U.S. Department of Transportation
Federal Highway Administration
Office of Infrastructure

2025 RADBUG Meeting FHWA Updates

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Boise, ID

FHWA is the source of all images in this presentation unless otherwise noted.

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Outlines

- FHWA NBIS Regulation Update
- Francis Scott Key Bridge Collapse
- Research Updates

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FHWA NBIS Regulation Update

FHWA NBIS Regulation Update 2022

- Became effective June 6th, 2022
  - Load rating provisions effective as of that date
- Incorporation of the Specifications for the National Bridge Inventory (SNBI)
  - Supersedes the 1995 "Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges"
  - Full implementation by 2028

3/15/2025, Last NBI data submittal in accordance with 1995 Coding Guide

3/15/2026, First SNBI-based NBI data submittal– Transitioned/Hybrid Dataset

3/15/2027, Second SNBI-based NBI data submittal – Transitioned/Hybrid Dataset

3/15/2028, Third SNBI-based NBI data submittal – 100% populated and verified

FHWA NBIS Regulation Update 2022

Specifications for the National Bridge Inventory (SNBI)

- Without errata – published in 3/2022

  https://www.fhwa.dot.gov/bridge/snbi/snbi_march_2022_publication.pdf

- Errata Number 1 Specifications for the National Bridge Inventory (SNBI) – published in 3/2024

  https://www.fhwa.dot.gov/bridge/snbi/errata1_to_snbi_march_2022_publication.pdf

- SECTION 5: LOADS, LOAD RATING, AND POSTING

FHWA NBIS Regulation Update 2022

SUBSECTION 5.1: LOADS AND LOAD RATING

- B.LR.01 Design Load
- B.LR.02 Design Method
- B.LR.03 Load Rating Date
- B.LR.04 Load Rating Method
- B.LR.05 Inventory Load Rating Factor
- B.LR.06 Operating Load Rating Factor
- B.LR.07 Controlling Legal Load Rating Factor
- B.LR.08 Routine Permit Loads

SUBSECTION 5.2: LOAD POSTING STATUS

- B.PS.01 Load Posting Status
- B.PS.02 Posting Status Change Date

SUBSECTION 5.3: LOAD EVALUATION AND POSTING

- B.EP.01 Legal Load Configuration
- B.EP.02 Legal Load Rating Factor
- B.EP.03 Posting Type
- B.EP.04 Posting Value

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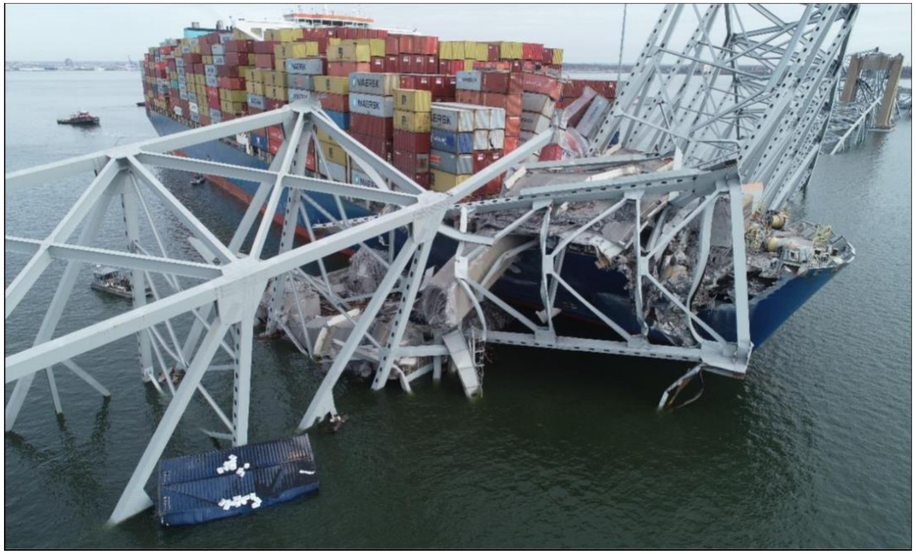
Francis Scott Key Bridge Collapse

Francis Scott Key Bridge Collapse

- March 26, 2024
- Baltimore, Maryland
  - Main steel truss spans and the three approach spans of the Francis Scott Key Bridge across the Patapsco River
- 6 fatalities
- Opened in 1977



© NTSB – Collapsed Key Bridge and the Cargo Ship

Francis Scott Key Bridge Collapse

- NTSB's Recommendation Report, March 18, 2025
- Report MIR-25-10, Safeguarding Bridges from Vessel Strikes: Need for Vulnerability Assessment and Risk Reduction Strategies

  (https://www.ntsb.gov/investigations/AccidentReports/Reports/MIR2510.pdf)

- Safety Recommendations H-25-1 through H-25-4:

  (https://www.ntsb.gov/safety/safety-recs/RecLetters/H-25-001-004.pdf)

Francis Scott Key Bridge – Vessel Collision Vulnerability Assessment and Findings

- AASHTO Method II vulnerability assessment
  - Critical/essential, the threshold AF value of 0.0001
  - NTSB calculated AF=0.002921, ~30 times the threshold
- Findings
  - aware that this bridge was above the AASHTO threshold of risk for catastrophic collapse from a vessel collision.
  - proactively identify strategies
  - 30 owners of 68 bridges over navigable waterways frequented by ocean-going vessels

Francis Scott Key Bridge – Safety Recommendations

- NTSB Safety Recommendations, March 20, 2025
  - H-25-001. to FHWA: …establish an interdisciplinary team… and provide guidance and assistance to bridge owners on evaluating and reducing the risk of a bridge collapse from a vessel collision.
  - H-25-002. to US Coast Guard, and US Army Corps
  - H-25-003. to 30 agencies: … Calculate …Method II annual frequency of collapse for the bridge(s) identified in appendix B (68 bridges US Bridges Over Navigable Waterways Frequented by Ocean-Going Vessels with Unknown Levels of Risk of Collapse from a Vessel Collision)
  - H-25-004. to 30 agencies: … develop and implement a comprehensive risk reduction plan…

Francis Scott Key Bridge Collapse

- Contact of Containership Dali with Francis Scott Key Bridge
- Project Summary: Marine Investigation
- Investigation ID: DCA24MM031

  Website: https://www.ntsb.gov/investigations/Pages/DCA24MM031.aspx

  Docket: https://data.ntsb.gov/Docket/?NTSBNumber=DCA24MM031

Recent Bridge Collapses and Incidents

- Foundation failures: 2013 on the Leo Frigo Bridge (WI) and 2014 on the I-495 Christina River Bridge (DE)
- 2013, the Skagit River Bridge (WA) – Over-height strike
- 2017, the I-85 Bridge over Piedmont Road (GA) and 2023 damage to a section of the I-10 Santa Monica Freeway (CA) - Fires
- Welding T-1 steel: 2021, fracture of a tension tie on the Hernando de Soto Bridge
- 2022 Fern Hollow Bridge (PA)
- 2024 Francis Scott Key Bridge (MD)

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Research Updates

Infrastructure Research Functional Areas

Eleven Functional Areas

- Construction
- Corrosion
- Loads and Evaluation
- Non-Destructive Evaluation
- Safety Inspection and Evaluation
- Security
- Seismic and Multi-hazard
- Structural Concrete
- Structural Steel
- Structures Management and Preservation
- Tunnels

FHWA Loads and Load Rating

- Concrete Bridge Shear Load Rating Synthesis Report, Publication No. FHWA-HIF-18-061 (11/2018)
- Concrete Bridge Shear Load Rating Guide and Examples: Using the Modified Compression Field Theory, Publication No. FHWA-HIF-22-025 (04/2022)

- Reference Guide for Load Rating of Tunnel Structures, Publication No. FHWA-HIF-19-010 (05/2019)
- Tunnel Load Rating Examples: A Supplement to the Reference Guide for Load Rating of Tunnel Structures, Publication No. FHWA-HIF-20-058 (12/2020)

FHWA Loads and Load Rating

- Advancing Bridge Load Rating: State of Practice and Frameworks, Publication No. FHWA-HIF-22-059 (12/2022)
- Truck Platooning Impacts on Bridges: Phase I – Structural Safety, Publication No. FHWA-HIF-21-043 (7/2021)

FHWA Loads and Load Rating

- Published Reports available at
  https://www.fhwa.dot.gov/bridge/loadrating/

Home / Programs / Bridges & Structures / Safety Inspection / Bridge Inspection / Load Rating

Load Rating

- Concrete Bridge Shear Load Rating Guide and Examples: Using the Modified Compression Field Theory, Publication No: FHWA-HIF-22-025 (04/2022)
- Tunnel Load Rating Examples: A Supplement to the Reference Guide for Load Rating of Tunnel Structures, Publication No. FHWA-HIF-20-058 (12/2020)
- Reference Guide for Load Rating of Tunnel Structures (05/2019)
- Manual for Refined Analysis in Bridge Design and Evaluation (05/2019)
- Report on Techniques for Bridge Strengthening (04/2019)
- Load Rating Policy and Guidance
- Load Rating for the FAST Act's Emergency Vehicles (11/03/2016)
  - Questions and Answers Revision R01 (03/16/2018)
- Load Rating of Specialized Hauling Vehicles (11/15/2013)
  - Questions and Answers (03/2014)
- Assigned Load Ratings (09/28/2011)
- America's Surface Transportation Act (FAST Act) Truck Size and Weight Provisions Guidance (02/24/2016)
- Assuring Bridge Safety and Serviceability in Europe (08/2010)

Research and Publications

- Advances in State Bridge Load Rating Processes and Practices - A Summary Report of 2024 Bridge Load Rating Peer Exchanges (2024) (.pdf)
- Advancing Bridge Load Rating: State of Practice and Frameworks (2022) (.pdf)
- Truck Platooning Impacts on Bridges: Phase I – Structural Safety (2021) (.pdf)
- Concrete Bridge Shear Load Rating Synthesis Report (2018) (.pdf)
- NCHRP 12-28/Report 301 - Load Capacity Evaluation of Existing Bridges (1989) (.pdf)
- NCHRP 12-46/Report 454 - Calibration of Load Factors for LRFR Bridge Evaluation (2001) (.pdf)
- NCHRP 12-46 Web Document - Manual for Condition Evaluation and Load Rating of Highway Bridges Using Load and Resistance Factor Philosophy (2001) (.pdf)
- NCHRP 20-07 (Task 122) - Load Rating by Load and Resistance Factor Evaluation Method (2005) (.pdf)
- NCHRP 20-05 (Topic 36-01)/Synthesis 359 - Bridge Rating Practices and Policies for Overweight Vehicles (2006) (.pdf)
- NCHRP 12-63/Report 575 - Legal Truck Loads and AASHTO Legal Loads for Posting (2006) (.pdf)
- NCHRP 12-78/Report 700 - A Comparison of AASHTO Bridge Load Rating Methods (2011) (.pdf)
- NCHRP 20-07 (Task 285) - Recalibration of LRFR Live Load Factors in the AASHTO Manual for Bridge Evaluation (2011) (.pdf)
- NCHRP 20-05 (Topic 44-15)/Synthesis 453 - State Bridge Load Posting Processes and Practices (2014) (.pdf)
- NCHRP 20-68A, Scan 12-01, US Domestic Scan - Advances in State DOT Superload Permit Processes and Practices (2014) (.pdf)
- NCHRP 15-54/ Web-Only Document 268 - Proposed Modifications to AASHTO Culvert Load Rating Specifications (2019) (.pdf)
- NCHRP 20-07/Task 410 - Load Rating for the Fast Act Emergency Vehicles Ev-2 and Ev-3 (2019) (.pdf)
- NCHRP 12-110 - Proposed New AASHTO Load Rating Provisions for Implements of Husbandry (2019)
- NCHRP 12-123 - Proposed AASHTO Guideline for Load Rating of Segmental Bridges (2024)
- NCHRP 12-127 - Load Rating and Posting of Long-Span Bridges (active)

FHWA Loads and Load Rating

Broad Agency Announcement - 2020

Risk-Based Methodology for Structural Evaluation of Bridge-Sized Culverts

- PI: Dr. David Yang (Portland State University)
- Kevin White, Ph.D., PE (E.L. Robinson)
- Timothy Wood, PhD, PE (The Citadel)

Risk-based Methodology - Culverts

Risk-Based Methodology for Bridge-Sized Culverts

- Key factors affecting culvert risks
  - High uncertainties
  - Varying consequences
- Structural, loading, analytical, and cost factors.

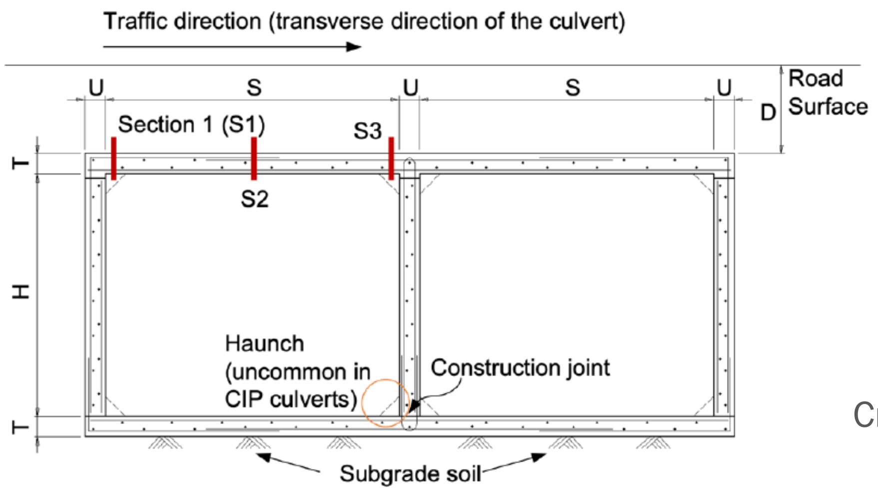

Figure 1.1 Cross sections of interest (S3 not considered in single-cell culverts)

Credit: David Yang, PSU

Risk-based Methodology - Culverts

Risk-Based Methodology for Bridge-Sized Culverts

- Uncertainty quantification and reliability analysis

Table 1.1 Reviewed culvert designs

Source	Year[a]	Number of culvert designs		
		Single-cell	Double-cell	Multi-cell
Acharya et al. (2016b)	2016	1	-	-
Alamo River culvert (Caltrans)	1969	-	1	-
Standard plans (Caltrans)	1952-2010	87	166	106
Strong Creek culvert (Caltrans)	1960	1	-	-
Han et al. (2013)	2013	2	-	-
Kadivar et al. (2018)	2018	2	-	-
McGrath et al. (2005)	2005	4	4	-
Standard plans (MnDOT)	1940-2019	80	19	25
Mlynarski et al. (2019)	2019	2	1	-
Orton et al. (2015)	2015	-	8	2
Ulger et al. (2020)	2020	-	1	7
Standard plans (TxDOT)	1934-2020	21	183	732

Note: (*a*) column represents release year of culvert plans under consideration, except for Almo River and Strong Creek culverts, which are their years of construction.

Credit: David Yang, PSU

Risk-based Methodology - Culverts

Risk-Based Methodology for Bridge-Sized Culverts

Table 1.2 Typical culverts for UQ and validation

Culvert	*N*	*S* (ft)	*H* (ft)	*T* (in)	*U* (in)	Culvert	*N*	*S* (ft)	*H* (ft)	*T* (in)	*U* (in)
1	1	10	4	9	8	17	2	6	2	8	6
2	1	10	6	9	8	18	2	6	4	8	6
3	1	10	8	9	8	19	2	6	6	8	6
4	1	10	10	9	8	20	2	8	4	9	6
5	1	12	6	10	8	21	2	8	6	9	7
6	1	12	8	10	8	22	2	8	8	9	7
7	1	12	10	10	9	23	2	10	4	9	8
8	1	12	12	10	9	24	2	10	6	9	8
9	1	14	8	12	10	25	2	10	8	9	8
10	1	14	10	12	10	26	2	10	10	9	8
11	1	14	12	12	12	27	2	12	6	10	8
12	1	14	14	12	12	28	2	12	8	10	9
13	1	16	6	12	10	29	2	12	10	10	10
14	1	16	8	12	10	30	2	12	12	10	10
15	1	16	10	12	12	31	2	14	8	12	10
16	1	16	12	12	12	32	2	14	10	12	10
						33	2	14	12	12	12
						34	2	14	14	12	13

Note: *N* = number of cells; *S* = clear cell span; *H* = clear cell height; *T* = slab thickness; *U* = wall thickness

Credit: David Yang, PSU

Risk-based Methodology - Culverts

Risk-Based Methodology for Bridge-Sized Culverts

Table 2.3 Uncertainty models for flexural resistance of RC members

Reference	Bias	COV	Distribution	Note
Ellingwood et al. (1980)	1.12	0.19	Normal	One-way simply supported slabs in buildings with a thickness ranging from 4 to 8 inches
NCHRP Report 368	1.14 (1.12)	0.13 (0.135)	Lognormal	Based on results of RC T-beams, two sets of values were reported in Table 3 and page C-9 of the reference. Both are presented herein.
NCHRP Report 454	1.12	0.10	Normal	Based on results of composite steel beams used in NCRHP Report 368.
NCHRP Report 700	1.13	0.13	Lognormal	RC bridge deck; used in this project

Table 2.4 Uncertainty models for components of total permanent load effect

Variable	Bias	COV	Distribution
Load effect under DC	1.05	0.10	Normal
Load effect under EV	1.0	0.112	Normal
Load effect under EH	1.0	0.15	Normal

Credit: David Yang, PSU

Risk-based Methodology - Culverts

Risk-Based Methodology for Bridge-Sized Culverts

UQ of Live Load Effects

$$LL = LL_{FR} \times \lambda_{NET} \times \lambda_{LDS} \times \lambda_{BF} \times \lambda_{DYN}$$

$$\overline{LL} = \overline{LL}_{FR} \times \bar{\lambda}_{NET} \times \bar{\lambda}_{LDS} \times \bar{\lambda}_{BF} \times \bar{\lambda}_{DYN}$$
$$V_{LL}^2 = V_{FR}^2 + V_{NET}^2 + V_{LDS}^2 + V_{BF}^2 + V_{DYN}^2$$

where LL_{FR} – maximum live load effect in a reference period based on a load distribution, 2D frame analysis, load spectrum, and statistical projection; *NET* – site to site variation; *LDS* – related to live load distribution with 2D frame analysis; *BF* – related to back fill; *DYN* – dynamic allowance

Risk-based Methodology - Culverts

Risk-Based Methodology for Bridge-Sized Culverts

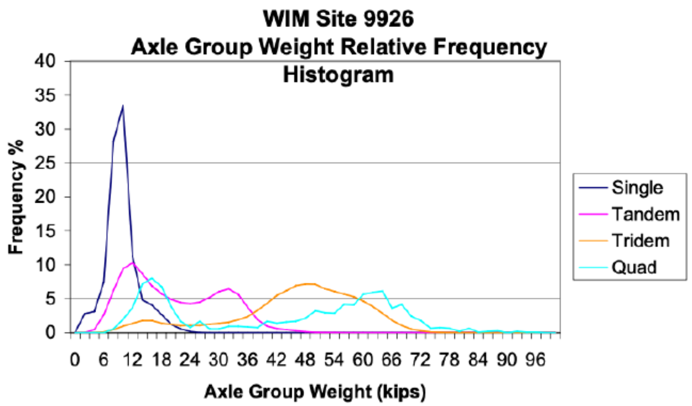

Figure 4.1 Histogram of axle group weight (reprinted from NCHRP Report 683)

- Gross Vehicle Weight – GVW
- Axle or Axle Group Weight

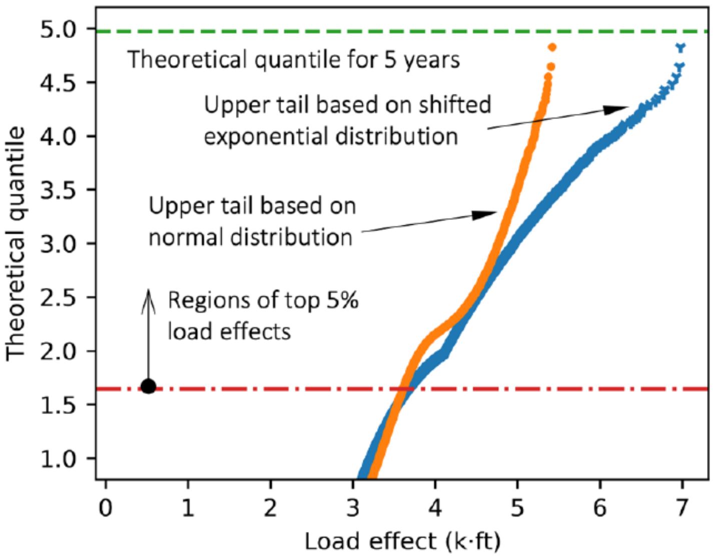

Figure 4.2 Load spectra obtained with axle statistics

Credit: David Yang, PSU

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Risk-based Methodology - Culverts

Risk-Based Methodology for Bridge-Sized Culverts

- Reliability Analysis

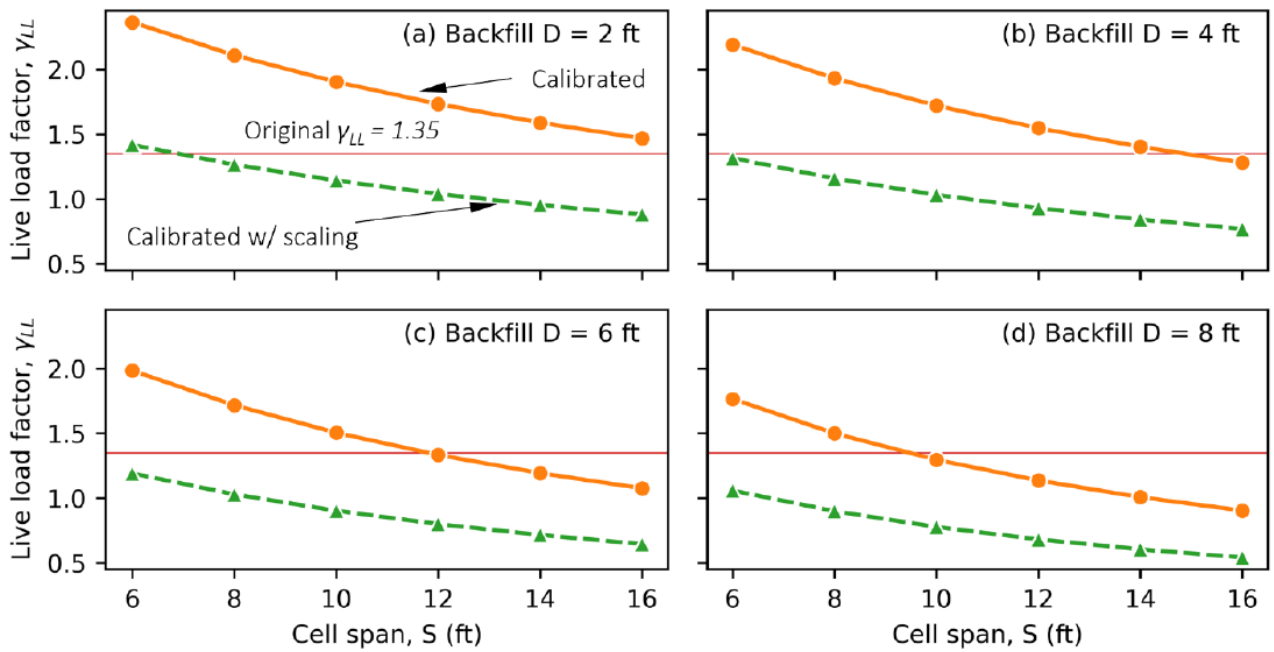


Figure 5.4 Calibrated live load factors for operating rating

Credit: David Yang, PSU

Risk-based Methodology - Culverts

Risk-Based Methodology for Bridge-Sized Culverts

- Reliability Analysis

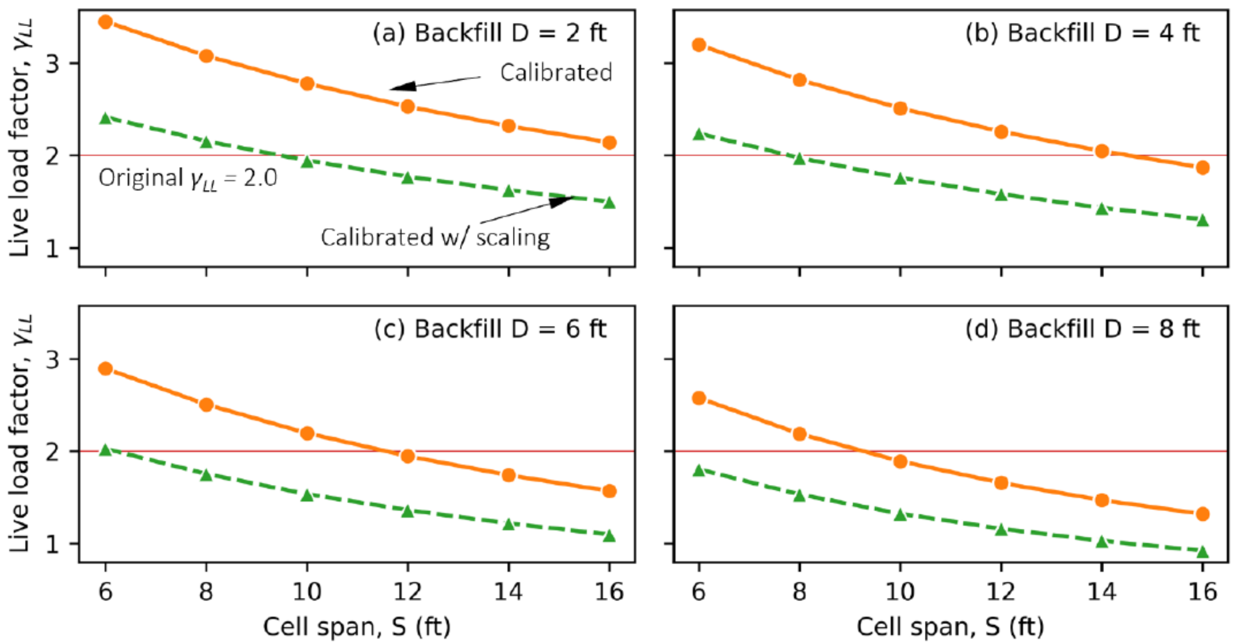


Figure 5.6 Calibrated live load factors for AASHTO legal loads

Credit: David Yang, PSU

Risk-based Methodology - Culverts

Risk-Based Methodology for Bridge-Sized Culverts

- Reliability Analysis

Table 5.4 Reliability with calibrated load factors for operating rating

Calibration	Mean	STD	Min.	25% percentile	75% percentile	Max.
Original (1.35)	3.29	0.34	2.44	3.12	3.51	3.96
Calibrated	3.58	0.34	2.86	3.32	3.88	4.13
With scaling	2.56	0.09	2.35	2.50	2.63	2.80

Table 5.5 Reliability with calibrated load factors for AASHTO legal loads

Calibration	Mean	STD	Min.	25% percentile	75% percentile	Max.
Original (2.0)	2.95	0.44	1.35	2.76	3.24	3.76
Calibrated	3.21	0.28	2.69	3.00	3.37	3.76
With scaling	2.53	0.17	1.92	2.44	2.62	3.00

Credit: David Yang, PSU

Risk-based Methodology - Culverts

Risk-Based Methodology for Bridge-Sized Culverts

- Reliability Analysis

$$b_{LL} = \frac{b_{FR}}{MPF\ (1.0 + IM)} \times \bar{\lambda}_{NET} \times \bar{\lambda}_{LDS} \times \bar{\lambda}_{BF} \times \bar{\lambda}_{DYN}$$

$$\bar{\lambda}_{NET} = \bar{\lambda}_{BF} = 1.0$$

$$\bar{\lambda}_{LDS} = \frac{1.0}{0.725 + 0.0623S}$$

$$\bar{\lambda}_{DYN} = 1.0 + 0.15 \times (1.0 - 0.125D) \geq 1.0$$

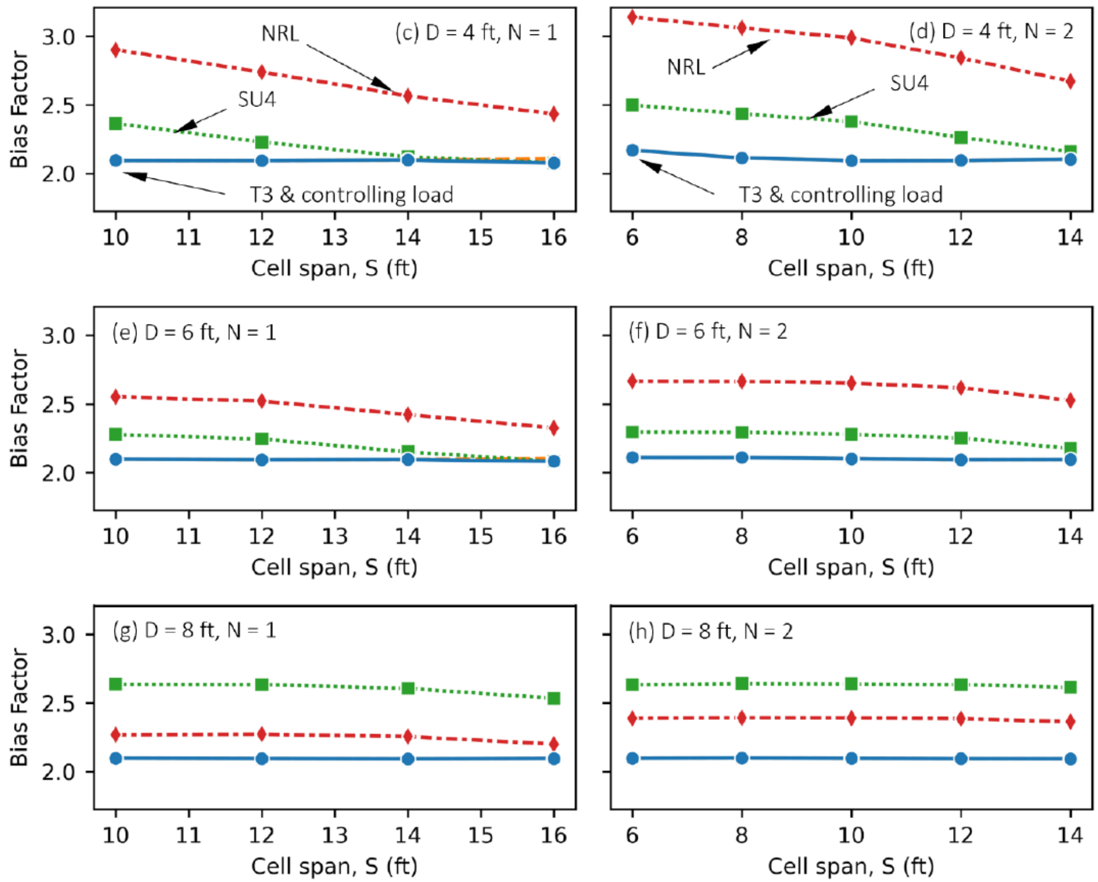
$$\hat{\alpha}_{LL} = \exp(-1.289 \times 10^{-3} D^2 S - 0.0148)$$

$$\gamma_{LL} = c\ b_{LL}(1.0 - 0.4499 V_{LL} + 1.2442 \hat{\alpha}_{LL}\ \beta_T V_{LL})$$

Credit: David Yang, PSU

Risk-based Methodology - Culverts

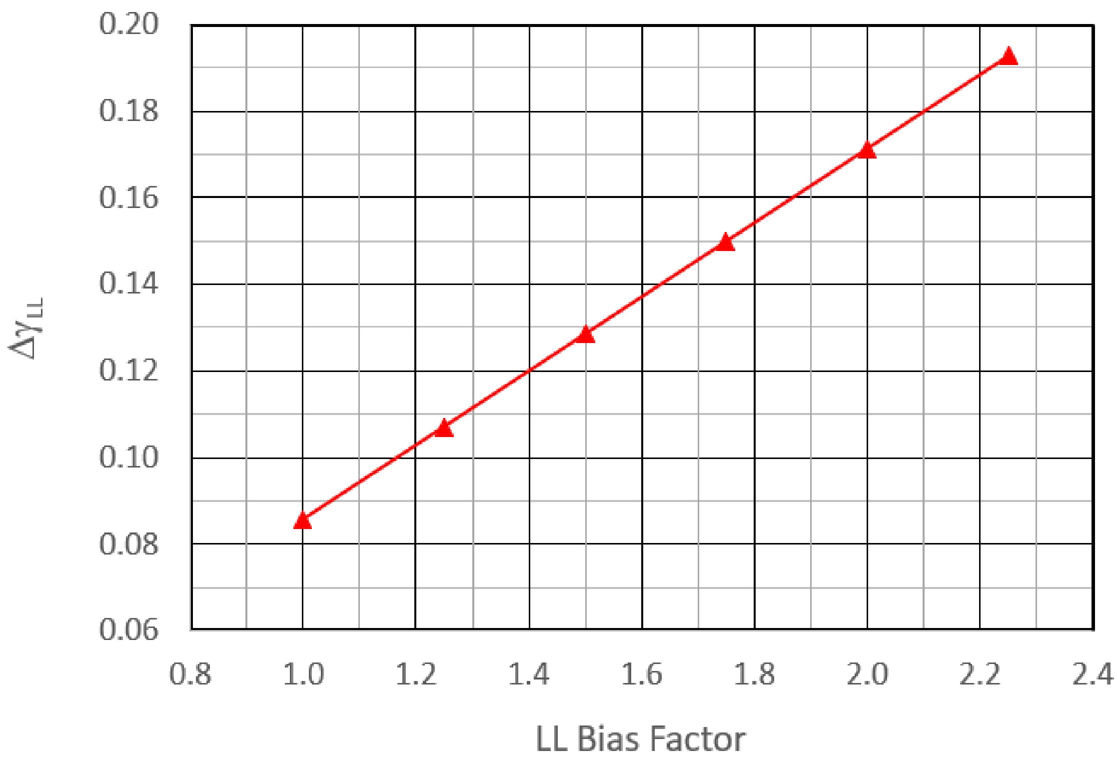
Risk-Based Methodology for Bridge-Sized Culverts



Credit: David Yang, PSU

Risk-based Methodology - Culverts

Risk-Based Methodology for Bridge-Sized Culverts



$\Delta\gamma_{LL}$ vs. Bias Factor for $\Delta\beta$=0.5

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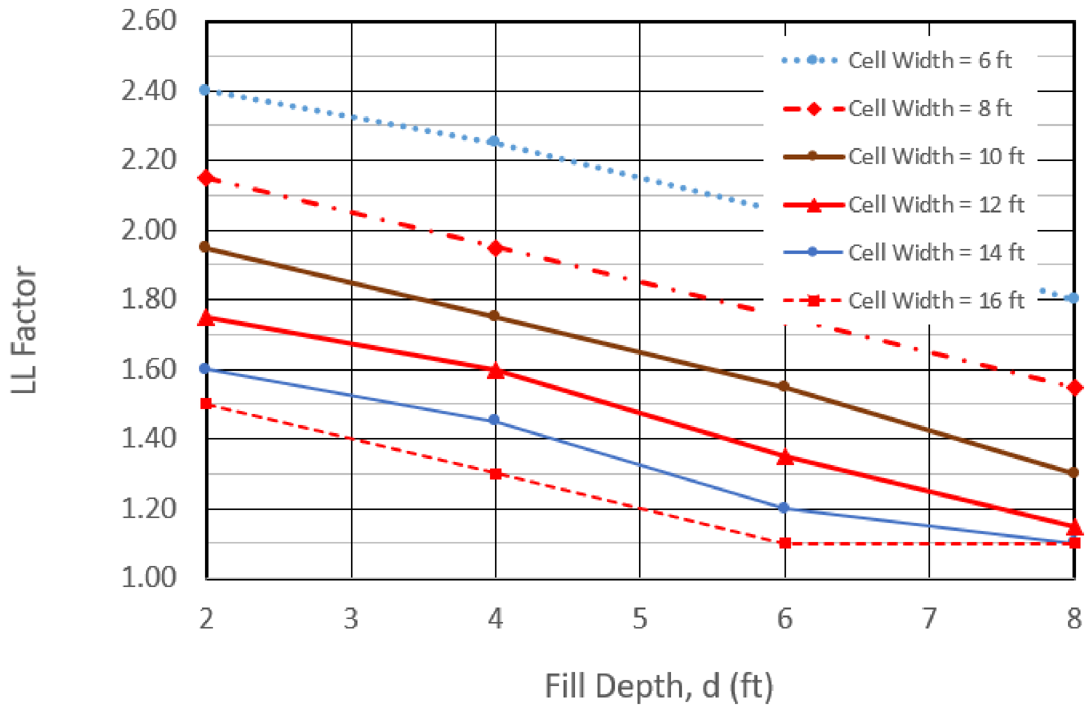
Risk-based Methodology - Culverts

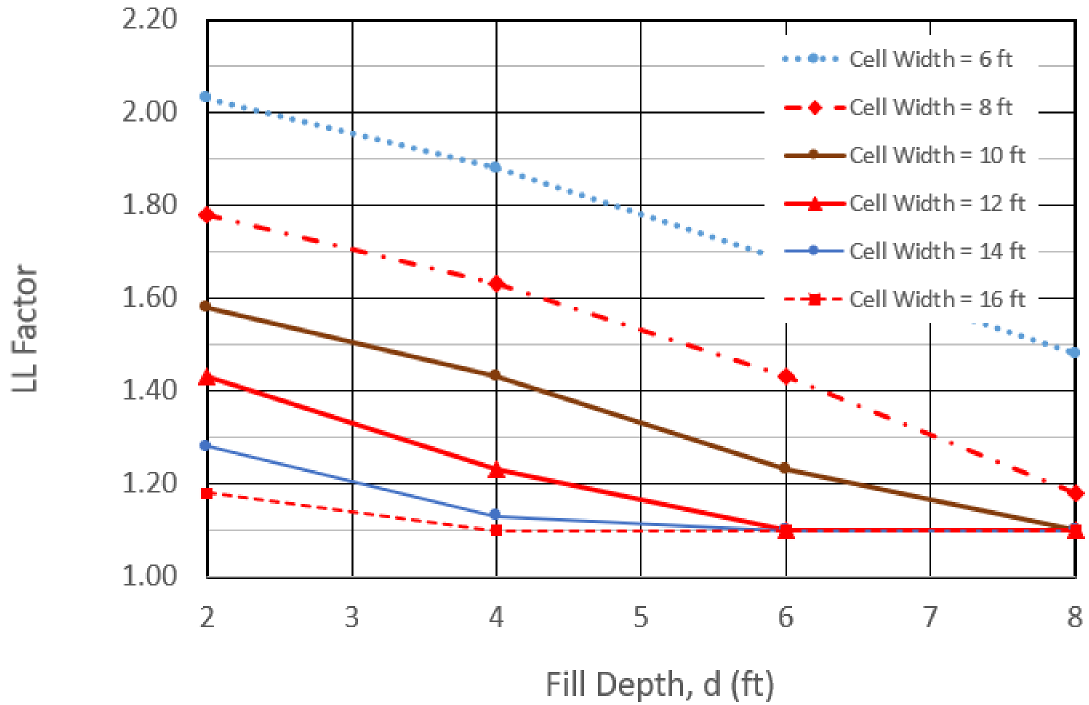
Risk-Based Methodology for Bridge-Sized Culverts



Live Load Factor for Legal Load Rating vs. Fill Depth
(ADTT=5000, β_T=2.5)

Risk-based Methodology - Culverts

Risk-Based Methodology for Bridge-Sized Culverts



Live Load Factor for Legal Load Rating vs. Fill Depth
(ADTT=1000, β_T=1.75)

Truck Platooning Bridge Impact

Truck Platooning Impacts on Bridges: Phase II – Structural Serviceability

The objective is to produce a report for FHWA that covers the technical aspects of truck platooning impacts on bridges with a focus on structural serviceability (service and fatigue limit states).

Truck Platooning Bridge Impact

References:

B. M. Kozy et al., “Truck Platooning Impacts on Bridges: Phase II – Structural Serviceability,” New York, NY, 2025.

https://c2smarter.engineering.nyu.edu/final-reports/32847190.pdf

https://rosap.ntl.bts.gov/view/dot/82533

FHWA Loads and Load Rating

Broad Agency Announcement - 2023

Mobile Lab for Bridge Load and Performance Testing

- Investigate the feasibility of developing a state-of-the-art, rapidly deployable, Mobile Bridge Testing Lab (MBTL) for diagnostic and proof load testing to support the load rating of bridges.
  - State of Technology
  - Feasibility Study and Conceptual Design

FHWA Loads and Load Rating

Mobile Bridge Test Lab (MBTL): From Feasibility to Plans

- Short term –a “blueprint” for an MBTL
- Medium term - more of the Nation’s bridges load tested.
- Long term – fewer bridges load posted; rapid assessment of bridges post disaster for continued use and more informed rehabilitation plans; state-of-the art research “facility”
- Safer and better maintained bridges, economic savings

Questions and Answers

Questions?

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