Load Rating of Slab Bridges with Rigorous Analysis

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Background and Significance of the Work

- NDOT Approximately 500 slab bridges
- Built as early as 1930's
- f_y = 33 ksi, f'_c about 3000 psi
- Failing Standard permit vehicles and P3
- BrR™ has several options for bridge alternatives (use-cases)

Summary Statement

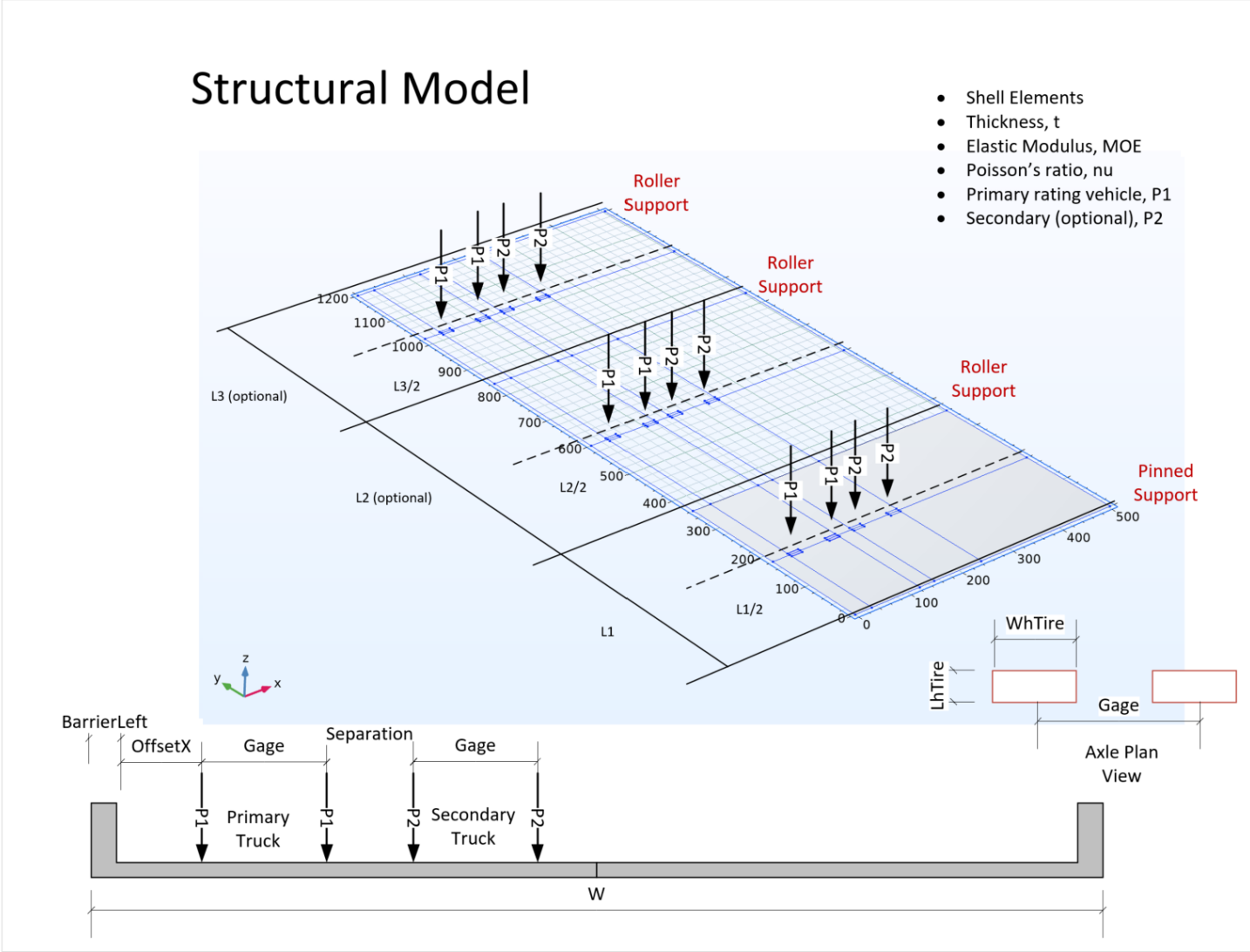
Create an APPlet for rigorous analysis of slab bridges using finite element analysis (FEA) to determine the live load distribution factors (LLFD or widths) for load rating, allowing improved computations.

APPlet: A focused, parametrically defined problem that is solved with refined FEA methods.

Approach

- Develop an “APPlet” to rigorously analyze slab bridges
- Rigorous effective widths (distribution factors)
- $E_{rigorous}$ into AASHTOWare BrR™ and Superload™ for the bridges*
- Load rates for target vehicle
- User controls parametric inputs
- Benefit: better load rating practice
- Saves $

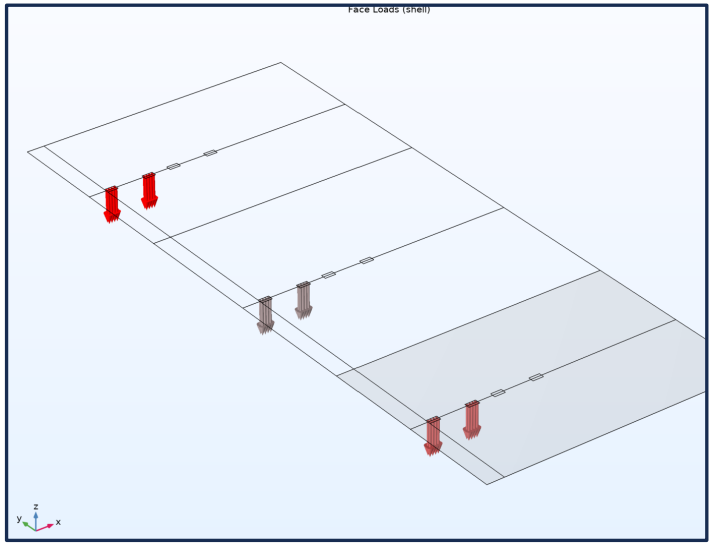
Parametric definition



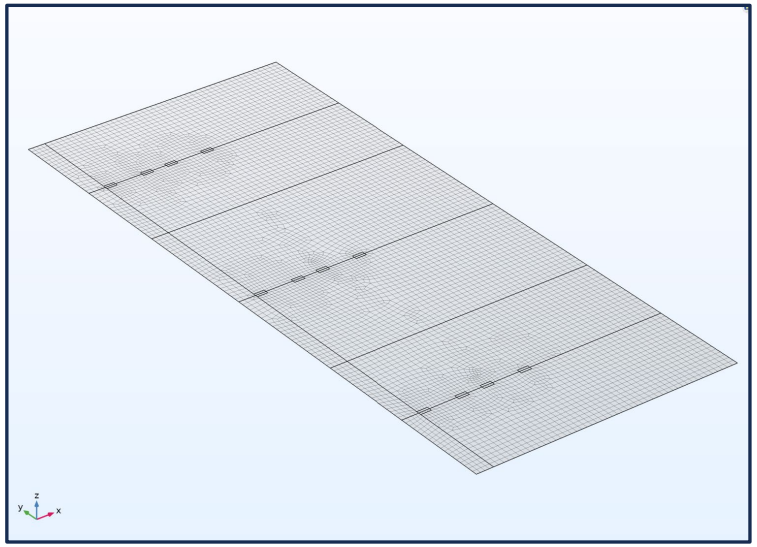
Assumptions

- Linear elastic isotropic material properties (uncracked concrete)
- Prismatic deck
- Pinned or roller supports
- Shell elements located at the mid-surface of the deck
- Max of three spans of individual lengths
- Axle loads will be modeled with patch loads defined by weight, gage, and truck spacing.
- One line of axles will be positioned at a user-defined transverse location (this was automated from one location to three during the project)
- Optionally include barrier stiffness
- Distribution width computed at midspan (M^+) and supports (M^-)

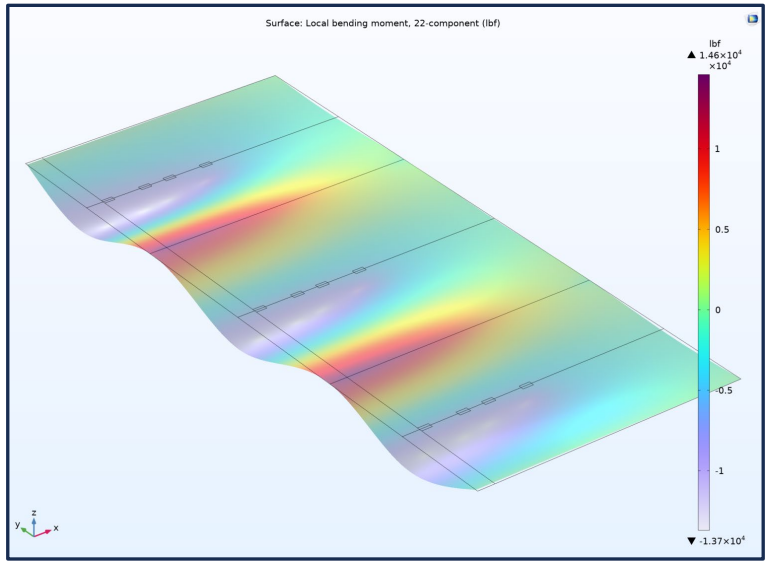
Typical Output Graphics



Typical one-lane load
For two-lane, the other patch are loaded



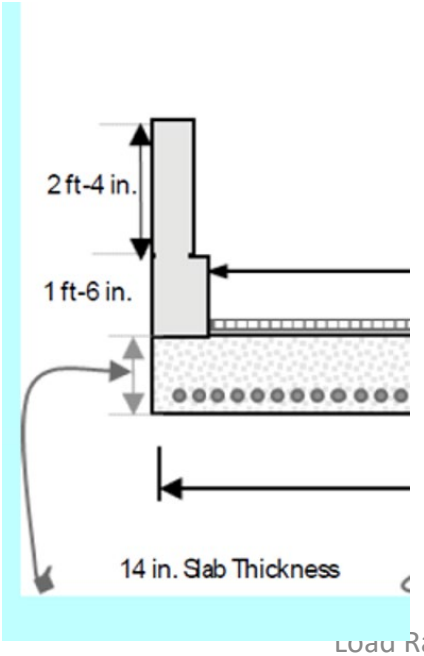
Meshing is automated
Mesh study was conducted



Typical bending moment (one and two lanes)
Automatically compute distribution width for each span M+ and support M- as desired

MBE: Example A7

- One span slab bridge
- Length = 21.5 ft
- Width = 43 ft
- Thickness = 14 in
- Analysis section = 12 in



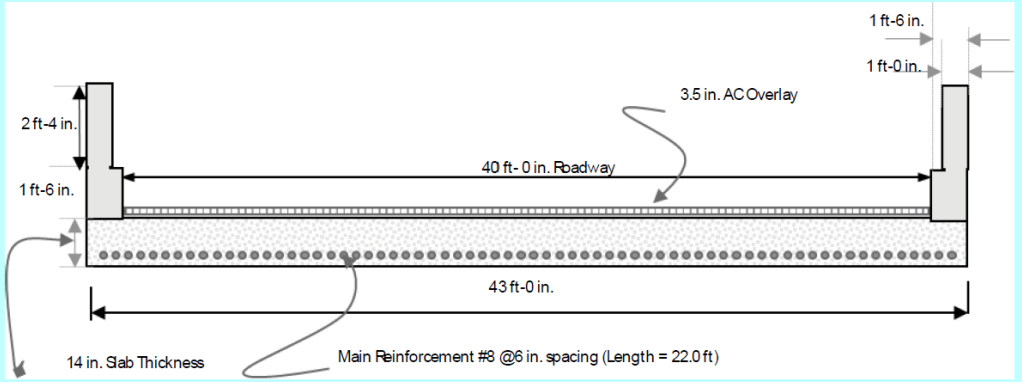
A7—REINFORCED CONCRETE SLAB BRIDGE DESIGN AND LEGAL LOAD CHECK

Editor's Note: Since all of Example A7 was revised by the AASHTO Committee on Bridges and Structures at their 2019 Annual Meeting, the new text in this Section has not been underlined.

Note: Evaluation of this bridge was performed in accordance to the 3rd Edition of the MBE and 8th edition of the AASHTO LRFD Bridge Design Specifications (LRFD Design.)

A7.1—Bridge Data

Span Length:	21.50 ft (simple span, distance from bearing to bearing) 0.50 ft End of the slab beyond the CL support)
Year Built:	1963
Material:	Deck Concrete f'_c = 3.00 ksi
	Reinforced Steel f_y = 40.00 ksi
Structure Condition:	No deterioration. NBI Item 59 = 7 Member is in good condition
Riding Surface:	Not field verified and documented
ADTT (one direction):	Unknown
Skew:	0°
Bridge category:	Interstate Bridge
Overlay Thickness:	3.5 in. (field verified)



Cross Section

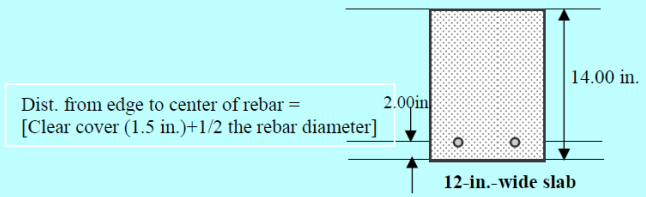


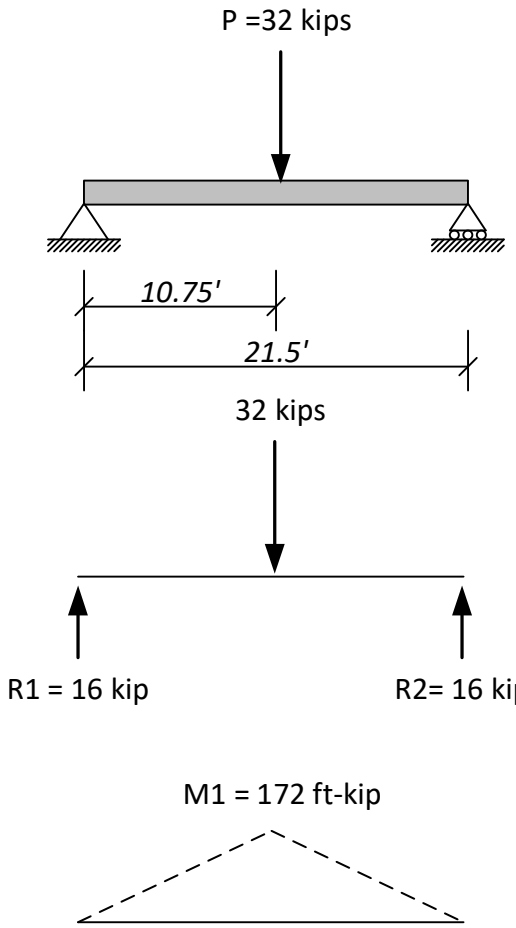
Figure A7.1-1—Reinforced Concrete Slab Bridge

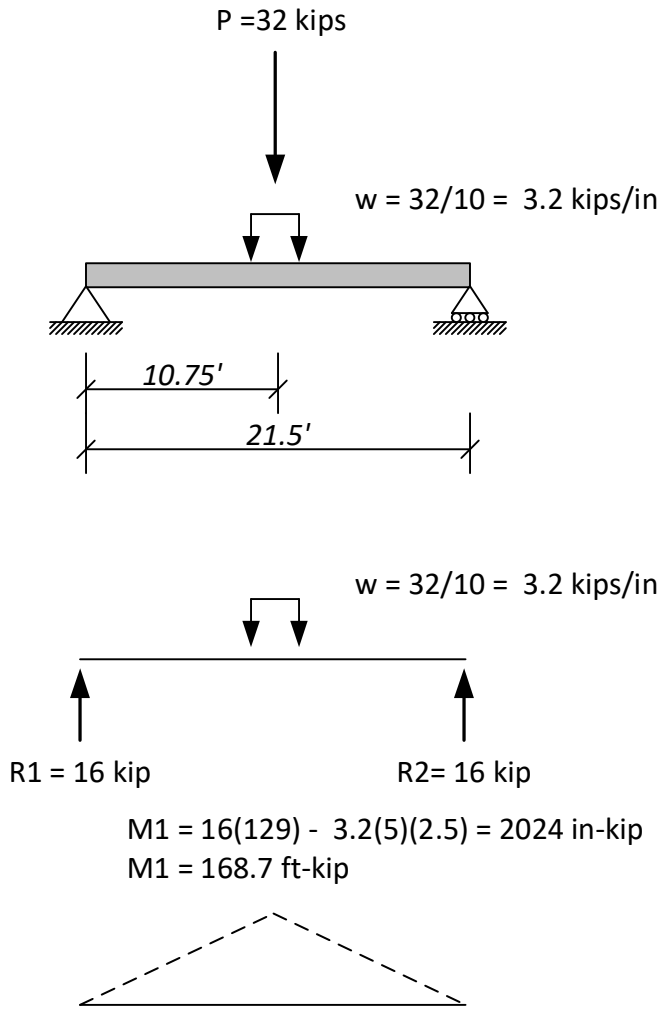
Example: one span at 21.5 ft with a concentrated load of 32 kips applied at midspan. The statics-based reactions and bending moment diagram for the bridge as a beamline are shown.

The equilibrium moment is 172 ft-kip assuming a concentrated load. Considering the patch load over 10 in, the moment is 168.7 ft-kip.

Ratio = 1.02

Summary: FEA and hand with concentrated load should be within plus or minus 2%



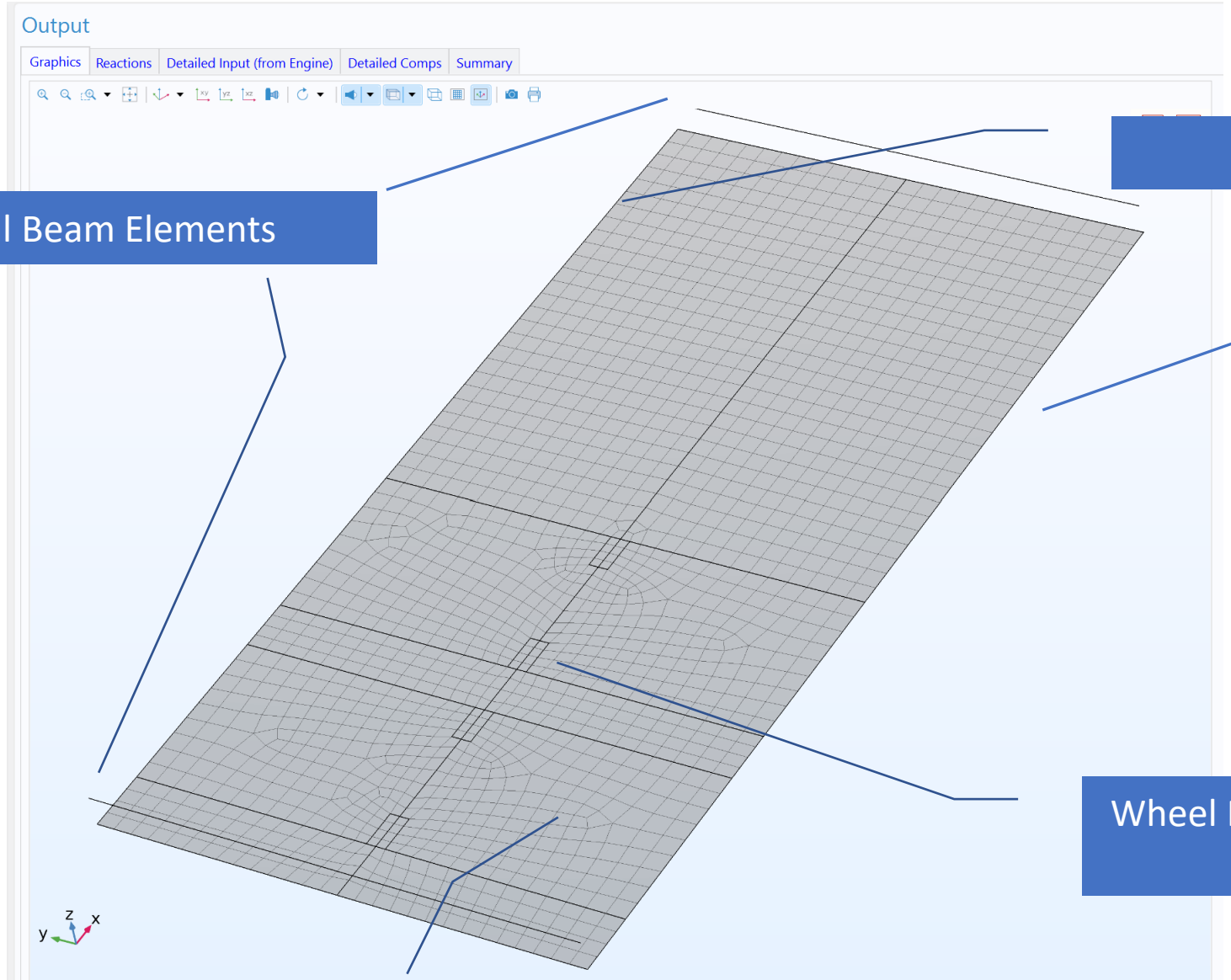


SlabDF Demonstration

- Use if available in the meeting
- Skip screenshot slides

Geometry and Loads (base case)

Parameter	Value
Span 1 Length	21.5 ft (one-span bridge)
Width	43 ft
Thickness	14 in
Wheel load	16 kips
Edge truck position from edge of travelway	24 in
Truck gage	72 in
Truck separation	48 in
Tire width	20 in
Tire length	10 in
Left barrier width	18 in
Right barrier width	18 in
Barrier stiffness	Ignore
Skew	0 degrees



Optional Beam Elements

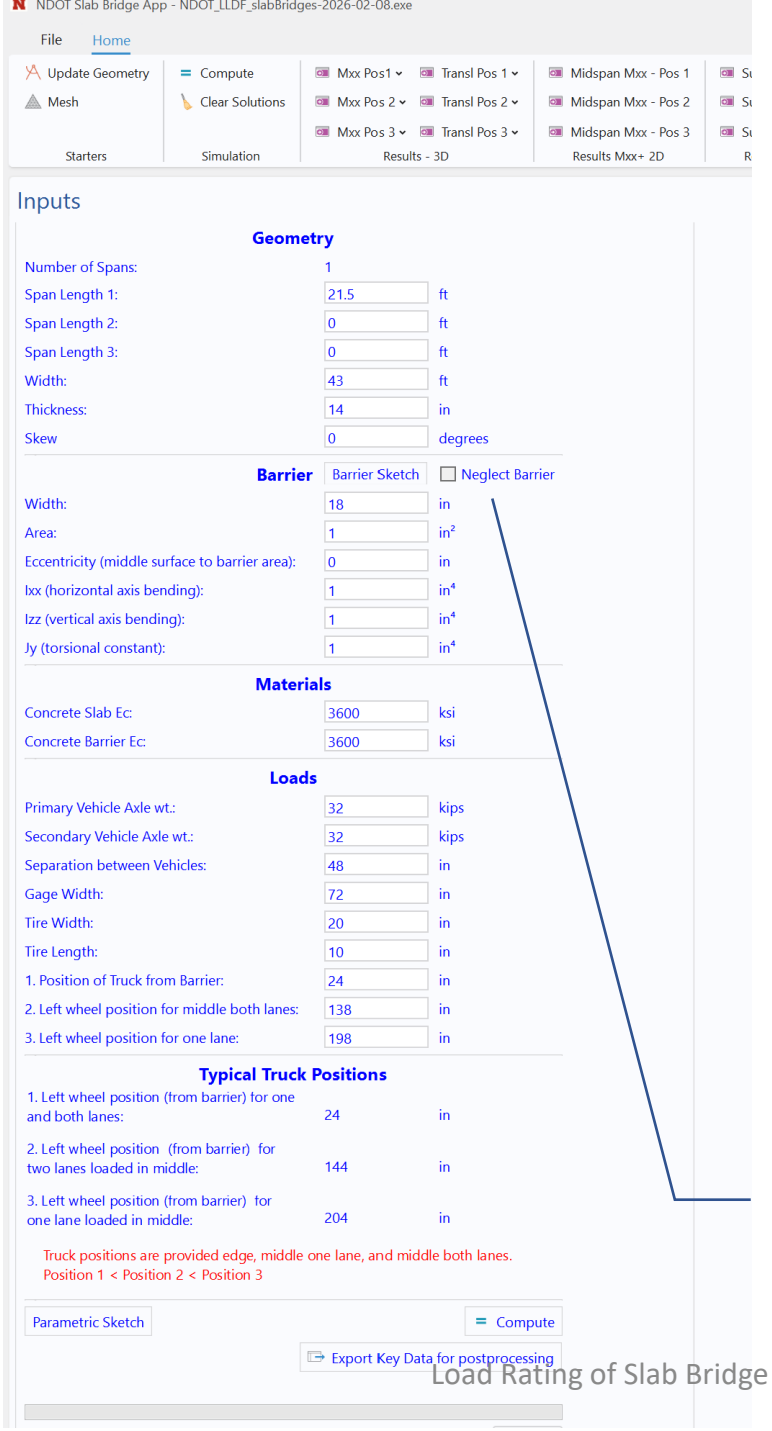
Simple Supports

Mesh

Wheel Patch Loads = 16 kips (uniform load)
(20” x 10”)

Evaluation Section $M_{equilibrium}$ = 32 kips (21.5 ft)/4 = 172 ft-kip = 2064 in-kip (also beamline for design)

Inputs



Neglected Barrier assigns small section stiffness with zero eccentricity

Echo Report for Input Parameters

Output

Graphics | Reactions | Detailed Input (from Engine) | Detailed Comps | Summary | Key Results for BrR

Detailed Inputs (from Engine)

Bridge Geometry

PosTruckX (in)	42.000	42.000	42.000	156.00	156.00	156.00	216.00	216.00	216.00
loadcase	1.0000	2.0000	3.0000	1.0000	2.0000	3.0000	1.0000	2.0000	3.0000
group.One_Lane_Loaded	1.0000	0.0000	1.0000	1.0000	0.0000	1.0000	1.0000	0.0000	1.0000
group.Second_Lane_Loaded	0.0000	1.0000	1.0000	0.0000	1.0000	1.0000	0.0000	1.0000	1.0000
Span Length 1 (in)	258.00	258.00	258.00	258.00	258.00	258.00	258.00	258.00	258.00
Span Length 2 (in)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Span Length 3 (in)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Width (in)	516.00	516.00	516.00	516.00	516.00	516.00	516.00	516.00	516.00
Left Barrier Width (in)	18.000	18.000	18.000	18.000	18.000	18.000	18.000	18.000	18.000
Right Barrier Width	18.000	18.000	18.000	18.000	18.000	18.000	18.000	18.000	18.000
Skew	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

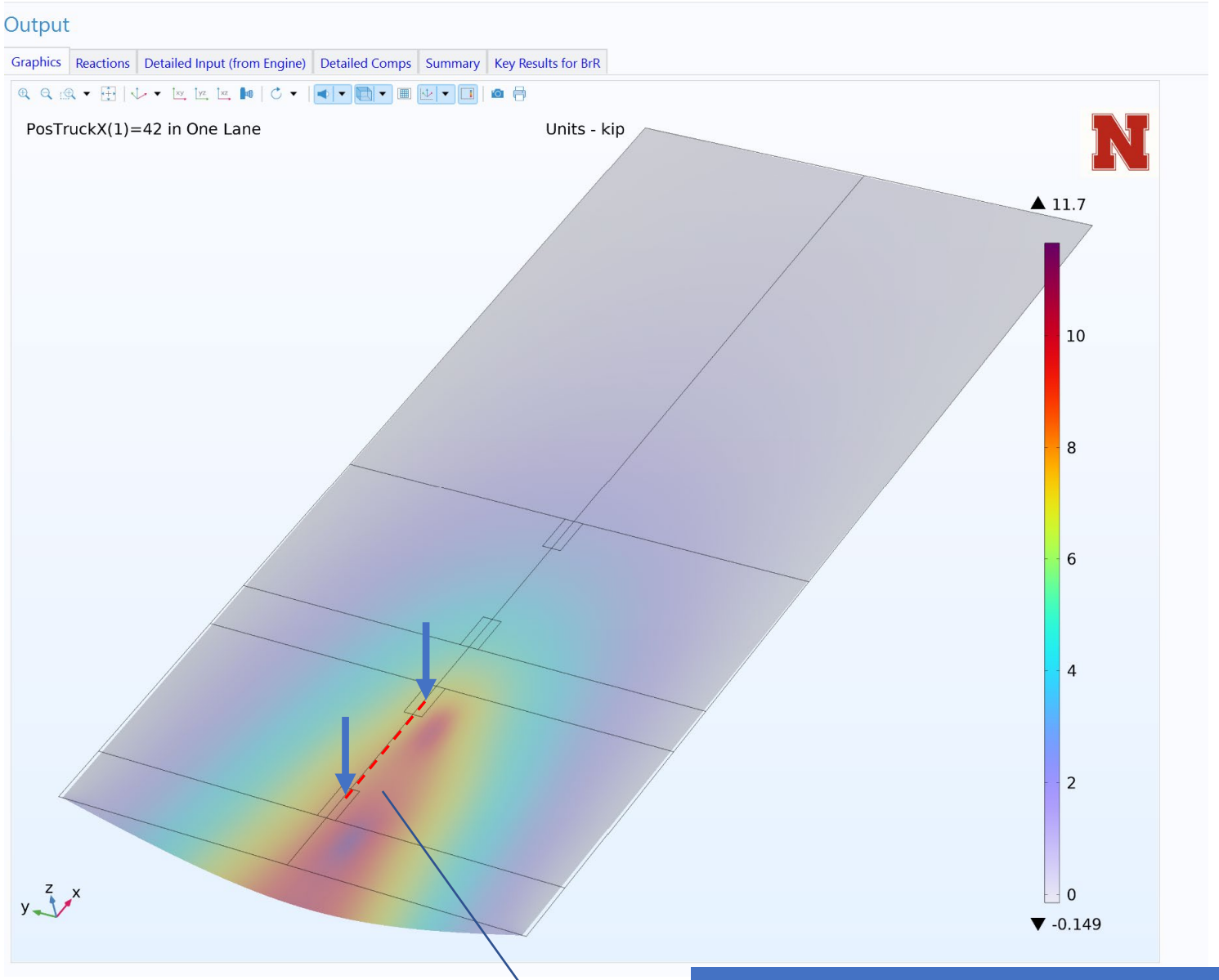
Barrier Geometry

PosTruckX (in)	42.000	42.000	42.000	156.00	156.00	156.00	216.00	216.00	216.00
loadcase	1.0000	2.0000	3.0000	1.0000	2.0000	3.0000	1.0000	2.0000	3.0000
group.One_Lane_Loaded	1.0000	0.0000	1.0000	1.0000	0.0000	1.0000	1.0000	0.0000	1.0000
group.Second_Lane_Loaded	0.0000	1.0000	1.0000	0.0000	1.0000	1.0000	0.0000	1.0000	1.0000
Rail Area	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Eccentricity (middle surface to centroid of Rail)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Rail Izz	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Rail Iyy	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Torsional Constant	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Loads

PosTruckX (in)	42.000	42.000	42.000	156.00	156.00	156.00	216.00	216.00	216.00
loadcase	1.0000	2.0000	3.0000	1.0000	2.0000	3.0000	1.0000	2.0000	3.0000
group.One_Lane_Loaded	1.0000	0.0000	1.0000	1.0000	0.0000	1.0000	1.0000	0.0000	1.0000
group.Second_Lane_Loaded	0.0000	1.0000	1.0000	0.0000	1.0000	1.0000	0.0000	1.0000	1.0000
Primary Vehicle Axle wt. (lbf)	32000	32000	32000	32000	32000	32000	32000	32000	32000
Secondary Vehicle Axle wt. (lbf)	32000	32000	32000	32000	32000	32000	32000	32000	32000
Gage Width (in)	72.000	72.000	72.000	72.000	72.000	72.000	72.000	72.000	72.000
Separation between Vehicles (in)	48.000	48.000	48.000	48.000	48.000	48.000	48.000	48.000	48.000
Left wheel position for leftmost (from Barrier) (in)	24.000	24.000	24.000	24.000	24.000	24.000	24.000	24.000	24.000
Left wheel position for middle both lanes (from Barrier) (in)	138.00	138.00	138.00	138.00	138.00	138.00	138.00	138.00	138.00
Left wheel position for one lane (from Barrier) (in)	198.00	198.00	198.00	198.00	198.00	198.00	198.00	198.00	198.00

Moments (M_{xx}) – Edge position (one lane loaded)

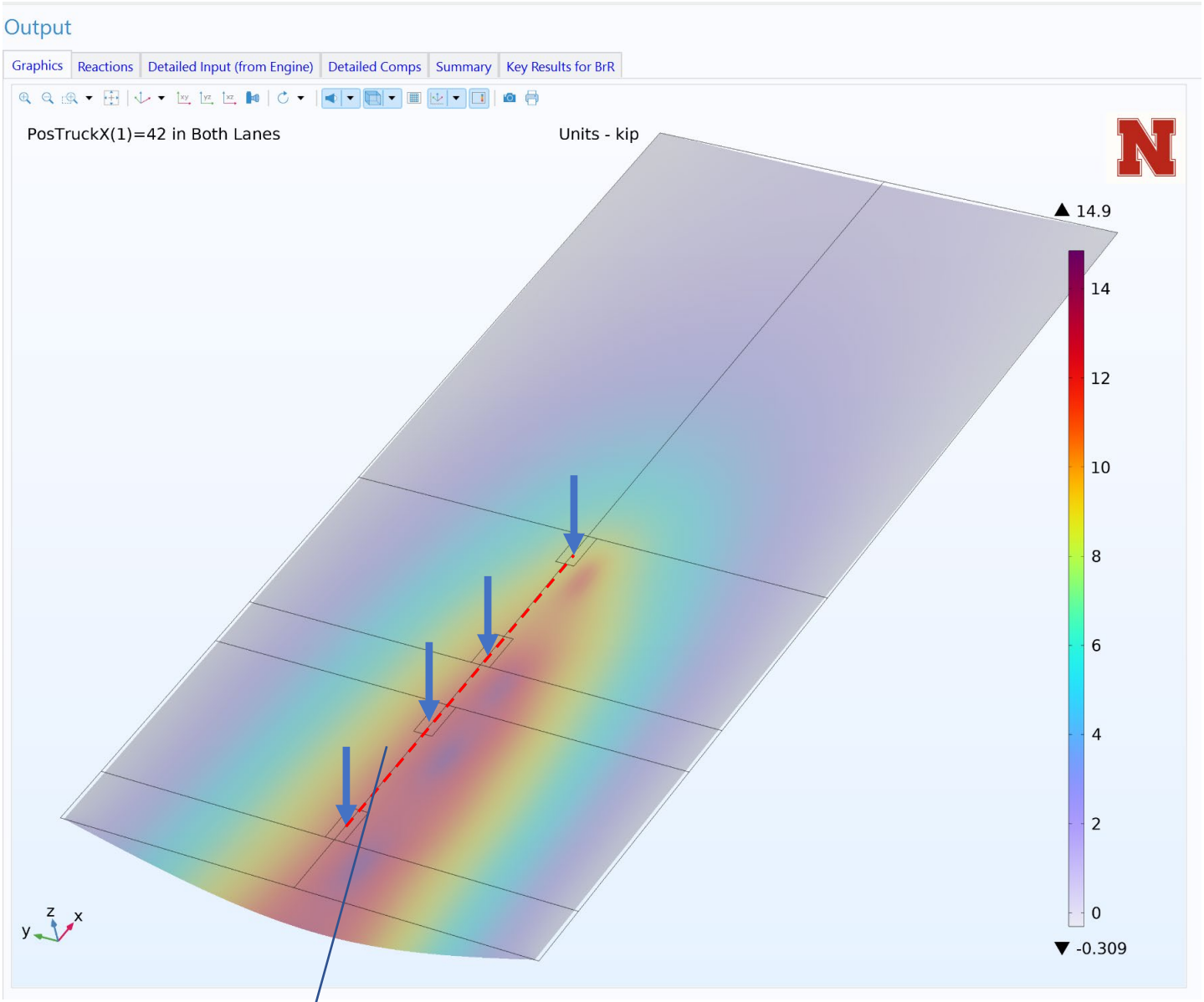


Max M_{xx} = 11.7 kips

Min M_{xx} = 0.0 kips

Analysis section = gage + one wheel width
Typical = 6 + 20/12 = 7.66 = 92 in

Moments (M_{xx}) – Edge position (two lanes loaded)

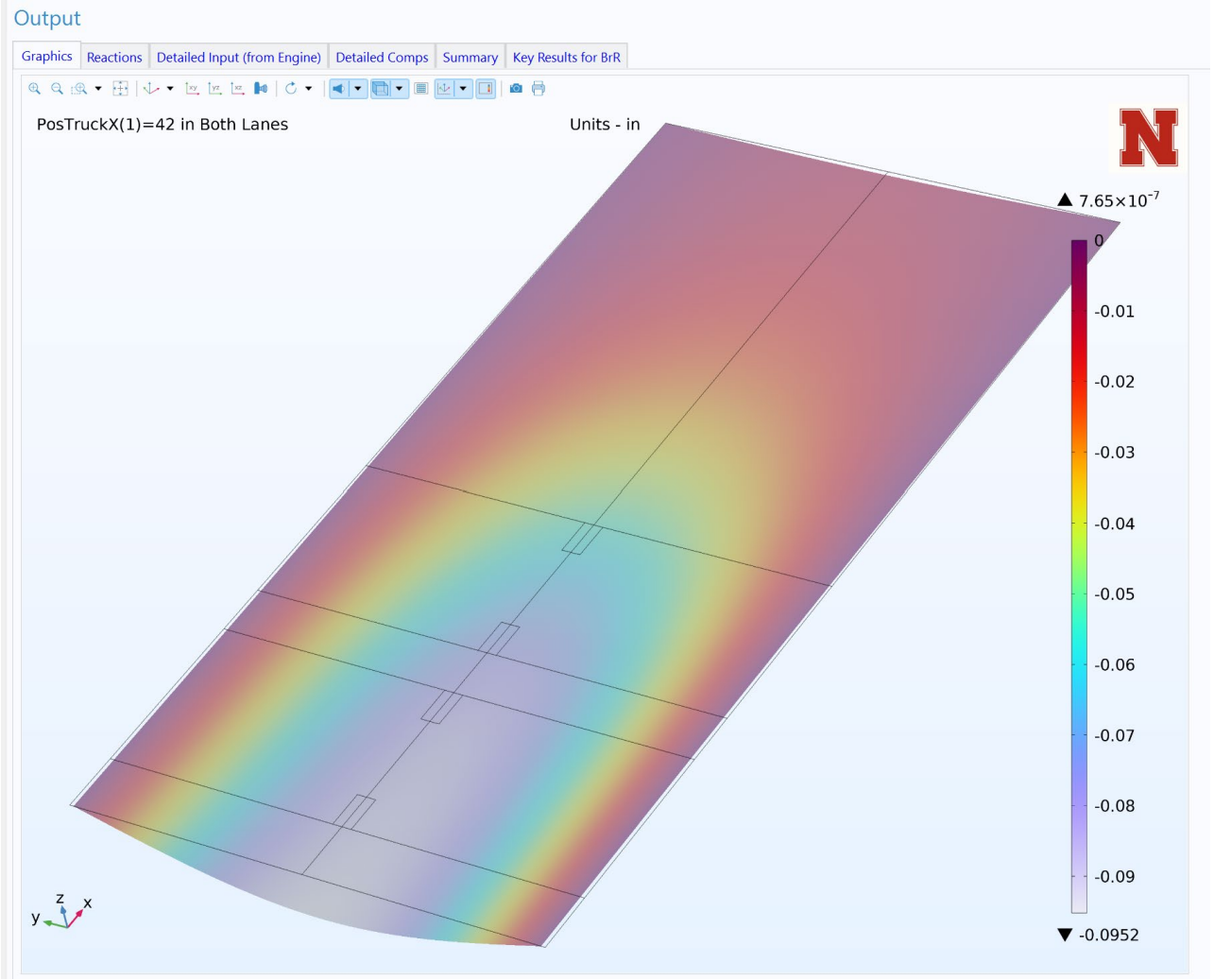


Max M_{xx} = 14.9 kips

Min M_{xx} = 0.0 kips

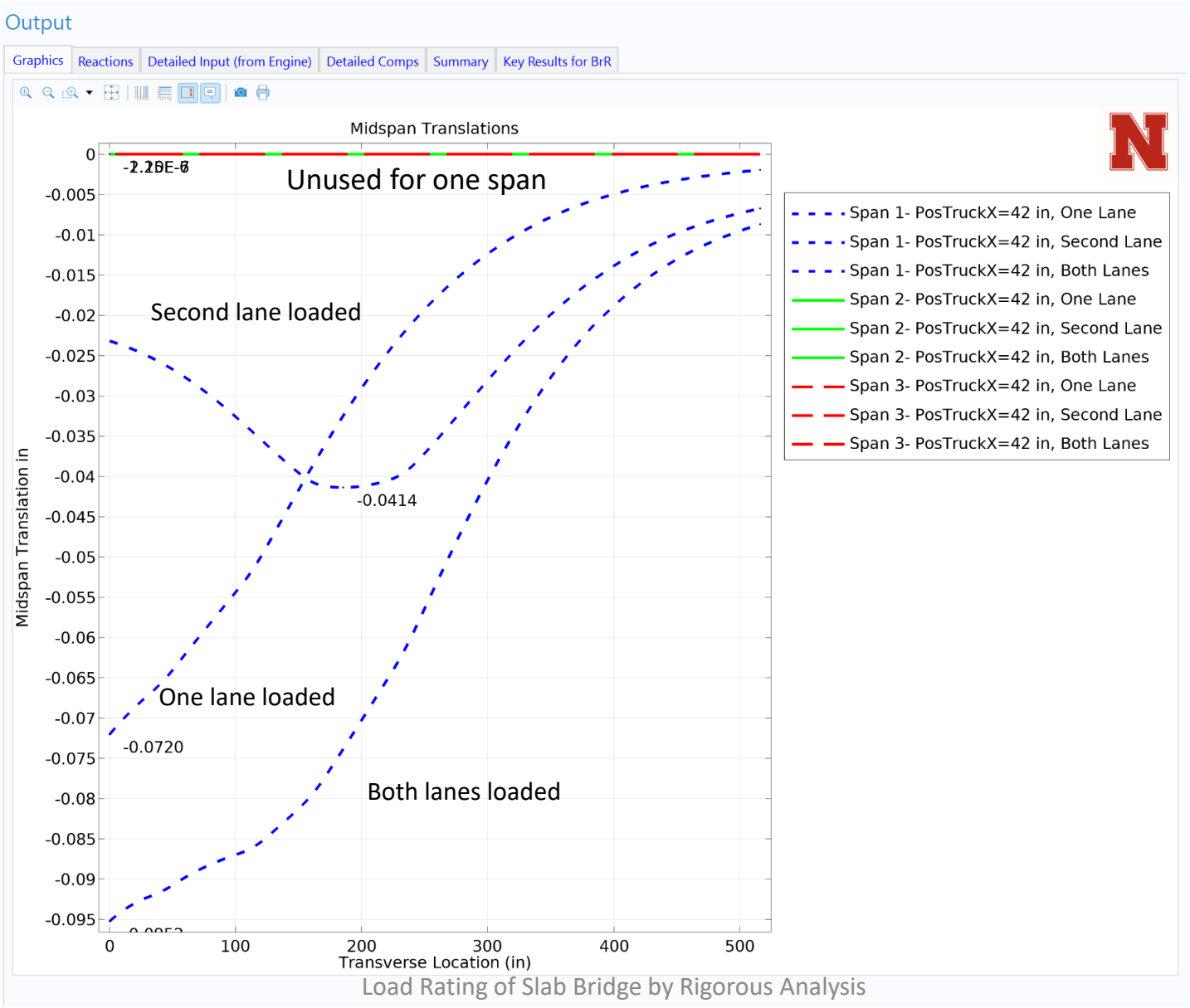
Analysis section = 2 x gage + 2 x wheel width + separation
Typical = 2(6) + 2(20/12) + 4 = 19.33 ft = 232 in

Translations Both Lanes loaded



Translations (in)

Midspan Translation

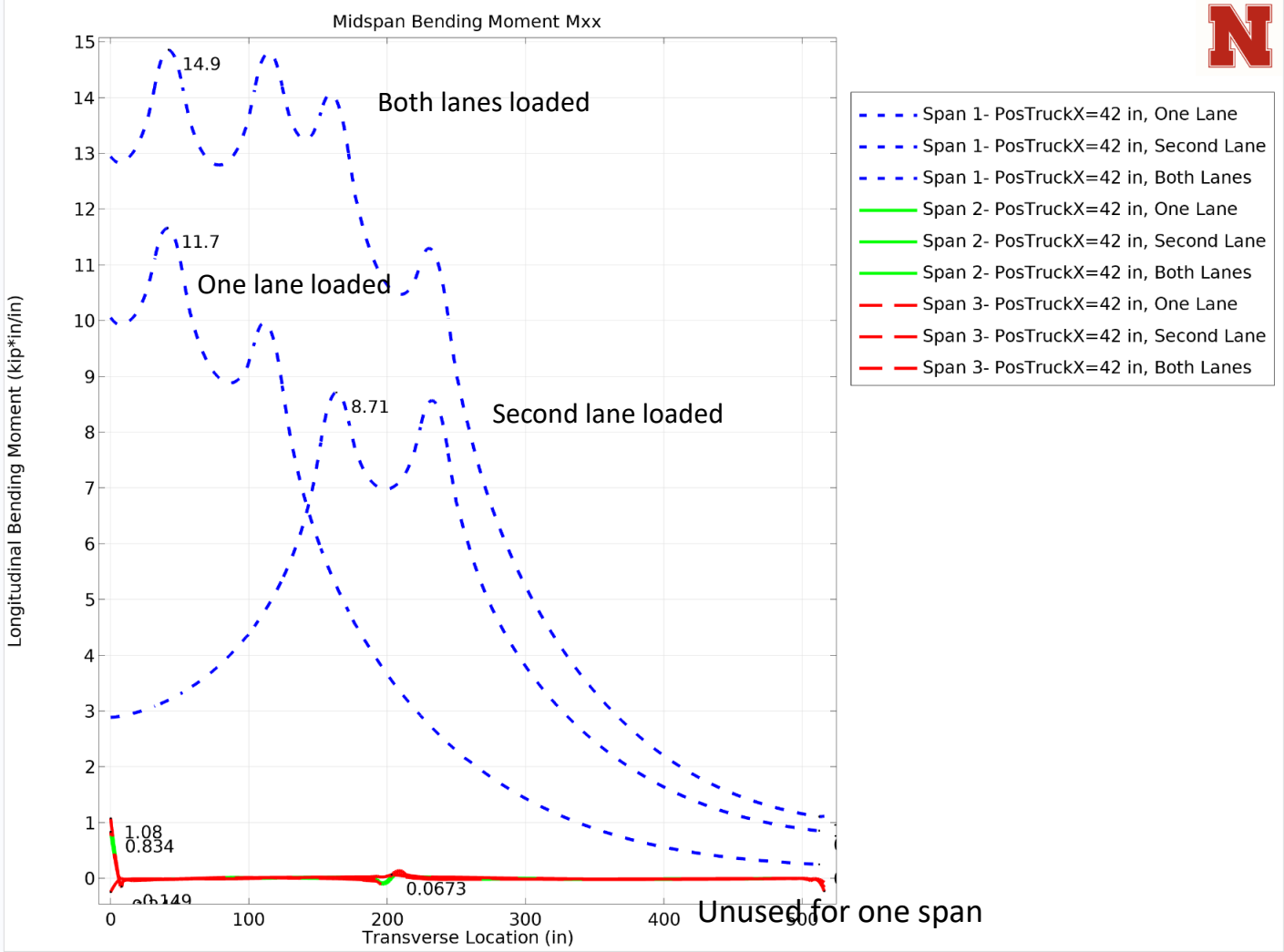


Unused for one span

Midspan Moments M_{xx}

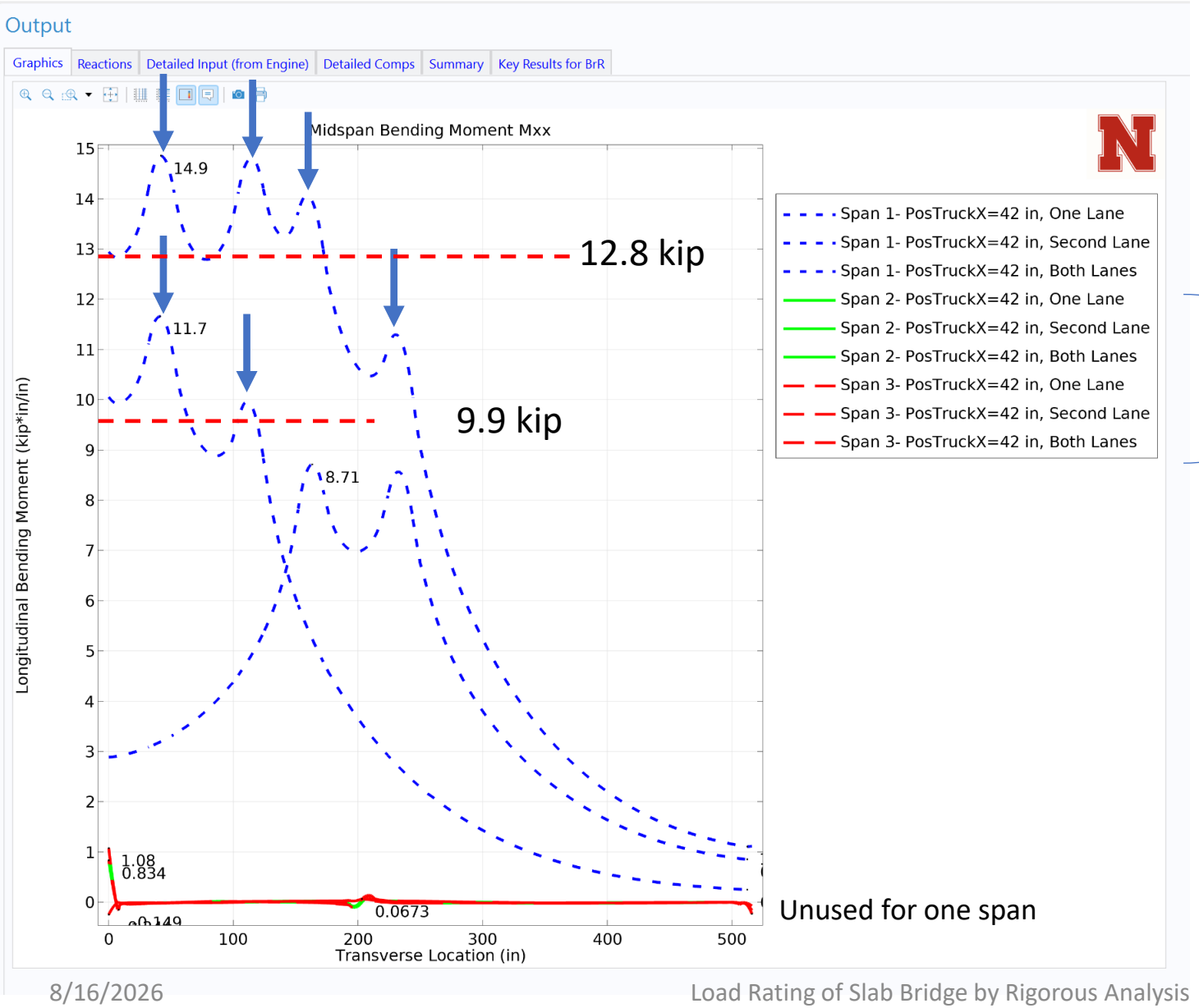
Output

Graphics | Reactions | Detailed Input (from Engine) | Detailed Comps | Summary | Key Results for BrR



Unused for one span

Moments Across Evaluation Section



Unused for one span

$M_{total-one\ lane}$ (from statics[1]) = 172 ft-kip = 2064 in-kips
$M_{total-one\ lane}$ (from statics[2]) = 168.7 ft-kip = 2024 in-kips

$M_{Average\ between\ axles-one\ lane}$ = 9.9 kips
$M_{Average\ between\ axles-two\ lanes}$ = 12.8 kips
$M_{total-one\ lane}$ (from FEA) = 161.25 ft-kip = 2032 in-kips

E_1 =2032/ 9.9 = 205 in
E_2 =2032/ 12.8 = 159 in

1. Statics – concentrated load (2064/2024 = 1.02)
2. Statics – patch load (2024/2024 = 1)
3. FEA (2032/2024) = 1.004

Live Load Distribution Details

FEA Computations

Span 1

PosTruckX (in)	42.000	42.000	42.000	156.00	156.00	156.00	216.00	216.00	216.00
loadcase	1.0000	2.0000	3.0000	1.0000	2.0000	3.0000	1.0000	2.0000	3.0000
group.One_Lane_Loaded	1.0000	0.0000	1.0000	1.0000	0.0000	1.0000	1.0000	0.0000	1.0000
group.Second_Lane_Loaded	0.0000	1.0000	1.0000	0.0000	1.0000	1.0000	0.0000	1.0000	1.0000
Length - Span 1 (ft)	21.500	21.500	21.500	21.500	21.500	21.500	21.500	21.500	21.500
FEA Width1 Net (in)	205.78	516.02	294.25	260.06	607.18	364.14	264.72	593.86	366.19
FEA Width2 Net (in)	147.11	171.40	158.33	179.85	180.59	180.22	180.59	172.97	176.70
FEA Ewidth1, in - Span 1 (in)	205.78	516.02	294.25	260.06	607.18	364.14	264.71	593.85	366.19
FEA Ewidth2, in - Span 1 Two lanes (in)	147.11	171.40	158.33	179.85	180.58	180.22	180.59	172.97	176.70
Skew Correction Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Percent to Slab - Span 1 (1)	0.99998	0.99999	0.99999	0.99999	0.99999	0.99999	0.99999	0.99999	0.99999
Percent to Beams - Span 1 (1)	1.9941E-5	8.3704E-6	1.4155E-5	7.5570E-6	7.0602E-6	7.3086E-6	6.3903E-6	1.0983E-5	8.6863E-6
MxTotalAll (Deck+Rails) - Span 1 (in*lbf)	2.0317E6	2.0323E6	4.0640E6	2.0325E6	2.0323E6	4.0648E6	2.0325E6	2.0324E6	4.0650E6
Mx Rail Left - Span 1 (in*lbf)	39.688	14.199	53.887	12.326	3.7403	16.066	6.3944	1.7067	8.1012
Mxx Deck - Span 1 (in*lbf)	2.0316E6	2.0323E6	4.0640E6	2.0325E6	2.0323E6	4.0648E6	2.0325E6	2.0324E6	4.0649E6
Mx Rail Right - Span 1 (in*lbf)	0.82486	2.8127	3.6376	3.0337	10.608	13.642	6.5941	20.614	27.209
Average Mxx under one lane - Span 1 (lbf)	9872.9	3938.5	13811	7815.6	3347.1	11163	7678.2	3422.4	11101
Average Mxx under both lanes - Span 1 (lbf)	6905.1	5928.7	12834	5650.5	5626.9	11277	5627.6	5875.0	11503
LLDF One Lane Net - Span 1 (per ft) (1)	0.058314	0.023255	0.040781	0.046143	0.019763	0.032954	0.045332	0.020207	0.032770
LLDF Both Lanes Net - Span 1 (per ft) (1)	0.081569	0.070013	0.075790	0.066721	0.066451	0.066586	0.066450	0.069375	0.067912

Typical Values of Interest (minor rounding in hand computations

Computations (edge position):

E1 = 206 in

E2 = 159 in

Skew factor = 1

Percent (fraction) to slab = 1

Mx (total section) = 2032 in-kip

M1xx (average) = 9.9 kip

E1 = 2032/9.9 = 206 in

M2xx (average) = 12.8 kip

E2 = (2032/12.8 = 159

LLDF1 = 12 (in design section)

/206 = 0.058

LLDF2 = 12/159 = 0.075

Live Load Distribution Summary

Summary

Span 1 Summary

PosTruckX (in)	42.000	42.000	42.000	156.00	156.00	156.00	216.00	216.00	216.00
loadcase	1.0000	2.0000	3.0000	1.0000	2.0000	3.0000	1.0000	2.0000	3.0000
group.One_Lane_Loaded	1.0000	0.0000	1.0000	1.0000	0.0000	1.0000	1.0000	0.0000	1.0000
group.Second_Lane_Loaded	0.0000	1.0000	1.0000	0.0000	1.0000	1.0000	0.0000	1.0000	1.0000
Length - Span 1 (ft)	21.500	21.500	21.500	21.500	21.500	21.500	21.500	21.500	21.500
LLDF One Lane Net - Span 1 (per ft) (1)	0.058014	0.023164	0.040586	0.046108	0.019747	0.032928	0.045313	0.020181	0.032747
LLDF Both Lanes Net - Span 1 (per ft) (1)	0.081195	0.069893	0.075543	0.066671	0.066406	0.066539	0.066406	0.069269	0.067837

Positions

- Both lanes loaded edge
- One lane loaded middle LLDF
- Both lanes loaded middle LLDF

Typical Values of Interest

1. One lane edge position (0.058) <<<<< critical E1 = 207 in
2. Both lanes edge position (0.076) <<<<< critical E2 = 158 in
3. Both lanes in middle position (0.067)
4. One lane in middle position (0.045)

AASHTO 4.6.2.3

Slab Bridge AASHTO Computations

Abstract: This spreadsheet computed AASHTO effective widths for slab bridges. The specification reference is provided.

Date: 4/29/2025

Variable	Value	Units	Comments
P =	32	kip	Axle load
L =	21.5	ft	Span length
M (LL approx) =	172	ft-kips	Simple-beam moment
M (LL approx) =	2064	in-kips	Simple-beam moment
W =	43	ft	Slab width
t =	14	in	Slab thickness
θ =	0	degrees	Skew Angle
BarrierWidth =	15	in	Barrier Width
Middle Strip Computations			
Skew Factor =	1.000		
NL	1		Number of lanes loaded
L1 =	21.5	ft	min(L,60)
W1 =	30	ft	min(30, W)
E1 (Formula) =	137.0	in	Eq. 4.6.2.3-1
E1 (Formula) =	11.4	ft	
E1*1.2=	164.4	in	remove multiple presence
E1*1.2 =	13.7	ft	
E1*1.2/SkewFactor =	13.7		Skew adjustment decreases load effect
LLDF =	0.073		Distribution factor of one-ft section
M1 =	12.6	kips-in/in	Required resistance
M1 =	150.7	kips-in/ft	
NL	2		More than one lane loaded
L1 =	21.5	ft	min(L,60)
W1 =	43.0	ft	See specifications
E2 (Formula) =	127.8	in	Eq. 4.6.2.3-2
E2 max =	258.0	in	12*W/NL
E2 =	10.6	ft	min(E2max, E2)
E2/SkewFactor =	10.6	ft	Skew adjustment decreases load effect
LLDF =	0.094		
Edge Strip Computations			
Barrier width =	15.00	in	Distance from edge of deck to edge of barrier
One foot per spec	12.00	in	See spec
1/4 for strip width =	41.10	in	See spec
Subtotal =	68.10	in	Total
1/2 of strip width =	82.19	in	See spec
Max 72	72.00	in	See spec
Edge Strip Width =	68.10	in	Check minimum
Edge Strip Width =	5.67	ft	Per spec, this is for one wheel line 1/2 axle
LLDFwheelLine=	0.176		For wheel line
LLDFperLane=	0.088		For lane

factor

4.6.2.3—Equivalent Strip Widths for Slab-Type Bridges

This Article shall be applied to the types of cross-sections shown schematically in Table 4.6.2.3-1. For the purpose of this Article, cast-in-place voided slab bridges may be considered as slab bridges.

The equivalent width of longitudinal strips per lane for both shear and moment with one lane, i.e., two lines of wheels, loaded may be determined as:

$$E = 10.0 + 5.0\sqrt{L_1 W_1} \qquad (4.6.2.3\text{-}1)$$

The equivalent width of longitudinal strips per lane for both shear and moment with more than one lane loaded may be determined as:

$$E = 84.0 + 1.44\sqrt{L_1 W_1} \le \frac{12.0W}{N_L} \qquad (4.6.2.3\text{-}2)$$

where:

E = equivalent width (in.)
L_1 = modified span length taken equal to the lesser of the actual span or 60.0 (ft)
W_1 = modified edge-to-edge width of bridge taken to be equal to the lesser of the actual width or 60.0 for multilane loading, or 30.0 for single-lane loading (ft)
W = physical edge-to-edge width of bridge (ft)
N_L = number of design lanes as specified in Article 3.6.1.1.1

C4.6.2.3

In Eq. 4.6.2.3-1, the strip width has been divided by 1.20 to account for the multiple presence effect.

AASHTO

E_1 = 137 in

E_1 = 164 in (without m=1.2) LLDF = 0.073

E_2 = 128 in LLDF = 0.094

E_{edge} = 68 in (one wheel line)

E_{edge} = 134 in (lane) LLDF = 0.090

For skewed bridges, the longitudinal force effects may be reduced by the factor, r:

$$r = 1.05 - 0.25\tan\theta \le 1.00 \qquad (4.6.2.3\text{-}3)$$

where:

θ = skew angle (degrees)

Comparison Edge Loading

No. Lanes Loaded	FEA	AASHTO (m = 1.2)	AASHTO (m = 1.0)	Ratio
1	207	137	164	207/164 = 1.26
2	158	n/a	128	159/128 = 1.24
1 edge strip	207	128.5*1.2 = 154	n/a	207/128.5 = 1.34

Reaction Summary

Output

Graphics | Reactions | Detailed Input (from Engine) | Detailed Comps | Summary

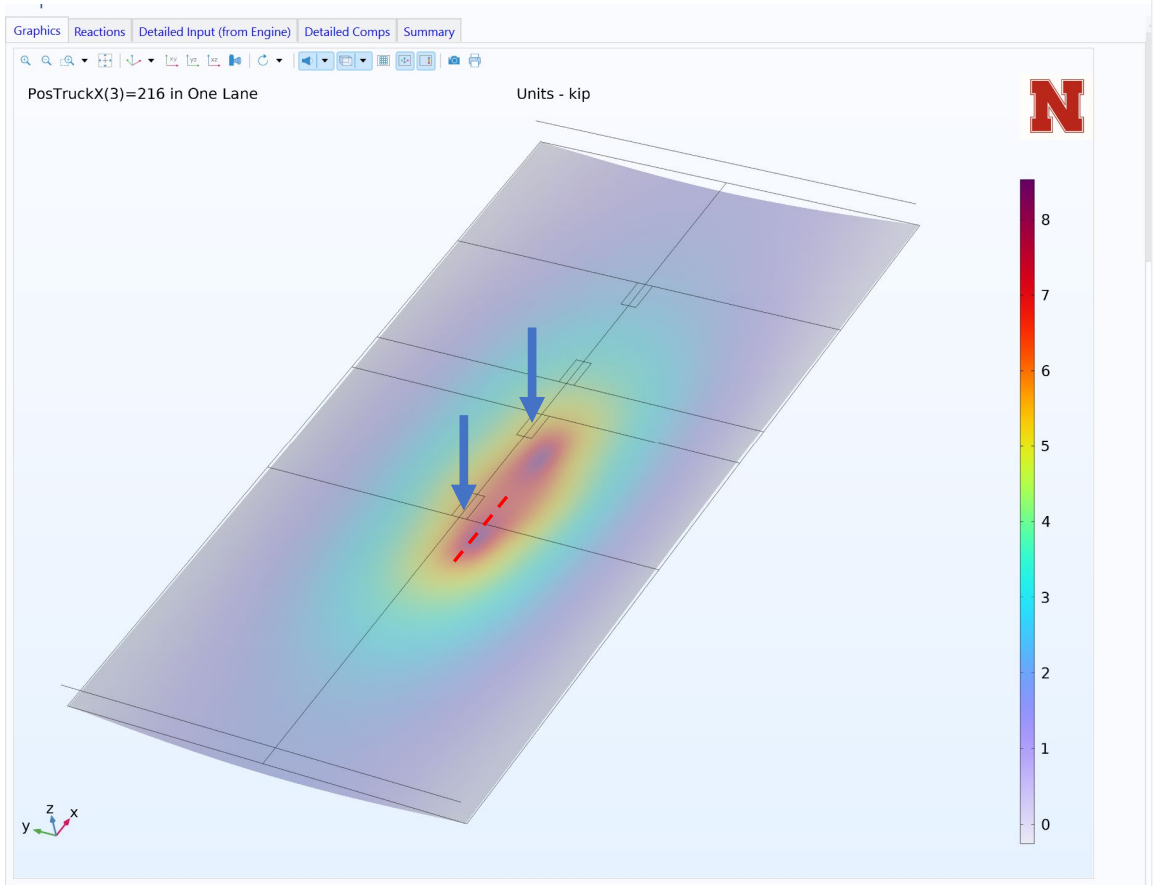
Reactions

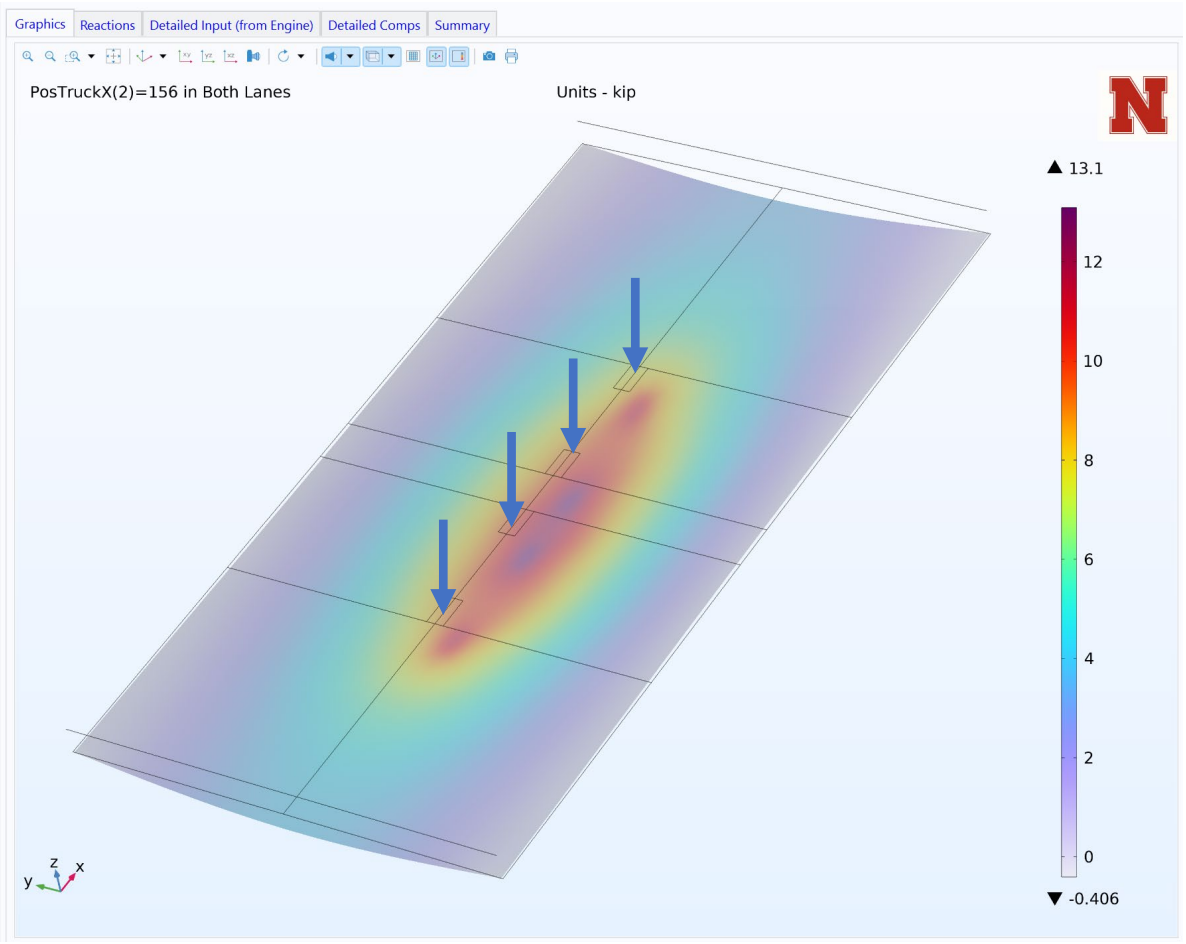
Reactions

PosTruckX (in)	42.000	42.000	42.000	156.00	156.00	156.00	216.00	216.00	216.00
loadcase	1.0000	2.0000	3.0000	1.0000	2.0000	3.0000	1.0000	2.0000	3.0000
group.One_Lane_Loaded	1.0000	0.0000	1.0000	1.0000	0.0000	1.0000	1.0000	0.0000	1.0000
group.Second_Lane_Loaded	0.0000	1.0000	1.0000	0.0000	1.0000	1.0000	0.0000	1.0000	1.0000
Reaction 1 (kip) (lbf)	16.000	16.000	32.000	16.000	16.000	32.000	16.000	16.000	32.000
Reaction 2 (kip) (lbf)	16.000	16.000	32.000	16.000	16.000	32.000	16.000	16.000	32.000
Reaction 3 (kip) (lbf)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Reaction 4 (kip) (lbf)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Rtotal (kip) (lbf)	32.000	32.000	64.000	32.000	32.000	64.000	32.000	32.000	64.000

Statics is checked for all load cases and positions

Mxx –One lane positioned in the middle (position 3)



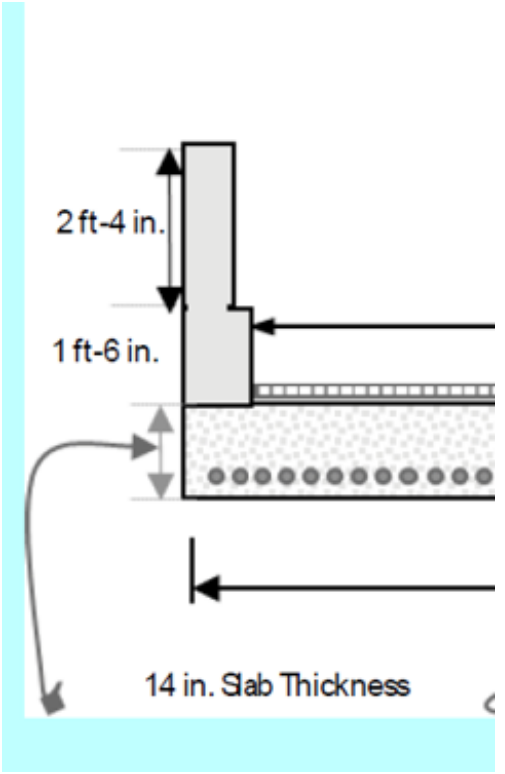


Comparison – load in middle

No. Lanes Loaded	FEA	AASHTO (m = 1.2)	AASHTO (m = 1.0)	Ratio
1	267*	183	164	267/164 = 1.63
2	180	n/a	128	180/128 = 1.41
* FEA does not include m = 1.2				

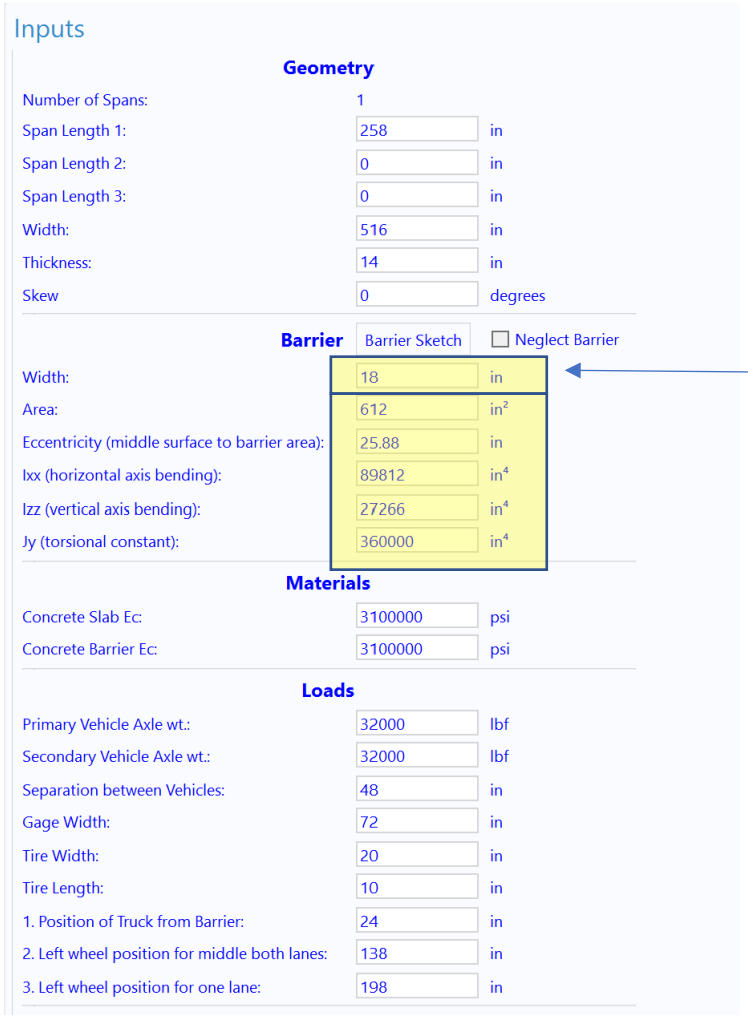
Geometry and Loads (with barrier stiffness)

Property	Value	
Ax	612 in2	
Iz	89812 in4	
Iy	27266 in4	
J	36000 in4	
e	25.88	



Inputs

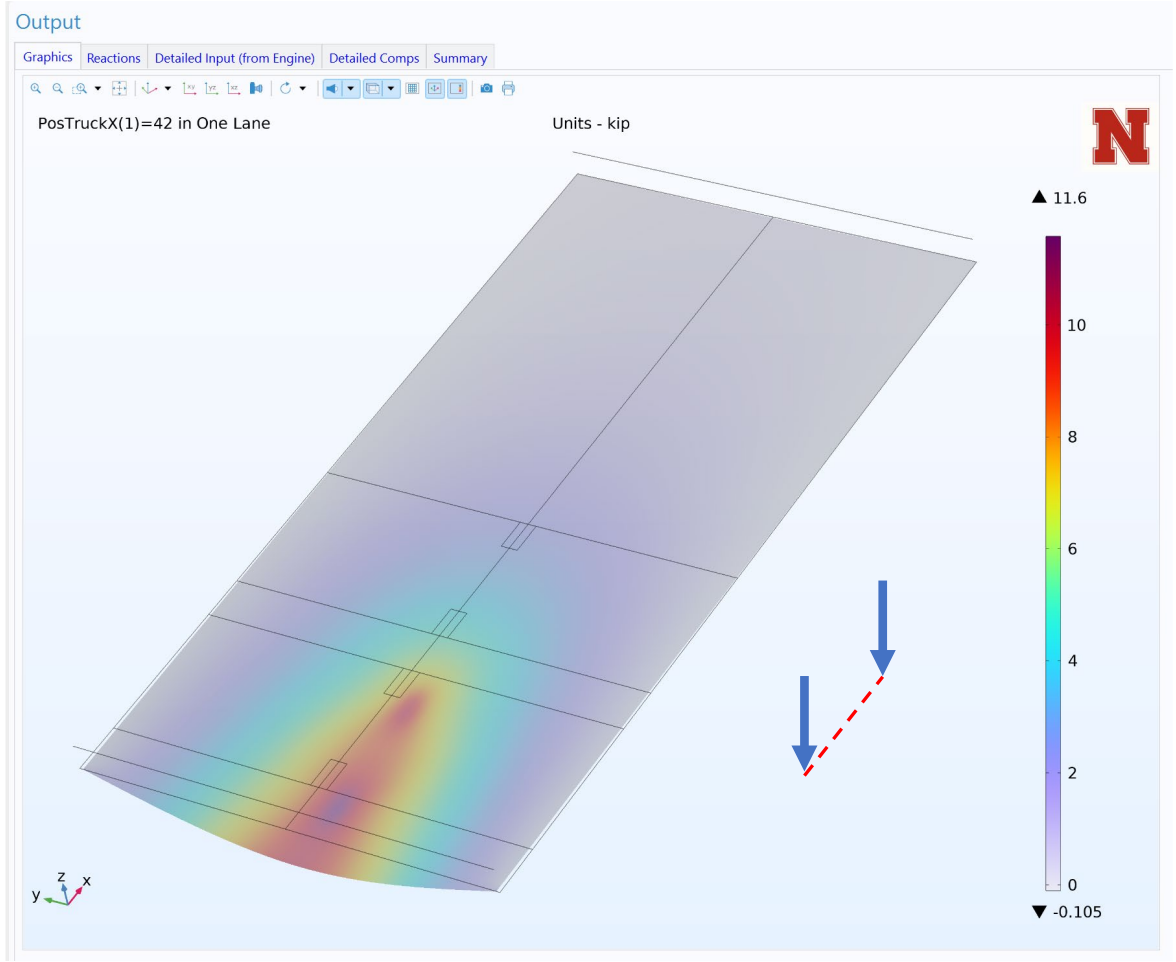
Add barrier stiffness

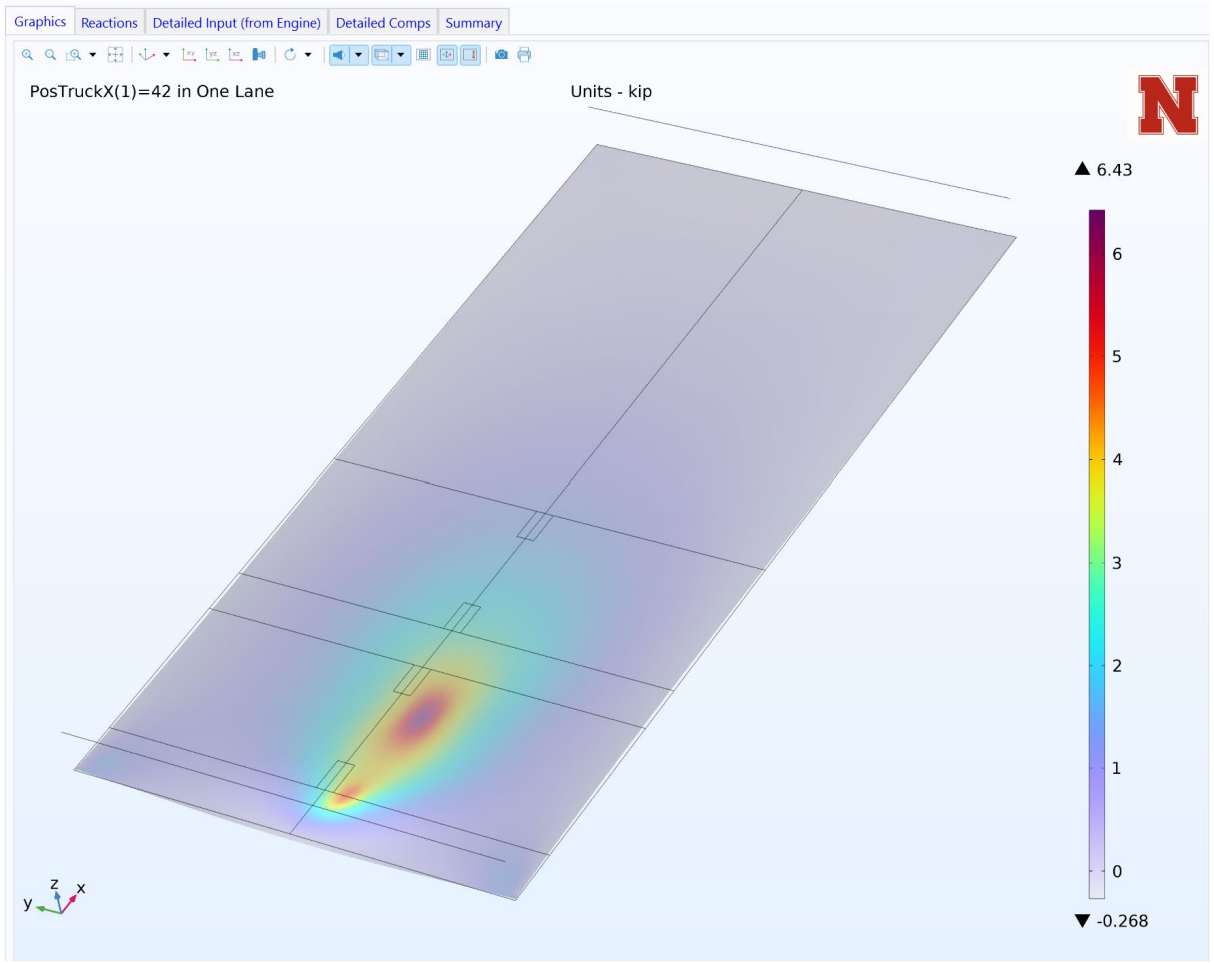


Width is used for travelway edge

No Barrier

With Barrier

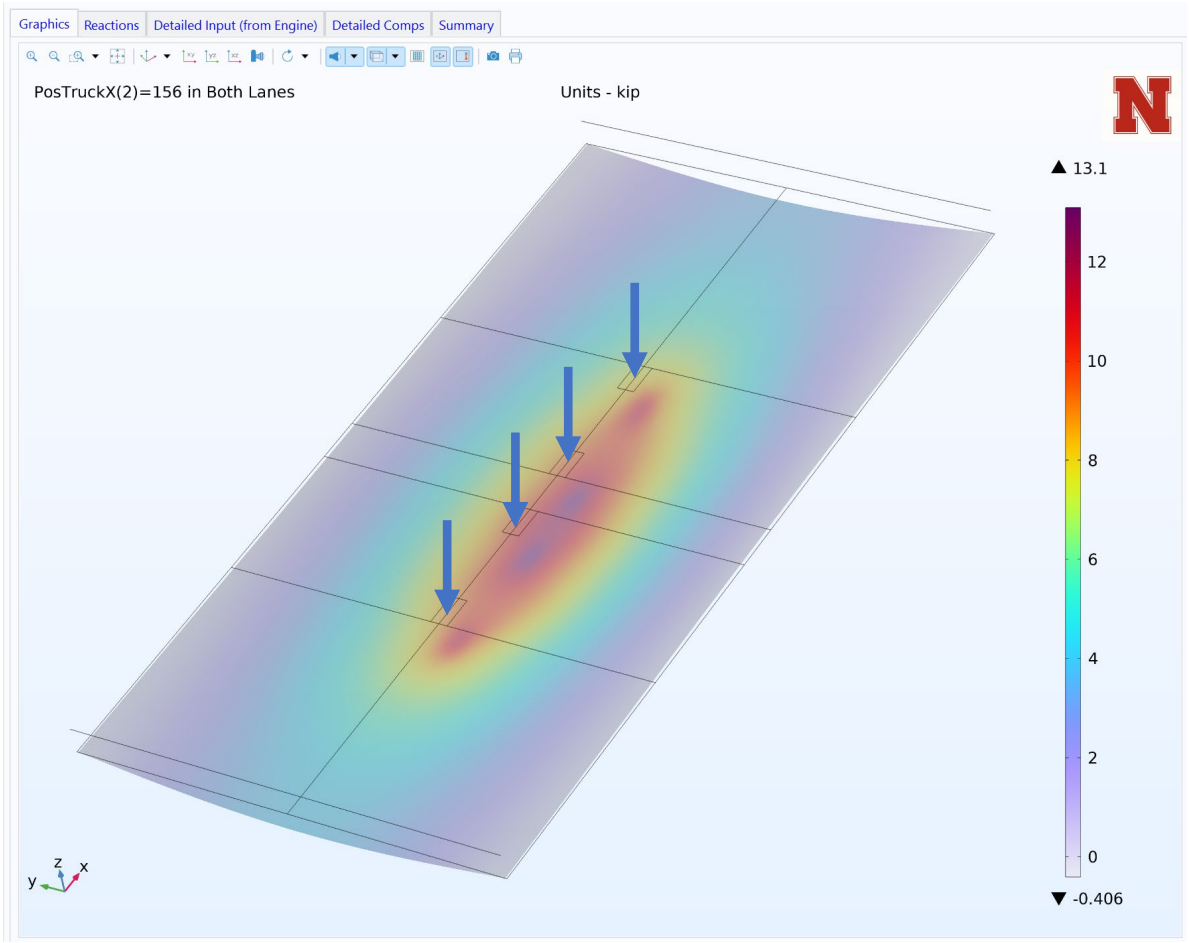




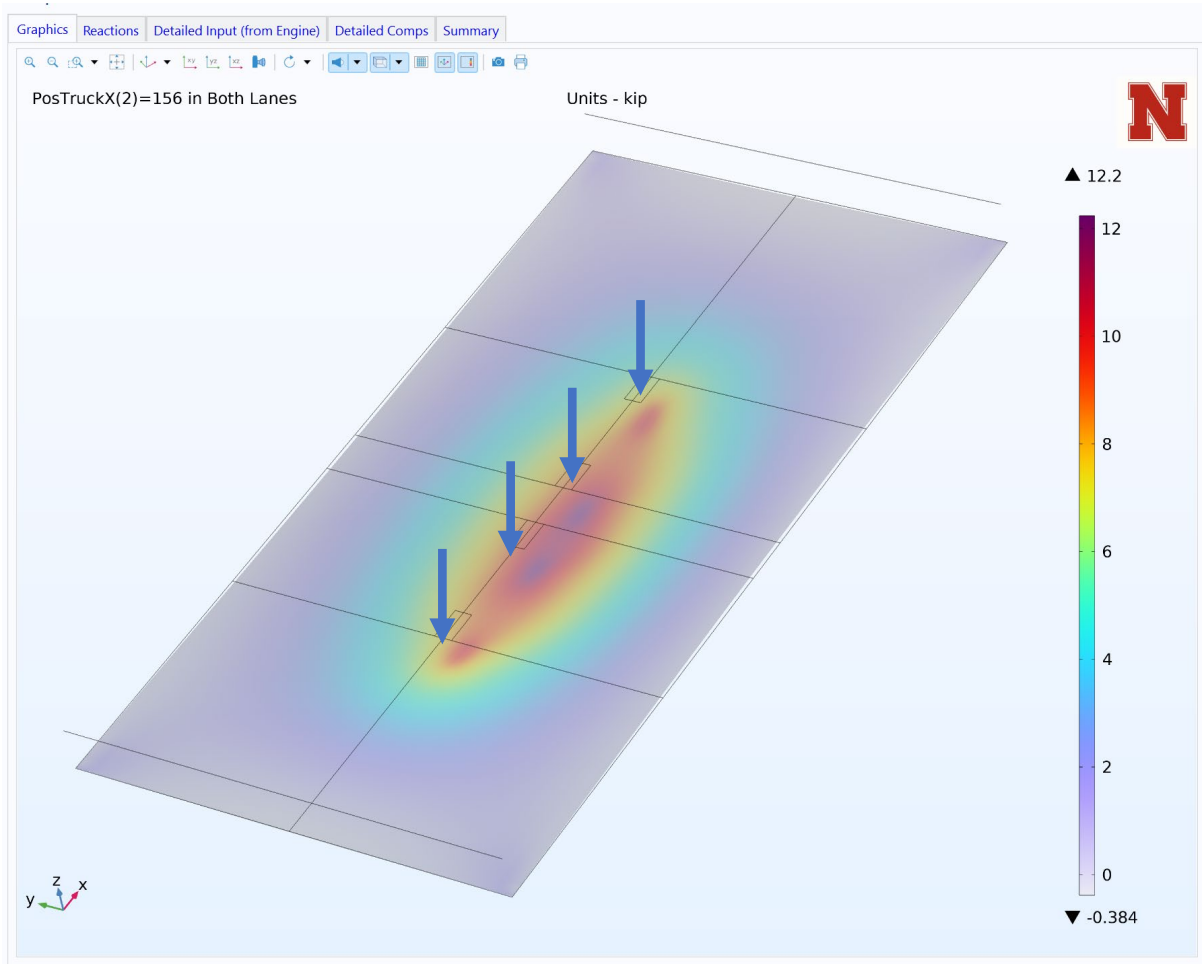
Max M_{xx} = 11.6 kips

Max M_{xx} = 6.43 kips (55%)

No Barrier



With Barrier



Max M_{xx} = 13.1 kips

Max M_{xx} = 12.2 kips (93%)

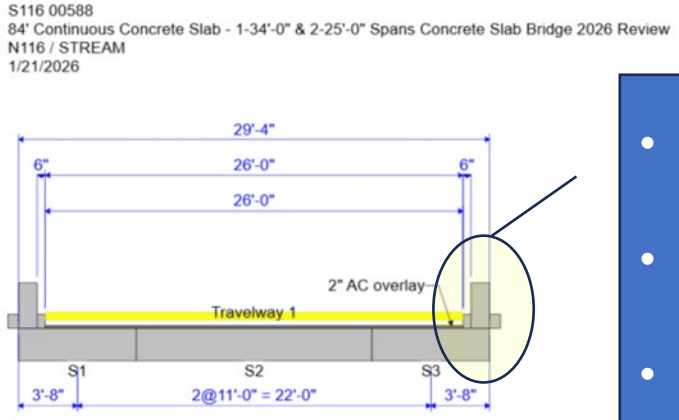
Summary – Load position (no consideration of barrier rail stiffness)

No. Lanes Loaded	Load Position	FEA/ Model	AASHTO E1 (m = 1.0)	AASHTO E2 (m = 1.0)	Ratio
1	Edge	207	164	n/a	207/164 = 1.26
2	Edge	158	n/a	128	159/128 = 1.24
1	Edge strip rules	207	164	n/a	207/164 = 1.26
2	Edge strip rules	158	n/a	n/a	n/a
1	Middle	267	164	n/a	267/164 = 1.63
2	Middle	180	n/a	128	180/128 = 1.41

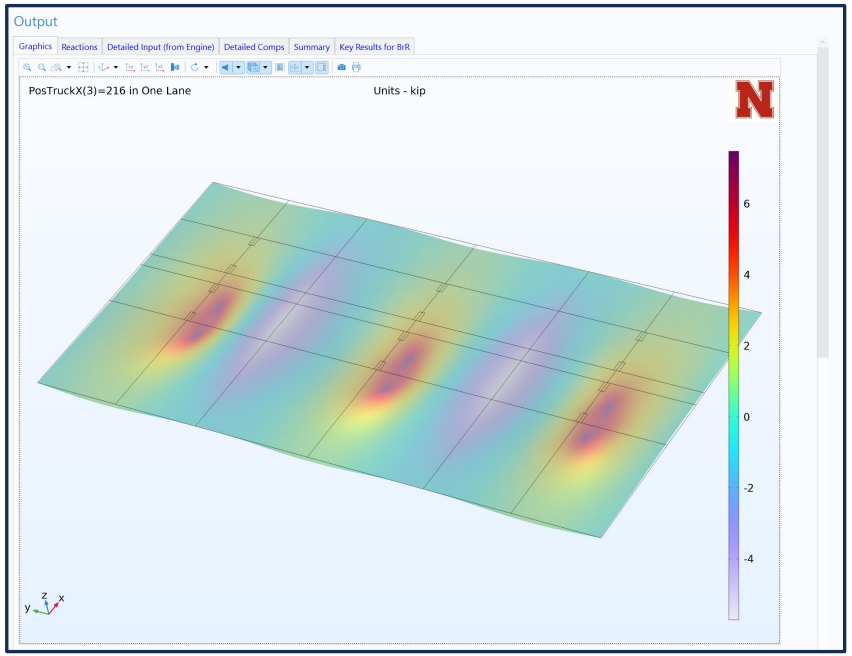
Summary – Load Position (considering barrier rail stiffness)

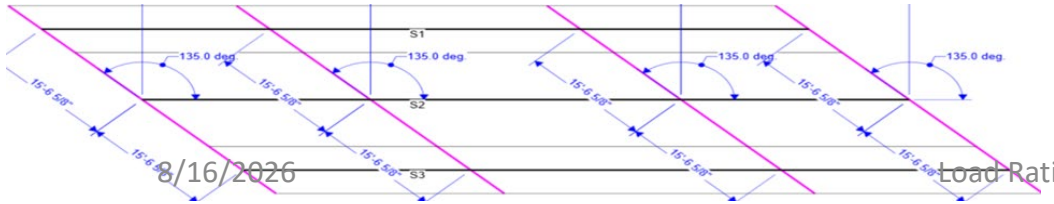
No. Lanes Loaded	Load Position	FEA/ Model	Percent to Slab	AASHTO E1 (m = 1.0)	AASHTO E2 (m = 1.0)	Ratio
1	Edge	274	73	164	n/a	274/164 = 1.67
2	Edge	187	81	n/a	128	187/128 = 1.46
1	Edge strip rules	274	73	164	n/a	274/164 = 1.67
2	Edge strip rules	274	n/a	n/a	n/a	274/136 = 2.01
1	Middle	261	92	164	n/a	267/164 = 1.64
2	Middle	182	90	n/a	128	182/128 = 1.42

Success Story

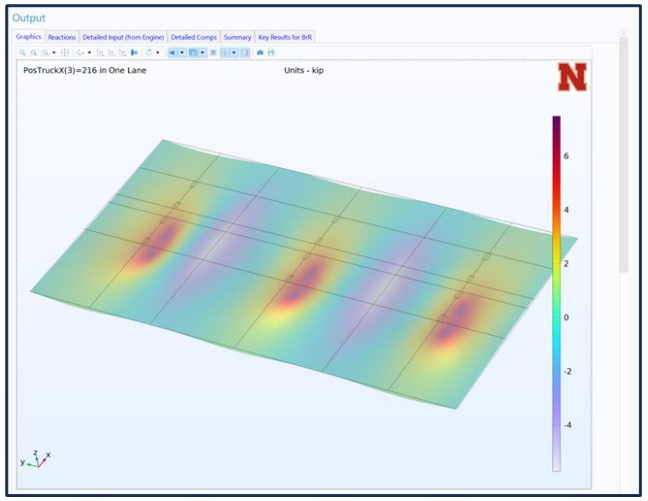


- Use existing curb and/or new rail
- Keep existing superstructure
- Saving ~$450K @ $125/ft^2





AASHTO BrR Interface



SlabDF formatted LLDF table

NEBRASKA
Good Life. Great Journey.
DEPARTMENT OF TRANSPORTATION
BRIDGE DIVISION

CN: Subject:
Project No:
Bridge No: By: Date:

Goal:	The goal of this spreadsheet is to convert the results from the Slab DF for refined analysis of slab bridges to the input required by BrR. This tab is for LRFR. A see other tab for LFR.
Instructions:	Fill out the bridge geometry information, the inputs from BrR model information, and the outputs from Slab DF. Indicate which truck positions should be used in the results (with an "x"). This spreadsheet will provide the distribution factors in the same format as required by BrR. Copy over the DF to BrR and run model. Create as many tabs as required for each member, load case, etc. Save as copy of this spreadsheet as pdf in the load rating calculations. Add a note in BrR saying that the DF were determined based on refined analysis of the structure.

Administration:	
Password to unlock fixed cells:	NDOT
Version:	Proto 2
Last modifed date:	
Modified by:	
TBD	
TBD	

File Name:	C:\UNL\Research\NDOT slab\NDOT feedback 2025-06-30\[Mock up - slab load rating - Refined DF spreadsheet-V1-JP-2025-08-18.xlsx]Slab DF
Date from System:	9/22/2025

Wheel Positions for Slab DF

This section is to record the wheel positions used in Slab DF.
Required: Pos truck1 < Pos truck2 < Pos truck3.

Use Case:	*Routine*	Comment:	*A comment goes here*		
			Default	**User specified**	
	Typical uses		Truck Position (in)	Description	Truck Position Used, in
Truck Position 1	First wheel 2 ft from face of rail		*38*		
Truck Position 2	2 trucks in the middle of the bridge		*134*		
Truck Position 3	1 truck in the middle of the bridge		*194*		

Excel spreadsheet – programmed to meet specific needs

AASHTOWare BRIDGE

AASHTO BrR

NEBRASKA
Good Life. Great Journey.
DEPARTMENT OF TRANSPORTATION
BRIDGE DIVISION

CN: | Subject:
Project No:
Bridge No: | By: | Date:

)F-BrR

Goal:	The goal of this spreadsheet is to convert the results from the Slab DF for refined analysis of slab bridges to the input required by BrR. This tab is for LRFR. A see other tab for LFR.

Administration:	
Password to unlock fixed cells:	NDOT
Version:	Proto 2
Last modifed date:	
Modified by:	
TBD	
TBD	

Instructions:	Fill out the bridge geometry information, the inputs from BrR model information, and the outputs from Slab DF. Indicate which truck positions should be used in the results (with an "x"). This spreadsheet will provide the distribution factors in the same format as required by BrR. Copy over the DF to BrR and run model. Create as many tabs as required for each member, load case, etc. Save as copy of this spreadsheet as pdf in the load rating calculations. Add a note in BrR saying that the DF were determined based on refined analysis of the structure.

File Name:	C:\UNL\Research\NDOT slab\NDOT feedback 2025-06-30\[Mock up - slab load rating - Refined DF spreadsheet-V1-JP-2025-08-18.xlsx]Slab DF
Date from System:	9/22/2025

	98	in

s
s Tab, Results Graph, Dead Load Moment
noment. (REF FROM AAHSTO?)
. 1

Wheel Positions for Slab DF

This section is to record the wheel positions used in Slab DF.
Required: Pos truck1 < Pos truck2 < Pos truck3.

Use Case:	*Routine*	Comment:	*A comment goes here*

		Default	User specified	
	Typical uses	Truck Position (in)	Description	Truck Position Used, in
Truck Position 1	First wheel 2 ft from face of rail	*38*		
Truck Position 2	2 trucks in the middle of the bridge	*134*		
Truck Position 3	1 truck in the middle of the bridge	*194*		

Slab DF	Positions	Load Cases/Factors			Span 1			Span 2						Span 3					
Include in results	PosTruckX (in)	loadcase	group.One_Lane_Loaded	group.Second_Lane_Loaded	Length - Span 1 (ft)	LLDF One Lane Net - Span 1 (per ft) (1)	LLDF Both Lanes Net - Span 1 (per ft) (1)	Support Location (ft)	LLDF One Lane Support 2 (per ft) (1)	LLDF Both Lanes Support 2 (per ft) (1)	Span Length 2 (ft)	LLDF One Lane Span 2 (per ft) (1)	LLDF Both Lanes Span 2 (per ft) (1)	Support Location (ft)	LLDF One Lane Support 3 (per ft) (1)	LLDF Both Lanes Support 3 (per ft) (1)	Span Length 3 (ft)	LLDF One Lane Span 3 (per ft) (1)	LLDF Both Lanes Span 3 (per ft) (1)
yes	38	1	1	0	23.75	0.065939	0.08728	23.75	0.059945	0.085478	32.417	0.066352	0.088019	56.167	0.059945	0.085478	23.75	0.065943	0.087283
yes	38	2	0	1	23.75	0.021421	0.07564	23.75	0.027537	0.070981	32.417	0.021712	0.075292	56.167	0.027537	0.070981	23.75	0.02142	0.075642
yes	38	3	1	1	23.75	0.043559	0.081428	23.75	0.043905	0.078303	32.417	0.04379	0.081586	56.167	0.043905	0.078303	23.75	0.043561	0.081431
no	134	1	1	0	23.75	0.053743	0.073801	23.75	0.043177	0.068503	32.417	0.053176	0.073382	56.167	0.043178	0.068502	23.75	0.05375	0.073807
no	134	2	0	1	23.75	0.019029	0.073802	23.75	0.024416	0.068504	32.417	0.019176	0.073406	56.167	0.024416	0.068504	23.75	0.019026	0.073813
no	134	3	1	1	23.75	0.036386	0.073802	23.75	0.033796	0.068503	32.417	0.036171	0.073394	56.167	0.033796	0.068503	23.75	0.036387	0.07381
no	194	1	1	0	23.75	0.052942	0.073773	23.75	0.042135	0.068679	32.417	0.052323	0.073304	56.167	0.042136	0.06868	23.75	0.052951	0.073778
no	194	2	0	1	23.75	0.019581	0.078401	23.75	0.024636	0.074047	32.417	0.019786	0.078432	56.167	0.024639	0.074048	23.75	0.019578	0.078406
no	194	3	1	1	23.75	0.036303	0.076081	23.75	0.033345	0.071376	32.417	0.036133	0.075856	56.167	0.033347	0.071376	23.75	0.036306	0.076086

Notes:	For exterior strips, typically include in results the truck position close to the edge (1st truck position)
	For interior strips, typically include in results the truck posiitons near the middle of the bridge. (2nd and 3rd truck position)
	For routes with specific paths, only include the correct truck position

SlabDF-BrR

Bridge Geometry (from Slab DF)		
Span 1	*26.660*	ft
Span 2	*40.000*	ft
Span 3	*26.660*	ft
Total Length	93.3200	ft
Number of Spans	3	

Inputs are in this color
xx are in this color -- second color TBD
Inputs (paste from Slab DF are in this color

Note: span length could come automatically from SlabDF data?

Strip location	Strip Width	
Exterior	*60*	in
Interior	120	in

[redacted]

Outputs from Slab DF
Summary Table from Slab DF

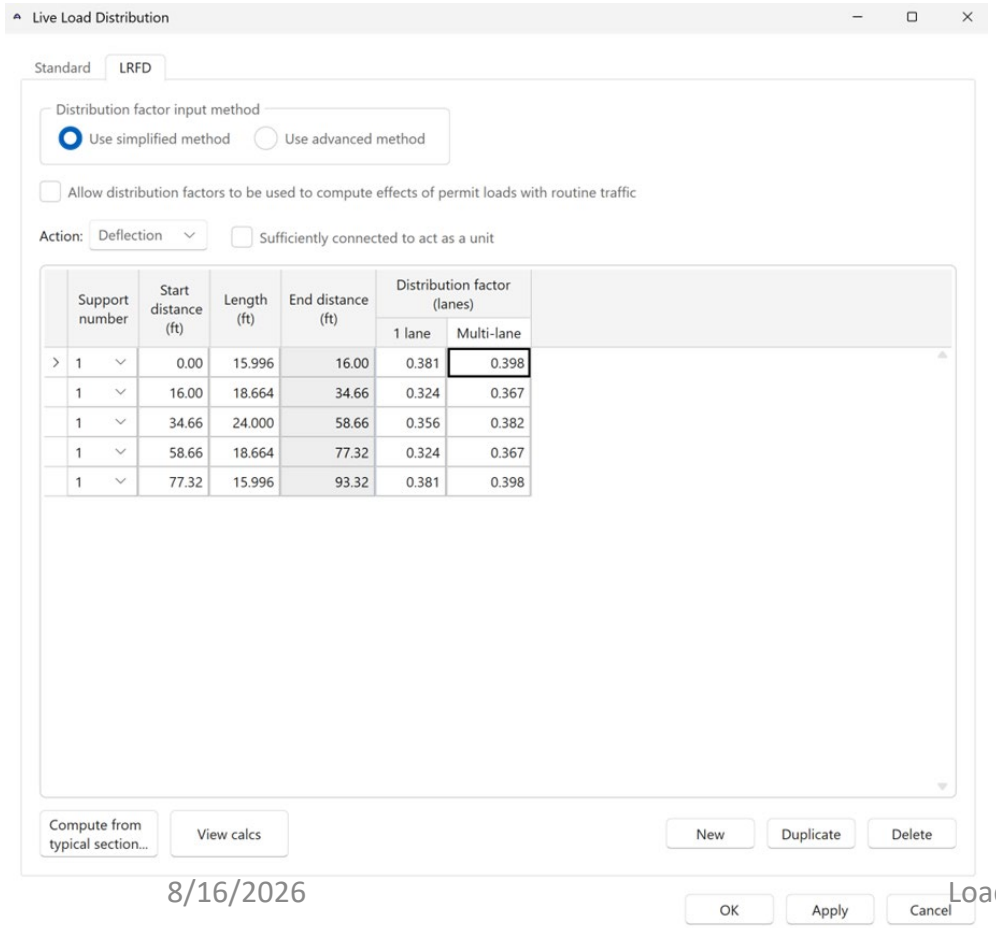
Values in this table from "From Slab DF" tab

Positions	Load Cases/Factors			Span 1			Support 2			Span 2			Support 3			Span 3		
PosTruckX (in)	loadcase	group.One_Lane_Loaded	group.Second_Lane_Loaded	Length - Span 1 (ft)	LLDF One Lane Net - Span 1 (per ft) (1)	LLDF Both Lanes Net - Span 1 (per ft) (1)	Support Location (ft)	LLDF One Lane Support 2 (per ft) (1)	LLDF Both Lanes Support 2 (per ft) (1)	Span Length 2 (ft)	LLDF One Lane Span 2 (per ft) (1)	LLDF Both Lanes Span 2 (per ft) (1)	Support Location (ft)	LLDF One Lane Support 3 (per ft) (1)	LLDF Both Lanes Support 3 (per ft) (1)	Span Length 3 (ft)	LLDF One Lane Span 3 (per ft) (1)	LLDF Both Lanes Span 3 (per ft) (1)
42	1	1	0	26.667	0.063	0.085	26.667	0.054	0.080	40.000	0.059	0.082	66.667	0.054	0.080	26.667	0.063	0.085
42	2	0	1	26.667	0.022	0.074	26.667	0.028	0.066	40.000	0.023	0.070	66.667	0.028	0.066	26.667	0.022	0.074
42	3	1	1	26.667	0.043	0.080	26.667	0.041	0.073	40.000	0.041	0.076	66.667	0.041	0.073	26.667	0.043	0.080
156	1	1	0	26.667	0.051	0.071	26.667	0.038	0.063	40.000	0.047	0.067	66.667	0.038	0.063	26.667	0.051	0.071
156	2	0	1	26.667	0.019	0.071	26.667	0.024	0.063	40.000	0.020	0.067	66.667	0.024	0.063	26.667	0.019	0.071
156	3	1	1	26.667	0.035	0.071	26.667	0.031	0.063	40.000	0.033	0.067	66.667	0.031	0.063	26.667	0.035	0.071
216	1	1	0	26.667	0.051	0.071	26.667	0.037	0.063	40.000	0.046	0.067	66.667	0.037	0.063	26.667	0.051	0.071
216	2	0	1	26.667	0.020	0.075	26.667	0.025	0.067	40.000	0.020	0.071	66.667	0.025	0.067	26.667	0.020	0.075
216	3	1	1	26.667	0.035	0.073	26.667	0.031	0.065	40.000	0.033	0.069	66.667	0.031	0.065	26.667	0.035	0.073

Summary											
	Analysis Strip, in	Span 1		Support 2		Span 2		Support 3		Span 3	
		1 lane	2 lanes	1 lane	2 lanes	1 lane	2 lanes	1 lane	2 lanes	1 lane	2 lanes
LLDF (Exterior) per ft	12	0.0635	0.0797	0.0539	0.0735	0.0594	0.0763	0.0539	0.0735	0.0635	0.0797
LLDF (Interior) per ft	12	0.0506	0.0713	0.0368	0.0627	0.0459	0.0672	0.0368	0.0627	0.0506	0.0713
LLDF Exterior Strip	60	0.3175	0.3983	0.2697	0.3673	0.2971	0.3817	0.2697	0.3673	0.3175	0.3984
LLDF Interior Strip	120	0.5063	0.7135	0.3675	0.6271	0.4593	0.6720	0.3675	0.6271	0.5064	0.7135

SlabDF-BrR

BrR Input Schedule Edge Strip (S1) (LRFR)							BrR LRFR
Support Number	Start Distance	Length	End distance	Distribution Factor			Data Used for which spans
	ft	ft	ft	1 lane	1 Lane x 1.2	Multi-lane	
1	0.000	15.996	15.996	0.317	0.381	0.398	1
1	15.996	18.664	34.660	0.270	0.324	0.367	2
1	34.660	24.000	58.660	0.297	0.356	0.382	2
1	58.660	18.664	77.324	0.270	0.324	0.367	3
1	77.324	15.996	93.320	0.317	0.381	0.398	3



Thanks to NDOT Bridge Staff for collaboration

Summary

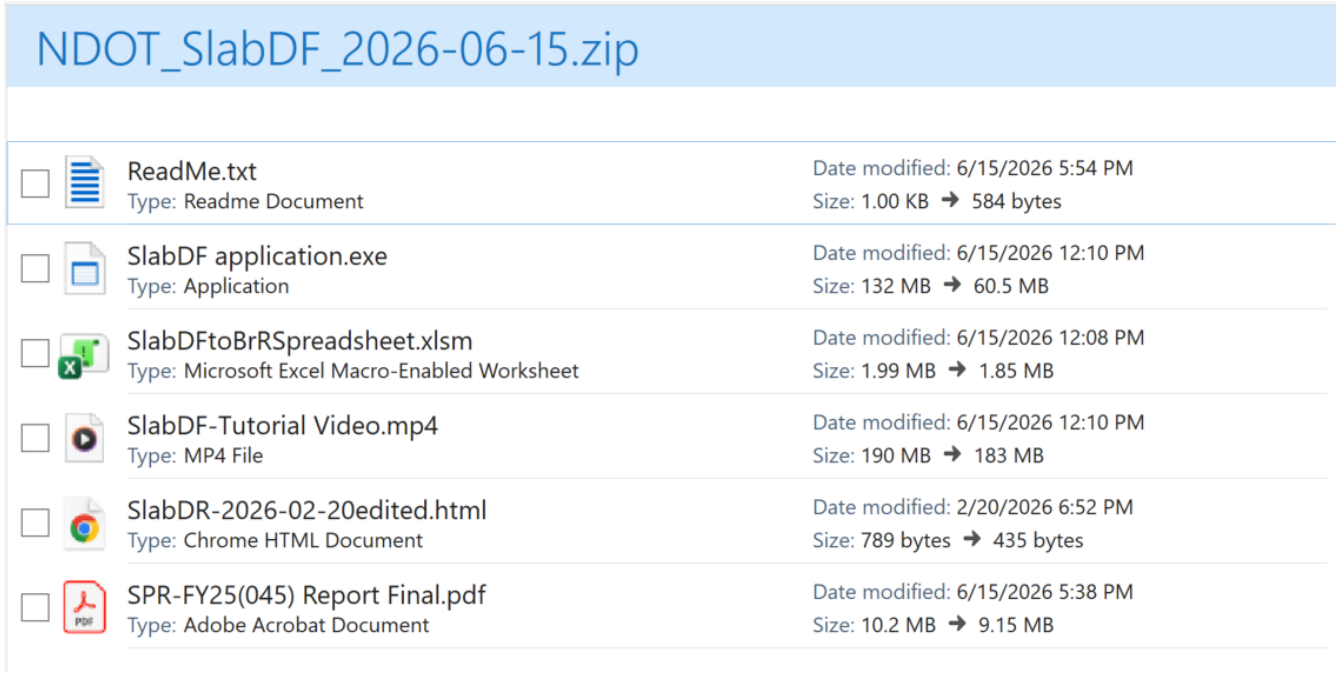
- Developed SlabDF – rigorous FEA application
- Optional Detailed Self-documenting Reports
- Static Checks are always available
- Interface spreadsheet SlabDF ->>> BrR
- Numerous examples
- How to video is available
- Nonstandard gage permit vehicles
- Already saved $450K

Big Picture Takeaway

- We can develop APPLETs to perform significant, rigorous analysis
- Address specific problems (parametric definition)
- New term “**democratization of simulation**”
- New approach to solving complex bridge engineering problems

Availability

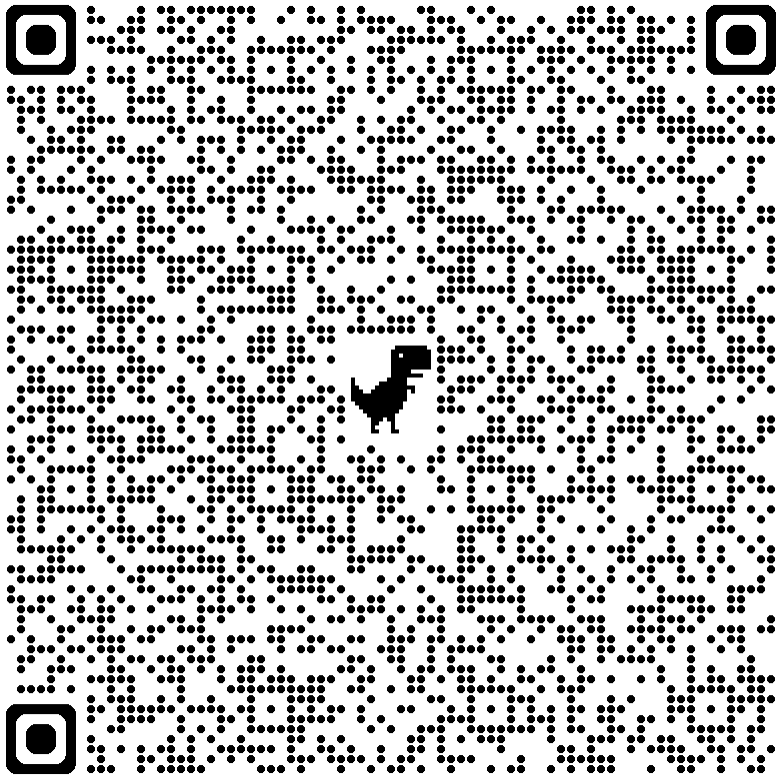
Name	Status	Date modified	Type	Size
NDOT_SlabDF_2026-06-15.zip		6/15/2026 5:54 PM	ZIP File	261,131 KB



NDOT_SlabDF_2026-06-15.zip

Availability

Jay Puckett
Puckett Research, LLC
JayPuckett@PuckettResearch.com



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- Put NDOT SlabDF in the subject
- Free
- We will keep track of downloads until I get this automated

NDOT SlabDF APPLET