FLORIDA BRIDGE CLASSIFICATION
FOR EMERGENCY VEHICLE LOAD RATING

Andrew DeVault, July 3, 2018

SUMMARY

This report determines which Florida highway bridges are affected by FAST Act Emergency Vehicles (EV), and classifies affected bridges into two groups. Group 1 bridges are sufficient for EV traffic, as existing load rating data shows adequate strength. Group 2 bridges have load rating data that is insufficient for EV traffic. Group 2 bridges will require reanalysis, and some will require weight restrictions.

The 11-03-2016 FHWA HIBS-1 memo and the 04-18-2018 FDOT Plan of Action for FAST Act Vehicles used $RF_{Inventory.LFR.HS20} < 1.0$ and $RF_{Inventory.LRFR.HL93} < 0.9$ to classify Group 2 bridges. This report refines those criteria by (1) applying chart-based concepts from "Questions and Answers, Load Rating for the FAST Act's Emergency Vehicles, Revision R01," (2) tailoring span length ranges to each bridge, and (3) including Florida reference trucks that resemble Emergency Vehicles.

In Florida:

- 2560 bridges are affected by the FAST Act
- 2482 bridge are Group 1, adequate for the EV
- 78 bridges are Group 2. These will be reanalyzed and considered for weight restriction.

CONTENTS

Additionally, all worksheets necessary to reproduce and check the process are contained within the calculations archive for this report, "Florida Bridge Classification for Emergency Vehicle Load Rating.zip."

HISTORY

On 12-04-2015, Fixing America's Surface Transportation Act (FAST Act) (Public Law 114-94) amended United States Code (USC) § 127 Vehicle Weight Limitations – Interstate System, with section (r) Emergency Vehicles.
http://uscode.house.gov/statviewer.htm?volume=129&page=1411#
https://www.law.cornell.edu/uscode/text/23/127

On 11-03-2016, Joseph Hartman of the FHWA provided initial guidance with a memorandum, "Action: Load Rating for the FAST Act's Emergency Vehicles."
https://www.fhwa.dot.gov/bridge/loadrating/161103.cfm

On 03-16-2018, Lubin Gao of the FHWA published technical guidance, "Questions and Answers, Load Rating for the FAST Act's Emergency Vehicles, Revision R01."
https://www.fhwa.dot.gov/bridge/loadrating/fast1410_qa.pdf

On 04-18-2018, Jeffrey Pouliotte of the FDOT submitted a Plan of Action (POA). Scheduling began with "Identification of Group 1 and Group 2 Bridges" by 07-01-2018, and ended with completion of load rating and posting of Group 2 bridges by 12-31-2019.

On 05-29-2018, Andrew DeVault of the FDOT informally discussed methodology with Nguyen Khoa, Jeffrey Ger, and Hector Laureano of the FHWA. Suggestions were (1) address continuity, (2) include working files, and (3) submit the methodology with the report due 07-01-2018.

REFERENCES

AASHTO LRFD Bridge Design Specifications, 8th Ed 2017 (LRFD)

AASHTO Manual for Bridge Evaluation 3rd Edition 2018 (MBE)

Florida Bridge Load Rating Manual, 2018 (BLRM)
http://www.fdot.gov/maintenance/STR/LR/FDOT_Load_Rating_Manual.pdf

METHOD TO SELECT BRIDGES AFFECTED BY THE FAST ACT

STEP 1. Begin with an initial list of State-owned highway bridges. Query the BRMSQL1 bridge database at DOT-WPSQL001-B.fdot.dot.state.fl.us\ENTPRODSQL with the query "EV_1_InitialSelection.sql." The first five results are:

BRKEY	LAT	LON	DISTRICT	FACILITY	FEATINT	KIND_HWY	OWNER
010001	27.02	-82.18	1	US-41 (SR-45)	CRESTWOOD WATER	2	1
010015	26.96	-81.76	1	SR-31	SHELL CREEK	3	1
010018	27.01	-81.76	1	SR-31	MYRTLE SLOUGH	3	1
010026	26.98	-82.09	1	US-41 (SR-45)	ELKHAM WATERWA	2	1
010028	26.97	-82.08	1	US-41 (SR-45)	HARBOR SQUARE DR.	2	1

Save the list to "DATA.xlsm," sheet BMS1.

STEP 2. Download the FDOT GIS Geodatabase from http://www.fdot.gov/statistics/gis/.

STEP 3. Use ESRI ArcMap to select state-owned bridges within 1 mile reasonable access.

- import StateBridges.xls from step 1 -> display xy data with Geographic World WGS 1984, save as StateBridges.shp
- import all interchanges from the geodatabase
- import all interstates from the geodatabase
- selection -> select by location -> select target=interchanges within 0.1 mile of source=interstate, save as Interchanges.shp
- selection -> select by location -> target=StateBridges within 1 mile of source=Interchanges.shp, save as StateBridges_NearInterchanges.shp
- selection -> select by attribute -> select StateBridges where Kind_Hwy = 1-interstate, save as StateBridges_Interstate.shp
- delete all NBI fields (the combination of integer and string data confuses ArcMap, so the merge tool would otherwise fail)
- toolbox -> merge StateBridges_NearInterchanges.shp and StateBridges_Interstate.shp, save as EV_Bridges.shp
- toolbox -> dissolve EV_Bridges.shp on Brkey to remove duplicates, save as EV_Bridges_Dissolved.shp
- toolbox -> export EV_Bridges_Dissolved to Google Earth kmz, save as EV_Bridges.kmz

STEP 4. Check the bridge selection in Google Earth. Exclude non-interstate bridges that are greater than 1 mile by State roadway, from the end of the exit ramp to the beginning of the bridge. Export to csv, and use the results to inform a new query, "EV_2_FinalSelection.sql."

METHOD TO CLASSIFY AFFECTED BRIDGES AS GROUP 1 OR GROUP 2

STEP 1. Query the BRMSQL1 database with "EV_2_FinalSelection.sql." This lists all bridges affected by the FAST Act, and pulls selected load rating data. Store the results in worksheet "DATA.xlsm," sheet "BMS3." The first 3 results are:

BrKey	LAT	LON	DISTRICT	MATERIALMAIN	DESIGNMAIN	MATERIALAPPR	DESIGNAPPR	TYPEMAIN	TYPEAPPR	TYPE	KIND_HWY	L MIN	L MAX	OPR	FLSU4	FL120
010059	26.98	-82.02	1	5 - Prestressed concre	2 - Stringer/Multi-bea	! - Not Applicable	0 - Other	Simple	NA	Simple	1 - Interstate highway	0	108.9	89.6	83.7	-1
010060	26.98	-82.02	1	5 - Prestressed concre	2 - Stringer/Multi-bea	! - Not Applicable	0 - Other	Simple	NA	Simple	1 - Interstate highway	0	108.7	89.6	83.7	-1
010067	26.94	-82.02	1	5 - Prestressed concre	2 - Stringer/Multi-bea	\N	\N	Simple	NA	Simple	2 - U.S. numbered higl	47	60	53.4	50.5	-1

LEGEND

- BrKey – bridge number
- LAT & LON – degrees latitude, longitude
- DISTRICT – managing district number
- MATERIALMAIN – main span material (NBI Item No. 43, Segment A)
- DESIGNMAIN – main span design (NBI Item No. 43, Segment B)
- MATERIALAPPR – approach span material (NBI Item No. 44, Segment A)
- DESIGNAPPR – approach span design (NBI Item No. 44, Segment B)
- TYPEMAIN & TYPEAPPR –whether the spans are simply-supported or continuous, where:
  when substring (BRIDGE.MATERIALMAIN,1,1) IN ('2', '4','6') then 'Continuous'
  when substring (BRIDGE.DESIGNMAIN,1,2) IN ('19', '21') then 'Continuous'
  else 'Simple'
- TYPE – Simple, Continuous, or Mix (both Simple and Continuous)
- L MIN – the minimum span length in feet. This is a new field, taken as at least 5 feet.
- L MAX – the maximum span length in feet (NBI Item No. 48).
- OPR – the operating rating in English tons for the design vehicle.
- FLSU4 – the operating rating in English tons for the Florida SU4 vehicle defined by the BLRM.
- FL120 – the permit rating in English tons for the Florida FL120 vehicle defined by the BLRM.

STEP 2. Use EV_3b_LL_UNISTIFF…xmcd to produce live load tables. Store the results in worksheet "DATA.xlsm" at sheets "LFR" and "LRFR."

STEP 3. Use MathCAD worksheet "EV_4_RFs.xmcd" to infer EV rating factors. Append "DATA.xlsm" sheet "BMS3" with the rating factor results. A detailed explanation is provided in Appendix A - Calculations. The first 3 results are:

BrKey	LAT	LON	DISTRICT	MATERIALMAIN	DESIGNMAIN	MATERIALAPPR	DESIGNAPPR	TYPEMAIN	TYPEAPPR	TYPE	KIND_HWY	L MIN	L MAX	OPR	FLSU4	FL120	**RF.EV**	**GROUP**
010059	26.98	-82.02	1	5 - Prestressed cor	2 - Stringer/Multi-	! - Not Applicable	0 - Other	Simple	NA	Simple	1 - Interstate high	0	108.9	89.6	83.7	-1	**1.6057**	**Group 1**
010060	26.98	-82.02	1	5 - Prestressed cor	2 - Stringer/Multi-	! - Not Applicable	0 - Other	Simple	NA	Simple	1 - Interstate high	0	108.7	89.6	83.7	-1	**1.6057**	**Group 1**
010067	26.94	-82.02	1	5 - Prestressed cor	2 - Stringer/Multi-	\N	\N	Simple	NA	Simple	2 - U.S. numbered	47	60	53.4	50.5	-1	**1.1722**	**Group 1**

LEGEND, NEW FIELDS

- RF.EV – inferred rating factors for the Emergency Vehicle
- GROUP – bridge classifications, Group 1 or Group 2

STEP 4. Review "DATA.xlsm" sheet "VERBOSE."

STEP 5. Export "DATA.xlsm" sheet "BMS3" to "MAP.kmz," and review the results in Google Earth.

EV BRIDGE CLASSIFICATION CALCULATIONS

Given existing Florida bridge load rating data, infer Rating Factors (RF) for Emergency Vehicles (EV) described by the FAST Act and clarified by FHWA Question and Answer guidance. If RF.EV > 1.00, judge the bridge sufficient for the EV (Group 1). If RF.EV < 1.00, identify the bridge for reanalysis (Group 2). Use known rating factors from reference vehicles to infer EV rating factors. For example, if the rating factor for the HS20 is known, and the span length is also known, then:

$$RF_{HS20} = \frac{Capacity - Dead\_Load}{Live\_Load_{HS20}} \text{ and } RF_{EV} = \frac{Capacity - Dead\_Load}{Live\_Load_{EV}}, \text{ so } RF_{EV} = RF_{HS20} \cdot \frac{Live\_Load_{HS20}}{Live\_Load_{EV}}$$

ASSUMPTIONS

(1) Maximum effects adequately model the inference. For example, say shear governs the FL120 at 30% span length, and the FL120 rating is 45 tons, but the inference instead assumes that the FL120 is governed by shear at 0% span length. Here RF.EV=0.965 at the bearing, yet RF.EV=0.918 at 30% span length. However governance is more likely to appear near maximum effects, and the discrepancy is acceptable.

(2) For truck-to-truck inferences, continuous spans are adequately modeled by two equal-length spans of uniform stiffness. This reasonably represents the governing truck-to-truck ratio, especially when many span lengths are considered.

(3) Say dynamic impact is always per AASHTO. For LFR, use Std.Spec Eq.3-1, and follow BARS; apply the same impact for moment and shear. For LRFR, apply 33% impact. LFR applies the same impact to axles and lane loading, so the truck-to-truck live load ratio is indifferent to impact. However LRFR only applies impact to axle loading, not lane loading. This affects the inference. However it is conservative to assume that impact was applied, when it in fact does not apply.

(4) Say HS20 ratings neglected the Military Tandem (conservative), and say Florida SU4 ratings excluded truck trains. Most LFR ratings in Florida were performed under Bridge Analysis and Rating System (BARS) software, and BARS did not natively apply the 24kip - 4ft - 24 kip tandem. Furthermore most ratings did not apply SU4 truck trains, as the provision irregularly applies to a single lane for spans over 200 feet (MBE 6B.7.2). In any case for a rating factor inference, it is conservative to assume that LFR ratings omitted Tandems and SU4 truck trains.

PROCESS

1. Try all maximum effects, taking the worst case. Simply-supported spans test positive moment and positive shear. Continuous spans test positive moment, negative moment, positive shear, and negative shear.

2. Try all plausible span lengths, taking the worst case. Consider many span lengths, ranging from the minimum span length to the maximum span length, but neglect span lengths that do not exist on the bridge under consideration..

3. Use two reference trucks, taking the best case. Trucks fit some spans better than others, and the inference is improved by considering more than one truck. For LFR ratings, consider the HS20 and the SU4. For LRFR ratings, consider the HL93 and the FL120.

BRIEF EXAMPLE

Bridge Number: 010071
Span Lengths, Minimum: 49.0 ft
Span Lengths, Maximum: 83.0 ft
HS20 Operating Rating: 64.4 tons
SU4 Operating Rating: 59.9 tons

1. Try all maximum effects. For this simply-supported bridge, both moment and shear were considered. Shear was the worst case.

2. Try all plausible span lengths, ranging from 49 to 83 feet. For this bridge, the worst-case was 49 feet. The live load table included 45ft and 50ft spans, linear interpolation approximated the effects for a 49ft span.

3. Try two trucks. For the governing location at this bridge, the Florida SU4 was the best fit.

$$RF_{EV} := \frac{59.9\text{tonf}}{35\text{tonf}} \cdot \frac{77.56\text{kip}}{95.45\text{kip}} = 1.39$$

DETAILED EXAMPLE

GIVEN

Bridge Number:	010071	
Span Lengths, Minimum:	49	ft
Span Lengths, Maximum:	83	ft
HS20 Operating Rating:	64.4	tons
SU4 Operating Rating:	59.9	tons
HS20 Operating Rating Factor:	1.789	
SU4 Operating Rating Factor:	1.711	

MAXIMUM LIVE LOAD WITH LFR IMPACT

SPAN	EV	EV	HS20	HS20	FL.SU4	FL.SU4
(ft)	(k-ft)	(kip)	(k-ft)	(kip)	(k-ft)	(kip)
45	943.39	94.61	697.14	73.85	801.67	76.86
50	1075.13	95.66	807.17	75.29	908.69	77.73
60	1334.64	96.96	1023.84	77.23	1119.51	78.81
70	1589.53	97.64	1237.88	78.4	1326.62	79.38
80	1840.48	97.96	1448.9	79.11	1530.55	79.65
90	2088.03	98.06	1656.99	79.54	1731.75	79.74

LIVE LOAD RATIOS: (REFERENCE VEHICLE)/(EMERGENCY VEHICLE)

SPAN	HS20/EV			FL.SU4/EV		
(ft)	(k-ft)	(kip)	min	(k-ft)	(kip)	min
45	0.739	0.781	0.739	0.850	0.812	0.812
50	0.751	0.787	0.751	0.845	0.813	0.813
60	0.767	0.797	0.767	0.839	0.813	0.813
70	0.779	0.803	0.779	0.835	0.813	0.813
80	0.787	0.808	0.787	0.832	0.813	0.813
90	0.794	0.811	0.794	0.829	0.813	0.813

INFERRED EV RATING FACTORS:

SPAN	(RF_{HS20})(HS20/EV)	(RF_{FLSU4})(FLSU4/EV)	RF_{EV}
45	1.3219	1.3903	1.3903
50	1.3430	1.3906	1.3906
60	1.3723	1.3911	1.3911
70	1.3931	1.3914	1.3931
80	1.4083	1.3915	1.4083
90	1.4196	1.3917	1.4196

EV RATING FACTOR, FOR MINIMUM & MAXIMUM SPANS, INTERPOLATE:

$$RF_{EV} := \min\left[\begin{pmatrix}1.3906\\1.3911\\1.3931\\1.4083\end{pmatrix}, \mathrm{linterp}\left[\begin{pmatrix}45\\50\\60\\70\\80\\90\end{pmatrix}, \begin{pmatrix}1.3903\\1.3906\\1.3911\\1.3931\\1.4083\\1.4196\end{pmatrix}, 49\right], \mathrm{linterp}\left[\begin{pmatrix}45\\50\\60\\70\\80\\90\end{pmatrix}, \begin{pmatrix}1.3903\\1.3906\\1.3911\\1.3931\\1.4083\\1.4196\end{pmatrix}, 83\right]\right]$$

$RF_{EV} = 1.3905$

EV CALCULATIONS (3 of 14)

TRUCK DESCRIPTIONS

Most HS20 Load Factor Ratings (LFR) were performed under BARS, which did not include the 24kip-4ft-24kip Military Tandem. Therefore assume all LFR ratings omitted the Military Tandem (conservative). Also, some LFR ratings did not apply a legal vehicle truck train for spans over 200 feet. Therefore assume all LFR ratings applied a single SU4 truck (conservative).

$$HS20moment = \begin{bmatrix} \begin{pmatrix} 0ft & 8kip \\ 14ft & 32kip \\ \text{"14 to 30 ft"} & 32kip \end{pmatrix} \\ \begin{pmatrix} 0 & 18kip & 0.64klf \end{pmatrix} \end{bmatrix} \quad HS20shear = \begin{bmatrix} \begin{pmatrix} 0ft & 8kip \\ 14ft & 32kip \\ \text{"14 to 30 ft"} & 32kip \end{pmatrix} \\ \begin{pmatrix} 0 & 18kip & 0.64klf \end{pmatrix} \end{bmatrix}$$

- HS20, simply-supported

$$HS20moment = \begin{bmatrix} \begin{pmatrix} 0ft & 8kip \\ 14ft & 32kip \\ \text{"14 to 30 ft"} & 32kip \end{pmatrix} \\ \begin{pmatrix} 0 & 18kip & 0.64klf \\ \text{"0 to }\infty\text{ ft"} & 18kip & 0.64klf \end{pmatrix} \end{bmatrix} \quad HS20shear = \begin{bmatrix} \begin{pmatrix} 0ft & 8kip \\ 14ft & 32kip \\ \text{"14 to 30 ft"} & 32kip \end{pmatrix} \\ \begin{pmatrix} 0 & 18kip & 0.64klf \end{pmatrix} \end{bmatrix}$$

- HS20, continuous spans

$$FLSU4\_truck = \begin{pmatrix} 0 & 13.9kip \\ 9.17ft & 18.7kip \\ 4.17ft & 18.7kip \\ 4.17ft & 18.7kip \end{pmatrix}$$

- Florida single-unit 4-axle truck

$$HL93 = \begin{bmatrix} \begin{pmatrix} 0 & 8kip & 0.64klf \\ 14ft & 32kip & 0 \\ \text{"14 to 30 ft"} & 32kip & 0 \end{pmatrix} \\ \begin{pmatrix} 0ft & 25kip & 0.64klf \\ 4ft & 25kip & 0 \end{pmatrix} \end{bmatrix}$$

- HL93, moment for simply-supported spans, and shear for all spans

$$HL93_{moment} = \begin{pmatrix} 0ft & 0.90 \cdot 8kip & 0.90 \cdot 0.64klf \\ 14ft & 0.90 \cdot 32kip & 0 \\ 14ft & 0.90 \cdot 32kip & 0 \\ \text{"50 to }\infty\text{ ft"} & 0.90 \cdot 8kip & 0 \\ 14ft & 0.90 \cdot 32kip & 0 \\ 14ft & 0.90 \cdot 32kip & 0 \end{pmatrix}$$

- additional HL93 truck for negative moment only

$$FL120\_truck = \begin{pmatrix} 0ft & 13.4kip & 0 \\ 14ft & 53.3kip & 200ft \\ 14ft & 53.3kip & 0.200klf \end{pmatrix}$$

- Florida routine permit truck

$$EV = \begin{bmatrix} \begin{pmatrix} 0ft & 24kip \\ 15ft & 33.5kip \end{pmatrix} \\ \begin{pmatrix} 0ft & 24kip \\ 15ft & 31kip \\ 4ft & 31kip \end{pmatrix} \end{bmatrix}$$

- Fast Act emergency vehicles

READ DATA: EV, HS20, & FLSU4 WITH LFR IMPACT

Live load in "DATA.xlsm" sheet "LFR" from previous calculations by "EV_3e_LL_UNISTIFF_multibridge.xmcd."

LFR impact = minimum [1.30, 1+ 50/(125 + SPAN)]. LFR impact is applied to axle loading and lane loading.

EV_1sMp_lfr := READEXCEL("DATA.xlsm","LFR!M5:M49","")·kip·ft - EV, single-span positive moment

HS20_1sMp_lfr := READEXCEL("DATA.xlsm","LFR!N5:N49","")·kip·ft - HS20, single-span positive moment

FLSU4_1sMp_lfr := READEXCEL("DATA.xlsm","LFR!O5:O49","")·kip·ft - SU4, single-span positive moment

EV_1sVp_lfr := READEXCEL("DATA.xlsm","LFR!S5:S49","")·kip·ft - EV, single-span positive shear

HS20_1sVp_lfr := READEXCEL("DATA.xlsm","LFR!T5:T49","")·kip·ft - HS20, single-span positive shear

FLSU4_1sVp_lfr := READEXCEL("DATA.xlsm","LFR!U5:U49","")·kip·ft - SU4, single-span positive shear

EV_2sMp_lfr := READEXCEL("DATA.xlsm","LFR!M50:M94","")·kip·ft - EV, 2-span continuous, positive moment

HS20_2sMp_lfr := READEXCEL("DATA.xlsm","LFR!N50:N94","")·kip·ft - HS20, 2-span continuous, positive moment

FLSU4_2sMp_lfr := READEXCEL("DATA.xlsm","LFR!O50:O94","")·kip·ft - SU4, 2-span continuous, positive moment

EV_2sMn_lfr := READEXCEL("DATA.xlsm","LFR!P50:P94","")·kip·ft - EV, 2-span continuous, negative moment

HS20_2sMn_lfr := READEXCEL("DATA.xlsm","LFR!Q50:Q94","")·kip·ft - HS20, 2-span continuous, negative moment

FLSU4_2sMn_lfr := READEXCEL("DATA.xlsm","LFR!R50:R94","")·kip·ft - SU4, 2-span continuous, negative moment

EV_2sVp_lfr := READEXCEL("DATA.xlsm","LFR!S50:S94","")·kip·ft - EV, 2-span continuous, span 1 positive shear

HS20_2sVp_lfr := READEXCEL("DATA.xlsm","LFR!T50:T94","")·kip·ft - HS20, 2-span continuous, span 1 positive shear

FLSU4_2sVp_lfr := READEXCEL("DATA.xlsm","LFR!U50:U94","")·kip·ft - SU4, 2-span continuous, span 1 positive shear

EV_2sVn_lfr := READEXCEL("DATA.xlsm","LFR!V50:V94","")·kip·ft - EV, 2-span continuous, span 1 negative shear

HS20_2sVn_lfr := READEXCEL("DATA.xlsm","LFR!W50:W94","")·kip·ft - HS20, 2-span continuous, span 1 negative shear

FLSU4_2sVn_lfr := READEXCEL("DATA.xlsm","LFR!X50:X94","")·kip·ft - SU4, 2-span continuous, span 1 negative shear

READ DATA: EV, HL93, & FL120 WITH LRFR IMPACT

LRFR applies a 1.33 impact factor to axle loading, and no impact to lane loading.

Live load in "DATA.xlsm" sheet "LRFR" from previous calculations by "EV_3e_LL_UNISTIFF_multibridge.xmcd."

EV_1sMp_lrfr:= READEXCEL("DATA.xlsm","LRFR!M5:M49","")·kip·ft - EV, single-span positive moment

HL93_1sMp_lrfr:= READEXCEL("DATA.xlsm","LRFR!N5:N49","")·kip·ft - HL93, single-span positive moment

FL120_1sMp_lrfr:= READEXCEL("DATA.xlsm","LRFR!O5:O49","")·kip·ft - FL120, single-span positive moment

EV_1sVp_lrfr:= READEXCEL("DATA.xlsm","LRFR!S5:S49","")·kip·ft - EV, single-span positive shear

HL93_1sVp_lrfr:= READEXCEL("DATA.xlsm","LRFR!T5:T49","")·kip·ft - HL93, single-span positive shear

FL120_1sVp_lrfr:= READEXCEL("DATA.xlsm","LRFR!U5:U49","")·kip·ft - FL120, single-span positive shear

EV_2sMp_lrfr:= READEXCEL("DATA.xlsm","LRFR!M50:M94","")·kip·ft - EV, 2-span continuous, positive moment

HL93_2sMp_lrfr:= READEXCEL("DATA.xlsm","LRFR!N50:N94","")·kip·ft - HL93, 2-span continuous, positive moment

FL120_2sMp_lrfr:= READEXCEL("DATA.xlsm","LRFR!O50:O94","")·kip·ft - FL120, 2-span continuous, positive moment

EV_2sMn_lrfr:= READEXCEL("DATA.xlsm","LRFR!P50:P94","")·kip·ft - EV, 2-span continuous, negative moment

HL93_2sMn_lrfr:= READEXCEL("DATA.xlsm","LRFR!Q50:Q94","")·kip·ft - HL93, 2-span continuous, negative moment

FL120_2sMn_lrfr:= READEXCEL("DATA.xlsm","LRFR!R50:R94","")·kip·ft - FL120, 2-span continuous, negative moment

EV_2sVp_lrfr:= READEXCEL("DATA.xlsm","LRFR!S50:S94","")·kip·ft - EV, 2-span continuous, span 1 positive shear

HL93_2sVp_lrfr:= READEXCEL("DATA.xlsm","LRFR!T50:T94","")·kip·ft - HL93, 2-span continuous, span 1 pos. shear

FL120_2sVp_lrfr:= READEXCEL("DATA.xlsm","LRFR!U50:U94","")·kip·ft - FL120, 2-span continuous, span 1 pos. shear

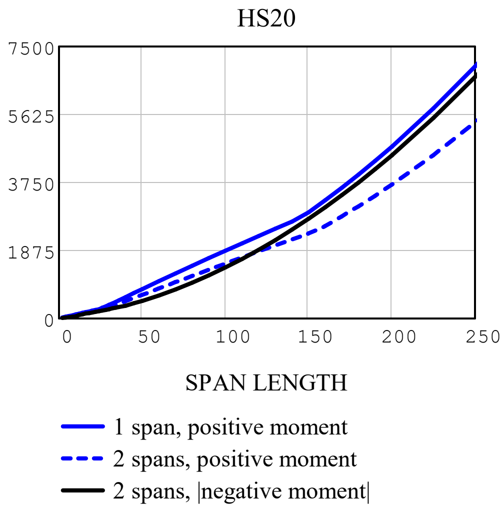
EV_2sVn_lrfr:= READEXCEL("DATA.xlsm","LRFR!V50:V94","")·kip·ft - EV, 2-span continuous, span 1 negative shear

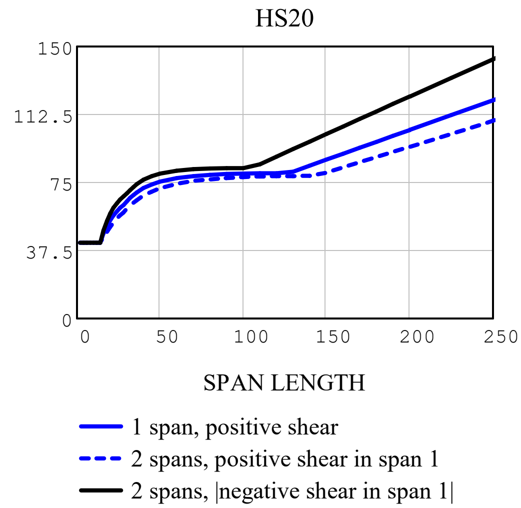
HL93_2sVn_lrfr:= READEXCEL("DATA.xlsm","LRFR!W50:W94","")·kip·ft - HL93, 2-span continuous, span 1 neg. shear

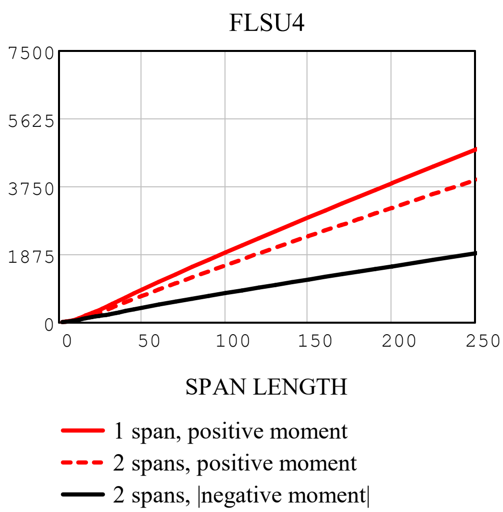
FL120_2sVn_lrfr:= READEXCEL("DATA.xlsm","LRFR!X50:X94","")·kip·ft - FL120, 2-span continuous, span 1 neg. shear

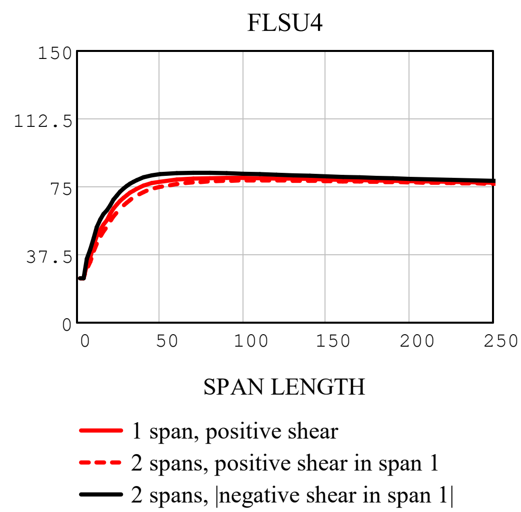
SPANS := READEXCEL("DATA.xlsm","LFR!C5:C49","")·ft

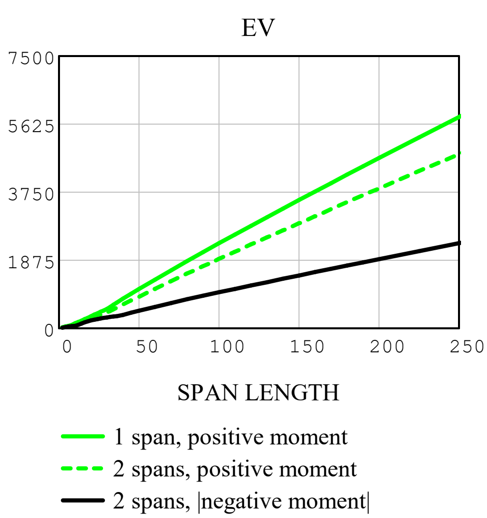
Live Load With Impact, LFR

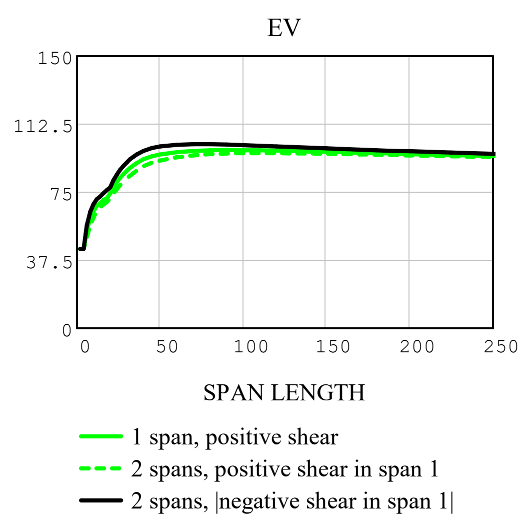




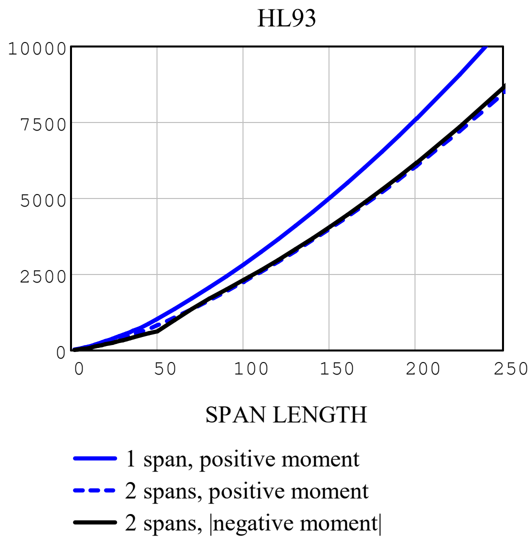


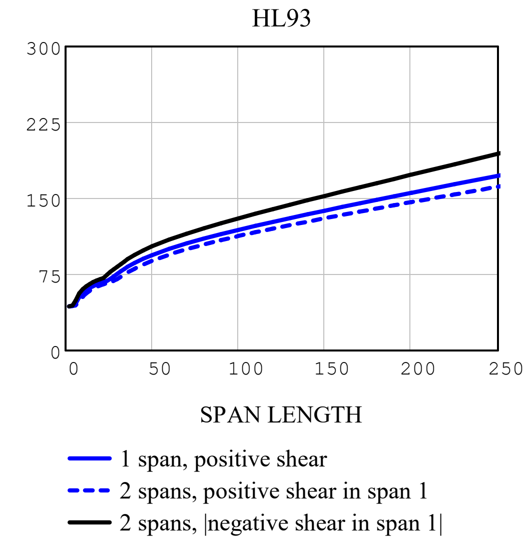


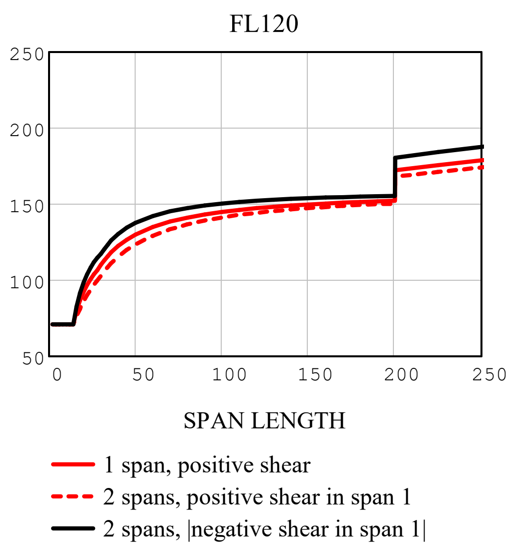


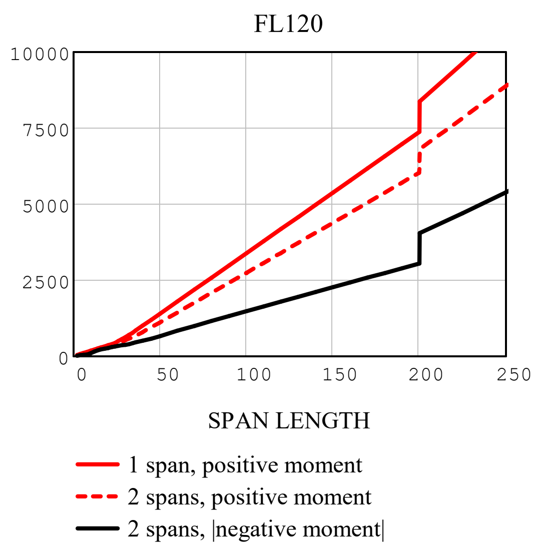


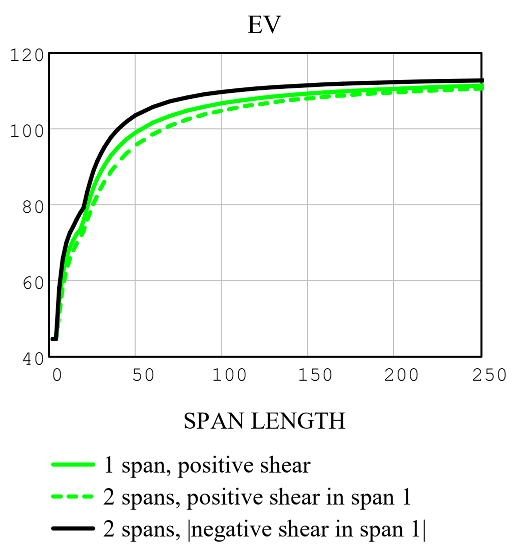
Live Load With Impact, LRFR

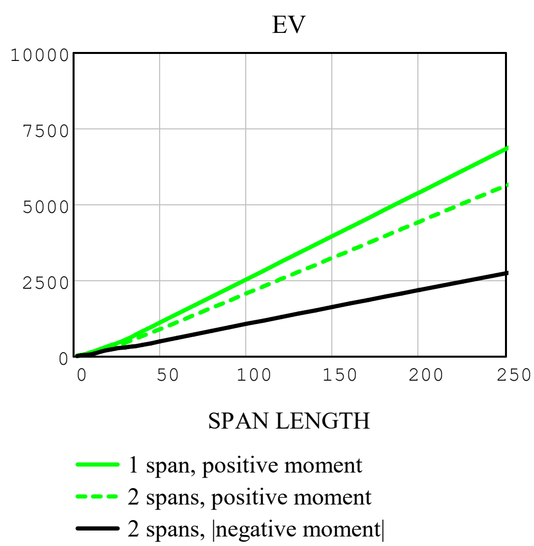




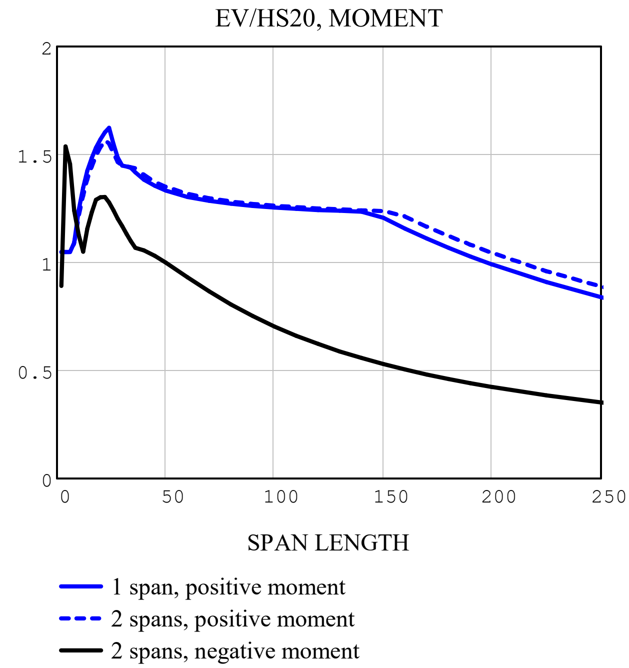


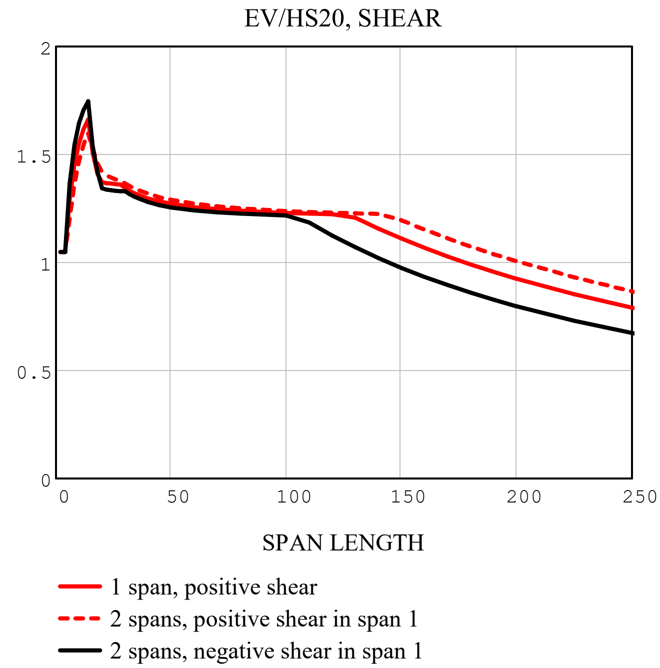




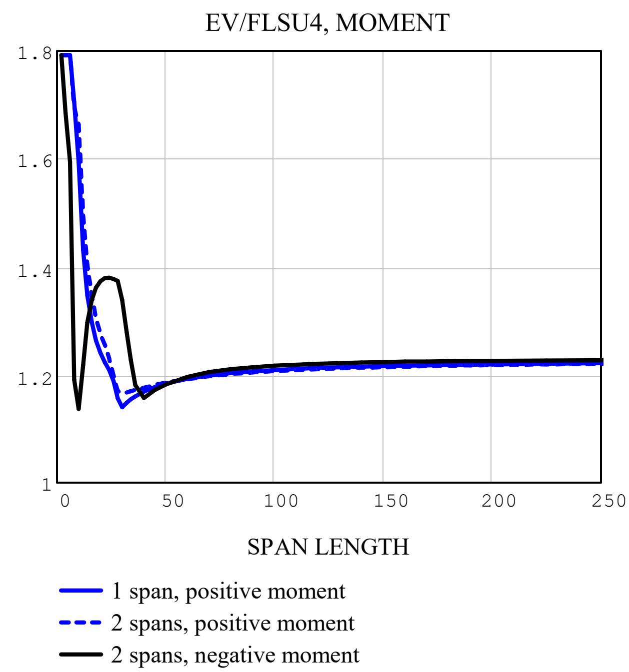


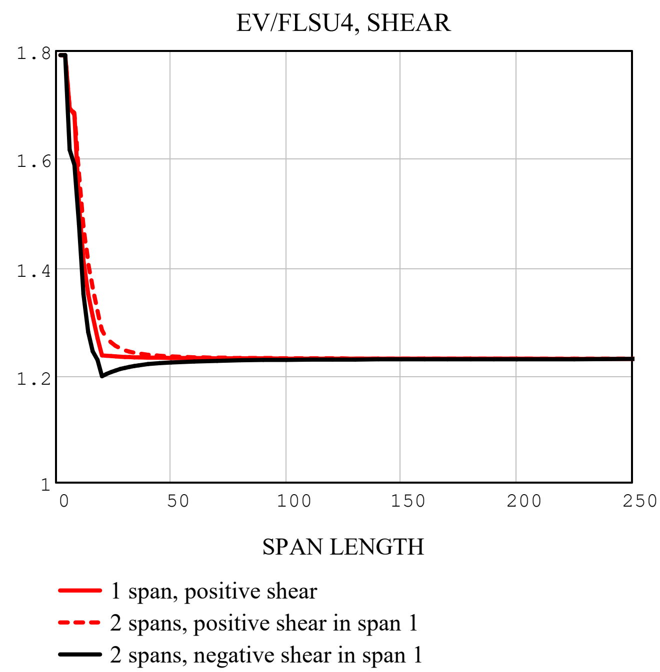
RFs Needed to Pass the EV, LFR HS20 Operating



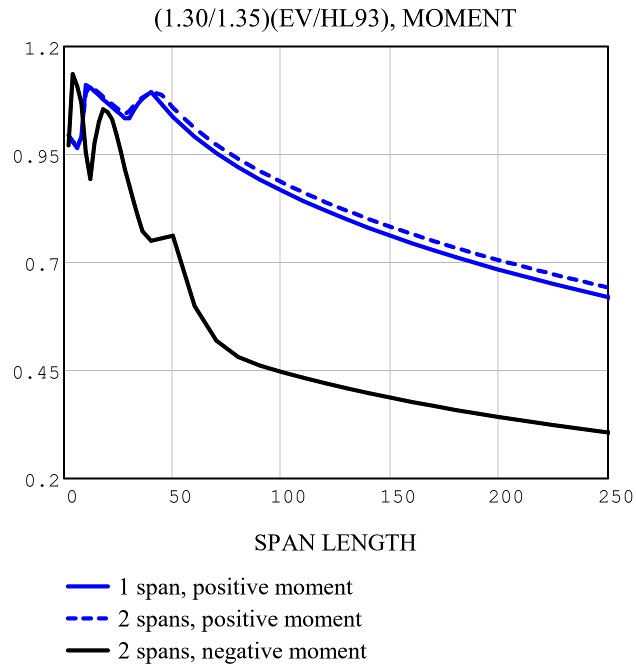


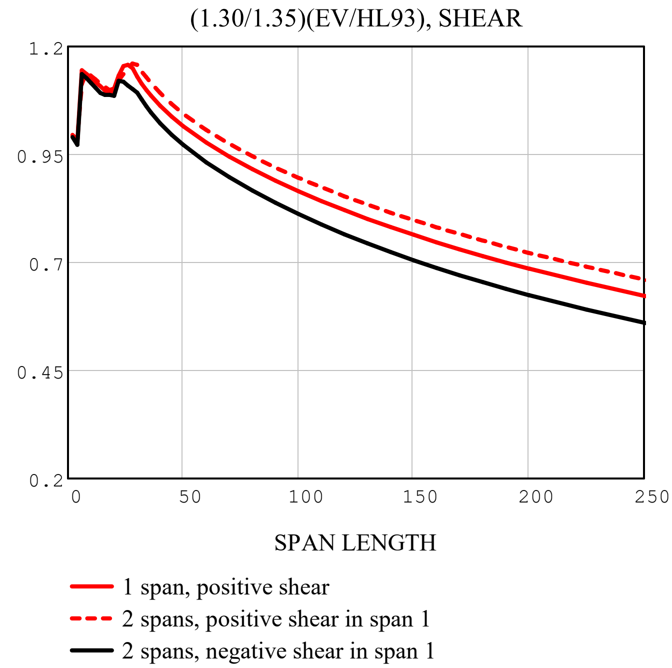
RFs Needed to Pass the EV, LFR FLSU4 Operating



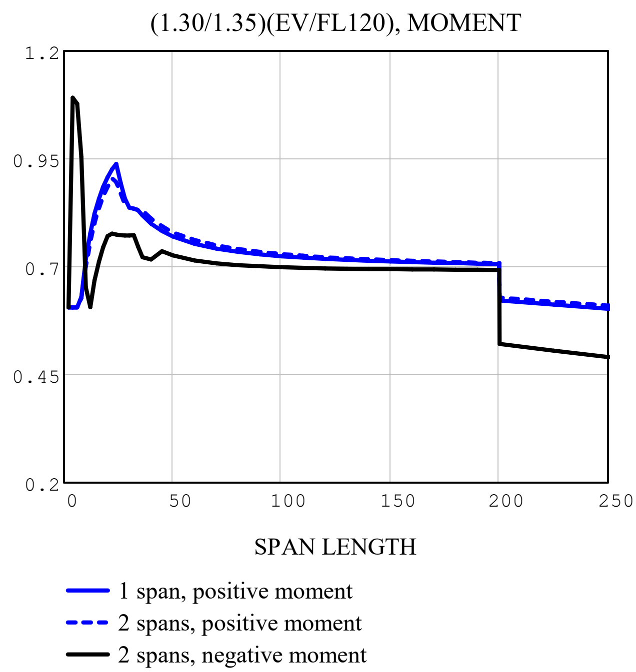


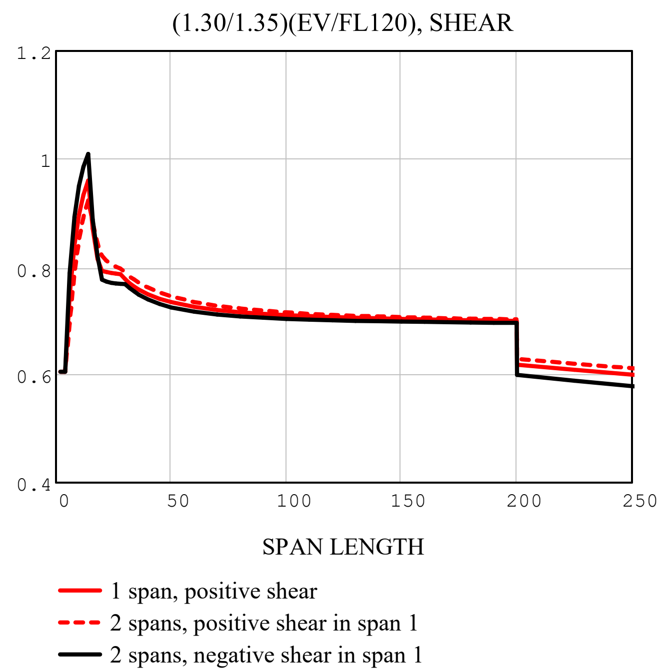
RFs Needed to Pass the EV, LRFR HL93 Operating





RFs Needed to Pass the EV, LRFR FL120 Permit





READ BMS DATA

BMS := READEXCEL("DATA.xlsm","BMS3!A1:Z3000","")

```
FindNull(V) := | i ← 1
               | while V_i ≠ "" ∧ i < rows(V)
               |   i ← i + 1
               | i − 1
```

$BMS\_nor := FindNull\left(BMS^{\langle 1 \rangle}\right) = 2562$

$BMS\_noc := FindNull\left[\left(BMS^{T}\right)^{\langle 2 \rangle}\right] = 19$

BMS_hdr := submatrix(BMS, 2, 2, 1, BMS_noc)

BMS_data := submatrix(BMS, 3, BMS_nor, 1, BMS_noc)

mxAB(A, B) := max(A, B)

LL(LiveLoad, SpanLength) := linterp(SPANS, LiveLoad, SpanLength)

$BrNos := BMS\_data^{\langle 1 \rangle}$ - bridge numbers

$TYPE := BMS\_data^{\langle 11 \rangle}$ - bridge type, simple or continuous

$Lmin := \overrightarrow{mxAB\left(5ft, BMS\_data^{\langle 13 \rangle} \cdot ft\right)}$ - minimum span lengths (if 0-unknown, say 5 feet)

$Lmax := BMS\_data^{\langle 14 \rangle} \cdot ft$ - maximum span lengths

$OPR := BMS\_data^{\langle 15 \rangle} \cdot tonf$ - Operating ratings (HS20 for LFR, or HL93 for LRFR)

$FLSU4 := BMS\_data^{\langle 16 \rangle} \cdot tonf$ - Florida SU4 ratings

$FL120 := BMS\_data^{\langle 17 \rangle} \cdot tonf$ - Florida FL120 ratings

EV RF EQUATIONS (1 OF 3)

$$RF_EV_LFR(L,OPR,FLSU4) := \begin{pmatrix}
\text{"HS20"} & \text{"Moment, Positive"} & \frac{1.30}{1.30}\cdot\frac{OPR}{36tonf}\cdot\frac{LL(HS20_1sMp_lfr,L)}{LL(EV_1sMp_lfr,L)} & \frac{1.30}{1.30}\cdot\frac{OPR}{36tonf}\cdot\frac{LL(HS20_2sMp_lfr,L)}{LL(EV_2sMp_lfr,L)} \\
\text{"HS20"} & \text{"Moment, Negative"} & 99 & \frac{1.30}{1.30}\cdot\frac{OPR}{36tonf}\cdot\frac{LL(HS20_2sMn_lfr,L)}{LL(EV_2sMn_lfr,L)} \\
\text{"HS20"} & \text{"Shear, Positive"} & \frac{1.30}{1.30}\cdot\frac{OPR}{36tonf}\cdot\frac{LL(HS20_1sVp_lfr,L)}{LL(EV_1sVp_lfr,L)} & \frac{1.30}{1.30}\cdot\frac{OPR}{36tonf}\cdot\frac{LL(HS20_2sVp_lfr,L)}{LL(EV_2sVp_lfr,L)} \\
\text{"HS20"} & \text{"Shear, Negative"} & 99 & \frac{1.30}{1.30}\cdot\frac{OPR}{36tonf}\cdot\frac{LL(HS20_2sVn_lfr,L)}{LL(EV_2sVn_lfr,L)} \\
\text{"FLSU4"} & \text{"Moment, Positive"} & \frac{1.30}{1.30}\cdot\frac{FLSU4}{35tonf}\cdot\frac{LL(FLSU4_1sMp_lfr,L)}{LL(EV_1sMp_lfr,L)} & \frac{1.30}{1.30}\cdot\frac{FLSU4}{35tonf}\cdot\frac{LL(FLSU4_2sMp_lfr,L)}{LL(EV_2sMp_lfr,L)} \\
\text{"FLSU4"} & \text{"Moment, Negative"} & 99 & \frac{1.30}{1.30}\cdot\frac{FLSU4}{35tonf}\cdot\frac{LL(FLSU4_2sMn_lfr,L)}{LL(EV_2sMn_lfr,L)} \\
\text{"FLSU4"} & \text{"Shear, Positive"} & \frac{1.30}{1.30}\cdot\frac{FLSU4}{35tonf}\cdot\frac{LL(FLSU4_1sVp_lfr,L)}{LL(EV_1sVp_lfr,L)} & \frac{1.30}{1.30}\cdot\frac{FLSU4}{35tonf}\cdot\frac{LL(FLSU4_2sVp_lfr,L)}{LL(EV_2sVp_lfr,L)} \\
\text{"FLSU4"} & \text{"Shear, Negative"} & 99 & \frac{1.30}{1.30}\cdot\frac{FLSU4}{35tonf}\cdot\frac{LL(FLSU4_2sVn_lfr,L)}{LL(EV_2sVn_lfr,L)}
\end{pmatrix}$$

$$RF_EV_LRFR(L,OPR,FL120) := \begin{pmatrix}
\text{"HL93"} & \text{"Moment, Positive"} & \frac{1.35}{1.30}\cdot\frac{OPR}{36tonf}\cdot\frac{LL(HL93_1sMp_lrfr,L)}{LL(EV_1sMp_lrfr,L)} & \frac{1.35}{1.30}\cdot\frac{OPR}{36tonf}\cdot\frac{LL(HL93_2sMp_lrfr,L)}{LL(EV_2sMp_lrfr,L)} \\
\text{"HL93"} & \text{"Moment, Negative"} & 99 & \frac{1.35}{1.30}\cdot\frac{OPR}{36tonf}\cdot\frac{LL(HL93_2sMn_lrfr,L)}{LL(EV_2sMn_lrfr,L)} \\
\text{"HL93"} & \text{"Shear, Positive"} & \frac{1.35}{1.30}\cdot\frac{OPR}{36tonf}\cdot\frac{LL(HL93_1sVp_lrfr,L)}{LL(EV_1sVp_lrfr,L)} & \frac{1.35}{1.30}\cdot\frac{OPR}{36tonf}\cdot\frac{LL(HL93_2sVp_lrfr,L)}{LL(EV_2sVp_lrfr,L)} \\
\text{"HL93"} & \text{"Shear, Negative"} & 99 & \frac{1.35}{1.30}\cdot\frac{OPR}{36tonf}\cdot\frac{LL(HL93_2sVn_lrfr,L)}{LL(EV_2sVn_lrfr,L)} \\
\text{"FL120"} & \text{"Moment, Positive"} & \frac{1.35}{1.30}\cdot\frac{FL120}{60tonf}\cdot\frac{LL(FL120_1sMp_lrfr,L)}{LL(EV_1sMp_lrfr,L)} & \frac{1.35}{1.30}\cdot\frac{FL120}{60tonf}\cdot\frac{LL(FL120_2sMp_lrfr,L)}{LL(EV_2sMp_lrfr,L)} \\
\text{"FL120"} & \text{"Moment, Negative"} & 99 & \frac{1.35}{1.30}\cdot\frac{FL120}{60tonf}\cdot\frac{LL(FL120_2sMn_lrfr,L)}{LL(EV_2sMn_lrfr,L)} \\
\text{"FL120"} & \text{"Shear, Positive"} & \frac{1.35}{1.30}\cdot\frac{FL120}{60tonf}\cdot\frac{LL(FL120_1sVp_lrfr,L)}{LL(EV_1sVp_lrfr,L)} & \frac{1.35}{1.30}\cdot\frac{FL120}{60tonf}\cdot\frac{LL(FL120_2sVp_lrfr,L)}{LL(EV_2sVp_lrfr,L)} \\
\text{"FL120"} & \text{"Shear, Negative"} & 99 & \frac{1.35}{1.30}\cdot\frac{FL120}{60tonf}\cdot\frac{LL(FL120_2sVn_lrfr,L)}{LL(EV_2sVn_lrfr,L)}
\end{pmatrix}$$

$$RF_EVa(L,OPR,FLSU4,FL120,TYPE) := 0 \text{ on error } \left|\begin{array}{l}
mnAB(A,B) \leftarrow \min(A,B) \\
\text{if } FL120 < 1tonf \\
\quad \left|\begin{array}{l}
\text{return } RF_EV_LFR(L,OPR,FLSU4)^{\langle 3\rangle} \text{ if } TYPE = \text{"Simple"} \\
\text{return } RF_EV_LFR(L,OPR,FLSU4)^{\langle 4\rangle} \text{ if } TYPE = \text{"Continuous"} \\
\text{return } \overrightarrow{mnAB\left(RF_EV_LFR(L,OPR,FLSU4)^{\langle 3\rangle}, RF_EV_LFR(L,OPR,FLSU4)^{\langle 4\rangle}\right)} \text{ if } TYPE = \text{"Mix"}
\end{array}\right. \\
\text{if } FL120 \geq 1tonf \\
\quad \left|\begin{array}{l}
\text{return } RF_EV_LRFR(L,OPR,FL120)^{\langle 3\rangle} \text{ if } TYPE = \text{"Simple"} \\
\text{return } RF_EV_LRFR(L,OPR,FL120)^{\langle 4\rangle} \text{ if } TYPE = \text{"Continuous"} \\
\text{return } \overrightarrow{mnAB\left(RF_EV_LRFR(L,OPR,FL120)^{\langle 3\rangle}, RF_EV_LRFR(L,OPR,FL120)^{\langle 4\rangle}\right)} \text{ if } TYPE = \text{"Mix"}
\end{array}\right. \\
(0\ 0\ 0\ 0\ 0\ 0\ 0\ 0)^T
\end{array}\right.$$

EV RF EQUATIONS (2 OF 3)

$$
\mathrm{RF\_EVb}(\mathrm{MMVV},\mathrm{FL120}) := \left|\begin{array}{l}
\text{for } i \in 1 .. \dfrac{\mathrm{rows}(\mathrm{MMVV})}{4} \\
\quad \left|\begin{array}{l} r \leftarrow 4\cdot(i-1) \\ \begin{pmatrix} T_{i,1} & T_{i,2} & T_{i,3} & T_{i,4} \end{pmatrix} \leftarrow \begin{pmatrix} \mathrm{MMVV}_{r+1} & \mathrm{MMVV}_{r+2} & \mathrm{MMVV}_{r+3} & \mathrm{MMVV}_{r+4} \end{pmatrix} \end{array}\right. \\
\text{for } i \in 1 .. 4 \\
\quad \left|\begin{array}{l} \mathrm{RF}_i \leftarrow \max\left(T^{\langle i \rangle}\right) \\ \mathrm{TruckNos}_i \leftarrow \mathrm{match}\left(\mathrm{RF}_i, T^{\langle i \rangle}\right)_1 \end{array}\right. \\
\mathrm{GOV\_RF} \leftarrow \min(\mathrm{RF}) \\
\mathrm{GOV\_iTRK} \leftarrow \mathrm{TruckNos}_{\mathrm{match}(\mathrm{GOV\_RF},\mathrm{RF})_1} \\
\mathrm{GOV\_TRUCK} \leftarrow \mathrm{if}\left[\mathrm{FL120} < 1\mathrm{tonf}, \begin{pmatrix} \text{"HS20"} \\ \text{"FLSU4"} \end{pmatrix}_{\mathrm{GOV\_iTRK}}, \begin{pmatrix} \text{"HL93"} \\ \text{"FL120"} \end{pmatrix}_{\mathrm{GOV\_iTRK}}\right] \\
\mathrm{MMVV} \leftarrow \begin{pmatrix} \text{"M+"} & \text{"M-"} & \text{"V+"} & \text{"V-"} \end{pmatrix}_{1,\mathrm{match}(\mathrm{GOV\_RF},\mathrm{RF})_1} \\
\begin{pmatrix} \mathrm{MMVV} \\ \mathrm{GOV\_TRUCK} \\ \mathrm{GOV\_RF} \end{pmatrix}
\end{array}\right.
$$

$$
\mathrm{RF\_EVc}(L,\mathrm{OPR},\mathrm{FLSU4},\mathrm{FL120},\mathrm{TYPE}) := \left|\begin{array}{l}
\mathrm{MMVV} \leftarrow \mathrm{RF\_EVa}(L,\mathrm{OPR},\mathrm{FLSU4},\mathrm{FL120},\mathrm{TYPE}) \\
\mathrm{GOV} \leftarrow \mathrm{RF\_EVb}(\mathrm{MMVV},\mathrm{FL120}) \\
\mathrm{stack}(\mathrm{MMVV},\mathrm{GOV})
\end{array}\right.
$$

$$
\mathrm{RF\_EVd}(\mathrm{Lmin},\mathrm{Lmax},\mathrm{OPR},\mathrm{FLSU4},\mathrm{FL120},\mathrm{TYPE}) := \left|\begin{array}{l}
\mathrm{RF\_EV\_min\_span} \leftarrow \mathrm{RF\_EVc}(\mathrm{Lmin},\mathrm{OPR},\mathrm{FLSU4},\mathrm{FL120},\mathrm{TYPE}) \\
\mathrm{RF\_EV\_max\_span} \leftarrow \mathrm{RF\_EVc}(\mathrm{Lmax},\mathrm{OPR},\mathrm{FLSU4},\mathrm{FL120},\mathrm{TYPE}) \\
\mathrm{RF\_EV\_other\_spans\_eq}(L) \leftarrow \left|\begin{array}{ll} \mathrm{RF\_EVc}(L,\mathrm{OPR},\mathrm{FLSU4},\mathrm{FL120},\mathrm{TYPE}) & \text{if } \mathrm{Lmin} < L < \mathrm{Lmax} \\ \mathrm{matrix}(11,1,f(i,j) \leftarrow 99) & \text{otherwise} \end{array}\right. \\
\text{for } i \in 1 .. \mathrm{rows}(\mathrm{SPANS}) \\
\quad \mathrm{RF\_EV\_other\_spans}^{\langle i \rangle} \leftarrow \mathrm{RF\_EV\_other\_spans\_eq}\left(\mathrm{SPANS}_i\right) \\
\mathrm{augment}(\mathrm{RF\_EV\_min\_span},\mathrm{RF\_EV\_max\_span},\mathrm{RF\_EV\_other\_spans})
\end{array}\right.
$$

$$
\mathrm{RF\_EVe}(\mathrm{Lmin},\mathrm{Lmax},\mathrm{OPR},\mathrm{FLSU4},\mathrm{FL120},\mathrm{TYPE}) := \left|\begin{array}{l}
T \leftarrow \mathrm{RF\_EVd}(\mathrm{Lmin},\mathrm{Lmax},\mathrm{OPR},\mathrm{FLSU4},\mathrm{FL120},\mathrm{TYPE}) \\
\mathrm{round}\left(\min\left(\mathrm{submatrix}\left(T,\mathrm{rows}(T),\mathrm{rows}(T),1,\mathrm{cols}(T)\right)\right),4\right)
\end{array}\right.
$$

$$
\mathrm{RF\_EVf} := \overrightarrow{\mathrm{RF\_EVe}(\mathrm{Lmin},\mathrm{Lmax},\mathrm{OPR},\mathrm{FLSU4},\mathrm{FL120},\mathrm{TYPE})}
$$

$$
\mathrm{RF\_EVg\_eq}(\mathrm{RF}) := \mathrm{if}\left(\mathrm{RF} \ge 1, \text{"Group 1"}, \text{"Group 2"}\right)
$$

$$
\mathrm{RF\_EVg} := \overrightarrow{\mathrm{RF\_EVg\_eq}(\mathrm{RF\_EVf})}
$$

EV RF EQUATIONS (3 OF 3)

```
alphabet := ("A" "B" "C" "D" "E" "F" "G" "H" "I" "J" "K" "L" "M" "N" "O" "P" "Q" "R" "S" "T" "U" "V" "W" "X" "Y

ExcelColName(ColumnNumber) := | return alphabet_ColumnNumber  if ColumnNumber ≤ 26
                              | concat(alphabet_trunc(ColumnNumber/26), alphabet_ColumnNumber−26·trunc(ColumnNumber/26))

WRITEOUT_RFs := WRITECSV(augment(BrNos, RF_EVf, RF_EVg), "TEMP_RFs.csv")

FAILS(RF, RFmin) := if(RF ≥ RFmin, 0, 1)

∑ vec(FAILS(RF_EVf, 1)) = 78
```

- number of Group 2 bridges

WRITE VERBOSE OUTPUT FOR CHECKING

```
VerboseLegend(Type, FL120) := | Type ← if(Type = "Simple", "1 SPAN", "2 SPAN")
                              | VEH ← if[FL120 < 1tonf, ("HS20,  " "FLSU4, "), ("HL93,  " "FL120, ")]
                              | for i ∈ 1..4
                              |   | T_i ← concat[VEH_1,1, Type, (", +M:" ", -M:" ", +V:" ", -V:")_1,i]
                              |   | T_i+4 ← concat[VEH_1,2, Type, (", +M:" ", -M:" ", +V:" ", -V:")_1,i]
                              | stack[T, ("GOV_TEST(SPAN)   :" "BEST_TRUCK(SPAN) :" "RF.EV(SPAN)        :")^T]

WRITE_VERBOSE(ROWS) := | OUT ← augment[BMS_hdr, ("TEST                        "), ("Lmin" "Lmax.Span:"), SPANS^T/ft]
                       | for i ∈ 1..ROWS
                       |   | for j ∈ 1..11
                       |   |   T^<j> ← submatrix(BMS_data, i, i, 1, cols(BMS_data))^T
                       |   | OUT ← stack(OUT, augment(T^T, VerboseLegend(TYPE_i, FL120_i), RF_EVd(Lmin_i, Lmax_i, OPR_i, FLSU4_i, FL120_i, TYPE_i)))
                       | WRITECSV(OUT, "TEMP_VERBOSE.csv")

z := WRITE_VERBOSE(2)          WRITE_VERBOSE(rows(BMS_data))
```

GROUP 2 BRIDGE LIST

DATA FROM JULY 2018

BrKey	LAT	LON	DISTRICT	MATERIALMAIN	DESIGNMAIN	MATERIALAPPR	DESIGNAPPR	TYPEMAIN	TYPEAPPR	TYPE	KIND_HWY	L MIN	L MAX	OPR	FLSU4	FL120	RF.EV	GROUP
030021	26.17	-81.09	1	2 - Reinforced Concrete Continuous	1 - Slab	\N	\N	Continuous	NA	Continuous	1 - Interstate highw	29	29.9	41.6	42.6	-1	0.98	Group 2
030027	26.17	-81.01	1	2 - Reinforced Concrete Continuous	1 - Slab	\N	\N	Continuous	NA	Continuous	1 - Interstate highw	29.3	29.9	40.3	41	-1	0.94	Group 2
030214	26.15	-81.56	1	5 - Prestressed concrete	1 - Slab	\N	\N	Simple	NA	Simple	1 - Interstate highw	0	40	57.6	-1	-1	0.96	Group 2
030221	26.15	-81.43	1	2 - Reinforced Concrete Continuous	1 - Slab	\N	\N	Continuous	NA	Continuous	1 - Interstate highw	40	40	36.1	35	-1	0.81	Group 2
030222	26.15	-81.43	1	2 - Reinforced Concrete Continuous	1 - Slab	! - Not Applicable	0 - Other	Continuous	NA	Continuous	1 - Interstate highw	40	40	36.1	35	-1	0.81	Group 2
030223	26.15	-81.42	1	2 - Reinforced Concrete Continuous	1 - Slab	\N	\N	Continuous	NA	Continuous	1 - Interstate highw	30	29.9	41.1	42.2	-1	0.97	Group 2
030225	26.15	-81.41	1	2 - Reinforced Concrete Continuous	1 - Slab	! - Not Applicable	0 - Other	Continuous	NA	Continuous	1 - Interstate highw	40	40	46.3	35.8	-1	0.92	Group 2
030226	26.15	-81.41	1	2 - Reinforced Concrete Continuous	1 - Slab	! - Not Applicable	0 - Other	Continuous	NA	Continuous	1 - Interstate highw	40	40	40.1	38.2	-1	0.88	Group 2
030227	26.15	-81.41	1	2 - Reinforced Concrete Continuous	1 - Slab	! - Not Applicable	0 - Other	Continuous	NA	Continuous	1 - Interstate highw	40	40	40.1	38.2	-1	0.88	Group 2
030228	26.15	-81.40	1	2 - Reinforced Concrete Continuous	1 - Slab	! - Not Applicable	0 - Other	Continuous	NA	Continuous	1 - Interstate highw	40	40	40.1	38.2	-1	0.88	Group 2
030230	26.15	-81.39	1	2 - Reinforced Concrete Continuous	1 - Slab	\N	\N	Continuous	NA	Continuous	1 - Interstate highw	30	29.9	40.8	41.4	-1	0.95	Group 2
030231	26.15	-81.38	1	2 - Reinforced Concrete Continuous	1 - Slab	\N	\N	Continuous	NA	Continuous	1 - Interstate highw	40	40	41.5	39.5	-1	0.91	Group 2
030232	26.15	-81.38	1	2 - Reinforced Concrete Continuous	1 - Slab	\N	\N	Continuous	NA	Continuous	1 - Interstate highw	40	40	40.1	38.2	-1	0.88	Group 2
030235	26.15	-81.36	1	2 - Reinforced Concrete Continuous	1 - Slab	\N	\N	Continuous	NA	Continuous	1 - Interstate highw	40	40	38.8	36.9	-1	0.85	Group 2
030265	26.17	-81.09	1	2 - Reinforced Concrete Continuous	1 - Slab	\N	\N	Continuous	NA	Continuous	1 - Interstate highw	29	29.9	41.6	42.6	-1	0.98	Group 2
260070	29.80	-82.51	2	5 - Prestressed concrete	2 - Stringer/Multi-beam or Girder	! - Not Applicable	0 - Other	Simple	NA	Simple	1 - Interstate highw	33.3	43	46.8	42	-1	0.98	Group 2
270015	30.27	-82.12	2	1 - Reinforced Concrete	19 - Culvert (includes frame culverts)	! - Not Applicable	0 - Other	Continuous	NA	Continuous	3 - State highway	9.8	8.9	40.7	56.2	-1	0.96	Group 2
270941	30.24	-82.26	2	5 - Prestressed concrete	2 - Stringer/Multi-beam or Girder	! - Not Applicable	0 - Other	Simple	NA	Simple	4 - County highwa	34.5	71.8	44.9	40.5	-1	0.95	Group 2
320018	30.59	-83.12	2	5 - Prestressed concrete	2 - Stringer/Multi-beam or Girder	! - Not Applicable	0 - Other	Simple	NA	Simple	3 - State highway	35.8	77.1	43.6	39.7	-1	0.92	Group 2
350049	30.43	-83.46	2	5 - Prestressed concrete	2 - Stringer/Multi-beam or Girder	\N	\N	Simple	NA	Simple	3 - State highway	27.3	87.9	43.4	40.1	-1	0.93	Group 2
720022	30.32	-81.66	2	3 - Steel	15 - Movable - Lift	3 - Steel	2 - Stringer/Multi-l	Simple	Simple	Simple	2 - U.S. numbered	34	365.2	31.7	35	39.6	0.82	Group 2
720023	30.41	-81.66	2	5 - Prestressed concrete	2 - Stringer/Multi-beam or Girder	\N	\N	Simple	NA	Simple	3 - State highway	37.7	73.2	41.8	37.8	-1	0.89	Group 2
720031	30.38	-81.67	2	1 - Reinforced Concrete	4 - Tee Beam	1 - Reinforced Cor	1 - Slab	Simple	Simple	Simple	3 - State highway	24.5	61	27.1	23.9	-1	0.55	Group 2
720124	30.31	-81.64	2	5 - Prestressed concrete	2 - Stringer/Multi-beam or Girder	\N	\N	Simple	NA	Simple	2 - U.S. numbered	52.6	89.9	40.9	36.4	-1	0.87	Group 2
720170	30.33	-81.67	2	5 - Prestressed concrete	2 - Stringer/Multi-beam or Girder	\N	\N	Simple	NA	Simple	1 - Interstate highw	39.7	86.9	48.6	40.8	-1	1.00	Group 2
720171	30.34	-81.67	2	5 - Prestressed concrete	2 - Stringer/Multi-beam or Girder	\N	\N	Simple	NA	Simple	1 - Interstate highw	40	66.9	43	38.6	-1	0.92	Group 2
720173	30.34	-81.67	2	5 - Prestressed concrete	2 - Stringer/Multi-beam or Girder	\N	\N	Simple	NA	Simple	1 - Interstate highw	40	66.9	45	40.8	-1	0.97	Group 2
720178	30.36	-81.67	2	5 - Prestressed concrete	2 - Stringer/Multi-beam or Girder	\N	\N	Simple	NA	Simple	1 - Interstate highw	65.2	66.9	46	40.8	-1	0.99	Group 2
720213	30.26	-81.76	2	5 - Prestressed concrete	2 - Stringer/Multi-beam or Girder	\N	\N	Simple	NA	Simple	1 - Interstate highw	36.6	55.1	36	-1	46.8	0.96	Group 2
720260	30.31	-81.77	2	5 - Prestressed concrete	2 - Stringer/Multi-beam or Girder	\N	\N	Simple	NA	Simple	1 - Interstate highw	40.2	74.1	45.2	39.5	-1	0.95	Group 2

BrKey	LAT	LON	DISTRICT	MATERIALMAIN	DESIGNMAIN	MATERIALAPPR	DESIGNAPPR	TYPEMAIN	TYPEAPPR	TYPE	KIND_HWY	L MIN	L MAX	OPR	FLSU4	FL120	RF.EV	GROUP
720261	30.26	-81.76	2	5 - Prestressed concrete	2 - Stringer/Multi-beam or Girder	\N	\N	Simple	NA	Simple	1 - Interstate highw	32.9	55.1	36	-1	46.8	0.94	Group 2
720370	30.42	-81.74	2	5 - Prestressed concrete	2 - Stringer/Multi-beam or Girder	\N	\N	Simple	NA	Simple	1 - Interstate highw	59.7	61	46.5	41.1	-1	0.99	Group 2
720446	30.41	-81.75	2	5 - Prestressed concrete	2 - Stringer/Multi-beam or Girder	\N	\N	Simple	NA	Simple	2 - U.S. numbered	49.8	51.8	47	39.7	-1	0.98	Group 2
720578	30.32	-81.67	2	4 - Steel continuous	2 - Stringer/Multi-beam or Girder	4 - Steel continuou	6 - Box Beam or G	Continuous	Continuous	Continuous	3 - State highway	118.7	154.9	43.2	40.9	-1	0.96	Group 2
780039	29.66	-81.29	2	1 - Reinforced Concrete	19 - Culvert (includes frame culverts)	! - Not Applicable	0 - Other	Continuous	NA	Continuous	1 - Interstate highw	9.8	10	40.9	40.2	-1	0.77	Group 2
480065	30.50	-87.27	3	5 - Prestressed concrete	2 - Stringer/Multi-beam or Girder	\N	\N	Simple	NA	Simple	1 - Interstate highw	41	66	36.7	43.8	47.4	0.99	Group 2
480951	30.45	-87.22	3	5 - Prestressed concrete	2 - Stringer/Multi-beam or Girder	! - Not Applicable	0 - Other	Simple	NA	Simple	3 - State highway	48.7	76.3	43.6	39.7	0	0.95	Group 2
500112	30.49	-84.42	3	1 - Reinforced Concrete	19 - Culvert (includes frame culverts)	\N	\N	Continuous	NA	Continuous	1 - Interstate highw	0	9	57	51	0	0.99	Group 2
520076	30.76	-85.68	3	5 - Prestressed concrete	2 - Stringer/Multi-beam or Girder	\N	\N	Simple	NA	Simple	1 - Interstate highw	34.3	71.1	38.5	40.3	44.4	0.98	Group 2
540061	30.47	-84.02	3	2 - Reinforced Concrete Continuous	1 - Slab	! - Not Applicable	0 - Other	Continuous	NA	Continuous	3 - State highway	25.9	26	51	38	-1	0.94	Group 2
860008	26.09	-80.18	4	3 - Steel	16 - Movable - Bascule	3 - Steel	2 - Stringer/Multi-l	Simple	Simple	Simple	3 - State highway	8.4	68	47	41	-1	0.83	Group 2
860038	26.11	-80.16	4	3 - Steel	16 - Movable - Bascule	5 - Prestressed con	2 - Stringer/Multi-l	Simple	Simple	Simple	3 - State highway	14.1	70.9	54.3	45	-1	0.95	Group 2
860125	26.33	-80.12	4	5 - Prestressed concrete	1 - Slab	! - Not Applicable	0 - Other	Simple	NA	Simple	1 - Interstate highw	31.8	33.3	50.4	37.2	-1	0.97	Group 2
860195	26.33	-80.12	4	5 - Prestressed concrete	1 - Slab	! - Not Applicable	0 - Other	Simple	NA	Simple	1 - Interstate highw	31.8	33.3	50.4	37.2	-1	0.97	Group 2
860341	26.09	-80.36	4	5 - Prestressed concrete	2 - Stringer/Multi-beam or Girder	\N	\N	Simple	NA	Simple	5 - City Street	33.8	125	28.4	39.9	42	0.84	Group 2
860392	26.10	-80.25	4	5 - Prestressed concrete	2 - Stringer/Multi-beam or Girder	\N	\N	Simple	NA	Simple	1 - Interstate highw	45.8	140	29.1	42.3	41.6	0.89	Group 2
860425	26.08	-80.20	4	5 - Prestressed concrete	2 - Stringer/Multi-beam or Girder	\N	\N	Simple	NA	Simple	1 - Interstate highw	69.5	135.9	26.6	36.5	42.4	0.95	Group 2
860528	26.09	-80.17	4	4 - Steel continuous	6 - Box Beam or Girders - Single or Spr	5 - Prestressed con	2 - Stringer/Multi-l	Continuous	Simple	Mix	3 - State highway	90	192	43.6	40.5	0	0.96	Group 2
860592	26.06	-80.16	4	5 - Prestressed concrete	2 - Stringer/Multi-beam or Girder	\N	\N	Simple	NA	Simple	3 - State highway	46.7	80	42.2	38.6	0	0.92	Group 2
930260	26.63	-80.07	4	5 - Prestressed concrete	2 - Stringer/Multi-beam or Girder	! - Not Applicable	0 - Other	Simple	NA	Simple	5 - City Street	22.9	100.7	42.1	0	0	0.72	Group 2
930263	26.63	-80.07	4	5 - Prestressed concrete	2 - Stringer/Multi-beam or Girder	! - Not Applicable	0 - Other	Simple	NA	Simple	5 - City Street	38.1	63.2	40.3	40.3	0	0.94	Group 2
930285	26.53	-80.07	4	5 - Prestressed concrete	2 - Stringer/Multi-beam or Girder	\N	\N	Simple	NA	Simple	3 - State highway	27.6	100.2	40	38	0	0.88	Group 2
930298	26.57	-80.07	4	5 - Prestressed concrete	2 - Stringer/Multi-beam or Girder	\N	\N	Simple	NA	Simple	1 - Interstate highw	26.2	67.5	39.2	35.7	0	0.83	Group 2
930299	26.57	-80.07	4	5 - Prestressed concrete	2 - Stringer/Multi-beam or Girder	\N	\N	Simple	NA	Simple	1 - Interstate highw	22.2	67.5	40.7	42.4	0	0.98	Group 2
930307	26.57	-80.07	4	5 - Prestressed concrete	2 - Stringer/Multi-beam or Girder	\N	\N	Simple	NA	Simple	5 - City Street	26.9	100	41.1	36.8	0	0.85	Group 2
934138	26.83	-80.11	4	5 - Prestressed concrete	1 - Slab	\N	\N	Simple	NA	Simple	3 - State highway	32.2	34	51	37.5	-1	0.98	Group 2
730045	29.65	-81.29	5	1 - Reinforced Concrete	1 - Slab	\N	\N	Simple	NA	Simple	2 - U.S. numbered	20	20	46.9	36.4	-1	0.84	Group 2
790021	29.16	-81.09	5	1 - Reinforced Concrete	1 - Slab	\N	\N	Simple	NA	Simple	2 - U.S. numbered	15	15.1	50.1	46.3	-1	1.00	Group 2
870073	25.85	-80.21	6	1 - Reinforced Concrete	1 - Slab	\N	\N	Simple	NA	Simple	2 - U.S. numbered	15.9	16.7	43	36.6	-1	0.80	Group 2
870074	25.92	-80.21	6	1 - Reinforced Concrete	1 - Slab	! - Not Applicable	-2 - Not Applicabl	Simple	NA	Simple	2 - U.S. numbered	18.3	24.9	54	43	-1	0.98	Group 2
870150	25.79	-80.21	6	3 - Steel	2 - Stringer/Multi-beam or Girder	5 - Prestressed con	2 - Stringer/Multi-l	Simple	Simple	Simple	3 - State highway	37	160.6	33.6	43.2	35.8	0.85	Group 2
870300	25.79	-80.21	6	3 - Steel	2 - Stringer/Multi-beam or Girder	5 - Prestressed con	2 - Stringer/Multi-l	Simple	Simple	Simple	3 - State highway	37	160.6	36.3	47.6	35.5	0.92	Group 2

GROUP 2 BRIDGES (2 of 3)

DATA FROM JULY 2018

BrKey	LAT	LON	DISTRICT	MATERIALMAIN	DESIGNMAIN	MATERIALAPPR	DESIGNAPPR	TYPEMAIN	TYPEAPPR	TYPE	KIND_HWY	L MIN	L MAX	OPR	FLSU4	FL120	RF.EV	GROUP
870349	25.92	-80.21	6	4 - Steel continuous	2 - Stringer/Multi-beam or Girder	! - Not Applicable	0 - Other	Continuous	NA	Continuous	1 - Interstate highw	89	140.1	40	37.9	-1	0.89	Group 2
870371	25.79	-80.20	6	4 - Steel continuous	2 - Stringer/Multi-beam or Girder	1 - Reinforced Cor	2 - Stringer/Multi-	Continuous	Simple	Mix	3 - State highway	61.6	127.9	45.3	40.1	-1	0.96	Group 2
870602	25.95	-80.35	6	6 - Prestressed concrete continuous	21 - Segmental Box Girder	\N	\N	Continuous	NA	Continuous	1 - Interstate highw	115.9	222.3	44	42	-1	0.99	Group 2
870605	25.90	-80.35	6	4 - Steel continuous	2 - Stringer/Multi-beam or Girder	\N	\N	Continuous	NA	Continuous	1 - Interstate highw	49.7	159.5	38.2	39.4	-1	0.91	Group 2
870624	25.94	-80.18	6	3 - Steel	2 - Stringer/Multi-beam or Girder	\N	\N	Simple	NA	Simple	3 - State highway	32.4	34	51.2	39.6	-1	0.99	Group 2
870646	25.90	-80.32	6	6 - Prestressed concrete continuous	21 - Segmental Box Girder	\N	\N	Continuous	NA	Continuous	1 - Interstate highw	102	174	44	38	-1	0.97	Group 2
870650	25.90	-80.32	6	5 - Prestressed concrete	2 - Stringer/Multi-beam or Girder	\N	\N	Simple	NA	Simple	3 - State highway	31	81	37.9	39.7	42.8	0.94	Group 2
870660	25.77	-80.20	6	3 - Steel	16 - Movable - Bascule	3 - Steel	2 - Stringer/Multi-	Simple	Simple	Simple	3 - State highway	9	156.5	50.6	41.6	-1	0.87	Group 2
870777	25.81	-80.21	6	4 - Steel continuous	2 - Stringer/Multi-beam or Girder	5 - Prestressed con	2 - Stringer/Multi-	Continuous	Simple	Mix	1 - Interstate highw	0	183.4	35.6	56.7	62.4	0.96	Group 2
100001	28.02	-82.45	7	1 - Reinforced Concrete	4 - Tee Beam	1 - Reinforced Cor	1 - Slab	Simple	Simple	Simple	2 - U.S. numbered	18.3	43	57.2	-1	-1	0.98	Group 2
100069	28.02	-82.46	7	1 - Reinforced Concrete	4 - Tee Beam	! - Not Applicable	0 - Other	Simple	NA	Simple	2 - U.S. numbered	38.4	40	49.7	39.7	-1	0.99	Group 2
100100	27.95	-82.46	7	3 - Steel	16 - Movable - Bascule	1 - Reinforced Cor	11 - Arch - Deck	Simple	Simple	Simple	3 - State highway	82.9	121	40.5	35	-1	0.89	Group 2
100140	27.96	-82.46	7	5 - Prestressed concrete	2 - Stringer/Multi-beam or Girder	! - Not Applicable	0 - Other	Simple	NA	Simple	1 - Interstate highw	44.2	102.7	41.6	37.4	-1	0.90	Group 2
100365	27.79	-82.35	7	5 - Prestressed concrete	1 - Slab	! - Not Applicable	0 - Other	Simple	NA	Simple	4 - County highwa	35.8	37.7	47	36.6	-1	0.92	Group 2
100420	28.07	-82.35	7	5 - Prestressed concrete	2 - Stringer/Multi-beam or Girder	! - Not Applicable	0 - Other	Simple	NA	Simple	1 - Interstate highw	32	83.7	45.2	42.4	-1	0.98	Group 2
150189	27.62	-82.66	7	6 - Prestressed concrete continuous	14 - Stayed Girder	5 - Prestressed con	2 - Stringer/Multi-	Continuous	Simple	Mix	1 - Interstate highw	0	1200	33.8	47.6	54.6	0.84	Group 2

GROUP 2 BRIDGES (3 of 3)