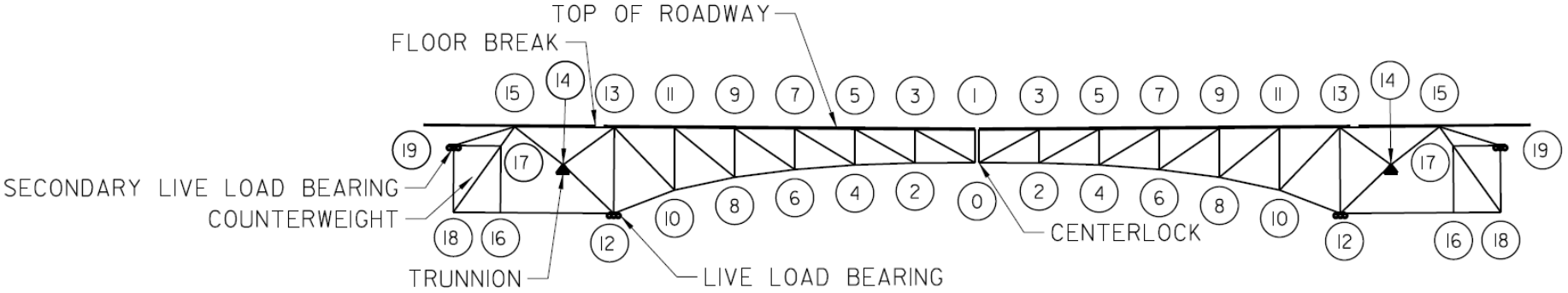
BRIDGE OPEN

Dead Load + Wind Load



BRIDGE CLOSED

Dead Load + Live Load (Including Pedestrian Load)



Roosevelt Rd. Bascule

Dead Load Forces

Dead Loads

- Truss member self weight
- Floorbeams
- Stringers
- Cantilever sidewalks
- Lateral Bracing
- Deck (Steel Grating)
- Counterweight
- Inspection Walkway

ALL WEIGHTS ARE FOR ONE LEAF

ITEM	WEIGHT	"X" IN FT.	"X" MOMENT IN FT. LBS. +	"X" MOMENT IN FT. LBS. −	"Y" IN INCHES	"Y" MOMENT IN INCH LBS. +	"Y" MOMENT IN INCH LBS. −
0	8805	101.125	890400		15.0	132100	
1	4095	101.125	414100		111.0	454500	
2	14515	86.354	1253400		13.0	188700	
3	9775	86.354	844100		111.0	1085000	
4	17345	11.583	124160		6.0	104100	
5	12850	11.583	919800		111.0	1426400	
6	19705	56.812	1119600		-9.0		177300
7	19950	56.812	1133400		111.0	2214400	
8	27140	42.042	1141000		-33.0		895600
9	21835	42.042	918000		111.0	2423700	
10	26700	27.271	728100		-72.0		1922400
11	28785	27.271	785000		111.0	3195100	
12	58360	12.5	729500		-142.0		8287100
13	70385	12.5	879800		111.0	7812700	
14	55170	0			0		
15	40240	-12.0		482900	111.0	4466600	
16	15210	-15.333		233200	-142.0		2159800
17	14725	-15.333		225800	54.444	801000	
18	13755	-24.917		370200	-142.0		1953200
19	8685	-24.917		233800	54.444	473000	
Floor Beam 0-0	24480	101.125	2475500		64.6	1581400	
" 2-2	22440	86.354	1937800		60.0	1346400	
" 4-4	22730	71.583	1627100		56.7	1288800	
" 6-6	21275	56.812	1208700		51.7	1099900	
" 8-8	18780	42.042	789500		41.4	786900	
" 10-10	24670	27.271	672800		44.6	1100300	
" 12-12	38730	14.875	576100		41.0	1587900	
Horizontal Truss 12-10	3440	21.75	118800		86.5	472300	
Latticed Strut 12-14	11670	6.08	70500		-68.5		799400
Sidewalk Brackets 1 to 11	16535	64.197	1061500		87.0	1438500	
" " 13a	2755	14.875	41000		87.0	239700	
" Laterals 1 to 11	1360	64.197	87300		113.0	153700	
" " 11 to 13a	270	21.073	5700		113.0	30500	
Curb L's & Brackets	5345	56.812	303700		129.0	689500	
Bottom Laterals 0 to 2	3930	93.74	368400		140	55000	
" " 2 to 4	3755	78.968	296500		9.5	35700	
" " 4 to 6	3755	64.197	241100		-1.5		5600
" " 6 to 8	4620	49.427	228400		-21.0		97000
" " 8 to 10	7480	34.656	276600		-52.5		414900
" " 10 to 12	5940	19.885	118100		-107.0		635600
Stringers 1 to 11	100450	64.197	6448600		100.5	10098200	
" 11 to Br. in Floor	26500	19.77	523900		98.0	2597000	
Rail Castings	13810	55.8	770600		104.0	1436200	
Tie Plates Rear Break	1195	13.9	16600		108.25	129400	
Carry Forward	876465		33262500	1545900		50942600	17352000

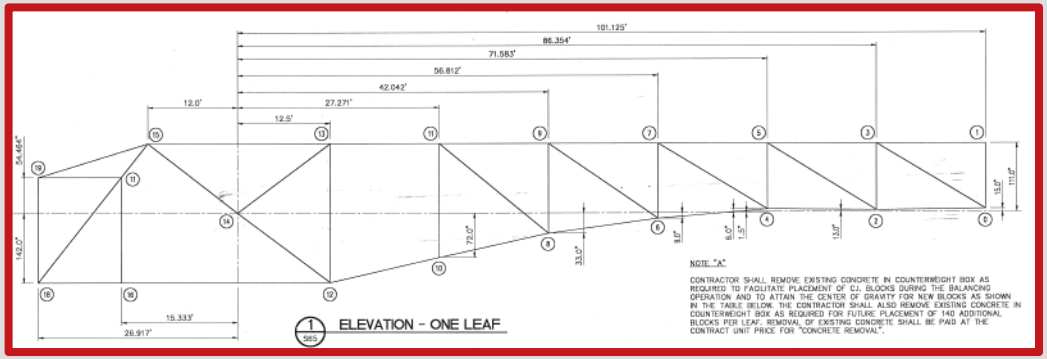
ITEM	WEIGHT	"X" IN FT.	"X" MOMENT IN FT. LBS. +	"X" MOMENT IN FT. LBS. −	"Y" IN INCHES	"Y" MOMENT IN INCH LBS. +	"Y" MOMENT IN INCH LBS. −
Brought Forward	876465		33262500	1545900		50942600	17352000
Ctrwt. Box - Front Truss	62145	-15.333		952900	-39.15		2433000
" " Top "	41480	-22.11		917100	54.44	2259200	
" " Rear Girder	41870	-26.917		1127000	-57.32		2400000
" " Bott. "	19225	-21.12		406000	-156.25		3004000
" " Cross Frames	27840	-18.32		510000	-46.0		1282800
Rack & Bolts	23530	-11.6		272600	-38.5		904800
Trunnion & Collars	26000	0			0		
Rear Bumper Casting	1870	-29.0		54200	-50.0		93500
Br in Fl Casting - Front	6700	101.62	680900		116.0	777200	
" " " Rear	21190	11.25	238400		110.0	2330900	
Gussets for Rear	88605	-14.0		1240500	18.5	1639200	
Center Island	11685	55.37	647000		123.0	1437300	
Center Lock Platform	7490	96.0	719000		6.0	44900	
Cent. Lock Machy & Castings	12200	9.54	116400		22.7	276900	
Live Load Casting at (12)	3460	12.5	43300		-169.0		584700
Strut at (12)	7750	12.5	96900		-142.0		1100500
⊕ Total for One Leaf for Initial Lowering	1279475		36834800	7026200		59708200	29591800
		23.13	(+29828600)		23.903	(+30582900)	
Edge Angles	3980	57.1	227300		117.0	465700	
Trolley Support at ①	4250	101.125	429800		245.0	1041300	
" " " ⑪	3950	27.271	107700		245.0	967700	
Rdwy & Sdwk. Floor, Etc.	308100	56.0	17253600		116.8	35986100	
Concrete-Top Chord-Rear	6600	9.1	60500		122.75	843200	
Concrete at Gussets at 14	14900	0.21	3100		41.5	605900	
⊕ Total for East Leaf Complete	1620955		54896800	7026200		99618100	29125900
Item ⑭ with 2% increase*	1655375	29.532	(+47870600)		43.488	(+70492800)	
			55994700	7166700		101610500	29707800
Item ⑭ with 4% increase*	1685795	29.532	(+48828000)		43.488	(+71902700)	
		29.532	(+44765400)		43.488	(+73312400)	
Item ⑭ less Cent. Lock Machy & Cent. Lock Platform	1801265		53011000	7026200		99296300	29125300
Cent. Lock Platform-W Leaf	1800	99.6	179300		11.0	19800	
Cent. Lock Machy - W Leaf	3800	100.6	382300		15.0	57000	
⊕ Total for W Leaf Complete	1606865		53572600	7026200		99373100	29125300
Item ⑫ with 2% decrease*	1574790		52501100	6885700		97385600	28542800
			(+4561400)			(+6884200)	

* Ctrwt. Pockets to provide adjustment from 2% below to 4% above moment required to balance leaf.

Roosevelt Rd. Bascule

Dead Load Balancing

- *1928: Original Balancing*
- *1973: Rebalancing*
- *1994: Rebalancing*



C.G. AND MOMENT - FIGURES ARE PER LEAF
BALANCING CALCULATIONS

	ITEM	NO.	UNIT WEIGHT	WT. PER LIN. FT.	LENGTH WEIGHT	TOTAL WEIGHT PER LEAF (LBS)	"X" FEET	"X" MOMENT (FT.-LBS.)	"Y" INCHES	"Y" MOMENT (IN.-LBS.)
	MATERIALS REMOVED									
1	FB 0-0	1				24,480.00	101.13	2,475,540.00	64.80	1,582,406.00
2	FB 2-2	1				22,440.00	86.35	1,937,783.76	60.00	1,346,400.00
3	FB 4-4	1				22,730.00	71.58	1,627,081.72	56.70	1,288,791.00
4	FB 6-6	1				21,375.00	56.81	1,214,475.30	51.70	1,105,237.50
5	FB 8-8	1				18,780.00	42.04	789,548.76	41.90	786,882.00
6	FB 10-10	1				24,670.00	27.27	672,775.57	44.60	1,100,282.00
7	FB 12-12	1				36,730.00	14.88	546,108.75	41.00	1,587,930.00
8	BOTTOM STRUT	1				6,154.00	12.50	76,925.00	-142.00	-873,868.00
	LATERAL BRACING:									
9	0-0 TO 2-2	1				3,930.00	93.74	368,398.20	14.00	55,020.00
10	2-2 TO 4-4	1				3,755.00	78.97	296,524.84	9.50	35,672.50
11	4-4 TO 6-6	1				3,755.00	64.20	241,059.74	6.00	22,530.00
12	6-6 TO 8-8	1				4,620.00	49.43	228,362.74	-21.00	-97,020.00
13	8-8 TO 10-10	1				7,980.00	34.66	276,526.68	-52.50	-418,950.00
14	10-10 TO 12-12	1				5,940.00	19.89	118,116.90	-107.00	-635,580.00
15	WT 15x 49.5 ON FB's	5				14,040.00*	56.87	798,454.80*	115.80	1,625,832.00*
	ROADWAY STRINGERS:									
16	FB 0-0 TO 10-10 (W16X45)	18				104,370.00*	84.20	8,700,554.00*	119.90	12,513,963.00*
17	FB 10-10 TO REAR BREAK (W14X 61)	19				34,040.00*	18.44	627,697.60*	121.20	4,125,648.00*
18	ROWY. STRINGER SUPPORTS (@ REAR BREAK)	6				6,740.00*	19.85	133,991.2*	110.60	745,444.00*
19	ORIGINAL STRINGERS, FB10-10 TO REAR BREAK					28,500.00	19.77	523,905.00	98.00	2,597,000.00
20	ORIGINAL STRINGER STUBS @ FLOORBEAMS					6,500.00	64.20	417,300.00	27.52	178,886.50
21	5" CONC. FILLED ROADWAY DECK		56.0 PSF.			141,580.00*	62.37*	8,830,344.60*	130.50	18,480,348.00*
22	5" OPEN ROADWAY DECK		19.1 PSF.			86,870.00*	52.07	4,523,120.90*	130.60	11,345,222.00*
	WELDMENTS:									
23	REAR BREAK			146.66*	74.80*	11,120.00*	9.97	110,977.60*	129.40*	1,438,928.00*
24	CENTER BREAK			119.89*	75.40*	8,040.00*	101.32	815,932.80*	127.50	1,152,600.00*
25	CENTER BREAK WELDMENT SUPPORT	1				3,210.00*	101.17	324,755.70*	116.30	373,323.00*
26	ROADWAY MEDIAN			335.50	90.50	30,360.00	55.82	1,694,695.20	135.00	4,098,600.00
27	FENCE (INCL. SUPPORTS)			43.40	180.00*	7,820.00*	55.36	432,915.20*	143.00	1,118,260.00*
28	STEEL CURB (INCL.GROUT)			42.30	184.00*	7,780.00*	56.10	436,458.00*	145.80	1,134,324.00*
					TOTALS (EAST LEAF)	699,209.00*		37,364,748.63*		67,818,793.50*
					TOTALS (WEST LEAF)	699,209.00*		37,364,748.63*		67,818,793.50*

C.G. AND MOMENT - FIGURES ARE PER LEAF
BALANCING CALCULATIONS

	ITEM	NO.	UNIT WEIGHT	WT. PER LIN. FT.	LENGTH WEIGHT	TOTAL WEIGHT PER LEAF (LBS)	"X" FEET	"X" MOMENT (FT-LBS.)	"Y" INCHES	"Y" MOMENT (IN.-LBS.)
	MATERIALS ADDED									
1	FB 0-0	1				15,500.00	101.25	1,569,375.00	76.32	1,182,960.00
2	FB 2-2	1				15,580.00	86.35	1,345,333.00+	75.64	1,178,471.20
3	FB 4-4	1				15,780.00	71.58	1,129,532.40+	60.58	955,952.40
4	FB 6-6	1				16,230.00	56.81	922,026.30+	65.74	1,066,960.00+
5	FB 8-8	1				16,930.00	42.04+	711,737.20+	54.31	919,468.30
6	FB 10-10	1				19,780.00	27.27	539,673.30+	35.97	711,546.30
7	FB 12-12	1				20,960.00	14.88	311,884.80+	-13.00	-272,480.00
8	BOTTOM STRUT	1				10,012.00	12.50	125,150.00	-142.00	1,421,704.00
	LATERAL BRACING:									
9	0-0 TO 2-2	1				5,618.00	93.74	526,631.32	13.25	74,438.50
10	2-2 TO 4-4	1				5,618.60	78.97	443,703.84+	8.75	49,162.75
11	4-4 TO 6-6	1				5,621.60	64.20	360,906.72+	5.25	29,513.40
12	6-6 TO 8-8	1				5,627.76	49.43	278,180.18+	-21.75	-122,403.78
13	8-8 TO 10-10	1				5,646.19	34.66	195,677.61+	-53.25	-300,553.12
14	10-10 TO 12-12	1				5,702.56	19.89	113,423.92+	-107.75	-614,450.84
	ROADWAY STRINGERS									
15	*FB 0-0 TO 8-8	34				71,703.95+	72.50+	5,202,037.1+	121.42	8,713,666.05+
16	*FB 8-8 TO REAR BREAK	24				61,326.00+	25.75+	1,579,420.51+	121.42	7,446,202.92+
17	5" CONC. FILLED ROADWAY DECK		49.3 (PSF)			333,666.00	56.01	18,686,632.86	133.67	44,601,134.22
18	*ROADWAY DECK CLAMPS					59,659.50+	53.75+	3,206,612.88+	131.31+	7,833,784.91+
	CENTER BREAK WELDMENTS:									
19	THRU ROADWAY (EAST)					11,041.00	101.48	1,120,219.88	133.67	1,475,850.47
20	THRU ROADWAY (WEST)					11,051.40	101.48	1,121,275.04	133.67+	1,477,240.64
21	THRU SIDEWALK (EAST)					183.50	101.48	18,288.71	143.00	23,360.50
22	THRU SIDEWALK (WEST)					457.15	101.48	46,382.44	143.00	65,372.45
23	REAR BREAK WELDMENT					13,528.00	9.98	135,009.44	129.60	1,750,523.20
24	ROADWAY MEDIAN					30,544.00	55.82	1,704,969.08	135.00	4,123,440.00
25	BRIDGE RAILINGS	1				23,063.00	55.13	1,271,463.19+	160.79	3,706,224.10
	INSPECTION PLATFORMS:									
26	EAST AND WEST LONGITUDINAL					5,425.00	47.75	259,043.75	-1.00	-5,425.00
27	WEST TRANSVERSE AT CENTER LINE					4,788.00	89.00	426,132.00	37.25	178,353.00
28	WEST UNDER CANTILEVER BRACKETS					1,932.00	93.00	179,676.00	37.25	71,967.00
29	SCUPPERS, EAST LEAF	12	120 (LBS)+			1,440.00	53.41	76,910.40	133.67	192,484.80
30	SCUPPERS, WEST LEAF	8	120 (LBS)+			960.00	49.90	47,904.00	133.67	128,323.20
31	*LATERAL BRACING (TOP CHORD BETWEEN 10-10 AND 12-12)	1				9,804.90+	21.15+	207,373.64+	108.47+	1,063,537.50+
32	*ROADWAY CURB	2			37.50	92.25 FT.+	6,918.75+	56.10+	388,141.88+	139.92+	968,071.50+
	TOTALS (EAST LEAF)						799,678.32+		43,036,480.71+		88,423,698.25+
	TOTALS (WEST LEAF)						799,502.37+		43,038,303.22+		88,402,918.77+
	TOTAL WEIGHT IN LBS. DIFFERENTIAL, (EAST LEAF) (WEST LEAF)						100,469.32+ 100,293.37+				
	UNBALANCED X MOMENT, (EAST LEAF) (WEST LEAF) IN FT-LBS.								5,671,712.08+ 5,673,554.59+		
	UNBALANCED Y MOMENT, (EAST LEAF) (WEST LEAF) IN IN-LBS.										20,604,904.75+ 20,584,125.27+
	COUNTERWEIGHT ADDED (EAST SIDE)	695+	450 PCF			312,750+	18.13+	5,670,157.50+	65.88+	20,603,970.00+
	COUNTERWEIGHT ADDED (WEST SIDE)	695+	450 PCF			312,750+	18.14+	5,673,285.00+	65.81+	20,582,077.50+

Roosevelt Rd. Bascule

Truss Line Input

- *Section Properties calculated in Excel, accounting for section loss as required*
  - *Ag, An, Material, Ix, Iy, Sx, Sy*
  - *Section Loss (if applicable)*

MEMBER: 1-3 — DESIGNATES USER INPUT

4Ls - 6"x4"x3/8" = 19.44
2 Webs - 22"x3/8" = 19.25
39.69 1-3

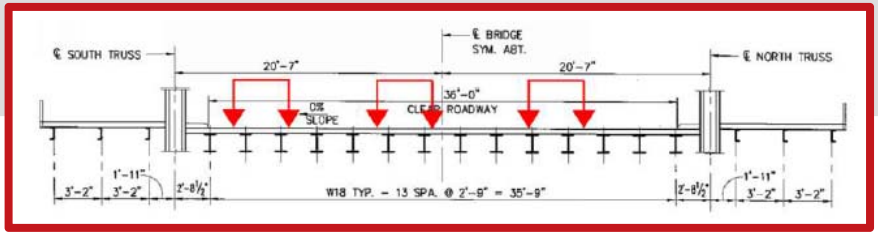
No.	Section	X_i (in)	Y_i (in)	A_g (in²)	I_x (in⁴)	I_y (in⁴)	d_x (in)	d_y (in)	A_gX_i (in³)	A_gY_i (in³)	$I_x+A_gd_y^2$ (in⁴)	$I_y+A_gd_x^2$ (in⁴)
1	L6x4x3/8	3.06	1.94	3.61	13.47	4.90	12.25	9.31	11.05	7.00	326.37	546.85
2	L6x4x3/8	3.06	20.56	3.61	13.47	4.90	12.25	-9.31	11.05	74.22	326.37	546.85
3	L6x4x3/8	27.57	1.94	3.61	13.47	4.90	-12.25	9.31	99.51	7.00	326.37	546.85
4	L6x4x3/8	27.57	20.56	3.61	13.47	4.90	-12.25	-9.31	99.51	74.22	326.37	546.85
5	22x7/16	4.22	11.25	9.63	388.21	0.15	11.09	0.00	40.61	108.28	388.21	1184.71
6	22x7/16	26.41	11.25	9.63	388.21	0.15	-11.09	0.00	254.16	108.28	388.21	1184.71
7							0.00	0.00	0.00	0.00	0.00	0.00
8							0.00	0.00	0.00	0.00	0.00	0.00
9							0.00	0.00	0.00	0.00	0.00	0.00
10							0.00	0.00	0.00	0.00	0.00	0.00
	Σ =			33.69					515.88	379.01	2081.90	4556.82

GROSS PROPERTIES

$\bar{X}$ = 15.31 in — r_x = 7.86 in
$\bar{Y}$ = 11.25 in — r_y = 11.63 in
A_g = 33.69 in² — Weight = 0.11 k/ft
I_x = 2081.90 in⁴ — $S_{x,top}$ = 185.06 in³
I_y = 4556.82 in⁴ — $S_{x,bot}$ = 185.06 in³
Depth = 22.50 in — S_y = 297.59 in³

No. Holes	Width (in)	Thickness (in)	Area (in²)
8	1.13	0.44	3.94
8	1.13	0.38	3.38
			0.00
			0.00
		A_{holes} =	7.31 in²

- *Live Load Distribution Factors*




```
Truss "North Truss"

Unit
Force kips
Length ft
Properties in

DefaultSysUnitType US

DefaultStructSteel "1905 to 1936"

DefaultEndConnection
Riveted

//DefaultMemConnection command not currently in use

MaterialType
steel1927 = "1905 to 1936"
Gr36Steel = "Grade 36"
Gr50Steel = "Grade 50"

//Member Cross Sections
//NonDetailed = <section name>
//gross area, net area, material type, Ix, Iy, Sx, Sy

MemberCrossSection //top chord
NonDetailed = section31
33.69 26.38 steel1927 2081.90 4556.82 185.06 297.59

NonDetailed = section53
33.69 26.38 steel1927 2081.90 4556.82 185.06 297.59
```

```
PanelPoint
U19w Upper 0 16.375
U15w Upper 14.917 21.083
U13w Upper 39.417 21.083
U11w Upper 54.188 21.083
U9w Upper 68.958 21.083
U7w Upper 83.729 21.083
U5w Upper 98.5 21.083
```

```
//Top chord
U19U15w U19w U15w section1915
U15U13w U15w U13w section1513
U13U11w U13w U11w section1311
U11U9w U11w U9w section119
U9U7w U9w U7w section97
U7U5w U7w U5w section75
U5U3w U5w U3w section53
```

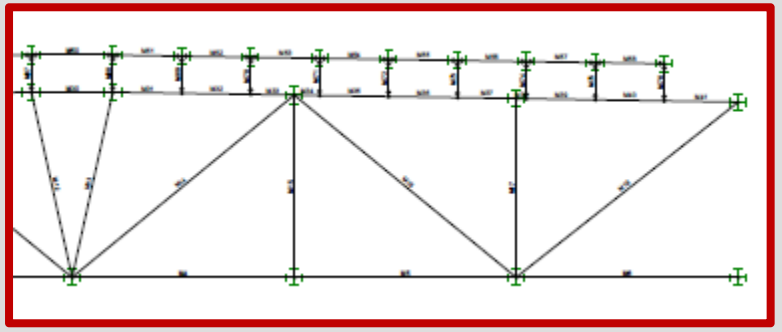
```
PanelPointLoad
L16w DC 0.0 -402
M17w DC 0.0 -402
L18w DC 0.0 -295
U19w DC 0.0 -295
L16e DC 0.0 -402
M17e DC 0.0 -402
L18e DC 0.0 -295
U19e DC 0.0 -295

LLDistribution
OneLane 0.996 0.5
MultiLane 2.528 2.25
```

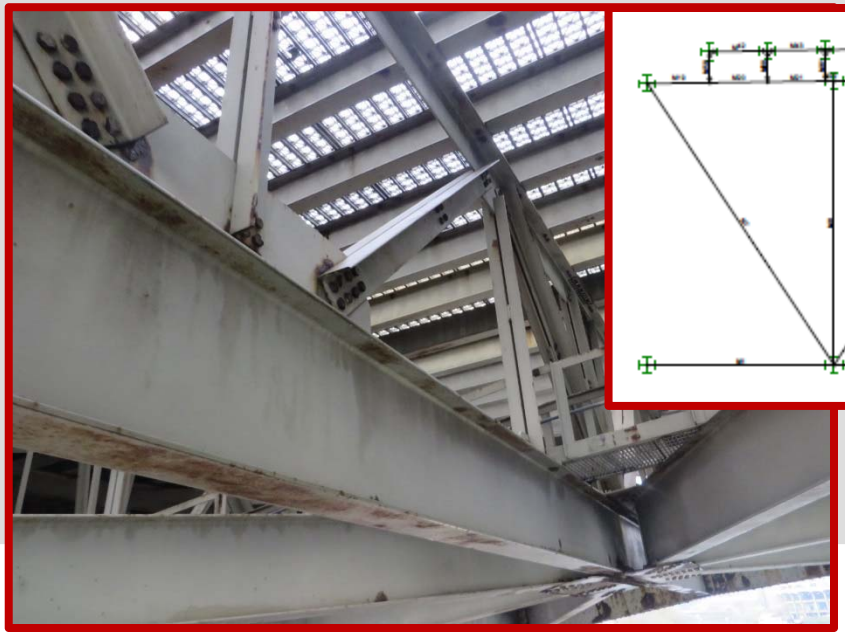
- *Half Deck Line Locations*
- *Panel Point Loads*

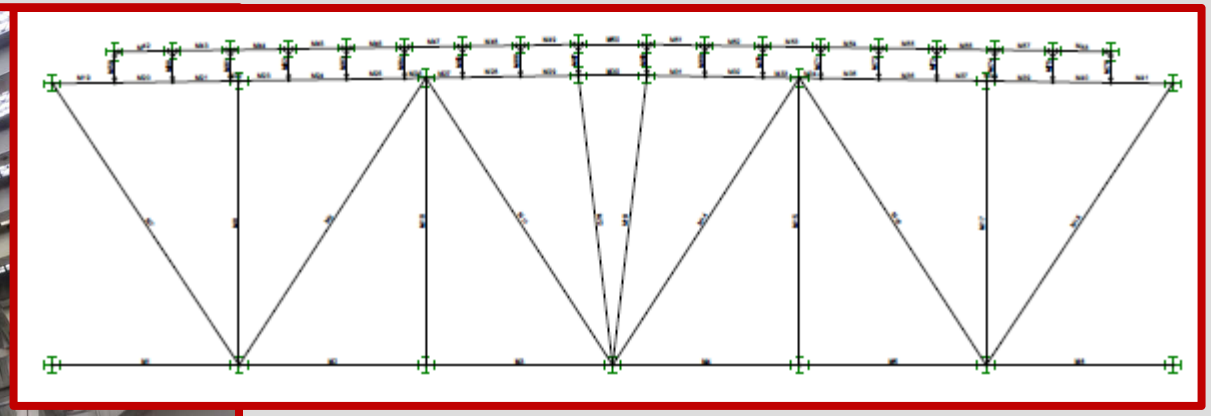
Roosevelt Rd. Bascule
Trussed Floorbeams

- *Moveable Span elements mostly rated in BrR*
- *Supplemental analysis independent of BrR for trussed floorbeams*
  - *Floorbeam 2-2*
  - *Floorbeam 10-10*



Floorbeam 2-2





Floorbeam 10-10

Roosevelt Rd. Bascule
Carrying Elements

- *Fixed Span elements mostly rated in BrR*
- *Supplemental analysis required outside of BrR for some carrying elements*
  - *Cross Girder (Trunnion Floorbeam)*
  - *Stub Columns*

Cermak Rd. Bascule

Scherzer Rolling Lift Bascule Bridge

Cermak Rd. Bascule Bridge Lift

Cermak Rd. Bascule
Original Construction

Construction/Repair History

- *1906: Original Construction*
- *1995: Majority of structure replaced as part of rehabilitation*
  - *Truss top and bottom chords, verticals and diagonals*
  - *Segmental and Track Girders*
  - *Anchor Girder and Columns*
  - *Bumping Girder*
  - *Floorbeams and Stringers*
- *1996: Deck replacement and rebalancing*
- *1,064 existing plan sheets*

Geometry

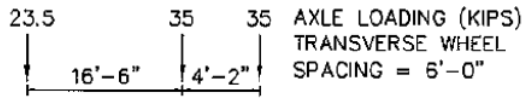
- *216'-0" CL to CL 'First Positions of Roll'*
- *29'-4" & 25'-10 ½" End Spans (each side)*

- *Design Load (Original)*

L.L. For Trusses: 3000# per lin ft of bridge occupying 22' in width of roadway and a load of 90# per sq ft for remainder of roadway and sidewalk.
For floor system and hangers: A concentrated load of 24 tons on two axles 10ft. ctrs. on any portion of the roadway, or on each car track for a space of 12' in width for each single track and 22' for double track and in addition a load of 100# per sq ft of remaining surface of roadway and sidewalk.

- *Design Load (1994 CDOT specifications)*

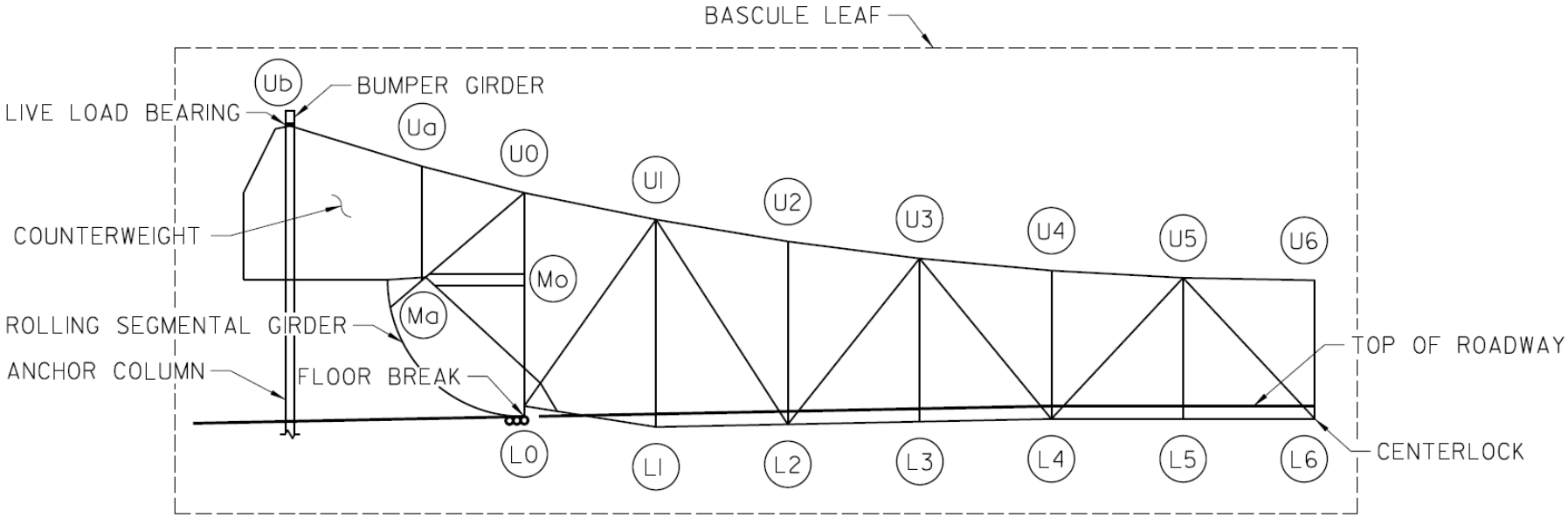
LIVE LOADS (LL)
ROADWAY – HS20–44 AND EQUIVALENT UNIFORM LANE LOADING = 1000LBS/LIN.FT.
– TRUCK LOADING AS SPECIFIED IN DESIGN STANDARDS FOR CHICAGO BASCULE BRIDGES AND SHOWN BELOW



CONCRETE READY MIX TRUCK

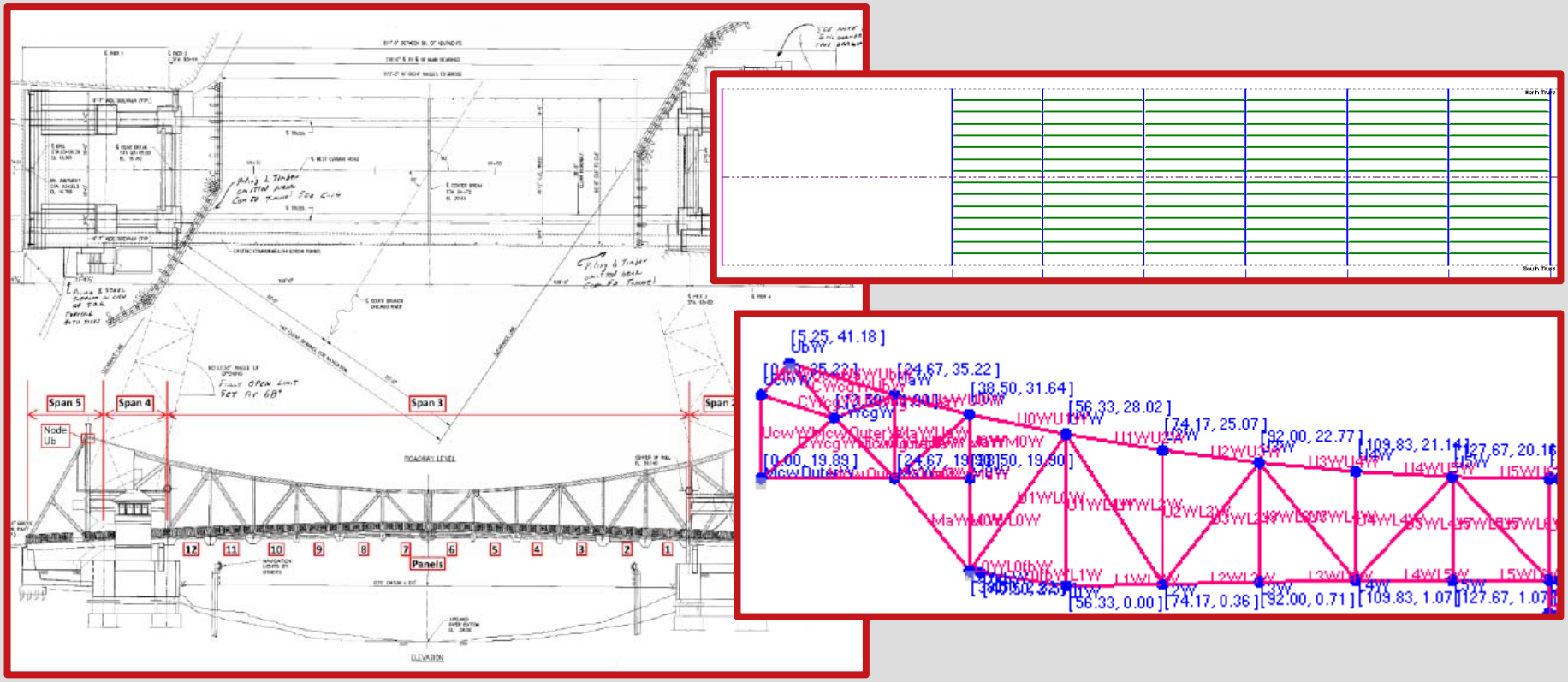
Cermak Rd. Bascule

Bascule Structure Components and Supports



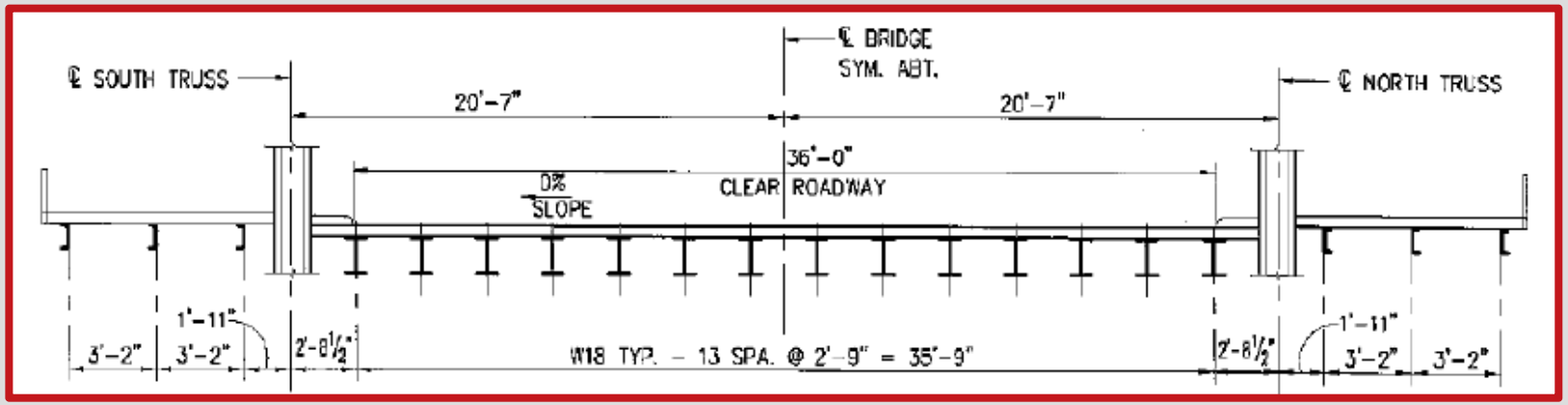
Cermak Rd. Bascule

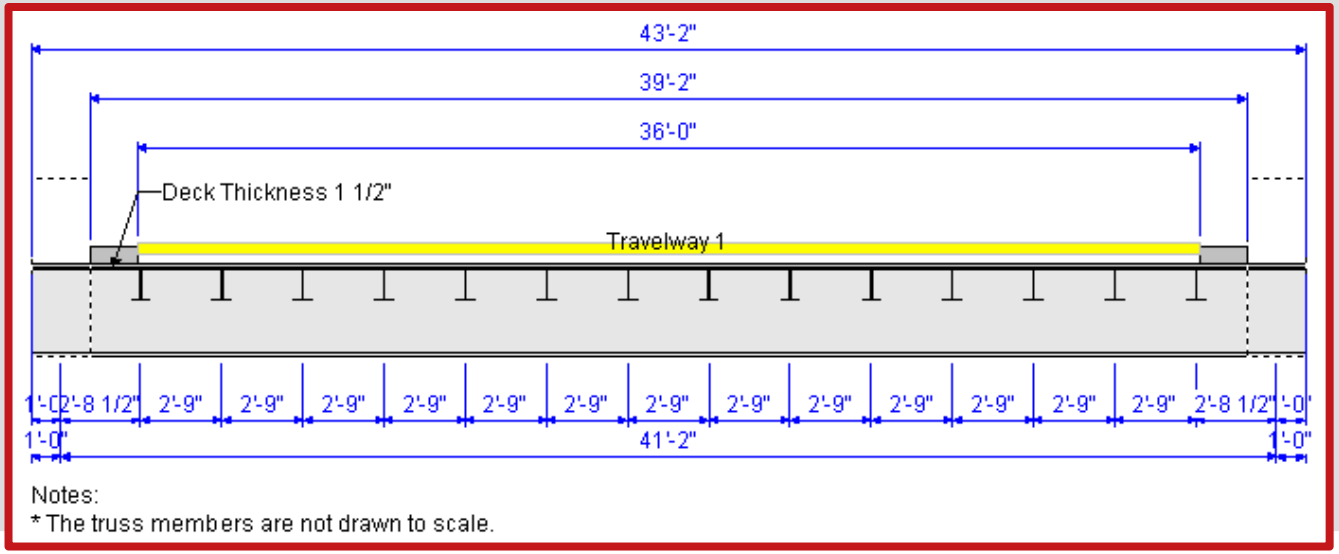
Plan and Elevation



Cermak Rd. Bascule

Cross Section





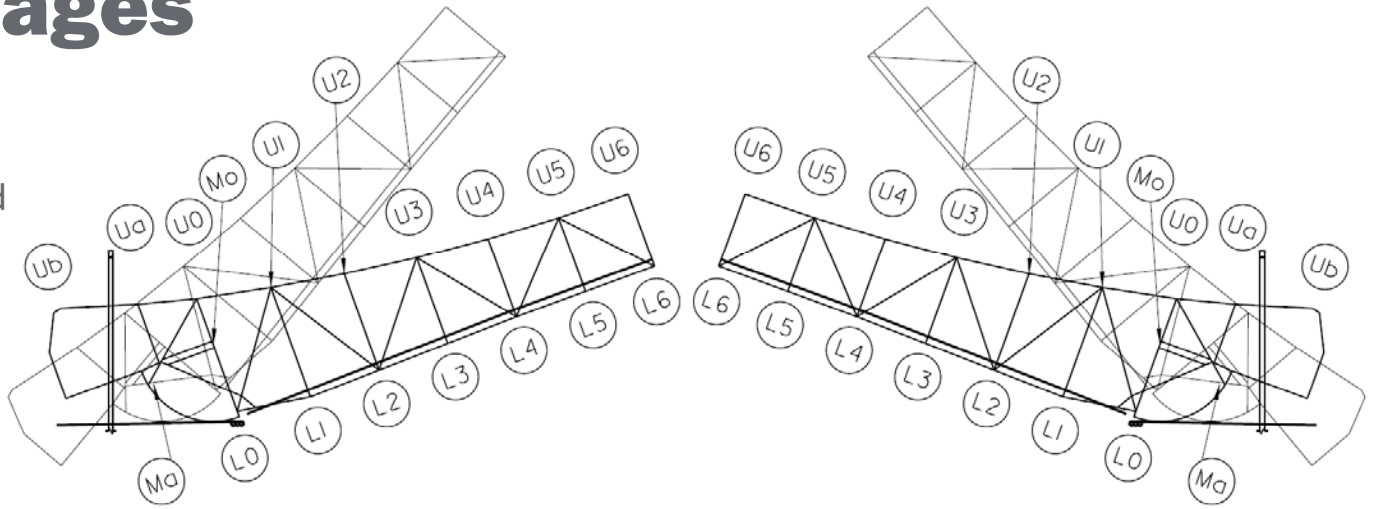
Notes:
* The truss members are not drawn to scale.

Cermak Rd. Bascule

Load Stages

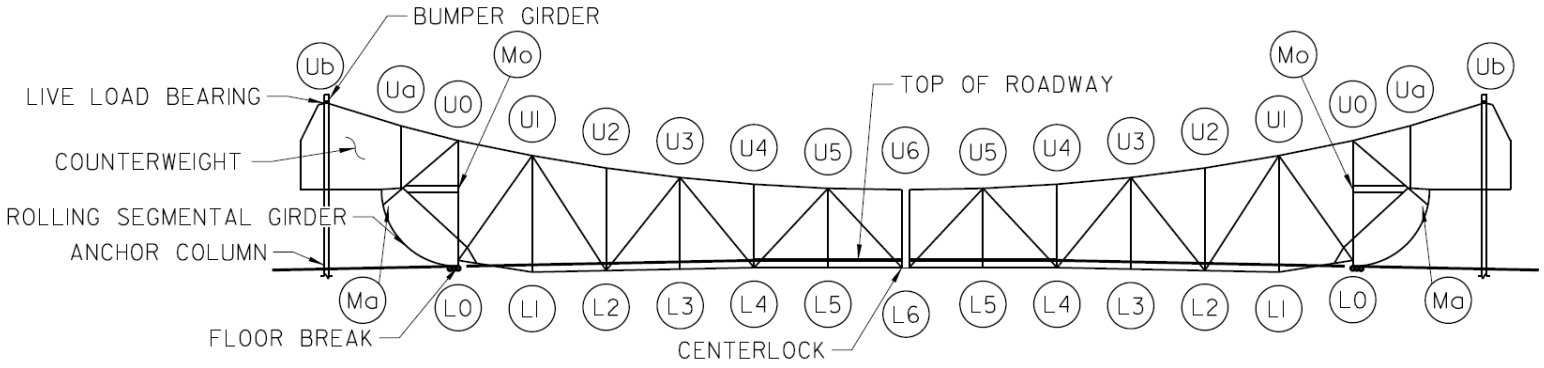
BRIDGE OPEN

Dead Load + Wind Load



BRIDGE CLOSED

Dead Load + Live Load (Including Pedestrian Load)

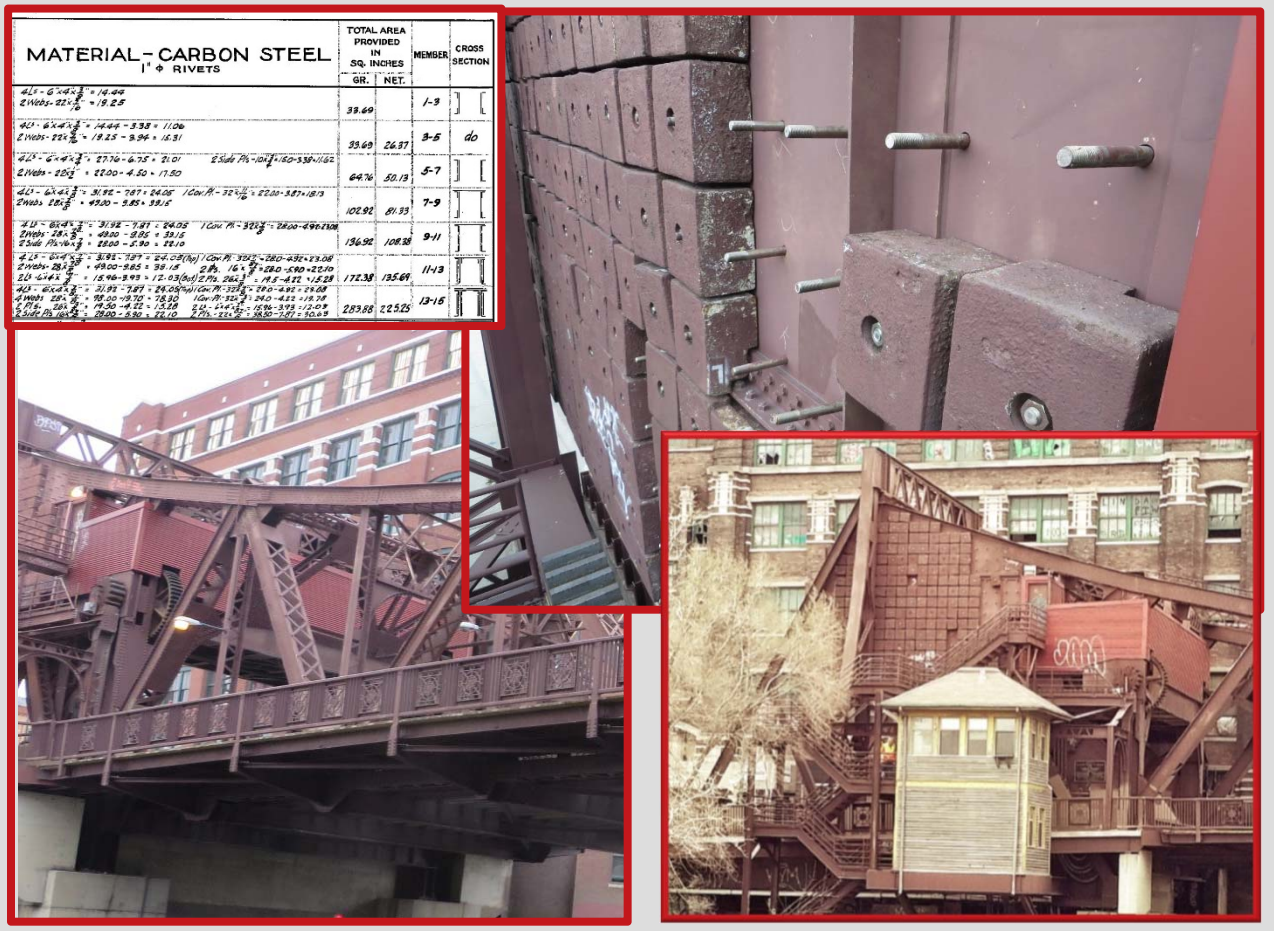


Cermak Rd. Bascule

Dead Load Forces

Dead Loads

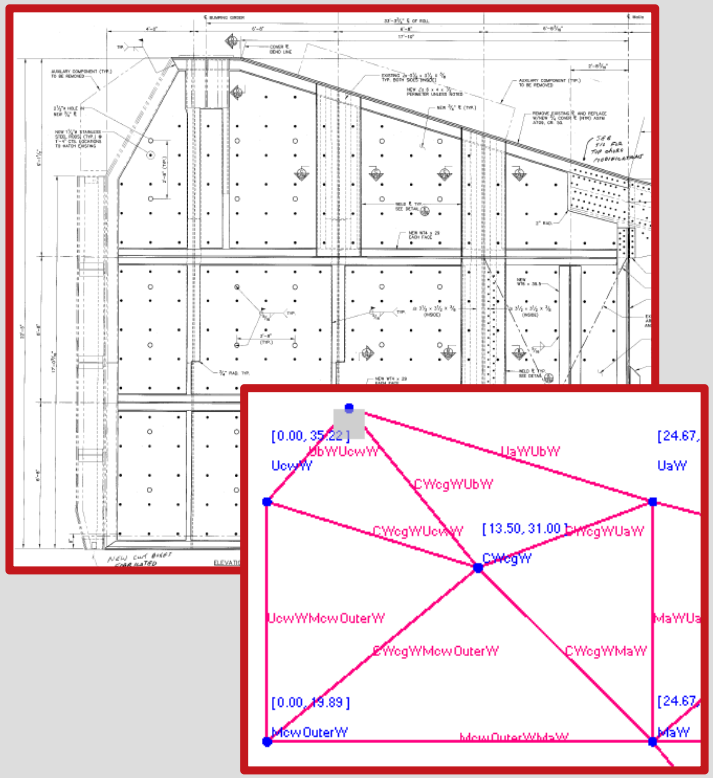
- Truss member self weight
- Floorbeams
- Stringers
- Cantilever sidewalks
- Lateral Bracing
- Deck (Steel Grating)
- Counterweight
- Mechanical Housing



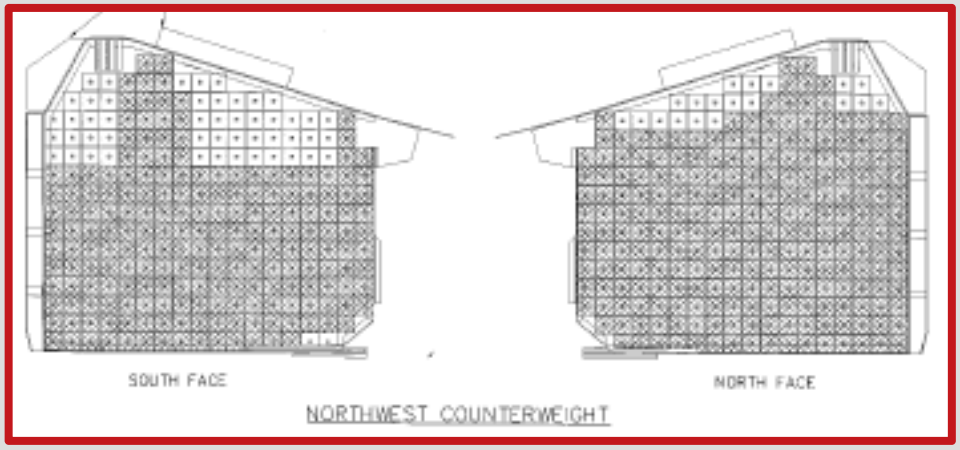
Cermak Rd. Bascule

Dead Load Balancing

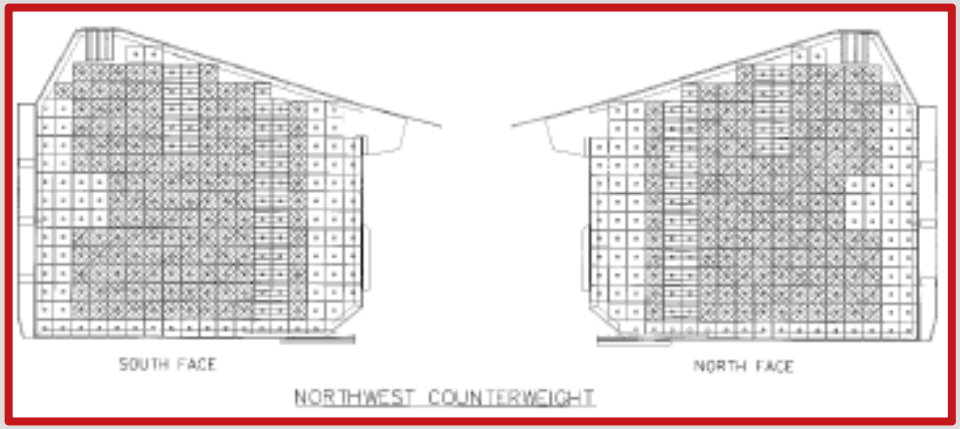
- *1906: Original Balancing*
- *1996: Rebalancing*



Original Blocks

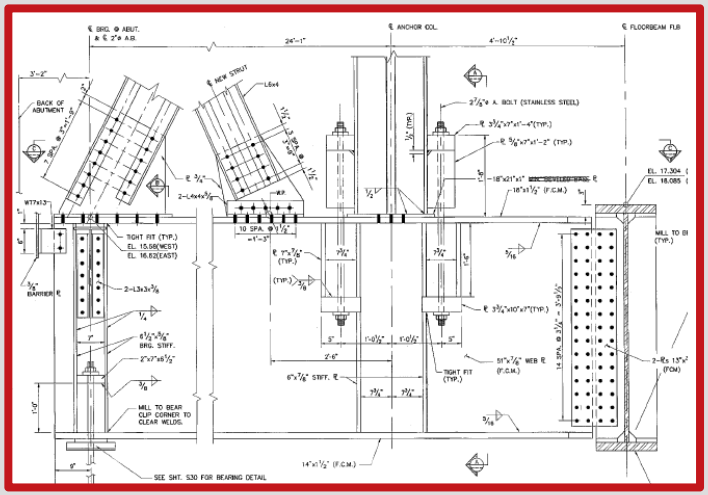


1996 Rebalancing



Cermak Rd. Bascule
Carrying Elements

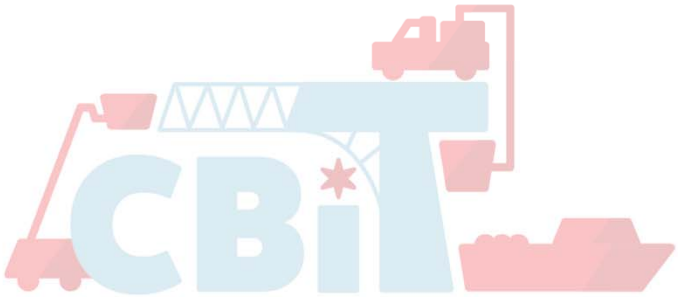
- *Fixed Span roadway elements mostly rated in BrR*
- *Supplemental analysis required outside of BrR for some carrying elements*
  - *Anchor Girder and Column*
  - *Bumping Girder*



Using BrR To Evaluate Bascule Bridges

2018 RADBUG MEETING – BOISE, IDAHO

AUGUST 7-8, 2018



A Joint Venture Teaming of Alfred Benesch & Company and Collins Engineers, Inc.

Thank You!

Questions?

CDOT CHICAGO DEPARTMENT OF TRANSPORTATION

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COLLINS ENGINEERS INC.

IDAHO TRANSPORTATION DEPARTMENT

BrR AASHTOWare Bridge Design & Rating AASHTO