

# Kansas DOT BRDR Workflow from Design to Load Rating

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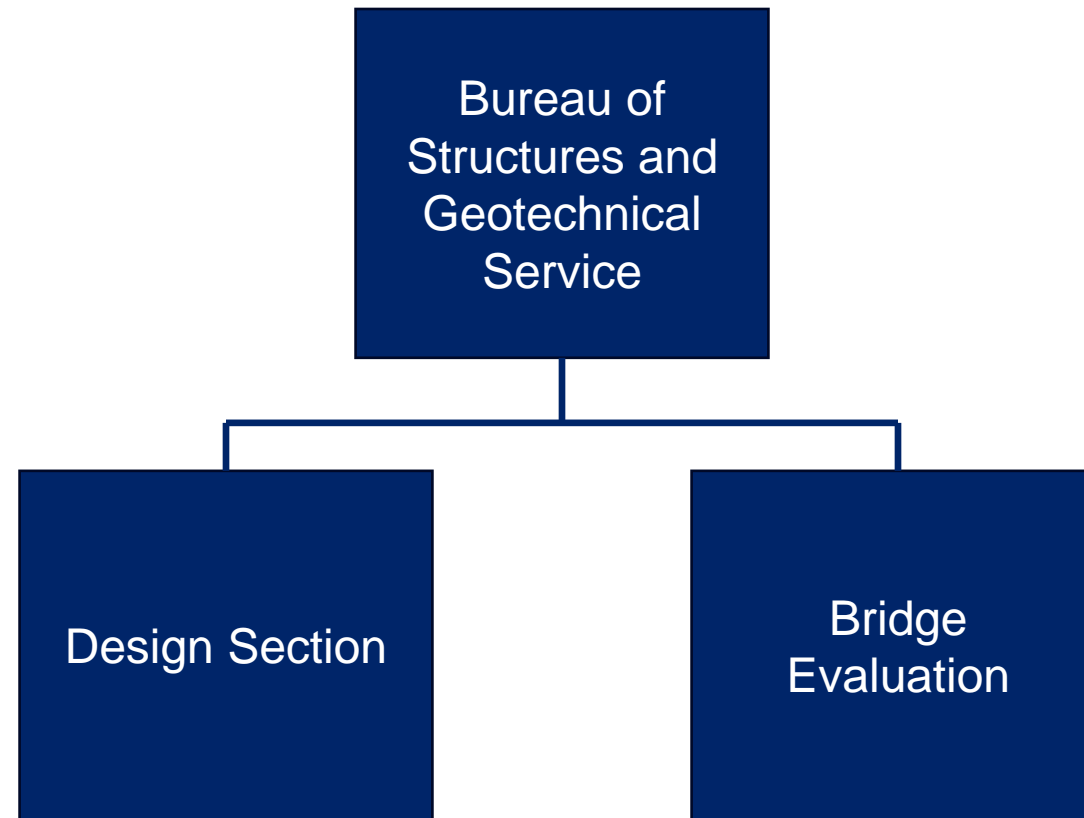
# Introduction

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# KDOT Org Chart

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# Overview

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- BRDR Models
- BRDR Model QAQC
- BRDR Model Life

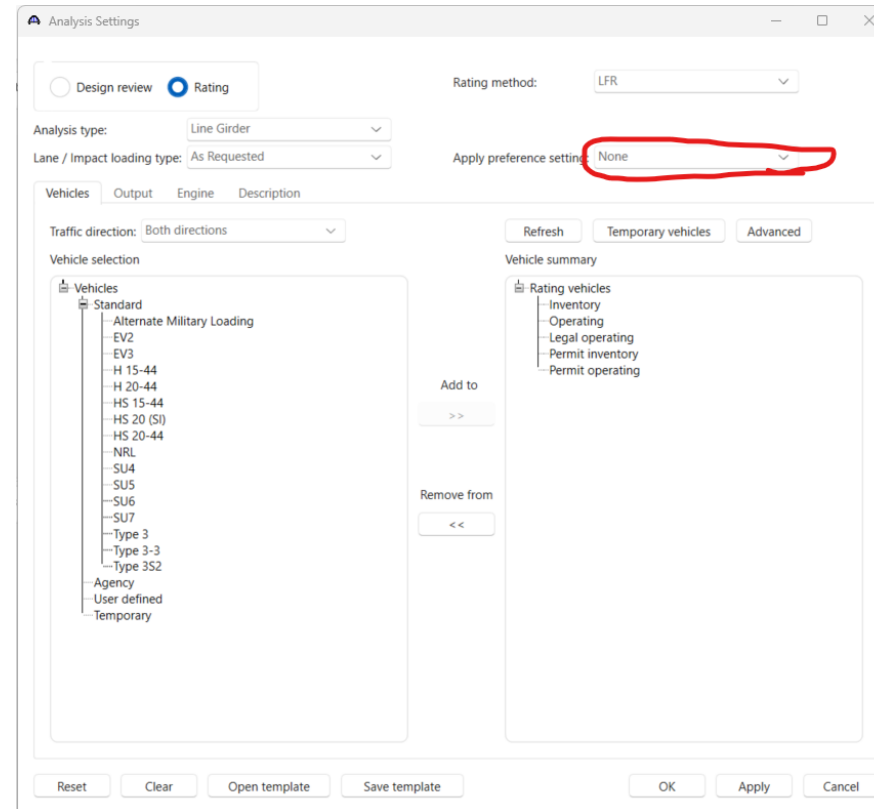
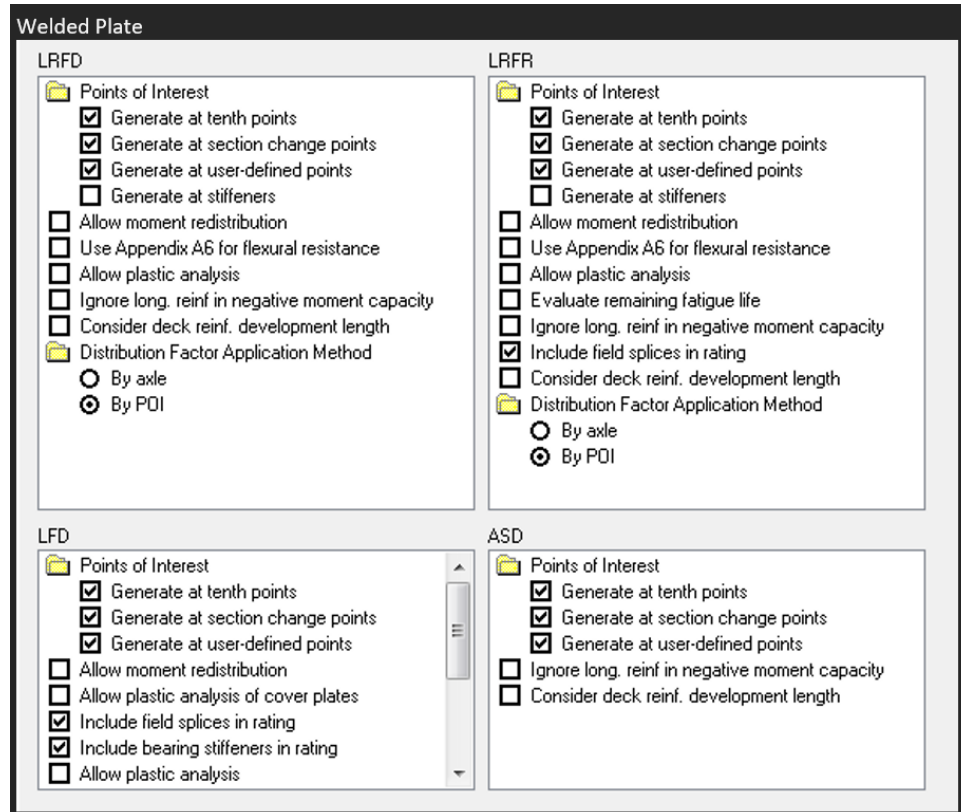
# BRDR Models

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- Design Model
  - Model a designer uses to determine all bridge loads, member sizes, and specification checks. Used to produce plan sheets.
  - Type, Size, and Location
- Checker Model
  - Model based on plan sheets. Modeled as close to 1-for-1 as possible to represent the physical bridge. Used to layout foundation of Load Rating Model.
  - Guided independent check

# BRDR Models – Design Model

- Control Options Templates



# BRDR Models – Design Model

- Prestress Beam Cheat Sheet

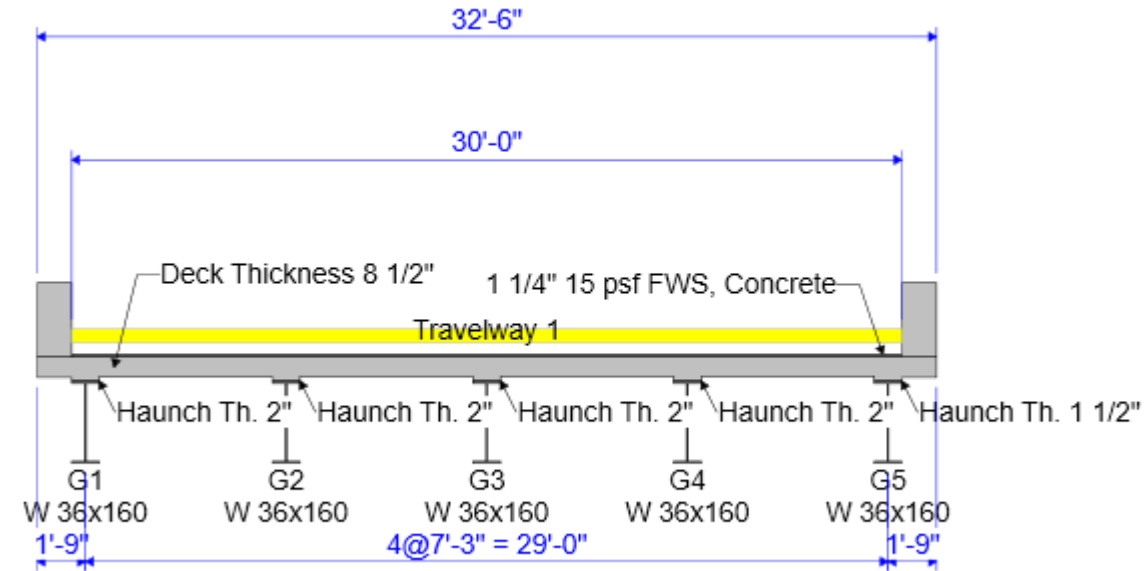
LFD and LRFD Prestressed Beams			AASHTO Code	Requirement	
				AASHTO	KDOT
<b>Strand Type &amp; Properties</b>					
Seven Wire Low Relaxation Strands (Dia)	1/2"			X	X
Tensile Strength ( $F_{pu}$ ) (ksi)	270 ksi		5.4.4.1-1	X	
Yield Strength ( $F_{py}$ ) (ksi)	0.90 $f_{pu} = 243$ ksi		5.4.4.1-1	X	
Modulus of Elasticity (ksi)	28,500 ksi		5.4.4.2	X	
Strand Area (in <sup>2</sup> )	0.153 in <sup>2</sup>				X
Mass/Wt per unit length (lbs/ft)	0.521 lbs/ft				
Transfer Length (in)	60 $d_s = 30"$		5.9.4.3.1	X	
<b>Strand Type &amp; Properties</b>					
Seven Wire Low Relaxation Strands (Dia) K4 or K6 Only	0.6"			X	X
Mass/Wt per unit length (lbs/ft)	0.732 lbs/ft				
Strand Area (in <sup>2</sup> )	0.215 in <sup>2</sup>				X
Transfer Length (in)	60 $d_s = 36"$		5.9.4.3.1	X	
<b>LFD Rating Stress Limits</b>					
	(ksi)	(psi)			
Initial Allowable Compression	$0.60 * f_{ci}$		9.15.1	X	
Initial Allowable Tension	$0.0948 * \text{SQRT}(f_{ci}) < 0.20$ ksi	$3 * \text{SQRT}(f_{ci}) < 200$ psi	9.15.1	X	X
Final Allowable Compression	$0.60 * f_c$		9.15.2	X	
Final Allowable Tension (Note Below)	Zero- Inv or $0.19 * \text{SQRT}(f_c)$ - Oper	Zero- Inv or $6 * \text{SQRT}(f_c)$ - Oper	9.15.2	X	X
Final Allowable DL Compression	$0.40 * f_c$		9.15.2	X	
Final Allowable Slab Compression	$0.60 * f_c$		9.15.2	X	
Final Allowable Compression (LL+1/2(Pe+DL))	$0.40 * f_c$		9.15.2	X	
If rating an LRFD designed bridge verify the Inventory rating factor for the HS design truck is 1.10 or greater =====> Visit the Factors Tab of the Member Alt. for each member and set the ASD Factor for P/S Concrete Tension for Inventory to ZERO <=====					
The Operating rating factor should be greater than 1.0 for the HET load rating truck using a single lane (S/7) and full impact.					
<b>LRFD Design Stress Limits</b>					
	(ksi)	(psi)			
Initial Allowable Compression	$0.65 * f_{ci}$		5.9.2.3.1a	X	
Initial Allowable Tension (With As proportioned as per Fig. C5.9.2.3.1b-1)	$0.24 * \text{SQRT}(f_{ci})$	$7.5 * \text{SQRT}(f_{ci})$	5.9.2.3.1b	X	X
Final Allowable Compression	$0.60 * f_c$		5.9.2.3.2a	X	
Final Allowable Tension	$0.0948 * \text{SQRT}(f_c)$	$3 * \text{SQRT}(f_c)$	5.9.2.3.2b	X	X
Final Allowable DL Compression	$0.45 * f_c$		5.9.2.3.2a	X	
Final Allowable Compression (PS+DL+LL)	$0.60 * f_c$		5.9.2.3.2a	X	
<b>Slab Interface</b>					
Interface Type	Intentionally Roughened				X
Interface Width	Top Flange Width		5.7.4.3	X	
Cohesion (ksi)	0.28 ksi		5.7.4.4	X	X
Friction Factor	1		5.7.4.4	X	X
K1	0.3		5.7.4.4	X	X
K2	1.8 ksi		5.7.4.4	X	X

# BRDR Models – Design Model

- Preliminary Models
- Final Design Models

Deck concrete   Reinforcement   Shear connectors

Support number	Start distance (ft)	Length (ft)	End distance (ft)	Connector ID	Number of spaces	Number per row	Transverse spacing (in)
> 1	0.00	252.00	252.00	Composite			



Deck concrete   Reinforcement   Shear connectors

Material	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Std bar count	LRFD bar count	Bar size	Distance (in)	Row	Bar spacing (in)
> Grade 60	1	0.00	252.00	252.00	10.00	10.00	4	2.0000	Bottom of Slab	6.0000
Grade 60	1	0.00	252.00	252.00	10.00	10.00	6	5.0000	Bottom of Slab	6.0000



# BRDR Models – Design Model

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- Initial Load Rating
  - Designer Load Rating Vehicles
    - HL-93
    - HET
    - HS-20



Live Load	Live Load Type	Rating Method	Inventory Load Rating (Ton)	Operating Load Rating (Ton)	Legal Load Rating (Ton)	Permit Load Rating (Ton)	Inventory Rating Factor	Operating Rating Factor
HL-93 (US)	Truck + Lane	LRFR	41.76	54.13			1.160	1.504
HL-93 (US)	0%(Truck Pair + Lane)	LRFR	48.48	62.84			1.347	1.746
HL-93 (US)	Tandem + Lane	LRFR	49.62	64.32			1.378	1.787

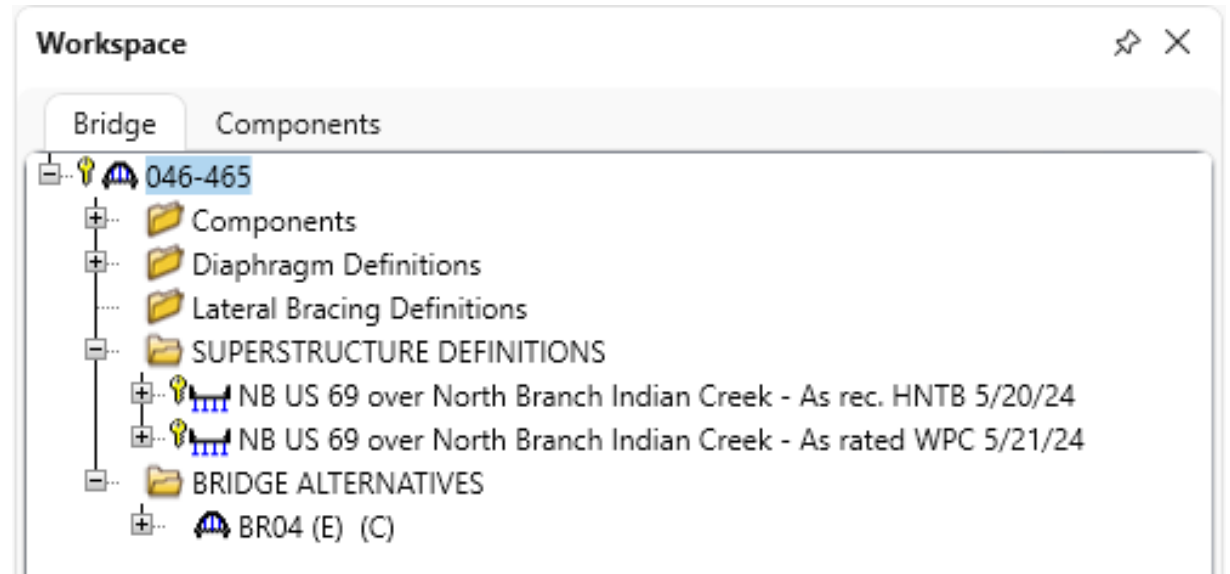
# BRDR Model QAQC – Checker Model

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- Checker develops completely independent model
- Checker develops the model based on the plans
- Checker builds the model as close to a 1-for-1 representation of the bridge as possible
- Checker and Designer compare models.
  - 2 Models – “same” outcome

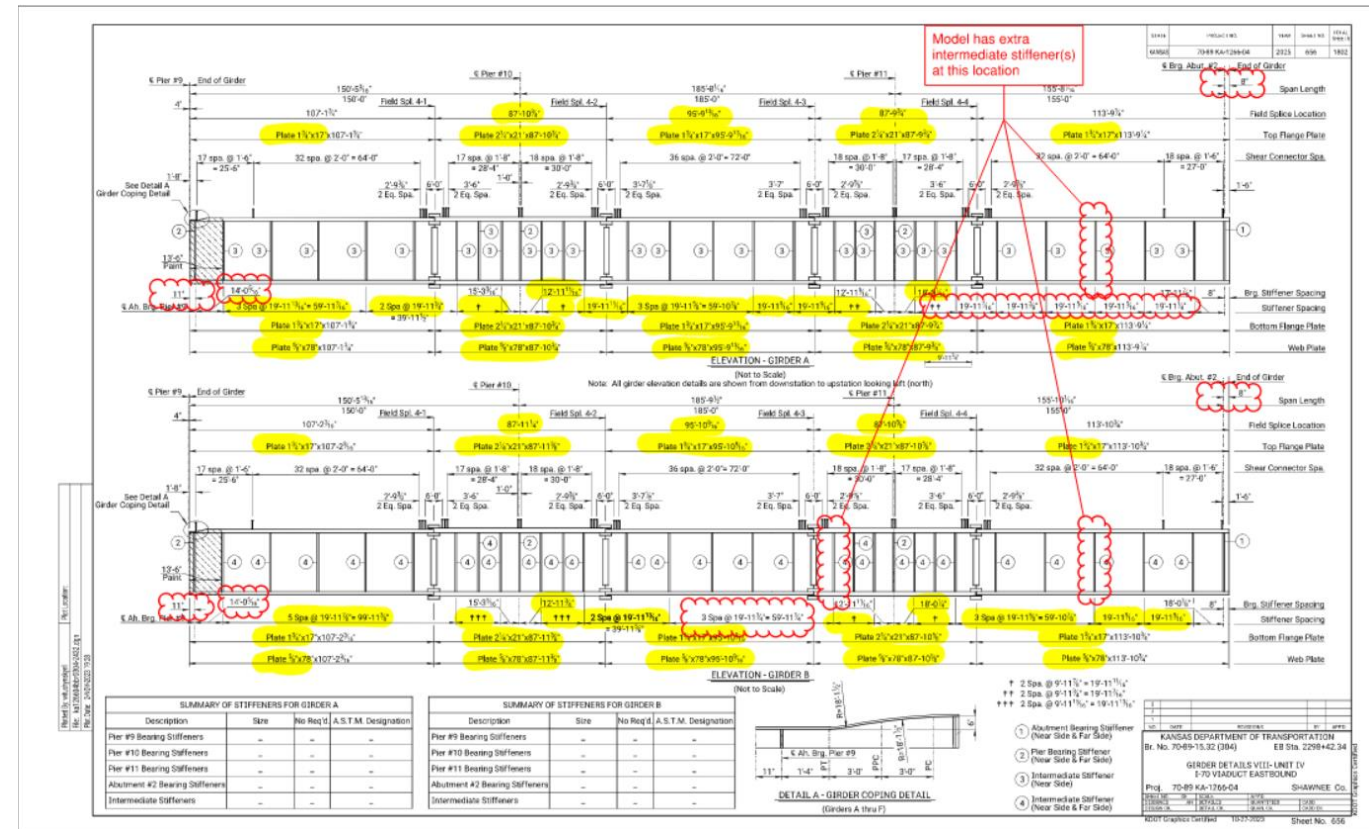
# BRDR Model QAQC – Load Rating Model

- Receive model and final plans from checker
- Duplicate superstructure definition of checker model
- Verify all control options and analysis settings



# BRDR Model QAQC – Load Rating Model

- Compare model with plans and identify any inconsistencies
- Mark up any inconsistencies on a copy of plans using Bluebeam
- Return marked up plans to checker and designer for them to address comments and resubmit model and/or plans
- Once a final model is submitted, it is load rated and results saved to database



# BRDR Model Life

- Model is maintained and updated throughout structure life
- Model is retired and stored once structure is replaced

BID	Bridge ID	Bridge Name	District	County	Facility	Location	Route	Feature Intersected	Mile/Km Post (mi)	Owner	Maintainer	Admin Area	Length (ft)	Year Built
5828	055-017	RFB-K25 HWY over TWIN BUTTE CREEK DRAIN	District 3	55 Logan	K25 HWY	7.28 MI N WICHITA COLN	25	TWIN BUTTE CREEK DRAIN	139.16	0 State HWY	0 State HWY	Area 4	37,500	1961
3500	055-018	RCB-2-10 X 3, K25 HWY over SMOKY HILL RIVER DRAIN	District 3	55 Logan	K25 HWY	12.72 MI N WICHITA COLN	25	SMOKY HILL RIVER DRAIN	144.60	0 State HWY	0 State HWY	Area 4	20,500	1961
3501	055-019	RCB-3-8 X 8, K25 HWY over SMOKY HILL RIVER DRAIN	District 3	55 Logan	K25 HWY	8.98 M W SMKY hll RV BR	25	SMOKY HILL RIVER DRAIN	147.18	0 State HWY	0 State HWY	Area 4	25,300	1959
3502	055-020	RCB-5-8 X 6, K25 HWY over SMOKY HILL RIVER DRAIN	District 3	55 Logan	K25 HWY	7.50 M W SMKY HLL RV BR	25	SMOKY HILL RIVER DRAIN	148.66	0 State HWY	0 State HWY	Area 4	42,700	1959
3503	055-021	RCB-4-10 X 9, K25 HWY over SMOKY HILL RIVER DRAIN	District 3	55 Logan	K25 HWY	4.41 M W SMKY HLL RV BR	25	SMOKY HILL RIVER DRAIN	151.75	0 State HWY	0 State HWY	Area 4	43,000	1959
3504	055-022	RCB-3-9 X 7, K25 HWY over SMOKY HILL RIVER DRAIN	District 3	55 Logan	K25 HWY	2.54 M W SMKY HLL RV BR	25	SMOKY HILL RIVER DRAIN	153.62	0 State HWY	0 State HWY	Area 4	28,100	1954
2402	055-024	RCSH US-83 over Plum Creek	District 3	55 Logan	US83 HWY	14.00 MI S US40	83	PLUM CREEK		0 State HWY	0 State HWY	Area 4	102,490	1982
2403	055-025	RCSH US-83 over Mid Br. Hackberry Creek	District 3	55 Logan	US83 HWY	8.10 MI S US40	83	MID BR HACKBERRY CR		0 State HWY	0 State HWY	Area 4	122,510	1982
362	055-026	PBMC, US-83 HWY over Smoky Hill River	District 3	55 Logan	US-83 HWY	6.76 MI N SCOTT COLN	83	SMOKY HILL RIVER	128.92	0 State HWY	0 State HWY	Area 4	738,083	1995
5829	055-027	RFB-US-83 HWY over SMOKY HILL RIVER DRAIN Skew 30	District 3	55 Logan	US-83 HWY	9.97 MI N SCOTT COLN	83	SMOKY HILL RIVER DRAIN	132.13	0 State HWY	0 State HWY	Area 4	36,090	1996
5830	055-028	RFB-US-83 HIWAY over HACKBERRY CR S BR	District 3	55 Logan	US-83 HIWAY	0.41 MI N OF RS272	83	HACKBERRY CR S BR	140.69	0 State HWY	0 State HWY	Area 4	26,310	1998
5831	055-029	RFB-US-83 HIWAY over HACKBERRY CR N BR	District 3	55 Logan	US-83 HIWAY	2.03 MI N OF RS1672	83	HACKBERRY CR N BR	148.31	0 State HWY	0 State HWY	Area 4	26,310	1998
8225	055-030	RCSH K 25 over Smoky Hill River	District 3	55 Logan	K 28	12.44 MI S-W JCT US-40	25	Smoky Hill River	156.16	0 State HWY	0 State HWY	Area 4	324,000	
8775	055-031	RFB US-40 over North Branch Hackberry Creek	District 3	55 Logan	US-40	Logan	40	North Branch Hackberry		0 State HWY	0 State HWY	Area 4	98,000	2023
3505	056-003	RCB-2-8 X 7, I-35 HY ov COTTONWOOD RIV DRAIN Sk 30 R	District 1	56 Lyon	I-35 HWY SB	0.19 MI E KTA TOLL BOOTH	35	COTTONWOOD RIV DRAIN	126.85	0 State HWY	0 State HWY	Area 2	22,000	1967
2409	056-009	RCSH Prairie St. over I-35/ URB 1107	District 1	56 Lyon	URB1107, PRAIRIES	1.27 MI E GRAPHIC ARTS RD	1107	I-35 HIGHWAY		0 State HWY	0 State HWY	Area 2	218,700	1965
5832	056-010	RFB-I-35HWY SB over LINCOLN ST	District 1	56 Lyon	I-35HWY SB	1.78 MI E GRAPHIC ARTS RD	35	LINCOLN ST	128.98	0 State HWY	0 State HWY	Area 2	26,000	1965
2410	056-011	RCSH K-99 over I-35	District 1	56 Lyon	K99 HWY	JCT K99/I35	99	I-35 HIGHWAY		0 State HWY	0 State HWY	Area 2	212,990	1966
2411	056-012	RCSH I-35 over Burlingame Rd./Rs 0414	District 1	56 Lyon	I-35 HWY NL	1.31 MI EAST OF K-99	35	RS0414, BURLINGAME RD		0 State HWY	0 State HWY	Area 1	170,510	1966
2412	056-013	RCSH I-35 over Burlingame Rd./RS 0414	District 1	56 Lyon	I-35 HWY SL	1.32 MI EAST OF K-99	35	RS0414, BURLINGAME RD		0 State HWY	0 State HWY	Area 2	170,510	1966
2413	056-014	RCSH I-35 over ATSF Railway	District 1	56 Lyon	I-35 HWY NL	1.65 MI SE K99, NL	35	ATSF RAILWAY		0 State HWY	0 State HWY	Area 2	234,280	1966
2414	056-015	RCSH I-35 over ATSF Railway	District 1	56 Lyon	I-35 HWY SL	1.64 MI EAST OF K-99	35	ATSF RAILWAY		0 State HWY	0 State HWY	Area 2	234,280	1966
5833	056-016	SWCC I-35 over RS 2066, US-50 Skew 59 Cu 2 Rt.	District 1	56 Lyon	I-35	2.57 MI E. of K-99	35	RS 2066, US-50	132.89	0 State HWY	0 State HWY	Area 2	239,800	1967
5834	056-023	RFB-US50 HWY over LUDY CREEK Skew 3 deg Lt	District 1	56 Lyon	US50 HWY	3.24 MI E CHASE CO LINE	50	LUDY CREEK	340.73	0 State HWY	0 State HWY	Area 2	29,000	1947
5835	056-025	RFB-US50 HWY over COTTONWOOD RIV DRAIN	District 1	56 Lyon	US50 HWY	0.44 MI WEST OF I-35 JCT	50	COTTONWOOD RIV DRAIN	343.57	0 State HWY	0 State HWY	Area 2	39,700	1947
5836	056-026	SBMC-1-35 HWY SB over US-50 HWY Skew 28 deg Lt	District 1	56 Lyon	1-35 HWY SB	JCT US 50/I35	35	US-50 HWY	126.69	1 Other State	1 Other State	Area 2	189,990	1956
5837	056-029	RFB US-56 over Allen Creek	District 1	56 Lyon	US-56		56	Allen Creek		0 State HWY	0 State HWY	Area 2	31,000	1942
3506	056-032	RCB-3-8 X 7, US56 HWY over 142 MILE CREEK DRAINAGE	District 1	56 Lyon	US56 HWY	0.67 MI E K99	56	142 MILE CREEK DRAINAGE	374.57	0 State HWY	0 State HWY	Area 2	25,400	1931
3507	056-034	RCB-2-10 X 10, US56 HWY over ELM CREEK DRAINAGE	District 1	56 Lyon	US56 HWY	0.77 MI E KTA	56	ELM CREEK DRAINAGE	378.41	0 State HWY	0 State HWY	Area 2	21,000	1931
3508	056-036	RCB-2-10 X 8, US56 HWY over SALT CREEK DRAINAGE	District 1	56 Lyon	US56 HWY	.33 MI WEST OF OASGE CL	56	SALT CREEK DRAINAGE	381.64	0 State HWY	0 State HWY	Area 2	20,800	1931
5838	056-048	SMCC Skew 30 Left over I-335 KTA	District 1	56 Lyon	K-99	4.61 MI N. of I-35 Jct.	99	I-335 (KTA)	111.60	0 State HWY	0 State HWY	Area 2	257,000	1956
5839	056-049	SMCC Skew 21 31' Rt. over I-335 (KTA)	District 1	56 Lyon	K-99	7.09 MI N of I-35 Jct.	99	I-335 (KTA)	114.09	0 State HWY	0 State HWY	Area 2	179,500	1956
4441	056-051	SBMC Sk48 Cu00 K-99 over KTA	District 1	56 Lyon	K-99 Hwy	N Jct K-99 & KTA	99	I-335 (KTA)	32.55	0 State HWY	0 State HWY	Area 2	257,000	1956
5840	056-054	SBMS Skew 0, MoPac RailRoad over K-99	District 1	56 Lyon	MoPac RailRoad	0.75 Mi. S. of US-56 Jct.	99	K-99	126.07	5 Railroad	5 Railroad	Area 2	101,900	1938
1234	056-057	WWCC K130 over Neosho River	District 1	56 Lyon	K-130	12.23 km S of I-35	130	Neosho River	0.23	0 State HWY	0 State HWY	Area 2	830,000	2009

# BRDR Model Life

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- Load rating data used in routing permit loads (KTRIPS)
- Non-standard gauge analysis (NSG)





# BRDR Model Life

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- Modeling deterioration or damage to structure
  - Concrete spalls
  - Steel section loss
  - Bridge strikes

# Summary

- Design Models
  - Preliminary Model
  - Design Model
  - Checker Model
  - Design QAQC
- Load Rating Model
  - Load Rating QAQC
  - Model Life
    - Permit Routing
    - Deterioration Modeling



Questions?

