# TRUCK PLATOONING EFFECTS ON GIRDER BRIDGES

F I N A L R E P O R T

Principal Investigators:

Joshua S. Steelman, Ph.D., P.E.    Jay A. Puckett, Ph.D., P.E.

Daniel G. Linzell, Ph.D., P.E.

Graduate Research Assistant: Bowen Yang

Department of Civil and Environmental Engineering
University of Nebraska-Lincoln
900 N. 16th Street
Nebraska Hall W181
PO Box 880531
Lincoln, NE 68588-0531

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**16. Abstract**

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The present research evaluates the Strength I limit state for steel and prestressed concrete I-girder bridges designed with LRFD and LFD. Herein, platoons are assumed to be advanced not only with respect to traffic operations but also in their ability to weigh and report axle weight and spacing, moble-WIM (mWIM). Consequently, the live load statistics (bias and *CoV*) differ from code assumptions, and are perhaps controllable, which poses significant opportunity with respect to operational strategies and associated economies.

A parametric study considered different girder spacings, span lengths, numbers of spans, types of structures, truck configurations, numbers of trucks, and adjacent lane loading scenarios. Reliability indices $\beta$ were calculated for each load case based on the Monte Carlo Simulation Method. The results indicated that loads significantly higher than legal loads are acceptable for truck platoons with lower uncertainties while maintaining a traditional operating target $\beta = 2.5$, consistent with permit loading in the *Manual for Bridge Evaluation*. Live load factors were developed and presented for a potential new permit load, i.e., a platoon permit. This approach helps to inform owners of effective operational strategies to safely benefit economies on a state or multistate corridor basis.

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## SYMBOLS

$C$: capacity

$COV$: covariance

$CoV$: coefficient of variation

$CoV_{adj}$: adjacent lane live load effect coefficient of variation

$CoV_D$: dead load coefficient of variation

$CoV_{event}$: linearized heavy live load effect coefficient of variation

$CoV_{GDF}$: girder distribution factor coefficient of variation

$CoV_{IM}$: dynamic impact factor coefficient of variation

$CoV_L$: static live load coefficient of variation

$CoV_{L\_GDF}$: static live load and girder distribution factor coefficient of variation

$CoV_{L\_GDF+IL}$: dynamic live load and girder distribution factor coefficient of variation

$CoV_{max}$: Extreme Type I coefficient of variation

$CoV_R$: resistance coefficient of variation

$D$: nominal dead load effect

$DC$: nominal dead load effect from components

$DW$: nominal dead load effect from wearing surface

$D_n$: nominal dead load

$F$: fabrication uncertainty for resistance, or count of Monte Carlo Simulation failure instances

$GDF$: girder distribution factor

$GDF_{LFR}$: single- or multiple-lanes loaded girder distribution factor in LFR, as applicable

$GDF_{LFR,m}$: multiple-lanes loaded girder distribution factor in LFR

$GDF_{LRFR}$: single- or multiple-lanes loaded girder distribution factor in LRFR, as applicable

$GDF_{LRFR,m}$: multiple-lanes loaded girder distribution factor in LRFR

$GDF_m$: multiple-lanes loaded girder distribution factor

$GDF_{platoon}$: girder distribution factor for a platoon

$GDF_s$: single-lane loaded girder distribution factor

$g$: limit state function

$g_m$: multiple-lanes loaded girder distribution factor

$mg_m$: multiple-lanes loaded girder distribution factor for moment

$vg_m$: multiple-lanes loaded girder distribution factor for shear

$g_s$: single-lane loaded girder distribution factor

$mg_s$: single-lane loaded girder distribution factor for moment

$vg_s$: single-lane loaded girder distribution factor for shear

$H$: platooning vehicle headway

$IM$: impact factor

$IM_{LFR}$: impact factor associated with AASHTO LFD/R HL-20 load

$IM_{HL\text{-}93}$: impact factor associated with AASHTO LRFD/R HL-93 load

$IM_{platoon}$: impact factor applied to platoon static live load

$K_g$: longitudinal stiffness parameter (in.$^4$)

$L$: span length (ft)

$L$: static HL-93 nominal load effect

$LL$: total live load effect, or nominal static live load effect

$LL_{platoon}$: platoon nominal static live load effect

$L_{adj}$: adjacent lane live load effect

$L_n$: nominal live load effect

$L_{platoon}$: platoon live load effect

$L_{total}$: total live load effect on critical girder from platoon and adjacent lane

$M$: material uncertainty for resistance

$N$: number of normally distributed maximum events

$N_p$: number of platoon loading events

$P$: nominal dead load effect from permanent loads, or professional uncertainty for resistance

$PL$: static platoon nominal load effect

$P_f$: probability of failure

$P_{sxs}$: probability of side-by-side occurrences

$Q$: load

$R$: resistance

$R_n$: nominal resistance

$R_{n,LFD}$: nominal resistance according to AASHTO LFD

$R_{n,LRFD}$: nominal resistance according to AASHTO LRFD

$RF$: Rating Factor

$S$: girder spacing (ft)

$t_s$: deck thickness (in.)

$m$: linearized heavy live load effect slope on probability paper (refer to NCHRP 683 Page 24)

$n$: linearized heavy live load effect intercept on probability paper (refer to NCHRP 683 Page 24)

$u$: uniformly distributed random number

$\alpha$: amplification factor

$\alpha_{LFD(calLFR\text{-}1)}$: amplification factor for safe platoon load on an LFD-designed bridge rated by a calibrated LFR method without considering GDF bias

$\alpha_{LFD(calLFR\text{-}2)}$: amplification factor for safe platoon load on an LFD-designed bridge rated by a calibrated LFR method also considering GDF bias

$\alpha_{LFD(LFR)}$: amplification factor for safe platoon load on an LFD-designed bridge rated by LFR

$\alpha_{LFD(LRFR)}$: amplification factor for safe platoon load on an LFD-designed bridge rated by LRFR

$\alpha_{LRFD(LRFR)}$: amplification factor for safe platoon load on an LRFD-designed bridge rated by LRFR

$\alpha_N$: Extreme Type I scale parameter

$\beta$: reliability index

$\beta_{target}$: target (minimum) reliability index

$\gamma$: load factor

$\gamma_D$: dead load factor

$\gamma_{DC}$: dead load factor for components

$\gamma_{DW}$: dead load factor for wearing surfaces

$\gamma_L$: live load factor

$\gamma_{LL}$: live load factor

$\gamma_{platoon}$: platoon live load factor

$\gamma_{platoon(calLFR)}$: platoon live load factor calibrated for LFR

$\gamma_{platoon(LRFR)}$: platoon live load factor calibrated for LRFR

$\lambda$: bias factor

$\lambda_D$: dead load bias factor

$\lambda_{GDF}$: girder distribution factor bias factor

$\lambda_L$: live load bias factor

$\lambda_{max}$: maximum mean live load effect bias for adjacent lane loading

$\lambda_{platoon}$: platoon live load bias factor

$\lambda_R$: resistance bias factor

$\mu$: mean value

$\mu_{adj}$: adjacent lane live load effect mean

$\mu_D$: mean dead load effect

$\mu_{event}$: linearized heavy live load effect mean

$\mu_{IM}$: mean dynamic amplification

$\mu_L$: mean live load effect

$\mu_{L\_GDF+IL}$: mean dynamic live load effect

$\mu_N$: Extreme Type I location parameter

$\mu_{max}$: Extreme Type I mean

$\mu_{PL}$: mean platoon live load effect

$\mu_{platoon}$: critical mean platoon static load effect for a given $CoV$ and target $\beta$

$\mu_R$: mean resistance

$\sigma_{adj}$: adjacent lane live load effect standard deviation

$\sigma_D$: dead load effect standard deviation

$\sigma_{event}$: linearized heavy live load effect standard deviation

$\sigma_{L\_GDF}$: static live load and girder distribution factor standard deviation

$\sigma_{IL}$: dynamic live load amplification standard deviation

$\sigma_{L\_GDF+IL}$: dynamic live load and girder distribution factor standard deviation

$\sigma_{max}$: Extreme Type I standard deviation

$\sigma_{PL}$: platoon live load effect standard deviation

$\sigma_R$: resistance standard deviation

Φ: standard normal cumulative density function

$\phi$: resistance factor

$\phi_c$: condition factor

$\phi_s$: system factor

## ABBREVIATIONS

| | |
|---|---|
| AASHTO | American Association of State Highway and Transportation Officials |
| ADTT | Average Daily Truck Traffic |
| AV | Automonous Vehicles |
| AWC | American Wood Council |
| BDS | Bridge Design Specifications |
| BIPM | Bridge Inspection Program Manual |
| BOPP | Bridge Office Policies and Procedures |
| CDF | Cumulative Distribution Function |
| COV | Covariance |
| CoV | Coefficient of Variation |
| CV | Connected Vehicles |
| DOT | Department of Transportation |
| FBF | Federal Bridge Formula |
| FHWA | Federal Highway Administration |
| GDF | Girder Distribution Factor |
| GVW | Gross Vehicle Weight |
| LFD | Load Factor Design |
| LFR | Load Factor Rating |
| LRFD | Load and Resistance Factor Design |
| LRFR | Load and Resistance Factor Rating |
| MBE | Manual for Bridge Evaluation |

| | |
|---|---|
| MCS | Monte Carlo Simulation |
| MPF | Multiple Presence Factor |
| NBI | National Bridge Inventory |
| NCHRP | National Cooperative Highway Research Program |
| NDOT | Nebraska Department of Transportation |
| NJTA | New Jersey Turnpike Authority |
| NRL | Notional Rating Load |
| PATH | Partners for Advanced Transit and Highways |
| PCI | Precast/Prestressed Concrete Institute |
| PS | Prestressed Segmental |
| PDF | Probability Distribution Function |
| RF | Rating Factor |
| SHV | Specialized Hauling Vehicles |
| SU | Single-Unit |
| TRB | Transportation Research Board |
| WIM | Weigh-in-Motion |

## ABSTRACT

Truck platooning – digitally linking two or more trucks to travel in a closely spaced convoy – is increasingly used to save fuel, and reduce driver work and road congestion. Currently, the platoon load effects with several constant headways on bridges have been evaluated and compared to AASHTO design and legal loads. However, reliability assessment and a more rigorous investigation of headway assumptions for platoons are lacking. This research provides a framework for determining how much a platoon permit load might be increased given strict control over the load characteristics and operational tactics.

The present research evaluates the Strength I limit state for steel and prestressed concrete I-girder bridges designed with LRFD and LFD. Herein, platoons are assumed to be advanced not only with respect to traffic operations but also in their ability to weigh and report axle weight and spacing, moble-WIM (mWIM). Consequently, the live load statistics (bias and *CoV*) differ from code assumptions, and are perhaps controllable, which poses significant opportunity with respect to operational strategies and associated economies.

A parametric study considered different girder spacings, span lengths, numbers of spans, types of structures, truck configurations, numbers of trucks, and adjacent lane loading scenarios. Reliability indices $\beta$ were calculated for each load case based on the Monte Carlo Simulation Method. The results indicated that loads significantly higher than legal loads are acceptable for truck platoons with lower uncertainties while maintaining a traditional operating target $\beta = 2.5$, consistent with permit loading in the *Manual for Bridge Evaluation*. Live load factors were developed and presented for a potential new permit load, i.e., *a platoon permit*. This approach helps to inform owners of effective operational strategies to safely benefit economies on a state or multistate corridor basis.

# 1 INTRODUCTION

## 1.1 Background

Truck platoons constitute a portion of an emerging population of Connected and Automated Driving System (C/ADS)-equipped vehicles, which are expected to become increasingly common in the United States and in industrialized countries globally. To address the challenges posed by these new systems on infrastructure, the Transportation Research Board has funded NCHRP Project 20-102: *Impacts of Connected Vehicles (CV) and Automated Vehicles (AV) on State and Local Transportation Agencies*. In particular, Project 20-102(03): *Challenges to CV and AV Application in Truck Freight Operations* produced NCHRP Web-Only Document 231 (Fitzpatrick et al., 2016), and Project 20-102(07): *Implications of Automation for Motor Vehicle Codes* had a 6 volume NCHRP Web-Only Document 253 (2018a-f). These documents provide guidance to assist transportation agencies responsible for bridge management with legal and operational changes due to increasing CV and AV applications. Fitzpatrick et al. (2016) note that truck platooning, which is referred to herein simply as platooning, has been studied as a means of reducing aerodynamic drag for many years, pointing to work ranging from a 2003 study by California Partners for Advanced Transit and Highways (PATH) and several additional studies with publication dates between 2010 and 2015. These studies focus primarily on transportation fuel efficiency, with little consideration of infrastructure safety and health.

Recent research on platooning has focused on deterministic analyses using legal loads. Reliability calibration for platoons and implications for structurally safe operations with reduced live load uncertainties is a gap in current literature. Yarnold (2019) considered load effects of two-, three-, and four-truck platoons with headway spacings, herein referred to simply as headway(s), from 20 to 40 ft on single- and multiple-span bridges. Their research mainly evaluated load equivalency to design and rating loading models for bridges subjected to platoons, but without considering structural reliability or calibrating platooning live load factors. Lipari (2017) proposed a gap control system and mentioned a minimum headway should be adjusted based on-site traffic and bridge safety considerations but did not provide guidance for how to manage platoons' headway. However, considering only specific headways for platoons is not sufficient to evaluate the most negative moments and middle support shears for two-span bridges.

Platooning with CV technologies places trucks potentially much closer than current design codes anticipate to realize aerodynamic benefits. Vehicle weights must be known with a greater degree of certainty than currently assumed in the American Association of State and Highway Transportation Officials (AASHTO) Load and Resistance Factor Design (LRFD) to ensure safe platooning operations while facilitating maximum benefits with very close separation (headway) distances. Reduced uncertainty should also enable increased vehicle weights while maintaining a particular target reliability. This strategy can provide higher fuel efficiency, reduce the driver's work, and potentially reduce highway congestion, but it can also potentially change infrastructure demands. Platooning can result in traffic conditions similar to those observed in Wyoming when interstates are closed due to weather, as shown in Figure 1.

AASHTO seeks to ensure in-service bridge safety under live loads through load rating. In the *AASHTO Manual for Bridge Evaluation* (herein referred to as MBE; AASHTO, 2018) 6A.4.2.1, the general Load and Resistance Factor Rating (LRFR) equation is given as

$$RF = \frac{C - (\gamma_{DC})DC - (\gamma_{DW})DW - (\gamma_P)P}{(\gamma_{LL})(LL + IM)} \qquad \text{(Eqn. 1)}$$

Figure 1. Typical truck spacing after roadway closure on I-80 in Wyoming
(Barker and Puckett, 2016)

Both live load effects, *LL*, and dynamic impact amplifications, *IM*, can potentially be influenced by platooning. For design, minimum required values of *C* are calculated corresponding to an implicit *RF* = 1 according to the *AASHTO LRFD Bridge Design Specifications* (herein referred to as BDS; AASHTO, 2020). The BDS LRFD equation was calibrated to use specific values of resistance factors, $\phi$, and load factors, $\gamma$, based on uncertainties associated with various terms (capacity, dead load, live load, etc.) to provide a target reliability index, $\beta$. For example, the $\gamma_{LL}$ factor was calibrated to 1.75 to provide a $\beta$ of 3.5 for design. This calibration presumed a 75-year design life traffic extrapolated from two-week Ontario data, according to NCHRP Report 368: *Calibration of LRFD Bridge Code* (Nowak, 1999). MBE live load rating factors for the Strength I limit state are given in AASHTO Table 6A.4.2.2.1, specifying $\gamma_{LL}$ equal to 1.75 for inventory level rating and 1.35 for operating level rating. Platoons are expected to be heavy, similar to typical permit loads, and may have less uncertainty assumed in LRFD/R calibration. Reduced uncertainty is recognized in MBE for single trip permits. When a permit vehicle is escorted so that there will be no other vehicles on a bridge, the $\gamma_{LL}$ factor can be reduced from 1.75 to 1.10 according to MBE Table 6A.4.5.4.2a-1, reproduced in Table 1. This means that higher load effects than design loads for permit vehicles are acceptable if less uncertainty is associated with the live load.

Table 1. Permit Load Factors: $\gamma_L$ (AASHTO, 2018)

| **Permit Type** | **Frequency** | **Loading Condtion** | **DF (LRFD distribution factor)** | **ADTT (one direction)** | **Load Factor by Permit Weight Ratio** | | |
|---|---|---|---|---|---|---|---|
| | | | | | **GVW/AL<2.0 (kip/ft)** | **2.0 < GVW/AL< 3.0 (kip/ft)** | **GVW/AL>3.0 (kip/ft)** |
| Routine or Annual | Unlimited Crossings | Mixed with traffic (other vehicles may be on the bridges) | Two or more lanes | >5000 | 1.40 | 1.35 | 1.30 |
| | | | | =1000 | 1.35 | 1.25 | 1.20 |
| | | | | <100 | 1.30 | 1.20 | 1.15 |
| | Unlimited Crossings (Reinforced Concrete Box Culverts) | Mixed with traffic (other vehicles may be on the bridges) | One Lane (remove MPF) | All *ADTTs* | 1.40 | | |
| | | | | | All Weights | | |
| Special or Limited Crossing | Single-Trip | Escorted with no other vehicles on the bridge | One Lane | N/A | 1.10 | | |
| | Single-Trip | Mixed with traffic (other vehicles may be on the bridges) | One Lane | All *ADTTs* | 1.20 | | |
| | Multiple-Trips (less than 100 crossings) | Mixed with traffic (other vehicles may be on the bridges) | One Lane | All *ADTTs* | 1.40 | | |

Figure 2 illustrates how live load uncertainty relates to “safe” mean live load. The solid line extending from the lower left corner of the plot delineates the boundary of safe and unsafe potential outcomes when evaluating combinations of uncertain loads and resistances. Each dot represents one randomly generated sample of dead and live loads and resistance. Dots that fall above the line are safe – they have more resistance than load. Conversely, the few dots that fall below the line correspond to situations where load exceeds resistance and a structural limit state is violated. Satisfying a reliability target means limiting the number of points that fall below the line. Permit vehicles, as platoons are expected to be, have a narrower horizontal dispersion resulting from lower live load uncertainties, illustrated by the “Permit Live + Dead Loads” case. The narrower horizontal dispersion means that the mean value can increase from that of the “HL-93 + Dead Loads” – the center of the dot cloud with permit live load moves to the right – while maintaining target reliability and therefore without compromising safety.

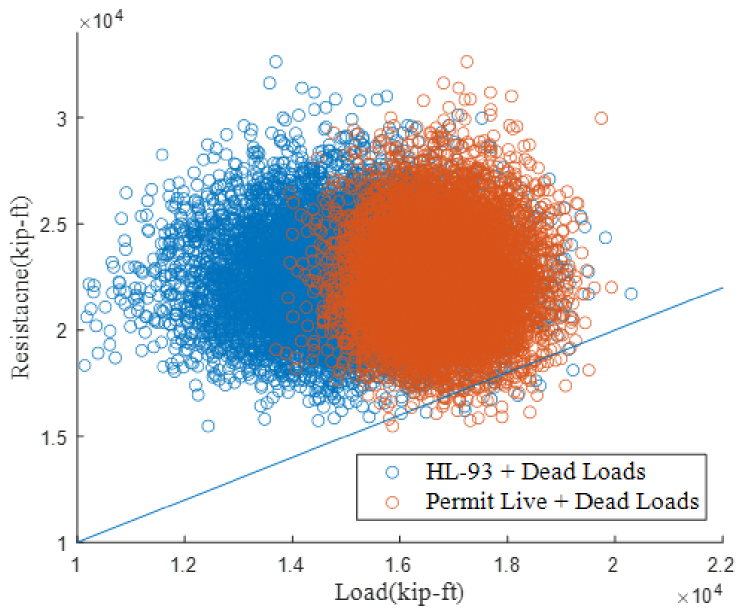



Figure 2. Illustrative Probability Simulations of Load and Resistance.

Platooning deployments are imminent according to the timeline provided in Trimble et al. (2018e). As mentioned, platooning could impose unacceptably high loads on bridges because of freight traffic density. However, deployment of smart systems to regulate truck traffic and enable platooning with less uncertainty than design traffic also presents an opportunity to reduce the rating live load factor. Most research and development efforts have been focused on traffic operations. The structural safety of bridges carrying the increased load from platoons has not yet been thoroughly studied, but DOTs will need to ensure that their structural assets will not be compromised before allowing platooning operations in their jurisdictions.

### 1.2 Research Objectives

The main objectives of this project are to:

1. Evaluate whether platooning on I-80 girder bridges in Nebraska could violate legal load limits according to typical assumptions and rating methods used by NDOT;
2. Provide a framework for determining how much a platoon permit load might be increased given strict control over the load characteristics, i.e., headways and variability (safe headway tables);
3. Provide general preliminary guidelines for managing legal load platoons' operations at operating and inventory level rating;
4. Calibrate platoon live load factors for LRFR at operating level and inventory level to maintain uniform and consistent reliability indexes with varying platoon load effect uncertainty; and
5. Provide general comparisons of LRFR and LFR rating methods for platoons.

## 1.3 Research Scope

The scope of this research included:

- one and two lanes loaded,
- span lengths: 30 – 200 ft,
- simple- and two-span continuous bridges,
- steel and prestressed composite I-girders,
- girder spacing: 8 – 12 ft,
- truck types: legal load vehicles at 80 kips GVW,
- headway:
    - primarily 5 – 50 ft constant headway
    - limited investigation of variable headways up to 200 ft
- loading scenarios:
    - single-lane platoon loaded in one lane,
    - two identical platoons in adjacent lanes,
    - platoon operating with routine traffic in an adjacent lane,
- rating level: inventory and operating level rating ($\beta_{target}$ = *3.5 or 2.5)*
- limit states: Strength I, girder moments and end shears

# 2 LITERATURE REVIEW

## 2.1 Scope of Review

The literature review focuses on two topics: platoons and their effects on bridges, and bridge safety under these load effects. Previous studies include reliability analysis for design and load rating; however, this is the first known study with respect to reliability analysis for platoons. Several previous and ongoing studies have taken a necessary first step to address bridge safety by investigating load effects of platoons. Platoon truck configurations were selected from journal publications and correspondence with FHWA. NCHRP reports also provided information on live load factor calibration methods and relevant load statistical parameters necessary to complete the present work.

Yarnold and Weidner (2019) studied the potential effects of platooning on existing and future bridge infrastructure and identify possible conditions for which past and current design specifications may not be adequate. A parametric study was conducted which focused on simple-, two-, and three-span steel multi-girder bridges. Span lengths ranged between 6 and 91 m (20 – 200 ft) in approximately 6 m (20 ft) increments. Their study was limited to consideration of total bridge cross-sectional moment, and neglected transverse distribution of live load. Yarnold and Weidner also did not consider multiple presence, and assumed the platoon was the sole source of live load on a bridge.

Yarnold and Weidner used the Florida C5 five-axle semi-tractor trailer truck (Figure 3(a)) as a representative platooning vehicle. The considered headways for platoons were 6.1, 7.6, 9.1, 10.7, and 12.2 m (20 ft, 25 ft, 30 ft, 35 ft, and 40 ft) (Figure 3(b)).

Moment and shear effects for different spans and platoon configurations were analyzed and compared to past and current design specifications. From simple-span bridge analyses, Yarnold and Weidner's results indicated that Florida C5 truck platoons would not overload bridges designed according to the BDS (2017), except for longer span bridges subjected to closely spaced platoons. They found that platoon shear force demands were greater than LRFD demands.

Similarly the results for LRFD-designed two-span bridges indicated the positive moment and shear capacities are adequate except for closely-spaced platoons passing over long span bridges. The negative moment effects caused by platoons are smaller than those required for design in the BDS. Yarnold and Weidner determined that bridges designed using LFD according to the AASHTO Standard Specifications (2002) were more vulnerable to platooning than identical, LRFD-designed bridges. Yarnold and Weidner mainly focused on load equivalence and did not conduct reliability analysis or load rating to evaluate bridge safety.

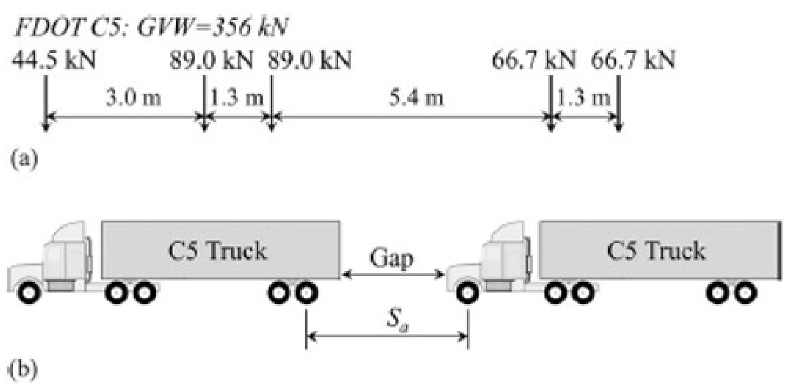



Figure 3. C5 truck axle weights and spacings and platoon configuration (Yarnold and Weidner, 2019)

Tohme and Yarnold (2020) extended the previous work by Yarnold and Weidner to evaluate platoon impacts on multi-girder steel bridge load ratings. The Florida C5 truck was again chosen as a typical platoon vehicle. Two-, three-, and four-truck platoons with 6 m and 12 m (20 ft and 40 ft) headways were considered. Tohme and Yarnold considered different span lengths and bridge configurations to investigate behavior of typical steel multi-girder bridges in the U.S. Tohme and Yarnold conducted a multivariate parametric study for simple-, two-, and three-span steel girder bridges with 6, 20, 37 and 74 m (20, 66, 112, and 245 ft) span lengths. The study used a general bridge cross-section consistent with the MBE (AASHTO, 2018) load rating Example A1, which satisfies inventory level load rating, as shown in Figure 4. Girders were redesigned for alternate span lengths and continuity conditions from the load rating example to maintain an AASHTO legal load rating of at least 1.0.

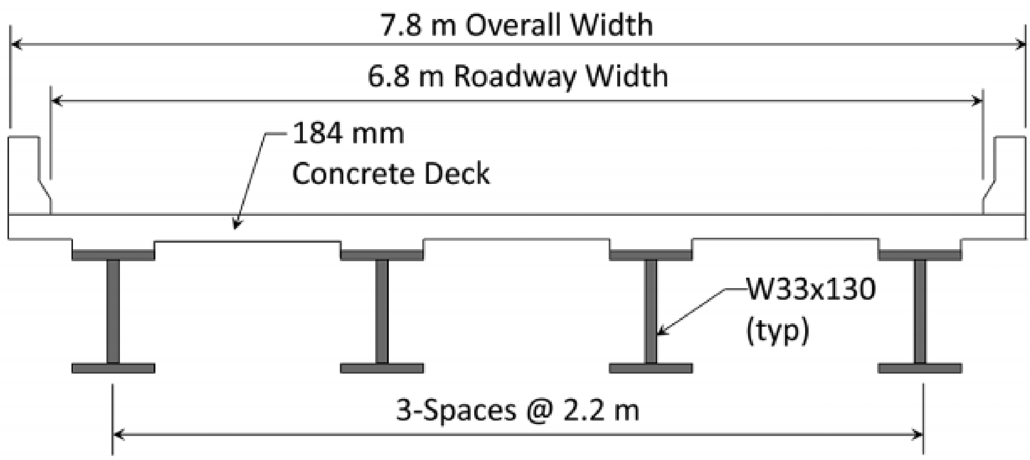



Figure 4. AASHTO MBE Example Bridge A1 Cross-section (Tohme and Yarnold, 2020)

ASR, LFR, and LRFR design and legal load moment load ratings were calculated for each bridge and for each platoon considered by the authors. The authors do not state the specific live load factor used for legal load ratings, other than that load ratings were performed at the operating level. Tohme and Yarnold first evaluated load rating ratios for platoon:design. If the ratio was less than 1.0, indicating that the platoon load rating was more critical than the design load rating, a subsequent evaluation was performed for platoon: legal. If the ratio was less than 1.0 when compared to AASHTO legal load rating, these situations were highlighted by the authors as instances for which the bridge could not safely carry the platoon.

Only LRFR and LFR results from Tohme and Yarnold are discussed here. Bridges were adequate in all LRFR cases for continuous-span negative moments, but bridges were unsafe for negative moments across a broad range of spans for LFR with 3- or 4- trucks in a platoon. All span lengths were unsafe for negative moment with 3 trucks at 6 m (20 ft) spacing and 4 trucks at 12 m (40 ft) spacing on two-span bridges. Bridges were unsafe according to LRFR for positive bending with small headways on longer spans, but limitations were less restrictive for LFR. Note, Tohme and Yarnold considered only moment ratings, but shear was previously found to be significant and potentially more critical than moment by Yarnold and Weidner (2019) for simple-span bridges.

## 2.2 Structural Reliability

Nowak and Collins (2013) provided a general limit state function containing resistance and load effect terms as

$$g(R,Q) = R - Q \qquad \text{(Eqn. 2)}$$

where $R$ and $Q$ are random variables representing resistance and load effect, respectively. Both $R$ and $Q$ are continuous random variables and have their own probability density functions (PDFs), as shown in Figure 5.

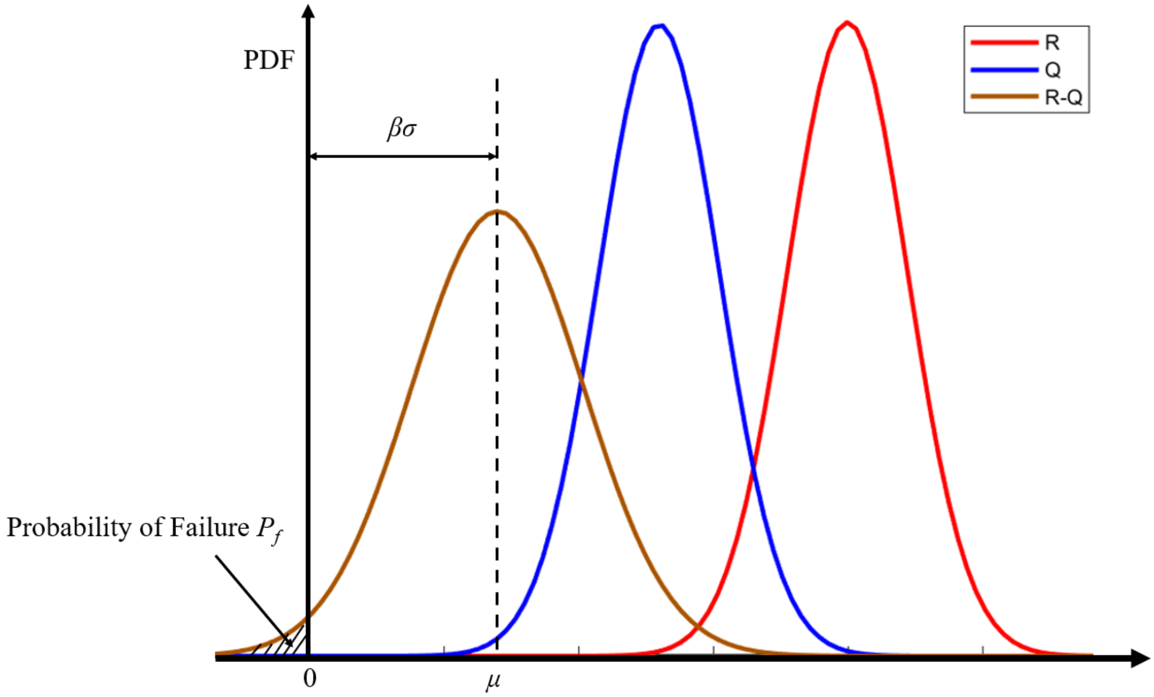



Figure 5. PDFs of Load, Resistance, and Safety Margin.

The $R - Q$ term becomes a random variable with its own PDF as shown on the left of Figure 5. If $g \geq 0$, the structure satisfies the limit state and is considered safe. When $g < 0$, corresponding to the shaded region, the structure does not satisfy the limit state and is considered unsafe and to have failed. The probability of failure, $P_f$, is expressed mathematically as

$$P_f = P(R - Q < 0) = P(g < 0) \quad \text{(Eqn. 3)}$$

Structural reliability analysis provides a method to assess whether the probability of failure is acceptable. The reliability index, $\beta$, is commonly used in structural reliability frameworks to provide a convenient term characterizing structural safety. In probabilistic terms, $\beta$ represents the number of standard deviations the mean value of $g$ is from zero. Assuming $g$ is normally distributed, $\beta$ is related to the probability of failure $P_f$ according to

$$\beta = -\Phi^{-1}\left(P_f\right) \quad \text{(Eqn. 4)}$$

where $\Phi^{-1}(\cdot)$ is the inverse of the standard normal cumulative distribution function (CDF).

Nowak (1999) developed a deterministic, reliability-calibrated format for LRFD bridge design in Project 12-33, as described in NCHRP Report 368: *Calibration of LRFD Bridge Code*. In LRFD structural design, the probabilistic limit state evaluation (Eqn. 2) is replaced with a deterministic equation of the form

$$\phi R_n - \gamma_D D_n - \gamma_L L_n \geq 0 \qquad \text{(Eqn. 5)}$$

where $\phi$ is resistance factor, $R_n$ is nominal resistance, $D_n$ is the nominal dead load, $L_n$ is the nominal live load, and $\gamma_D$ and $\gamma_L$ are the dead and live load factors, respectively. Nowak provided the basic procedure, and dead load, live load, and resistance models for load and resistance factor calibration. Load and resistance factors reflect relative uncertainties among constituent terms. Satisfying this deterministic equation approximately satisfies a target minimum reliability index, $\beta$, and maximum tolerable probability of failure, $P_f$.

Nowak estimated load effects for different truck design horizons based on two weeks of WIM data obtained in Canada, containing 9,250 measured trucks at an ADTT of 1,000. Figure 6 shows normal probability paper distributions for positive moment effects on various span lengths subjected to the WIM data truck loads. Live load demand for a 75-year design life was extrapolated from the two-week data by assuming the upper tail end approaches to a normal distribution.

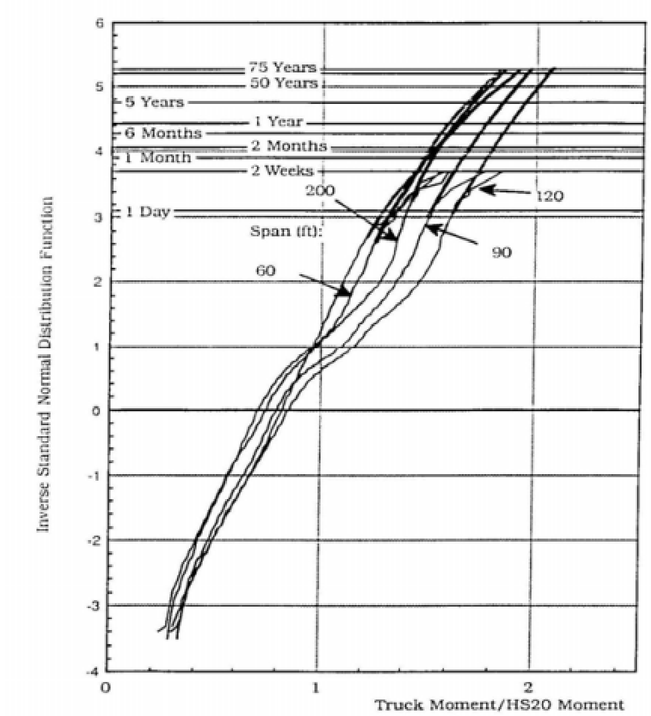



Figure 6. Original and Extrapolated CDF's of Simple-Span Moment (Nowak, 1999)

Nowak accounted for multiple presence of heavy trucks based on truck survey data and observations on interstate highways in Michigan. For two traffic lanes, the probability of one truck adjacent to second, uncorrelated truck was assumed to be 1/15. Every 450$^{th}$ truck was assumed fully correlated with an adjacent truck and every 150$^{th}$ truck was assumed partially correlated. Scenarios for two traffic lanes were:

1. maximum 75 year truck with no adjacent truck;
2. maximum 5-year truck and the average truck from the survey;
3. maximum 6-month truck and maximum 1-day truck; and
4. two maximum 2-month trucks side-by-side.

Overall, NCHRP Report 368 proposed load and resistance factors to generally satisfy a target minimum reliability index, $\beta$, of 3.5 for LRFD-designed bridges.

Moses (2001) calibrated live load factors for LRFR load rating in NCHRP Project 12-46 as documented in Report 454: *Calibration of Load Factors for LRFR Bridge Evaluation*. This research unified reliability bases for evaluation and design and outlined the process to calibrate live load factors for LRFR, including statistical parameters used in the calibration. Moses used the same Canadian, two-week truck-weight data used for calibration in the earliest versions of the BDS (Nowak 1999). Statistical parameters for dead loads and resistance were also identical to Nowak.

The methodology described by Moses simplified load factor calibration by assuming that resistance is mainly based on live load effects to the extent that dead load could be ignored during calibration. This is a reasonable assumption for shorter spans but not for longer bridges. Moses derived and used a live load factor calibration method that relies only on the ratio of vehicle weight for which the bridge is being evaluated and the weight of a Type 3S2 truck, and a reference live load factor associated with the Type 3S2. Table 2 provides the resulting calibrated live load factors for legal and permit loads, later adopted by AASHTO in the MBE (AASHTO, 2016).

Table 2. Permit Live Load Factors Table (AASHTO, 2016)

| **Permit Type** | **Frequency** | **Loading Condtion** | **DF (LRFD distribution factor)** | **ADTT (one direction)** | **Load Factor by Permit Weight** | |
|---|---|---|---|---|---|---|
| | | | | | **Up to 100 kips** | **≥ 150 kips** |
| Routine or Annual | Unlimited Crossings | Mixed with traffic (other vehicles may be on the bridges) | Two or more lanes | >5000 | 1.80 | 1.30 |
| | | | | =1000 | 1.60 | 1.20 |
| | | | | <100 | 1.40 | 1.10 |
| | | | | | All Weights | |
| Special or Limited Crossing | Single-Trip | Escorted with not other vehicles on the bridge | One Lane (remove MPF) | NA | 1.15 | |
| | Single-Trip | Mixed with traffic (other vehicles may be on the bridges) | One Lane | >5000 | 1.50 | |
| | | | | =1000 | 1.40 | |
| | | | | <100 | 1.35 | |
| | Multiple-Trips (less than 100 crossings) | Mixed with traffic (other vehicles may be on the bridges) | One Lane | >5000 | 1.85 | |
| | | | | =1000 | 1.75 | |
| | | | | <100 | 1.55 | |

Kulicki et al. (2007) updated the AASHTO LRFD Strength limit state calibration from NCHRP Report 368 in NCHRP Project 20-7/186: *Updating the Calibration Report for AASHTO LRFD Code*. The researchers computed reliability indices for an updated database of representative bridges designed using ASD, LFD, and LRFD, with differing structural configurations and materials, including prestressed concrete I-beams, reinforced concrete T-beams, non-composite and composite steel girders, and simple-span and continuous bridges. Kulicki et al. adopted the live model and statistics from NCHRP 368 but incorporated adjustments to estimate increased live load moment and shear effects at ADTTs up to 5,000.

Kulicki et al. used Monte Carlo Simulation (MCS) to evaluate shear and moment reliability analyses for a database of 124 representative bridges. $\beta$ was calibrated for a target of 3.5. The bridges in the database satisfied this reliability target on average, and possessed minimum and maximum individual $\beta$ values of about 2.7 and 4.1, respectively. $\beta$ generally decreased with increasing span length, a consequence of increasing dead-to-live load ratio with span length. Maximum values exceeding 4.0 occurred at the shortest spans. The average $\beta$ for spans longer than 200 ft was less than 3.5.

Sivakumar and Ghosn (2011) selected target $\beta$ values for permit loads and recalibrated permit live load factors for LRFR by using recent national WIM data in NCHRP Project 20-07 Task 285: *Recalibration of LRFR Live Load Factors in the AASHTO Manual for Bridge Evaluation*. Permit classifications in NCHRP Project 20-07 Task 285 were: routine permits (unrestricted crossings), single-trip special permits (can mix with regular truck traffic), escorted single-trip special permits (no other vehicles), and multiple-trip special permits (less than 100 crossings in bridge evaluation period). Sivakumar and Ghosn used $\beta_{target} = 2.5$ for single-trip escorted cases without routine traffic, or unlimited crossings with routine traffic, and $\beta_{target} = 3.5$ (same as for design) for single or multiple trips mixed with routine traffic. WIM data from six U.S. sites recorded for NCHRP project 12-76 was used to establish maximum bridge live load effects. NCHRP Project 20-07 Task 285 included moment and shear reliability analyses for simple-span T-beams, prestressed I-beams, and composite and non-composite steel I-girder bridges ranging from 20 to 200 ft. Recalibrated permit live load factors produced by Sivakumar and Ghosn were adopted in the MBE (AASHTO, 2018) and are shown in Table 3. The values are generally lower than those from NCHRP Report 454 shown in Table 2. Table 3 has also been simplified to reflect that special permit live load factors are insensitive to ADTT.

Table 3. Permit Live Load Factors Table (AASHTO, 2018)

| Permit Type | Frequency | Loading Condtion | DF (LRFD distribution factor) | ADTT (one direction) | Load Factor by Permit Weight Ratio | | |
|---|---|---|---|---|---|---|---|
| | | | | | GVW/AL<2.0 (kip/ft) | 2.0 < GVW/AL< 3.0 (kip/ft) | GVW/AL>3.0 (kip/ft) |
| Routine or Annual | Unlimited Crossings | Mixed with traffic (other vehicles may be on the bridges) | Two or more lanes | >5000 | 1.40 | 1.35 | 1.30 |
| | | | | =1000 | 1.35 | 1.25 | 1.20 |
| | | | | <100 | 1.30 | 1.20 | 1.15 |
| | Unlimited Crossings (Reinforced Concrete Box Culverts) | Mixed with traffic (other vehicles may be on the bridges) | One Lane (remove MPF) | All *ADTTs* | 1.40 | | |
| | | | | | All Weights | | |
| Special or Limited Crossing | Single-Trip | Escorted with no other vehicles on the bridge | One Lane | N/A | 1.10 | | |
| | Single-Trip | Mixed with traffic (other vehicles may be on the bridges) | One Lane | All *ADTTs* | 1.20 | | |
| | Multiple-Trips (less than 100 crossings) | Mixed with traffic (other vehicles may be on the bridges) | One Lane | All *ADTTs* | 1.40 | | |

Barker and Puckett (2016) examined the reliability indices of Wyoming bridges along the I-80 corridor considering interstate truck WIM data applied to roadway closures that often occur due to weather in FHWA-WY-17/02F Final Report: *Assessment and Evaluations of I-80 Truck Loads and Their Load Effects*. Simple- and two-equal-span bridges were considered with spans of 30, 50, 100, 150, and 200 ft. A total of nine years of truck WIM data were reviewed. Differences were insignificant between 2014 WIM data and the nine-year data as a whole. The 2014 truck data includes about 820,000 vehicles, corresponding to an ADTT of about 2000. Characteristics of the maximum 1000 GVW vehicles, excluding vehicles heavier than 125 kips which were assumed to be special permit vehicles, are shown in Table 4 classified by number of axles.

Table 4. Barker and Puckett (2016) Heavy Truck Properties

| Number of Axles | Number in Database | Average Length (ft) | Average GVW (kips) | Legal Load (kips) | Number Exceeding Legal | Percent Exceeding Legal |
|---|---|---|---|---|---|---|
| 2 | 1 | 16.1 | 37.04 | 40 | 0 | 0.0% |
| 3 | 35 | 20.8 | 62.4 | 60 | 23 | 65.7% |
| 4 | 8 | 37.6 | 77.1 | 80 | 3 | 37.5% |
| 5 | 325 | 59.7 | 97.6 | 100 | 173 | 53.2% |
| 6 | 168 | 65.6 | 108.1 | 111 | 63 | 37.5% |
| 7 | 296 | 70.9 | 114.7 | 115.5 | 125 | 42.2% |
| 8 | 135 | 81.1 | 115.9 | 117 | 55 | 40.7% |
| 9 or more | 32 | 99.8 | 116.4 | 117 | 14 | 43.8% |

Positive and negative dynamic moment developed in each bridge configuration by each truck were determined using influence line analyses and expressed as a bias factor relative to the HL-93 design loading, also including a 0.33 dynamic impact factor. A bias factor is defined as the ratio of mean to nominal values for a parameter, in this case

$$\lambda_L = \frac{\mu_L}{L_n} \qquad \text{(Eqn. 6)}$$

where $\lambda_L$ is the live load bias factor, $\mu_L$ is the mean live load effect, and $L_n$ in the nominal live load effect.

Barker and Puckett used MCS to predict maximum single vehicle effects based on normal distribution assumptions for the 1000 truck database for different time horizons. Resulting means and *CoV*s are shown for 150-ft simple-span and two-span bridges in Table 5 and Table 6, respectively. Barker and Puckett used optimally-designed (*RF* = 1.0) bridge nominal resistances. The reliability index for I-80 traffic was generally smaller than the target $\beta$ of 3.5 proposed for LRFD. To meet target safety requirements, a dual tandem load (so-called “low-boy” in the BDS Commentary C3.6.1.3.1) was recommended for short, multi-span bridges along with an increased design live load factor of 2.0.

Table 5. Single Vehicle Live Load Bias for 150-ft Simple Span (Barker and Puckett, 2016)

| Time Frame | Bias Mean | Bias CoV |
|---|---|---|
| Average | 0.755 | 0.121 |
| 1 Day Max | 0.820 | 0.081 |
| 2 Week Max | 0.947 | 0.045 |
| 1 Month Max | 0.979 | 0.044 |
| 2 Month Max | 1.001 | 0.038 |
| 6 Month Max | 1.032 | 0.033 |
| 1 Year Max | 1.052 | 0.030 |
| 5 Year Max | 1.092 | 0.025 |
| 50 Year Max | 1.141 | 0.023 |
| 75 Year Max | 1.149 | 0.021 |

Table 6. Single Vehicle Live Load Bias for 150-ft Two-Span Bridge (Barker and Puckett, 2016)

| Time Frame | Bias Mean | Bias CoV |
|---|---|---|
| Average | 0.443 | 0.135 |
| 1 Day Max | 0.484 | 0.094 |
| 2 Week Max | 0.571 | 0.047 |
| 1 Month Max | 0.588 | 0.044 |
| 2 Month Max | 0.603 | 0.040 |
| 6 Month Max | 0.626 | 0.036 |
| 1 Year Max | 0.639 | 0.034 |
| 5 Year Max | 0.664 | 0.029 |
| 50 Year Max | 0.695 | 0.023 |
| 75 Year Max | 0.701 | 0.023 |

Sivakumar et al. (2007) investigated contemporary special truck configurations and state legal loads for the AASHTO Manual for Condition Evaluation and Load and Resistance Factor Rating of Highway Bridges in NCHRP Project 12-63: *Legal Truck Loads and AASHTO Legal Loads for Posting*. WIM data from highways in Idaho, Michigan, and Ohio were used to evaluate multiple presence assumptions in NCHRP Project 12-33 and NCHRP Project 12-46. Idaho's multiple-presence probabilities were relatively low (<1.37%) for ADTT approximately 1000 to

3000, which suggested that a 1/15 side by side assumption was over-conservative for bridges having 5000 ADTT. More detailed discussion of multiple presence is provided in Chapter 3.

NCHRP Report 575 also presents details from a state survey and review of state legal vehicles, including both those that satisfied Federal Bridge Formula (FBF) B (FHWA, 2019) and those that did not – “grandfathered” vehicles. FBF B is a general framework enacted by the U.S. Congress in 1975 to protect bridges from increasingly heavy vehicles appearing on interstates in the 1950s and 1960s by limiting the weight-to-length ratio, and also imposing an upper limit of 80 kips GVW. Three candidate FBF truck models with seven and eight axles were proposed: T7A, T7B, and T8. These three FBF trucks typically have greater effects on simple and continuous spans than AASHTO legal loads, as shown in Table 7. A notional rating load (NRL) for all possible Formula B truck configurations was also recommended and NCHRP Report 575. The NRL envelopes nearly all load effects for FBF B legal load vehicles, including the additional configurations proposed in Sivakumar et al. (2007). A set of new single-unit posting loads (SU4, SU5, SU6, SU7) were developed to evaluate bridges that do not rate adequately using the NRL. SU truck configurations are shown in Figure 7. Live load factors for NRL and SU trucks are presented in Table 8 for a target reliability index, $\beta$, of 2.5.

Table 7. T7A, T7B, and T8 Single Vehicle Live Load Bias for 150-ft Two-Span Bridge (Sivakumar et al., 2007)

| Force Effect | Maximum Overstress Ratio = FBF / AASHTO Legal |
|---|---|
| Simple-Span Bending | 1.49 |
| Simple-Span Shear | 1.37 |
| Two-Span Cont. Positive Bending | 1.48 |
| Two-Span Cont. Negative Bending | 1.26 |
| Two-Span Cont. Shear | 1.36 |
| Three-Span Cont. Positive Bending | 1.48 |
| Three-Span Cont. Negative Bending | 1.39 |
| Three-Span Cont. Shear | 1.35 |
| Four-Span Cont. Positive Bending | 1.48 |
| Four-Span Cont. Negative Bending | 1.34 |
| Four-Span Cont. Shear | 1.34 |

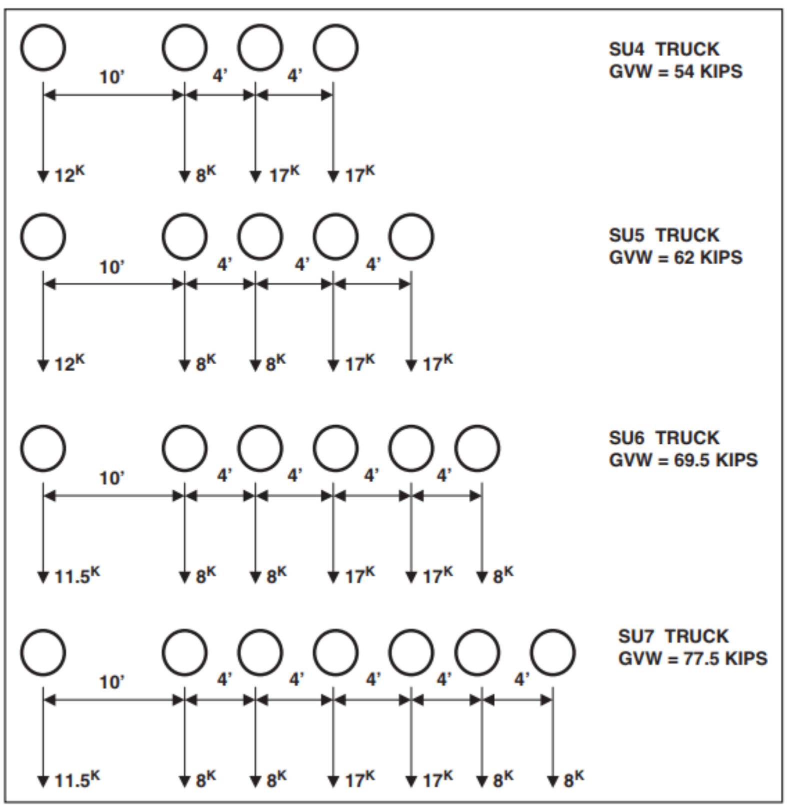



Figure 7. Bridge Posting Loads for FBF Single-Unit SHVs (Sivakumar et al., 2007)

Table 8. Live-Load Factors for Formula B SHVs. (Sivakumar et al., 2007)

| **Traffic Volume (one direction)** | **Load Factor for NRL, SU4, SU5,SU6, and SU7** |
|---|---|
| Unknown | 1.60 |
| ADTT ≥ 5000 | 1.60 |
| ADTT = 1000 | 1.40 |
| ADTT ≤ 100 | 1.15 |

Sivakumar et al. (2011) developed a set of protocols for calibrating live load factors for bridge design using WIM data in NCHRP Project 12-76 for NCHRP Report 683*: Protocols for Collecting and Using Traffic Data in Bridge Design*. The researchers presented a framework to estimate future maximum load effects based on limited WIM data. Three different methods were discussed: convolution or numerical integrations, Monte Carlo simulations, and simplified statistical projection methods. The simplified statistical projection method implemented by Sivakumar et al. used closed-form equations to determine maximum live load effects by considering recorded WIM data for individual truck load effects, number of side-by-side crossings, and a five-year bridge evaluation period.

Figure 8 is the probability plot of the data collected at an I-81 site in upstate New York. As shown in Figure 8, the entire set of single loading events do not fit a normal distribution. However, the upper tail, about 5% of the data, can be treated as a normal distribution. A linear fit of this portion of the data on the probability plot produced a straight line with slope *m* and an intercept *n*. The mean of the event is expressed as $\mu_{event}$ = −n/m and the standard deviation $\sigma_{event}$ = 1/m. For the data in Figure 8, the $\mu_{event}$ =0.0232 and $\sigma_{event}$ = 0.333.

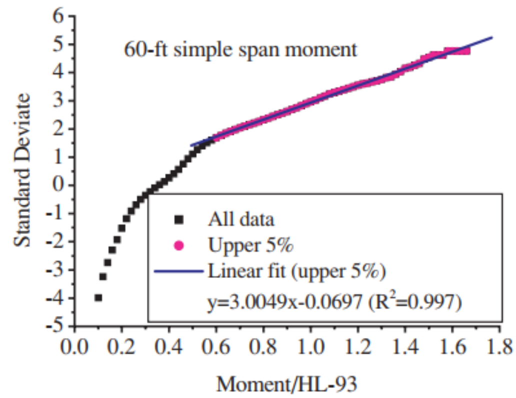



Figure 8. Normal Probability Plot for Moment of Trucks in Drive Lane of I-81 NB (Sivakumar et al., 2011)

The maximum value of a random normally distributed event having mean, $\mu_{event}$, and standard deviation, $\sigma_{event}$, can be represented as an Extreme Value Type I (Gumbel) distribution according to Ang and Tang (2007). If the maximum value is taken from a normally distributed sample of random values (e.g., the maximum annual value taken from a single year of daily maximum wind speeds), and this process is repeated over many successive normally distributed random samples (e.g., repeatedly sample the maximum wind speed every year over many years), then the distribution of sampled maximum values will take the form of the Extreme Type I distribution. Nowak and Collins (2013) note that extreme value distributions are therefore often used to characterize probability distributions of extreme values (largest or smallest values) for some phenomenon during a period. Maximum load effects and *CoV* can be estimated for a prescribed number of events, *N*, where *N* is directly related to the evaluated period, number of crossings, and ADTT. Closed-form equations to estimate maximum load effects and standard deviation are given as

$$\alpha_N = \frac{\sqrt{2\ln(N)}}{\sigma_{event}} \qquad \text{(Eqn. 7)}$$

$$\mu_N = \mu_{event} + \sigma_{event}\left(\sqrt{2\ln(N)} - \frac{\ln(\ln(N)) + \ln(4\pi)}{2\sqrt{2\ln(N)}}\right) \quad \text{(Eqn. 8)}$$

$$\mu_{\max} = \mu_N + \frac{0.577216}{\alpha_N} \quad \text{(Eqn. 9)}$$

$$\sigma_{\max} = \frac{\pi}{\sqrt{6}\alpha_N} \quad \text{(Eqn. 10)}$$

$$CoV_{\max} = \frac{\sigma_{\max}}{\mu_{\max}} \quad \text{(Eqn. 11)}$$

where $\mu_N$ and $\alpha_N$ are Extreme Type I distribution location and scale parameters, respectively, $\mu_{max}$ is the mean of the maximum load effect, $\sigma_{max}$ is the standard deviation of the maximum load effect, and $COV_{max}$ is the coefficient of variation of the maximum load effect. $\mu_{event}$ and $\sigma_{event}$ are determined from the Barker and Puckett (2016) I-80 WIM data and used to characterize adjacent lane load for the present study.

### 2.3 Summary

Platoon effects on bridges have been evaluated by comparing load effects and load ratings with a limited set of constant headways to AASHTO design and legal loads. Broad examination of headways is lacking. Platooning effects also have not yet been evaluated within a probabilistic, reliability-based paradigm. Platooning research has not considered potential benefits of reduced truck weight uncertainty and associated opportunities for increased truck weight. The degree of uncertainty associated with live load effects and general guidance for minimum truck headways need to be investigated. Additionally, implications for selection of

$\beta_{target}$ for platooning operations and policy has not been fully investigated. Therefore, both $\beta_{target}=2.5$ and $3.5$ are evaluated in present study.

Fundamental reliability-based analysis and calibration processes for live load factors were reviewed. NCHRP 575 reports provide a potential envelope truck type (NRL) for platoons. Most statistical parameters are adopted from NCHRP Report 20-07/186 for this project. WIM data from Barker and Puckett (2016) and the adjacent lane live load characterization methodology from NCHRP Report 683 are used to evaluate potential mixed traffic conditions with platoons adjacent to routine heavy trucks. A detailed research methodology building on the literature reviewed here is outlined in the next Chapter.

# 3 RESEARCH METHODOLOGY

## 3.1 Overview

This research investigates potential platooning operations within a strength-based structural reliability paradigm. General platoon and bridge characteristics and configurations are described. Probabilistic representations of uncertain dead loads, live loads, and resistances are well understood from previous work and are used here. To adequately address project objectives, the live load model requires closer scrutiny than other studies in existing literature. An equation is proposed to calculate the total $CoV$ of a platoon, explicitly accounting for individual contributions from vehicle weights, dynamic amplification, and load distribution.

Monte Carlo Simulation (MCS) is used to compute reliability indices, $\beta$, that subsequently are used to calibrate live load factors for AASHTO LRFR and LFR methods. Reliability indices are determined from probability of failure, which was obtained using MCS according to the framework presented in Figure 9. Platoons were parametrically investigated by varying the:

- type of trucks in the platoon,
- number of trucks in the platoon,
- headway between trucks,
- weight of individual trucks, and
- degree of uncertainty associated with live loads.

These platoon parameters are noted in the top portion of Figure 9. Three primary use cases are listed for live load:

- a platoon in a single bridge lane,
- two identical platoons operating in adjacent lanes, and
- a combination of a platoon in one lane and routine traffic in the adjacent lane.

These cases are evaluated and results for moment and shear are presented independently.

Considered bridges were parameterized using span length, span type (simple- and two-span continuous), construction material (steel and prestressed concrete), and girder spacing. Representative nominal dead loads were estimated according to construction material and span length. Resistances were estimated following the BDS Strength I load combination to support estimated nominal dead loads and HL-93 design live loads. AASHTO LFD was also used to model bridges designed according to the Standard Specifications. Lastly, nominal demands and resistances were mapped into probabilistic distributions with characteristic means and dispersions, and the probability of failure for each parametric combination was obtained using MCS to establish reliability for that combination.

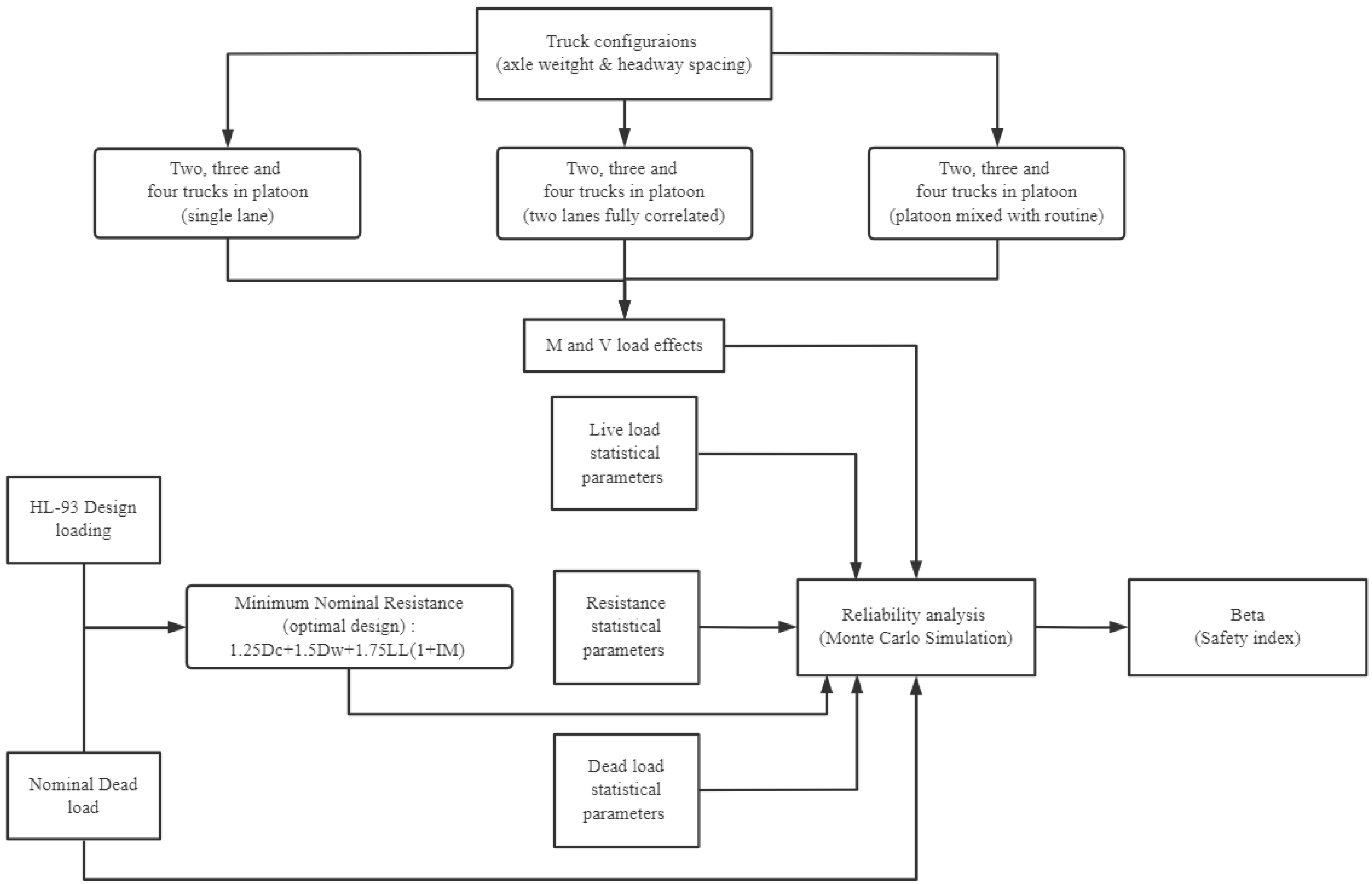



Figure 9. Reliability Analysis Flowchart.

## 3.2 Platoon Parameters

### 3.2.1 Truck Type

The FHWA sponsored a study that considered historical AASHTO Type 3S2 and Type 3-3 legal vehicles and examined vehicle configurations from ten states' WIM data to identify a critical configuration representative of a potential platooning vehicle. The FHWA-sponsored research team observed from the WIM data that the FHWA Class 9 configuration was most common. This configuration was therefore included in a suite of potential platooning truck configurations (Lubin Gao, July 10, 2019).

The present study adopted similar vehicles to define platooning vehicle relative axle weights and spacings, as shown in Figures 10 and 11. The gross vehicle weight (GVW) of an AASHTO Type 3S2 is 72 kips rather than the 80 kip upper limit from Federal Bridge Formula B (FBF), as was the case for FHWA Class 9 and AASHTO Type 3-3. For the present study, an NJTA Type 3S2 was adopted identical to the NJTA Type 3S2 configuration used by the New Jersey Turnpike Authority (NJTA) Load Rating Manual (HNTB Corporation, 2016). The NJTA Type 3S2 has a GVW of 80 kips as shown in Figure 12. Selection of this vehicle allows for uniform characterization by weight regardless of axle configuration.

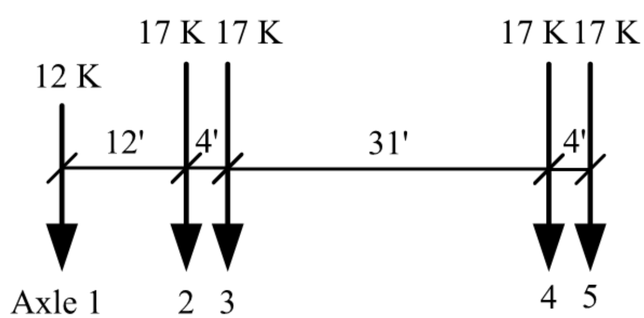



Figure 10. FHWA Class 9 Configuration

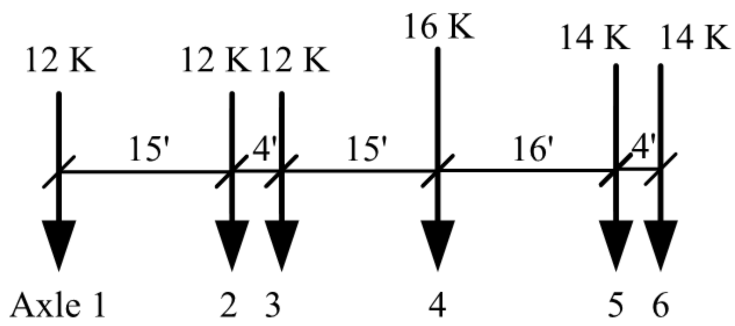



Figure 11. Type 3-3 Configuration (AASHTO, 2018)

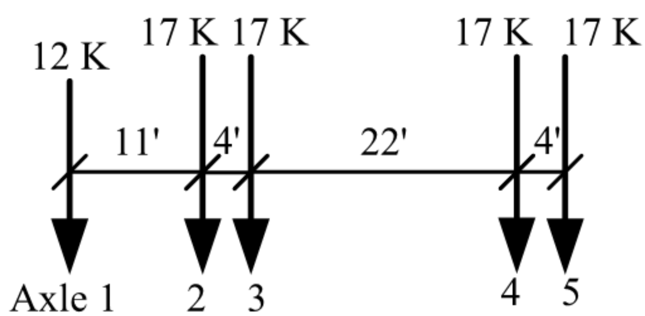



Figure 12. Type 3S2 Configuration Modified for NJTA (HNTB, 2016)

As noted in the literature review, NCHRP Report 575 summarizes a research project that examined legal load vehicles and proposed an expanded suite of SHVs to supplement Type 3, Type 3S2, and Type 3-3 legal configurations. The NRL (see Figure 13) was also proposed and subsequently adopted in the MBE as a single configuration that generally envelopes SHV effects. To ensure that the present study captures potential load effects from all routine legal vehicle configurations, the NRL was also included within the platooning vehicle configuration suite. As shown in Figure 13, to obtain critical live load effects NRL first axle spacing can vary between 6 ft and 14 ft.

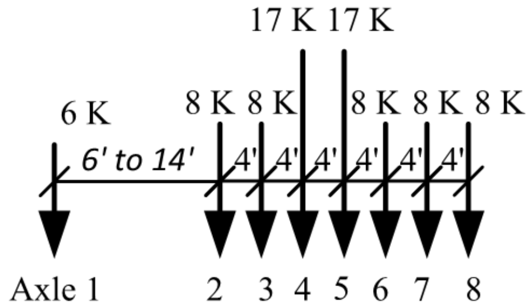


Figure 13. Notional Rating Load (AASHTO, 2018)

In summary, the current study included FHWA Class 9, NJTA 3S2, AASHTO Type 3-3, and the NRL as possible platoon vehicle configurations. The most severe demands from the suite were retained to establish an envelope of platoon demand for each particular vehicle type and spacing combination. An alternate set of potential platooning vehicles unique to the state of Nebraska was also investigated in a companion study (Chapter 8).

### 3.2.2 Number of Platoon Trucks

Up to three trucks were considered for platoons traversing a simple-span bridge. Additional platoon trucks would not significantly increase bridge demands for simple-span bridges whose span lengths were considered in the present study. Up to four trucks were considered for two-span continuous bridges to capture critical negative moment load effects for the studied bridge lengths.

### 3.2.3 Headway

The headway definition selected for the current study is illustrated in Figure 14. Headway is the distance between the leading truck's last axle and the first axle of the following truck. Previous platooning studies assumed several constant headways between vehicles. The present research focused primarily on consistent close headways between platoon vehicles. Consistent headways varied between 5 ft and 50 ft. Previous studies indicated that the minimum headway of trucks in a platoon is approximately 10 ft, however, the present study reduced the minimum considered spacing to 5 ft to ensure that results would remain applicable if the minimum operational headways were reduced in the future. The selected 5 ft lower bound is expected to represent a minimum physically achievable axle spacing between leading and trailing vehicles accounting for wheel sizes, recognizing that existing tandem axles tend to be spaced about 4 ft apart. The upper bound was set at 50 ft because it corresponds to a routine traffic spacing that provides negligible benefit to aerodynamic efficiency.

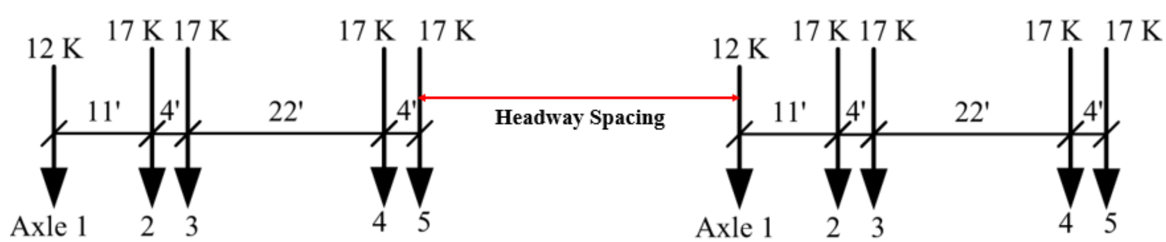



Figure 14. Typical Two-Truck Configuration and Headway Definition (Yarnold and Weidner, 2019)

The present study also considers the effects of potential abnormal situations on headways, such as inclement weather, which may result in variable headways as shown in Figure 15. Live load effects caused by these abnormal headway configurations are discussed in

Chapter 4. All headways were incremented parametrically using 1-ft intervals. Considered headway cases are summarized below:

- Simple span

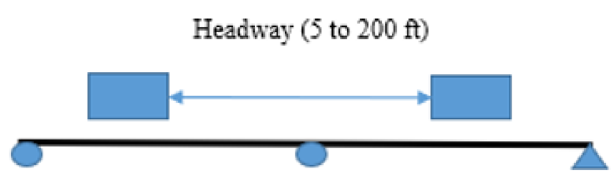
  CASE 1: 5 to 50-ft constant headway

- Two-span bridges

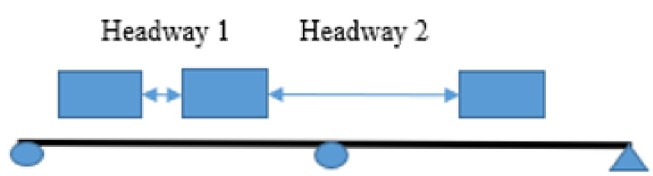
  CASE 1: 5 to 50-ft constant headway

  CASE 2: 5 to 200-ft constant headway (Figure 15a)

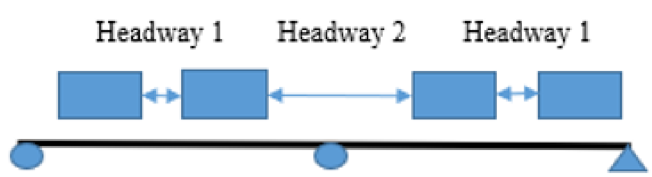
  CASE 3: varied headways (Figure 15b & Figure 15c)




[a] Two-truck scenario




[b] Three-truck scenario

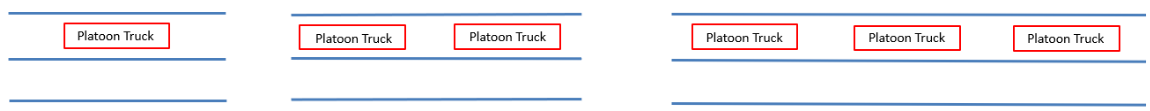



[c] Four-truck scenario

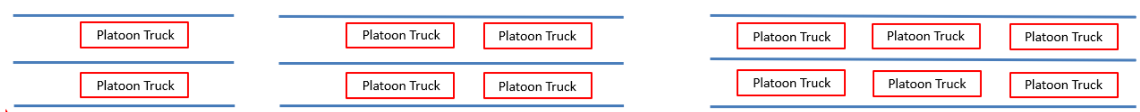
Figure 15. Critical Headway Governing Situations

### 3.2.4 Lane Loading Scenarios

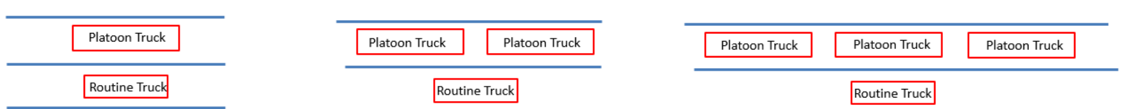
One- and two-lane loading cases are considered. Scenarios included a single platoon in one lane (Figure 16a), two identical platoons in adjacent lanes (Figure 16b), and a platoon operating with routine traffic in an adjacent lane (Figure 16c) to fully formulate operational permitting guidelines.




[a] Single platoon, with the adjacent lane empty




[b] Two identical platoons in adjacent lanes (fully correlated lanes)




[c] Platoons and routine traffic in adjacent lanes (uncorrelated lanes)

Figure 16. Considered Loading Scenarios

### 3.3 Bridge Parameters

The present study included the following bridge types:

- simple-span steel composite girders,
- two equal-span continuous steel composite girders,
- simple-span prestressed I-girders, and
- two equal-span continuous prestressed I-girders girders.

Bridges were assumed to carry two traffic lanes. Nowak (1999) considered multi-girder prestressed concrete and composite steel bridges with spans ranging between 30 ft and 200 ft. This project similarly focused on 30 ft to 200 ft long steel girder bridges. The upper bound span length for prestressed concrete girders was set to 150 ft based on the Precast Concrete Institute (PCI) Bridge Design Manual (2011). Nowak (1999) considered girder spacings from 4 ft to 12 ft. Typical girder spacings for interstate bridges in Nebraska range from 8 ft to 12 ft, and the scope of the present study was limited to this narrower representative range. Interior girders are expected to be the critical load carrying elements. In summary, parameter ranges for bridge analyses were:

- prestressed concrete I-girder bridges with spans of 30, 60, 90, 120, and 150 ft;
- composite steel girders with spans of 30, 60, 90, 120, 150, and 200 ft; and
- Girder spacing of 8, 10, 12 ft.

## 3.4 Dead Loads

### 3.4.1 Nominal Values

Realistic estimated values for nominal dead loads were computed to facilitate reliability analyses for various bridge type, span length, and girder spacing combinations as noted in Figure 9. For consistency with contemporary AASHTO BDS design and MBE evaluation procedures, this study considered dead load effects of components, *DC*, and wearing surfaces, *DW*. Component dead loads included girder and slab weights and a miscellaneous allowance of 10% of the girder weight to account for cross frames, stiffeners and other miscellaneous components. Girder weights were estimated from preliminary design calculations accounting for deck and wearing surface weights, miscellaneous dead load, and HL-93 design live load effects. The deck thickness was estimated to be $S/14$, but no less than 8 in., where $S$ is the girder spacing in inches. Although this differs from NDOT standard practice, which uses empirical deck design, the results of analyses for this study will not be significantly influenced. As noted in a later section, capacities were specified as a function of assumed dead loads. Deck concrete was assumed to nominally weigh 150 pcf. Wearing surfaces were assumed to consist of a 3 in. asphalt layer and nominally weigh 30 psf.

Steel girders were proportioned to satisfy BDS Strength I and Service II limits. For prestressed concrete I-girder bridges, girder self-weight was taken from the PCI Bridge Design Manual (2011) design charts. The chart used for the present study is shown in Figure 17, which establishes minimum AASHTO girder sizes (Type II, III, IV, V, or VI) for combinations of span and girder spacing. Selected girder sizes used in this study are given in Table 9. Similar to deck, these girders differ from NDOT standard practice, which uses NU girders, but the results of analyses for this study will not be significantly influenced. In the absence of available information, Type VI girders were assumed for 150-ft long bridges and a girder spacing of 10 ft or 12 ft. This assumption resulted in slightly unconservative dead loads for these cases, which is deemed negligible in comparison to the dead load contributions from deck weight and live load effects.

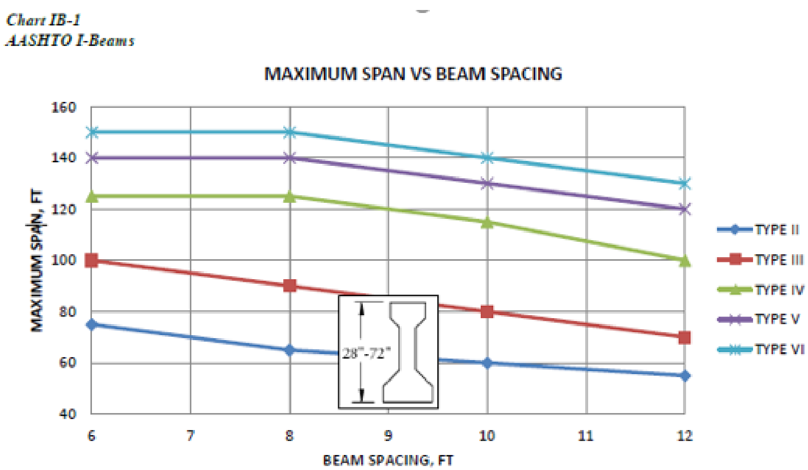



Figure 17. Simple-span prestressed concrete girder selection design chart (PCI Bridge Design Manual, 2011)

Table 9. Preliminary Prestressed Concrete I Girder Sections

| Span (ft) | Girder S = 8 ft | Girder S = 10 ft | Girder S = 12 ft |
|---|---|---|---|
| 30 | TYPE II | TYPE II | TYPE II |
| 60 | TYPE II | TYPE II | TYPE II |
| 90 | TYPE III | TYPE IV | TYPE IV |
| 120 | TYPE IV | TYPE V | TYPE V |
| 150 | TYPE VI | TYPE VI | TYPE VI |

Steel and prestressed concrete girder sections were assumed to be identical for similar simple- versus two-span bridges. NDOT bridge policy (BOPP, 2016) assumes prestressed girder continuity at the interior supports only for live loads. Therefore, *DC* moment effects are zero at the support for two-span prestressed concrete girder bridges. The *DC* middle support shear effects were taken equal to those for simple spans. Nominal dead loads are summarized in Figure 18. Nominal dead load moments for simple-span steel and prestressed bridges are given in Table 10.

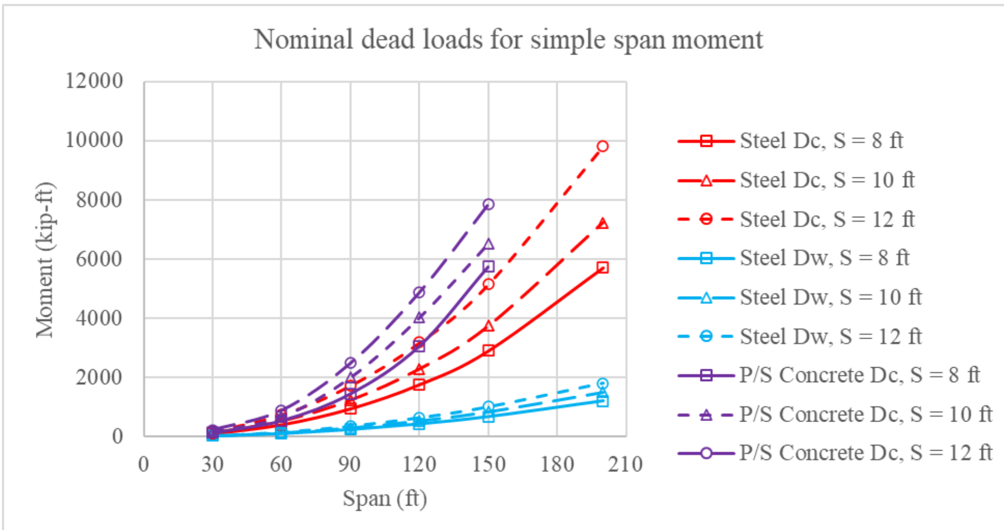



Figure 18. Nominal Simple Span Dead Load Moments

Table 10. Nominal Simple Span Dead Load Moment Effects

| Span (ft) | Spacing (ft) | Steel Bridges | | P/S Concrete Bridges | |
|---|---|---|---|---|---|
| | | DC | DW | DC | DW |
| 30 | 8 | 97 | 27 | 138 | 27 |
| | 10 | 129 | 34 | 168 | 34 |
| | 12 | 182 | 41 | 221 | 41 |
| 60 | 8 | 404 | 108 | 550 | 108 |
| | 10 | 533 | 135 | 674 | 135 |
| | 12 | 749 | 162 | 885 | 162 |
| 90 | 8 | 947 | 243 | 1459 | 243 |
| | 10 | 1240 | 304 | 2004 | 304 |
| | 12 | 1734 | 365 | 2480 | 365 |
| 120 | 8 | 1762 | 432 | 3068 | 432 |
| | 10 | 2292 | 540 | 4024 | 540 |
| | 12 | 3184 | 648 | 4870 | 648 |
| 150 | 8 | 2902 | 675 | 5746 | 675 |
| | 10 | 3742 | 844 | 6519 | 844 |
| | 12 | 5155 | 1013 | 7841 | 1013 |
| 200 | 8 | 5711 | 1200 | NA | NA |
| | 10 | 7234 | 1500 | NA | NA |
| | 12 | 9815 | 1800 | NA | NA |

In summary, girders and decks were proportioned to determine the typical sizes in order to estimate the dead *DC* and *DW* loads as a function of span length. The strength of these sections was not used directly in the study. Section resistance is from optimal design as explained elsewhere. Reliability computation only relies on the relative load effects from dead and live loads, so an estimated dead load effect is typically used.

### 3.4.2 Statistical Parameters

The present study assumed both component dead and wearing surface load effects to be normally distributed, consistent with NCHRP Report 20-07/186 (Kulicki et al., 2007) and Barker and Puckett (2016). Bias factors and coefficients of variation (*CoV*s) also conformed to the values used in NCHRP Report 20-07/186 and Barker and Puckett, as shown in Table 11. Dead load effect means ($\mu_D$) and standard deviations ($\sigma_D$) were determined by relating nominal values ($D_n$) to means through bias factors ($\lambda_D$)

$$\mu_D = D_n * \lambda_D \quad \text{(Eqn. 12)}$$

Means and standard deviations were related through $CoV_D$ values

$$\sigma_D = \mu_D * CoV_D \quad \text{(Eqn. 13)}$$

Table 11. Dead Load Statistical Parameters

| **Compoment** | $\lambda_D$ | $CoV_D$ |
|---|---|---|
| DC | 1.05 | 0.10 |
| DW | 1.00 | 0.25 |

## 3.5 Live Loads

Live load effects are induced in girders through a combination of static live load effects, dynamic amplification, transverse load distribution between girders, and multiple presence of heavy vehicles in adjacent lanes. The following subsections discuss each live load consideration, followed by a discussion of associated statistical parameters (bias and *CoV*) and how these were used in the MCS reliability analyses (see Figure 9).

### 3.5.1 Moving Load Analyses

The present study used influence line equations to determine maximum positive moments and end shears for simple-span bridges, and maximum negative moments and interior support shears for two-span bridges when subjected to various combinations of relative axle weights and spacings presented in Section 3.2. The process for simulating platoons passing over simple-span bridges is to:

1. Specify the number of trucks in the platoon;
2. Simulate the first axle of the leading truck 1 ft from the left support;
3. Compute mid-span moment and end shears due to all axles for the platoon using influence lines;
4. Increment the leading truck position by 1 ft traveling left to right;
5. Repeat Step 3;
6. Repeat Step 4 until the last axle of the platoon passes over the bridge;
7. Identify the maximum mid-span moment and end shear.

The process is similar for two-span bridges. The primary difference is that critical moments and shears both occur at the interior support. Details are provided in Appendices. For the same span length(s), the M+ for simple-spans is greater than for two-span girders; therefore, only M- was investigated for two-span bridges. Moreover, the simple- and two-span bridges envelope other multiple-span cases.

### 3.5.2 Nominal LRFD and LFD Design Live Loads

This project required separate consideration of three static loading models. The entire suite of vehicles described in Section 3.2 represents one "model." Live load analysis results from this first model were used directly in the MCS to characterize platoon live loads. MCS analyses required capacity statistical parameters, and so a second type of live load model was required to estimate reasonable nominal capacities as described in Section 3.6. Live loads referenced in Section 3.6 are described in this subsection. A third live load model was needed when evaluating structural reliability when a platoon is operating adjacent to routine traffic (Figure 16c) to characterize load in the lane adjacent to the platoon. The third type of live load model is discussed in Section 3.5.5.

This study included bridges designed using AASHTO LRFD and LFD. Therefore, nominal design basis live load models included HL-93 for LRFD and HS-20 for LFD. The HL-93 loading is defined in the BDS and is the typical design loading for highway bridges in the United States and is a combination of HS 20-44 trucks (see Figure 19) or design tandems (two 25 kip axles at 4 ft spacing), together with design lane loads (0.64 kip-ft). Spacing between the two 32.0 kips axles varies from 14 ft to 30 ft to produce critical load effects. The HL-93 loading also provides for consideration of critical negative moments through a supplemental combination. The combination includes: 90% of the effect of two design trucks having 14 ft spacing between the 32 kips axles and a minimum headway of 50 ft between the trucks, which are spaced to create maximum loading effects; 90% of the design lane load.

Calculated nominal HL-93 loading moment and shear live load effects for simple-span bridges were validated using MBE Appendix E6A (AASHTO, 2018). Two-span bridge negative moment and shear effects were calculated using MATLAB and validated using SAP2000 and are also provided in Appendices.

The AASHTO Standard Specifications for Highway Bridges (2002) requires that bridges support a HS-20 44 design truck, shown in Figure 19, and this loading configuration typically governs for short- and medium-span bridges. Additionally, bridges must support an alternate load case comprised of a 0.64 kip/ft uniform load and a single concentrated load as shown in Figure 20. Article 3.7.1.2 in the Standard Specifications also requires consideration of two concentrated loads for negative moments at interior supports of continuous structures.

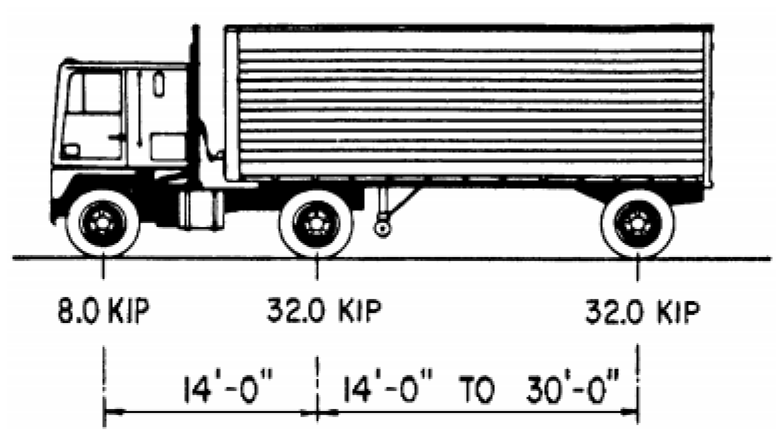


Figure 19. HS-20 Design Truck (AASHTO, 2020)

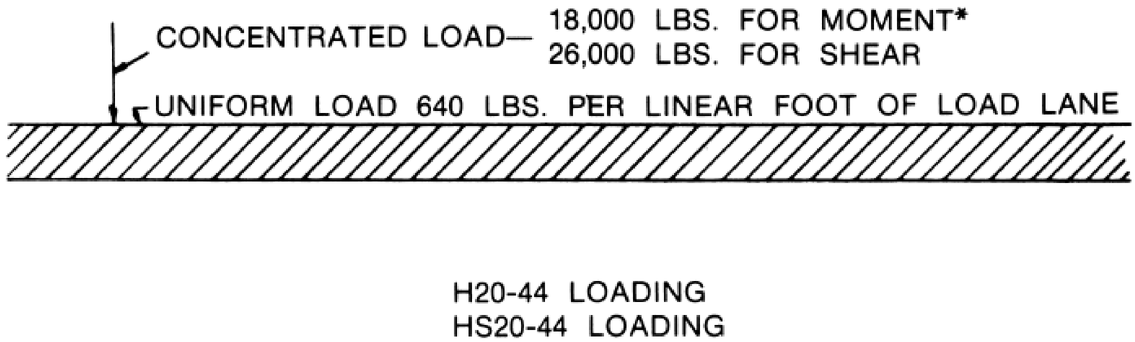



Figure 20. HS-20 Lane Loading (AASHTO, 2002)

### 3.5.3 Dynamic Load Amplification

The AASHTO BDS and MBE require applying a dynamic amplification factor, or impact factor, *IM*, to static live load effects to account for potential dynamic amplification induced from vehicle travel over irregular surfaces. The BDS specifies a constant *IM* = 33%.

MBE (2018) Article 6A.4.4.3 indicates that an *IM* value of 33% should be applied to design and legal loads for typical traffic speeds; however, Article 6A.4.5.5 states that *IM* may be taken as zero for crawl speeds. Additionally, the impact factor can be reduced for bridge evaluation based on smoothness of the riding surface and approach according to the MBE Commentary C6A.4.4.3. Accordingly, the impact factor used for load ratings can be reduced to 20% or 10%, based on inspector judgment. Furthermore, MBE Article 8.4.2 discusses options to obtain dynamic response data, which a smart truck could potentially obtain directly with on-board sensing at instrumented axles or suspensions. MBE Article 8.3.5 states that measured dynamic response data may be used in place of the code-specified values noted above for load rating.

The impact factor for design and legal loads in LFD differs from LRFD and is span dependent. AASHTO Standard Specifications (2002) provide the impact factor as a function of span length

$$IM = \frac{50}{L+125} \leq 0.3 \qquad \text{(Eqn. 14)}$$

where *IM* is the impact factor (maximum 30 percent) and *L* is the span length (ft). The span dependent impact factor was used to determine nominal resistance for LFD designed bridges.

### 3.5.4 Girder Distribution Factors

Transverse load distribution is approximated in the BDS using girder distribution factors (GDFs). A GDF represents the number of loaded lanes resisted by the most heavily loaded girder and is therefore used to establish moment and shear effects for girder design and evaluation. Approximate moment and shear GDF equations for interior girders are provided in BDS (2020) Articles 4.6.2.2 and 4.6.2.3 for single-lane cases and multiple-lane cases. Moment and shear GDFs for steel and prestressed concrete girder bridges are shown in Eqns. 15 to 18.

The one-lane loaded moment GDF (which includes $m$ = 1.2) is

$$mg_s = 0.06 + \left(\frac{S}{14}\right)^{0.4} \left(\frac{S}{L}\right)^{0.3} \left(\frac{K_g}{12Lt_s^3}\right)^{0.1} \qquad \text{(Eqn. 15)}$$

The two- or more lanes loaded moment GDF is

$$mg_m = 0.075 + \left(\frac{S}{9.5}\right)^{0.6} \left(\frac{S}{L}\right)^{0.2} \left(\frac{K_g}{12Lt_s^3}\right)^{0.1} \qquad \text{(Eqn. 16)}$$

The one-lane loaded shear GDF (which includes $m$ = 1.2) is

$$vg_s = 0.36 + \frac{S}{25.0} \quad \text{(Eqn. 17)}$$

The two- or more lanes loaded shear GDF is

$$vg_m = 0.2 + \frac{S}{12} - \left(\frac{S}{35}\right)^{2.0} \quad \text{(Eqn. 18)}$$

where $S$ is the girder spacing (ft), $L$ is the span length (ft), $t_s$ is the deck thickness (in.), and $K_g$ is the longitudinal stiffness parameter (in.$^4$). BDS Table 4.6.2.2.1.3 provides approximate values of the term containing $K_g$. Bridges with steel and prestressed concrete girders may use estimates of 1.02 and 1.09, respectively. GDFs for steel and prestressed bridge span lengths with a 10-ft girder spacing are given in Table 12 and Table 13. BDS approximate GDF equations include multiple presence factors (MPFs) of 1.2 for a single-lane cases and 1.0 for multiple lane cases. Embedded GDFs in the BDS equations correspond to the HL-93 design load. Herein, platoons are considered to be permit vehicles, so the MPF should be removed from GDFs in accordance with MBE Article 6A.4.5.4.2b. Single-lane loaded tabulated values in Table 12 and Table 13 have been adjusted to remove the MPF. Exterior girders cannot be evaluated for single-lane cases without specifying deck overhang widths and applying the lever rule. The current study did not use bridge designs of sufficient detail to facilitate such evaluations.

Table 12. Steel Bridge GDF for Moment and Shear (Girder Spacing = 10 ft)

| **Steel Bridge** | **Moment** | | **Shear** | |
|---|---|---|---|---|
| **Span (ft)** | **GDFs** | **GDFm** | **GDFs** | **GDFm** |
| 30 | 0.58 | 0.92 | 0.76 | 0.95 |
| 60 | 0.48 | 0.81 | 0.76 | 0.95 |
| 90 | 0.43 | 0.75 | 0.76 | 0.95 |
| 120 | 0.40 | 0.71 | 0.76 | 0.95 |
| 150 | 0.38 | 0.69 | 0.76 | 0.95 |
| 200 | 0.35 | 0.65 | 0.76 | 0.95 |

Table 13. Prestressed Concrete Bridge GDF for Moment and Shear
(Girder Spacing = 10 ft)

| **Prestressed Concrete Bridge** | **Moment** | | **Shear** | |
|---|---|---|---|---|
| **Span (ft)** | **GDFs** | **GDFm** | **GDFs** | **GDFm** |
| 30 | 0.62 | 0.98 | 0.76 | 0.95 |
| 60 | 0.51 | 0.86 | 0.76 | 0.95 |
| 90 | 0.46 | 0.80 | 0.76 | 0.95 |
| 120 | 0.43 | 0.76 | 0.76 | 0.95 |
| 150 | 0.40 | 0.73 | 0.76 | 0.95 |

Load Factor Design (LFD) uses the "S-over" method to calculate GDFs. For interior girder bending moments, the AASHTO Standard Specifications (2002) effectively specifies lane GDFs of $S/11$ and $S/14$ for two- and single-lane loaded cases, respectively. Girder shears are determined using the lever rule for wheel loads near supports and S-over factors for loads away from supports. These values have been converted from the wheel line values published in the AASHTO Standard Specifications to maintain consistency with lane GDFs in the BDS.

Platoons operating alongside routine traffic in the adjacent lane were evaluated using Eqn. 19, which closely resembles BDS Eqn. (4.6.2.2.5-1). The platoon produces a live load effect, $L_{platoon}$, which is multiplied by the single-lane loaded GDF, $g_s$. The $g_s$ term is either the single-lane loaded GDF after removing the MPF in LRFD, or S/14 in LFD. The $g_m$ term is either the GDF for multiple loaded lanes in LRFD, or S/11 in LFD. The adjacent load effect, $L_{max}$, was determined as described in Section 3.5.5. Effects of routine traffic in the adjacent lane are superposed onto the critically loaded girder supporting platoon loading according to

$$L_{total} = L_{platoon} * (g_s) + L_{\max} * (g_m - g_s) \quad \text{(Eqn. 19)}$$

This is a simple linear interpolation using the available GDFs. Using *S*/11-*S*/14 as an example, the last term is approximately 0.20, or 20% of the adjacent lane's load is superposed on to the primary platoon-loaded girder. This scaling is important for understanding the effects of an adjacent lane carrying typical traffic on the critically loaded girder supporting heavier platoon loading.

### 3.5.5 Multiple Presence

Multiple presence effects were evaluated with platoons and routine traffic simultaneously in adjacent lanes. As discussed in the literature review, multiple presence effects have been investigated in previous bridge reliability calibration studies. The two primary aspects required to evaluate multiple presence are to establish the mean and *CoV* of the maximum adjacent lane loads and to establish side-by-side lane loading probabilities.

Nowak (1999) assumed side-by-side probabilities of 0.5%, 1%, and 6.67% for ADTTs of 100 (light truck volume), 1000 (average truck volume), and 5000 (heavy truck volume), respectively. Nowak's assumptions were also used in NCHRP Report 454. However, the 6.67% side-by-side probability has been observed to be conservative according to WIM data in NCHRP Report 575. Table 2.6 in Ghosn (2011) summarized side-by-side probabilities from several sources in literature and is reproduced in Table 14. Ghosn also collected WIM data in New York and observed side-by-side probabilities of two percent (2%) for heavy truck volumes, providing additional information indicating that Nowak's heavy truck side-by-side probabilities were more conservative than representative. Ghosn's side-by-side probabilities were used for the present study.

Table 14. Different Side-by-Side Probabilities in Literature (Ghosn, 2011)

| Traffic Volume | Low | Medium | High |
|---|---|---|---|
| AASHTO LRFR classification | ADTT <= 100 | ADTT = 1000 | ADTT >= 5000 |
| AASHTO LRFR percent side by side probability | 0.5% of heaviest 20% of trucks | 1% of heaviest 20% of trucks | 6.67% of heaviest 20% of trucks |
| NCHRP 12-76 classification | ADTT < 1000 | 1000< ADTT<2500 | 2500< ADTT<5000 |
| NCHRP 12-76 percent side by side probability | 0.54% of all trucks | 1.25 % of all trucks | 1.95 % of all trucks |
| Proposed ADTT classification for calibration study | ADTT = 100 | ADTT = 1000 | ADTT = 5000 |
| Proposed for NYSDOT LRFR load simulation | 0.5% of all trucks | 1.25% of all trucks | 2% of all trucks |

The method to obtain the maximum mean load effect, $L_{max}$, and $CoV$ for adjacent lane load over a five-year bridge evaluation period was based on the assumption that a normally distributed variable after $N$ repetitions would approach an Extreme Type I (Gumbel) distribution. As shown in Figure 8, the upper tail of heavy load effects can be approximated using a normal distribution fit, appearing as a straight line on normal probability paper space with slope $m$ and an intercept $n$. The mean of the event is expressed as $\mu_{event} = -n / m$ and the standard deviation $\sigma_{event} = 1 / m$. Eqns. 7 to 11 can then be used to obtain a characteristic maximum mean load effect $L_{max}$ and $CoV$ for adjacent lane loads.

Adjacent lane loads were characterized in terms of $\mu_{event}$ and $\sigma_{event}$ using interstate I-80 WIM data recorded in Wyoming by Barker and Puckett (2016). The available data represented the 1000 heaviest trucks out of approximately 820,000 trucks recorded during a typical year.

This proportion represents 0.1% of the data, rather than 5% used by Ghosn. Use of a narrower band at the upper tail may slightly skew results, but the dominant load effect is induced by the platoon and the methodology fundamentally ensures that a relatively high load is be imposed in the adjacent lane, so this approach was deemed acceptably conservative.

Barker and Puckett simulated each WIM vehicle passage over bridges of various span lengths to obtain static live load effects, amplified the static loads using a dynamic amplification according to the BDS, and normalized the effects with respect to the HL-93 design loading, which also accounted for dynamic amplification. Span lengths analyzed by Barker and Puckett did not address all individual span lengths considered in the present study. As a result, single truck event load effect $\mu_{event}$ and $CoV_{event}$ values for 60 ft, 90 ft, and 120 ft span lengths were approximated using linear interpolation between available data points. Mean, $\mu_{event}$, $CoV$, and standard deviation, $\sigma_{event}$, of single truck effects for simple- and two-span bridges are provided in Table 15 and Table 16. The mean of single truck effects shown in the tables includes the BDS 0.33 dynamic amplification (Barker and Puckett, 2016).

Data from Barker and Puckett represents single-truck events. However, as span length increases, critical load effects may be governed by more than one truck in an adjacent routine traffic lane. The BDS explicitly requires consideration of two sequential vehicles traveling with a minimum headway of 50 ft, creating critical moment effects for continuous locations over interior supports. For this study, the lane adjacent to a platoon was assumed to contain two separate trucks positioned in alternate spans for two-span, 90 to 200 ft bridges to determine critical negative moments. Truck-to-truck variability was assumed random and uncorrelated. Algorithmic details are presented in section 3.7.

Table 15 and Table 16 summarize the statistical parameters for static adjacent live load moment and shear effects relative to HL-93 taken from Barker and Puckett (2016). Barker and Puckett only provided values for moment. End shear bias was assumed equal to the simple-span moment bias in the present study. This assumption is reasonably consistent with data provided in NCHRP Report 683, although the data provided in that report does show that both absolute moment and shear and relative moment versus shear biases can vary appreciably by WIM data site. The middle support shear effects for two-span bridges were assumed to be equal to simple-span end shear effects, which can be readily confirmed through a comparison of simple-span versus two-span shear influence lines. $\mu_{event}$ and $\sigma_{event}$ in Table 15 and Table 16 represent mean and standard deviation of bias relative to HL-93 to maintain consistency with NCHRP Report 683, and were substituted into Eqn. 7 to Eqn. 11. NCHRP Report 683 uses $L_{max}$ to represent bias, but doing so introduces confusion whether the symbol represents a bias or a load effect. Herein, $\lambda_{max}$ is adopted as the symbol for adjacent live load bias for internal consistency and clarity, instead of $L_{max}$ used in NCHRP Report 683.

Table 15. Single Vehicle Live Load Mean, CoV, and Standard Deviations for Simple-Span Bridges

| **Span (ft)** | $\mu_{event}$ | *CoV* | $\sigma_{event}$ |
|---|---|---|---|
| **30** | 0.802 | 0.128 | 0.103 |
| **60** | 0.743 | 0.119 | 0.088 |
| **90** | 0.737 | 0.116 | 0.085 |
| **120** | 0.743 | 0.118 | 0.088 |
| **150** | 0.755 | 0.121 | 0.091 |
| **200** | 0.727 | 0.127 | 0.092 |

Table 16. Single Vehicle Live Load Mean, CoV, and Standard Deviations for Two-Span Bridges

| Span (ft) | $\mu_{event}$ | $CoV$ | $\sigma_{event}$ |
|---|---|---|---|
| **30** | 0.580 | 0.159 | 0.092 |
| **60** | 0.675 | 0.152 | 0.103 |
| **90** | 0.527 | 0.147 | 0.077 |
| **120** | 0.464 | 0.141 | 0.065 |
| **150** | 0.443 | 0.135 | 0.060 |
| **200** | 0.411 | 0.140 | 0.058 |

After probabilistically characterizing heavy load events in the adjacent lane, the final step to establish the nominal live load effect is to augment the adjacent lane to reflect higher likely adjacent loads with increasing opportunities for multiple presence. The method described by Ghosn (2011) was adopted to address the final consideration. The number of multiple presence occurrences, $N$, having adjacent platoon and routine traffic was determined from the product of the number of platoon loading events, $N_p$, and the probability of side-by-side occurrences, $P_{sxs}$,

$$N = N_p * P_{sxs} \quad \text{(Eqn. 20)}$$

where $N_p$ is estimated from an assumed number of crossings per day and an assumed evaluation period. Two cases for number of crossings per day, 10 and 100, were considered consistent with the approach described in NCHRP Report 454. A five-year evaluation period was assumed, consistent with the conservative upper bound considered in NCHRP 454. $P_{sxs}$ was assumed as a function of ADTT using values from Ghosn (see Table 14).

As an example, if a bridge is expected to carry 100 platoon crossings per day over a period of 5 years, $N_p$ = 100 * 365 * 5 = 182,500. If the ADTT is 5000 then $P_{sxs}$ = 2%. The total number of multiple presence occurrences over the five-year period is $N$ = 182,500 * 2% = 3,650. This value is substituted into Eqns. 7 and 8 to produce Extreme Type I distribution live load parameters in the adjacent lane. Adjacent lane loading characteristics for all combinations of considered spans, ADTTs, and number of crossings is summarized in Tables 17 to 20. The tables refer to $CoV_{max}$ and Total $CoV$. The distinction between these terms is addressed in Section 3.5.6.

Table 17. Expected Maximum Adjacent Live Load and CoV for Simple-Span Bridges, Span Lengths from 30 to 90 ft

| **Number of crossings per day** | **ADTT** | **30 ft** | | | **60 ft** | | | **90 ft** | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **λmax** | **CoVmax** | **Total COV** | **λmax** | **CoVmax** | **Total COV** | **λmax** | **CoVmax** | **Total COV** |
| **10** | **100** | 1.060 | 0.041 | 0.147 | 0.965 | 0.039 | 0.146 | 0.953 | 0.038 | 0.146 |
| | **1000** | 1.091 | 0.036 | 0.145 | 0.992 | 0.035 | 0.145 | 0.980 | 0.034 | 0.145 |
| | **5000** | 1.106 | 0.035 | 0.145 | 1.005 | 0.033 | 0.144 | 0.992 | 0.032 | 0.144 |
| **100** | **100** | 1.134 | 0.031 | 0.144 | 1.029 | 0.030 | 0.144 | 1.015 | 0.029 | 0.144 |
| | **1000** | 1.160 | 0.029 | 0.144 | 1.051 | 0.027 | 0.143 | 1.037 | 0.027 | 0.143 |
| | **5000** | 1.172 | 0.028 | 0.143 | 1.062 | 0.026 | 0.143 | 1.047 | 0.026 | 0.143 |

Table 18. Expected Maximum Adjacent Live Load and *CoV* for Simple-Span Bridges, Span Lengths from 120 to 200 ft

| **Number of crossings per day** | **ADTT** | **120 ft** | | | **150 ft** | | | **200 ft** | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **λmax** | **CoVmax** | **Total COV** | **λmax** | **CoVmax** | **Total COV** | **λmax** | **CoVmax** | **Total COV** |
| **10** | **100** | 0.964 | 0.039 | 0.146 | 0.985 | 0.039 | 0.146 | 0.960 | 0.041 | 0.147 |
| | **1000** | 0.990 | 0.034 | 0.145 | 1.013 | 0.035 | 0.145 | 0.988 | 0.036 | 0.145 |
| | **5000** | 1.003 | 0.033 | 0.144 | 1.026 | 0.033 | 0.145 | 1.002 | 0.034 | 0.145 |
| **100** | **100** | 1.027 | 0.030 | 0.144 | 1.051 | 0.030 | 0.144 | 1.026 | 0.031 | 0.144 |
| | **1000** | 1.049 | 0.027 | 0.143 | 1.073 | 0.028 | 0.143 | 1.050 | 0.029 | 0.144 |
| | **5000** | 1.059 | 0.026 | 0.143 | 1.085 | 0.027 | 0.143 | 1.061 | 0.028 | 0.143 |

Table 19. Expected Maximum Adjacent Live Load and *CoV* for Two-Span Bridges, Span Lengths from 30 to 90 ft

| Number of crossings per day | ADTT | 30 ft | | | 60 ft | | | 90 ft | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | λmax | CoVmax | Total COV | λmax | CoVmax | Total COV | λmax | CoVmax | Total COV |
| 10 | 100 | 0.813 | 0.048 | 0.149 | 0.934 | 0.047 | 0.148 | 0.723 | 0.046 | 0.148 |
| | 1000 | 0.841 | 0.043 | 0.147 | 0.965 | 0.041 | 0.147 | 0.746 | 0.040 | 0.146 |
| | 5000 | 0.854 | 0.040 | 0.146 | 0.980 | 0.039 | 0.146 | 0.758 | 0.038 | 0.146 |
| 100 | 100 | 0.879 | 0.036 | 0.145 | 1.008 | 0.035 | 0.145 | 0.778 | 0.035 | 0.145 |
| | 1000 | 0.903 | 0.033 | 0.145 | 1.034 | 0.032 | 0.144 | 0.798 | 0.032 | 0.144 |
| | 5000 | 0.914 | 0.032 | 0.144 | 1.046 | 0.031 | 0.144 | 0.807 | 0.030 | 0.144 |

Table 20. Expected Maximum Adjacent Live Load and *CoV* for Two-Span Bridges, Span Lengths from 120 to 200 ft

| Number of crossings per day | ADTT | 120 ft | | | 150 ft | | | 200 ft | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | λmax | CoVmax | Total COV | λmax | CoVmax | Total COV | λmax | CoVmax | Total COV |
| 10 | 100 | 0.629 | 0.044 | 0.148 | 0.594 | 0.043 | 0.147 | 0.556 | 0.044 | 0.147 |
| | 1000 | 0.649 | 0.039 | 0.146 | 0.612 | 0.038 | 0.146 | 0.574 | 0.039 | 0.146 |
| | 5000 | 0.659 | 0.037 | 0.145 | 0.621 | 0.036 | 0.145 | 0.582 | 0.037 | 0.145 |
| 100 | 100 | 0.676 | 0.034 | 0.145 | 0.637 | 0.033 | 0.144 | 0.598 | 0.033 | 0.145 |
| | 1000 | 0.693 | 0.031 | 0.144 | 0.652 | 0.030 | 0.144 | 0.612 | 0.031 | 0.144 |
| | 5000 | 0.701 | 0.030 | 0.144 | 0.660 | 0.029 | 0.144 | 0.619 | 0.029 | 0.144 |

### 3.5.6 Statistical Model

Each component of live load effects –live loads weights, dynamic amplification factor, and GDF – is uncertain. For a single-lane platoon loading, or two identical adjacent platoons, the present study examined a range of prescribed total live load *CoV*s and contributions of individual components were not specified. However, when an adjacent lane loading is considered, the components of live load uncertainty must be examined and reconstituted for the routine traffic lane. The general form of the probabilistic live load model adopted in the present study is consistent with AASHTO LRFD as described in NCHRP 20/07-186, so that the mean dynamic live load is

$$\mu_{L\_GDF+IL} = (1+\mu_{IM}) * \lambda_{LL} * \lambda_{GDF} * L \qquad \text{(Eqn. 21)}$$

where $L$ is the HL-93 nominal load effect, $\mu_{IM}$ represents the mean dynamic amplification, taken as 0.1, and $\lambda_{GDF}$ is the bias factor for AASHTO approximate GDFs and is assumed to be 1.0 consistent with NCHRP 20/07-186. The $CoV$ for GDFs, $CoV_{GDF}$, is 0.12. The $CoV_{L\_GDF}$ and standard deviation, $\sigma_{L\_GDF}$, for static live load and girder distribution factor effects were determined as

$$CoV_{L\_GDF} = \sqrt{CoV_L^2 + CoV_{GDF}^2} \qquad \text{(Eqn. 22)}$$

$$\sigma_{L\_GDF} = CoV_{L\_GDF} * \mu_{L\_GDF} = CoV_{L\_GDF} * \left(\lambda_L * \lambda_{GDF} * L\right) \qquad \text{(Eqn. 23)}$$

The standard deviation, $\sigma_{L\_GDF+IL}$, and $CoV_{L\_GDF+IL}$, for the live load including dynamic amplification effects are

$$\sigma_{L\_GDF+IL} = \sqrt{\sigma^2{}_{L\_GDF} + \sigma^2{}_{IL}} \qquad \text{(Eqn. 24)}$$

$$CoV_{L\_GDF+IL} = \frac{\sigma_{L\_GDF+IL}}{\mu_{L\_GDF+IL}} \qquad \text{(Eqn. 25)}$$

NCHRP Report 20/07-186 states that $CoV_{L\_GDF+IL}$ is 0.18 for most spans and 0.19 for short spans with two lanes loaded. The present study incorporated an independent derivation of total *CoV*, which is provided in the Appendices. Total dynamic *CoV* results from the NCHRP Report 20/07-186 model and the independently derived method are similar. The general expression for the probabilistic dynamic live load is

$$LL = L(GDF)(1+IM) = L(GDF) + L(GDF)IM \qquad \text{(Eqn. 26)}$$

where: $LL$ is the total live load effect; *L* is the static live load effect; *IM* is the dynamic amplification factor; and *GDF* is the girder distribution factor. Live load, girder distribution factor, and dynamic amplification effects are assumed to be statistically independent. The variance of the *LL* can therefore be expressed as

$$Var(LL) = Var[L(GDF)] + Var[L(GDF)IM] + 2COV[L(GDF), L(GDF)IM] \qquad \text{(Eqn. 27)}$$

where the covariance term, *COV*, is

$$COV[L(GDF), L(GDF)IM] = \mu_{IM}(\sigma^2{}_L\sigma^2{}_{GDF} + \sigma^2{}_L\mu^2{}_{GDF} + \sigma^2{}_{GDF}\mu^2{}_L) \qquad \text{(Eqn. 28)}$$

The proposed total dynamic live load $CoV_{L\_GDF+IL}$ is determined according to

$$CoV_{L\_GDF+IL} = \frac{\sqrt{(1+2\mu_{IM})(A) + \mu_{IM}{}^2(A+B)}}{(1+\mu_{IM})} \qquad \text{(Eqn. 29)}$$

$$A = (CoV^2{}_L + CoV^2{}_{GDF} + CoV^2{}_{GDF}CoV^2{}_L) \qquad \text{(Eqn. 30)}$$

$$B = (CoV^2{}_L CoV^2{}_{GDF} CoV^2{}_{IM} + CoV^2{}_{GDF} CoV^2{}_{IM} + CoV^2{}_L CoV^2{}_{IM} + CoV^2{}_{IM}) \qquad \text{(Eqn. 31)}$$

where $\mu_{IM}$ is the mean of the dynamic impact factor; $CoV_L$ is the coefficient of variation of static live load; $CoV_{GDF}$ is the *CoV* of the AASHTO approximate GDF; and $CoV_{IM}$ is the *CoV* of impact factor. Based on field tests from Eom and Nowak (2001), $\mu_{IM}$ was approximately 0.1 with a relatively high $CoV_{IM}$ of 0.80. These values were used herein, consistent with NCHRP Report

20/07-186 and Puckett and Barker (2016). Platoon live load effects were assumed to be normally distributed, consistent with routine traffic live load effects in NCHRP Report 20/07-186.

To account for routine traffic flowing adjacent to a platoon, the routine static live load was probabilistically characterized, then the live load uncertainty was integrated with other contributing sources, i.e., distribution and impact. Live load $\mu_{event}$ and $\sigma_{event}$ for simple-span and two-span continuous bridges were defined as shown in Table 15 and Table 16, respectively. $N$ values were determined according to combinations of ADTT and number of platoon crossings per day, as described in Section 3.5.5. Static live load $\mu_{max}$ and $CoV_{max}$ were determined using $\mu_{event}$, $\sigma_{event}$ , and $N$ in Eqns. 7 to 11. Lastly, $CoV_{max}$ was substituted for $CoV_L$ in Eqns. 29 to 31 to characterize dynamic live load uncertainty for routine traffic adjacent to a platoon, referred to as Total $CoV$ in Tables 17 to 20. The total $CoV$ was generally between 0.143 and 0.148.

Due to the lack of data of $CoV$ for static platoon loads, this study postulated a range of potential total platoon uncertainties in terms of $CoV$, but additional work is needed to formulate protocols for assessing and incorporating reduced uncertainties in-operation for future research. The potential range of $CoV$ for total platoons ranged from 0 to 0.2 with an interval of 0.01, which is discussed in detail later. The lower $CoV$ bound of 0 is an ambitious assumption, but it is possible that IM, GDF, and truck weight $CoV$s could approach zero in the future.  In short, it is bounded high and low in the present work.

## 3.6 Resistance

### 3.6.1 Nominal Resistance

Recall the Load and Resistance Factor Rating equation in the MBE

$$RF = \frac{C - (\gamma_{DC})DC - (\gamma_{DW})DW - (\gamma_{P})P}{(\gamma_{LL})(LL + IM)} \quad \text{(Eqn. 1)}$$

The MBE considers dead load effects from components, *DC*, wearing surfaces *DW*, and permanent loads, *P*. Both live load effects, *LL*, and dynamic impact amplification, *IM*, can potentially be influenced by platooning.

The MBE LRFR equation is a rearranged form of the LFRD basic equation

$$C = (\gamma_{DW})DW + (\gamma_{DC})DC + (\gamma_{LL})(LL + IM)RF \quad \text{(Eqn. 32)}$$

Here, *C* represents capacity, and can be factored moment, shear, or other capacity values. $\gamma_{LL}$ is a live load factor and *LL* is the nominal static live load effect. A minimum value of *C* corresponds to an implicit *RF* = 1. As stated in the literature review, AASHTO LRFD and LRFR were calibrated to provide a target level of safety at the inventory level corresponding to a reliability index, $\beta = 3.5$. MBE Table 6.A.4.2.2-1 provides load factors for the inventory level Strength I limit state, which can be substituted into Eqn. 32 and rearranged to produce an optimal required resistance of

$$R_n = \frac{1.25DC + 1.5DW + 1.75L_n(1 + IM)(GDF_m)}{\phi} \quad \text{(Eqn. 33)}$$

where $R_n$ is the minimum required nominal resistance, $\phi$ is the resistance factor corresponding to the material and limit state under consideration, and $L_n$ is the nominal effect due to HL-93 loading. *IM* is the dynamic amplification factor, equal to 0.33 for truck loads and 0 for uniform lane loading, as prescribed by the BDS for HL-93. $GDF_m$ is the AASHTO approximate GDF for multiple loaded lanes, which typically governs over single-lane loading for interior girder designs. $R_n$ values were determined for shear and moment for each span configuration.

This project also considered bridges designed by LFD. Therefore, nominal LFD resistances were also required. The load factor rating (LFR) method can be applied to bridges designed by LFD, as were most in-service bridges. LFR is the predominant rating method used by NDOT across their inventory, and was used to rate 81 out of 83 bridges carrying I-80 west of Lincoln according to 2018 National Bridge Inventory (NBI) data (FHWA, 2020). A significant philosophical difference between LRFR and LFR methods is that LFR does not provide a uniform level of reliability, instead relying primarily on historical accepted practice and engineering judgement to provide adequate safety through the codified load and resistance factors. The general LFR rating equation is

$$RF = \frac{C - (\gamma_D)D}{\gamma_{LL} LL(1 + IM)} \qquad \text{(Eqn. 34)}$$

where $C$ is the capacity, $D$ is the dead load effect, $\gamma_D$ and $\gamma_{LL}$ are dead and live load factors, respectively, $LL$ is the nominal live load effect for which the bridge is being evaluated, and $IM$ is the dynamic amplification factor calculated by Eqn. 14. For LFR, $\gamma_D$ is 1.30, and $\gamma_{LL}$ is 2.17 for inventory ratings or 1.30 for operating ratings, which includes legal and permit loads.

Moment and shear resistance factors for steel composite and prestressed concrete girders are given in Table 21. Optimally designed LFD bridges possess a nominal resistance according to Eqn. 35

$$R_n = \frac{1.3DC + 1.3DW + 2.17L_n(1 + IM)(GDF_m)}{\phi} \qquad \text{(Eqn. 35)}$$

where $R_n$ is the minimum required nominal resistance for LFD bridges, $L_n$ is the nominal value of HS-20 design loading in LFD, $IM$ is the dynamic amplification factor obtained from Eqn. 14, and $GDF_m$ equals $S$/11 for multiple lanes loaded, where $S$ is the girder spacing in ft.

Table 21. Resistance Factors for Moment and Shear in LRFD and LFD

| Load Effects | LRFD | | LFD | |
|---|---|---|---|---|
| | **Steel** | **Prestressed Concrete** | **Steel** | **Prestressed Concrete** |
| Moment | 1.00 | 1.00 | 1.00 | 1.00 |
| Shear | 1.00 | 0.90 | 1.00 | 0.90 |

### 3.6.2 Statistical Parameters

Resistance uncertainty arises from material variations, fabrication tolerances and errors, and analysis simplifications and approximations. So, the random variable for resistance, $R$, can be expressed as shown in Eqn. 36 according to NCHRP Report 368

$$R = M * F * P * R_n \qquad \text{(Eqn. 36)}$$

where $M$ is the material factor, $F$ is the fabrication factor, and $P$ is the professional analysis factor. The $CoV$ of resistance then can be expressed as

$$CoV_R = \sqrt{CoV_M^{\ 2} + CoV_F^{\ 2} + CoV_P^{\ 2}} \qquad \text{(Eqn. 37)}$$

Resistance statistical parameters (bias, $\lambda_R$, and $CoV_R$) for steel and prestressed concrete girder bridges were selected from those shown in Table 22. Resistance was assumed to follow a lognormal distribution in MCS reliability analyses. Indicated values match those used in NCHRP Report 20-07/186. The resistance mean, $\mu_R$, and standard deviation, $\sigma_R$, used in reliability analyses were determined as

$$\mu_R = R_n * \lambda_R \qquad \text{(Eqn. 38)}$$

$$\sigma_R = \mu_R * CoV \qquad \text{(Eqn. 39)}$$

Table 22. Resistance Statistical Parameters

| Type of Structures | $\lambda_R$ | $CoV_R$ |
|---|---|---|
| Composite steel girders | | |

| | | |
|---|---|---|
| Moment | 1.12 | 0.10 |
| Shear | 1.14 | 0.105 |
| Prestressed Concrete | | |
| Moment | 1.05 | 0.075 |
| Shear | 1.15 | 0.14 |

**3.7 Monte Carlo Simulation**

Monte Carlo Simulation (MCS) is widely used to conduct reliability analysis for bridge evaluations, as noted in the literature review. MCS numerically determines probability of failure by generating many random instances of simultaneous uncertain parameters and substituting random numbers into a limit state function to obtain pass or fail outcomes. For the present study, MATLAB was used to perform MCS to calculate reliability indices, $\beta$, for various parametric combinations of bridge and platoon configurations and scenarios. Details for MCS processes used to evaluate each of the three loading scenarios shown in Figure 16 are provided in the following subsections. The general MCS procedure for LFR is like LRFR, with substitutions of different load factors, resistance factors, GDFs, and IM, and nominal resistances.

The general procedure was to randomly generate dead load effects, live load effects, and resistances $N$ times, where $N$ is a sufficiently large number to verify a target probability of failure, then evaluate the limit-state function in Eqn. 2, as shown in Figure 21. If the limit state evaluation result was negative, the outcome was recorded as a failure. Failure probability, $P_f$, was determined as the ratio of the total number of failure instances, $F$, to the total number of simulations, $N$. The reliability index $\beta$ then can be determined using Eqn. 4.

The total $CoV$ of the platoon was parameterized from 0 to 0.2 with platoon vehicle headways primarily between 5 and 50 ft. The platoon load effect mean was systematically adjusted by an amplification factor, $\alpha$, to scale the platoon load effect to a maximum, structurally safe limit. Bridges were initially evaluated using legal loads scaled by $\alpha = 0.8$, and then $\alpha$ was increased incrementally until the target $\beta$ was reached.

The selection of target $\beta$ is a key point when calibrating live load factors. Gao (2012) summarized target $\beta$ values for different rating scenarios, as shown in Table 23. Bridges are generally rated at inventory or operating levels, with corresponding $\beta$ targets of 3.5 and 2.5, respectively. The general definition of inventory level is a load level that can safely operate on bridges for an indefinite period, whereas loading at the operating level is safe for a relatively short term but may accelerate deterioration of the bridge. The operating level of reliability also applies to legal and permit loads. Platoons are a specialized case and may be considered permit vehicles, which allows the target to be set at $\beta = 2.5$. However, if platooning is expected to occur with a large number of passes over bridges, it may be prudent to set the target $\beta = 3.5$ to mitigate accelerated bridge deterioration with heavy loads. Accordingly, live load factors for both inventory and operating levels were calibrated.

Table 23. Target Reliability Index $\beta$ (Gao, L. 2012)

| **Evaluation Level** | | **Reliability Index $\beta$** |
|---|---|---|
| Design | | 3.5 |
| Design Load Rating | Inventory Level | 3.5 |
| | Operating Level | 2.5 |
| Legal Load Rating | | 2.5 |
| Permit Load Rating | Routine Permits | 2.5 |
| | Special Permits (Single Trip, Escorted) | 2.5 |
| | Special Permits (Single or Multiple Trip, Mixed in Traffic) | 3.5 |

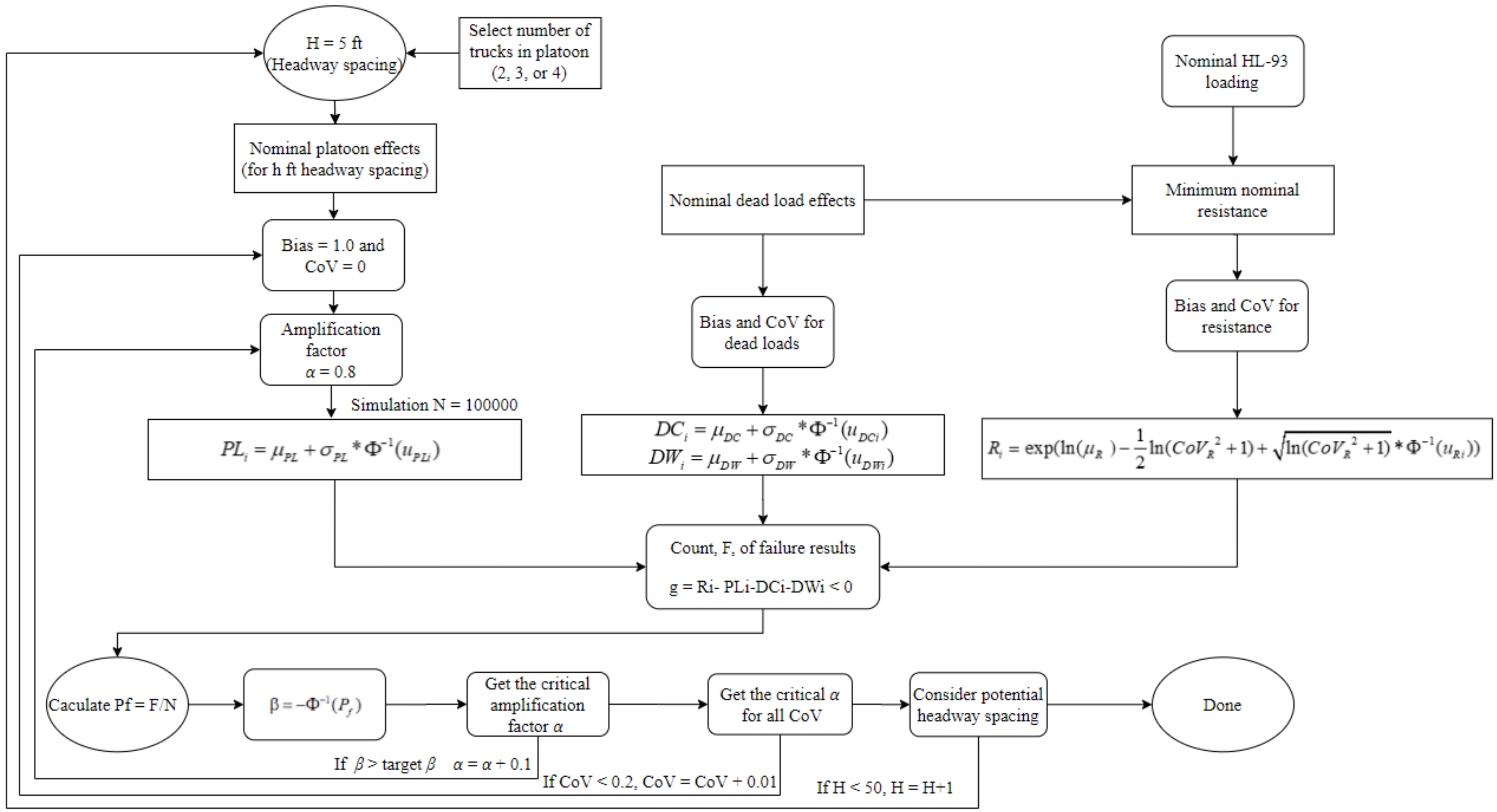



Figure 21. Monte Carlo Simulation Flowchart

A flow chart of the MCS procedure is illustrated in Figure 21. There are three primary use cases:

- Case I refers to Figure 16a, with a single lane of platoon loading applied to the bridge.
- Case II refers to Figure 16b, with two identical platoons operating in adjacent lanes on a bridge.
- Case III refers to Figure 16c, with one lane of platoon loading operating adjacent to routine traffic.

The procedure is outlined below

1. Specify bridge characteristics:
   a) span length,
   b) simply-supported or two-span continuous, and
   c) steel or prestressed concrete girders.
2. Starting at the upper center of the flowchart in Figure 21, obtain nominal dead load, *DC*, and nominal wearing load, *DW*, from Section 3.4.1.
3. At the upper right corner of the flowchart determine the nominal HL-93 loading, $L_n$, including the AASHTO GDF for multiple loaded lanes. Amplify the truck component using $IM = 0.33$ per the BDS, as noted in Section 3.5.2.
4. Determine the nominal resistance from Eqn. 33.
5. At the upper left corner of the flowchart, specify platoon configuration:
   a) truck type (refer to Section 3.2.1), and
   b) number of trucks in the platoon.
6. Specify headway, *H*, between trucks.
   a) If initializing, set $H = 5$ ft.

b) Otherwise, increase $H$ by 1 ft, up to a maximum of $H = 50$ ft.

7. Determine nominal platoon effects, $PL$, for the specific bridge and platoon configuration under consideration, including an AASHTO approximate GDF.

   a) If the scenario under consideration is Case I or Case III, use $g = GDF_s / 1.2$, where $GDF_s$ is the single lane AASHTO GDF with an embedded MPF.

   b) If the scenario under consideration is Case II, use g = $GDF_m$, where $GDF_m$ is the multi-lane AASHTO GDF.

8. Determine nominal adjacent lane routine truck effects, $L_{adj}$, for the specific bridge and platoon configuration under consideration, including an AASHTO approximate GDF.

   a) If the scenario under consideration is Case I or Case II, $L_{adj} = 0$.

   b) If the scenario under consideration is Case III,

$$L_{adj} = \left(\frac{\lambda_{\max}}{1.33}\right) * \left(g = \left(GDF_m - \frac{GDF_s}{1.2}\right)\right) * L_n \qquad \text{(Eqn. 40)}$$

   where $L_n$ is identical to Step 3, except without dynamic amplification, and $\lambda_{max}$ is the normalized mean of adjacent load (bias) from Tables 17 to 20, as appropriate. The $\lambda_{max}$ term is scaled by 1/1.33 to remove the BDS dynamic modification included by Barker and Puckett.

9. Amplify the nominal static live loads, $PL$ and $L_{adj}$, by $(1 + \mu_{IM}) = 1.1$.

10. Set the platoon load effect bias and $CoV$. Note that platoon load effect bias was assumed to be unity throughout this study.

    a) If initializing, set platoon load effect $CoV$ = zero.

    b) Otherwise, increase $CoV$ by 0.01.

11. Specify platoon load effect amplification factor $\alpha$
    a) If initializing, set $\alpha = 0.8$.
    b) Otherwise, increase $\alpha$ by 0.1.
12. Convert nominal values of platoon load effects to their mean, $\mu_{PL} = \lambda * \alpha * PL$ and standard deviation, $\sigma_{PL} = \mu_{PL} * CoV_{\text{platoon}}$
13. For Case III, the dynamic adjacent lane load effect (product of Steps 8 and 9) is a mean value, $\mu_{\text{adj}}$. Calculate the standard deviation of the adjacent lane load effect as $\sigma_{adj} = \mu_{adj} * CoV_{adj}$, where $CoV_{adj}$ corresponds to Total CoV in Tables 17 to 20.
14. Convert nominal values of component dead loads, wearing dead loads, and resistances to means and standard deviations using biases and $CoV$s provided in Table 11 and Table 22.
15. Generate $N$ = 100,000 uniformly distributed random values, $u$, between 0 and 1 for each of $DC$, $DW$, $PL$, and $R$ for all cases. Additionally, generate values for $L_{adj}$ if considering Case III.
16. Calculate values of $DC_i$ (a normal random variable)

    $$DC_i = \mu_{DC} + \sigma_{DC} * \Phi^{-1}(u_{DCi}) \qquad \text{(Eqn. 41)}$$

    where $\Phi^{-1}$ represents the inverse standard normal CDF.
17. Calculate the corresponding value of $DW_i$ (a normal random variable)

    $$DW_i = \mu_{DW} + \sigma_{DW} * \Phi^{-1}(u_{DWi}) \qquad \text{(Eqn. 42)}$$

18. Calculate the corresponding value of $PL_i$ (a normal random variable)

    $$PL_i = \mu_{PL} + \sigma_{PL} * \Phi^{-1}(u_{PLi}) \qquad \text{(Eqn. 43)}$$

19. a) If considering Case III, for all cases except for negative moments for 90 to 200 ft two-span bridges, calculate the corresponding value of $L_{adj,i}$ (an Extreme Type I random variable)

    $$L_{adj,i} = \mu_{adj} - 0.78 * \sigma_{adj} * \log(-\log(u_{adji})) \qquad \text{(Eqn. 44)}$$

b) If considering Case III for negative moments for 90 to 200 ft two-span bridges, simulate two independent adjacent loads and calculate the corresponding values of $L_{adj1,i}$ and $L_{adj2,i}$ (an Extreme Type I random variable)

$$L_{adj1,i} = \mu_{adj} - 0.78 * \sigma_{adj} * \log(-\log(u_{adji})) \tag{Eqn. 45}$$

$$L_{adj2,i} = \mu_{adj} - 0.78 * \sigma_{adj} * \log(-\log(u_{adji})) \tag{Eqn. 46}$$

20. Calculate the corresponding value of $R_i$ (a lognormal random variable)

$$R_i = \exp(\ln(\mu_R) - \frac{1}{2}\ln(CoV_R^{\ 2} + 1) + \sqrt{\ln(CoV_R^{\ 2} + 1)} * \Phi^{-1}(u_{Ri})) \tag{Eqn. 47}$$

21. a) If considering Case III (except for negative moments for 90 to 200 ft two-span bridges), Evaluate the limit state function

$$g_i = R_i - (DC_i + DW_i + PL_i + L_{adj,i}) \tag{Eqn. 48}$$

b) If considering Case III (negative moments for 90 to 200 ft two-span bridges), Evaluate the limit state function

$$g_i = R_i - (DC_i + DW_i + PL_i + L_{adj1,i} + L_{adj2,i}) \tag{Eqn. 49}$$

22. Count the number of failure cases, $F$, for which $g_i < 0$.
23. Calculate the probability of failure, $P_f = F / N$.
24. Determine the reliability index $\beta$ according to $\beta = -\Phi^{-1}(P_f)$.
25. Compare calculated and target $\beta$. If calculated $\beta$ > target $\beta$, return to Step 11. Otherwise, store the critical value of $\alpha$ and proceed to the next step.
26. If the platoon load effect $CoV$ is less than 0.2, return to Step 10. Otherwise, proceed to the next step.

27. If the platoon headway is less than 50 ft, return to Step 6. Otherwise, the parametric sweep is complete.
28. If needed or desired, select an alternative truck configuration at Step 5 and/or alternative bridge configuration at Step 1 and/or alternate ADTT for Case III and/or alternate number of crossings for Case III. If no additional variations in truck or bridge configuration are required, all analyses are complete.

# 4 PLATOON LIVE LOAD RESULTS

## 4.1 Overview

The section presents analysis procedures and results for platoon live load moment and shear effects for simple- and two-span bridges subjected to FHWA Class 9, Type 3S2, Type 3-3, and NRL vehicle loadings as a function of headway. Guidance for headway considerations is provided.

## 4.2 Simple-Span Effects

Simple-span positive moments and end shears for platoons with up to three trucks were calculated using influence lines as discussed in Chapter 3. Constant headway scenarios ranged from 5 to 50 ft. As expected, the minimum headway (5 ft) causes maximum positive moments and end shears for simple-span bridges. Detailed results are provided in Appendices.

Reliability analysis results are reported in Chapter 5 accounting for live load effects discussed in this chapter. These reliability analyses were used to develop recommended headway tables, provided in Chapter 7, that offer guidelines for acceptable combinations of platoon loads, platoon-load uncertainty, and acceptable headway ranges.

Illustrative examples are provided for a simple-span bridge in Figures 22 to 24, considering two trucks operating in a platoon with a 5 ft headway and passing over a 200-ft bridge. Two Type 3-3 trucks produce a maximum positive moment of 5640 kip-ft when the leading truck's first axle is 154 ft from the left support, as shown in Figure 22. If the platooning vehicles are NJTA Type 3S2 trucks, a maximum positive moment of 6160 kip-ft occurs when the leading truck's first axle is 141 ft from the left support, as shown in Figure 23. Two FHWA Class

9 trucks produce a maximum positive moment of 5760 kip-ft when the leading truck's first axle is 151 ft to the left support, as shown in Figure 24. The NJTA Type 3S2 vehicle is therefore critical among these platooning vehicle options for this bridge.

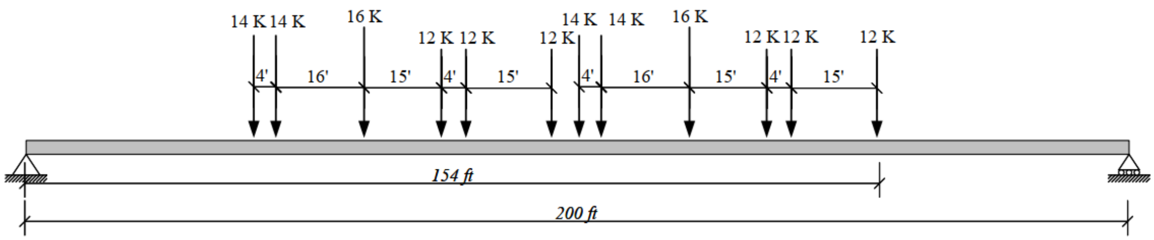



Figure 22. Critical Positive Moment Position for Two Type 3-3 with 5-ft Headway

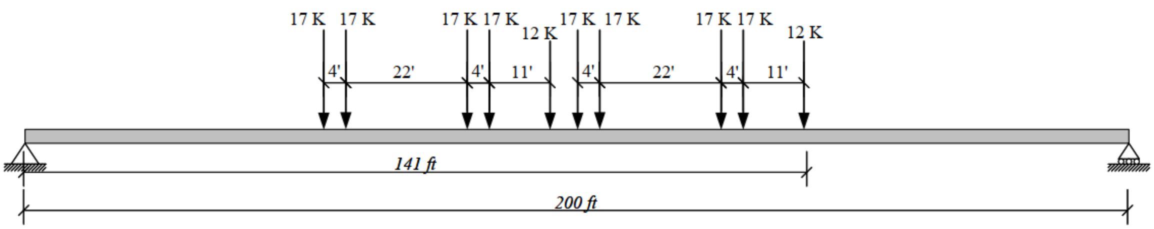



Figure 23. Critical Positive Moment Position for Two Type 3S2 with 5-ft Headway

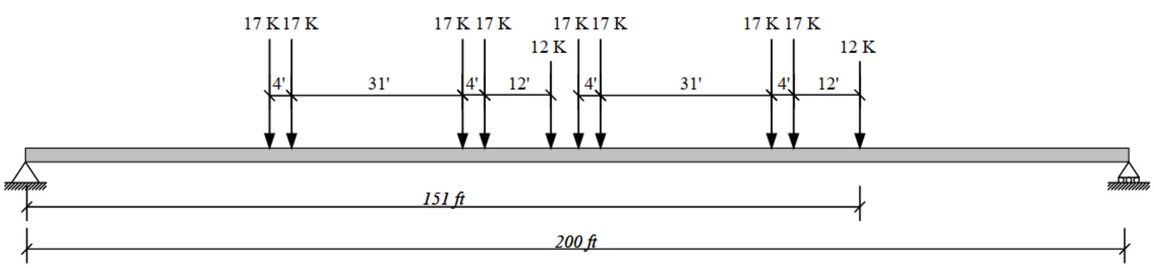
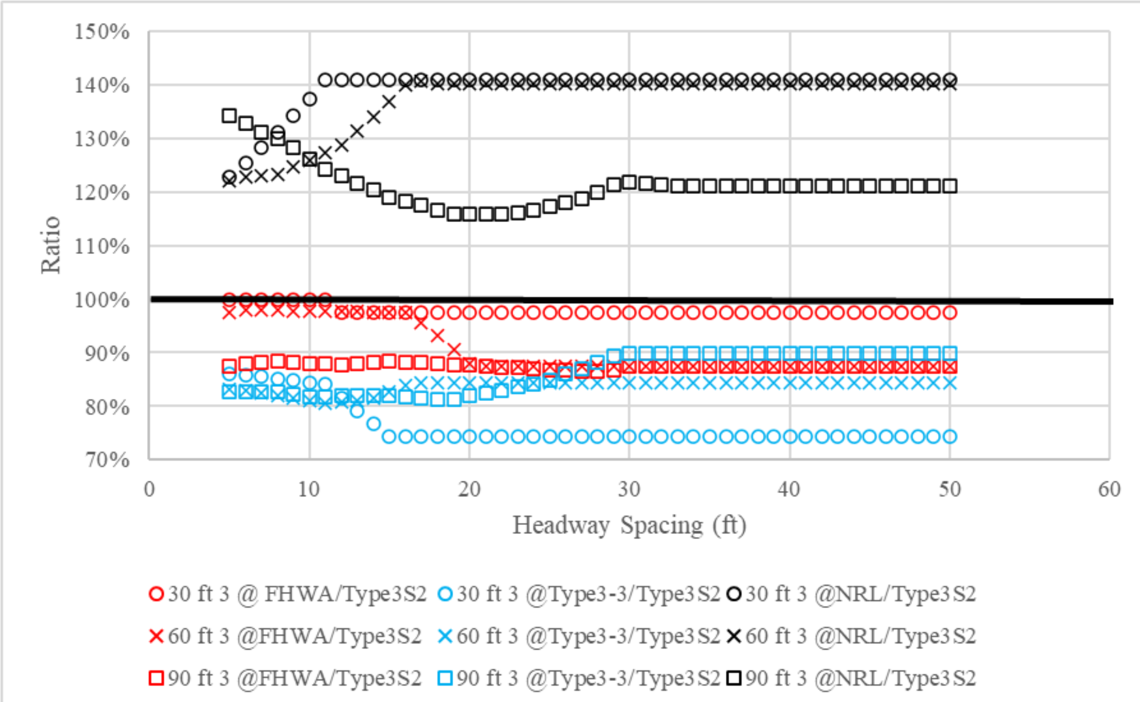



Figure 24. Critical Positive Moment Position for Two FHWA Class 9 with 5-ft Headway

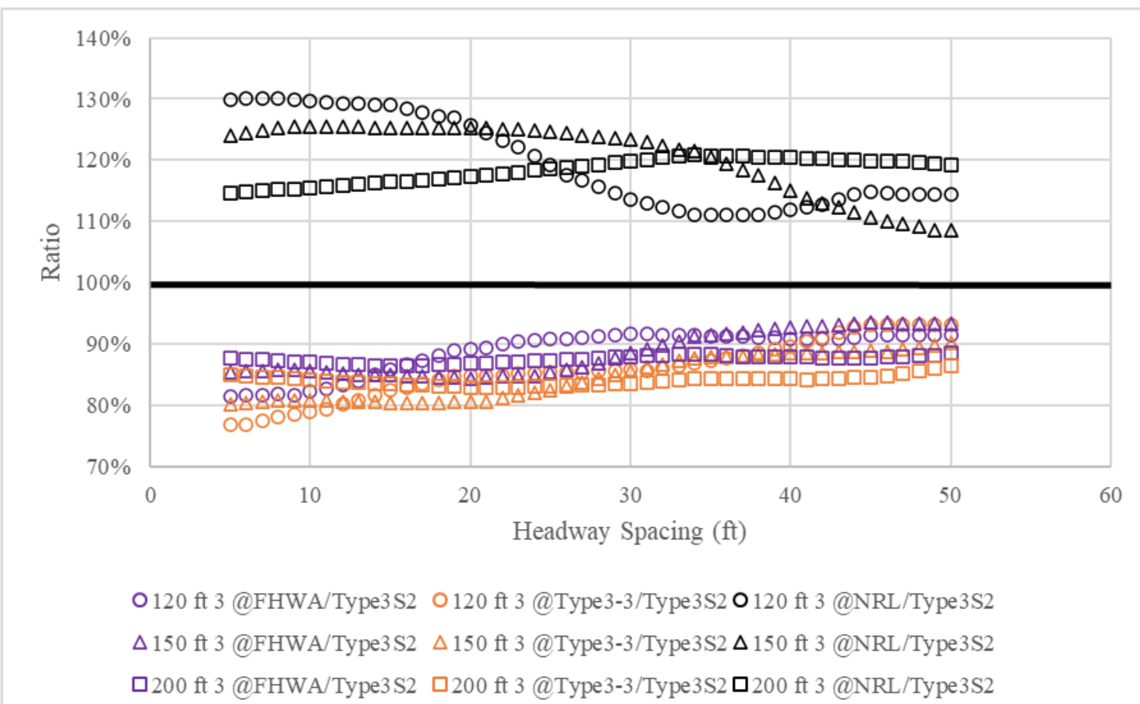
These computations were repeated for several span lengths. Positive moment ratios and end shears comparing three-truck FHWA Class 9 and Type 3-3 load effects to the critical, NJTA Type 3S2 load effects are presented in Figure 25 for positive moments and Figure 26 for end shears. Data points with values less than 100% indicate that the vehicle’s load effects are less severe than NJTA Type 3S2 trucks. The results show that NJTA Type 3S2 trucks govern over

FHWA Class 9 and Type 3-3 trucks for simple-span bridges included in the study. Similar computations were performed to compare the NRL and NJTA Type 3S2 loadings and revealed that the NRL controls for all examined headways.

Figure 25 indicates that, for positive moment, the NRL governed for all examined simple-span bridges. The NRL also generally governs for end shear, except for two- or three-truck platoons with a 5-ft headway on 30-ft simple span bridges. In those cases, the NJTA Type 3S2 trucks provide a 0.3% higher end shear than the NRL, which was deemed negligible. Therefore, envelope live load effects are effectively governed by the NRL for simple-span bridges, and the NRL was exclusively used for their reliability analyses with simple spans.

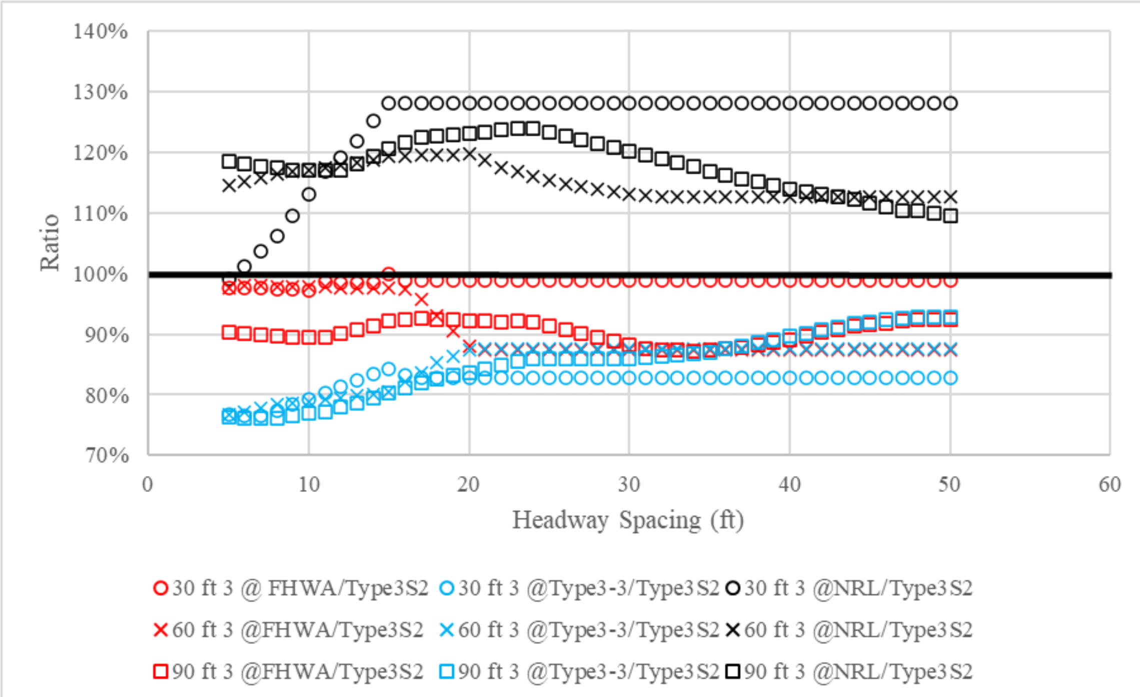



[a] Span Lengths from 30 ft to 90 ft

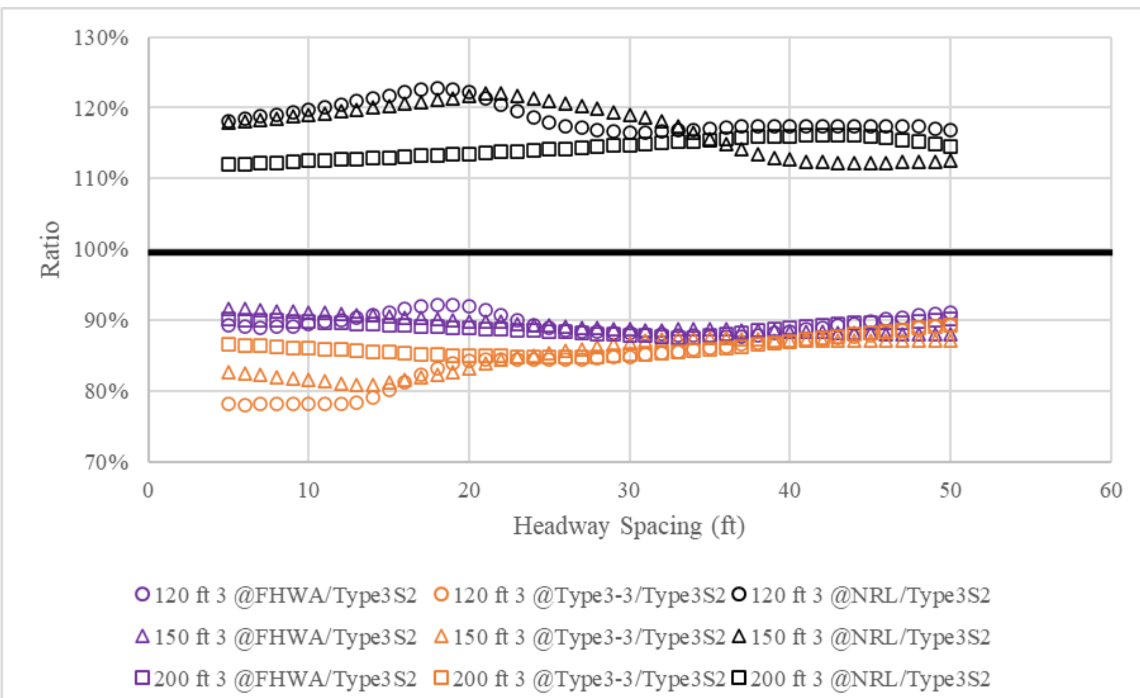



[b] Span Lengths from 120 ft to 200 ft

Figure 25. Simple Span Bridge Positive Moments for Three-Truck Platoons at Various Headways




[a] Span Lengths from 30 ft to 90 ft




[b] Span Lengths from 120 ft to 200 ft

Figure 26. Simple Span Bridge End Shears for Three-Truck Platoons at Various Headways

### 4.3 Two-Span Effects, 5 to 50 ft Uniform Headway

For two-span bridges, critical negative moments may occur when adjacent spans are loaded for short- to medium-span bridges, or with both vehicles principally located on a single span for long-span bridges. While the NRL effectively envelopes positive moment and end shear for simple-span bridges, it does not always govern for negative moments loaded by platoons with constant headways from 5 to 50 ft on two-span bridges.

Consider two trucks in a platoon at a 35-ft headway passing over a two-span bridge with 150-ft spans. In this case, the Type 3-3 truck governs for negative moment among the considered vehicles. As presented in Figure 27, two Type 3-3 trucks produce a critical negative moment equal to −1929 kip-ft when the leading truck's first axle is 225 ft from the left end of the bridge. For two FHWA Class 9 trucks, the critical negative moment is −1879 kip-ft when the leading truck's first axle is 220 ft from the left end of the bridge, as shown in Figure 28. Two NJTA Type 3S2 trucks produce a critical negative moment equal to −1842 kip-ft when the leading axle is 210 ft from the left end of the bridge, as shown in Figure 29. As shown in Figure 30, two NRL vehicles produce a critical negative moment equal to −1885 kip-ft when the leading truck's first axle is 211 ft from the left end of the bridge. The leading NRL axle spacing was varied from 6 to 14 ft to produce critical load effects, which occurred at 14 ft for this case. Two-span bridge negative moment and middle support shear results for two-, three-, and four-truck platoons having 5 to 50 ft headways and individual spans ranging from 30 to 200 ft are provided in Appendices.

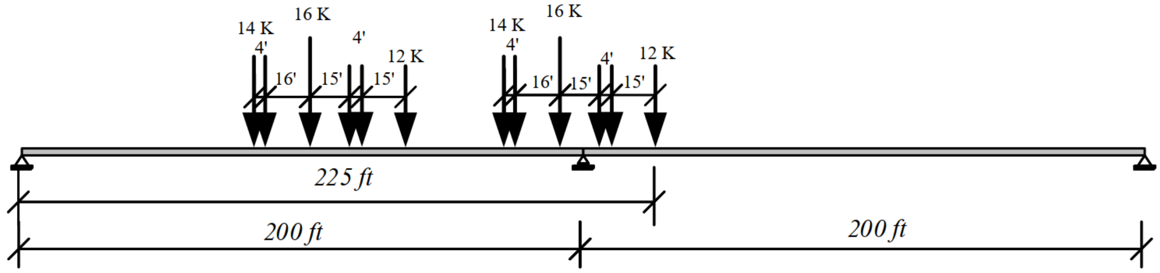



Figure 27. Critical Negative Moment Position for Two Type 3-3 trucks with 35-ft Headway.

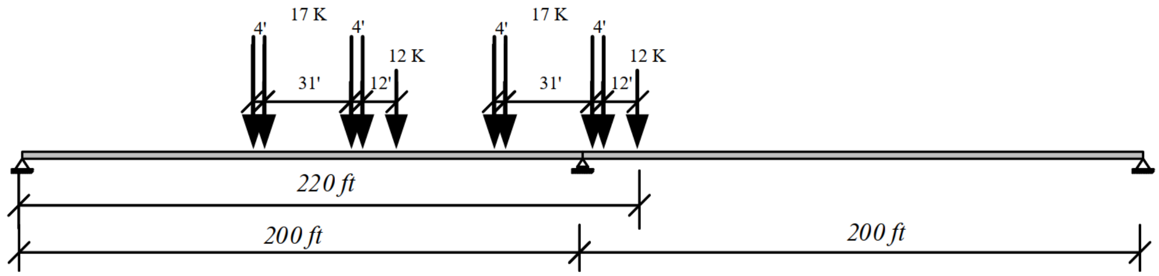



Figure 28. Critical Negative Moment Position for Two Type FHWA Class 9 trucks with 35-ft Headway.

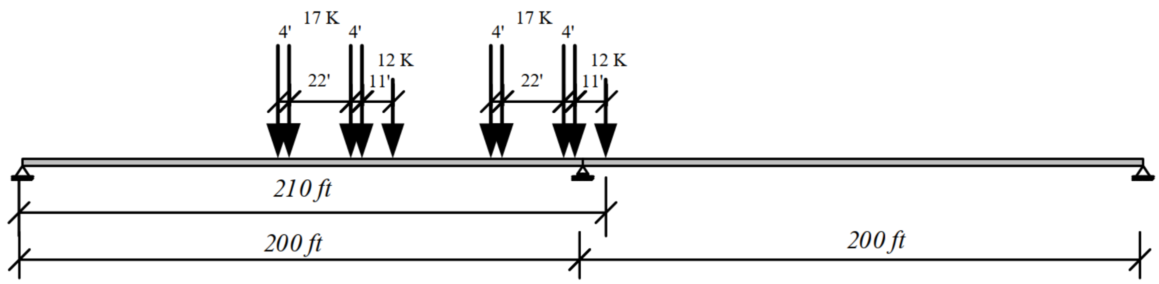



Figure 29. Critical Negative Moment Position for Two NJTA Type 3S2 trucks with 35-ft Headway.

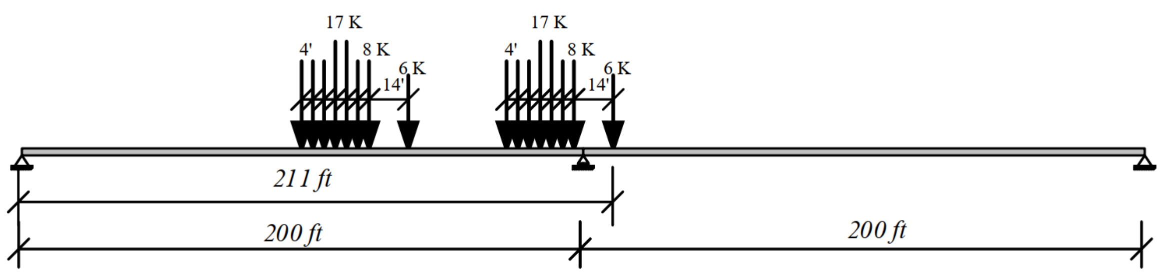



Figure 30. Critical Negative Moment Position for Two NRL trucks with 35-ft Headway.

Negative moment ratios between FHWA Class 9, Type 3-3, and NRL load effects and NJTA Type 3S2 load effects are presented in Figure 31. The results demonstrate that the NRL governs negative moments for most cases. As shown in Figure 31a, the Type 3S2 governs negative moment for two-span bridges having 30-ft spans for platooning headways greater than 20 ft. Figure 31b illustrates that Type 3-3 governs negative moments for 150-ft two-span bridges for platooning headways between 31 ft and 46 ft. The NRL generally governs for middle-support shears, as shown in Figure 32. Cases for which the NRL does not govern for negative moments are summarized below:

Two-Truck Platoons:

- 30 -ft bridges: $H > 20$ ft (governed by Type 3S2)
- 150-ft bridges: 31 ft $< H <$ 46 ft (governed by Type 3-3)

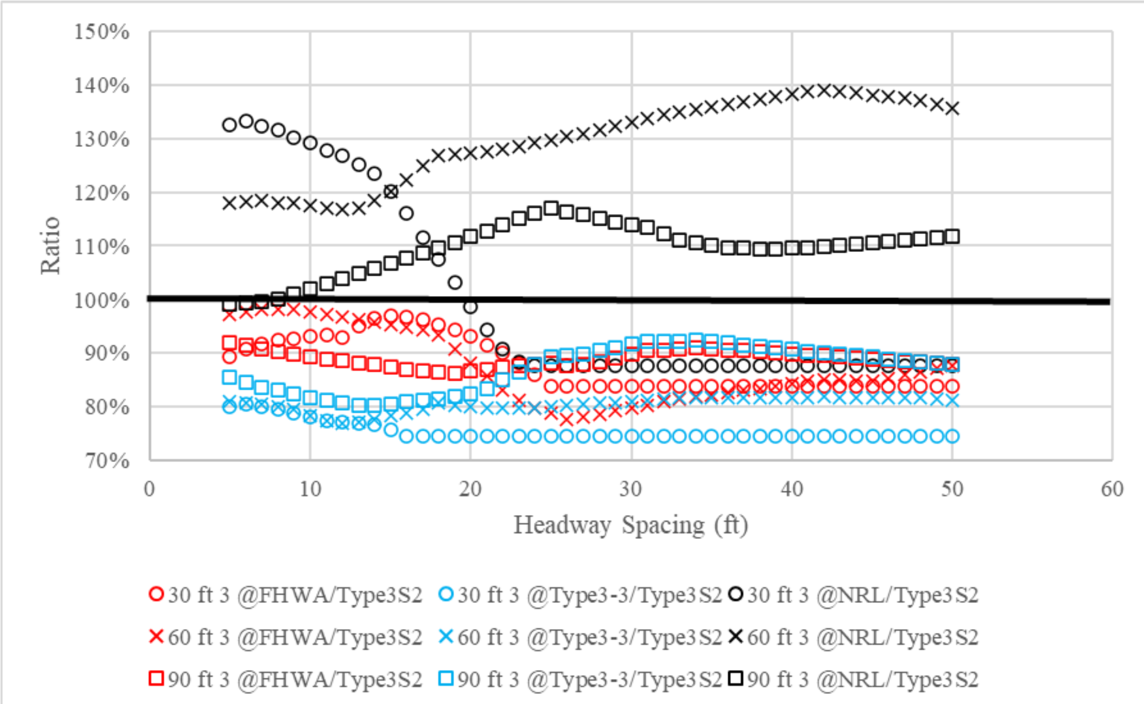
Three-Truck Platoons:

- 30-ft bridges: $H > 20$ ft (governed by Type 3S2)
- 90-ft bridges: 5 ft $< H <$ 7 ft (governed by FHWA Class 9)
- 120-ft bridges: 5 ft $< H <$ 9 ft (governed by FHWA Class 9)

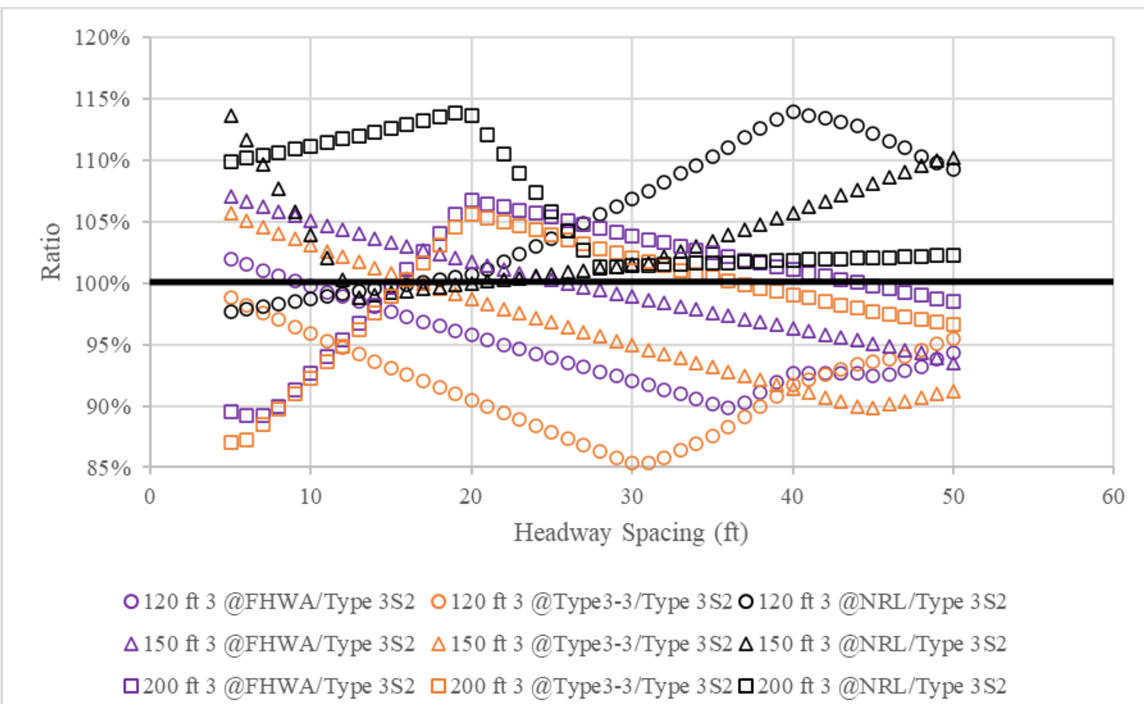
  10 ft $< H <$ 16 ft (governed by Type 3S2)
- 150-ft bridges: 10 ft $< H <$ 23 ft (governed by FHWA Class 9)
- 200-ft bridges: 26 ft $< H <$ 37 ft (governed by FHWA Class 9)

Four-Truck Platoons:

- 30-ft bridges: $H > 20$ ft (governed by Type 3S2)
- 200-ft bridges: 11 ft $< H <$ 17 ft (governed by Type 3-3)

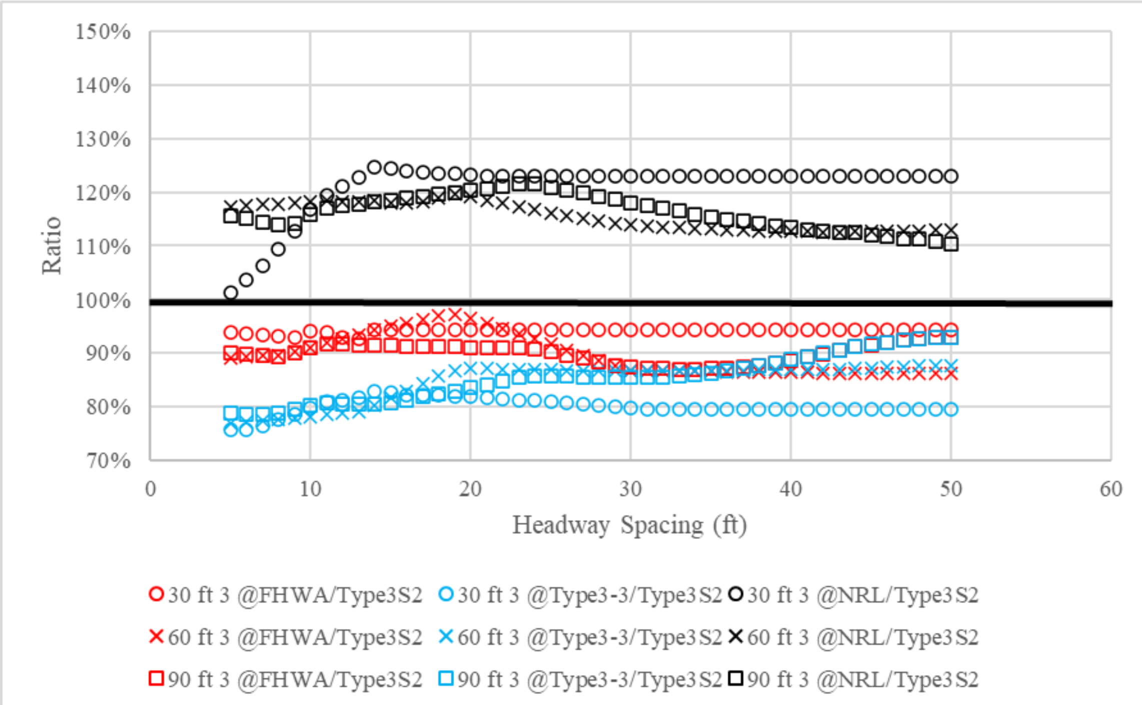



[a] Span Lengths from 30 ft – 90 ft

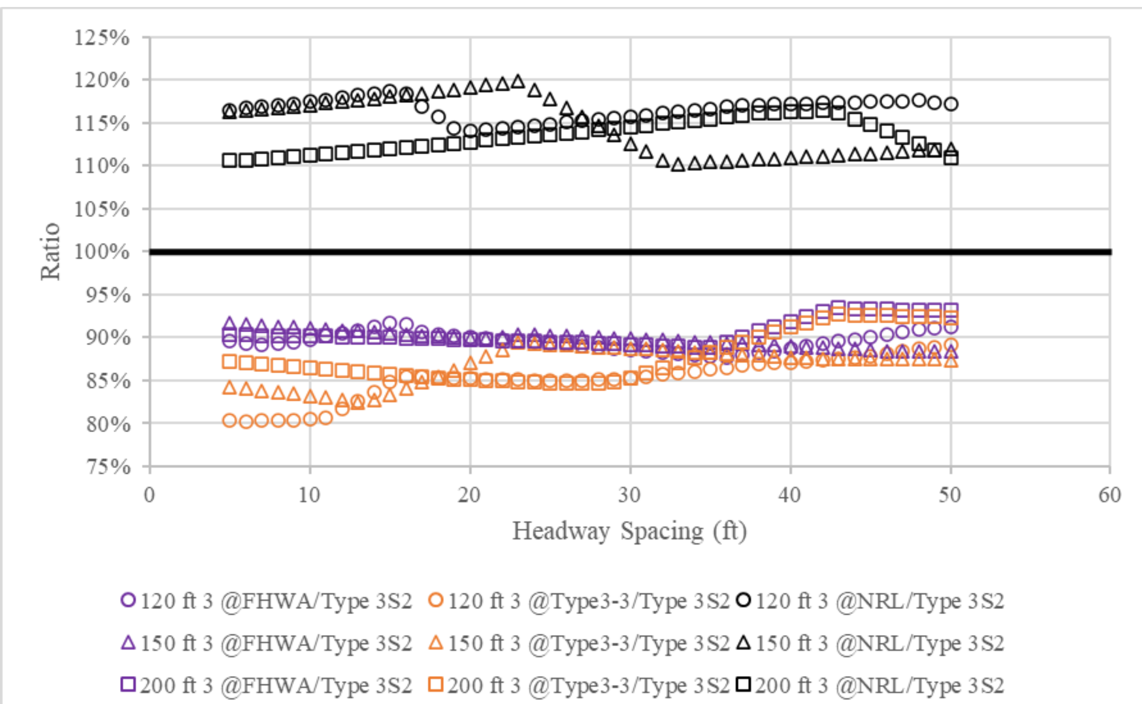



[b] Span Lengths from 120 ft to 200 ft

Figure 31. Two-Span Bridge Negative Moments for Three-Truck Platoons at Various Headways




[a] Span Lengths from 30 ft – 90 ft




[b] Span Lengths from 120 ft to 200 ft

Figure 32. Two-Span Bridge Middle-Support Shear for Three-Truck Platoons at Various Headways

In summary, the NRL governs for both positive moment and end shear for simple-span bridges, and middle support shear for two-span bridges. The NRL does not envelope all moments, as presented in Figure 31. Therefore, in Section 5 platoon load effect envelopes were constructed and used in reliability analyses for critical moments in two-span bridges to establish maximum amplification factors and calibrate live load factors. The procedure to obtain platoon negative moment envelopes for two-span bridges was:

1. Determine number of trucks (2, 3, or 4) in a platoon,
2. Determine live load effects for NJTA Type 3S2, FHWA Class 9, Type 3-3, and NRL vehicles at a 5-ft headway,
3. Save maximum load effects from these four vehicles as platoon effect $L_{platoon}$ for 5-ft headway, two-span bridges,
4. Repeat step 2 to 3 for headways to 50 ft, and
5. Save $L_{platoon}$ for headways from 5 ft to 50 ft and repeat steps 2 to 4 for alternate number of platoon trucks until all options have been evaluated and appropriate envelope constructed.

Resulting moment envelopes, $L_{platoon}$, used in reliability analyses are provided in Appendices for simple- and two-span bridges subjected to platoons with 5 to 50 ft headways.

### 4.4 Two-Span Effects, Variable Headway to 200 ft

Variable headway platoon configurations were also considered to investigate abnormal situations for which platoons may need or want to operate without constant headways. Figure 15 presents critical negative moment scenarios for two-, three-, and four-truck platoons. As shown in Figure 15a, critical headways for relatively long span bridges may be similar to their individual span lengths, and greater than the upper bound 50 ft spacing considered in previous sections. For three-truck platoons, the critical negative moment situation is two trucks at a small headway with another truck at a large headway primarily loading the alternate span, as shown in Figure 15b. The four-truck platoon critical configuration is two pairs of closely spaced trucks in alternate spans, as shown in Figure 15c. Platoons are generally expected to travel with all vehicles closely spaced to maximize aerodynamic benefits. However, adverse weather or other conditions may necessitate configurations that produce these extreme loading scenarios.

Critical negative moment cases were determined for the extreme conditions noted above for two-, three-, and four-truck platoons. These extreme demands were then compared to otherwise identical scenarios with uniform headways between 5 and 50 ft. An example considering a two-truck FHWA Class 9 platoon passing over a 200-ft two-span bridge is illustrated in Figure 33 and Figure 34. If the platoon conforms to the constrained 5 to 50-ft uniform headway range typically assumed in this study, a 5-ft headway produces a critical negative moment equal to −2682 kip-ft. In this case, both trucks occupy the same span and the first axle of the leading truck is located 165 ft from the left end of the bridge, as shown in Figure 33. If platoon headway can exceed 50 ft, the critical headway is 118 ft with individual trucks in alternate spans, producing a negative moment equal to −2944 kip-ft. The critical truck position occurs with the leading truck's first axle 311 ft from the left end of the bridge, as shown in Figure 34.

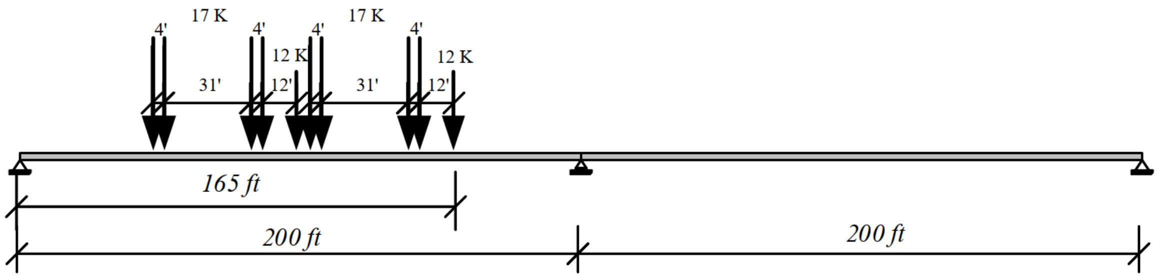



Figure 33. Critical Negative Moment of Two Type FHWA with 5 ft Headway Position.

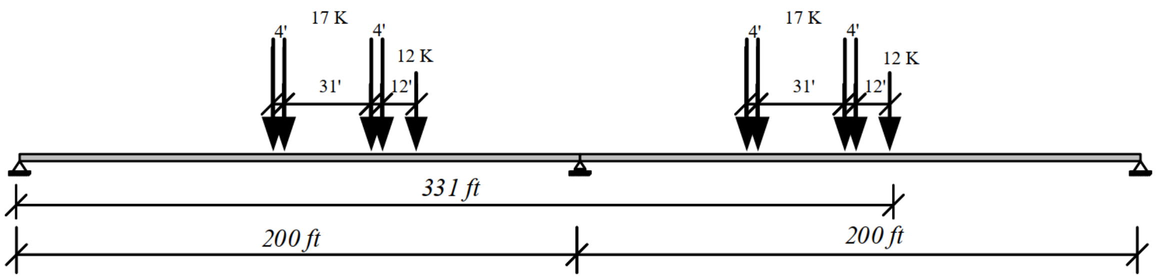



Figure 34. Critical Negative Moment of Two Type FHWA with 118 ft Headway Position.

Critical headway and negative moments are summarized in Table 24 for FHWA Class 9 platoons. Critical headways and negative moment results for Type 3S2 and Type 3-3 trucks were close to those observed for FHWA Class 9 trucks and are provided in Appendices. Table 24 shows that differences between constant-headway and abnormal-headway critical negative moments for two-, three-, and four-truck platoons are not large (≤ 5%) for 30 to 150-ft span bridges, but is appreciable (10~15% ) for 200-ft spans. However, only 2 out of 83 bridges were identified in the National Bridge Inventory (FHWA, 2020) carrying I-80 traffic west of Lincoln, Nebraska with spans greater than 150 ft. As a result, these findings support the decision to neglect atypical headways in the present study. If bridges with spans greater than 150 ft are of concern to a particular agency, results suggest that operational requirements should explicitly require that platoons maintain short headways or else separate by appreciably more than the individual span being crossed if headways less than 50 ft cannot be maintained.

Table 24. Critical Headway and Negative Moments for FHWA Class 9 Platoons

| Span | 2 Trucks | | | | 3 Trucks | | | | | 4 Trucks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5 - 50 ft | | 5 - 200 ft | | 5 - 50 ft | | Varying Headways | | | 5 - 50 ft | | Varying Headways | | |
| | H | M | H | M | H | M | H1 | H2 | M | H | M | H1 | H2 | M |
| **30** | 7 | -208 | 7 | -208 | 7 | -208 | 5 | 7 | -208 | 7 | -208 | 5 | 7 | -208 |
| **60** | 5 | -656 | 5 | -656 | 5 | -811 | 5 | 5 | -811 | 5 | -811 | 5 | 5 | -811 |
| **90** | 33 | -1096 | 33 | -1096 | 5 | -1494 | 5 | 5 | -1494 | 5 | -1519 | 5 | 5 | -1519 |
| **120** | 50 | -1621 | 56 | -1627 | 5 | -2205 | 6 | 5 | -2205 | 5 | -2524 | 5 | 5 | -2524 |
| **150** | 50 | -2022 | 80 | -2131 | 15 | -2750 | 5 | 57 | -2855 | 5 | -3482 | 5 | 34 | -3578 |
| **200** | 5 | -2682 | 121 | -2944 | 35 | -3602 | 5 | 97 | -4155 | 22 | -4751 | 5 | 73 | -5363 |

Note: H is the critical headway (ft) and M is the negative moment (kip-ft)

## 4.5 Summary

Four well-known vehicle types were used to model platoons of up to four trucks. For simple-span bridges, as expected critical moments and shears were obtained for small headways. The same is true for shear in two-span bridges. However, critical negative moments in multi-span bridges may correspond to larger headways that position vehicles in adjacent spans, as a result headways that applied load to areas of critical influence were investigated. Upon examination of nontypical, varying, and inefficiently large platooning headways, negative moments were found to slightly increase for individual span lengths less than 150 ft. For longer spans, the negative moment increased up to 15 percent relative to the examined range of constant headways. While not true for I-80 in Nebraska, this observation suggests that longer spans might call for slightly different platooning operational procedures for longer spans.

# 5 LRFR LIVE LOAD FACTORS

## 5.1 Overview

Live load factors were calibrated for platoon cases with a single-lane loaded, two-lanes loaded and fully-correlated, and with routine traffic in the lane adjacent to the platoon. Critical amplification and live load factors for simple- and two-span steel and prestressed concrete bridges are discussed. Effects of the number of trucks in a platoon, number of spans, girder material, and moment versus shear strength limits on live load factors are evaluated. A live load factor table for platoons rated using LRFR is proposed for considered loading parameters.

## 5.2 Calibration Procedure

As described in the methodology, platoon live load effects were investigated over a range of potential *CoV*s. Parameter uncertainties deviating from code calibration assumptions require live load factor calibration to facilitate platoon ratings. Eqn. 33 in Section 3.6.1 provided an expression for optimal resistance at an inventory level rating with $RF = 1$. When rating for platoon loads, their effects take the place of the typical live load terms, while resistance and dead load terms remain unchanged. Rearranging Eqn. 33 to isolate live load effects,

$$\phi R_n - 1.25DC - 1.5DW = 1.75L_n(1+IM)(GDF_m) \qquad \text{(Eqn. 50)}$$

Setting platoon effects equal to typical design live load effects gives

$$\gamma_{platoon}\lambda_{platoon}\alpha LL_{platoon}(1+IM_{platoon})GDF_{platoon} = 1.75LL_{HL-93}(1+IM_{HL-93})GDF_m \qquad \text{(Eqn. 51)}$$

Right-hand side subscripts in Eqn. 51 are modified to clarify that those terms are associated with a typical AASHTO LRFD/R basis. Isolating the platoon live load factor on one side of the equation gives

$$\gamma_{platoon} = \frac{1.75 LL_{HL-93}(1 + IM_{HL-93})GDF_m}{\lambda_{platoon}\alpha LL_{platoon}(1 + IM_{platoon})GDF_{platoon}} \qquad \text{(Eqn. 52)}$$

where $IM_{HL\text{-}93}$ and $GDF_m$ correspond to the typical AASHTO LRFD/R dynamic impact amplification factor and AASHTO GDF for multiple lanes-loaded, respectively. The live load bias for platoons, $\lambda_{platoon}$, has been assumed equal to 1.0 throughout this research. The critical amplification factor, $\alpha$, is applied to the platoon nominal static load effect, $LL_{platoon}$, which is determined using MCS to satisfy a target $\beta$. $GDF_{platoon}$ depends on the Case being considered (see Figure 16 and Section 3.7 Step 7). The same GDF that produced the critical mean platoon static load, $\mu_{platoon} = \alpha\ LL_{platoon}$, in the MCS was used to calibrate the live load factor.

$IM_{platoon}$ is the deterministic impact factor value selected for platoon ratings, and was set at 0.1 for consistency with the probabilistic mean value for dynamic amplification used in MCS. The selected value is a departure from the guidance in MBE for permit ratings, which specifies the use of the typical LRFD/R value used for design. If a load rating engineer requires that live load factors provided by this study be calibrated for use with the typical MBE *IM* value, the adjustment could be accomplished by adjusting provided live load factors by 0.83 (= 1.1/1.33).

All live load factors were calibrated for a 5-ft headway. The exact headway value does not influence live load factor calibration, because headway only influences $LL_{platoon}$. If a noncritical headway is selected, $LL_{platoon}$ decreases from its critical maximum value, but the MCS produces a correspondingly higher $\alpha$, so that $\mu_{platoon}$ remains at the target $\beta$. A 5-ft headway is the critical spacing for all structural limits except negative moment for two-span continuous bridges. Results in the following subsections include both $\alpha$ and $\gamma_{platoon}$, and the selected headway produces the critical (minimum) $\alpha$.

LFR live load factor calibration follows essentially the same process as has been described for LRFR. Platoon nominal live load effect, bias, *CoV*, and $\mu_{IM}$ used for MCS analyses were identical to those used for LRFR. Differences are associated with the nominal resistance equation, rating equation terms and factors, dynamic amplification factor, and GDFs.

## 5.3 Results

### 5.3.1 Single-Lane Loaded

Table 25 provides critical $\alpha$ factors obtained using MCS for three-truck platoons traversing steel simple-span bridges at a 5-ft headway without adjacent traffic. These are representative results, with $\alpha$ factors for other parametric variations provided in Appendices. *CoV* ranged from 0 to 0.2 in 0.01 increments, although only 0.05 increments are shown in the table. Results for all *CoV* increments are available in Appendices. All $\alpha$ factors for target reliability indices of $\beta$ = 2.5 or 3.5, corresponding to operating and inventory rating levels, respectively, are greater than 1.0 for *CoVs* between 0 and 0.2, meaning a three-truck platoon with all vehicles at the legal load limit could safely travel across these bridges at a 5-ft headway. Average $\alpha$ factors for a target reliability index $\beta$ = 2.5 are about 20% to 30% higher than for $\beta$ = 3.5. $\alpha$ factors also increase by approximately 15% to 35% as the *CoV* decreases from 0.2 to 0.

Table 25. Single-Lane Platoon Positive Moment Critical Amplification Factor, $\alpha$

| Steel Bridges | Target reliability index β = 2.5 | | | | | Target reliability index β = 3.5 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Span / CoV | **0** | **0.05** | **0.1** | **0.15** | **0.2** | **0** | **0.05** | **0.1** | **0.15** | **0.2** |
| **30** | 3.2 | 3.1 | 3 | 2.8 | 2.6 | 2.8 | 2.7 | 2.5 | 2.3 | 2.1 |
| **60** | 3 | 2.9 | 2.8 | 2.6 | 2.4 | 2.6 | 2.5 | 2.3 | 2.2 | 2 |
| **90** | 2.5 | 2.4 | 2.3 | 2.2 | 2.1 | 2 | 2 | 1.9 | 1.8 | 1.6 |
| **120** | 2.2 | 2.2 | 2.1 | 2 | 1.9 | 1.8 | 1.7 | 1.7 | 1.5 | 1.4 |
| **150** | 2.1 | 2.1 | 2 | 1.9 | 1.8 | 1.7 | 1.6 | 1.6 | 1.5 | 1.3 |
| **200** | 2.2 | 2.2 | 2.1 | 2 | 1.9 | 1.7 | 1.6 | 1.5 | 1.5 | 1.4 |
| **Min** | **2.1** | **2.1** | **2** | **1.9** | **1.8** | **1.7** | **1.6** | **1.5** | **1.5** | **1.3** |
| **Avg** | **2.5** | **2.5** | **2.4** | **2.3** | **2.1** | **2.1** | **2.0** | **1.9** | **1.8** | **1.6** |

Corresponding live load factors, as well as maximum and average values for each *CoV*, are shown in Table 26 for select span lengths. Live load factors are generally uniform across different span lengths for a given *CoV*, with maximum percent differences being 4% and 11% at $\beta$ = 2.5 and 3.5, respectively. An increase of live load factors when changing the target reliability index $\beta$ = 2.5 to 3.5 is inversely proportional to the decrease of amplification factors when $\beta$ goes from 2.5 to 3.5. Note that provided values were calibrated with $IM_{platoon}$ = 0.1, whereas tabulated permit live load factors in the MBE were calibrated using *IM* = 0.33. The MBE was calibrated in NCHRP 20-07/Task 285 using an assumed permit live load *CoV* of 0.184. Linearly interpolating between the average live load factor of 1.28 for *CoV* = 0.15 and 1.36 for *CoV* = 0.20, the live load factor at *CoV* = 0.184 is 1.334. Adjusting for differing impact factors, the platoon live load factor is

$$\gamma_{platoon(MBE)} = 1.334\left(\frac{1+\left(IM_{platoon}=0.1\right)}{1+\left(IM_{MBE}=0.33\right)}\right) = 1.104 \quad \text{(Eqn. 53)}$$

This result agrees well with the single-trip permit, escorted vehicle factor in MBE Table 6A.4.5.4.2a-1 when no other vehicles are on the bridge.

Table 26. Single-Lane Platoon Positive Moment Calibrated Live Load Factors

| **Steel Bridges** | **Target reliability index β = 2.5** | | | | | **Target reliability index β = 3.5** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Span \ CoV** | **0** | **0.05** | **0.1** | **0.15** | **0.2** | **0** | **0.05** | **0.1** | **0.15** | **0.2** |
| **30** | 1.15 | 1.18 | 1.22 | 1.31 | 1.41 | 1.31 | 1.36 | 1.47 | 1.59 | 1.75 |
| **60** | 1.14 | 1.18 | 1.22 | 1.31 | 1.42 | 1.31 | 1.37 | 1.49 | 1.55 | 1.71 |
| **90** | 1.13 | 1.17 | 1.22 | 1.28 | 1.34 | 1.41 | 1.41 | 1.48 | 1.56 | 1.76 |
| **120** | 1.13 | 1.13 | 1.19 | 1.25 | 1.31 | 1.39 | 1.47 | 1.47 | 1.66 | 1.78 |
| **150** | 1.15 | 1.15 | 1.21 | 1.27 | 1.35 | 1.42 | 1.51 | 1.51 | 1.61 | 1.86 |
| **200** | 1.14 | 1.14 | 1.20 | 1.26 | 1.33 | 1.48 | 1.57 | 1.68 | 1.68 | 1.80 |
| **Max** | **1.15** | **1.18** | **1.22** | **1.31** | **1.42** | **1.48** | **1.57** | **1.68** | **1.68** | **1.86** |
| **Avg** | **1.14** | **1.16** | **1.21** | **1.28** | **1.36** | **1.39** | **1.45** | **1.52** | **1.61** | **1.78** |

### 5.3.2 Two-Lanes Loaded, Fully-Correlated

The only difference between a single land loaded and a two-lane, fully-correlated platoon loading scenario is the use of a multi-lane rather than a single-lane AASHTO GDF. Amplification, $\alpha$, and live load factors, $\gamma_{platoon}$, are provided in Table 27 and Table 28, respectively. The values in Table 27 are proportionately less than those in Table 25 by the ratio of single- to multi-lane GDFs. At the operating level, platoons at the legal load limit could traverse a bridge at a critical headway for any span and $CoV$. At the inventory level, however, medium- to long-span bridges may not possess adequate capacity to meet the target reliability, indicated by highlighted cells in Table 27 and Table 28 having values less than 1.0. Inventory reliability may be attained by increasing headway (see Chapter 7). Because increased load reflected in a multi-lane GDF is offset by a reduced $\alpha$, live load factors are not substantially affected. Values in Table 28 vary only slightly from corresponding entries in Table 26.

Table 27. Positive Moment Critical Amplification Factor, $\alpha$, Two Lanes Loaded, 5-ft Headway

| Steel Bridges | Target reliability index β = 2.5 | | | | | Target reliability index β = 3.5 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Span / CoV | 0 | 0.05 | 0.1 | 0.15 | 0.2 | 0 | 0.05 | 0.1 | 0.15 | 0.2 |
| 30 | 2.0 | 2.0 | 1.8 | 1.7 | 1.6 | 1.7 | 1.7 | 1.6 | 1.5 | 1.3 |
| 60 | 1.8 | 1.7 | 1.6 | 1.5 | 1.4 | 1.5 | 1.4 | 1.4 | 1.3 | 1.2 |
| 90 | 1.4 | 1.4 | 1.3 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.0 | 0.9 |
| 120 | 1.2 | 1.2 | 1.1 | 1.1 | 1.0 | 1.0 | 0.9 | 0.9 | 0.9 | 0.8 |
| 150 | 1.2 | 1.1 | 1.1 | 1.0 | 1.0 | 0.9 | 0.9 | 0.9 | 0.8 | 0.7 |
| 200 | 1.2 | 1.1 | 1.1 | 1.1 | 1.0 | 0.9 | 0.9 | 0.8 | 0.8 | 0.7 |
| **Min** | **1.2** | **1.1** | **1.1** | **1.0** | **1.0** | **0.9** | **0.9** | **0.8** | **0.8** | **0.7** |
| **Avg** | **1.5** | **1.4** | **1.3** | **1.3** | **1.2** | **1.2** | **1.2** | **1.1** | **1.1** | **0.9** |

Table 28. Positive Moment Calibrated Live Load Factors, Two-Lanes Loaded, 5-ft Headway

| Steel Bridges | Target reliability index β = 2.5 | | | | | Target reliability index β = 3.5 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Span / CoV | 0 | 0.05 | 0.1 | 0.15 | 0.2 | 0 | 0.05 | 0.1 | 0.15 | 0.2 |
| 30 | 1.16 | 1.16 | 1.29 | 1.37 | 1.45 | 1.37 | 1.37 | 1.45 | 1.55 | 1.79 |
| 60 | 1.13 | 1.20 | 1.27 | 1.36 | 1.46 | 1.36 | 1.46 | 1.46 | 1.57 | 1.70 |
| 90 | 1.16 | 1.16 | 1.25 | 1.36 | 1.36 | 1.36 | 1.48 | 1.48 | 1.63 | 1.81 |
| 120 | 1.17 | 1.17 | 1.28 | 1.28 | 1.40 | 1.40 | 1.56 | 1.56 | 1.56 | 1.76 |
| 150 | 1.12 | 1.22 | 1.22 | 1.35 | 1.35 | 1.49 | 1.49 | 1.49 | 1.68 | 1.92 |
| 200 | 1.13 | 1.23 | 1.23 | 1.23 | 1.36 | 1.51 | 1.51 | 1.69 | 1.69 | 1.94 |
| **Max** | **1.17** | **1.23** | **1.29** | **1.37** | **1.46** | **1.40** | **1.48** | **1.48** | **1.63** | **1.79** |
| **Avg** | **1.15** | **1.19** | **1.26** | **1.32** | **1.40** | **1.37** | **1.43** | **1.46** | **1.58** | **1.74** |

### 5.3.3 Platoon, Routine Traffic in Adjacent Lane

As expected for critical platoons that are heavier than routine traffic loads, critical amplification factors with routine traffic in an adjacent lane are enveloped by single- and two-lane, fully-correlated platoon cases, as shown in Figure 35.

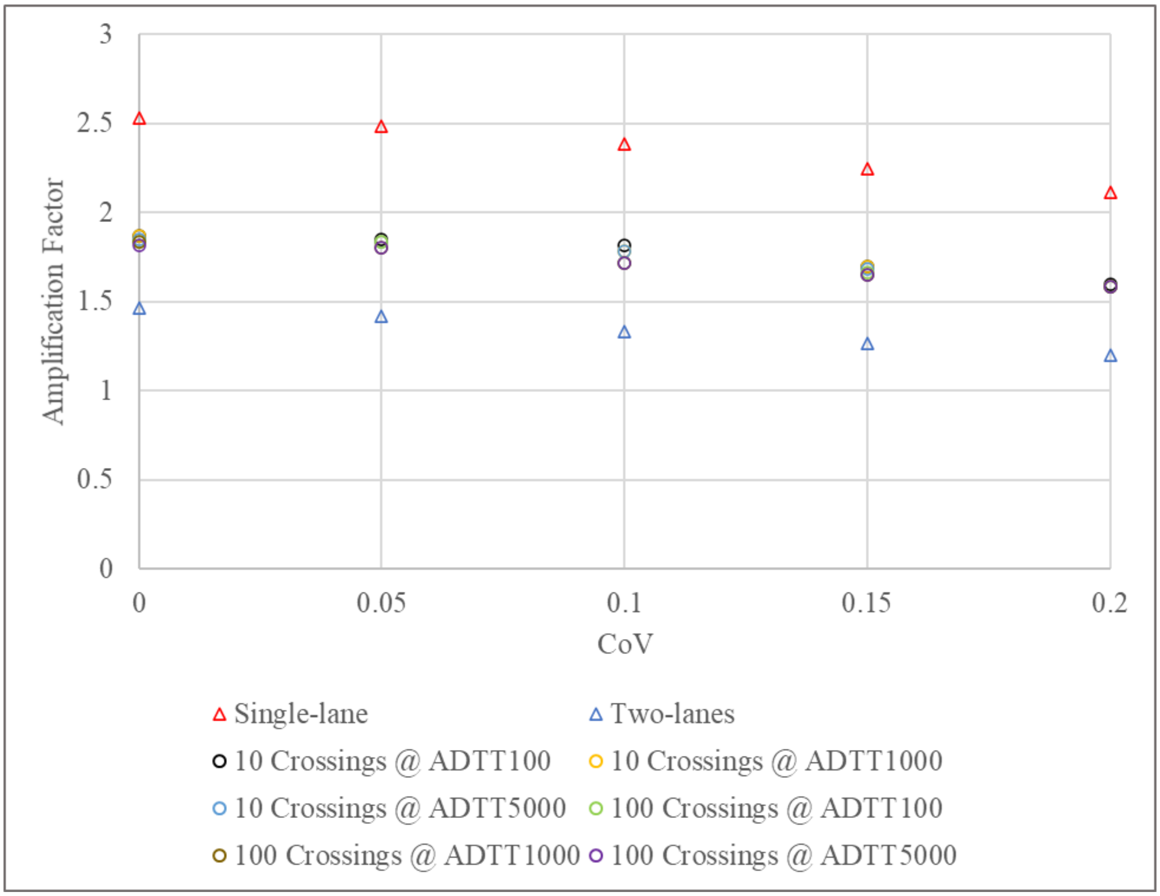



Figure 35. Critical Amplification Factors, $\alpha$, vs. *CoV*s for Different Loading Scenarios, $\beta_{target}$ = 2.5

Figure 35 also illustrates that critical amplification factors are not sensitive to number of crossings per day or ADTT. Because the platoon is the dominant live load effect on the bridge, the important consideration is whether the platoon may traverse a bridge adjacent to a routine heavy vehicle. Amplification factors are relatively insensitive to the precise value of the adjacent load effect if multiple presence is possible.

Figure 36 shows live load factors for platoon operations in a single-lane, in two-lanes that are fully-correlated, and with routine traffic in the adjacent lane. Single-lane and two-lane, fully-correlated cases can be evaluated using practically identical live load factors for a given *CoV*, provided the denominator in the rating factor equation incorporates the appropriate GDF for single- or multiple-lanes loaded. Routine traffic in an adjacent lane is not explicitly included in the rating factor equation, so the platoon live load effect must be amplified with an increased live load factor to reflect adjacent lane loading.

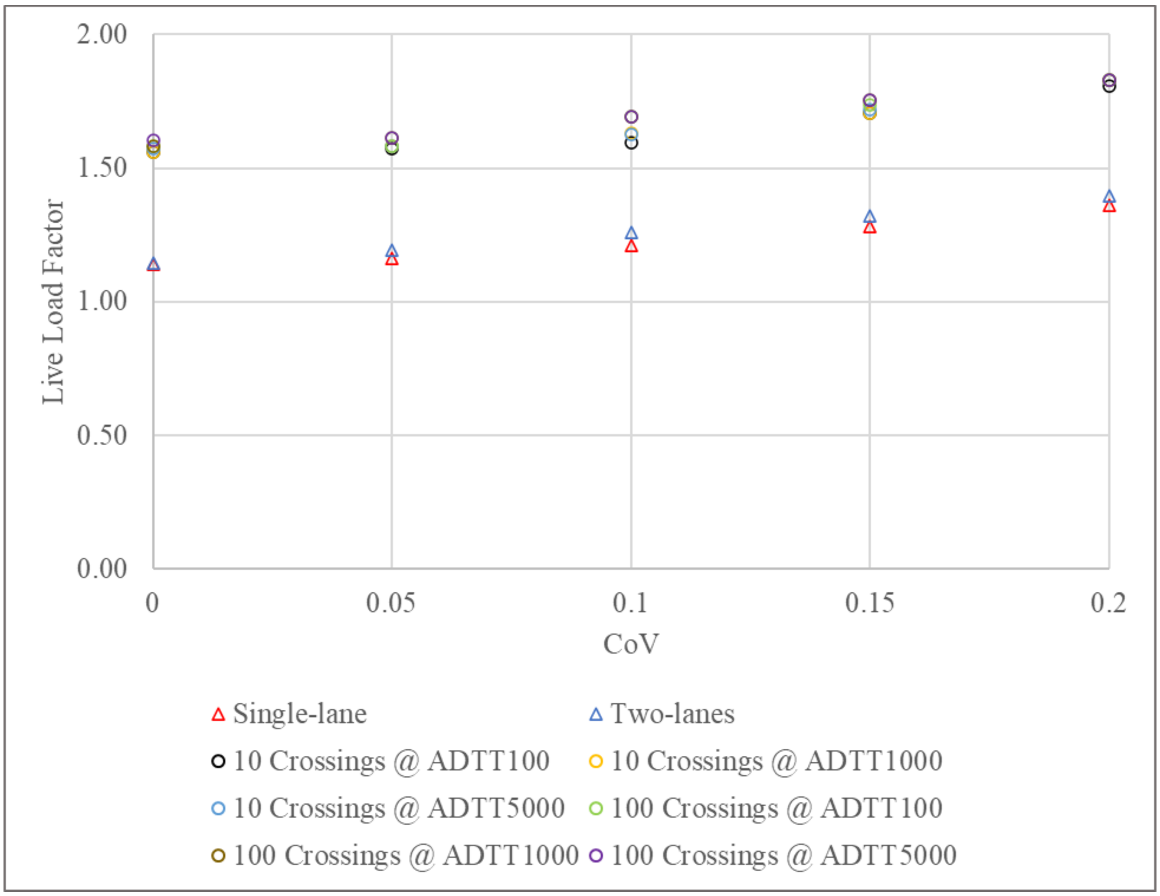



Figure 36. Live Load Factors vs. *CoV*s for Different Loading Scenarios at $\beta_{target}$ = 2.5

### 5.4 Sensitivity

Live load factors were evaluated similarly to the single-lane loaded platooning case discussed in Section 5.3.1 to investigate sensitivity to number of trucks and governing limit state. As shown in Figure 37, live load factors were insensitive to these characteristics. Similarly, Figure 38 illustrates that live load factors are also insensitive to superstructure type or continuity.

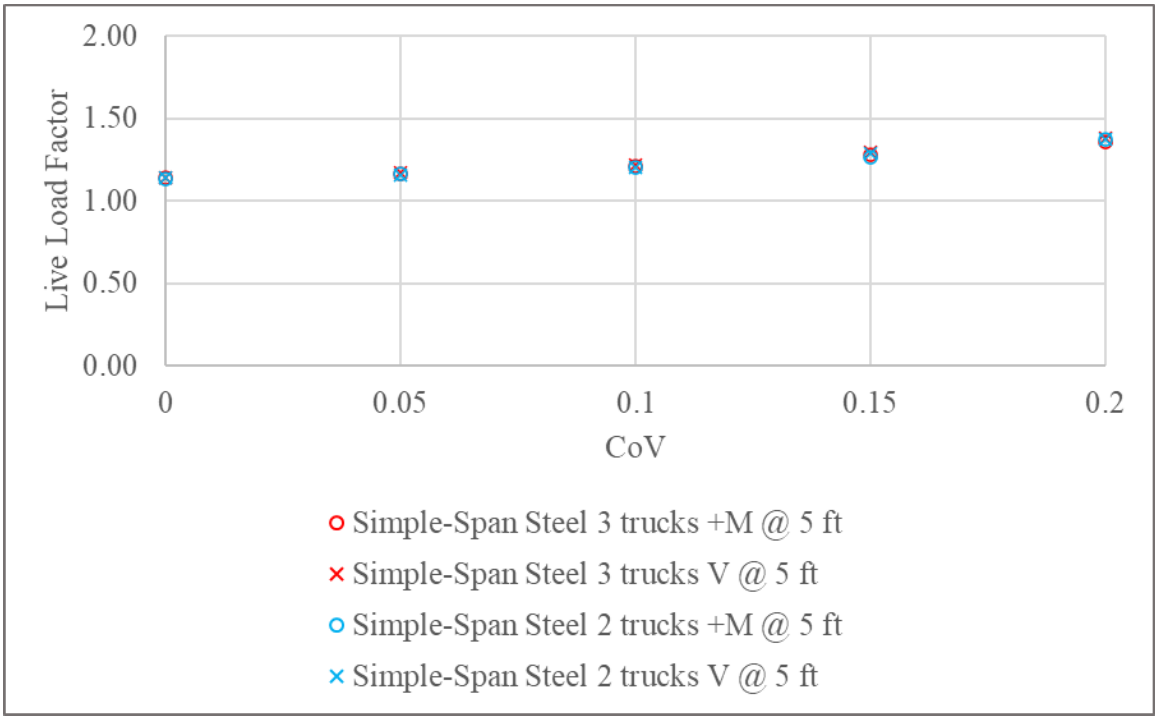



Figure 37. Platoon Live Load Factor Sensitivity to Governing Limit State and Number of Trucks, Simple-Span Steel Bridges

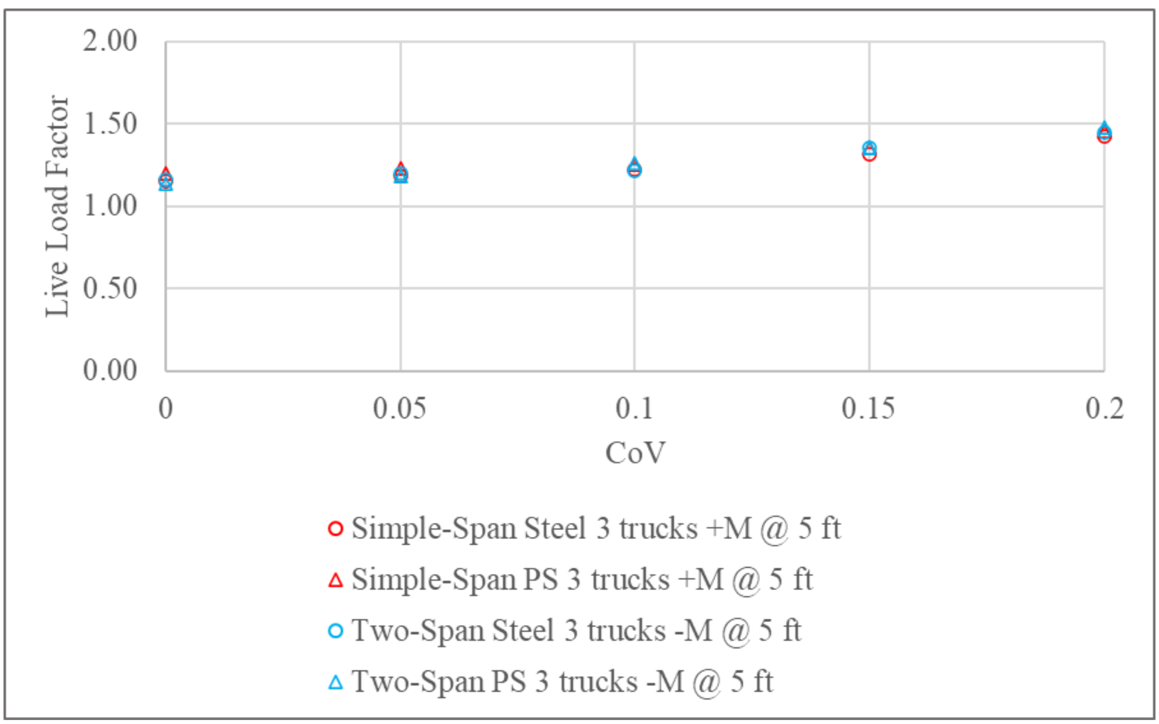



Figure 38. Platoon Live Load Factors Sensitivity to Superstructure Type and Continuity

### 5.5 Proposed LRFR Factors

Results for moment and shear live load factors for all considered platoons, headways, superstructure types and span numbers are provided in Appendices. A 5-ft headway provides the smallest amplification factor, $\alpha$, for positive moments and end shears in simple-span bridges, and for interior support shear for two-span bridges. However, 5-ft headway is not always critical for negative moments in two-span bridges. Headway was shown to not significantly affect live load factors. Proposed LRFR live load factors calibrated to $\beta = 2.5$ for different loading scenarios are given in Table 29. Factors proposed in Table 29 were rounded upward from calculated values to the nearest 0.05 increment for simplicity of implementation. Figure 39 and Figure 40 reproduce Figure 37 and Figure 38 to compare proposed and calculated live load factors. The proposed live load factors envelope all calculated values. The difference of proposed live load factors between the maximum calculated values is about 5%.

Table 29. Proposed Moment Calibrated Live Load Factors

| Truck Platoon | Frequency | Loading Condition | DF | ADTT (One direction) | Live load factors for CoV from 0 to 0.2 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | COVLL = 0 | COVLL = 0.05 | COVLL = 0.1 | COVLL = 0.15 | COVLL = 0.2 |
| Multiple Trucks in Platoon | Single-trip | No other vehicles on the bridge | One lane | N/A | 1.20 | 1.25 | 1.30 | 1.40 | 1.50 |
| | Single-trip | Two indentical platoons loaded on two lanes | Two or more lanes | N/A | 1.20 | 1.25 | 1.30 | 1.40 | 1.50 |
| | 10 Crossings | Mix with routine traffic on the another lane | One lane | > 5000 | 1.60 | 1.60 | 1.65 | 1.75 | 1.85 |
| | | | | 1000 | 1.60 | 1.60 | 1.65 | 1.70 | 1.80 |
| | | | | < 100 | 1.60 | 1.60 | 1.65 | 1.70 | 1.80 |
| | 100 Crossings | Mix with routine traffic on the another lane | One lane | > 5000 | 1.60 | 1.65 | 1.70 | 1.80 | 1.90 |
| | | | | 1000 | 1.60 | 1.65 | 1.70 | 1.75 | 1.85 |
| | | | | < 100 | 1.60 | 1.60 | 1.70 | 1.75 | 1.85 |

a. DF is the AASHTO LRFD approximate GDF, with the multiple presence factor (MPF=1.2) removed for one-lane GDFs.

b. To use with a different *IM* factor, scale tabulated values by 1.1 / (1 + $IM_{desired}$).

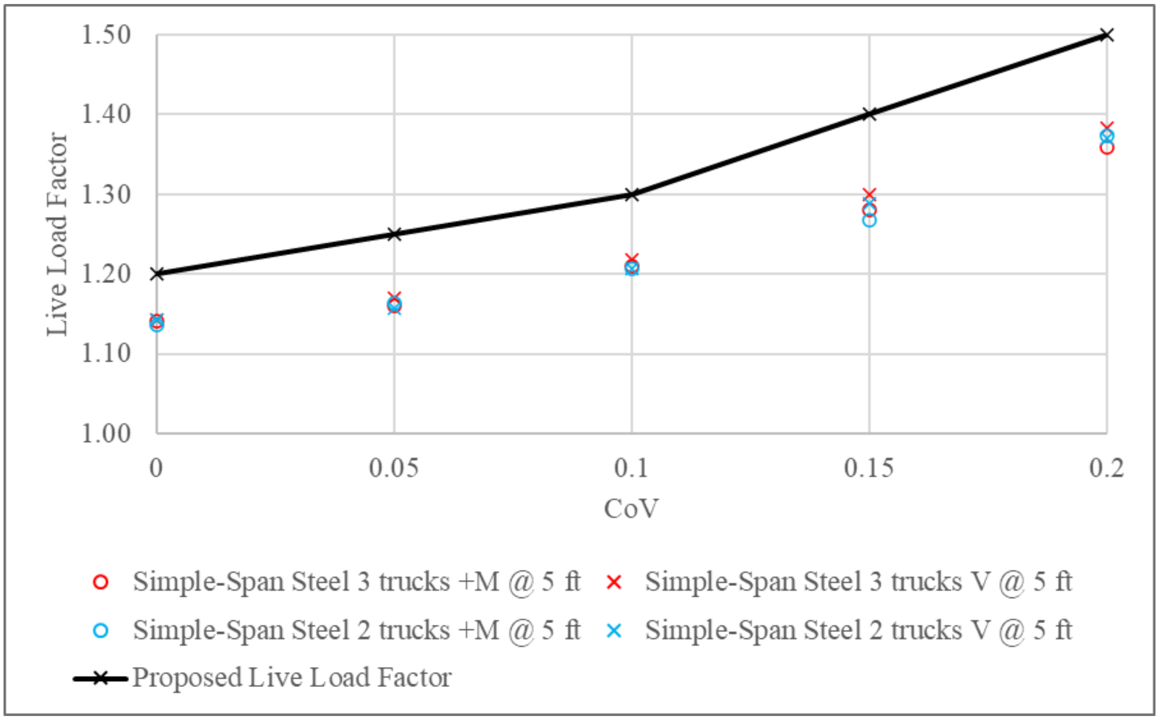



Figure 39. Proposed and Calculated Live Load Factors, Simple-Span Steel Bridges with Two- or Three-Truck Platoons, for Moment and Shear Strength I Limit States

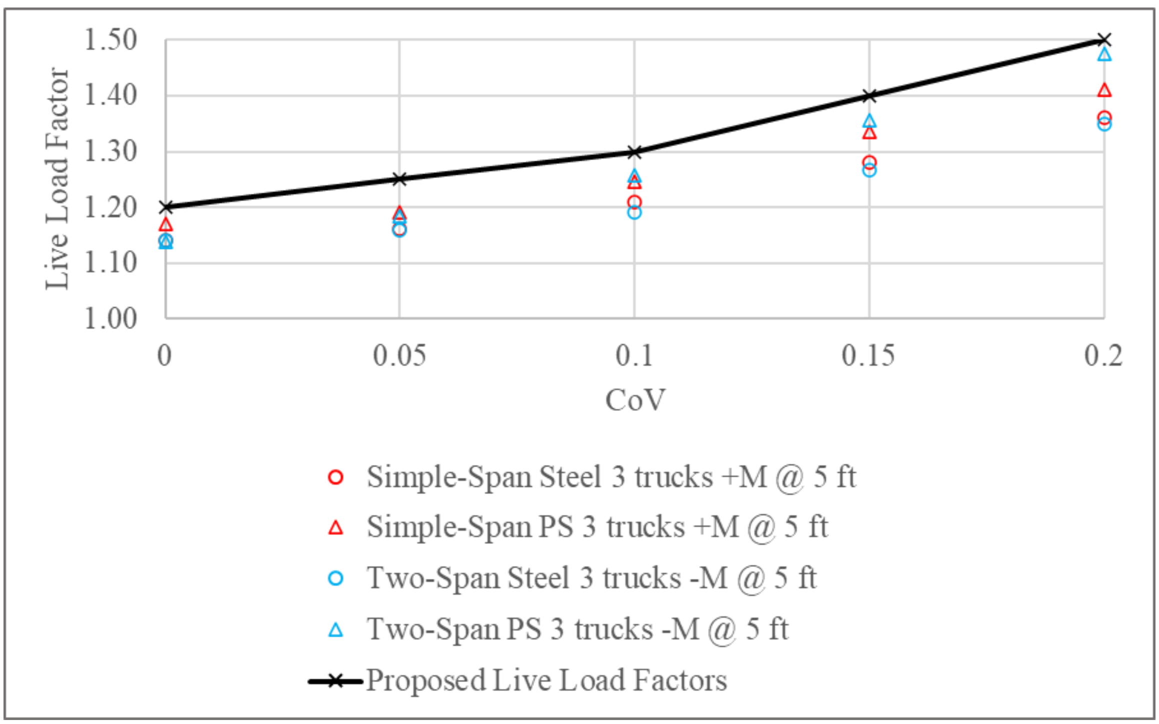



Figure 40. Proposed and Calculated Live Load Factors, Steel and Prestressed Concrete, Simple- and Two-Span Bridges

# 6 COMPARISON BETWEEN LRFR AND LFR RATINGS

## 6.1 Overview

LRFR and LFR load rating equations are introduced. A detailed comparison between LRFR and LFR ratings with respect to dead loads, resistance, and live load components is provided. Five different load rating scenarios are presented, compared, and discussed.

## 6.2 LRFR and LFR

The load and resistance factor rating (LRFR) equation is

$$RF = \frac{\phi_c \phi_s \phi R_n - (\gamma_{DC})DC - (\gamma_{DW})DW}{(\gamma_{LL})(LL + IM)} \qquad \text{(Eqn. 54)}$$

where $R_n$ is the nominal resistance, $\phi_c$ is the condition factor, $\phi_s$ is the system factor, $\phi$ is the resistance factor, *DC* is the nominal dead load of components, *DW* is the nominal wearing surface dead load, $\gamma_{DC}$ and $\gamma_{DW}$ are load factors for dead and wearing surface loads. $\gamma_{LL}$ is the live load factor and *LL* is the nominal static live load effect. For this research, condition and system factors were assumed to be 1.0, corresponding to bridges in good condition and having typical levels of redundancy. Both AASHTO BDS and MBE typically assume *IM* equal to 0.33 and that value is used here to establish optimum design resistances. AASHTO MBE Table 6.A.4.2.2-1 indicates that, for Strength I limit states, $\gamma_{DC}$ = 1.25, $\gamma_{DW}$ = 1.50, and $\gamma_{LL}$ = 1.75 for inventory level rating ($\beta_{target}$ = 3.5) or 1.35 for operating level rating ($\beta_{target}$ = 2.5).

The general LFR rating equation is

$$RF = \frac{C - (\gamma_D)D}{\gamma_{LL} LL(1 + IM)} \qquad \text{(Eqn. 55)}$$

where the $C$ is the capacity, which in some cases includes $\phi$ similar to LRFR, $D$ is the dead load effect, $IM$ is the dynamic amplification factor calculated by Eqn. 14, $\gamma_{LL}$ is the live load factor, and $LL$ is the nominal evaluated live load effect. The nominal live load effect is determined using a $GDF_{LFR,m}$ equal to $S$/11 for moment with multiple lanes loaded, or the lever rule for wheel loads near the supports during shear rating. A single dead load factor is used for both component and wearing surface dead load effects with $\gamma_D$ = 1.30 and $\gamma_{LL}$ = 2.17 for inventory level rating and 1.30 for operating level rating. Permit and legal load ratings in LFR are performed at the operating level. Unlike LRFR, LFR was not calibrated to provide a uniform reliability level, which is evident by comparing LRFR and LFR operating and inventory live load factor ratios.

### 6.3 Comparison of Load and Resistance Components for LRFR and LFR Ratings

Factored dead load positive moments for 30 to 200-ft simple-span bridges with 10 ft girder spacing are shown in Figure 41. The line denoted as Equivalent represents equal factored dead load moments determined according to LRFR and LFR. Factored dead load LRFR and LFR moments are observed to be nearly identical for steel and prestressed concrete simple-span bridges with a maximum absolute difference of 1.8%. The difference of factored dead load negative moment effects between LRFR and LFR for two-span prestressed concrete bridges is about 15%, which arises primarily from differences in wearing load factors.

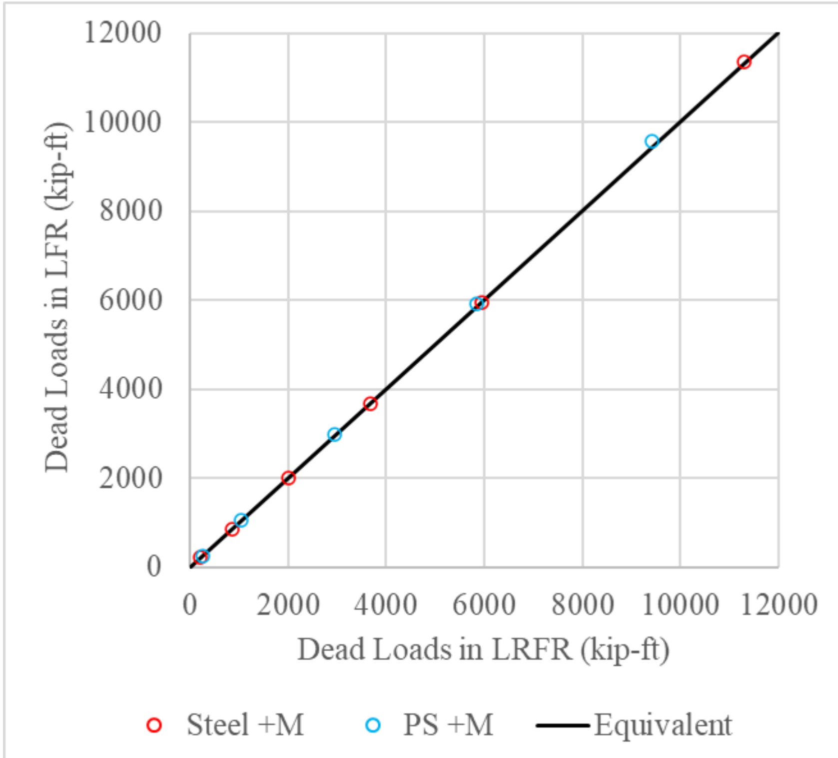



Figure 41. Factored LRFR and LFR Design Dead Load Moments, Simple-Span Bridges

LRFR and LFR live load comparisons are more complicated due to differences between each method's nominal static load models, girder distribution factors, impact factors, and live load factors. LRFR uses the HL-93 live load model, while LFR uses the HS-20 model. HL-93 loading considers lane loading simultaneously with a design HS-20 truck or tandem, whereas the HS-20 truck and lane loading are considered separately in LFR. HL-93 also specifies a 10% reduction for continuous girder negative moments, but no such reduction is mentioned for LFR. The current work used AASHTO approximate girder distribution factors (GDFs) for moments and shears for LRFR and the "S-over" and lever rule methods for LFR. A constant *IM* of 0.33 is used in LRFR, whereas a span length dependent *IM* (Eqn. 14) is used for LFR. The live load factor for inventory rating is 1.75 for LRFR, versus 2.17 for LFR. Factored positive moment

LRFR and LFR dynamic live load effects, including *IM* and GDF, for 30 to 200-ft simple-span bridges are provided in Figure 42. Factored LRFR and LFR live load moments tracked reasonably well, yet were slightly more variable than factored dead load moments when comparing. The maximum absolute difference for values shown in Figure 42 was 12.4%.

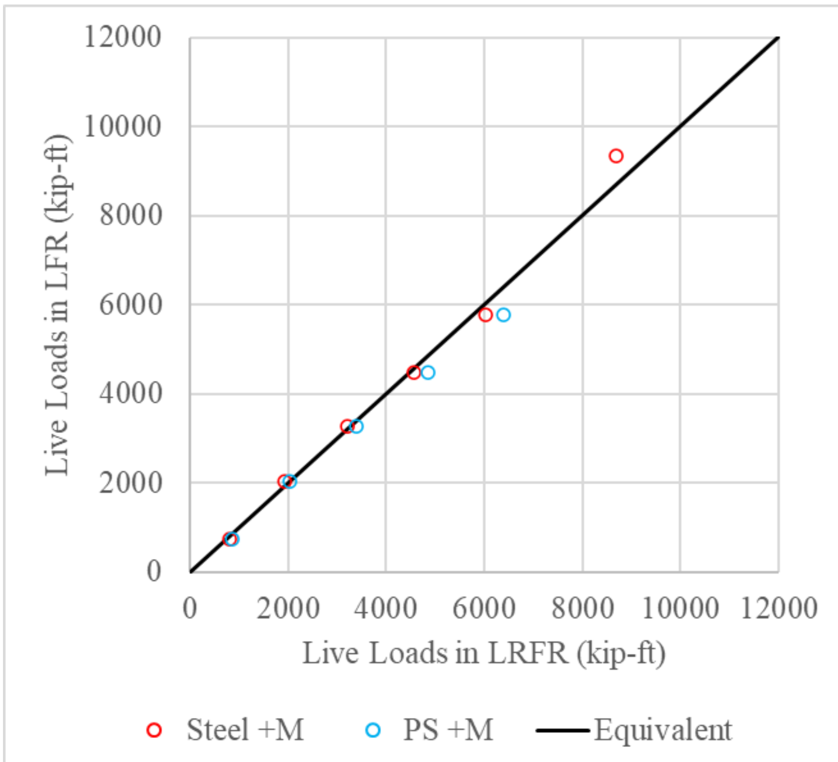



Figure 42. Factored LRFR and LFR Design Dynamic Live Load Moments, Simple-Span Bridges.

Factored and nominal LRFR and LFR resistances were determined assuming optimal designs with $RF = 1.0$, according to Eqns. 33 and 35, respectively. LRFR versus LFR resistances varied slightly as a result of differing factored dead and live load components, as shown for factored simple-span positive moment resistances in Figure 43. Otherwise comparable bridges possessed a maximum of 3.4% higher and 12.3% lower simple-span steel bridge factored resistances determined for optimal LFR versus optimal LRFR.

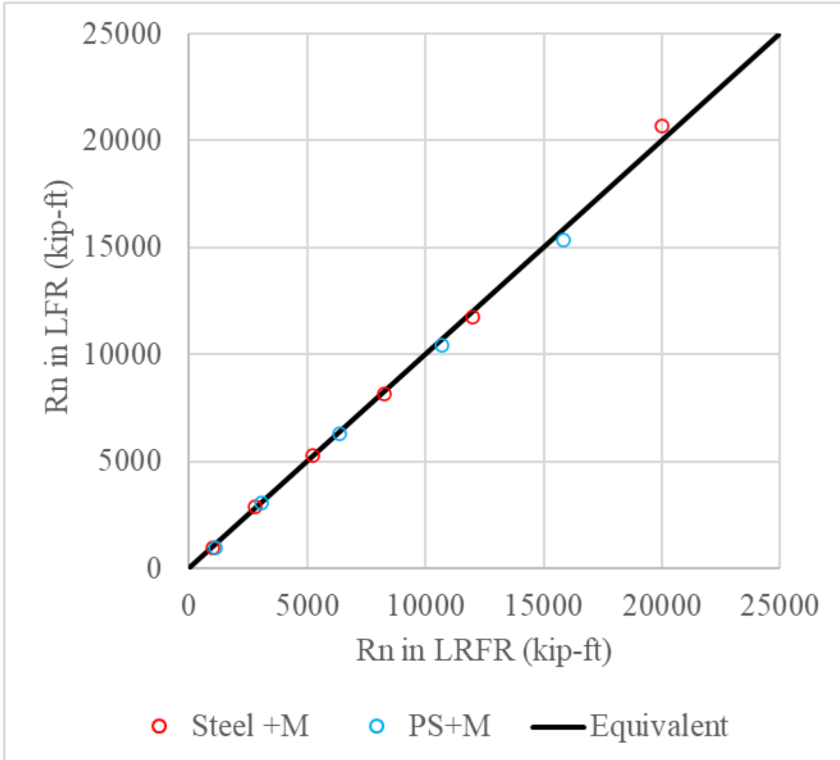



Figure 43. LRFR and LFR Factored Resistances, Simple-Span Bridges

### 6.4 Scenarios

Five platoon load rating scenarios are discussed below:

1. LRFD bridges rated using LRFR,
2. LFD bridges rated using LFR,
3. LFD bridges rated using LRFR,
4. LFD bridges rated using calibrated LFR without GDF bias, and
5. LFD bridges rated using calibrated LFR with GDF bias.

The first method was the primary focus of this research, for which bridge designs and ratings are determined at prescribed target reliabilities. This method is applicable to relatively recently designed bridges, and therefore is only strictly applicable to a narrow population of the

Nebraska inventory. Most bridges managed by Nebraska were designed by LFD and are rated by LFR. Therefore, this research also examined the implications of platoons operating on bridges designed and rated by LFD/R. A third alternative would be to rate a bridge designed by LFD according to LRFR. The last two options would be to evaluate a bridge designed by LFD using a calibrated LFR method to satisfy a target reliability.

### 6.4.1 Scenario 1: LRFD bridges LRFR-rated

General LRFR equations, Eqn. 50 to 52, can be rearranged to isolate a critical $\alpha$ determined using a calibrated live load factor

$$\alpha_{LRFD(LRFR)} = \frac{\phi R_{n,LRFD} - 1.25DC - 1.5DW}{\gamma_{platoon\,(LRFR)} LL_{platoon} (1 + IM_{platoon}) GDF_{LRFR}} \qquad \text{(Eqn. 56)}$$

and equivalently

$$\alpha_{LRFD(LRFR)} = \frac{1.75 LL_{HL-93} (1 + IM_{HL-93}) GDF_{LRFR,m}}{\gamma_{platoon\,(LRFR)} LL_{platoon} (1 + IM_{platoon}) GDF_{LRFR}} \qquad \text{(Eqn. 57)}$$

where $IM_{HL-93}$ is 0.33 for the HL-93 truck load, $R_{n,LRFD}$ is the nominal resistance in LRFD, $DC$ and $DW$ are nominal components and wearing surface dead loads, $GDF_{LRFR,m}$ is the AASHTO GDF for multiple lanes loaded, $GDF_{LRFR}$ is based on the platooning load case under consideration (see Section 3.7), $IM_{platoon}$ is taken as 0.1, and $\gamma_{platoon(LRFR)}$ is a calibrated live load factor corresponding to platoon live load $CoV$. Subscripts for $\alpha$ represent *{design method}({rating method})*, where the design method establishes nominal resistance. The critical amplification factor is equivalent to the rating factor for platoon vehicles operating at the legal load limit. Amplification factors serve as a reference metric for rating method comparisons.

### 6.4.2 Scenario 2: LFD bridges LRFR-rated

An LFD bridge rated by LRFR differs from an LRFD bridge only with respect to nominal resistance. So, Eqn. 56 for an LFD bridge becomes

$$\alpha_{LRFD(LRFR)} = \frac{\phi R_{n,LFD} - 1.25DC - 1.5DW}{\gamma_{platoon\,(LRFR)} LL_{platoon}(1 + IM_{platoon})GDF_{LRFR}} \quad \text{(Eqn. 58)}$$

where the $R_{n,LFD}$ is the optimal nominal LFD resistance from Eqn. 35. The definitions of $GDF_{LRFR}$, $\gamma_{platoon(LRFR)}$, and $IM_{platoon}$ are identical to those used for LRFD bridges rated by LRFR-rated. Because only the numerator differs when comparing $\alpha_{LFD(LRFR)}$ to $\alpha_{LRFD(LRFR)}$, relative amplification between these methods can be determined solely from dead loads and resistances as

$$\frac{\alpha_{LFD(LRFR)}}{\alpha_{LRFD(LRFR)}} = \frac{\phi R_{n,LFD} - 1.25DC - 1.5DW}{\phi R_{n,LRFD} - 1.25DC - 1.5DW} \quad \text{(Eqn. 59)}$$

### 6.4.3 Scenario 3: LFD bridges LFR-rated

LFR typically uses a live load factor of 1.30 for legal and permit load rating. Considering platoons as a permit case that is evaluated according to operating requirements under LFR, the amplification factor for LFD bridges rated by LFR is

$$\alpha_{LFD(LFR)} = \frac{\phi R_{n,LFD} - 1.3DC - 1.3DW}{1.30 LL_{platoon}(1 + IM_{LFR})GDF_{LFR}} \quad \text{(Eqn. 60)}$$

or

$$\alpha_{LFD(LFR)} = \frac{2.17 LL_{HS-20}(1 + IM_{LFR})GDF_{LFR,m}}{1.30 LL_{platoon}(1 + IM_{LFR})GDF_{LFR}} \quad \text{(Eqn. 61)}$$

where $GDF_{LFR}$ is a single-lane S-over factor for moments from platoons in a single lane with or without adjacent routine traffic cases, a multi-lane S-over factor for moments from two-lane, fully-correlated platoons, or is determined according to the lever rule for shear. The GDF in the numerator corresponds to the design load, and is therefore a multiple-lanes loaded factor, regardless of the platoon loading scenario. Dynamic amplification effects are identical in the numerator and denominator, and therefore do not influence the amplification factor. The critical amplification factor $\alpha_{LFD(LFR)}$ simplifies to

$$\alpha_{LFD(LFR)} = \frac{2.17 LL_{HS-20} GDF_{LFR,m}}{1.30 LL_{platoon} GDF_{LFR}} \qquad \text{(Eqn. 62)}$$

### 6.4.4 Scenario 4: LFD bridges calibrated-LFR-rated without GDF bias

Platoon live load factors were determined for a reliability-calibrated LFR method by performing MCS with modifications to optimal-design resistance live load and platooning load distribution effects, as noted in Figure 44. Nominal resistances were determined as described previously for LFD bridges, using an HS-20 live load model, $GDF_{LFR,m}$, and $IM_{LFR}$. Platoon live load effects were calculated using $GDF_{LFR}$. Critical $\alpha$ factors obtained from MCS were used to develop calibrated live load factors in an LFR format from

$$\gamma_{platoon\,(calLFR)} = \frac{2.17 LL_{HS20}(1 + IM_{LFR}) GDF_{LFR,m}}{\alpha LL_{platoon}(1 + IM_{platoon}) GDF_{LFR}} \qquad \text{(Eqn. 63)}$$

Note that $IM_{platoon}$ in the denominator is 0.1, not the span dependent $IM_{LFR}$. As observed in the previous chapter, computed live load factors exhibit a degree of variability for any given $CoV$ with increasing span. To compare with previously discussed rating scenarios, amplification factors were calculated using an average $\gamma_{platoon(calLFR)}$ according to

$$\alpha_{LFD(cal\,LFR-1)} = \frac{2.17 LL_{HS-20}(1+IM_{LFR})GDF_{LFR,m}}{\gamma_{platoon\,(calLFR)} LL_{platoon}(1+IM_{platoon})GDF_{LFR}} \tag{Eqn. 64}$$

### 6.4.5 Scenario 5: LFD bridges calibrated-LFR-rated with GDF bias

Platoon live load factors were also determined for a reliability-calibrated LFR method similarly to Scenario 4, with the further modification that platoon live load effects were calculated using $GDF_{LRFR}$, not $GDF_{LFR}$, which effectively introduces a GDF bias factor. Otherwise, Scenario 5 was procedurally identical to Scenario 4. $\alpha_{LFD(calLFR-2)}$ values were calculated similarly to $\alpha_{LFD(calLFR-1)}$ for Scenario 4.

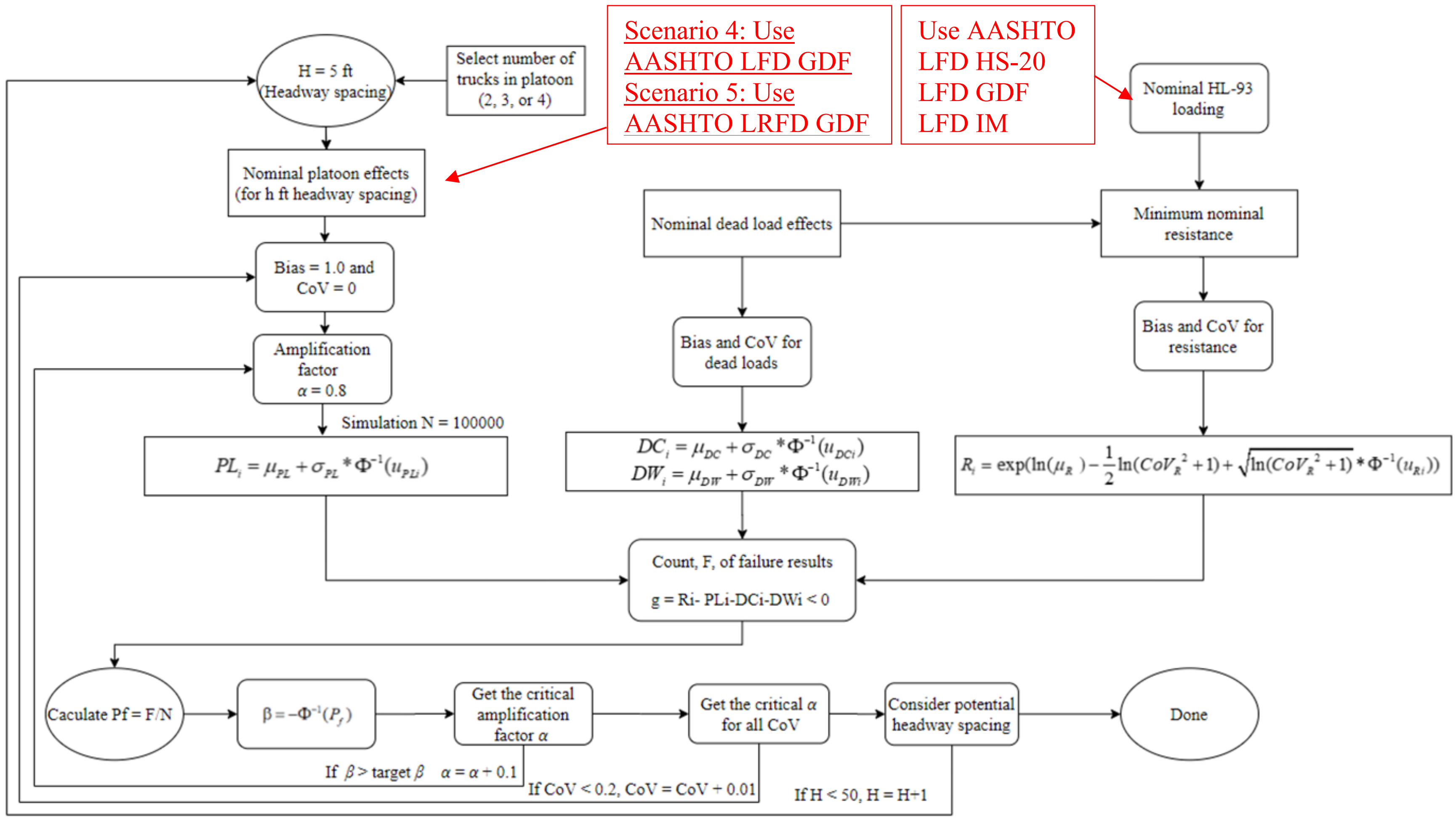



Figure 44. Calibrated LFR MCS Flowchart.

### 6.5 Scenario Comparisons

For illustrative purposes, positive moment amplification factors and calibrated live load factors are presented in Table 30 and Table 31 for three-truck platoons in a single lane on LFD simple-span steel bridges (S = 10 ft) and rated according to Scenario 4 in Section 6.4.4. Scenario 4 assumed identical live load statistical parameters to those used for LRFR, but used nominal static live load, GDF, and IM values as specified for LFR. Calibrated LFR amplification factors are significantly smaller in Table 30 in comparison to corresponding cells in Table 25, which were obtained for LRFD bridges rated by LRFR as described in Scenario 1 in Section 6.4.1. Bridges rated according to Scenario 1 possessed $\alpha_{LRFD(LRFR)}$ factors greater than 1.0 for all combinations of span length and *CoV* in Table 25, yet $\alpha_{LFD(calLFR\text{-}1)}$ factors in Table 30 were less than 1.0 for medium- to long-span bridges at $\beta$ = 3.5. Low amplification factors are attributable to relatively high $GDF_{LFR}$ values used to establish platoon live load effects in MCS.

Table 30. Scenario 4 Positive Moment Critical Amplification Factor, $\alpha_{LFD(calLFR\text{-}1)}$, for a Single-Lane Platoon

| Steel Bridges | Target reliability index β = 2.5 | | | | | Target reliability index β = 3.5 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Span \ CoV | **0** | **0.05** | **0.1** | **0.15** | **0.2** | **0** | **0.05** | **0.1** | **0.15** | **0.2** |
| **30** | 2.3 | 2.3 | 2.2 | 2 | 1.9 | 2.1 | 2 | 1.8 | 1.7 | 1.6 |
| **60** | 2.1 | 2.1 | 2 | 1.9 | 1.7 | 1.8 | 1.8 | 1.7 | 1.5 | 1.4 |
| **90** | 1.5 | 1.5 | 1.4 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.1 | 1 |
| **120** | 1.2 | 1.2 | 1.1 | 1.1 | 1 | 1 | 0.9 | 0.9 | 0.8 | 0.8 |
| **150** | 1.1 | 1.1 | 1 | 1 | 0.9 | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 |
| **200** | 1.1 | 1.1 | 1.1 | 1.1 | 1 | 0.9 | 0.8 | 0.8 | 0.8 | 0.7 |
| **Min** | **1.1** | **1.1** | **1.0** | **1.0** | **0.9** | **0.80** | **0.80** | **0.80** | **0.70** | **0.70** |
| **Avg** | **1.6** | **1.6** | **1.5** | **1.4** | **1.3** | **1.3** | **1.3** | **1.2** | **1.1** | **1.0** |

Although the amplification factors were low, live load factors for calibrated LFR, $\gamma_{platoon(calLFR)}$, in Table 31 were close to those in Table 26 for LRFR, $\gamma_{platoon(LRFR)}$. Live load factors for the Scenario 4 calibrated-LFR method included the $GDF_{LFR}$, which had produced a smaller $\alpha$ from MCS than did Scenario 1. The reduced $\alpha$ effect is then counteracted by $GDF_{LFR}$ appearing again in the denominator during the live load factor calibration process.

Table 31. Scenario 4 Positive Moment Calibrated Live Load Factors, $\gamma_{platoon(calLFR)}$, for a Single-Lane Platoon

| Steel Bridges | Target reliability index β = 2.5 | | | | | Target reliability index β = 3.5 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Span / CoV | 0 | 0.05 | 0.1 | 0.15 | 0.2 | 0 | 0.05 | 0.1 | 0.15 | 0.2 |
| **30** | 1.17 | 1.17 | 1.22 | 1.34 | 1.41 | 1.28 | 1.34 | 1.49 | 1.58 | 1.68 |
| **60** | 1.17 | 1.17 | 1.23 | 1.29 | 1.44 | 1.36 | 1.36 | 1.44 | 1.64 | 1.75 |
| **90** | 1.17 | 1.17 | 1.26 | 1.35 | 1.35 | 1.35 | 1.47 | 1.47 | 1.60 | 1.76 |
| **120** | 1.15 | 1.15 | 1.26 | 1.26 | 1.38 | 1.38 | 1.53 | 1.53 | 1.73 | 1.73 |
| **150** | 1.13 | 1.13 | 1.24 | 1.24 | 1.38 | 1.56 | 1.56 | 1.56 | 1.78 | 1.78 |
| **200** | 1.21 | 1.21 | 1.21 | 1.21 | 1.33 | 1.48 | 1.67 | 1.67 | 1.67 | 1.91 |
| **Max** | **1.21** | **1.21** | **1.26** | **1.35** | **1.44** | **1.38** | **1.47** | **1.49** | **1.64** | **1.76** |
| **Avg** | **1.17** | **1.17** | **1.24** | **1.28** | **1.39** | **1.34** | **1.39** | **1.47** | **1.61** | **1.73** |

Amplification factor variation with span length and scenario is presented in Figure 45 for *CoV* = 0.15 and target *β* = 2.5. The results show that LFD rated by LFR may sacrifice a significant margin of load carrying capacity, even when using a reliability-calibrated method. However, when the reliability calibration accounts for the over-prediction of $GDF_{LFR}$ versus $GDF_{LRFR}$, as demonstrated with Scenario 5, LFR can then produce comparable amplification factors compared to LRFR.

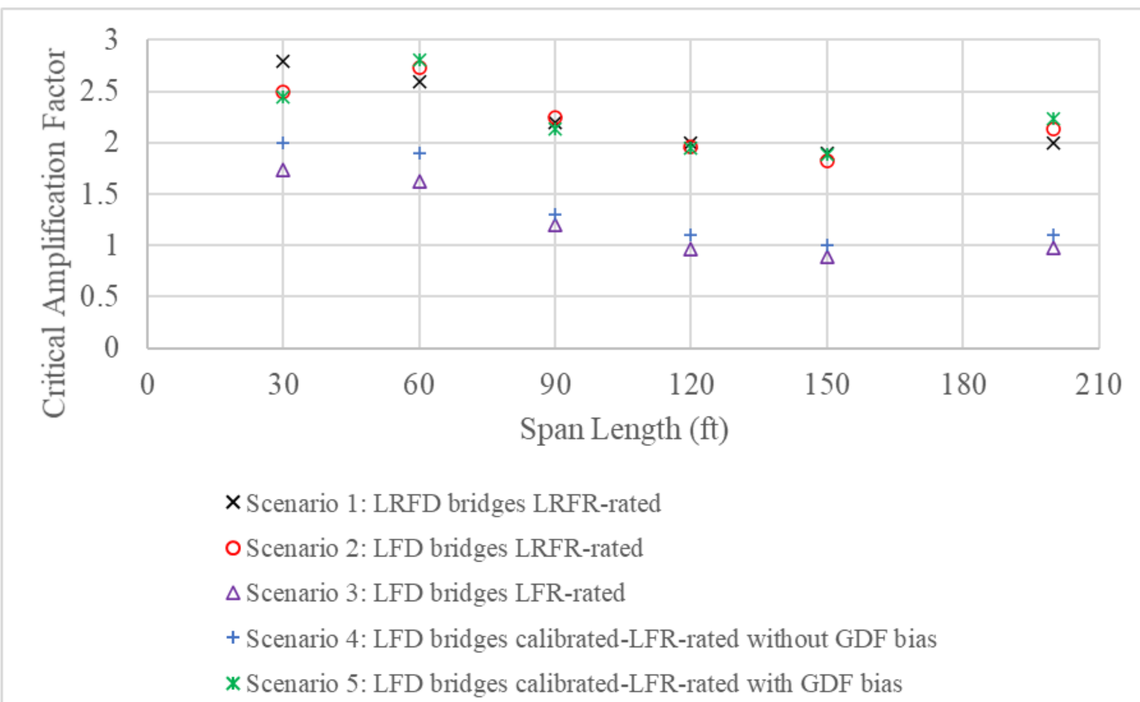



Figure 45. Single-lane Platoon Loading Amplification Factors for Various Rating Methods (*CoV* = 0.15, *β* = 2.5)

The amplification factor for a 30-ft, LRFD simple-span steel bridge rated by LRFR, and carrying a single platoon with no adjacent traffic is 2.8 as shown in Figure 45. If the bridge was designed by LFD and rated by LRFR, the result would be 2.5. Substituting these values into Eqn. 59, the ratio of amplification factors is 0.89, indicating that an LFD bridge has an 11% loss of platoon live load-carrying capacity relative to an LRFD bridge.

Table 32 and Figure 46 summarize moment amplification ratios over a range of span lengths and girder types and spacings.  The maximum moment amplification factor penalty for an LFD steel simple-span 30-ft long bridge having an 8-ft girder spacing and rated by LRFR is 16%, compared to the same bridge being designed by LRFD. Prestressed concrete girders fare worse, at 29%. However, few interstate bridges span such short distances. The spans that constitute most of the interstate inventory in Nebraska are 60 to 120 ft, and LFD penalties are no more than 8% and 12% for steel and prestressed concrete bridges, respectively. Table 33 and Figure 47 summarize shear amplification ratios over a range of span lengths and girder types and spacings. LFD bridges typically incur a shear capacity penalty at all span lengths 60 ft and greater. In the range of 60 to 120 ft span, the penalty is from 0% to 28%, with similar penalties for otherwise identical cases between steel and prestressed concrete girders.

Table 32. Positive Moment Amplification Factor Ratios for Simple-Span LFD Bridges Relative to LRFD Bridges, rated by LRFR

| Span | Steel 8 ft | Steel 10 ft | Steel 12 ft | PS 8 ft | PS 10 ft | PS 12 ft |
|---|---|---|---|---|---|---|
| **30** | 0.84 | 0.89 | 0.94 | 0.79 | 0.84 | 0.88 |
| **60** | 0.99 | 1.05 | 1.11 | 0.94 | 1.00 | 1.05 |
| **90** | 0.96 | 1.02 | 1.08 | 0.91 | 0.97 | 1.02 |
| **120** | 0.92 | 0.98 | 1.04 | 0.88 | 0.94 | 0.99 |
| **150** | 0.90 | 0.96 | 1.01 | 0.87 | 0.93 | 0.97 |
| **200** | 1.01 | 1.08 | 1.14 | NA | NA | NA |
| **Avg** | **0.94** | **1.00** | **1.05** | **0.88** | **0.94** | **0.98** |

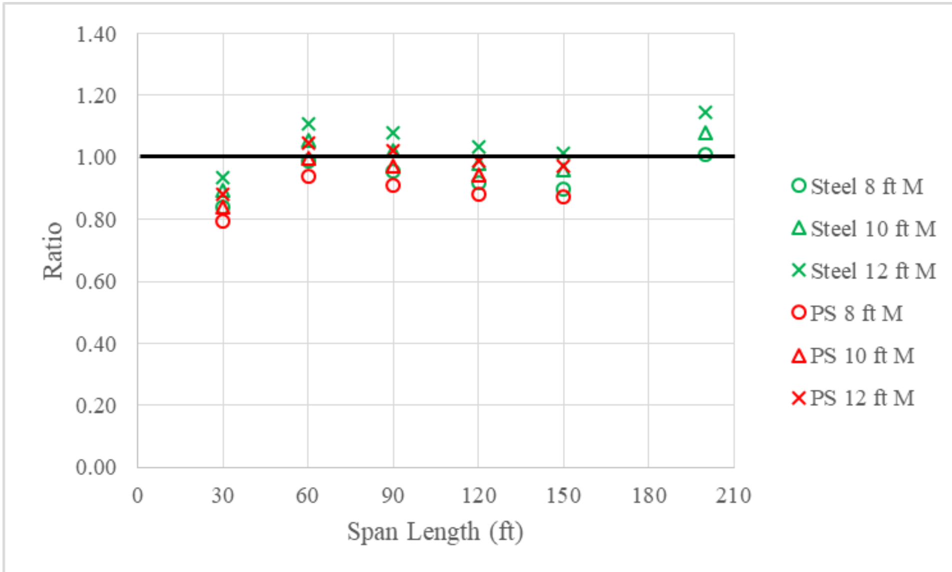



Figure 46. Positive Moment Amplification Factor Ratio Variation with Span Length Simple-Span Bridge for Simple-Span LFD Bridges Relative to LRFD Bridges, rated by LRFR

Table 33. End Shear Amplification Factor Ratios for Simple-Span LFD Bridges Relative to LRFD Bridges, rated by LRFR

| Span | Steel 8 ft | Steel 10 ft | Steel 12 ft | PS 8 ft | PS 10 ft | PS 12 ft |
|---|---|---|---|---|---|---|
| **30** | 0.97 | 1.11 | 1.07 | 0.98 | 1.11 | 1.07 |
| **60** | 0.88 | 1.01 | 0.97 | 0.88 | 1.01 | 0.97 |
| **90** | 0.79 | 0.90 | 0.87 | 0.80 | 0.91 | 0.87 |
| **120** | 0.72 | 0.82 | 0.79 | 0.72 | 0.83 | 0.80 |
| **150** | 0.73 | 0.83 | 0.80 | 0.73 | 0.83 | 0.80 |
| **200** | 0.77 | 0.88 | 0.84 | NA | NA | NA |
| **Avg** | **0.81** | **0.92** | **0.89** | **0.82** | **0.94** | **0.90** |

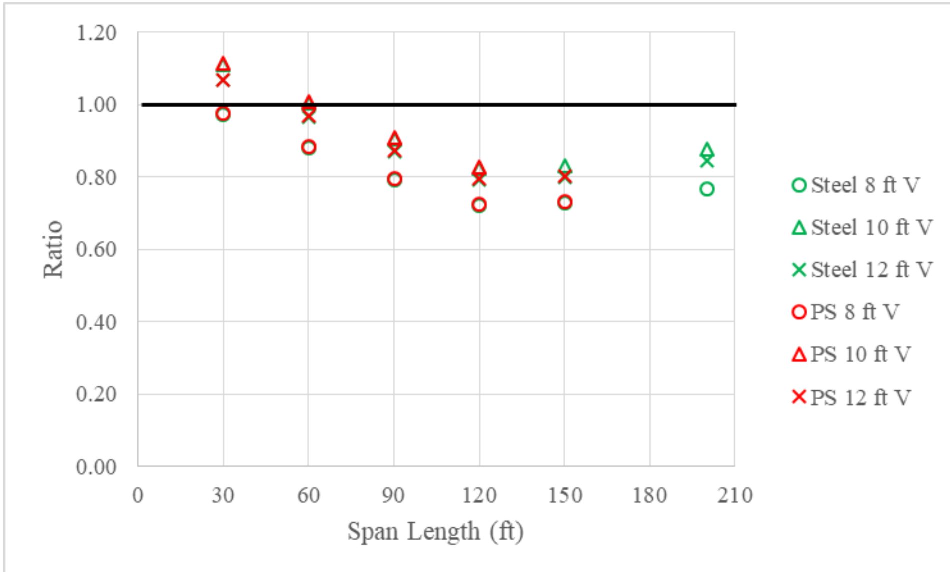



Figure 47. End Shear Amplification Factor Ratio Variation with Span Length for Simple-Span LFD Bridges Relative to LRFD Bridges, rated by LRFR

In conclusion, the difference between rating factors for LRFR and LFR is a consequence of different live load components, GDF, impact factor, and resistance effects. Differences in factored dead loads have little effect on rating factors. A calibrated LFR method that accounts for the bias of LFR GDFs relative to LRFR GDFs produces rating factors close to those obtained from LRFR. Using a reliability-calibrated LFR method that neglects this bias may significantly penalize perceived bridge load-carrying capabilities. LFD bridges may possess noticeably less capacity than LRFD bridges, particularly for shear. LFD bridges are able to carry up to 11% higher truck loads in some cases for moment, but as low as 21% less in others. For shear, the beneficial margin is similar at 11%, but the maximum penalty is greater at 28%. Extended supplemental results related to this chapter are provided in Appendices.

# 7 SAFE COMBINATIONS OF VEHICLE WEIGHT, CoV, AND HEADWAY

## 7.1 Overview

Headway tables for a target $\beta = 2.5$ are provided for three-truck platoons traversing steel simple- and two-span bridges for each studied loading scenario (single-lane platoon, identical platoons adjacent lanes, and single-lane platoon adjacent to routine traffic). The headway tables, including different span lengths, amplification factors, and *CoVs*, are provided so that bridge engineers can efficiently evaluate safe headway ranges without requiring moving load or reliability analyses. General guidelines are provided at the end of the chapter for legal load platoons ($\alpha = 1.0$) for the three load scenarios for steel and prestressed concrete, simple- and two-span LRFD girder bridges.

## 7.2 Simple-Span Bridges

Platoons operating with close headways and weights exceeding legal limits (i.e., platoon permits) could potentially induce unacceptably large live load effects and result in reliability indices, $\beta$, less than the target $\beta$. For simple-span bridges, platoon live load effects consistently decrease with increasing headway. Therefore, if a desired combination of headway and vehicle weight is unacceptable, safety could be maintained by temporarily increasing headway when the platoon traverses the bridge. Alternatively, if the platoon operator can justify reduced uncertainty in vehicle weight or dynamic amplification, the desired headway may potentially be justified without requiring temporary headway adjustment.

Tables 34 to 51 provide minimum headway thresholds corresponding to a minimum target $\beta$ of 2.5, for a three-truck platoon operating on simple-span bridges. For illustrative purposes, Figure 48 shows how positive moment demands vary for a platoon over a range of load amplifications, $\alpha$, and headways for CoV=0.18.

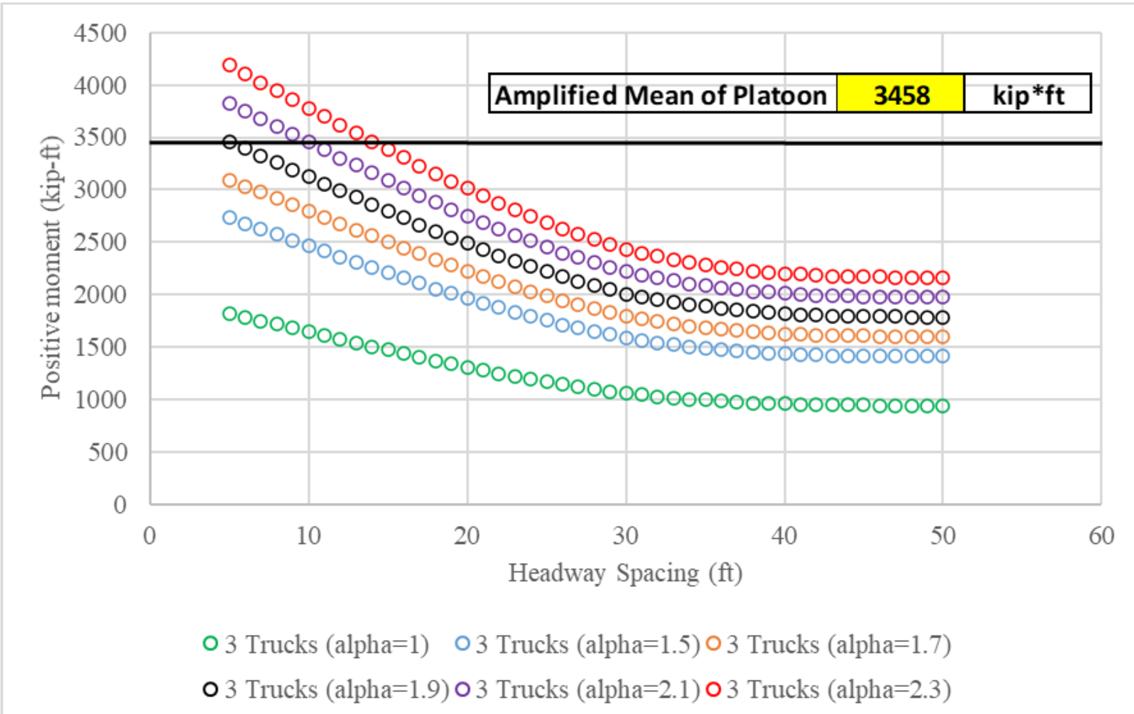



Figure 48. Three-truck Platoon Positive Moments for Varying Headways on a 120-ft Simple-Span Bridge

For $\alpha$ values between 1 (legal load limit) and 1.9, all positive moments fall under the critical threshold of 3458 k-ft, which is the limiting moment obtained from dynamic mean platoon live load effects corresponding to the target $\beta$. These heavy platoon vehicles can operate at the minimum headway of 5 ft, maximizing aerodynamic benefits without compromising bridge safety. At $\alpha = 2.1$, platoon load effects slightly exceed the safe threshold. As a result, the platoon is required to operate at a headway of at least 10 ft. If $\alpha = 2.3$ is desired by the platooning operator, then the headway would need to be at least 14 ft to avoid exceeding the3458 k-ft critical moment limit.

Algorithmically, these findings were determined for various parametric combinations in the scope of the present study by initially assuming a minimum headway of 5 ft. If $\beta$ is adequate, this minimum value is provided in the table. If $\beta$ is unacceptable, headway was incrementally increased until the calculated $\beta$ met or exceeded the target $\beta$.

### 7.2.1 Single-Lane Platoon Without Adjacent Traffic

Table 34 provides minimum headways to ensure safe positive moments for a 200-ft span simply-supported bridge carrying only a platoon in one lane. Values stated above in reference to Figure 48 occur in cells corresponding to the respective $\alpha$ rows, and in the column for $CoV$ = 0.18 which reflects a routine level of highway truck load uncertainty. Cells containing "Fail" reflect that the required spacing is greater than 50 ft and trucks are no longer acting as a platoon to satisfy the target $\beta$. In such cases, typical processes provided in the AASHTO MBE may allow a heavy vehicle to cross the bridge under special permitting conditions that fall outside the scope of the present study. Table 35 provides complementary minimum headways to ensure safe end shears for a 120-ft span simply-supported bridge carrying a single platoon in one lane. Shear was observed to govern over moment when establishing critical headways for simple span bridges. Table 36 provides minimum safe headways accounting for moment and shear.

Table 34. Positive Moment (+M) Safe Headways, Single-Lane Platoons, 120-ft Simple-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.7** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 9 |
| **2.1** | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 8 | 10 | 11 |
| **2.2** | 5 | 5 | 5 | 6 | 7 | 8 | 8 | 10 | 11 | 12 | 13 |
| **2.3** | 7 | 7 | 8 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| **2.4** | 9 | 9 | 10 | 10 | 11 | 12 | 13 | 14 | 14 | 16 | 17 |
| **2.5** | 11 | 11 | 12 | 12 | 13 | 14 | 14 | 15 | 16 | 18 | 18 |
| **2.6** | 13 | 13 | 13 | 14 | 15 | 15 | 16 | 17 | 18 | 19 | 20 |
| **2.7** | 15 | 15 | 15 | 15 | 16 | 17 | 18 | 18 | 20 | 21 | 22 |
| **2.8** | 16 | 16 | 17 | 17 | 18 | 19 | 19 | 20 | 21 | 22 | 23 |
| **2.9** | 18 | 18 | 18 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
| **3** | 19 | 19 | 20 | 20 | 21 | 22 | 22 | 23 | 24 | 26 | 26 |
| **3.1** | 21 | 21 | 21 | 22 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| **3.2** | 22 | 22 | 22 | 22 | 24 | 24 | 25 | 26 | 27 | 29 | 30 |
| **3.3** | 23 | 23 | 23 | 24 | 25 | 26 | 26 | 28 | 29 | 30 | 32 |
| **3.4** | 24 | 25 | 25 | 26 | 26 | 27 | 28 | 29 | 30 | 32 | 34 |
| **3.5** | 26 | 26 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 34 | 37 |
| **3.6** | 27 | 27 | 27 | 28 | 29 | 30 | 31 | 33 | 35 | 38 | 41 |
| **3.7** | 28 | 29 | 29 | 30 | 30 | 32 | 33 | 35 | 38 | 43 | Fail |
| **3.8** | 30 | 30 | 30 | 31 | 32 | 34 | 36 | 37 | 42 | Fail | Fail |
| **3.9** | 31 | 31 | 32 | 33 | 34 | 36 | 38 | 44 | Fail | Fail | Fail |
| **4** | 33 | 34 | 34 | 36 | 38 | 39 | 44 | Fail | Fail | Fail | Fail |
| **4.1** | 36 | 36 | 37 | 39 | 41 | 50 | Fail | Fail | Fail | Fail | Fail |
| **4.2** | 38 | 39 | 41 | 44 | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.3** | 44 | 43 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table 35. End Shear (V) Safe Headways, Single-Lane Platoons, 120-ft Simple-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 |
| **1.7** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 7 | 9 | 10 |
| **1.8** | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 9 | 11 | 12 | 14 |
| **1.9** | 5 | 6 | 7 | 7 | 8 | 10 | 11 | 13 | 14 | 16 | 17 |
| **2** | 9 | 9 | 10 | 11 | 12 | 13 | 15 | 16 | 17 | 19 | 21 |
| **2.1** | 13 | 13 | 13 | 14 | 15 | 16 | 17 | 19 | 20 | 22 | 24 |
| **2.2** | 16 | 16 | 16 | 17 | 18 | 19 | 21 | 22 | 23 | 26 | 27 |
| **2.3** | 18 | 18 | 19 | 19 | 21 | 22 | 23 | 25 | 27 | 30 | 32 |
| **2.4** | 21 | 21 | 21 | 22 | 23 | 25 | 26 | 29 | 32 | 35 | 40 |
| **2.5** | 24 | 24 | 24 | 25 | 26 | 28 | 31 | 34 | 38 | 41 | 45 |
| **2.6** | 26 | 27 | 28 | 28 | 30 | 33 | 36 | 40 | 43 | 46 | 50 |
| **2.7** | 30 | 30 | 32 | 33 | 36 | 39 | 41 | 45 | 49 | Fail | Fail |
| **2.8** | 35 | 36 | 37 | 39 | 41 | 45 | 47 | 50 | Fail | Fail | Fail |
| **2.9** | 40 | 41 | 42 | 44 | 46 | 48 | Fail | Fail | Fail | Fail | Fail |
| **3** | 45 | 46 | 47 | 48 | 50 | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.1** | 50 | 50 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.2** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.7** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.8** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.9** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.1** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.2** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table 36. Positive Moment (+M) and End Shear (V) Safe Headways, Single-Lane Platoons, 120-ft Simple-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.8 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 0.9 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 1 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 1.1 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 1.2 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 1.3 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 1.4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 1.5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 1.6 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 |
| 1.7 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 7 | 9 | 10 |
| 1.8 | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 9 | 11 | 12 | 14 |
| 1.9 | 5 | 6 | 7 | 7 | 8 | 10 | 11 | 13 | 14 | 16 | 17 |
| 2 | 9 | 9 | 10 | 11 | 12 | 13 | 15 | 16 | 17 | 19 | 21 |
| 2.1 | 13 | 13 | 13 | 14 | 15 | 16 | 17 | 19 | 20 | 22 | 24 |
| 2.2 | 16 | 16 | 16 | 17 | 18 | 19 | 21 | 22 | 23 | 26 | 27 |
| 2.3 | 18 | 18 | 19 | 19 | 21 | 22 | 23 | 25 | 27 | 30 | 32 |
| 2.4 | 21 | 21 | 21 | 22 | 23 | 25 | 26 | 29 | 32 | 35 | 40 |
| 2.5 | 24 | 24 | 24 | 25 | 26 | 28 | 31 | 34 | 38 | 41 | 45 |
| 2.6 | 26 | 27 | 28 | 28 | 30 | 33 | 36 | 40 | 43 | 46 | 50 |
| 2.7 | 30 | 30 | 32 | 33 | 36 | 39 | 41 | 45 | 49 | Fail | Fail |
| 2.8 | 35 | 36 | 37 | 39 | 41 | 45 | 47 | 50 | Fail | Fail | Fail |
| 2.9 | 40 | 41 | 42 | 44 | 46 | 48 | Fail | Fail | Fail | Fail | Fail |
| 3 | 45 | 46 | 47 | 48 | 50 | Fail | Fail | Fail | Fail | Fail | Fail |
| 3.1 | 50 | 50 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 3.2 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 3.3 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 3.4 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 3.5 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 3.6 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 3.7 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 3.8 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 3.9 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 4 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 4.1 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 4.2 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 4.3 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 4.4 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table 37 reconfigures the results to show minimum headway variations as a function of span length that ensure safe positive moment demands, assuming a constant *CoV* = 0.18. As shown in Chapter 4, platoon live load effects are only sensitive to headway for limited ranges. Ranges increase with longer span lengths as more axles can occur simultaneously on a bridge. The shortest vehicle configuration in the scope of this study was the 30 ft NRL. Because only one vehicle can occupy a 30 ft bridge, headway has no effect on platoon effects for this span length. A platoon operating with an $\alpha$ = 2.7 is the maximum that can operate safely on a 30-ft span based on moment (assuming *CoV* = 0.18). Table 37 shows that as that platoon travels along a highway and encounters longer bridges, platoon vehicles must increase headway between vehicles to 8, 13, 21, 28, or 34 ft when crossing 60, 90, 120, 150, or 200 ft simple spans, respectively, to maintain safe operations. Similar trends appear for $\alpha$ values between 2.7 and 1.8, at which the platoon can operate at the minimum headway on any span.

Table 38 provides similar results for headways limited by end shear. The maximum safe $\alpha$ for a 30-ft span is slightly higher for shear than moment (2.8 versus 2.7). However, shear generally restricts headway more stringently than moment. At an $\alpha$ = 2.7, the headway must increase from 13 to 18 ft for a 60-ft span, and from 21 to 36 ft for a 120-ft span. Maximum $\alpha$ initially trends upward with increasing span as platoons can take advantage of increased headways to reduce load effects. At 120-ft and longer spans, the maximum $\alpha$ progressively decreases because of the 50-ft headway limit selected for the current study. Results from Table 37 and Table 38 are synthesized in Table 39 to envelope maximum headways when considering both moment and shear.

Table 37. Acceptable Simple-Span Positive Moment Single-lane Headways (*CoV*= 0.18)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.7** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.9** | 5 | 5 | 5 | 5 | 6 | 5 |
| **2** | 5 | 5 | 5 | 7 | 9 | 6 |
| **2.1** | 5 | 5 | 5 | 10 | 12 | 10 |
| **2.2** | 5 | 5 | 6 | 12 | 16 | 15 |
| **2.3** | 5 | 5 | 8 | 14 | 19 | 21 |
| **2.4** | 5 | 5 | 9 | 16 | 21 | 24 |
| **2.5** | 5 | 5 | 11 | 18 | 23 | 27 |
| **2.6** | 5 | 6 | 12 | 19 | 25 | 31 |
| **2.7** | 5 | 8 | 13 | 21 | 28 | 34 |
| **2.8** | Fail | 11 | 15 | 22 | 29 | 37 |
| **2.9** | Fail | 19 | 17 | 24 | 31 | 40 |
| **3** | Fail | Fail | 18 | 26 | 33 | 43 |
| **3.1** | Fail | Fail | 21 | 27 | 35 | 45 |
| **3.2** | Fail | Fail | 23 | 29 | 37 | 47 |
| **3.3** | Fail | Fail | 28 | 30 | 38 | 49 |
| **3.4** | Fail | Fail | Fail | 32 | 39 | Fail |
| **3.5** | Fail | Fail | Fail | 34 | 41 | Fail |
| **3.6** | Fail | Fail | Fail | 38 | 43 | Fail |
| **3.7** | Fail | Fail | Fail | 43 | 45 | Fail |
| **3.8** | Fail | Fail | Fail | Fail | 47 | Fail |
| **3.9** | Fail | Fail | Fail | Fail | 49 | Fail |
| **4** | Fail | Fail | Fail | Fail | Fail | Fail |

Table 38. Acceptable Simple-Span Shear Single-lane Safe Headways ($CoV = 0.18$)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 7 | 5 |
| **1.7** | 5 | 5 | 5 | 9 | 13 | 13 |
| **1.8** | 5 | 5 | 6 | 12 | 18 | 21 |
| **1.9** | 5 | 5 | 9 | 16 | 22 | 28 |
| **2** | 5 | 5 | 10 | 19 | 26 | 34 |
| **2.1** | 5 | 5 | 13 | 22 | 31 | 40 |
| **2.2** | 5 | 6 | 17 | 26 | 34 | 44 |
| **2.3** | 5 | 9 | 21 | 30 | 37 | 50 |
| **2.4** | 5 | 11 | 25 | 35 | 41 | Fail |
| **2.5** | 5 | 13 | 29 | 41 | 49 | Fail |
| **2.6** | 5 | 16 | 32 | 46 | Fail | Fail |
| **2.7** | 5 | 18 | 36 | Fail | Fail | Fail |
| **2.8** | 8 | 20 | 39 | Fail | Fail | Fail |
| **2.9** | Fail | 25 | 43 | Fail | Fail | Fail |
| **3** | Fail | Fail | 47 | Fail | Fail | Fail |
| **3.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.7** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.8** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.9** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4** | Fail | Fail | Fail | Fail | Fail | Fail |

Table 39. Acceptable Simple-Span Moment and Shear Single-lane Headways (*CoV* = 0.18)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 7 | 5 |
| **1.7** | 5 | 5 | 5 | 9 | 13 | 13 |
| **1.8** | 5 | 5 | 6 | 12 | 18 | 21 |
| **1.9** | 5 | 5 | 9 | 16 | 22 | 28 |
| **2** | 5 | 5 | 10 | 19 | 26 | 34 |
| **2.1** | 5 | 5 | 13 | 22 | 31 | 40 |
| **2.2** | 5 | 6 | 17 | 26 | 34 | 44 |
| **2.3** | 5 | 9 | 21 | 30 | 37 | 50 |
| **2.4** | 5 | 11 | 25 | 35 | 41 | Fail |
| **2.5** | 5 | 13 | 29 | 41 | 49 | Fail |
| **2.6** | 5 | 16 | 32 | 46 | Fail | Fail |
| **2.7** | 5 | 18 | 36 | Fail | Fail | Fail |
| **2.8** | Fail | 20 | 39 | Fail | Fail | Fail |
| **2.9** | Fail | 25 | 43 | Fail | Fail | Fail |
| **3** | Fail | Fail | 47 | Fail | Fail | Fail |
| **3.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.7** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.8** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.9** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4** | Fail | Fail | Fail | Fail | Fail | Fail |

### 7.2.2 Fully-Correlated Platoons, Adjacent Lanes

Table 40 provides minimum headways to ensure safe positive moment demands for a 120-ft simply-supported bridge carrying two lanes of identical three-truck platoons. This is an upper-bound demand condition for the parameters that were studied. As expected, comparison of 34 to Table 40 indicates the minimum headway is more restrictive than the single-lane loaded case as the maximum critical amplification factor for *CoV* = 0 reduces from $\alpha = 3.8$ to 2.1. Similar trends to the single-lane loaded case are observed in that minimum headways increase with increasing amplification factors and *CoVs*. Table 41 presents the end-shear headway table. Again, shear further restricts safe minimum headways. Table 42 combines moment and shear headways, and is primarily governed by and reflective of shear limitations. Tables 43 to 45 detail safe headways for positive moment, end shear, and combined moment and shear for different span lengths, assuming a *CoV* = 0.18.

Table 40. Two-lanes Fully-Correlated Safe Headway Table for Simple-Span 120-ft bridges (+M)

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 8 | 9 | 11 | 12 |
| **1.3** | 7 | 7 | 8 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| **1.4** | 11 | 11 | 11 | 12 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| **1.5** | 14 | 14 | 15 | 15 | 16 | 16 | 17 | 18 | 19 | 20 | 21 |
| **1.6** | 17 | 17 | 17 | 18 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| **1.7** | 19 | 19 | 20 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| **1.8** | 22 | 22 | 22 | 23 | 23 | 24 | 25 | 26 | 27 | 29 | 30 |
| **1.9** | 24 | 25 | 25 | 25 | 26 | 26 | 28 | 29 | 30 | 31 | 33 |
| **2** | 26 | 26 | 27 | 27 | 28 | 29 | 30 | 31 | 34 | 36 | 38 |
| **2.1** | 29 | 29 | 29 | 30 | 31 | 32 | 34 | 36 | 39 | 43 | Fail |
| **2.2** | 32 | 31 | 32 | 33 | 34 | 36 | 39 | 45 | Fail | Fail | Fail |
| **2.3** | 36 | 36 | 36 | 37 | 39 | 47 | Fail | Fail | Fail | Fail | Fail |
| **2.4** | 41 | 42 | 43 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table 41. Two-lanes Fully-Correlated Safe Headway Table for Simple-Span 120-ft bridges (V)

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 7 | 8 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 6 | 8 | 9 | 11 | 12 | 14 |
| **1.3** | 7 | 8 | 8 | 9 | 10 | 12 | 13 | 15 | 16 | 17 | 19 |
| **1.4** | 12 | 13 | 13 | 14 | 15 | 17 | 18 | 19 | 21 | 23 | 24 |
| **1.5** | 17 | 17 | 17 | 18 | 19 | 21 | 22 | 24 | 25 | 27 | 30 |
| **1.6** | 20 | 21 | 21 | 22 | 23 | 25 | 27 | 28 | 32 | 35 | 38 |
| **1.7** | 25 | 25 | 25 | 27 | 29 | 31 | 34 | 37 | 41 | 44 | 48 |
| **1.8** | 30 | 30 | 33 | 33 | 36 | 39 | 41 | 45 | 48 | Fail | Fail |
| **1.9** | 38 | 39 | 40 | 41 | 43 | 47 | 50 | Fail | Fail | Fail | Fail |
| **2** | 45 | 45 | 46 | 48 | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.1** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table 42. Two-lanes Fully-Correlated Safe Headway Table for Simple-Span 120-ft bridges (+M, and V)

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 7 | 8 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 6 | 8 | 9 | 11 | 12 | 14 |
| **1.3** | 7 | 8 | 8 | 9 | 10 | 12 | 13 | 15 | 16 | 17 | 19 |
| **1.4** | 12 | 13 | 13 | 14 | 15 | 17 | 18 | 19 | 21 | 23 | 24 |
| **1.5** | 17 | 17 | 17 | 18 | 19 | 21 | 22 | 24 | 25 | 27 | 30 |
| **1.6** | 20 | 21 | 21 | 22 | 23 | 25 | 27 | 28 | 32 | 35 | 38 |
| **1.7** | 25 | 25 | 25 | 27 | 29 | 31 | 34 | 37 | 41 | 44 | 48 |
| **1.8** | 30 | 30 | 33 | 33 | 36 | 39 | 41 | 45 | 48 | Fail | Fail |
| **1.9** | 38 | 39 | 40 | 41 | 43 | 47 | 50 | Fail | Fail | Fail | Fail |
| **2** | 45 | 45 | 46 | 48 | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.1** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table 43. Two-lanes Fully-Correlated Safe Headway Table for Simple-Span Bridges (+M, and $CoV = 0.18$)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 6 | 8 | 7 |
| **1.2** | 5 | 5 | 5 | 11 | 14 | 17 |
| **1.3** | 5 | 5 | 7 | 14 | 20 | 25 |
| **1.4** | 5 | 5 | 10 | 17 | 24 | 31 |
| **1.5** | 5 | 5 | 12 | 20 | 28 | 37 |
| **1.6** | 5 | 8 | 15 | 23 | 31 | 42 |
| **1.7** | 5 | 14 | 17 | 26 | 34 | 47 |
| **1.8** | Fail | Fail | 21 | 29 | 37 | 50 |
| **1.9** | Fail | Fail | 27 | 31 | 40 | Fail |
| **2** | Fail | Fail | Fail | 36 | 43 | Fail |
| **2.1** | Fail | Fail | Fail | 43 | 46 | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.7** | Fail | Fail | Fail | Fail | Fail | Fail |

Table 44. Two-lanes Fully-Correlated Safe Headway Table for Simple-Span Bridges (V and *CoV* = 0.18)

| **α / Span** | **30 ft** | **60 ft** | **90 ft** | **120 ft** | **150 ft** | **200 ft** |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 7 | 10 | 8 |
| **1.2** | 5 | 5 | 6 | 12 | 18 | 21 |
| **1.3** | 5 | 5 | 9 | 17 | 24 | 31 |
| **1.4** | 5 | 5 | 12 | 23 | 30 | 39 |
| **1.5** | 5 | 7 | 19 | 27 | 35 | 48 |
| **1.6** | 5 | 11 | 25 | 35 | 42 | Fail |
| **1.7** | 5 | 14 | 31 | 44 | Fail | Fail |
| **1.8** | 5 | 18 | 36 | Fail | Fail | Fail |
| **1.9** | 11 | 22 | 41 | Fail | Fail | Fail |
| **2** | Fail | Fail | 47 | Fail | Fail | Fail |
| **2.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.7** | Fail | Fail | Fail | Fail | Fail | Fail |

Table 45. Two-lanes Fully-Correlated Safe Headway Table for Simple-Span Bridges (+M, V, and *CoV* = 0.18)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 7 | 10 | 8 |
| **1.2** | 5 | 5 | 6 | 12 | 18 | 21 |
| **1.3** | 5 | 5 | 9 | 17 | 24 | 31 |
| **1.4** | 5 | 5 | 12 | 23 | 30 | 39 |
| **1.5** | 5 | 7 | 19 | 27 | 35 | 48 |
| **1.6** | 5 | 11 | 25 | 35 | 42 | Fail |
| **1.7** | 5 | 14 | 31 | 44 | Fail | Fail |
| **1.8** | Fail | Fail | 36 | Fail | Fail | Fail |
| **1.9** | Fail | Fail | 41 | Fail | Fail | Fail |
| **2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.7** | Fail | Fail | Fail | Fail | Fail | Fail |

### 7.2.3 Single-Lane Platoon, Routine Traffic in Adjacent Lane

Single-lane and two-lane, fully-correlated platoons are expected to envelope headway requirements for the single-lane platoon and routine traffic scenario. Tables 46 to 48 provide minimum headways applicable to this scenario for positive moment, end shear, and combined moment and shear, respectively. Results were obtained assuming 100 platoon crossings per day over a bridge with an ADTT of 5000. These parameters conservatively influence the estimated adjacent lane load, and results shown previously demonstrated that platoon ratings are not sensitive to the precise values selected. Comparison between these tables and those for the single- and two-lanes fully-correlated scenarios confirms the adjacent routine traffic scenarios was bounded by platoon-only cases. Shear ultimately governs all critical minimum headways for the single-lane platoon adjacent to routine traffic scenario and Table 48 matches Table 47.

Table 46. Platoon Loaded with Routine Traffic Safe Headway Table for Simple-Span 120 ft Bridges (+M, 100 Crossings, and ADTT=5000)

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 8 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 9 | 9 | 10 | 11 |
| **1.7** | 8 | 8 | 8 | 8 | 9 | 10 | 10 | 11 | 12 | 13 | 14 |
| **1.8** | 10 | 11 | 11 | 11 | 12 | 12 | 13 | 14 | 14 | 15 | 16 |
| **1.9** | 13 | 13 | 13 | 14 | 14 | 15 | 15 | 16 | 17 | 18 | 19 |
| **2** | 15 | 15 | 15 | 16 | 16 | 17 | 17 | 18 | 19 | 20 | 21 |
| **2.1** | 17 | 17 | 18 | 18 | 18 | 19 | 20 | 21 | 21 | 22 | 23 |
| **2.2** | 19 | 19 | 20 | 20 | 20 | 21 | 22 | 22 | 23 | 24 | 25 |
| **2.3** | 21 | 21 | 21 | 22 | 22 | 23 | 24 | 24 | 25 | 26 | 27 |
| **2.4** | 23 | 23 | 23 | 24 | 24 | 25 | 25 | 26 | 27 | 28 | 29 |
| **2.5** | 25 | 25 | 25 | 25 | 26 | 27 | 27 | 28 | 30 | 30 | 32 |
| **2.6** | 26 | 26 | 26 | 27 | 28 | 29 | 30 | 30 | 32 | 33 | 34 |
| **2.7** | 28 | 28 | 29 | 29 | 30 | 31 | 32 | 33 | 34 | 37 | 40 |
| **2.8** | 30 | 30 | 31 | 31 | 31 | 33 | 34 | 36 | 39 | 43 | Fail |
| **2.9** | 33 | 33 | 33 | 34 | 34 | 36 | 38 | 41 | Fail | Fail | Fail |
| **3** | 36 | 36 | 36 | 37 | 38 | 43 | Fail | Fail | Fail | Fail | Fail |
| **3.1** | 41 | 40 | 42 | 43 | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.2** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table 47. Platoon Loaded with Routine Traffic Safe Headway Table for Simple-Span 120 ft Bridges (V, 100 Crossings, and ADTT=5000)

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 8 | 9 | 11 |
| **1.5** | 5 | 5 | 6 | 6 | 8 | 9 | 10 | 11 | 12 | 14 | 15 |
| **1.6** | 10 | 10 | 10 | 11 | 12 | 13 | 14 | 15 | 17 | 18 | 19 |
| **1.7** | 13 | 14 | 14 | 15 | 15 | 17 | 18 | 19 | 20 | 21 | 23 |
| **1.8** | 17 | 17 | 17 | 18 | 19 | 20 | 21 | 23 | 24 | 25 | 28 |
| **1.9** | 20 | 20 | 21 | 22 | 22 | 24 | 25 | 26 | 29 | 31 | 34 |
| **2** | 24 | 24 | 24 | 25 | 26 | 27 | 30 | 32 | 35 | 39 | 41 |
| **2.1** | 28 | 28 | 29 | 30 | 31 | 34 | 37 | 40 | 42 | 45 | 48 |
| **2.2** | 34 | 34 | 34 | 37 | 39 | 41 | 43 | 45 | 49 | Fail | Fail |
| **2.3** | 40 | 40 | 41 | 42 | 44 | 47 | 49 | Fail | Fail | Fail | Fail |
| **2.4** | 46 | 45 | 47 | 49 | 50 | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.7** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.8** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.9** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.1** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.2** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table 48. Platoon Loaded with Routine Traffic Safe Headway Table for Simple-Span 120 ft Bridges (+M and V, 100 Crossings, and ADTT=5000)

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 8 | 9 | 11 |
| **1.5** | 5 | 5 | 6 | 6 | 8 | 9 | 10 | 11 | 12 | 14 | 15 |
| **1.6** | 10 | 10 | 10 | 11 | 12 | 13 | 14 | 15 | 17 | 18 | 19 |
| **1.7** | 13 | 14 | 14 | 15 | 15 | 17 | 18 | 19 | 20 | 21 | 23 |
| **1.8** | 17 | 17 | 17 | 18 | 19 | 20 | 21 | 23 | 24 | 25 | 28 |
| **1.9** | 20 | 20 | 21 | 22 | 22 | 24 | 25 | 26 | 29 | 31 | 34 |
| **2** | 24 | 24 | 24 | 25 | 26 | 27 | 30 | 32 | 35 | 39 | 41 |
| **2.1** | 28 | 28 | 29 | 30 | 31 | 34 | 37 | 40 | 42 | 45 | 48 |
| **2.2** | 34 | 34 | 34 | 37 | 39 | 41 | 43 | 45 | 49 | Fail | Fail |
| **2.3** | 40 | 40 | 41 | 42 | 44 | 47 | 49 | Fail | Fail | Fail | Fail |
| **2.4** | 46 | 45 | 47 | 49 | 50 | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.7** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.8** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.9** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.1** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.2** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Tables 49 to 51 provide safe headways for positive moment, end shear, and combined moment and shear for different span lengths, assuming $CoV = 0.18$. Again, shear is generally more restrictive than moment. The only exceptions are $\alpha = 2.1$ or 2.2 for a span of 30 ft, or 2.3 or 2.4 for a span of 60 ft, for which a moment limitation prevents platoon operation ("Fail").

Table 49. Platoon Loaded with Routine Traffic Safe Headway Table for Simple-Span Bridges (+M, 100 Crossings, and ADTT=5000)

| **α \ Span** | **30 ft** | **60 ft** | **90 ft** | **120 ft** | **150 ft** | **200 ft** |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 7 | 11 | 7 |
| **1.6** | 5 | 5 | 5 | 10 | 14 | 14 |
| **1.7** | 5 | 5 | 7 | 13 | 18 | 20 |
| **1.8** | 5 | 5 | 9 | 15 | 22 | 26 |
| **1.9** | 5 | 5 | 11 | 18 | 25 | 31 |
| **2** | 5 | 6 | 12 | 20 | 28 | 35 |
| **2.1** | Fail | 9 | 14 | 22 | 29 | 38 |
| **2.2** | Fail | 13 | 16 | 24 | 32 | 42 |
| **2.3** | Fail | Fail | 19 | 26 | 34 | 45 |
| **2.4** | Fail | Fail | 22 | 28 | 37 | 48 |
| **2.5** | Fail | Fail | 26 | 30 | 39 | 50 |
| **2.6** | Fail | Fail | Fail | 33 | 41 | Fail |
| **2.7** | Fail | Fail | Fail | 37 | 43 | Fail |
| **2.8** | Fail | Fail | Fail | 43 | 46 | Fail |
| **2.9** | Fail | Fail | Fail | Fail | 49 | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail |

Table 50. Platoon Loaded with Routine Traffic Safe Headway Table for Simple-Span Bridges (V, 100 Crossings, and ADTT=5000)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 6 | 5 |
| **1.4** | 5 | 5 | 5 | 9 | 14 | 13 |
| **1.5** | 5 | 5 | 7 | 14 | 20 | 23 |
| **1.6** | 5 | 5 | 10 | 18 | 25 | 32 |
| **1.7** | 5 | 5 | 12 | 21 | 31 | 39 |
| **1.8** | 5 | 7 | 17 | 25 | 34 | 46 |
| **1.9** | 5 | 10 | 23 | 31 | 39 | Fail |
| **2** | 5 | 13 | 27 | 39 | 47 | Fail |
| **2.1** | 5 | 15 | 32 | 45 | Fail | Fail |
| **2.2** | 7 | 18 | 36 | Fail | Fail | Fail |
| **2.3** | Fail | 22 | 40 | Fail | Fail | Fail |
| **2.4** | Fail | 29 | 45 | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.7** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.8** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.9** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail |

Table 51. Platoon Loaded with Routine Traffic Safe Headway Table for Simple-Span Bridges (+M and V, 100 Crossings, and ADTT=5000)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 6 | 5 |
| **1.4** | 5 | 5 | 5 | 9 | 14 | 13 |
| **1.5** | 5 | 5 | 7 | 14 | 20 | 23 |
| **1.6** | 5 | 5 | 10 | 18 | 25 | 32 |
| **1.7** | 5 | 5 | 12 | 21 | 31 | 39 |
| **1.8** | 5 | 7 | 17 | 25 | 34 | 46 |
| **1.9** | 5 | 10 | 23 | 31 | 39 | Fail |
| **2** | 5 | 13 | 27 | 39 | 47 | Fail |
| **2.1** | Fail | 15 | 32 | 45 | Fail | Fail |
| **2.2** | Fail | 18 | 36 | Fail | Fail | Fail |
| **2.3** | Fail | Fail | 40 | Fail | Fail | Fail |
| **2.4** | Fail | Fail | 45 | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.7** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.8** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.9** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail |

### 7.2.4 Interpretation

A single platoon can operate at a constant headway of 5 ft on all considered spans up to an $\alpha = 1.5$, or 150% of the legal load limit, without taking advantage of any reduction in uncertainty associated with platoon live load effects. This readily available overload capacity is a reflection of presumed capacities consistent with LRFD optimal design which includes HL-93, multiple-lane distribution factors and dynamic load allowance (IM = 0.33), which correspond to rating at the inventory level and a reliability index of $\beta = 3.5$. $\alpha$ was obtained from MCS with one-lane distribution factors adjusted to remove multiple presence effects and targeting the operating level reliability with a $\beta = 2.5$.

If the platoon operator is willing to adjust headways along the route to accommodate varying bridge lengths, vehicle weights can be increased by an additional 80% above the legal load limit, to 230%. Shorter spans can generally carry heavier platoon loads. If the route includes no simple-span bridges longer than 120 ft, the load can increase up to 260% of the legal limit, also without taking advantage of any reduced live load uncertainty. If a platoon route includes only 120-ft simple-span bridges, and the platoon $CoV$ can be reduced to 0.02 or less, it can operate up to 310% of the legal load limit for headways up to 50 ft.

With routine traffic in an adjacent lane, a platoon operating at a constant headway of 5 ft can traverse all considered spans with $\alpha$ up to 1.2, or 120% of the legal load limit, without taking advantage of any reduction in uncertainty. The presence of adjacent lane loading reduces the permissible increase above legal load by 30% (120% with adjacent lane loading versus 150% without). If the operator is willing to adjust headways along the route to accommodate varying bridge lengths, vehicle weights can increase up to 180% of the legal load limit with adjacent lane loading versus 230% without. If the route has no simple-span bridges longer than 150 ft, load can increase to 200% of the legal limit without taking advantage of any reduced live load uncertainty with adjacent lane loading versus 260% without. If a platoon route includes only 120-ft simple-span bridges, and the platoon *CoV* can be reduced to 0.08 or less, for headways up to 50 ft it can operate at up to 240% of the legal limit with adjacent lane loading versus up to 310% without. Additional headway tables are presented in Appendices.

### 7.3 Two-Span Bridges

As mentioned in Section 4.3, negative moment does not always decrease with increasing headway for two-span continuous bridges. Therefore, minimum and maximum headways must be satisfied. Two-span bridges with equal spans envelope other multiple-span situations. Hence, here only two-spans are considered.

#### 7.3.1 Single-Lane Platoon Without Adjacent Traffic

Figure 49 presents negative moments in a 120-ft two-span bridge by a three-truck platoon operating in a single lane and without adjacent lane traffic. The platoon amplified mean moment corresponding to the threshold of a target reliability, $\beta = 2.5$, with typical live load uncertainty, $CoV = 0.18$, is −2814 kip-ft. The safe headway range for amplification factors, $\alpha$, up to about 2.9 is 5 to 50 ft. For $\alpha = 3.2$, the range narrows to about 44 to 50 ft. When $\alpha$ increases above about 3.3, headways need to exceed 50 ft to maintain the target reliability (see Table 52). This condition is illustrated in Figure 49 for $\alpha = 3.6$, where all data points fall below the critical negative moment limit, but negative moment demands diminish with increasing headway. This study was limited to a 50 ft maximum considered headway based on the expectation that platoons are not likely to operate at larger headways where aerodynamic benefits become negligible. Table 52 provides minimum and maximum acceptable headway with respect to negative moment demands.

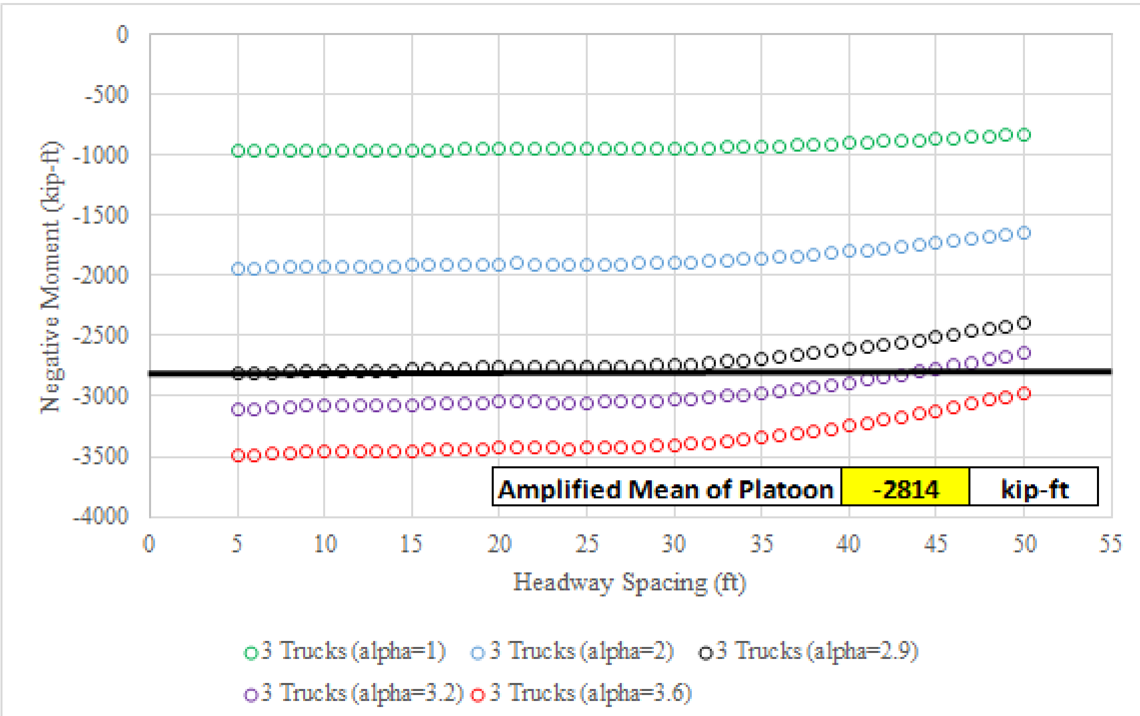



Figure 49. Negative Moments for Three-truck Platoons on 120-ft Two-Span Bridges

Middle support shears for two-span bridges reduce with increasing headways. As a result, only a single value for minimum headway needs to be provided for shear. Shear results in Table 53 are similar to Table 35 for simple-span bridges. Safe headways are determined from the envelope of two-span negative moment and middle support shear. Table 54 provides combined moment and shear headways. Similar to simple-spans, shear is found to primarily control for 120-ft two-span bridges.

Table 52. Single-lane Safe Headway Table for Two-Span 120 ft bridges (-M)

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.4** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.5** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.6** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.7** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.4** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.5** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.6** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.7** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 26\|50 |
| **3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 15\|50 | 34\|50 | 38\|50 |
| **3.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 20\|50 | 36\|50 | 40\|50 | 44\|50 |
| **3.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 17\|50 | 34\|50 | 37\|50 | 40\|50 | 44\|50 | 47\|50 |
| **3.3** | 6\|50 | 6\|50 | 10\|50 | 21\|50 | 32\|50 | 36\|50 | 40\|50 | 42\|50 | 44\|50 | 48\|50 | 49\|50 |
| **3.4** | 31\|50 | 32\|50 | 34\|50 | 36\|50 | 38\|50 | 41\|50 | 44\|50 | 46\|50 | 48\|50 | Fail | Fail |
| **3.5** | 38\|50 | 39\|50 | 40\|50 | 41\|50 | 42\|50 | 45\|50 | 47\|50 | 49\|50 | Fail | Fail | Fail |
| **3.6** | 42\|50 | 43\|50 | 43\|50 | 45\|50 | 46\|50 | 48\|50 | 50\|50 | Fail | Fail | Fail | Fail |
| **3.7** | 46\|50 | 45\|50 | 46\|50 | 47\|50 | 49\|50 | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.8** | 48\|50 | 49\|50 | 49\|50 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.9** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.1** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.2** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table 53. Single-lane Safe Headway Table for Two-Span 120 ft bridges (V)

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 |
| **1.7** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 8 | 11 |
| **1.8** | 5 | 5 | 5 | 5 | 5 | 6 | 8 | 9 | 10 | 12 | 14 |
| **1.9** | 5 | 6 | 6 | 7 | 9 | 10 | 11 | 12 | 14 | 15 | 16 |
| **2** | 9 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 17 | 18 | 19 |
| **2.1** | 12 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 24 | 27 |
| **2.2** | 15 | 15 | 16 | 16 | 17 | 18 | 20 | 24 | 27 | 31 | 35 |
| **2.3** | 18 | 18 | 18 | 19 | 20 | 23 | 27 | 30 | 34 | 38 | 42 |
| **2.4** | 20 | 22 | 23 | 25 | 27 | 31 | 34 | 37 | 40 | 43 | 46 |
| **2.5** | 28 | 28 | 30 | 32 | 34 | 37 | 40 | 42 | 46 | 49 | Fail |
| **2.6** | 34 | 34 | 35 | 38 | 40 | 42 | 45 | 48 | 50 | Fail | Fail |
| **2.7** | 40 | 40 | 41 | 43 | 45 | 47 | 50 | Fail | Fail | Fail | Fail |
| **2.8** | 44 | 45 | 46 | 48 | 49 | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.9** | 48 | 48 | 50 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.1** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.2** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.7** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.8** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.9** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.1** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.2** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table 54. Single-lane Safe Headway Table for Two-Span 120 ft bridges (-M and V)

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.4** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.5** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.6** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 |
| **1.7** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 8\|50 | 11\|50 |
| **1.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 8\|50 | 9\|50 | 10\|50 | 12\|50 | 14\|50 |
| **1.9** | 5\|50 | 6\|50 | 6\|50 | 7\|50 | 9\|50 | 10\|50 | 11\|50 | 12\|50 | 14\|50 | 15\|50 | 16\|50 |
| **2** | 9\|50 | 9\|50 | 10\|50 | 11\|50 | 12\|50 | 13\|50 | 14\|50 | 15\|50 | 17\|50 | 18\|50 | 19\|50 |
| **2.1** | 12\|50 | 12\|50 | 13\|50 | 14\|50 | 15\|50 | 16\|50 | 17\|50 | 18\|50 | 19\|50 | 24\|50 | 27\|50 |
| **2.2** | 15\|50 | 15\|50 | 16\|50 | 16\|50 | 17\|50 | 18\|50 | 20\|50 | 24\|50 | 27\|50 | 31\|50 | 35\|50 |
| **2.3** | 18\|50 | 18\|50 | 18\|50 | 19\|50 | 20\|50 | 23\|50 | 27\|50 | 30\|50 | 34\|50 | 38\|50 | 42\|50 |
| **2.4** | 20\|50 | 22\|50 | 23\|50 | 25\|50 | 27\|50 | 31\|50 | 34\|50 | 37\|50 | 40\|50 | 43\|50 | 46\|50 |
| **2.5** | 28\|50 | 28\|50 | 30\|50 | 32\|50 | 34\|50 | 37\|50 | 40\|50 | 42\|50 | 46\|50 | 49\|50 | Fail |
| **2.6** | 34\|50 | 34\|50 | 35\|50 | 38\|50 | 40\|50 | 42\|50 | 45\|50 | 48\|50 | 50\|50 | Fail | Fail |
| **2.7** | 40\|50 | 40\|50 | 41\|50 | 43\|50 | 45\|50 | 47\|50 | 50\|50 | Fail | Fail | Fail | Fail |
| **2.8** | 44\|50 | 45\|50 | 46\|50 | 48\|50 | 49\|50 | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.9** | 48\|50 | 48\|50 | 50\|50 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.1** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.2** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.7** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.8** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.9** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.1** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.2** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table 55 presents safe headways for three-truck platoons as a function of limiting negative moment at different span lengths, assuming $CoV = 0.18$. Maximum $\alpha$ tends to increase with span, because critical negative moment demands tend to occur with loads in adjacent spans spaced at distance approximately equal to the span length. The 50-ft headway upper limit adopted in this study constrains platoons to avoid maximum potential negative moments on long, two-span bridges.

A platoon with an $\alpha = 1.6$ can safely operate for negative moment on any span with any spacing between 5 and 50 ft. $\alpha$ can increase to 2.4 if the platoon operator is capable and willing to constrain headways to between 28 and 50 ft on 60 ft spans, and between 20 and 50 ft on 30 ft spans. If the minimum individual span on the route is 60 ft, $\alpha$ can increase to 3.0. However, the operator would need to ensure a headway of exactly 50 ft when crossing 60 ft spans. Headways could reduce to more aerodynamically favorable distances when crossing longer span bridges.

Table 55. Single-lane Safe Headway Table for Two-Span Bridges (-M, and *CoV*= 0.18)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.4** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.5** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.6** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.7** | 8\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.8** | 11\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.9** | 13\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2** | 15\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.1** | 16\|50 | 7\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.2** | 18\|50 | 10\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.3** | 19\|50 | 12\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.4** | 20\|50 | 28\|28 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.5** | Fail | 35\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.6** | Fail | 40\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.7** | Fail | 44\|50 | 16\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.8** | Fail | 46\|50 | 22\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.9** | Fail | 48\|50 | 25\|50 | 6\|50 | 5\|50 | 5\|50 |
| **3** | Fail | 50\|50 | 29\|50 | 34\|50 | 7\|50 | 5\|50 |
| **3.1** | Fail | Fail | 31\|50 | 40\|50 | 8\|50 | 5\|50 |
| **3.2** | Fail | Fail | 34\|45 | 44\|50 | 48\|50 | 5\|50 |
| **3.3** | Fail | Fail | Fail | 48\|50 | Fail | 9\|50 |
| **3.4** | Fail | Fail | Fail | Fail | Fail | 14\|50 |
| **3.5** | Fail | Fail | Fail | Fail | Fail | 18\|50 |
| **3.6** | Fail | Fail | Fail | Fail | Fail | 21\|50 |
| **3.7** | Fail | Fail | Fail | Fail | Fail | 25\|41 |
| **3.8** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.9** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4** | Fail | Fail | Fail | Fail | Fail | Fail |

Table 56 presents safe headways to limit middle support shear at different span lengths, assuming a $CoV = 0.18$. Maximum $\alpha$ tends to decrease with increasing span, because platoons can concentrate an unusually large number of heavy axles in shear-influential regions. As was observed for simple-span bridges, shear often imposed a more restrictive headway limit than negative moment.

For shear, a platoon with $\alpha = 1.6$ can operate on any span and with any spacing between 5 and 50 ft, a result consistent with negative moment. $\alpha$ can increase to 2.3 if the platoon operator is willing to increase headways to 48 ft on 200 ft spans, and between 20 and 50 ft on 30 ft spans. If the maximum individual span on the route is 90 ft, $\alpha$ can increase to 2.9.

Table 57 provides headway limitations imposed by both moments and shear. As noted previously for individual moment and shear results, a platoon can operate on any span and with any spacing between 5 and 50 ft up to an $\alpha = 1.6$. If a platoon route crosses two-span bridges with only 60 to 90 ft individual span lengths, $\alpha$ can increase up to 2.9, but the operator must maintain headways between 47 and 50 ft when crossing bridges. Cases where the maximum spacing was less than 50 ft were rare for negative moment, and these cases were not permissible for any headway when considering shear. The maximum spacing was therefore consistently identified as 50 ft in the table.

Table 56. Single-lane Safe Headway Table for Two-Span Bridges (V, and *CoV*= 0.18)

| α Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | s | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.7** | 5 | 5 | 5 | 8 | 12 | 9 |
| **1.8** | 5 | 5 | 6 | 12 | 17 | 18 |
| **1.9** | 5 | 5 | 8 | 15 | 21 | 25 |
| **2** | 5 | 5 | 11 | 18 | 26 | 32 |
| **2.1** | 5 | 7 | 18 | 24 | 29 | 38 |
| **2.2** | 5 | 10 | 22 | 31 | 33 | 43 |
| **2.3** | 5 | 12 | 26 | 38 | 43 | 48 |
| **2.4** | 5 | 14 | 30 | 43 | Fail | Fail |
| **2.5** | 5 | 16 | 34 | 49 | Fail | Fail |
| **2.6** | 5 | 18 | 38 | Fail | Fail | Fail |
| **2.7** | 5 | 24 | 40 | Fail | Fail | Fail |
| **2.8** | 7 | 29 | 44 | Fail | Fail | Fail |
| **2.9** | 12 | 41 | 47 | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.7** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.8** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.9** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4** | Fail | Fail | Fail | Fail | Fail | Fail |

Table 57. Single-lane Safe Headway Table for Two-Span Bridges (-M, V, and *CoV*= 0.18)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.4** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.5** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.6** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.7** | 8\|50 | 5\|50 | 5\|50 | 8\|50 | 12\|50 | 9\|50 |
| **1.8** | 11\|50 | 5\|50 | 6\|50 | 12\|50 | 17\|50 | 18\|50 |
| **1.9** | 13\|50 | 5\|50 | 8\|50 | 15\|50 | 21\|50 | 25\|50 |
| **2** | 15\|50 | 5\|50 | 11\|50 | 18\|50 | 26\|50 | 32\|50 |
| **2.1** | 16\|50 | 7\|50 | 18\|50 | 24\|50 | 29\|50 | 38\|50 |
| **2.2** | 18\|50 | 10\|50 | 22\|50 | 31\|50 | 33\|50 | 43\|50 |
| **2.3** | 19\|50 | 12\|50 | 26\|50 | 38\|50 | 43\|50 | 48\|50 |
| **2.4** | 20\|50 | 28\|50 | 30\|50 | 43\|50 | Fail | Fail |
| **2.5** | Fail | 35\|50 | 34\|50 | 49\|50 | Fail | Fail |
| **2.6** | Fail | 40\|50 | 38\|50 | Fail | Fail | Fail |
| **2.7** | Fail | 44\|50 | 40\|50 | Fail | Fail | Fail |
| **2.8** | Fail | 46\|50 | 44\|50 | Fail | Fail | Fail |
| **2.9** | Fail | 48\|50 | 47\|50 | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.7** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.8** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.9** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4** | Fail | Fail | Fail | Fail | Fail | Fail |

### 7.3.2 Fully-Correlated Platoons, Adjacent Lanes

Table 58 presents minimum headways that ensure safe negative moments for a two-span bridge with individual spans of 120-ft and carrying two lanes of identical three-truck platoons. Similar to the single-lane, platoon-only loading scenario, consideration of two adjacent platoons establishes an upper bound for platoon load effects. Comparison of Table 58 to Table 52 indicates that minimum headway for the two-lane, fully-correlated load case is more restrictive than for the single-lane loaded case as the maximum critical amplification for a *CoV* = 0 reduces from 4.1 to 2.2. Table 59 presents headways for middle support shear. Again, shear further restricts safe minimum headways for two-lane, fully-correlated platoons. Table 60 provides the combined moments and shear headway table and is primarily governed by shear limitations.

Table 58. Two-Lanes Fully Correlated Safe Headway Table for Two-Span 120-ft bridges (-M)

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.4** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.5** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.6** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 9\|50 |
| **1.7** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 18\|50 | 34\|50 | 39\|50 |
| **1.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 16\|50 | 34\|50 | 38\|50 | 40\|50 | 44\|50 | 46\|50 |
| **1.9** | 21\|50 | 28\|50 | 31\|50 | 34\|50 | 36\|50 | 40\|50 | 43\|50 | 45\|50 | 48\|50 | 50\|50 | Fail |
| **2** | 40\|50 | 40\|50 | 42\|50 | 43\|50 | 45\|50 | 46\|50 | 48\|50 | 50\|50 | Fail | Fail | Fail |
| **2.1** | 46\|50 | 46\|50 | 47\|50 | 48\|50 | 50\|50 | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table 59. Two-Lanes Fully Correlated Safe Headway Table for Two-Span 120-ft bridges (V)

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 8 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 9 | 10 | 12 | 13 |
| **1.3** | 7 | 8 | 8 | 9 | 10 | 11 | 13 | 14 | 15 | 17 | 18 |
| **1.4** | 12 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 24 | 28 |
| **1.5** | 16 | 17 | 17 | 18 | 18 | 20 | 23 | 27 | 31 | 35 | 38 |
| **1.6** | 20 | 21 | 23 | 24 | 28 | 30 | 34 | 37 | 40 | 43 | 46 |
| **1.7** | 31 | 32 | 32 | 34 | 36 | 40 | 43 | 46 | 48 | Fail | Fail |
| **1.8** | 40 | 40 | 41 | 43 | 45 | 47 | 50 | Fail | Fail | Fail | Fail |
| **1.9** | 47 | 48 | 48 | 49 | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.1** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table 60. Two-Lanes Fully Correlated Safe Headway Table for Two-Span 120-ft bridges (-M and V)

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 8\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 7\|50 | 9\|50 | 10\|50 | 12\|50 | 13\|50 |
| **1.3** | 7\|50 | 8\|50 | 8\|50 | 9\|50 | 10\|50 | 11\|50 | 13\|50 | 14\|50 | 15\|50 | 17\|50 | 18\|50 |
| **1.4** | 12\|50 | 12\|50 | 13\|50 | 14\|50 | 15\|50 | 16\|50 | 17\|50 | 18\|50 | 19\|50 | 24\|50 | 28\|50 |
| **1.5** | 16\|50 | 17\|50 | 17\|50 | 18\|50 | 18\|50 | 20\|50 | 23\|50 | 27\|50 | 31\|50 | 35\|50 | 38\|50 |
| **1.6** | 20\|50 | 21\|50 | 23\|50 | 24\|50 | 28\|50 | 30\|50 | 34\|50 | 37\|50 | 40\|50 | 43\|50 | 46\|50 |
| **1.7** | 31\|50 | 32\|50 | 32\|50 | 34\|50 | 36\|50 | 40\|50 | 43\|50 | 46\|50 | 48\|50 | Fail | Fail |
| **1.8** | 40\|50 | 40\|50 | 41\|50 | 43\|50 | 45\|50 | 47\|50 | 50\|50 | Fail | Fail | Fail | Fail |
| **1.9** | 47\|50 | 48\|50 | 48\|50 | 49\|50 | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.1** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Tables 61 to 63 present safe headways for negative moment, middle support shear, and combined positive and negative moments and shear for different span lengths, assuming a *CoV* = 0.18. As expected, trends of controlling mechanisms are similar to those observed for single-lane, platoon-only loading. The difference is only a scale factor on *α* reflecting the difference of multi- versus single-lane GDFs.

Table 61. Two-Lanes Fully-Correlated Safe Headway Table for Two-Span Bridges (-M, and *CoV*= 0.18)

| **α \ Span** | **30 ft** | **60 ft** | **90 ft** | **120 ft** | **150 ft** | **200 ft** |
|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 9\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 13\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 16\|50 | 9\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.4** | 18\|50 | 13\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.5** | 19\|50 | 36\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.6** | Fail | 42\|50 | 20\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.7** | Fail | 47\|50 | 27\|50 | 34\|50 | 8\|50 | 5\|50 |
| **1.8** | Fail | 50\|50 | 32\|50 | 44\|50 | Fail | 11\|50 |
| **1.9** | Fail | Fail | Fail | 50\|50 | Fail | 17\|50 |
| **2** | Fail | Fail | Fail | Fail | Fail | 25\|34 |
| **2.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail |

Table 62. Two-Lanes Fully-Correlated Safe Headway Table for Two-Span Bridges (V, and *CoV*= 0.18)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 6 | 9 | 5 |
| **1.2** | 5 | 5 | 6 | 12 | 17 | 17 |
| **1.3** | 5 | 5 | 9 | 17 | 23 | 29 |
| **1.4** | 5 | 7 | 17 | 24 | 29 | 38 |
| **1.5** | 5 | 11 | 25 | 35 | 37 | 46 |
| **1.6** | 5 | 14 | 31 | 43 | Fail | Fail |
| **1.7** | 5 | 17 | 36 | Fail | Fail | Fail |
| **1.8** | 5 | 24 | 41 | Fail | Fail | Fail |
| **1.9** | 10 | 35 | 46 | Fail | Fail | Fail |
| **2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail |

Table 63. Two-Lanes Fully-Correlated Safe Headway Table for Two-Span Bridges (-M, V, and *CoV*= 0.18)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 9\|50 | 5\|50 | 5\|50 | 6\|50 | 9\|50 | 5\|50 |
| **1.2** | 13\|50 | 5\|50 | 6\|50 | 12\|50 | 17\|50 | 17\|50 |
| **1.3** | 16\|50 | 9\|50 | 9\|50 | 17\|50 | 23\|50 | 29\|50 |
| **1.4** | 18\|50 | 13\|50 | 17\|50 | 24\|50 | 29\|50 | 38\|50 |
| **1.5** | 19\|50 | 36\|50 | 25\|50 | 35\|50 | 37\|50 | 46\|50 |
| **1.6** | Fail | 42\|50 | 31\|50 | 43\|50 | Fail | Fail |
| **1.7** | Fail | 47\|50 | 36\|50 | Fail | Fail | Fail |
| **1.8** | Fail | 50\|50 | 41\|50 | Fail | Fail | Fail |
| **1.9** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail |

### 7.3.3 Single-Lane Platoon, Routine Traffic in Adjacent Lane

Single-lane and two-lane, fully-correlated platoons established lower- and upper-headway limits and, therefore, envelope headway requirements for one lane of platoon vehicles adjacent to routine traffic. Tables 64 to 66 provide minimum headways when adjacent lane loading is present for negative moment, end shear, and combined consideration of moment and shear. Results were obtained assuming 100 platoon crossings per day over a bridge with an ADTT of 5000. Comparison to the single-lane and two-lanes, fully-correlated results shown previously confirms this scenario was bounded by the platoon-only cases. Ultimately, shear governs all critical minimum headways in Table 66. All restrictions on maximum headway based on negative moment were superseded by the study scope limit of 50 ft.

Table 64. Platoon with Routine Traffic Safe Headway Table for Two-Span 120 ft Bridges (-M, 100 Crossings, and ADTT=5000)

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.4** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.5** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.6** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.7** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 12\|50 | 33\|50 | 35\|50 |
| **2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 8\|50 | 20\|50 | 32\|50 | 37\|50 | 40\|50 | 41\|50 | 43\|50 |
| **2.1** | 35\|50 | 34\|50 | 36\|50 | 37\|50 | 39\|50 | 41\|50 | 43\|50 | 44\|50 | 46\|50 | 47\|50 | 48\|50 |
| **2.2** | 42\|50 | 41\|50 | 42\|50 | 44\|50 | 44\|50 | 46\|50 | 48\|50 | 49\|50 | Fail | Fail | Fail |
| **2.3** | 48\|50 | 48\|50 | 48\|50 | 49\|50 | 49\|50 | 50\|50 | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table 65. Platoon with Routine Traffic Safe Headway Table for Two-Span 120 ft Bridges (V, 100 Crossings, and ADTT=5000)

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 8 | 9 | 11 | 12 |
| **1.5** | 7 | 7 | 7 | 8 | 9 | 10 | 11 | 13 | 14 | 15 | 16 |
| **1.6** | 11 | 11 | 12 | 12 | 13 | 14 | 16 | 16 | 17 | 18 | 20 |
| **1.7** | 15 | 15 | 16 | 16 | 17 | 17 | 19 | 20 | 24 | 25 | 29 |
| **1.8** | 18 | 18 | 19 | 19 | 20 | 23 | 27 | 30 | 34 | 36 | 39 |
| **1.9** | 24 | 25 | 25 | 27 | 30 | 33 | 36 | 38 | 40 | 43 | 47 |
| **2** | 33 | 34 | 35 | 36 | 38 | 40 | 41 | 45 | 47 | 50 | Fail |
| **2.1** | 40 | 40 | 42 | 43 | 45 | 47 | 49 | 50 | Fail | Fail | Fail |
| **2.2** | 46 | 46 | 47 | 49 | 50 | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table 66. Platoon with Routine Traffic Safe Headway Table for Two-Span 120 ft Bridges (-M and V, 100 Crossings, and ADTT=5000)

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 7\|50 |
| **1.4** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 7\|50 | 8\|50 | 9\|50 | 11\|50 | 12\|50 |
| **1.5** | 7\|50 | 7\|50 | 7\|50 | 8\|50 | 9\|50 | 10\|50 | 11\|50 | 13\|50 | 14\|50 | 15\|50 | 16\|50 |
| **1.6** | 11\|50 | 11\|50 | 12\|50 | 12\|50 | 13\|50 | 14\|50 | 16\|50 | 16\|50 | 17\|50 | 18\|50 | 20\|50 |
| **1.7** | 15\|50 | 15\|50 | 16\|50 | 16\|50 | 17\|50 | 17\|50 | 19\|50 | 20\|50 | 24\|50 | 25\|50 | 29\|50 |
| **1.8** | 18\|50 | 18\|50 | 19\|50 | 19\|50 | 20\|50 | 23\|50 | 27\|50 | 30\|50 | 34\|50 | 36\|50 | 39\|50 |
| **1.9** | 24\|50 | 25\|50 | 25\|50 | 27\|50 | 30\|50 | 33\|50 | 36\|50 | 38\|50 | 40\|50 | 43\|50 | 47\|50 |
| **2** | 33\|50 | 34\|50 | 35\|50 | 36\|50 | 38\|50 | 40\|50 | 41\|50 | 45\|50 | 47\|50 | 50\|50 | Fail |
| **2.1** | 40\|50 | 40\|50 | 42\|50 | 43\|50 | 45\|50 | 47\|50 | 49\|50 | 50\|50 | Fail | Fail | Fail |
| **2.2** | 46\|50 | 46\|50 | 47\|50 | 49\|50 | 50\|50 | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Tables 67 to 69 present safe headways for positive moment, middle support shear, and combined moment and shear for different span lengths, assuming a *CoV* = 0.18. Minimum headways for smaller span lengths considered in the parametric study tended to be governed by moment, whereas longer span lengths tended to be governed by shear.

Table 67. Platoon with Routine Traffic Safe Headway Table for Two-Span Bridges (-M, 100 Crossings, and ADTT=5000)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.4** | 9\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.5** | 13\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.6** | 15\|50 | 8\|50 | 16\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.7** | 17\|50 | 12\|50 | 25\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.8** | 18\|50 | 29\|50 | 30\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.9** | 19\|50 | 37\|50 | 34\|39 | 33\|50 | 5\|50 | 5\|50 |
| **2** | Fail | 42\|50 | Fail | 41\|50 | 8\|50 | 5\|50 |
| **2.1** | Fail | 46\|50 | Fail | 47\|50 | Fail | 5\|50 |
| **2.2** | Fail | 49\|50 | Fail | Fail | Fail | 12\|50 |
| **2.3** | Fail | Fail | Fail | Fail | Fail | 17\|50 |
| **2.4** | Fail | Fail | Fail | Fail | Fail | 22\|50 |
| **2.5** | Fail | Fail | Fail | Fail | Fail | 25\|25 |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table 68. Platoon with Routine Traffic Safe Headway Table for Two-Span Bridges (V, 100 Crossings, and ADTT=5000)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 6 | 9 | 5 |
| **1.4** | 5 | 5 | 5 | 11 | 16 | 15 |
| **1.5** | 5 | 5 | 7 | 15 | 23 | 25 |
| **1.6** | 5 | 5 | 13 | 18 | 27 | 35 |
| **1.7** | 5 | 8 | 19 | 25 | 32 | 41 |
| **1.8** | 5 | 11 | 25 | 36 | 40 | 47 |
| **1.9** | 5 | 13 | 30 | 43 | Fail | Fail |
| **2** | 5 | 16 | 34 | 50 | Fail | Fail |
| **2.1** | 5 | 21 | 38 | Fail | Fail | Fail |
| **2.2** | 8 | 28 | 43 | Fail | Fail | Fail |
| **2.3** | 23 | 38 | 47 | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table 69. Platoon with Routine Traffic Safe Headway Table for Two-Span Bridges (-M and V, 100 Crossings, and ADTT=5000)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 9\|50 | 5\|50 |
| **1.4** | 9\|50 | 5\|50 | 5\|50 | 11\|50 | 16\|50 | 15\|50 |
| **1.5** | 13\|50 | 5\|50 | 7\|50 | 15\|50 | 23\|50 | 25\|50 |
| **1.6** | 15\|50 | 8\|50 | 16\|50 | 18\|50 | 27\|50 | 35\|50 |
| **1.7** | 17\|50 | 12\|50 | 25\|50 | 25\|50 | 32\|50 | 41\|50 |
| **1.8** | 18\|50 | 29\|50 | 30\|50 | 36\|50 | 40\|50 | 47\|50 |
| **1.9** | 19\|50 | 37\|50 | 34\|39 | 43\|50 | Fail | Fail |
| **2** | Fail | 42\|50 | Fail | 50\|50 | Fail | Fail |
| **2.1** | Fail | 46\|50 | Fail | Fail | Fail | Fail |
| **2.2** | Fail | 49\|50 | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |

### 7.3.4 Interpretation

A single platoon operating at a constant headway of 5 ft can traverse all considered spans only up to an $\alpha$ = 1.6, or 160% of the legal limit, without taking advantage of any reduction in uncertainty associated with those loads. Similar to the simple-span case, this readily available overload capacity is a reflection of presumed capacities consistent with LRFD optimal design which includes HL93, multiple-lane distribution factors and dynamic load allowance (IM = 0.33), which correspond to rating at the inventory level and a reliability index of $\beta$ = 3.5. The amplification factor, $\alpha$, was obtained from MCS with one-lane distribution factors adjusted to remove multiple presence effects and targeting the operating level reliability with a $\beta$ = 2.5.

If the operator is willing to adjust headways along the route to accommodate varying bridge lengths, vehicle weights can be increased by an additional 70% above the legal limit, to

230%. A range of shorter spans can carry heavier platoon loads. If the route includes two-span bridges with spans only between 60 and 90 ft, the load can increase up to 290% of the legal limit, without needing to take advantage of any reduced live load uncertainty. If a platoon route includes 120-ft simple-span bridges, and the *CoV* can be reduced to 0.16 or less, it can also operate under these conditions up to 260% of the legal limit with headways of at least 50 ft. Note that the results of this study require a headway of exactly 50 ft in this case because this value was the maximum considered headway in analyses, but larger headways may also be safe.

With routine traffic in an adjacent lane, a platoon operating at a constant headway of 5 ft can traverse all considered spans to an $\alpha = 1.2$, or 120% of the legal load limit, without needing to take advantage of any reduction in uncertainty associated with the loads. The presence of adjacent lane loading reduces the permissible increase above legal load by 40% (120% with adjacent lane loading versus 160% without). If the operator is willing to adjust headways along the route to accommodate varying bridge lengths, vehicle weights can increase to 180% above the load limit with adjacent lane loading versus 230% without. If the route includes only two-span continuous bridges with spans equal or lesser than 120 ft, the load can increase up to 190% of the legal load limit with adjacent lane loading versus 240% without, also without taking advantage of any reduced live load uncertainty. If a platoon having headways up to 50 ft travels across 120-ft two-span bridges, and the platoon CoV can be reduced to 0.08 or less, it can operate under these conditions up to 220% of the legal load limit with adjacent lane loading versus 280% without. Additional headway tables are presented in Appendices.

## 7.4 Preliminary Operational Guidance

Initial platoon deployments are expected to be limited to vehicles operating within the FBF legal load limit, corresponding to $\alpha$ equal to one in the present study, and without any benefits realized from reduced load uncertainty. This section seeks to address this set of considerations and facilitate practical next steps for operational platoon deployment.

At the operating level ($\beta_{\text{target}} = 2.5$) for $\alpha$ equal to one and $CoV$ equal to 0.18, a minimum headway of 5 ft is acceptable for all bridge configurations and platoon configurations and loading scenarios. Supporting data is available in Tables 36, 39, 42, 45, 48, 51, 54, 57, 60, 63, 66, and 69, with supplemental data in Appendices. At the inventory level, any headway between 5 and 50 ft is acceptable for all bridge configurations and platoon configurations only for the single-lane, platoon-only loading scenario ($\beta_{\text{target}} = 3.5$).

Table 70 and Table 71 present general guidance to satisfy inventory level target reliability for steel and prestressed concrete simple-span bridges subjected to two-lane, fully-correlated platoons and platoons operating adjacent to routine traffic, assuming 100 platoon crossings per day and bridges carrying an ADTT of 5000. The case with two adjacent platoons is most restrictive but could be avoided via operational management using scheduling and vehicle GPS tracking. The case with adjacent routine traffic, which allows platoons to operate without regard to the presence or absence of adjacent routine heavy trucks, is expected to be of immediate practical importance. For the case with adjacent routine traffic, no restrictions are necessary for two-truck platoons. Three-truck platoons would need to comply with these headway requirements: at least 7 ft for 150-ft steel girder bridges; at least 12 ft for 150-ft prestressed concrete girder bridges; and at least 9 ft for 200-ft steel girder bridges. Simple-span bridges less than 150 ft do not have platooning headway restrictions at or below the legal load limit.

Table 70. Legal Load Platoon Inventory Level Restrictions for Steel, Simple-Span Bridges

| Load Conditions | Three-Truck Platoons | | | Two-Truck Platoons | | |
|---|---|---|---|---|---|---|
| | Moment | Shear | Combine | Moment | Shear | Combine |
| **Single-Lane Platoon** | NA | NA | NA | NA | NA | NA |
| **Two-Lanes Fully Correlated** | 90 ft: $H > 6$ ft<br>120 ft: $H > 12$ ft<br>150 ft: $H > 20$ ft<br>200 ft: $H > 23$ ft | 90 ft: $H > 7$ ft<br>120 ft: $H > 15$ ft<br>150 ft: $H > 20$ ft<br>200 ft: $H >$ 29ft | 90 ft: $H > 7$ ft<br>120 ft: $H > 15$ ft<br>150 ft: $H > 20$ ft<br>200 ft: $H >$ 29ft | NA | NA | NA |
| **Platoon & Routine Traffic (100 Crossings, ADTT 5000)** | 150 ft: H > 6 ft<br>200 ft: $H > 9$ ft | 150 ft: H > 7 ft<br>200 ft: $H > 9$ ft | 150 ft: H > 7 ft<br>200 ft: $H > 9$ ft | NA | NA | NA |

Table 71. Legal Load Platoon Inventory Level Restrictions for Prestressed Concrete, Simple-Span Bridges

| Load Conditions | Three-Truck Platoons | | | Two-Truck Platoons | | |
|---|---|---|---|---|---|---|
| | Moment | Shear | Combine | Moment | Shear | Combine |
| **Single-Lane Platoon** | NA | NA | NA | NA | NA | NA |
| **Two-Lanes Fully Correlated** | 90 ft: $H > 6$ ft<br>120 ft: $H > 9$ ft<br>150 ft: $H > 15$ ft | 90 ft: $H > 6$ ft<br>120 ft: $H > 14$ ft<br>150 ft: $H > 21$ ft | 90 ft: $H > 6$ ft<br>120 ft: $H > 14$ ft<br>150 ft: $H > 21$ ft | NA | NA | NA |
| **Platoon & Routine Traffic (100 Crossings, ADTT 5000)** | 150 ft: $H > 12$ ft | 150 ft: $H >$12 ft | 150 ft: $H >$12 ft | NA | NA | NA |

Table 72 and Table 73 present general guidance to satisfy inventory level target reliability for steel and prestressed concrete two-span continuous bridges subjected to two-lane, fully-correlated platoons and platoons operating adjacent to routine traffic, assuming 100 platoon crossings per day and bridges carrying an ADTT of 5000. Again, the case with two adjacent platoons is more restrictive, but could potentially be avoided through platoon management protocols. For the case with adjacent routine traffic, no restrictions are necessary for two-truck or three-truck platoons. Four-truck platoons would need to comply with headway requirements indicated in the tables. Even the most severe restriction of a minimum 36 ft headway may still offer aerodynamic efficiency. A platoon could still operate at shorter headways between bridges.

### 7.5 Summary

This chapter summarizes an investigation of safe headways, as influenced by platoon vehicle weight, platoon live load effect uncertainty, and span length. For simple spans, critical loading occurs with closely grouped vehicles, so permitted truck weight can increase with increasing headway. However, the two-span M- case is fundamentally different and must consider headways that create critical loading with vehicles located in adjacent spans. This becomes obvious with review of influence lines for M- at the interior support and M+ for simple-span bridges. Owners or operators may desire to employ adaptive headway strategies, particularly if doing so becomes a trivial matter in the future with advances in controls and technologies. This research provides a rigorous approach to develop simple or involved operational strategies.

Table 72. Steel Two-Span Bridge Legal Load Platoon Inventory Level Guidance

| Load Conditions | Four-Truck Platoons | | | Three-Truck Platoons | | | Two-Truck Platoons | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Moment** | **Shear** | **Combine** | **Moment** | **Shear** | **Combine** | **Moment** | **Shear** | **Combine** |
| **Single-Lane Platoon** | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **Two-Lanes Fully Correlated** | 30 ft: $H > 14$ ft<br>60 ft: $H > 8$ ft<br>90 ft: $H > 14$ ft<br>120 ft: $H > 23$ ft<br>150 ft: $H > 36$ ft<br>200 ft: 29 ft > $H$ > 7ft | 90 ft: $H > 10$ ft<br>120 ft: $H > 17$ ft<br>150 ft: $H > 25$ ft<br>200 ft: $H > 31$ ft | 90 ft: $H > 14$ ft<br>120 ft: $H > 23$ ft<br>150 ft: $H > 36$ ft<br>200 ft: *Fail* | 30 ft: $H > 13$ ft<br>60 ft: $H > 6$ ft | 90 ft: $H > 8$ ft<br>120 ft: $H > 13$ ft<br>150 ft: $H > 22$ ft<br>200 ft: $H > 29$ ft | 30 ft: $H > 13$ ft<br>60 ft: $H > 6$ ft<br>90 ft: $H > 8$ ft<br>120 ft: $H > 13$ ft<br>150 ft: $H > 22$ ft<br>200 ft: $H > 29$ ft | 30 ft: $H > 13$ ft | NA | 30 ft: $H > 13$ ft |
| **Platoon & Routine Traffic (100 Crossings, ADTT 5000)** | 90 ft: $H > 13$ ft<br>120 ft: $H > 8$ ft<br>150 ft: *10 ft > H > 6 ft, or H > 31 ft* | 90 ft: H > 10 ft<br>120 ft: $H > 10$ ft<br>150 ft: $H > 16$ ft<br>200 ft: $H > 25$ ft | 90 ft: H > 13 ft<br>120 ft: $H > 10$ ft<br>150 ft: $H > 31$ ft<br>200 ft: $H > 25$ ft | NA | NA | NA | NA | NA | NA |

Table 73. Prestressed Concrete Two-Span Bridge Legal Load Platoon Inventory Level Guidance

| Load Conditions | Four-Truck Platoons | | | Three-Truck Platoons | | | Two-Truck Platoons | | |
|---|---|---|---|---|---|---|---|---|---|
| | Moment | Shear | Combine | Moment | Shear | Combine | Moment | Shear | Combine |
| **Single-Lane Platoon** | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **Two-Lanes Fully Correlated** | 30 ft: $H$ > 14 ft<br>60 ft: $H$ > 9 ft<br>90 ft: $H$ > 15 ft<br>120 ft: $H$ > 24 ft<br>150 ft: 12 ft > $H$ > 5 ft, $H$ > 30 ft | 90 ft: $H$ > 8 ft<br>120 ft: $H$ > 16 ft<br>150 ft: $H$ > 22 ft | 90 ft: $H$ > 15ft<br>120 ft: $H$ > 24 ft<br>150 ft: $H$ > 30 ft | 30 ft: $H$ > 14 ft<br>60 ft: $H$ > 7 ft | 90 ft: $H$ > 6 ft<br>120 ft: $H$ > 13 ft<br>150 ft: $H$ > 18 ft | 30 ft: $H$ > 14 ft<br>60 ft: $H$ > 7 ft<br>90 ft: $H$ > 15ft<br>120 ft: $H$ > 24 ft<br>150 ft: $H$ > 30 ft | 30 ft: $H$ > 14 ft | NA | 30 ft: $H$ > 14 ft |
| **Platoon & Routine Traffic (100 Crossings, ADTT 5000)** | 90 ft: $H$ > 14 ft | 120 ft: $H$ > 6 ft<br>150 ft: $H$ > 13 ft | 90 ft: $H$ > 14 ft<br>120 ft: $H$ > 6 ft<br>150 ft: $H$ > 13 ft | NA | NA | NA | NA | NA | NA |

# 8 NEBRASKA LEGAL LOAD PLATOONS

## 8.1 Overview

Nebraska-specific legal loads were reviewed. Analysis results for NE legal load platoon live load moment and shear effects are presented for simple- and two-span bridges subjected to NE Type 3-3 loadings. Guidance is provided for an amplification factor, $\alpha$, equal to 1.0 and $CoV = 0.18$ to account for NE Type 3-3 trucks in addition to NJTA 3S2 and NRL vehicles.

## 8.2 Nebraska Legal Loads

This research primarily considered live load effect envelopes including AASHTO Type 3-3, FHWA Class 9, NJTA Type 3S2, and NRL vehicles to establish critical $\alpha$ and $\gamma_{platoon}$ values. Nebraska load rates for seven types of legal trucks. Special Hauling Vehicles (SHVs) SU4, SU5, SU6, and SU7 for load rating in Nebraska are the same as shown in Chapter 2. The NE Type 3 truck, shown in Figure 50, is consistent with the AASHTO Type 3, and has a GVW of 50 kips. This vehicle's live load effects lie within the envelopes considered throughout the project. NE Type 3S2 and Type 3-3 axle weights differ from AASHTO according to the NDOT Bridge Inspection Program Manual (BIPM) (NDOT, 2018), with configurations shown in Figure 51 and Figure 52, respectively. The GVW of a NE Type 3S2 is 74 kips, which is less than the NJTA Type 3S2 (HNTB, 2016) used primarily in this research. However, the GVW of a NE Type 3-3 is 86 kips which is greater than the AASHTO Type 3-3. The NRL generally envelopes

SHV load effects. Therefore, the NE Type 3-3 is the only state-specific legal truck that might cause load effects outside the envelopes used primarily throughout this research.

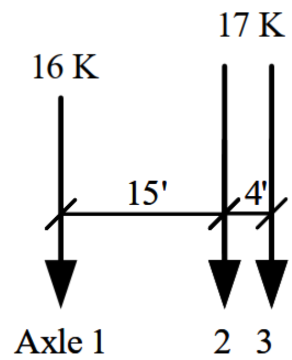



Figure 50. Nebraska Type 3 Configuration (AASHTO, 2018)

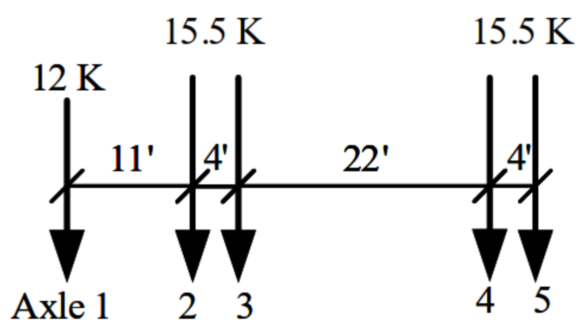



Figure 51. Nebraska Type 3S2 Configuration (NDOT, 2018)

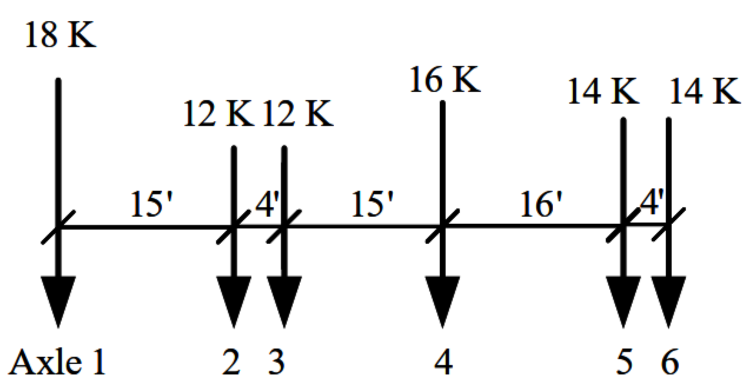



Figure 52. Nebraska Type 3-3 Configuration (NDOT, 2018)

Simple-span positive moments and end shears for NE Type 3-3 platoons with up to three trucks were calculated using influence lines as discussed in Chapter 3. Constant headway scenarios ranged from 5 to 50 ft. Figure 25 shows ratios of NE Type 3-3 load effects to previously developed load effect envelopes. The NE Type 3-3 load effects lie within the prior envelopes for all simple-span lengths.

For two-span bridges, negative moment ratios between four-truck NE Type 3-3 and four-truck load effect envelopes are presented in Figure 54. Data points with values less than 100% indicate that the vehicle's load effects are less severe than prior load effect envelopes. The prior envelope governs negative moments for most cases. However, the NE Type 3-3 governs two-span negative moments between 5 and 7 ft headways for 150-ft spans and between 7 and 31 ft headways 200-ft spans. The prior envelope governs for middle-support shears.

Cases for which the NE Type 3-3 governs for negative moments are summarized below:

Two-Truck Platoons:

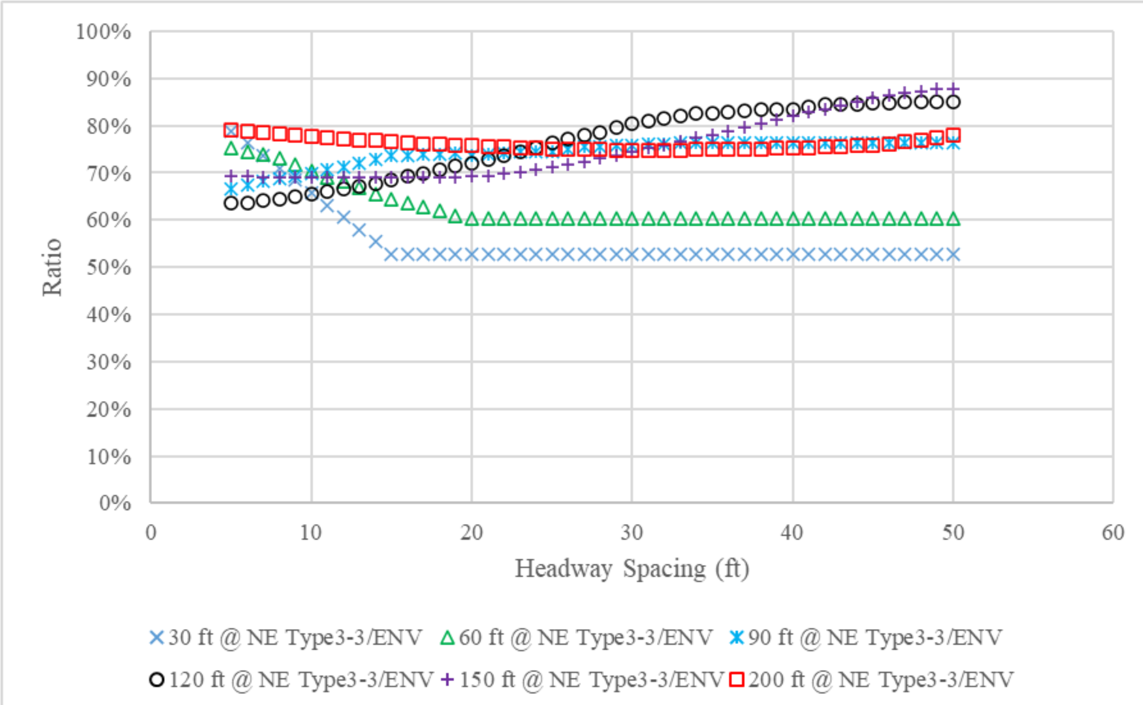
- 120-ft bridges: 16 ft < H < 44 ft
- 150-ft bridges: 26 ft < H < 50 ft
- 200-ft bridges: 44 ft < H < 50 ft

Three-Truck Platoons:

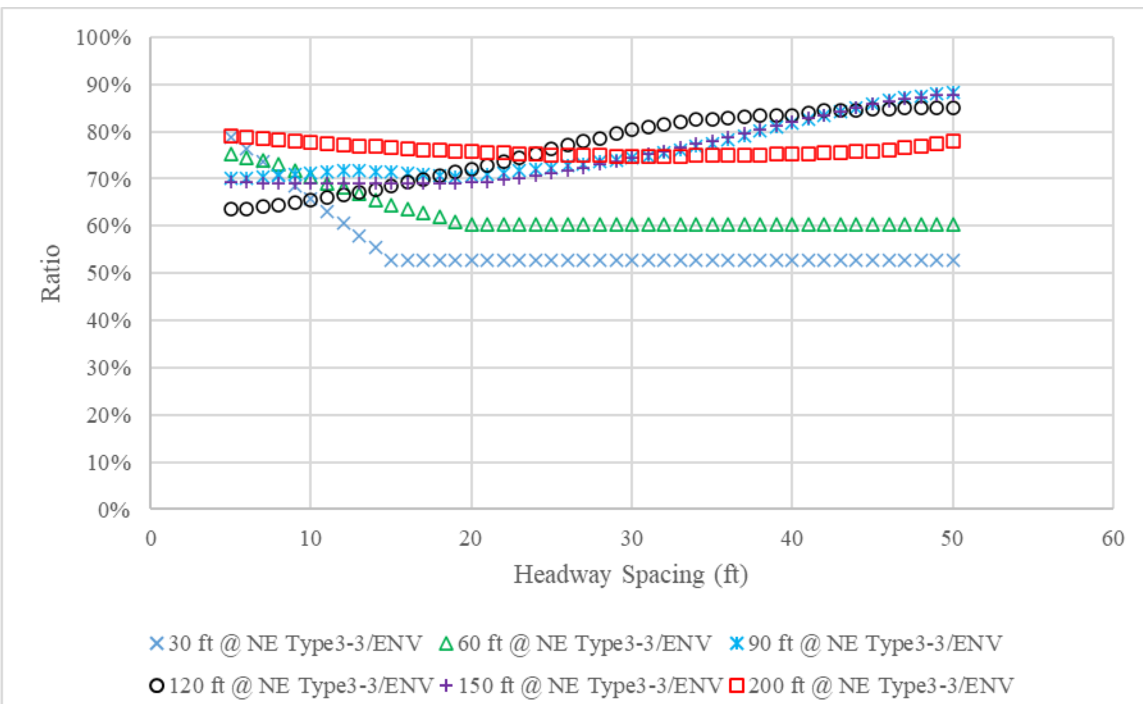
- 120-ft bridges: 5 ft < H < 15 ft
- 150-ft bridges: 5 ft < H < 31 ft
- 200-ft bridges: 20 ft < H < 50 ft

Four-Truck Platoons:

- 150-ft bridges: 5 ft < H < 7 ft
- 200-ft bridges: 7 ft < H < 31 ft

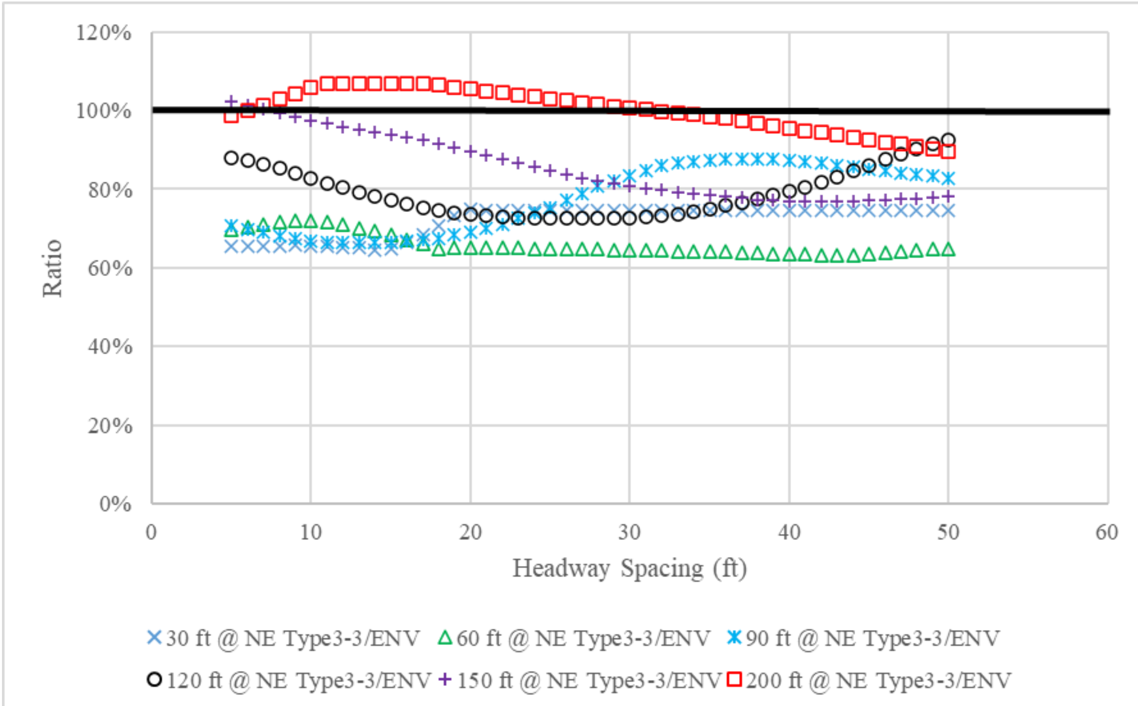



[a] Positive Moments

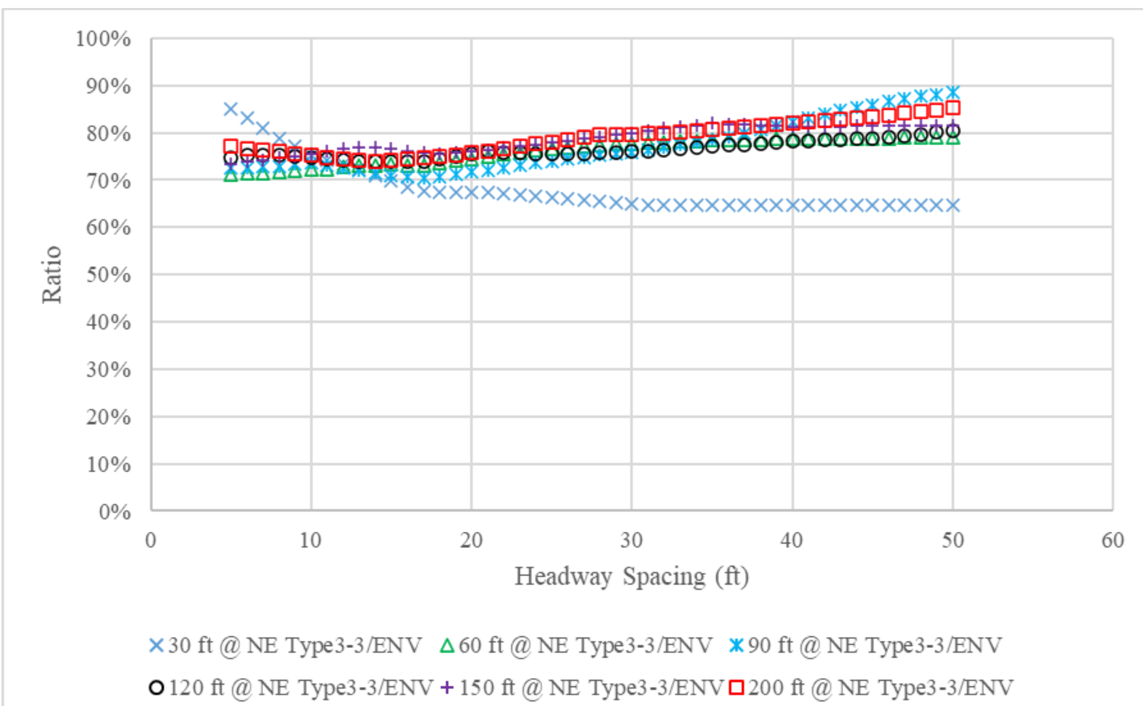



[b] End Shear

Figure 53. Simple Span Bridge Positive Moments and End-Shears for Three-Truck Platoons at Various Headways




[a] Negative Moments




[b] Middle Support Shear

Figure 54. Two-Span Bridge Negative Moments and Middle-Support Shears for Four-Truck Platoons at Various Headways

### 8.3 Preliminary Operational Guidance

Nebraska state legal vehicles at GVW limits may safely operate in any platoon scenario with any headway between 5 and 50 ft on all bridge configurations at the operating level ($\beta_{\text{target}} = 2.5$). At the inventory level ($\beta_{\text{target}} = 3.5$), any headway between 5 and 50 ft is acceptable for

- all bridge configurations carrying a single-lane platoon without adjacent traffic,
- simple-span bridges carrying two lanes of fully-correlated platoons,
- simple-span bridges carrying a platoon with routine traffic in an adjacent lane,
- two-span bridges carrying a two-truck platoon with routine traffic in an adjacent lane,
- two-span bridges carrying a three-truck platoon with routine traffic in an adjacent lane, and
- two-span, prestressed concrete bridges carrying a four-truck platoon with routine traffic in an adjacent lane.

Additional restrictions for two-span bridges carrying two-lanes, fully-correlated, or single-lane platoon loading with adjacent routine traffic are provided in **Error! Reference source not found.** and **Error! Reference source not found.**. Restrictions are only required for spans 150 ft and greater. This guidance was obtained using *CoV* equal to 0.18 for platoon live loads, and assuming 100 platoon crossings per day on bridges carrying an ADTT of 5000 to estimate maximum adjacent lane load effects.

Table 74. Nebraska Legal Load Platoon Restrictions for Steel, Two-Span Bridges

| Load Conditions | Four-Truck Platoons | | | Three-Truck Platoons | | | Two-Truck Platoons | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Moment** | **Shear** | **Combine** | **Moment** | **Shear** | **Combine** | **Moment** | **Shear** | **Combine** |
| **Single-Lane Platoon** | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **Two-Lanes Fully Correlated** | 150 ft: $H > 9$ft<br>200 ft: 11 ft $> H > 6$ ft<br>or $H > 26$ ft | 200 ft: $H > 10$ ft | 150 ft: $H > 9$ ft<br>200 ft: 11 ft $> H > 10$ ft<br>or $H > 26$ ft | NA | NA | NA | NA | NA | NA |
| **Platoon & Routine Traffic (100 Crossings, ADTT 5000)** | 150 ft: $H > 7$ ft<br>200 ft: 7 ft $> H > 6$ ft<br>or $H > 24$ ft | 200 ft: $H > 8$ ft | 150 ft: $H > 7$ ft<br>200 ft: $H > 24$ *ft* | NA | NA | NA | NA | NA | NA |

Table 75. Nebraska Legal Load Platoon Restrictions for Prestressed Concrete, Two-Span Bridges

| Load Conditions | Four-Truck Platoons | | | Three-Truck Platoons | | | Two-Truck Platoons | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Moment** | **Shear** | **Combine** | **Moment** | **Shear** | **Combine** | **Moment** | **Shear** | **Combine** |
| **Single-Lane Platoon** | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **Two-Lanes Fully Correlated** | 150 ft: $H > 6$ ft | NA | 150 ft: $H > 6$ ft | NA | NA | NA | NA | NA | NA |
| **Platoon & Routine Traffic (100 Crossings, ADTT 5000)** | NA | NA | NA | NA | NA | NA | NA | NA | NA |

## 8.4 Summary

Initial platoon deployments are expected to be limited to vehicles operating within state legal limits. The NE Type 3-3 does not conform to the FBF legal load limit because its GVW of 86 kips exceeds the FBF upper bound of 80 kips. NE Type 3-3 load effects were generally enveloped by the vehicles considered throughout this research, except for two-span negative moments with long spans. The results of this section are supplemental to those presented in Section 7.4. Ultimately, the NE-specific loads do not influence the recommendations presented previously. Although the NE Type 3-3 does in some instances exceed the prior envelopes for moment, the governing limit state in those situations was shear. NE-specific legal loads can operate in platoons based solely on the guidance presented in Section 7.4.

# 9 CONCLUSIONS AND RECOMMENDATIONS

## 9.1 Summary and Conclusions

Platoons are anticipated to operate at close headways, creating more severe load effects on bridges than accounted for in routine design. Additionally, platooning vehicles are expected to possess onboard data acquisition and processing necessary to ensure safe operation at high speeds with little to no human interaction. A platooning truck may therefore function as its own individual WIM data collector, providing vehicle weight and dynamic amplification data that enable reductions in bridge rating live load uncertainties. Ultimately, this could result in platoons operating safely with elevated weights. Platoons may benefit not only from reduced aerodynamic drag with close headways, but also may be able to operate with fewer vehicles in total by increasing the weight of freight per vehicle.

This research developed a Load and Resistance Factor Rating (LRFR) methodology for up to four-truck platoons on simple- and two-span steel and prestressed girder bridges to investigate the Strength I limit state. Monte Carlo Simulations (MCS) were used to determine live load factors associated with a target reliability index, $\beta$. Additionally, the research included an LFR calibration enabling benefits to be realized for LFD bridges according to the typical rating procedure used by NDOT. Bridges were assumed to possess optimal (no excess) design capacity under HL-93 load for LRFD and HS-20 load for LFD. Findings therefore may be conservative for existing bridges that have a higher capacity than needed, but may not be applicable to LFD bridges designed for loading less than HS-20.

This project characterizes platoon load effects for different headway (truck spacing) assumptions based on the envelope of NRL, AASHTO Type 3-3, NJTA Type 3S2, and FHWA Class 9 trucks, which are at the legal GVW limit of 80 kips. The NRL generally governed for simple-span moment and shear, and two-span shear, but may not always control for two-span negative moments among the considered truck types. Platoon vehicle weights were scaled by an amplification factor, $\alpha$, relative to the 80 kip GVW baseline for parametric combinations of headways and *CoVs* to determine critical (maximum) safe vehicle weights satisfying a target reliability index, $\beta_{target}$. Total live load *CoV* was determined from a formulation developed in this research to account for the combination of truck static weight, transverse load distribution (GDF), and dynamic amplification uncertainties. Calibrated live load factors are proposed to account for platoon-loading scenario and live load *CoV*.

This project focused primarily on a $\beta_{target}$ of 2.5, but also considered $\beta_{target}$ equal to 3.5. Calibrated live load factors are proposed for a single platoon without adjacent lane load, two adjacent lanes of fully-correlated platoons, and a platoon adjacent to routine traffic. Live load factor calibration for platoons with adjacent routine traffic considered 10 and 100 platoon bridge crossings per day and routine traffic ADTTs of 100, 1000, and 5000.

Adjacent lane maximum load effects were estimated using Weigh-In-Motion (WIM) data for positive and negative moments based on a single truck on Interstate I-80 in Wyoming from Barker and Puckett (2016). WIM data was mapped to Extreme Type I live load models and incorporated together with platoon loading in the MCS to evaluate combined platoon and routine traffic critical loading. Data from Barker and Puckett was originally for moment only, and this project approximated the two-span interior shear and simple-span shear by using the data for simple-span bridge positive moments. Also, the project simulated critical adjacent routine truck loading with two statistically independent heavy trucks for two-span bridges from 90 to 200 ft. These assumptions are believed to be conservative at present, and could be revisited if Nebraska-specific WIM data becomes available. The duration of applicability for WIM data is beyond the scope of this study, and relies on freight operations, which may differ with expansion of platooning.

Key findings for this project are:

- Legal load platoons can safely traverse all bridge configurations in the scope of this research for all load cases at the operating level ($\beta_{target} = 2.5$).
- Single-lane loaded legal load platoons without adjacent traffic can safely traverse all bridge configurations in the scope of this research at the inventory level ($\beta_{target} = 3.5$).
- Legal-load platoons with adjacent traffic can safely traverse all simple-span bridge configurations in the scope of this research at the inventory level ($\beta_{target} = 3.5$) with headways at least 20 ft.
- Two- and three-truck legal load platoons with adjacent traffic can safely traverse all two-span bridge configurations in the scope of this research at the inventory level ($\beta_{target} = 3.5$) with headways between 5 and 50 ft.

- <u>Four-truck legal load</u> platoons <u>with adjacent traffic</u> can safely traverse <u>all two-span</u> bridge configurations in the scope of this research <u>at the inventory level ($\beta_{\text{target}} = 3.5$)</u> with <u>headways between 36and 50 ft</u>.
- Platoons can operate on simple- and two-span bridges adjacent to routine traffic at 110% of the legal load limit for any headway and without taking advantage of any reduction in uncertainty. If the platoon can avoid traveling adjacent to routine traffic, it can potentially operate at 150% of the legal load limit or higher.
- Platoons can operate on simple- and two-span bridges adjacent to routine traffic up to 200% of the legal load limit by controlling headways <u>and</u> taking advantage of reductions in uncertainty. If the platoon can avoid traveling adjacent to routine traffic, it can potentially operate at 260% of the legal load limit or higher.
- Average $\alpha$ factors for $\beta_{target} = 2.5$ are about 20%-30% higher than for $\beta_{target} = 3.5$. Conversely, calibrated live load factors for $\beta_{target} = 3.5$ are about 20%-30% higher than for $\beta_{target} = 2.5$.
- Platoons with varying and atypically large headways may create critical load effects greater than accounted for in the recommendations above. A limited parametric study suggested that platoon effects for atypical headways would likely only be appreciable, on the order of 10 to 15% higher, only for long spans (only for the 200 ft span in this study). Atypical headways produced load effects no more than 5% higher than constant headways for spans 150 ft and shorter. Consequently, typical headways are likely sufficient for spans less than 150 ft.

- LFD bridges may possess noticeably less capacity than LRFD bridges, particularly for shear. LFD bridges are able to carry up to 11% higher truck weights in some cases, but as low as 28% less in others.

### 9.2 Recommended Future Research

The following topics are proposed for future research:

- The research reported herein was limited in scope to the Strength I limit state. Consideration of Service and Fatigue limit states is needed. Such research should consider desired performance in the evaluation of these limit states. Service limit states in particular are explicitly noted in the MBE not to be reliability-calibrated, but rather based on historical practice and engineering judgement.
- Only critical sections were considered in this research. Additional studies considering all other sections along bridge spans are necessary to investigate and confirm comprehensive applicability of the headway tables provided in Chapter 7. The headway tables may be considered reasonable estimates at present, but should be verified for each specific application using the live load factors proposed herein.
- Platoon live load effects were broadly characterized as a parametric *CoV* range from 0 to 0.2. Future research is needed to operationalize benefits from reduced uncertainties, accounting for individual contributions from reduced truck weight and dynamic amplification uncertainties available from onboard sensing. Transverse load distribution (GDF) uncertainties may also be reduced by

integrating detailed analyses and/or load testing for bridges along platooning corridors. Additional GDF bias benefits may be available from positioning truck wheel paths in specific tracks relative to girders.

- Additional collection and review of WIM data is recommended to reduce unnecessary conservativism for adjacent lane load effects. On-going WIM data collection is recommended to confirm applicability or reveal appropriate changes in adjacent lane loading.

### 9.3 Implementation and Technology Transfer

The procedures outlined herein may be implemented in AASHTOWare™ Bridge Rating software:

1. Truck library supports all typical truck configurations.
2. Platoons with trucks at various headways can be defined in the library.
3. GDFs may be automatically computed with a system-based bridge model.
4. Multiple presence settings may be overridden for single-lane rating cases.
5. Load factors can be defined in a library or modified at several levels in the bridge workspace tree.
6. Impact factors can be modified at several levels in the bridge workspace tree.
7. Resistances are computed in the usual manner.
8. Rating factors are computed in the usual manner.
9. Bridge can be readily linked into a folder for easy route/permit analysis.
10. Route permits may be adjusted further for impact by slowing speed across critical bridges.
11. Similarly, routine adjacent traffic might be eliminated by adjusting lane position over critical bridges.

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# 11 APPENDICES

## Appendix A. Recommended LRFR and LFR live load factors tables

Proposed LRFR live load factors for $\beta_{target}$ = 3.5 are provided in Table A-1. Note that applicable GDFs corresponding to each platoon loading case match those shown in Table 29 for $\beta_{target}$ = 2.5. LFR live load factors in Table A-2 through Table A-5 are based on the critical case among 8, 10, and 12 ft girder spacings. The tables assume LFR GDFs calculated as described in Section 6.4.4.

Table A-1. Live load factors for LRFR ($\beta_{target}$ = 3.5)

| **Truck Platoon** | **Frequency** | **Loading Condition** | **DF** | **ADTT (One direction)** | **Live load factors for CoV from 0 to 0.2** | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | **COVLL = 0** | **COVLL = 0.05** | **COVLL = 0.1** | **COVLL = 0.15** | **COVLL = 0.2** |
| Multiple Trucks in Platoon | Single-trip | No other vehicles on the bridge | One lane | N/A | 1.60 | 1.65 | 1.70 | 1.80 | 1.90 |
| | Single-trip | Two indentical platoons loaded on two lanes | Two or more lanes | N/A | 1.60 | 1.65 | 1.70 | 1.80 | 1.90 |
| | 10 Crossings | Mix with routine traffic on the another lane | One lane | > 5000 | 2.05 | 2.05 | 2.10 | 2.20 | 2.30 |
| | | | | 1000 | 2.05 | 2.05 | 2.10 | 2.15 | 2.25 |
| | | | | < 100 | 2.05 | 2.05 | 2.10 | 2.15 | 2.25 |
| | 100 Crossings | Mix with routine traffic on the another lane | One lane | > 5000 | 2.05 | 2.10 | 2.15 | 2.25 | 2.35 |
| | | | | 1000 | 2.05 | 2.10 | 2.15 | 2.20 | 2.30 |
| | | | | < 100 | 2.05 | 2.05 | 2.15 | 2.20 | 2.30 |

Table A-2. Moment live load factors for LFR ($\beta_{target}$ = 2.5)

| Truck Platoon | Frequency | Loading Condition | DF | ADTT (One direction) | Live load factors for CoV from 0 to 0.2 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | COVLL = 0 | COVLL = 0.05 | COVLL = 0.1 | COVLL = 0.15 | COVLL = 0.2 |
| Multiple Trucks in Platoon | Single-trip | No other vehicles on the bridge | One lane | N/A | 0.80 | 0.80 | 0.85 | 0.90 | 0.95 |
| | Single-trip | Two indentical platoons loaded on two lanes | Two or more lanes | N/A | 1.05 | 1.05 | 1.10 | 1.15 | 1.25 |
| | 10 Crossings | Mix with routine traffic on the another lane | One lane | > 5000 | 1.15 | 1.15 | 1.15 | 1.20 | 1.25 |
| | | | | 1000 | 1.15 | 1.15 | 1.15 | 1.15 | 1.20 |
| | | | | < 100 | 1.15 | 1.15 | 1.15 | 1.15 | 1.20 |
| | 100 Crossings | Mix with routine traffic on the another lane | One lane | > 5000 | 1.15 | 1.15 | 1.20 | 1.25 | 1.30 |
| | | | | 1000 | 1.15 | 1.15 | 1.20 | 1.25 | 1.30 |
| | | | | < 100 | 1.15 | 1.15 | 1.20 | 1.25 | 1.30 |

Table A-3. Shear live load factors for LFR ($\beta_{target}$ = 2.5)

| Truck Platoon | Frequency | Loading Condition | DF | ADTT (One direction) | Live load factors for CoV from 0 to 0.2 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | COVLL = 0 | COVLL = 0.05 | COVLL = 0.1 | COVLL = 0.15 | COVLL = 0.2 |
| Multiple Trucks in Platoon | Single-trip | No other vehicles on the bridge | One lane | N/A | 1.05 | 1.10 | 1.15 | 1.20 | 1.25 |
| | Single-trip | Two indentical platoons loaded on two lanes | Two or more lanes | N/A | 1.15 | 1.20 | 1.25 | 1.30 | 1.35 |
| | 10 Crossings | Mix with routine traffic on the another lane | One lane | > 5000 | 1.40 | 1.40 | 1.40 | 1.50 | 1.60 |
| | | | | 1000 | 1.40 | 1.40 | 1.40 | 1.45 | 1.55 |
| | | | | < 100 | 1.40 | 1.40 | 1.40 | 1.45 | 1.55 |
| | 100 Crossings | Mix with routine traffic on the another lane | One lane | > 5000 | 1.40 | 1.40 | 1.45 | 1.55 | 1.60 |
| | | | | 1000 | 1.40 | 1.40 | 1.45 | 1.55 | 1.60 |
| | | | | < 100 | 1.40 | 1.40 | 1.45 | 1.55 | 1.60 |

Table A-4. Moment live load factors for LFR ($\beta_{target}$ = 3.5)

| Truck Platoon | Frequency | Loading Condition | DF | ADTT (One direction) | Live load factors for CoV from 0 to 0.2 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | COVLL = 0 | COVLL = 0.05 | COVLL = 0.1 | COVLL = 0.15 | COVLL = 0.2 |
| Multiple Trucks in Platoon | Single-trip | No other vehicles on the bridge | One lane | N/A | 1.00 | 1.00 | 1.05 | 1.10 | 1.20 |
| | Single-trip | Two indentical platoons loaded on two lanes | Two or more lanes | N/A | 1.30 | 1.30 | 1.40 | 1.50 | 1.60 |
| | 10 Crossings | Mix with routine traffic on the another lane | One lane | > 5000 | 1.45 | 1.45 | 1.45 | 1.60 | 1.70 |
| | | | | 1000 | 1.45 | 1.45 | 1.45 | 1.55 | 1.65 |
| | | | | < 100 | 1.45 | 1.45 | 1.45 | 1.55 | 1.65 |
| | 100 Crossings | Mix with routine traffic on the another lane | One lane | > 5000 | 1.45 | 1.45 | 1.55 | 1.65 | 1.70 |
| | | | | 1000 | 1.45 | 1.45 | 1.50 | 1.65 | 1.70 |
| | | | | < 100 | 1.45 | 1.45 | 1.50 | 1.65 | 1.70 |

Table A-5. Shear live load factors for LFR ($\beta_{target}$ = 3.5)

| Truck Platoon | Frequency | Loading Condition | DF | ADTT (One direction) | Live load factors for CoV from 0 to 0.2 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | COVLL = 0 | COVLL = 0.05 | COVLL = 0.1 | COVLL = 0.15 | COVLL = 0.2 |
| Multiple Trucks in Platoon | Single-trip | No other vehicles on the bridge | One lane | N/A | 1.30 | 1.30 | 1.40 | 1.45 | 1.55 |
| | Single-trip | Two indentical platoons loaded on two lanes | Two or more lanes | N/A | 1.55 | 1.55 | 1.65 | 1.70 | 1.75 |
| | 10 Crossings | Mix with routine traffic on the another lane | One lane | > 5000 | 1.80 | 1.80 | 1.80 | 1.95 | 2.05 |
| | | | | 1000 | 1.80 | 1.80 | 1.80 | 1.90 | 2.00 |
| | | | | < 100 | 1.80 | 1.80 | 1.80 | 1.90 | 2.00 |
| | 100 Crossings | Mix with routine traffic on the another lane | One lane | > 5000 | 1.80 | 1.80 | 1.85 | 1.95 | 2.05 |
| | | | | 1000 | 1.80 | 1.80 | 1.85 | 1.95 | 2.05 |
| | | | | < 100 | 1.80 | 1.80 | 1.85 | 1.95 | 2.05 |

# Appendix B. Simple-Span LRFD Bridge Headway Tables for Single-lane Platoon-only Loading ($\beta_{target}$ = 2.5)

Bridge type and girder spacing do not significantly affect LRFR live load factors as shown in Section 5.4. Steel bridges with 10 ft girder spacing subjected to three-truck platoons were selected to develop the headway tables below. Three different loading scenarios were considered, similar to the main body of the report: single-lane, two-lane fully correlated, and platoons mixed with routine traffic. Headways shown in Appendices B to D were determined with three-truck platoons on simple-span bridges. Similarly, headways shown in Appendices E to G were determined with four-truck platoons on two-span bridges. As shown in Section 5.3.3, live load factors are not significantly affected by ADTT and number of platoon crossings. Therefore, the critical case of ADTT = 5000 and 100 crossings per day was used in the determination of safe headway spacing tables for platoons mixed with routine traffic. Safe headway spacing tables for CoV ranges from 0 to 0.2 for span lengths from 60 to 120 ft are provided in these Appendices.

Safe headway spacing tables for five different CoVs of total live load are also provided, as shown in Table B-1. A baseline *CoV* of 0.18 is consistent with the routine uncertainty assumed for dynamic live load in LRFD/R calibration. If the static weight of the vehicle is certain, such as by precise mobile WIM instrumentation on truck axles, then the net *CoV* reduces to 0.14. If the dynamic uncertainty is likewise eliminated in addition to the static weight uncertainty, the net *CoV* is 0.12. If the dynamic effects remain uncertain, but the load distribution in the bridge is certain, such as through detailed bridge modeling validated and calibrated using diagnostic field testing, then the net *CoV* is 0.07. Lastly, if static weight uncertainty, dynamic amplification uncertainty, and load distribution uncertainties are all eliminated, then the net live load *CoV* becomes 0. The tables only varied uncertainties as quantified by live load *CoV*, but additional modifications from adjusted biases may further relax the tabulated safe headways.

Table B-1. Considered CoV for different cases

| | |
|---|---|
| Original CoV | 0.18 |
| CoV ($CoV_{PL}$ = 0) | 0.14 |
| CoV ($CoV_{PL}$ = 0, $CoV_{IM}$ = 0) | 0.12 |
| CoV ($CoV_{PL}$ = 0, $CoV_{GDF}$ = 0) | 0.07 |
| CoV ($CoV_{PL}$ = 0, $CoV_{IM}$ = 0, $CoV_{GDF}$=0) | 0 |

Table B-2. Positive Moment (+M) Safe Headways, Single-Lane Platoons, 60-ft Simple-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.7** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **2.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **2.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **2.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **2.4** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **2.5** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 |
| **2.6** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 8 |
| **2.7** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 7 | 8 | 10 |
| **2.8** | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 9 | 11 | 16 |
| **2.9** | 5 | 5 | 5 | 5 | 6 | 7 | 8 | 10 | 12 | 19 | Fail |
| **3** | 5 | 5 | 6 | 6 | 7 | 8 | 11 | 14 | Fail | Fail | Fail |
| **3.1** | 6 | 7 | 7 | 8 | 9 | 12 | 15 | Fail | Fail | Fail | Fail |
| **3.2** | 8 | 8 | 9 | 11 | 12 | 18 | Fail | Fail | Fail | Fail | Fail |
| **3.3** | 11 | 11 | 12 | 16 | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.4** | 17 | 17 | 38 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table B-3. End Shear (V) Safe Headways, Single-Lane Platoons, 60-ft Simple-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.7** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **2.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **2.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 8 |
| **2.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 9 | 10 |
| **2.4** | 5 | 5 | 5 | 5 | 5 | 5 | 7 | 8 | 10 | 11 | 13 |
| **2.5** | 5 | 5 | 5 | 5 | 7 | 8 | 9 | 11 | 12 | 13 | 15 |
| **2.6** | 6 | 6 | 7 | 8 | 9 | 10 | 12 | 13 | 14 | 16 | 17 |
| **2.7** | 8 | 8 | 9 | 10 | 11 | 12 | 13 | 15 | 16 | 18 | 20 |
| **2.8** | 10 | 11 | 11 | 12 | 13 | 14 | 15 | 17 | 19 | 20 | 24 |
| **2.9** | 12 | 12 | 13 | 14 | 15 | 16 | 18 | 19 | 21 | 25 | 31 |
| **3** | 14 | 14 | 15 | 16 | 17 | 18 | 20 | 23 | 27 | Fail | Fail |
| **3.1** | 16 | 16 | 17 | 18 | 19 | 21 | 23 | 28 | Fail | Fail | Fail |
| **3.2** | 18 | 18 | 19 | 19 | 22 | 24 | 29 | Fail | Fail | Fail | Fail |
| **3.3** | 20 | 20 | 21 | 23 | 25 | 34 | Fail | Fail | Fail | Fail | Fail |
| **3.4** | 24 | 23 | 25 | 29 | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | 29 | 29 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table B-4. Positive Moment (+M) and End Shear (V) Safe Headways, Single-Lane Platoons, 60-ft Simple-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.7** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **2.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **2.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 8 |
| **2.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 9 | 10 |
| **2.4** | 5 | 5 | 5 | 5 | 5 | 5 | 7 | 8 | 10 | 11 | 13 |
| **2.5** | 5 | 5 | 5 | 5 | 7 | 8 | 9 | 11 | 12 | 13 | 15 |
| **2.6** | 6 | 6 | 7 | 8 | 9 | 10 | 12 | 13 | 14 | 16 | 17 |
| **2.7** | 8 | 8 | 9 | 10 | 11 | 12 | 13 | 15 | 16 | 18 | 20 |
| **2.8** | 10 | 11 | 11 | 12 | 13 | 14 | 15 | 17 | 19 | 20 | 24 |
| **2.9** | 12 | 12 | 13 | 14 | 15 | 16 | 18 | 19 | 21 | 25 | Fail |
| **3** | 14 | 14 | 15 | 16 | 17 | 18 | 20 | 23 | Fail | Fail | Fail |
| **3.1** | 16 | 16 | 17 | 18 | 19 | 21 | 23 | Fail | Fail | Fail | Fail |
| **3.2** | 18 | 18 | 19 | 19 | 22 | 24 | Fail | Fail | Fail | Fail | Fail |
| **3.3** | 20 | 20 | 21 | 23 | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.4** | 24 | 23 | 38 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table B-5. Positive Moment (+M) Safe Headways, Single-Lane Platoons, 90-ft Simple-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.7** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **2.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **2.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 |
| **2.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 8 | 9 |
| **2.4** | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 7 | 9 | 9 | 10 |
| **2.5** | 5 | 5 | 6 | 6 | 7 | 7 | 8 | 9 | 10 | 11 | 11 |
| **2.6** | 7 | 7 | 7 | 7 | 8 | 9 | 10 | 10 | 11 | 12 | 13 |
| **2.7** | 8 | 8 | 8 | 9 | 9 | 10 | 11 | 12 | 13 | 13 | 14 |
| **2.8** | 9 | 9 | 10 | 10 | 11 | 11 | 12 | 13 | 14 | 15 | 16 |
| **2.9** | 10 | 11 | 11 | 11 | 12 | 13 | 14 | 14 | 15 | 17 | 18 |
| **3** | 12 | 12 | 12 | 13 | 13 | 14 | 15 | 16 | 17 | 18 | 20 |
| **3.1** | 13 | 13 | 13 | 14 | 15 | 15 | 16 | 18 | 19 | 21 | 23 |
| **3.2** | 14 | 14 | 15 | 15 | 16 | 17 | 18 | 19 | 21 | 23 | 27 |
| **3.3** | 15 | 15 | 16 | 17 | 17 | 18 | 20 | 22 | 24 | 28 | Fail |
| **3.4** | 17 | 17 | 17 | 18 | 19 | 21 | 23 | 26 | 32 | Fail | Fail |
| **3.5** | 18 | 19 | 19 | 20 | 22 | 24 | 26 | 32 | Fail | Fail | Fail |
| **3.6** | 21 | 21 | 21 | 22 | 24 | 27 | Fail | Fail | Fail | Fail | Fail |
| **3.7** | 22 | 23 | 23 | 25 | 28 | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.8** | 26 | 26 | 27 | 39 | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.9** | 41 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table B-6. End Shear (V) Safe Headways, Single-Lane Platoons, 90-ft Simple-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.7** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 |
| **1.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 9 | 9 |
| **2** | 5 | 5 | 5 | 5 | 6 | 6 | 7 | 8 | 10 | 10 | 12 |
| **2.1** | 6 | 6 | 6 | 7 | 8 | 8 | 9 | 11 | 11 | 13 | 15 |
| **2.2** | 8 | 8 | 8 | 9 | 10 | 10 | 12 | 12 | 15 | 17 | 19 |
| **2.3** | 9 | 10 | 10 | 10 | 12 | 12 | 14 | 16 | 18 | 21 | 23 |
| **2.4** | 11 | 12 | 12 | 12 | 14 | 16 | 17 | 21 | 22 | 25 | 28 |
| **2.5** | 14 | 14 | 15 | 16 | 18 | 19 | 22 | 24 | 27 | 29 | 32 |
| **2.6** | 17 | 17 | 18 | 20 | 21 | 24 | 26 | 28 | 30 | 32 | 36 |
| **2.7** | 21 | 21 | 22 | 23 | 26 | 28 | 29 | 32 | 34 | 36 | 39 |
| **2.8** | 25 | 25 | 26 | 27 | 29 | 31 | 33 | 35 | 37 | 39 | 42 |
| **2.9** | 28 | 28 | 29 | 30 | 32 | 34 | 36 | 38 | 41 | 43 | 46 |
| **3** | 31 | 31 | 32 | 34 | 35 | 36 | 39 | 41 | 44 | 47 | Fail |
| **3.1** | 34 | 35 | 35 | 37 | 38 | 40 | 43 | 45 | 47 | Fail | Fail |
| **3.2** | 37 | 37 | 38 | 39 | 41 | 43 | 46 | 48 | Fail | Fail | Fail |
| **3.3** | 40 | 40 | 42 | 43 | 45 | 46 | Fail | Fail | Fail | Fail | Fail |
| **3.4** | 43 | 43 | 44 | 45 | 48 | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | 46 | 46 | 47 | 50 | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.7** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.8** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.9** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table B-7. Positive Moment (+M) and End Shear (V) Safe Headways, Single-Lane Platoons, 90-ft Simple-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.7** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 |
| **1.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 9 | 9 |
| **2** | 5 | 5 | 5 | 5 | 6 | 6 | 7 | 8 | 10 | 10 | 12 |
| **2.1** | 6 | 6 | 6 | 7 | 8 | 8 | 9 | 11 | 11 | 13 | 15 |
| **2.2** | 8 | 8 | 8 | 9 | 10 | 10 | 12 | 12 | 15 | 17 | 19 |
| **2.3** | 9 | 10 | 10 | 10 | 12 | 12 | 14 | 16 | 18 | 21 | 23 |
| **2.4** | 11 | 12 | 12 | 12 | 14 | 16 | 17 | 21 | 22 | 25 | 28 |
| **2.5** | 14 | 14 | 15 | 16 | 18 | 19 | 22 | 24 | 27 | 29 | 32 |
| **2.6** | 17 | 17 | 18 | 20 | 21 | 24 | 26 | 28 | 30 | 32 | 36 |
| **2.7** | 21 | 21 | 22 | 23 | 26 | 28 | 29 | 32 | 34 | 36 | 39 |
| **2.8** | 25 | 25 | 26 | 27 | 29 | 31 | 33 | 35 | 37 | 39 | 42 |
| **2.9** | 28 | 28 | 29 | 30 | 32 | 34 | 36 | 38 | 41 | 43 | 46 |
| **3** | 31 | 31 | 32 | 34 | 35 | 36 | 39 | 41 | 44 | 47 | Fail |
| **3.1** | 34 | 35 | 35 | 37 | 38 | 40 | 43 | 45 | 47 | Fail | Fail |
| **3.2** | 37 | 37 | 38 | 39 | 41 | 43 | 46 | 48 | Fail | Fail | Fail |
| **3.3** | 40 | 40 | 42 | 43 | 45 | 46 | Fail | Fail | Fail | Fail | Fail |
| **3.4** | 43 | 43 | 44 | 45 | 48 | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | 46 | 46 | 47 | 50 | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.7** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.8** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.9** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table B-8. Acceptable Simple-Span Positive Moment Single-lane Headways (CoV= 0.18)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.7** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.9** | 5 | 5 | 5 | 5 | 6 | 5 |
| **2** | 5 | 5 | 5 | 7 | 9 | 6 |
| **2.1** | 5 | 5 | 5 | 10 | 12 | 10 |
| **2.2** | 5 | 5 | 6 | 12 | 16 | 15 |
| **2.3** | 5 | 5 | 8 | 14 | 19 | 21 |
| **2.4** | 5 | 5 | 9 | 16 | 21 | 24 |
| **2.5** | 5 | 5 | 11 | 18 | 23 | 27 |
| **2.6** | 5 | 6 | 12 | 19 | 25 | 31 |
| **2.7** | 5 | 8 | 13 | 21 | 28 | 34 |
| **2.8** | Fail | 11 | 15 | 22 | 29 | 37 |
| **2.9** | Fail | 19 | 17 | 24 | 31 | 40 |
| **3** | Fail | Fail | 18 | 26 | 33 | 43 |
| **3.1** | Fail | Fail | 21 | 27 | 35 | 45 |
| **3.2** | Fail | Fail | 23 | 29 | 37 | 47 |
| **3.3** | Fail | Fail | 28 | 30 | 38 | 49 |
| **3.4** | Fail | Fail | Fail | 32 | 39 | Fail |
| **3.5** | Fail | Fail | Fail | 34 | 41 | Fail |
| **3.6** | Fail | Fail | Fail | 38 | 43 | Fail |
| **3.7** | Fail | Fail | Fail | 43 | 45 | Fail |
| **3.8** | Fail | Fail | Fail | Fail | 47 | Fail |
| **3.9** | Fail | Fail | Fail | Fail | 49 | Fail |
| **4** | Fail | Fail | Fail | Fail | Fail | Fail |

Table B-9. Acceptable Simple-Span Shear Single-lane Headways (CoV= 0.18)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 7 | 5 |
| **1.7** | 5 | 5 | 5 | 9 | 13 | 13 |
| **1.8** | 5 | 5 | 6 | 12 | 18 | 21 |
| **1.9** | 5 | 5 | 9 | 16 | 22 | 28 |
| **2** | 5 | 5 | 10 | 19 | 26 | 34 |
| **2.1** | 5 | 5 | 13 | 22 | 31 | 40 |
| **2.2** | 5 | 6 | 17 | 26 | 34 | 44 |
| **2.3** | 5 | 9 | 21 | 30 | 37 | 50 |
| **2.4** | 5 | 11 | 25 | 35 | 41 | Fail |
| **2.5** | 5 | 13 | 29 | 41 | 49 | Fail |
| **2.6** | 5 | 16 | 32 | 46 | Fail | Fail |
| **2.7** | 5 | 18 | 36 | Fail | Fail | Fail |
| **2.8** | 8 | 20 | 39 | Fail | Fail | Fail |
| **2.9** | Fail | 25 | 43 | Fail | Fail | Fail |
| **3** | Fail | Fail | 47 | Fail | Fail | Fail |
| **3.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.7** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.8** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.9** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4** | Fail | Fail | Fail | Fail | Fail | Fail |

Table B-10. Acceptable Simple-Span Moment and Shear Single-lane Headways (CoV= 0.18)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 7 | 5 |
| **1.7** | 5 | 5 | 5 | 9 | 13 | 13 |
| **1.8** | 5 | 5 | 6 | 12 | 18 | 21 |
| **1.9** | 5 | 5 | 9 | 16 | 22 | 28 |
| **2** | 5 | 5 | 10 | 19 | 26 | 34 |
| **2.1** | 5 | 5 | 13 | 22 | 31 | 40 |
| **2.2** | 5 | 6 | 17 | 26 | 34 | 44 |
| **2.3** | 5 | 9 | 21 | 30 | 37 | 50 |
| **2.4** | 5 | 11 | 25 | 35 | 41 | Fail |
| **2.5** | 5 | 13 | 29 | 41 | 49 | Fail |
| **2.6** | 5 | 16 | 32 | 46 | Fail | Fail |
| **2.7** | 5 | 18 | 36 | Fail | Fail | Fail |
| **2.8** | Fail | 20 | 39 | Fail | Fail | Fail |
| **2.9** | Fail | 25 | 43 | Fail | Fail | Fail |
| **3** | Fail | Fail | 47 | Fail | Fail | Fail |
| **3.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.7** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.8** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.9** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4** | Fail | Fail | Fail | Fail | Fail | Fail |

Table B-11. Acceptable Simple-Span Positive Moment Single-lane Headways (CoV= 0.14)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.7** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **2** | 5 | 5 | 5 | 5 | 6 | 5 |
| **2.1** | 5 | 5 | 5 | 7 | 10 | 6 |
| **2.2** | 5 | 5 | 5 | 10 | 13 | 11 |
| **2.3** | 5 | 5 | 6 | 12 | 16 | 16 |
| **2.4** | 5 | 5 | 7 | 14 | 18 | 20 |
| **2.5** | 5 | 5 | 9 | 15 | 21 | 24 |
| **2.6** | 5 | 5 | 10 | 17 | 23 | 27 |
| **2.7** | 5 | 5 | 12 | 18 | 26 | 31 |
| **2.8** | 5 | 7 | 13 | 20 | 27 | 34 |
| **2.9** | Fail | 10 | 14 | 22 | 29 | 37 |
| **3** | Fail | 14 | 16 | 23 | 31 | 39 |
| **3.1** | Fail | Fail | 18 | 25 | 32 | 42 |
| **3.2** | Fail | Fail | 19 | 26 | 34 | 44 |
| **3.3** | Fail | Fail | 22 | 28 | 36 | 47 |
| **3.4** | Fail | Fail | 26 | 29 | 37 | 49 |
| **3.5** | Fail | Fail | 32 | 31 | 39 | 50 |
| **3.6** | Fail | Fail | Fail | 33 | 40 | Fail |
| **3.7** | Fail | Fail | Fail | 35 | 42 | Fail |
| **3.8** | Fail | Fail | Fail | 37 | 43 | Fail |
| **3.9** | Fail | Fail | Fail | 44 | 46 | Fail |
| **4** | Fail | Fail | Fail | Fail | 47 | Fail |
| **4.1** | Fail | Fail | Fail | Fail | 50 | Fail |
| **4.2** | Fail | Fail | Fail | Fail | Fail | Fail |

Table B-12. Acceptable Simple-Span Shear Single-lane Headways (CoV= 0.14)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.7** | 5 | 5 | 5 | 5 | 8 | 6 |
| **1.8** | 5 | 5 | 5 | 9 | 13 | 15 |
| **1.9** | 5 | 5 | 6 | 13 | 19 | 21 |
| **2** | 5 | 5 | 8 | 16 | 22 | 29 |
| **2.1** | 5 | 5 | 11 | 19 | 27 | 35 |
| **2.2** | 5 | 5 | 12 | 22 | 30 | 40 |
| **2.3** | 5 | 6 | 16 | 25 | 33 | 45 |
| **2.4** | 5 | 8 | 21 | 29 | 37 | Fail |
| **2.5** | 5 | 11 | 24 | 34 | 41 | Fail |
| **2.6** | 5 | 13 | 28 | 40 | 48 | Fail |
| **2.7** | 5 | 15 | 32 | 45 | Fail | Fail |
| **2.8** | 5 | 17 | 35 | 50 | Fail | Fail |
| **2.9** | 6 | 19 | 38 | Fail | Fail | Fail |
| **3** | 8 | 23 | 41 | Fail | Fail | Fail |
| **3.1** | Fail | 28 | 45 | Fail | Fail | Fail |
| **3.2** | Fail | Fail | 48 | Fail | Fail | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.7** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.8** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.9** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.2** | Fail | Fail | Fail | Fail | Fail | Fail |

Table B-13. Acceptable Simple-Span Moment and Shear Single-lane Headways (CoV= 0.14)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.7** | 5 | 5 | 5 | 5 | 8 | 6 |
| **1.8** | 5 | 5 | 5 | 9 | 13 | 15 |
| **1.9** | 5 | 5 | 6 | 13 | 19 | 21 |
| **2** | 5 | 5 | 8 | 16 | 22 | 29 |
| **2.1** | 5 | 5 | 11 | 19 | 27 | 35 |
| **2.2** | 5 | 5 | 12 | 22 | 30 | 40 |
| **2.3** | 5 | 6 | 16 | 25 | 33 | 45 |
| **2.4** | 5 | 8 | 21 | 29 | 37 | Fail |
| **2.5** | 5 | 11 | 24 | 34 | 41 | Fail |
| **2.6** | 5 | 13 | 28 | 40 | 48 | Fail |
| **2.7** | 5 | 15 | 32 | 45 | Fail | Fail |
| **2.8** | 5 | 17 | 35 | 50 | Fail | Fail |
| **2.9** | Fail | 19 | 38 | Fail | Fail | Fail |
| **3** | Fail | 23 | 41 | Fail | Fail | Fail |
| **3.1** | Fail | Fail | 45 | Fail | Fail | Fail |
| **3.2** | Fail | Fail | 48 | Fail | Fail | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.7** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.8** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.9** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.2** | Fail | Fail | Fail | Fail | Fail | Fail |

Table B-14. Acceptable Simple-Span Positive Moment Single-lane Headways (CoV= 0.12)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.7** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **2.1** | 5 | 5 | 5 | 6 | 8 | 5 |
| **2.2** | 5 | 5 | 5 | 8 | 12 | 10 |
| **2.3** | 5 | 5 | 5 | 11 | 14 | 13 |
| **2.4** | 5 | 5 | 7 | 13 | 17 | 18 |
| **2.5** | 5 | 5 | 8 | 14 | 20 | 22 |
| **2.6** | 5 | 5 | 10 | 16 | 22 | 26 |
| **2.7** | 5 | 5 | 11 | 18 | 24 | 29 |
| **2.8** | 5 | 6 | 12 | 19 | 26 | 32 |
| **2.9** | 5 | 8 | 14 | 21 | 28 | 35 |
| **3** | Fail | 11 | 15 | 22 | 29 | 38 |
| **3.1** | Fail | 15 | 16 | 24 | 31 | 40 |
| **3.2** | Fail | Fail | 18 | 25 | 33 | 43 |
| **3.3** | Fail | Fail | 20 | 26 | 34 | 45 |
| **3.4** | Fail | Fail | 23 | 28 | 36 | 47 |
| **3.5** | Fail | Fail | 26 | 30 | 37 | 50 |
| **3.6** | Fail | Fail | Fail | 31 | 39 | Fail |
| **3.7** | Fail | Fail | Fail | 33 | 41 | Fail |
| **3.8** | Fail | Fail | Fail | 36 | 42 | Fail |
| **3.9** | Fail | Fail | Fail | 38 | 44 | Fail |
| **4** | Fail | Fail | Fail | 44 | 46 | Fail |
| **4.1** | Fail | Fail | Fail | Fail | 47 | Fail |
| **4.2** | Fail | Fail | Fail | Fail | 50 | Fail |
| **4.3** | Fail | Fail | Fail | Fail | Fail | Fail |

Table B-15. Acceptable Simple-Span Shear Single-lane Headways (CoV= 0.12)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.7** | 5 | 5 | 5 | 5 | 6 | 5 |
| **1.8** | 5 | 5 | 5 | 7 | 12 | 11 |
| **1.9** | 5 | 5 | 5 | 11 | 16 | 19 |
| **2** | 5 | 5 | 7 | 15 | 20 | 26 |
| **2.1** | 5 | 5 | 9 | 17 | 25 | 32 |
| **2.2** | 5 | 5 | 12 | 21 | 29 | 37 |
| **2.3** | 5 | 5 | 14 | 23 | 32 | 43 |
| **2.4** | 5 | 7 | 17 | 26 | 35 | 48 |
| **2.5** | 5 | 9 | 22 | 31 | 38 | Fail |
| **2.6** | 5 | 12 | 26 | 36 | 43 | Fail |
| **2.7** | 5 | 13 | 29 | 41 | Fail | Fail |
| **2.8** | 5 | 15 | 33 | 47 | Fail | Fail |
| **2.9** | 5 | 18 | 36 | Fail | Fail | Fail |
| **3** | 7 | 20 | 39 | Fail | Fail | Fail |
| **3.1** | 11 | 23 | 43 | Fail | Fail | Fail |
| **3.2** | Fail | 29 | 46 | Fail | Fail | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.7** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.8** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.9** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.3** | Fail | Fail | Fail | Fail | Fail | Fail |

Table B-16. Acceptable Simple-Span Moment and Shear Single-lane Headways (CoV= 0.12)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.7** | 5 | 5 | 5 | 5 | 6 | 5 |
| **1.8** | 5 | 5 | 5 | 7 | 12 | 11 |
| **1.9** | 5 | 5 | 5 | 11 | 16 | 19 |
| **2** | 5 | 5 | 7 | 15 | 20 | 26 |
| **2.1** | 5 | 5 | 9 | 17 | 25 | 32 |
| **2.2** | 5 | 5 | 12 | 21 | 29 | 37 |
| **2.3** | 5 | 5 | 14 | 23 | 32 | 43 |
| **2.4** | 5 | 7 | 17 | 26 | 35 | 48 |
| **2.5** | 5 | 9 | 22 | 31 | 38 | Fail |
| **2.6** | 5 | 12 | 26 | 36 | 43 | Fail |
| **2.7** | 5 | 13 | 29 | 41 | Fail | Fail |
| **2.8** | 5 | 15 | 33 | 47 | Fail | Fail |
| **2.9** | 5 | 18 | 36 | Fail | Fail | Fail |
| **3** | Fail | 20 | 39 | Fail | Fail | Fail |
| **3.1** | Fail | 23 | 43 | Fail | Fail | Fail |
| **3.2** | Fail | Fail | 46 | Fail | Fail | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.7** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.8** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.9** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.3** | Fail | Fail | Fail | Fail | Fail | Fail |

Table B-17. Acceptable Simple-Span Positive Moment Single-lane Headways (CoV= 0.07)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.7** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **2.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **2.2** | 5 | 5 | 5 | 6 | 8 | 6 |
| **2.3** | 5 | 5 | 5 | 9 | 11 | 10 |
| **2.4** | 5 | 5 | 5 | 10 | 14 | 14 |
| **2.5** | 5 | 5 | 6 | 12 | 17 | 18 |
| **2.6** | 5 | 5 | 8 | 14 | 19 | 22 |
| **2.7** | 5 | 5 | 9 | 16 | 21 | 26 |
| **2.8** | 5 | 5 | 10 | 17 | 24 | 29 |
| **2.9** | 5 | 5 | 11 | 19 | 26 | 32 |
| **3** | 5 | 7 | 13 | 20 | 27 | 35 |
| **3.1** | 5 | 9 | 14 | 22 | 29 | 37 |
| **3.2** | Fail | 12 | 15 | 23 | 31 | 39 |
| **3.3** | Fail | 18 | 17 | 25 | 32 | 43 |
| **3.4** | Fail | Fail | 18 | 26 | 34 | 44 |
| **3.5** | Fail | Fail | 21 | 27 | 35 | 47 |
| **3.6** | Fail | Fail | 23 | 29 | 37 | 49 |
| **3.7** | Fail | Fail | 27 | 30 | 39 | Fail |
| **3.8** | Fail | Fail | Fail | 32 | 40 | Fail |
| **3.9** | Fail | Fail | Fail | 34 | 41 | Fail |
| **4** | Fail | Fail | Fail | 36 | 43 | Fail |
| **4.1** | Fail | Fail | Fail | 39 | 44 | Fail |
| **4.2** | Fail | Fail | Fail | 50 | 46 | Fail |
| **4.3** | Fail | Fail | Fail | Fail | 48 | Fail |
| **4.4** | Fail | Fail | Fail | Fail | Fail | Fail |

Table B-18. Acceptable Simple-Span Shear Single-lane Headways (CoV= 0.07)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.7** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.8** | 5 | 5 | 5 | 5 | 6 | 5 |
| **1.9** | 5 | 5 | 5 | 8 | 12 | 13 |
| **2** | 5 | 5 | 5 | 11 | 17 | 20 |
| **2.1** | 5 | 5 | 7 | 14 | 21 | 26 |
| **2.2** | 5 | 5 | 9 | 17 | 25 | 32 |
| **2.3** | 5 | 5 | 11 | 20 | 28 | 37 |
| **2.4** | 5 | 5 | 13 | 23 | 32 | 42 |
| **2.5** | 5 | 6 | 17 | 25 | 35 | 47 |
| **2.6** | 5 | 8 | 20 | 29 | 38 | Fail |
| **2.7** | 5 | 10 | 24 | 34 | 42 | Fail |
| **2.8** | 5 | 12 | 28 | 40 | 48 | Fail |
| **2.9** | 5 | 14 | 31 | 44 | Fail | Fail |
| **3** | 5 | 16 | 34 | 49 | Fail | Fail |
| **3.1** | 5 | 18 | 37 | Fail | Fail | Fail |
| **3.2** | 7 | 20 | 41 | Fail | Fail | Fail |
| **3.3** | 12 | 23 | 44 | Fail | Fail | Fail |
| **3.4** | Fail | 30 | 47 | Fail | Fail | Fail |
| **3.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.7** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.8** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.9** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.4** | Fail | Fail | Fail | Fail | Fail | Fail |

Table B-19. Acceptable Simple-Span Moment and Shear Single-lane Headways (CoV= 0.07)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.7** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.8** | 5 | 5 | 5 | 5 | 6 | 5 |
| **1.9** | 5 | 5 | 5 | 8 | 12 | 13 |
| **2** | 5 | 5 | 5 | 11 | 17 | 20 |
| **2.1** | 5 | 5 | 7 | 14 | 21 | 26 |
| **2.2** | 5 | 5 | 9 | 17 | 25 | 32 |
| **2.3** | 5 | 5 | 11 | 20 | 28 | 37 |
| **2.4** | 5 | 5 | 13 | 23 | 32 | 42 |
| **2.5** | 5 | 6 | 17 | 25 | 35 | 47 |
| **2.6** | 5 | 8 | 20 | 29 | 38 | Fail |
| **2.7** | 5 | 10 | 24 | 34 | 42 | Fail |
| **2.8** | 5 | 12 | 28 | 40 | 48 | Fail |
| **2.9** | 5 | 14 | 31 | 44 | Fail | Fail |
| **3** | 5 | 16 | 34 | 49 | Fail | Fail |
| **3.1** | 5 | 18 | 37 | Fail | Fail | Fail |
| **3.2** | Fail | 20 | 41 | Fail | Fail | Fail |
| **3.3** | Fail | 23 | 44 | Fail | Fail | Fail |
| **3.4** | Fail | Fail | 47 | Fail | Fail | Fail |
| **3.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.7** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.8** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.9** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.4** | Fail | Fail | Fail | Fail | Fail | Fail |

Table B-20. Acceptable Simple-Span Positive Moment Single-lane Headways (CoV= 0)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.7** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **2.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **2.2** | 5 | 5 | 5 | 5 | 7 | 5 |
| **2.3** | 5 | 5 | 5 | 7 | 10 | 8 |
| **2.4** | 5 | 5 | 5 | 9 | 12 | 12 |
| **2.5** | 5 | 5 | 5 | 11 | 16 | 16 |
| **2.6** | 5 | 5 | 7 | 13 | 18 | 21 |
| **2.7** | 5 | 5 | 8 | 15 | 20 | 23 |
| **2.8** | 5 | 5 | 9 | 16 | 22 | 27 |
| **2.9** | 5 | 5 | 10 | 18 | 24 | 30 |
| **3** | 5 | 5 | 12 | 19 | 26 | 33 |
| **3.1** | 5 | 6 | 13 | 21 | 28 | 36 |
| **3.2** | 5 | 8 | 14 | 22 | 30 | 39 |
| **3.3** | Fail | 11 | 15 | 23 | 31 | 41 |
| **3.4** | Fail | 17 | 17 | 24 | 33 | 43 |
| **3.5** | Fail | Fail | 18 | 26 | 34 | 45 |
| **3.6** | Fail | Fail | 21 | 27 | 36 | 47 |
| **3.7** | Fail | Fail | 22 | 28 | 37 | 49 |
| **3.8** | Fail | Fail | 26 | 30 | 38 | Fail |
| **3.9** | Fail | Fail | 41 | 31 | 40 | Fail |
| **4** | Fail | Fail | Fail | 33 | 41 | Fail |
| **4.1** | Fail | Fail | Fail | 36 | 43 | Fail |
| **4.2** | Fail | Fail | Fail | 38 | 44 | Fail |
| **4.3** | Fail | Fail | Fail | 44 | 46 | Fail |
| **4.4** | Fail | Fail | Fail | Fail | 48 | Fail |
| **4.5** | Fail | Fail | Fail | Fail | 50 | Fail |
| **4.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table B-21. Acceptable Simple-Span Shear Single-lane Headways (CoV= 0)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.7** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.9** | 5 | 5 | 5 | 5 | 9 | 9 |
| **2** | 5 | 5 | 5 | 9 | 14 | 17 |
| **2.1** | 5 | 5 | 6 | 13 | 18 | 23 |
| **2.2** | 5 | 5 | 8 | 16 | 22 | 29 |
| **2.3** | 5 | 5 | 9 | 18 | 26 | 35 |
| **2.4** | 5 | 5 | 11 | 21 | 29 | 40 |
| **2.5** | 5 | 5 | 14 | 24 | 32 | 45 |
| **2.6** | 5 | 6 | 17 | 26 | 35 | 49 |
| **2.7** | 5 | 8 | 21 | 30 | 39 | Fail |
| **2.8** | 5 | 10 | 25 | 35 | 43 | Fail |
| **2.9** | 5 | 12 | 28 | 40 | 50 | Fail |
| **3** | 5 | 14 | 31 | 45 | Fail | Fail |
| **3.1** | 5 | 16 | 34 | 50 | Fail | Fail |
| **3.2** | 5 | 18 | 37 | Fail | Fail | Fail |
| **3.3** | 6 | 20 | 40 | Fail | Fail | Fail |
| **3.4** | 10 | 24 | 43 | Fail | Fail | Fail |
| **3.5** | Fail | 29 | 46 | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.7** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.8** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.9** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table B-22. Acceptable Simple-Span Moment and Shear Single-lane Headways (CoV= 0)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.7** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.9** | 5 | 5 | 5 | 5 | 9 | 9 |
| **2** | 5 | 5 | 5 | 9 | 14 | 17 |
| **2.1** | 5 | 5 | 6 | 13 | 18 | 23 |
| **2.2** | 5 | 5 | 8 | 16 | 22 | 29 |
| **2.3** | 5 | 5 | 9 | 18 | 26 | 35 |
| **2.4** | 5 | 5 | 11 | 21 | 29 | 40 |
| **2.5** | 5 | 5 | 14 | 24 | 32 | 45 |
| **2.6** | 5 | 6 | 17 | 26 | 35 | 49 |
| **2.7** | 5 | 8 | 21 | 30 | 39 | Fail |
| **2.8** | 5 | 10 | 25 | 35 | 43 | Fail |
| **2.9** | 5 | 12 | 28 | 40 | 50 | Fail |
| **3** | 5 | 14 | 31 | 45 | Fail | Fail |
| **3.1** | 5 | 16 | 34 | 50 | Fail | Fail |
| **3.2** | 5 | 18 | 37 | Fail | Fail | Fail |
| **3.3** | Fail | 20 | 40 | Fail | Fail | Fail |
| **3.4** | Fail | 24 | 43 | Fail | Fail | Fail |
| **3.5** | Fail | Fail | 46 | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.7** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.8** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.9** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **4.6** | Fail | Fail | Fail | Fail | Fail | Fail |

## Appendix C. Simple-Span LRFD Bridge Headway Tables for Two-lane, Fully-Correlated Platoon-only Loading ($\beta_{target}$ = 2.5)

Table C-1. Positive Moment (+M) Safe Headways, Two-lanes Fully-Correlated Platoons, 60-ft Simple-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 8 | 10 |
| **1.7** | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 8 | 10 | 14 | Fail |
| **1.8** | 5 | 5 | 6 | 6 | 8 | 9 | 11 | 15 | Fail | Fail | Fail |
| **1.9** | 8 | 8 | 9 | 10 | 12 | 17 | Fail | Fail | Fail | Fail | Fail |
| **2** | 12 | 14 | 17 | 48 | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.1** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table C-2. End Shear (V) Safe Headways, Two-lanes Fully-Correlated Platoons, 60-ft Simple-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 9 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 | 7 | 8 | 10 | 11 | 13 |
| **1.7** | 5 | 5 | 6 | 6 | 8 | 9 | 10 | 11 | 13 | 14 | 16 |
| **1.8** | 8 | 8 | 9 | 10 | 11 | 12 | 13 | 15 | 16 | 18 | 20 |
| **1.9** | 11 | 11 | 12 | 13 | 14 | 15 | 16 | 18 | 19 | 22 | 27 |
| **2** | 14 | 14 | 15 | 16 | 17 | 18 | 20 | 22 | 25 | Fail | Fail |
| **2.1** | 17 | 17 | 18 | 19 | 20 | 22 | 26 | 35 | Fail | Fail | Fail |
| **2.2** | 20 | 20 | 21 | 23 | 26 | 32 | Fail | Fail | Fail | Fail | Fail |
| **2.3** | 26 | 26 | 28 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table C-3. Positive Moment (+M) and End Shear (V) Safe Headways, Two-lanes Fully-Correlated Platoons, 60-ft Simple-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 9 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 | 7 | 8 | 10 | 11 | 13 |
| **1.7** | 5 | 5 | 6 | 6 | 8 | 9 | 10 | 11 | 13 | 14 | Fail |
| **1.8** | 8 | 8 | 9 | 10 | 11 | 12 | 13 | 15 | Fail | Fail | Fail |
| **1.9** | 11 | 11 | 12 | 13 | 14 | 17 | Fail | Fail | Fail | Fail | Fail |
| **2** | 14 | 14 | 17 | 48 | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.1** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table C-4. Positive Moment (+M) Safe Headways, Two-lanes Fully-Correlated Platoons, 90-ft Simple-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 6 | 7 | 8 |
| **1.4** | 5 | 5 | 5 | 5 | 6 | 6 | 7 | 8 | 9 | 10 | 11 |
| **1.5** | 7 | 7 | 7 | 7 | 8 | 9 | 9 | 10 | 11 | 12 | 13 |
| **1.6** | 9 | 9 | 9 | 10 | 10 | 11 | 11 | 13 | 14 | 15 | 15 |
| **1.7** | 11 | 11 | 11 | 12 | 13 | 13 | 14 | 15 | 16 | 17 | 19 |
| **1.8** | 13 | 13 | 14 | 14 | 15 | 15 | 16 | 18 | 19 | 21 | 23 |
| **1.9** | 15 | 15 | 16 | 16 | 17 | 18 | 20 | 21 | 24 | 27 | Fail |
| **2** | 18 | 18 | 18 | 19 | 20 | 22 | 24 | 28 | Fail | Fail | Fail |
| **2.1** | 21 | 21 | 22 | 23 | 25 | 31 | Fail | Fail | Fail | Fail | Fail |
| **2.2** | 26 | 27 | 27 | 43 | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table C-5. End Shear (V) Safe Headways, Two-lanes Fully-Correlated Platoons, 90-ft Simple-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 8 | 9 | 11 |
| **1.4** | 6 | 6 | 6 | 7 | 7 | 8 | 9 | 10 | 12 | 12 | 15 |
| **1.5** | 9 | 9 | 9 | 10 | 11 | 11 | 12 | 14 | 17 | 19 | 21 |
| **1.6** | 12 | 12 | 12 | 13 | 14 | 16 | 18 | 21 | 23 | 25 | 28 |
| **1.7** | 15 | 16 | 16 | 18 | 19 | 22 | 24 | 26 | 29 | 31 | 33 |
| **1.8** | 21 | 21 | 22 | 23 | 26 | 27 | 29 | 32 | 34 | 36 | 38 |
| **1.9** | 26 | 26 | 27 | 29 | 30 | 33 | 34 | 37 | 39 | 41 | 44 |
| **2** | 31 | 31 | 32 | 34 | 35 | 37 | 38 | 41 | 44 | 47 | Fail |
| **2.1** | 35 | 36 | 36 | 38 | 40 | 42 | 44 | 46 | Fail | Fail | Fail |
| **2.2** | 40 | 40 | 41 | 42 | 44 | 46 | Fail | Fail | Fail | Fail | Fail |
| **2.3** | 44 | 45 | 45 | 48 | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table C-6. Positive Moment (+M) and End Shear (V) Safe Headways, Two-lanes Fully-Correlated, 90-ft Simple-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 8 | 9 | 11 |
| **1.4** | 6 | 6 | 6 | 7 | 7 | 8 | 9 | 10 | 12 | 12 | 15 |
| **1.5** | 9 | 9 | 9 | 10 | 11 | 11 | 12 | 14 | 17 | 19 | 21 |
| **1.6** | 12 | 12 | 12 | 13 | 14 | 16 | 18 | 21 | 23 | 25 | 28 |
| **1.7** | 15 | 16 | 16 | 18 | 19 | 22 | 24 | 26 | 29 | 31 | 33 |
| **1.8** | 21 | 21 | 22 | 23 | 26 | 27 | 29 | 32 | 34 | 36 | 38 |
| **1.9** | 26 | 26 | 27 | 29 | 30 | 33 | 34 | 37 | 39 | 41 | Fail |
| **2** | 31 | 31 | 32 | 34 | 35 | 37 | 38 | 41 | Fail | Fail | Fail |
| **2.1** | 35 | 36 | 36 | 38 | 40 | 42 | Fail | Fail | Fail | Fail | Fail |
| **2.2** | 40 | 40 | 41 | 43 | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table C-7. Acceptable Simple-Span Positive Moment Two-lanes Fully-Correlated Headways (CoV= 0.18)

| α / Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 6 | 8 | 7 |
| **1.2** | 5 | 5 | 5 | 11 | 14 | 17 |
| **1.3** | 5 | 5 | 7 | 14 | 20 | 25 |
| **1.4** | 5 | 5 | 10 | 17 | 24 | 31 |
| **1.5** | 5 | 5 | 12 | 20 | 28 | 37 |
| **1.6** | 5 | 8 | 15 | 23 | 31 | 42 |
| **1.7** | 5 | 14 | 17 | 26 | 34 | 47 |
| **1.8** | Fail | Fail | 21 | 29 | 37 | 50 |
| **1.9** | Fail | Fail | 27 | 31 | 40 | Fail |
| **2** | Fail | Fail | Fail | 36 | 43 | Fail |
| **2.1** | Fail | Fail | Fail | 43 | 46 | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.7** | Fail | Fail | Fail | Fail | Fail | Fail |

Table C-8. Acceptable Simple-Span Shear Two-lanes Fully-Correlated Headways (CoV= 0.18)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 7 | 10 | 8 |
| **1.2** | 5 | 5 | 6 | 12 | 18 | 21 |
| **1.3** | 5 | 5 | 9 | 17 | 24 | 31 |
| **1.4** | 5 | 5 | 12 | 23 | 30 | 39 |
| **1.5** | 5 | 7 | 19 | 27 | 35 | 48 |
| **1.6** | 5 | 11 | 25 | 35 | 42 | Fail |
| **1.7** | 5 | 14 | 31 | 44 | Fail | Fail |
| **1.8** | 5 | 18 | 36 | Fail | Fail | Fail |
| **1.9** | 11 | 22 | 41 | Fail | Fail | Fail |
| **2** | Fail | Fail | 47 | Fail | Fail | Fail |
| **2.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.7** | Fail | Fail | Fail | Fail | Fail | Fail |

Table C-9. Acceptable Simple-Span Moment and Shear Two-lanes Fully-Correlated Headways (CoV= 0.18)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 7 | 10 | 8 |
| **1.2** | 5 | 5 | 6 | 12 | 18 | 21 |
| **1.3** | 5 | 5 | 9 | 17 | 24 | 31 |
| **1.4** | 5 | 5 | 12 | 23 | 30 | 39 |
| **1.5** | 5 | 7 | 19 | 27 | 35 | 48 |
| **1.6** | 5 | 11 | 25 | 35 | 42 | Fail |
| **1.7** | 5 | 14 | 31 | 44 | Fail | Fail |
| **1.8** | Fail | Fail | 36 | Fail | Fail | Fail |
| **1.9** | Fail | Fail | 41 | Fail | Fail | Fail |
| **2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.7** | Fail | Fail | Fail | Fail | Fail | Fail |

Table C-10. Acceptable Simple-Span Positive Moment Two-lanes Fully-Correlated Headways (CoV= 0.14)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 8 | 11 | 12 |
| **1.3** | 5 | 5 | 6 | 12 | 17 | 21 |
| **1.4** | 5 | 5 | 8 | 15 | 21 | 26 |
| **1.5** | 5 | 5 | 10 | 18 | 25 | 33 |
| **1.6** | 5 | 5 | 13 | 21 | 28 | 39 |
| **1.7** | 5 | 8 | 15 | 24 | 32 | 43 |
| **1.8** | 5 | 15 | 18 | 26 | 35 | 48 |
| **1.9** | Fail | Fail | 21 | 29 | 38 | Fail |
| **2** | Fail | Fail | 28 | 31 | 40 | Fail |
| **2.1** | Fail | Fail | Fail | 36 | 43 | Fail |
| **2.2** | Fail | Fail | Fail | 45 | 46 | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.7** | Fail | Fail | Fail | Fail | Fail | Fail |

Table C-11. Acceptable Simple-Span Shear Two-lanes Fully-Correlated Headways

(CoV= 0.14)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 9 | 14 | 15 |
| **1.3** | 5 | 5 | 7 | 15 | 20 | 25 |
| **1.4** | 5 | 5 | 10 | 19 | 26 | 35 |
| **1.5** | 5 | 5 | 14 | 24 | 31 | 43 |
| **1.6** | 5 | 8 | 21 | 28 | 37 | 50 |
| **1.7** | 5 | 11 | 26 | 37 | 44 | Fail |
| **1.8** | 5 | 15 | 32 | 45 | Fail | Fail |
| **1.9** | 5 | 18 | 37 | Fail | Fail | Fail |
| **2** | 10 | 22 | 41 | Fail | Fail | Fail |
| **2.1** | Fail | 35 | 46 | Fail | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.7** | Fail | Fail | Fail | Fail | Fail | Fail |

Table C-12. Acceptable Simple-Span Moment and Shear Two-lanes Fully-Correlated Headways (CoV= 0.14)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 9 | 14 | 15 |
| **1.3** | 5 | 5 | 7 | 15 | 20 | 25 |
| **1.4** | 5 | 5 | 10 | 19 | 26 | 35 |
| **1.5** | 5 | 5 | 14 | 24 | 31 | 43 |
| **1.6** | 5 | 8 | 21 | 28 | 37 | 50 |
| **1.7** | 5 | 11 | 26 | 37 | 44 | Fail |
| **1.8** | 5 | 15 | 32 | 45 | Fail | Fail |
| **1.9** | Fail | Fail | 37 | Fail | Fail | Fail |
| **2** | Fail | Fail | 41 | Fail | Fail | Fail |
| **2.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.7** | Fail | Fail | Fail | Fail | Fail | Fail |

Table C-13. Acceptable Simple-Span Positive Moment Two-lanes Fully-Correlated Headways (CoV= 0.12)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 7 | 10 | 11 |
| **1.3** | 5 | 5 | 5 | 11 | 15 | 19 |
| **1.4** | 5 | 5 | 7 | 14 | 20 | 26 |
| **1.5** | 5 | 5 | 9 | 17 | 24 | 32 |
| **1.6** | 5 | 5 | 11 | 20 | 27 | 37 |
| **1.7** | 5 | 7 | 14 | 23 | 31 | 42 |
| **1.8** | 5 | 11 | 16 | 25 | 34 | 46 |
| **1.9** | Fail | Fail | 20 | 28 | 36 | 50 |
| **2** | Fail | Fail | 24 | 30 | 39 | Fail |
| **2.1** | Fail | Fail | Fail | 34 | 42 | Fail |
| **2.2** | Fail | Fail | Fail | 39 | 45 | Fail |
| **2.3** | Fail | Fail | Fail | Fail | 49 | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |

Table C-14. Acceptable Simple-Span Shear Two-lanes Fully-Correlated Headways

(CoV= 0.12)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 8 | 11 | 12 |
| **1.3** | 5 | 5 | 6 | 13 | 19 | 23 |
| **1.4** | 5 | 5 | 9 | 18 | 24 | 32 |
| **1.5** | 5 | 5 | 12 | 22 | 30 | 40 |
| **1.6** | 5 | 7 | 18 | 27 | 35 | 48 |
| **1.7** | 5 | 10 | 24 | 34 | 41 | Fail |
| **1.8** | 5 | 13 | 29 | 41 | Fail | Fail |
| **1.9** | 5 | 16 | 34 | 50 | Fail | Fail |
| **2** | 7 | 20 | 38 | Fail | Fail | Fail |
| **2.1** | Fail | 26 | 44 | Fail | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |

Table C-15. Acceptable Simple-Span Moment and Shear Two-lanes Fully-Correlated Headways (CoV= 0.12)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 8 | 11 | 12 |
| **1.3** | 5 | 5 | 6 | 13 | 19 | 23 |
| **1.4** | 5 | 5 | 9 | 18 | 24 | 32 |
| **1.5** | 5 | 5 | 12 | 22 | 30 | 40 |
| **1.6** | 5 | 7 | 18 | 27 | 35 | 48 |
| **1.7** | 5 | 10 | 24 | 34 | 41 | Fail |
| **1.8** | 5 | 13 | 29 | 41 | Fail | Fail |
| **1.9** | Fail | Fail | 34 | 50 | Fail | Fail |
| **2** | Fail | Fail | 38 | Fail | Fail | Fail |
| **2.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |

Table C-16. Acceptable Simple-Span Positive Moment Two-lanes Fully-Correlated Headways (CoV= 0.07)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 7 | 7 |
| **1.3** | 5 | 5 | 5 | 9 | 13 | 15 |
| **1.4** | 5 | 5 | 5 | 12 | 18 | 22 |
| **1.5** | 5 | 5 | 8 | 15 | 22 | 28 |
| **1.6** | 5 | 5 | 10 | 18 | 25 | 34 |
| **1.7** | 5 | 5 | 12 | 21 | 29 | 39 |
| **1.8** | 5 | 7 | 14 | 23 | 32 | 43 |
| **1.9** | 5 | 11 | 17 | 25 | 34 | 47 |
| **2** | Fail | Fail | 20 | 28 | 37 | Fail |
| **2.1** | Fail | Fail | 24 | 30 | 39 | Fail |
| **2.2** | Fail | Fail | Fail | 34 | 42 | Fail |
| **2.3** | Fail | Fail | Fail | 38 | 45 | Fail |
| **2.4** | Fail | Fail | Fail | Fail | 49 | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |

Table C-17. Acceptable Simple-Span Shear Two-lanes Fully-Correlated Headways (CoV= 0.07)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 6 | 5 |
| **1.3** | 5 | 5 | 5 | 9 | 14 | 17 |
| **1.4** | 5 | 5 | 7 | 14 | 21 | 26 |
| **1.5** | 5 | 5 | 10 | 19 | 26 | 35 |
| **1.6** | 5 | 5 | 13 | 23 | 32 | 43 |
| **1.7** | 5 | 7 | 19 | 27 | 36 | 49 |
| **1.8** | 5 | 10 | 25 | 34 | 42 | Fail |
| **1.9** | 5 | 13 | 29 | 43 | Fail | Fail |
| **2** | 5 | 16 | 34 | 50 | Fail | Fail |
| **2.1** | 6 | 19 | 39 | Fail | Fail | Fail |
| **2.2** | 12 | 24 | 43 | Fail | Fail | Fail |
| **2.3** | Fail | Fail | 49 | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |

Table C-18. Acceptable Simple-Span Moment and Shear Two-lanes Fully-Correlated Headways (CoV= 0.07)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 7 | 7 |
| **1.3** | 5 | 5 | 5 | 9 | 14 | 17 |
| **1.4** | 5 | 5 | 7 | 14 | 21 | 26 |
| **1.5** | 5 | 5 | 10 | 19 | 26 | 35 |
| **1.6** | 5 | 5 | 13 | 23 | 32 | 43 |
| **1.7** | 5 | 7 | 19 | 27 | 36 | 49 |
| **1.8** | 5 | 10 | 25 | 34 | 42 | Fail |
| **1.9** | 5 | 13 | 29 | 43 | Fail | Fail |
| **2** | Fail | Fail | 34 | 50 | Fail | Fail |
| **2.1** | Fail | Fail | 39 | Fail | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |

Table C-19. Acceptable Simple-Span Positive Moment Two-lanes Fully-Correlated Headways (CoV= 0)

| α / Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 7 | 11 | 13 |
| **1.4** | 5 | 5 | 5 | 11 | 16 | 20 |
| **1.5** | 5 | 5 | 7 | 14 | 20 | 26 |
| **1.6** | 5 | 5 | 9 | 17 | 24 | 32 |
| **1.7** | 5 | 5 | 11 | 19 | 27 | 38 |
| **1.8** | 5 | 5 | 13 | 22 | 30 | 42 |
| **1.9** | 5 | 8 | 15 | 24 | 33 | 46 |
| **2** | 5 | 12 | 18 | 26 | 35 | 49 |
| **2.1** | Fail | Fail | 21 | 29 | 38 | Fail |
| **2.2** | Fail | Fail | 26 | 32 | 41 | Fail |
| **2.3** | Fail | Fail | Fail | 36 | 43 | Fail |
| **2.4** | Fail | Fail | Fail | 41 | 46 | Fail |
| **2.5** | Fail | Fail | Fail | Fail | 50 | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table C-20. Acceptable Simple-Span Shear Two-lanes Fully-Correlated Headways (CoV= 0)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 7 | 11 | 13 |
| **1.4** | 5 | 5 | 6 | 12 | 19 | 22 |
| **1.5** | 5 | 5 | 9 | 17 | 24 | 31 |
| **1.6** | 5 | 5 | 12 | 20 | 29 | 40 |
| **1.7** | 5 | 5 | 15 | 25 | 34 | 46 |
| **1.8** | 5 | 8 | 21 | 30 | 39 | Fail |
| **1.9** | 5 | 11 | 26 | 38 | 46 | Fail |
| **2** | 5 | 14 | 31 | 45 | Fail | Fail |
| **2.1** | 5 | 17 | 35 | Fail | Fail | Fail |
| **2.2** | 6 | 20 | 40 | Fail | Fail | Fail |
| **2.3** | 21 | 26 | 44 | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table C-21. Acceptable Simple-Span Moment and Shear Two-lanes Fully-Correlated Headways (CoV= 0)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 7 | 11 | 13 |
| **1.4** | 5 | 5 | 6 | 12 | 19 | 22 |
| **1.5** | 5 | 5 | 9 | 17 | 24 | 31 |
| **1.6** | 5 | 5 | 12 | 20 | 29 | 40 |
| **1.7** | 5 | 5 | 15 | 25 | 34 | 46 |
| **1.8** | 5 | 8 | 21 | 30 | 39 | Fail |
| **1.9** | 5 | 11 | 26 | 38 | 46 | Fail |
| **2** | 5 | 14 | 31 | 45 | Fail | Fail |
| **2.1** | Fail | Fail | 35 | Fail | Fail | Fail |
| **2.2** | Fail | Fail | 40 | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |

# Appendix D. Simple-Span LRFD Bridge Headway Tables for Platoons Adjacent to Routine Traffic ($\beta_{target}$ = 2.5)

Table D-1. Positive Moment (+M) Safe Headways, Platoons & Routine Traffic, 60-ft Simple-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.7** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 |
| **2.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 8 | 9 | 10 |
| **2.2** | 5 | 5 | 5 | 5 | 5 | 7 | 8 | 9 | 11 | 13 | 45 |
| **2.3** | 6 | 7 | 7 | 7 | 8 | 9 | 11 | 13 | 31 | Fail | Fail |
| **2.4** | 9 | 9 | 9 | 10 | 11 | 14 | Fail | Fail | Fail | Fail | Fail |
| **2.5** | 12 | 12 | 15 | 16 | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.7** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.8** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.9** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table D-2. End Shear (V) Safe Headways, Platoons & Routine Traffic, 60-ft Simple-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.7** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 7 | 8 |
| **1.9** | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 8 | 10 | 11 |
| **2** | 5 | 5 | 5 | 6 | 6 | 7 | 9 | 10 | 11 | 13 | 14 |
| **2.1** | 7 | 7 | 8 | 9 | 9 | 10 | 12 | 13 | 14 | 15 | 16 |
| **2.2** | 10 | 10 | 11 | 11 | 12 | 13 | 14 | 15 | 17 | 18 | 20 |
| **2.3** | 12 | 12 | 13 | 13 | 14 | 16 | 16 | 18 | 19 | 22 | 24 |
| **2.4** | 15 | 15 | 15 | 16 | 17 | 18 | 19 | 21 | 23 | 29 | Fail |
| **2.5** | 17 | 17 | 18 | 18 | 19 | 21 | 22 | 27 | Fail | Fail | Fail |
| **2.6** | 19 | 20 | 21 | 21 | 23 | 26 | 34 | Fail | Fail | Fail | Fail |
| **2.7** | 23 | 24 | 25 | 26 | 33 | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.8** | 30 | 33 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.9** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table D-3. Positive Moment and End Shear (+M) Safe Headways, Platoons & Routine Traffic, 60-ft Simple-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.7** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 7 | 8 |
| **1.9** | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 8 | 10 | 11 |
| **2** | 5 | 5 | 5 | 6 | 6 | 7 | 9 | 10 | 11 | 13 | 14 |
| **2.1** | 7 | 7 | 8 | 9 | 9 | 10 | 12 | 13 | 14 | 15 | 16 |
| **2.2** | 10 | 10 | 11 | 11 | 12 | 13 | 14 | 15 | 17 | 18 | 45 |
| **2.3** | 12 | 12 | 13 | 13 | 14 | 16 | 16 | 18 | 31 | Fail | Fail |
| **2.4** | 15 | 15 | 15 | 16 | 17 | 18 | Fail | Fail | Fail | Fail | Fail |
| **2.5** | 17 | 17 | 18 | 18 | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.7** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.8** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.9** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table D-4. Positive Moment (+M) Safe Headways, Platoons & Routine Traffic, 90-ft Simple-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.7** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 7 |
| **1.8** | 5 | 5 | 5 | 5 | 5 | 6 | 6 | 7 | 8 | 9 | 10 |
| **1.9** | 6 | 6 | 6 | 7 | 7 | 8 | 8 | 9 | 10 | 11 | 11 |
| **2** | 8 | 8 | 8 | 9 | 9 | 9 | 10 | 11 | 11 | 12 | 13 |
| **2.1** | 10 | 10 | 10 | 10 | 10 | 11 | 12 | 13 | 13 | 14 | 15 |
| **2.2** | 11 | 11 | 12 | 12 | 12 | 13 | 14 | 14 | 15 | 16 | 17 |
| **2.3** | 13 | 13 | 13 | 14 | 14 | 15 | 15 | 16 | 18 | 19 | 20 |
| **2.4** | 15 | 15 | 15 | 15 | 16 | 17 | 18 | 19 | 20 | 22 | 24 |
| **2.5** | 17 | 17 | 17 | 17 | 18 | 19 | 20 | 21 | 23 | 26 | 33 |
| **2.6** | 19 | 19 | 19 | 20 | 21 | 22 | 24 | 26 | 33 | Fail | Fail |
| **2.7** | 21 | 22 | 22 | 23 | 24 | 26 | 34 | Fail | Fail | Fail | Fail |
| **2.8** | 25 | 25 | 26 | 28 | 36 | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.9** | 39 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table D-5. End Shear (V) Safe Headways, Platoons & Routine Traffic, 90-ft Simple-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 8 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 8 | 8 | 10 | 11 |
| **1.7** | 6 | 6 | 7 | 7 | 8 | 9 | 9 | 10 | 11 | 12 | 14 |
| **1.8** | 9 | 9 | 9 | 10 | 10 | 11 | 12 | 13 | 15 | 17 | 19 |
| **1.9** | 11 | 11 | 11 | 12 | 13 | 14 | 16 | 17 | 20 | 23 | 25 |
| **2** | 14 | 15 | 15 | 16 | 17 | 18 | 20 | 23 | 25 | 27 | 30 |
| **2.1** | 18 | 18 | 19 | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 |
| **2.2** | 23 | 23 | 24 | 25 | 27 | 28 | 30 | 32 | 33 | 36 | 38 |
| **2.3** | 27 | 27 | 28 | 29 | 31 | 32 | 34 | 36 | 38 | 40 | 42 |
| **2.4** | 31 | 31 | 32 | 33 | 34 | 36 | 38 | 40 | 42 | 45 | 47 |
| **2.5** | 35 | 35 | 36 | 37 | 38 | 40 | 42 | 43 | 46 | Fail | Fail |
| **2.6** | 39 | 39 | 39 | 41 | 42 | 44 | 46 | 49 | Fail | Fail | Fail |
| **2.7** | 42 | 42 | 43 | 44 | 46 | 49 | Fail | Fail | Fail | Fail | Fail |
| **2.8** | 46 | 47 | 48 | 49 | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.9** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table D-6. Positive Moment and End Shear (+M) Safe Headways, Platoons & Routine Traffic, 90-ft Simple-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 8 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 8 | 8 | 10 | 11 |
| **1.7** | 6 | 6 | 7 | 7 | 8 | 9 | 9 | 10 | 11 | 12 | 14 |
| **1.8** | 9 | 9 | 9 | 10 | 10 | 11 | 12 | 13 | 15 | 17 | 19 |
| **1.9** | 11 | 11 | 11 | 12 | 13 | 14 | 16 | 17 | 20 | 23 | 25 |
| **2** | 14 | 15 | 15 | 16 | 17 | 18 | 20 | 23 | 25 | 27 | 30 |
| **2.1** | 18 | 18 | 19 | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 |
| **2.2** | 23 | 23 | 24 | 25 | 27 | 28 | 30 | 32 | 33 | 36 | 38 |
| **2.3** | 27 | 27 | 28 | 29 | 31 | 32 | 34 | 36 | 38 | 40 | 42 |
| **2.4** | 31 | 31 | 32 | 33 | 34 | 36 | 38 | 40 | 42 | 45 | 47 |
| **2.5** | 35 | 35 | 36 | 37 | 38 | 40 | 42 | 43 | 46 | Fail | Fail |
| **2.6** | 39 | 39 | 39 | 41 | 42 | 44 | 46 | 49 | Fail | Fail | Fail |
| **2.7** | 42 | 42 | 43 | 44 | 46 | 49 | Fail | Fail | Fail | Fail | Fail |
| **2.8** | 46 | 47 | 48 | 49 | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.9** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table D-7. Acceptable Simple-Span Positive Moment Platoons & Routine Traffic Headways (CoV= 0.18)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 7 | 11 | 7 |
| **1.6** | 5 | 5 | 5 | 10 | 14 | 14 |
| **1.7** | 5 | 5 | 7 | 13 | 18 | 20 |
| **1.8** | 5 | 5 | 9 | 15 | 22 | 26 |
| **1.9** | 5 | 5 | 11 | 18 | 25 | 31 |
| **2** | 5 | 6 | 12 | 20 | 28 | 35 |
| **2.1** | Fail | 9 | 14 | 22 | 29 | 38 |
| **2.2** | Fail | 13 | 16 | 24 | 32 | 42 |
| **2.3** | Fail | Fail | 19 | 26 | 34 | 45 |
| **2.4** | Fail | Fail | 22 | 28 | 37 | 48 |
| **2.5** | Fail | Fail | 26 | 30 | 39 | 50 |
| **2.6** | Fail | Fail | Fail | 33 | 41 | Fail |
| **2.7** | Fail | Fail | Fail | 37 | 43 | Fail |
| **2.8** | Fail | Fail | Fail | 43 | 46 | Fail |
| **2.9** | Fail | Fail | Fail | Fail | 49 | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail |

Table D-8. Acceptable Simple-Span Shear Platoons & Routine Traffic Headways (CoV= 0.18)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 6 | 5 |
| **1.4** | 5 | 5 | 5 | 9 | 14 | 13 |
| **1.5** | 5 | 5 | 7 | 14 | 20 | 23 |
| **1.6** | 5 | 5 | 10 | 18 | 25 | 32 |
| **1.7** | 5 | 5 | 12 | 21 | 31 | 39 |
| **1.8** | 5 | 7 | 17 | 25 | 34 | 46 |
| **1.9** | 5 | 10 | 23 | 31 | 39 | Fail |
| **2** | 5 | 13 | 27 | 39 | 47 | Fail |
| **2.1** | 5 | 15 | 32 | 45 | Fail | Fail |
| **2.2** | 7 | 18 | 36 | Fail | Fail | Fail |
| **2.3** | Fail | 22 | 40 | Fail | Fail | Fail |
| **2.4** | Fail | 29 | 45 | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.7** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.8** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.9** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail |

Table D-9. Acceptable Simple-Span Moment and Shear Platoons & Routine Traffic Headways (CoV= 0.18)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 6 | 5 |
| **1.4** | 5 | 5 | 5 | 9 | 14 | 13 |
| **1.5** | 5 | 5 | 7 | 14 | 20 | 23 |
| **1.6** | 5 | 5 | 10 | 18 | 25 | 32 |
| **1.7** | 5 | 5 | 12 | 21 | 31 | 39 |
| **1.8** | 5 | 7 | 17 | 25 | 34 | 46 |
| **1.9** | 5 | 10 | 23 | 31 | 39 | Fail |
| **2** | 5 | 13 | 27 | 39 | 47 | Fail |
| **2.1** | Fail | 15 | 32 | 45 | Fail | Fail |
| **2.2** | Fail | 18 | 36 | Fail | Fail | Fail |
| **2.3** | Fail | Fail | 40 | Fail | Fail | Fail |
| **2.4** | Fail | Fail | 45 | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.7** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.8** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.9** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail |

Table D-10. Acceptable Simple-Span Positive Moment Platoons & Routine Traffic Headways (CoV= 0.14)

| α / Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 7 | 5 |
| **1.6** | 5 | 5 | 5 | 9 | 11 | 10 |
| **1.7** | 5 | 5 | 5 | 11 | 15 | 17 |
| **1.8** | 5 | 5 | 7 | 14 | 19 | 23 |
| **1.9** | 5 | 5 | 9 | 16 | 23 | 28 |
| **2** | 5 | 5 | 11 | 18 | 26 | 32 |
| **2.1** | 5 | 6 | 13 | 21 | 28 | 36 |
| **2.2** | Fail | 9 | 14 | 22 | 31 | 40 |
| **2.3** | Fail | 13 | 16 | 24 | 33 | 43 |
| **2.4** | Fail | Fail | 19 | 26 | 35 | 46 |
| **2.5** | Fail | Fail | 21 | 28 | 37 | 49 |
| **2.6** | Fail | Fail | 26 | 30 | 39 | Fail |
| **2.7** | Fail | Fail | Fail | 33 | 41 | Fail |
| **2.8** | Fail | Fail | Fail | 36 | 44 | Fail |
| **2.9** | Fail | Fail | Fail | 41 | 46 | Fail |
| **3** | Fail | Fail | Fail | Fail | 48 | Fail |
| **3.1** | Fail | Fail | Fail | Fail | Fail | Fail |

Table D-11. Acceptable Simple-Span Shear Two-lanes Platoons & Routine Traffic

(CoV= 0.14)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 6 | 10 | 8 |
| **1.5** | 5 | 5 | 5 | 11 | 16 | 18 |
| **1.6** | 5 | 5 | 8 | 15 | 22 | 27 |
| **1.7** | 5 | 5 | 10 | 19 | 27 | 34 |
| **1.8** | 5 | 5 | 13 | 23 | 31 | 41 |
| **1.9** | 5 | 7 | 17 | 26 | 35 | 47 |
| **2** | 5 | 10 | 23 | 32 | 40 | Fail |
| **2.1** | 5 | 13 | 28 | 40 | 48 | Fail |
| **2.2** | 5 | 15 | 32 | 45 | Fail | Fail |
| **2.3** | 7 | 18 | 36 | Fail | Fail | Fail |
| **2.4** | Fail | 21 | 40 | Fail | Fail | Fail |
| **2.5** | Fail | 27 | 43 | Fail | Fail | Fail |
| **2.6** | Fail | Fail | 49 | Fail | Fail | Fail |
| **2.7** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.8** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.9** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.1** | Fail | Fail | Fail | Fail | Fail | Fail |

Table D-12. Acceptable Simple-Span Moment and Shear Platoons & Routine Traffic Headways (CoV= 0.14)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 6 | 10 | 8 |
| **1.5** | 5 | 5 | 5 | 11 | 16 | 18 |
| **1.6** | 5 | 5 | 8 | 15 | 22 | 27 |
| **1.7** | 5 | 5 | 10 | 19 | 27 | 34 |
| **1.8** | 5 | 5 | 13 | 23 | 31 | 41 |
| **1.9** | 5 | 7 | 17 | 26 | 35 | 47 |
| **2** | 5 | 10 | 23 | 32 | 40 | Fail |
| **2.1** | 5 | 13 | 28 | 40 | 48 | Fail |
| **2.2** | Fail | 15 | 32 | 45 | Fail | Fail |
| **2.3** | Fail | 18 | 36 | Fail | Fail | Fail |
| **2.4** | Fail | Fail | 40 | Fail | Fail | Fail |
| **2.5** | Fail | Fail | 43 | Fail | Fail | Fail |
| **2.6** | Fail | Fail | 49 | Fail | Fail | Fail |
| **2.7** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.8** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.9** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.1** | Fail | Fail | Fail | Fail | Fail | Fail |

Table D-13. Acceptable Simple-Span Positive Moment Platoons & Routine Traffic Headways (CoV= 0.12)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 6 | 5 |
| **1.6** | 5 | 5 | 5 | 7 | 11 | 9 |
| **1.7** | 5 | 5 | 5 | 10 | 15 | 16 |
| **1.8** | 5 | 5 | 6 | 13 | 18 | 21 |
| **1.9** | 5 | 5 | 8 | 15 | 22 | 25 |
| **2** | 5 | 5 | 10 | 17 | 25 | 31 |
| **2.1** | 5 | 5 | 12 | 20 | 27 | 35 |
| **2.2** | 5 | 8 | 14 | 22 | 30 | 39 |
| **2.3** | Fail | 11 | 15 | 24 | 32 | 42 |
| **2.4** | Fail | Fail | 18 | 25 | 34 | 45 |
| **2.5** | Fail | Fail | 20 | 27 | 36 | 48 |
| **2.6** | Fail | Fail | 24 | 30 | 38 | Fail |
| **2.7** | Fail | Fail | 34 | 32 | 41 | Fail |
| **2.8** | Fail | Fail | Fail | 34 | 43 | Fail |
| **2.9** | Fail | Fail | Fail | 38 | 45 | Fail |
| **3** | Fail | Fail | Fail | Fail | 47 | Fail |
| **3.1** | Fail | Fail | Fail | Fail | Fail | Fail |

Table D-14. Acceptable Simple-Span Shear Two-lanes Platoons & Routine Traffic (CoV= 0.12)

| α Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 8 | 6 |
| **1.5** | 5 | 5 | 5 | 10 | 15 | 15 |
| **1.6** | 5 | 5 | 7 | 14 | 20 | 25 |
| **1.7** | 5 | 5 | 9 | 18 | 26 | 32 |
| **1.8** | 5 | 5 | 12 | 21 | 30 | 39 |
| **1.9** | 5 | 6 | 16 | 25 | 34 | 45 |
| **2** | 5 | 9 | 20 | 30 | 38 | Fail |
| **2.1** | 5 | 12 | 26 | 37 | 44 | Fail |
| **2.2** | 5 | 14 | 30 | 43 | Fail | Fail |
| **2.3** | 6 | 16 | 34 | 49 | Fail | Fail |
| **2.4** | 9 | 19 | 38 | Fail | Fail | Fail |
| **2.5** | Fail | 22 | 42 | Fail | Fail | Fail |
| **2.6** | Fail | 34 | 46 | Fail | Fail | Fail |
| **2.7** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.8** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.9** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.1** | Fail | Fail | Fail | Fail | Fail | Fail |

Table D-15. Acceptable Simple-Span Moment and Shear Platoons & Routine Traffic Headways (CoV= 0.12)

| α / Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 8 | 6 |
| **1.5** | 5 | 5 | 5 | 10 | 15 | 15 |
| **1.6** | 5 | 5 | 7 | 14 | 20 | 25 |
| **1.7** | 5 | 5 | 9 | 18 | 26 | 32 |
| **1.8** | 5 | 5 | 12 | 21 | 30 | 39 |
| **1.9** | 5 | 6 | 16 | 25 | 34 | 45 |
| **2** | 5 | 9 | 20 | 30 | 38 | Fail |
| **2.1** | 5 | 12 | 26 | 37 | 44 | Fail |
| **2.2** | 5 | 14 | 30 | 43 | Fail | Fail |
| **2.3** | Fail | 16 | 34 | 49 | Fail | Fail |
| **2.4** | Fail | Fail | 38 | Fail | Fail | Fail |
| **2.5** | Fail | Fail | 42 | Fail | Fail | Fail |
| **2.6** | Fail | Fail | 46 | Fail | Fail | Fail |
| **2.7** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.8** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.9** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.1** | Fail | Fail | Fail | Fail | Fail | Fail |

Table D-16. Acceptable Simple-Span Positive Moment Platoons & Routine Traffic Headways (CoV= 0.07)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 6 | 8 | 6 |
| **1.7** | 5 | 5 | 5 | 8 | 13 | 13 |
| **1.8** | 5 | 5 | 5 | 11 | 17 | 18 |
| **1.9** | 5 | 5 | 7 | 14 | 20 | 23 |
| **2** | 5 | 5 | 9 | 16 | 23 | 28 |
| **2.1** | 5 | 5 | 10 | 18 | 26 | 31 |
| **2.2** | 5 | 5 | 12 | 20 | 28 | 36 |
| **2.3** | 5 | 8 | 14 | 22 | 30 | 39 |
| **2.4** | Fail | 11 | 16 | 24 | 32 | 43 |
| **2.5** | Fail | 24 | 18 | 26 | 35 | 46 |
| **2.6** | Fail | Fail | 20 | 27 | 36 | 49 |
| **2.7** | Fail | Fail | 23 | 29 | 38 | Fail |
| **2.8** | Fail | Fail | 28 | 32 | 40 | Fail |
| **2.9** | Fail | Fail | Fail | 34 | 43 | Fail |
| **3** | Fail | Fail | Fail | 37 | 45 | Fail |
| **3.1** | Fail | Fail | Fail | 48 | 48 | Fail |
| **3.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail |

Table D-17. Acceptable Simple-Span Shear Platoons & Routine Traffic Headways

(CoV= 0.07)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 7 | 11 | 10 |
| **1.6** | 5 | 5 | 5 | 11 | 17 | 20 |
| **1.7** | 5 | 5 | 7 | 15 | 23 | 28 |
| **1.8** | 5 | 5 | 10 | 19 | 27 | 35 |
| **1.9** | 5 | 5 | 12 | 22 | 31 | 41 |
| **2** | 5 | 6 | 16 | 25 | 35 | 46 |
| **2.1** | 5 | 9 | 21 | 31 | 38 | Fail |
| **2.2** | 5 | 11 | 25 | 37 | 47 | Fail |
| **2.3** | 5 | 14 | 30 | 44 | Fail | Fail |
| **2.4** | 5 | 17 | 34 | 49 | Fail | Fail |
| **2.5** | 8 | 19 | 37 | Fail | Fail | Fail |
| **2.6** | Fail | 22 | 42 | Fail | Fail | Fail |
| **2.7** | Fail | 29 | 45 | Fail | Fail | Fail |
| **2.8** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.9** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail |

Table D-18. Acceptable Simple-Span Moment and Shear Platoons & Routine Traffic Headways (CoV= 0.07)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 7 | 11 | 10 |
| **1.6** | 5 | 5 | 5 | 11 | 17 | 20 |
| **1.7** | 5 | 5 | 7 | 15 | 23 | 28 |
| **1.8** | 5 | 5 | 10 | 19 | 27 | 35 |
| **1.9** | 5 | 5 | 12 | 22 | 31 | 41 |
| **2** | 5 | 6 | 16 | 25 | 35 | 46 |
| **2.1** | 5 | 9 | 21 | 31 | 38 | Fail |
| **2.2** | 5 | 11 | 25 | 37 | 47 | Fail |
| **2.3** | 5 | 14 | 30 | 44 | Fail | Fail |
| **2.4** | Fail | 17 | 34 | 49 | Fail | Fail |
| **2.5** | Fail | 24 | 37 | Fail | Fail | Fail |
| **2.6** | Fail | Fail | 42 | Fail | Fail | Fail |
| **2.7** | Fail | Fail | 45 | Fail | Fail | Fail |
| **2.8** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.9** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail |

Table D-19. Acceptable Simple-Span Positive Moment Platoons & Routine Traffic Headways (CoV= 0)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 7 | 5 |
| **1.7** | 5 | 5 | 5 | 8 | 11 | 10 |
| **1.8** | 5 | 5 | 5 | 10 | 15 | 16 |
| **1.9** | 5 | 5 | 6 | 13 | 18 | 22 |
| **2** | 5 | 5 | 8 | 15 | 22 | 26 |
| **2.1** | 5 | 5 | 10 | 17 | 24 | 30 |
| **2.2** | 5 | 5 | 11 | 19 | 27 | 35 |
| **2.3** | 5 | 6 | 13 | 21 | 29 | 39 |
| **2.4** | 5 | 9 | 15 | 23 | 31 | 42 |
| **2.5** | Fail | 12 | 17 | 25 | 34 | 45 |
| **2.6** | Fail | Fail | 19 | 26 | 35 | 48 |
| **2.7** | Fail | Fail | 21 | 28 | 37 | 50 |
| **2.8** | Fail | Fail | 25 | 30 | 39 | Fail |
| **2.9** | Fail | Fail | 39 | 33 | 41 | Fail |
| **3** | Fail | Fail | Fail | 36 | 44 | Fail |
| **3.1** | Fail | Fail | Fail | 41 | 46 | Fail |
| **3.2** | Fail | Fail | Fail | Fail | 48 | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail |

Table D-20. Acceptable Simple-Span Shear Platoons & Routine Traffic Headways

(CoV= 0)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 9 | 6 |
| **1.6** | 5 | 5 | 5 | 10 | 15 | 17 |
| **1.7** | 5 | 5 | 6 | 13 | 20 | 25 |
| **1.8** | 5 | 5 | 9 | 17 | 25 | 32 |
| **1.9** | 5 | 5 | 11 | 20 | 30 | 38 |
| **2** | 5 | 5 | 14 | 24 | 33 | 43 |
| **2.1** | 5 | 7 | 18 | 28 | 37 | 50 |
| **2.2** | 5 | 10 | 23 | 34 | 41 | Fail |
| **2.3** | 5 | 12 | 27 | 40 | 50 | Fail |
| **2.4** | 5 | 15 | 31 | 46 | Fail | Fail |
| **2.5** | 6 | 17 | 35 | Fail | Fail | Fail |
| **2.6** | 9 | 19 | 39 | Fail | Fail | Fail |
| **2.7** | Fail | 23 | 42 | Fail | Fail | Fail |
| **2.8** | Fail | 30 | 46 | Fail | Fail | Fail |
| **2.9** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail |

Table D-21. Acceptable Simple-Span Moment and Shear Platoons & Routine Traffic Headways (CoV= 0)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 9 | 6 |
| **1.6** | 5 | 5 | 5 | 10 | 15 | 17 |
| **1.7** | 5 | 5 | 6 | 13 | 20 | 25 |
| **1.8** | 5 | 5 | 9 | 17 | 25 | 32 |
| **1.9** | 5 | 5 | 11 | 20 | 30 | 38 |
| **2** | 5 | 5 | 14 | 24 | 33 | 43 |
| **2.1** | 5 | 7 | 18 | 28 | 37 | 50 |
| **2.2** | 5 | 10 | 23 | 34 | 41 | Fail |
| **2.3** | 5 | 12 | 27 | 40 | 50 | Fail |
| **2.4** | 5 | 15 | 31 | 46 | Fail | Fail |
| **2.5** | Fail | 17 | 35 | Fail | Fail | Fail |
| **2.6** | Fail | Fail | 39 | Fail | Fail | Fail |
| **2.7** | Fail | Fail | 42 | Fail | Fail | Fail |
| **2.8** | Fail | Fail | 46 | Fail | Fail | Fail |
| **2.9** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail |

# Appendix E. Two-Span LRFD Bridge Headway Tables for Single-lane Platoon-only Loading ($\beta_{target}$ = 2.5)

Table E-1. Negative Moment (-M) Safe Headways, Single-Lane Platoons, 60-ft Two-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.4** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.5** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.6** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.7** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 6\|50 |
| **2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 7\|50 | 7\|50 | 8\|50 |
| **2.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 7\|50 | 7\|50 | 8\|50 | 9\|50 | 10\|50 |
| **2.2** | 5\|50 | 5\|50 | 6\|50 | 6\|50 | 7\|50 | 8\|50 | 8\|50 | 9\|50 | 10\|50 | 11\|50 | 12\|50 |
| **2.3** | 7\|50 | 7\|50 | 7\|50 | 8\|50 | 8\|50 | 9\|50 | 10\|50 | 11\|50 | 12\|50 | 14\|50 | 17\|50 |
| **2.4** | 8\|50 | 8\|50 | 9\|50 | 9\|50 | 10\|50 | 11\|50 | 12\|50 | 14\|50 | 17\|50 | 28\|50 | 34\|50 |
| **2.5** | 10\|50 | 10\|50 | 10\|50 | 11\|50 | 12\|50 | 13\|50 | 15\|50 | 19\|19 | 31\|50 | 36\|50 | 39\|50 |
| **2.6** | 12\|50 | 12\|50 | 12\|50 | 14\|50 | 15\|50 | 18\|50 | 31\|50 | 34\|50 | 37\|50 | 40\|50 | 43\|50 |
| **2.7** | 14\|50 | 15\|50 | 16\|50 | 18\|50 | 31\|50 | 33\|50 | 36\|50 | 39\|50 | 41\|50 | 43\|50 | 45\|50 |
| **2.8** | 29\|50 | 30\|50 | 31\|50 | 33\|50 | 36\|50 | 38\|50 | 40\|50 | 42\|50 | 44\|50 | 46\|50 | 48\|50 |
| **2.9** | 35\|50 | 35\|50 | 36\|50 | 38\|50 | 40\|50 | 41\|50 | 44\|50 | 45\|50 | 47\|50 | 48\|50 | 50\|50 |
| **3** | 39\|50 | 39\|50 | 40\|50 | 41\|50 | 43\|50 | 44\|50 | 46\|50 | 47\|50 | 49\|50 | 50\|50 | Fail |
| **3.1** | 42\|50 | 42\|50 | 43\|50 | 44\|50 | 45\|50 | 46\|50 | 48\|50 | 49\|50 | Fail | Fail | Fail |
| **3.2** | 44\|50 | 44\|50 | 45\|50 | 46\|50 | 47\|50 | 49\|50 | 49\|50 | Fail | Fail | Fail | Fail |
| **3.3** | 46\|50 | 47\|50 | 47\|50 | 48\|50 | 49\|50 | 50\|50 | Fail | Fail | Fail | Fail | Fail |
| **3.4** | 48\|50 | 48\|50 | 49\|50 | 50\|50 | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | 50\|50 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.7** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.8** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table E-2. Middle Support Shear (V) Safe Headways, Single-Lane Platoons, 60-ft Two-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.7** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 |
| **2.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 8 |
| **2.2** | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 8 | 10 | 11 |
| **2.3** | 5 | 5 | 5 | 5 | 5 | 7 | 8 | 9 | 10 | 12 | 13 |
| **2.4** | 5 | 6 | 6 | 7 | 8 | 9 | 10 | 12 | 13 | 14 | 15 |
| **2.5** | 7 | 8 | 8 | 9 | 10 | 11 | 12 | 13 | 15 | 16 | 18 |
| **2.6** | 10 | 10 | 10 | 11 | 12 | 13 | 14 | 16 | 17 | 19 | 23 |
| **2.7** | 12 | 12 | 12 | 13 | 14 | 15 | 16 | 18 | 20 | 24 | 29 |
| **2.8** | 13 | 14 | 14 | 15 | 16 | 17 | 19 | 22 | 25 | 30 | 37 |
| **2.9** | 15 | 15 | 16 | 17 | 17 | 20 | 24 | 26 | 33 | 40 | Fail |
| **3** | 17 | 17 | 18 | 19 | 22 | 25 | 28 | 35 | 44 | Fail | Fail |
| **3.1** | 20 | 20 | 22 | 24 | 26 | 31 | 38 | 46 | Fail | Fail | Fail |
| **3.2** | 24 | 24 | 25 | 29 | 34 | 39 | 50 | Fail | Fail | Fail | Fail |
| **3.3** | 30 | 31 | 33 | 37 | 43 | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.4** | 38 | 39 | 42 | 48 | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | 49 | 49 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.7** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.8** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table E-3. Negative Moment (-M) and Middle Support Shear (V) Safe Headways, Single-Lane Platoons, 60-ft Two-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.8 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 0.9 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.1 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.2 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.3 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.4 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.5 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.6 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.7 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.8 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.9 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 6\|50 |
| 2 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 7\|50 | 7\|50 | 8\|50 |
| 2.1 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 7\|50 | 7\|50 | 8\|50 | 9\|50 | 10\|50 |
| 2.2 | 5\|50 | 5\|50 | 6\|50 | 6\|50 | 7\|50 | 8\|50 | 8\|50 | 9\|50 | 10\|50 | 11\|50 | 12\|50 |
| 2.3 | 7\|50 | 7\|50 | 7\|50 | 8\|50 | 8\|50 | 9\|50 | 10\|50 | 11\|50 | 12\|50 | 14\|50 | 17\|50 |
| 2.4 | 8\|50 | 8\|50 | 9\|50 | 9\|50 | 10\|50 | 11\|50 | 12\|50 | 14\|50 | 17\|50 | 28\|50 | 34\|50 |
| 2.5 | 10\|50 | 10\|50 | 10\|50 | 11\|50 | 12\|50 | 13\|50 | 15\|50 | 19\|19 | 31\|50 | 36\|50 | 39\|50 |
| 2.6 | 12\|50 | 12\|50 | 12\|50 | 14\|50 | 15\|50 | 18\|50 | 31\|50 | 34\|50 | 37\|50 | 40\|50 | 43\|50 |
| 2.7 | 14\|50 | 15\|50 | 16\|50 | 18\|50 | 31\|50 | 33\|50 | 36\|50 | 39\|50 | 41\|50 | 43\|50 | 45\|50 |
| 2.8 | 29\|50 | 30\|50 | 31\|50 | 33\|50 | 36\|50 | 38\|50 | 40\|50 | 42\|50 | 44\|50 | 46\|50 | 48\|50 |
| 2.9 | 35\|50 | 35\|50 | 36\|50 | 38\|50 | 40\|50 | 41\|50 | 44\|50 | 45\|50 | 47\|50 | 48\|50 | Fail |
| 3 | 39\|50 | 39\|50 | 40\|50 | 41\|50 | 43\|50 | 44\|50 | 46\|50 | 47\|50 | 49\|50 | Fail | Fail |
| 3.1 | 42\|50 | 42\|50 | 43\|50 | 44\|50 | 45\|50 | 46\|50 | 48\|50 | 49\|50 | Fail | Fail | Fail |
| 3.2 | 44\|50 | 44\|50 | 45\|50 | 46\|50 | 47\|50 | 49\|50 | 50\|50 | Fail | Fail | Fail | Fail |
| 3.3 | 46\|50 | 47\|50 | 47\|50 | 48\|50 | 49\|50 | Fail | Fail | Fail | Fail | Fail | Fail |
| 3.4 | 48\|50 | 48\|50 | 49\|50 | 50\|50 | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 3.5 | 50\|50 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 3.6 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 3.7 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 3.8 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table E-4. Negative Moment (-M) Safe Headways, Single-Lane Platoons, 90-ft Two-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.4** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.5** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.6** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.7** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 7\|50 | 10\|50 |
| **2.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 7\|50 | 10\|50 | 12\|50 | 14\|50 |
| **2.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 7\|50 | 10\|50 | 13\|50 | 14\|50 | 15\|50 | 17\|50 |
| **2.3** | 5\|50 | 6\|50 | 7\|50 | 9\|50 | 11\|50 | 13\|50 | 14\|50 | 15\|50 | 17\|50 | 18\|50 | 19\|50 |
| **2.4** | 11\|50 | 11\|50 | 12\|50 | 13\|50 | 14\|50 | 15\|50 | 16\|50 | 17\|50 | 19\|50 | 20\|50 | 21\|50 |
| **2.5** | 14\|50 | 14\|50 | 15\|50 | 16\|50 | 16\|50 | 18\|50 | 18\|50 | 19\|50 | 20\|50 | 22\|50 | 23\|50 |
| **2.6** | 17\|50 | 17\|50 | 17\|50 | 17\|50 | 18\|50 | 19\|50 | 20\|50 | 21\|50 | 22\|50 | 23\|50 | 24\|50 |
| **2.7** | 18\|50 | 18\|50 | 19\|50 | 20\|50 | 20\|50 | 21\|50 | 22\|50 | 23\|50 | 24\|50 | 25\|50 | 26\|50 |
| **2.8** | 20\|50 | 20\|50 | 21\|50 | 21\|50 | 22\|50 | 23\|50 | 23\|50 | 24\|50 | 26\|50 | 26\|50 | 28\|50 |
| **2.9** | 21\|50 | 22\|50 | 22\|50 | 23\|50 | 23\|50 | 24\|50 | 25\|50 | 26\|50 | 27\|50 | 28\|50 | 29\|50 |
| **3** | 23\|50 | 23\|50 | 23\|50 | 24\|50 | 25\|50 | 25\|50 | 26\|50 | 27\|50 | 29\|50 | 30\|50 | 31\|50 |
| **3.1** | 25\|50 | 25\|50 | 25\|50 | 25\|50 | 26\|50 | 27\|50 | 28\|50 | 29\|50 | 30\|50 | 32\|50 | 34\|50 |
| **3.2** | 26\|50 | 26\|50 | 26\|50 | 27\|50 | 28\|50 | 28\|50 | 29\|50 | 31\|50 | 33\|50 | 36\|40 | Fail |
| **3.3** | 27\|50 | 27\|50 | 28\|50 | 28\|50 | 29\|50 | 30\|50 | 32\|50 | 33\|50 | Fail | Fail | Fail |
| **3.4** | 29\|50 | 29\|50 | 29\|50 | 30\|50 | 31\|50 | 32\|50 | 35\|50 | Fail | Fail | Fail | Fail |
| **3.5** | 30\|50 | 31\|50 | 31\|50 | 32\|50 | 33\|50 | 37\|47 | Fail | Fail | Fail | Fail | Fail |
| **3.6** | 32\|50 | 32\|50 | 34\|50 | 35\|50 | 41\|41 | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.7** | 36\|44 | 36\|45 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.8** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table E-5. Middle Support Shear (V) Safe Headways, Single-Lane Platoons, 90-ft Two-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.7** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 6 |
| **1.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 8 | 9 |
| **1.9** | 5 | 5 | 5 | 5 | 6 | 6 | 7 | 8 | 9 | 10 | 13 |
| **2** | 6 | 6 | 6 | 7 | 7 | 9 | 10 | 11 | 13 | 15 | 17 |
| **2.1** | 8 | 8 | 8 | 9 | 10 | 11 | 13 | 15 | 18 | 19 | 22 |
| **2.2** | 10 | 10 | 10 | 12 | 14 | 15 | 17 | 19 | 21 | 23 | 25 |
| **2.3** | 13 | 14 | 15 | 16 | 18 | 19 | 21 | 23 | 25 | 27 | 29 |
| **2.4** | 17 | 17 | 18 | 19 | 21 | 23 | 24 | 26 | 28 | 31 | 32 |
| **2.5** | 21 | 21 | 22 | 23 | 24 | 26 | 27 | 30 | 32 | 34 | 36 |
| **2.6** | 24 | 24 | 24 | 26 | 27 | 29 | 31 | 33 | 35 | 37 | 40 |
| **2.7** | 27 | 27 | 28 | 29 | 30 | 32 | 34 | 36 | 39 | 41 | 43 |
| **2.8** | 30 | 30 | 31 | 32 | 34 | 36 | 37 | 39 | 42 | 44 | 47 |
| **2.9** | 33 | 33 | 34 | 35 | 37 | 38 | 41 | 42 | 45 | 49 | Fail |
| **3** | 36 | 36 | 37 | 38 | 40 | 41 | 44 | 46 | 50 | Fail | Fail |
| **3.1** | 39 | 39 | 40 | 41 | 43 | 45 | 48 | 50 | Fail | Fail | Fail |
| **3.2** | 42 | 42 | 43 | 44 | 46 | 50 | Fail | Fail | Fail | Fail | Fail |
| **3.3** | 45 | 46 | 46 | 48 | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.4** | 49 | 50 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.7** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.8** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table E-6. Negative Moment (-M) and Middle Support Shear (V) Safe Headways, Single-Lane Platoons, 90-ft Two-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.4** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.5** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.6** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.7** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 6\|50 |
| **1.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 7\|50 | 8\|50 | 9\|50 |
| **1.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 6\|50 | 7\|50 | 8\|50 | 9\|50 | 10\|50 | 13\|50 |
| **2** | 6\|50 | 6\|50 | 6\|50 | 7\|50 | 7\|50 | 9\|50 | 10\|50 | 11\|50 | 13\|50 | 15\|50 | 17\|50 |
| **2.1** | 8\|50 | 8\|50 | 8\|50 | 9\|50 | 10\|50 | 11\|50 | 13\|50 | 15\|50 | 18\|50 | 19\|50 | 22\|50 |
| **2.2** | 10\|50 | 10\|50 | 10\|50 | 12\|50 | 14\|50 | 15\|50 | 17\|50 | 19\|50 | 21\|50 | 23\|50 | 25\|50 |
| **2.3** | 13\|50 | 14\|50 | 15\|50 | 16\|50 | 18\|50 | 19\|50 | 21\|50 | 23\|50 | 25\|50 | 27\|50 | 29\|50 |
| **2.4** | 17\|50 | 17\|50 | 18\|50 | 19\|50 | 21\|50 | 23\|50 | 24\|50 | 26\|50 | 28\|50 | 31\|50 | 32\|50 |
| **2.5** | 21\|50 | 21\|50 | 22\|50 | 23\|50 | 24\|50 | 26\|50 | 27\|50 | 30\|50 | 32\|50 | 34\|50 | 36\|50 |
| **2.6** | 24\|50 | 24\|50 | 24\|50 | 26\|50 | 27\|50 | 29\|50 | 31\|50 | 33\|50 | 35\|50 | 37\|50 | 40\|50 |
| **2.7** | 27\|50 | 27\|50 | 28\|50 | 29\|50 | 30\|50 | 32\|50 | 34\|50 | 36\|50 | 39\|50 | 41\|50 | 43\|50 |
| **2.8** | 30\|50 | 30\|50 | 31\|50 | 32\|50 | 34\|50 | 36\|50 | 37\|50 | 39\|50 | 42\|50 | 44\|50 | 47\|50 |
| **2.9** | 33\|50 | 33\|50 | 34\|50 | 35\|50 | 37\|50 | 38\|50 | 41\|50 | 42\|50 | 45\|50 | 49\|50 | Fail |
| **3** | 36\|50 | 36\|50 | 37\|50 | 38\|50 | 40\|50 | 41\|50 | 44\|50 | 46\|50 | 50\|50 | Fail | Fail |
| **3.1** | 39\|50 | 39\|50 | 40\|50 | 41\|50 | 43\|50 | 45\|50 | 48\|50 | 50\|50 | Fail | Fail | Fail |
| **3.2** | 42\|50 | 42\|50 | 43\|50 | 44\|50 | 46\|50 | 50\|50 | Fail | Fail | Fail | Fail | Fail |
| **3.3** | 45\|50 | 46\|50 | 46\|50 | 48\|50 | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.4** | 49\|50 | 50\|50 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.7** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.8** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table E-7. Negative Moment (-M) Safe Headways, Single-Lane Platoons, 120-ft Two-Span Bridge

<table>
<tr><th>α CoV</th><th>0</th><th>0.02</th><th>0.04</th><th>0.06</th><th>0.08</th><th>0.1</th><th>0.12</th><th>0.14</th><th>0.16</th><th>0.18</th><th>0.2</th></tr>
<tr><td>0.8</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td></tr>
<tr><td>0.9</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td></tr>
<tr><td>1</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td></tr>
<tr><td>1.1</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td></tr>
<tr><td>1.2</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td></tr>
<tr><td>1.3</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td></tr>
<tr><td>1.4</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td></tr>
<tr><td>1.5</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td></tr>
<tr><td>1.6</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td></tr>
<tr><td>1.7</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td></tr>
<tr><td>1.8</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td></tr>
<tr><td>1.9</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td></tr>
<tr><td>2</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td></tr>
<tr><td>2.1</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td></tr>
<tr><td>2.2</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>17|50</td><td>23|50</td></tr>
<tr><td>2.3</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>20|50</td><td>23|50</td><td>26|50</td><td>28|50</td></tr>
<tr><td>2.4</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>5|50</td><td>20|50</td><td>23|50</td><td>26|50</td><td>28|50</td><td>29|50</td><td>31|50</td></tr>
<tr><td>2.5</td><td>9|50</td><td>8|50</td><td>21|50</td><td>22|50</td><td>23|50</td><td>26|50</td><td>27|50</td><td>30|50</td><td>31|50</td><td>33|50</td><td>34|50</td></tr>
<tr><td>2.6</td><td>25|50</td><td>25|50</td><td>26|50</td><td>26|50</td><td>28|50</td><td>30|50</td><td>31|50</td><td>32|50</td><td>34|50</td><td>35|50</td><td>36|50</td></tr>
<tr><td>2.7</td><td>29|50</td><td>28|50</td><td>29|50</td><td>31|50</td><td>31|50</td><td>32|50</td><td>33|50</td><td>35|50</td><td>36|50</td><td>37|50</td><td>39|50</td></tr>
<tr><td>2.8</td><td>32|50</td><td>32|50</td><td>32|50</td><td>33|50</td><td>34|50</td><td>34|50</td><td>36|50</td><td>37|50</td><td>38|50</td><td>39|50</td><td>41|50</td></tr>
<tr><td>2.9</td><td>34|50</td><td>34|50</td><td>34|50</td><td>35|50</td><td>36|50</td><td>37|50</td><td>38|50</td><td>39|50</td><td>40|50</td><td>41|50</td><td>42|50</td></tr>
<tr><td>3</td><td>36|50</td><td>36|50</td><td>36|50</td><td>37|50</td><td>38|50</td><td>39|50</td><td>39|50</td><td>41|50</td><td>42|50</td><td>43|50</td><td>44|50</td></tr>
<tr><td>3.1</td><td>38|50</td><td>38|50</td><td>38|50</td><td>39|50</td><td>39|50</td><td>40|50</td><td>41|50</td><td>42|50</td><td>44|50</td><td>44|50</td><td>46|50</td></tr>
<tr><td>3.2</td><td>39|50</td><td>40|50</td><td>40|50</td><td>41|50</td><td>41|50</td><td>42|50</td><td>43|50</td><td>44|50</td><td>45|50</td><td>46|50</td><td>47|50</td></tr>
<tr><td>3.3</td><td>41|50</td><td>41|50</td><td>41|50</td><td>42|50</td><td>43|50</td><td>44|50</td><td>44|50</td><td>46|50</td><td>47|50</td><td>48|50</td><td>50|50</td></tr>
<tr><td>3.4</td><td>42|50</td><td>42|50</td><td>43|50</td><td>44|50</td><td>44|50</td><td>45|50</td><td>46|50</td><td>47|50</td><td>49|50</td><td>Fail</td><td>Fail</td></tr>
<tr><td>3.5</td><td>44|50</td><td>44|50</td><td>44|50</td><td>45|50</td><td>46|50</td><td>46|50</td><td>48|50</td><td>49|50</td><td>Fail</td><td>Fail</td><td>Fail</td></tr>
<tr><td>3.6</td><td>46|50</td><td>46|50</td><td>46|50</td><td>47|50</td><td>47|50</td><td>48|50</td><td>50|50</td><td>Fail</td><td>Fail</td><td>Fail</td><td>Fail</td></tr>
<tr><td>3.7</td><td>47|50</td><td>47|50</td><td>48|50</td><td>49|50</td><td>49|50</td><td>Fail</td><td>Fail</td><td>Fail</td><td>Fail</td><td>Fail</td><td>Fail</td></tr>
<tr><td>3.8</td><td>49|50</td><td>50|50</td><td>50|50</td><td>Fail</td><td>Fail</td><td>Fail</td><td>Fail</td><td>Fail</td><td>Fail</td><td>Fail</td><td>Fail</td></tr>
<tr><td>3.9</td><td>Fail</td><td>Fail</td><td>Fail</td><td>Fail</td><td>Fail</td><td>Fail</td><td>Fail</td><td>Fail</td><td>Fail</td><td>Fail</td><td>Fail</td></tr>
</table>

Table E-8. Middle Support Shear (V) Safe Headways, Single-Lane Platoons, 120-ft Two-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 6 | 8 |
| **1.7** | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 9 | 11 | 13 |
| **1.8** | 5 | 5 | 6 | 6 | 7 | 9 | 10 | 12 | 13 | 15 | 16 |
| **1.9** | 8 | 8 | 9 | 10 | 11 | 12 | 14 | 15 | 17 | 18 | 20 |
| **2** | 12 | 12 | 12 | 13 | 15 | 16 | 17 | 18 | 20 | 21 | 25 |
| **2.1** | 15 | 15 | 16 | 16 | 18 | 19 | 20 | 21 | 25 | 28 | 31 |
| **2.2** | 18 | 18 | 19 | 20 | 21 | 22 | 25 | 28 | 30 | 33 | 36 |
| **2.3** | 21 | 21 | 22 | 23 | 25 | 28 | 30 | 33 | 36 | 38 | 41 |
| **2.4** | 26 | 27 | 28 | 29 | 31 | 33 | 35 | 38 | 41 | 44 | 47 |
| **2.5** | 31 | 32 | 32 | 33 | 36 | 38 | 40 | 43 | 46 | 49 | Fail |
| **2.6** | 35 | 36 | 37 | 38 | 41 | 43 | 45 | 48 | Fail | Fail | Fail |
| **2.7** | 40 | 41 | 41 | 43 | 45 | 46 | 50 | Fail | Fail | Fail | Fail |
| **2.8** | 44 | 45 | 46 | 47 | 50 | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.9** | 49 | 49 | 50 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.1** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.2** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.7** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.8** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.9** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table E-9. Negative Moment (-M) and Middle Support Shear (V) Safe Headways, Single-Lane Platoons, 120-ft Two-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.4** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.5** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.6** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 6\|50 | 8\|50 |
| **1.7** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 7\|50 | 9\|50 | 11\|50 | 13\|50 |
| **1.8** | 5\|50 | 5\|50 | 6\|50 | 6\|50 | 7\|50 | 9\|50 | 10\|50 | 12\|50 | 13\|50 | 15\|50 | 16\|50 |
| **1.9** | 8\|50 | 8\|50 | 9\|50 | 10\|50 | 11\|50 | 12\|50 | 14\|50 | 15\|50 | 17\|50 | 18\|50 | 20\|50 |
| **2** | 12\|50 | 12\|50 | 12\|50 | 13\|50 | 15\|50 | 16\|50 | 17\|50 | 18\|50 | 20\|50 | 21\|50 | 25\|50 |
| **2.1** | 15\|50 | 15\|50 | 16\|50 | 16\|50 | 18\|50 | 19\|50 | 20\|50 | 21\|50 | 25\|50 | 28\|50 | 31\|50 |
| **2.2** | 18\|50 | 18\|50 | 19\|50 | 20\|50 | 21\|50 | 22\|50 | 25\|50 | 28\|50 | 30\|50 | 33\|50 | 36\|50 |
| **2.3** | 21\|50 | 21\|50 | 22\|50 | 23\|50 | 25\|50 | 28\|50 | 30\|50 | 33\|50 | 36\|50 | 38\|50 | 41\|50 |
| **2.4** | 26\|50 | 27\|50 | 28\|50 | 29\|50 | 31\|50 | 33\|50 | 35\|50 | 38\|50 | 41\|50 | 44\|50 | 47\|50 |
| **2.5** | 31\|50 | 32\|50 | 32\|50 | 33\|50 | 36\|50 | 38\|50 | 40\|50 | 43\|50 | 46\|50 | 49\|50 | Fail |
| **2.6** | 35\|50 | 36\|50 | 37\|50 | 38\|50 | 41\|50 | 43\|50 | 45\|50 | 48\|50 | Fail | Fail | Fail |
| **2.7** | 40\|50 | 41\|50 | 41\|50 | 43\|50 | 45\|50 | 46\|50 | 50\|50 | Fail | Fail | Fail | Fail |
| **2.8** | 44\|50 | 45\|50 | 46\|50 | 47\|50 | 50\|50 | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.9** | 49\|50 | 49\|50 | 50\|50 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.1** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.2** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.7** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.8** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.9** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table E-10. Acceptable Two-Span Negative Moment Single-lane Headways (CoV= 0.18)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.4** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.5** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.6** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.7** | 8\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.8** | 11\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.9** | 13\|50 | 6\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2** | 15\|50 | 7\|50 | 7\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.1** | 16\|50 | 9\|50 | 12\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.2** | 18\|50 | 11\|50 | 15\|50 | 17\|50 | 5\|50 | 5\|50 |
| **2.3** | 19\|50 | 14\|50 | 18\|50 | 26\|50 | 5\|50 | 5\|50 |
| **2.4** | 20\|50 | 28\|50 | 20\|50 | 29\|50 | 38\|50 | 5\|50 |
| **2.5** | Fail | 36\|50 | 22\|50 | 33\|50 | 42\|50 | 5\|50 |
| **2.6** | Fail | 40\|50 | 23\|50 | 35\|50 | 47\|50 | 5\|50 |
| **2.7** | Fail | 43\|50 | 25\|50 | 37\|50 | 50\|50 | 8\|28 |
| **2.8** | Fail | 46\|50 | 26\|50 | 39\|50 | Fail | 10\|17 |
| **2.9** | Fail | 48\|50 | 28\|50 | 41\|50 | Fail | Fail |
| **3** | Fail | 50\|50 | 30\|50 | 43\|50 | Fail | Fail |
| **3.1** | Fail | Fail | 32\|50 | 44\|50 | Fail | Fail |
| **3.2** | Fail | Fail | 36\|40 | 46\|50 | Fail | Fail |
| **3.3** | Fail | Fail | Fail | 48\|50 | Fail | Fail |
| **3.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table E-11. Acceptable Two-Span Shear Single-lane Headways (CoV= 0.18)

| α / Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 6 |
| **1.5** | 5 | 5 | 5 | 5 | 8 | 12 |
| **1.6** | 5 | 5 | 5 | 6 | 11 | 17 |
| **1.7** | 5 | 5 | 6 | 11 | 15 | 22 |
| **1.8** | 5 | 5 | 8 | 15 | 20 | 26 |
| **1.9** | 5 | 5 | 10 | 18 | 25 | 31 |
| **2** | 5 | 5 | 15 | 21 | 29 | 37 |
| **2.1** | 5 | 7 | 19 | 28 | 33 | 43 |
| **2.2** | 5 | 10 | 23 | 33 | 38 | 48 |
| **2.3** | 5 | 12 | 27 | 38 | 45 | Fail |
| **2.4** | 5 | 14 | 31 | 44 | Fail | Fail |
| **2.5** | 5 | 16 | 34 | 49 | Fail | Fail |
| **2.6** | 5 | 19 | 37 | Fail | Fail | Fail |
| **2.7** | 5 | 24 | 41 | Fail | Fail | Fail |
| **2.8** | 8 | 30 | 44 | Fail | Fail | Fail |
| **2.9** | 15 | 40 | 49 | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table E-12. Acceptable Two-Span Moment and Shear Single-lane Headways (CoV= 0.18)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.4** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 |
| **1.5** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 8\|50 | 12\|50 |
| **1.6** | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 11\|50 | 17\|50 |
| **1.7** | 8\|50 | 5\|50 | 6\|50 | 11\|50 | 15\|50 | 22\|50 |
| **1.8** | 11\|50 | 5\|50 | 8\|50 | 15\|50 | 20\|50 | 26\|50 |
| **1.9** | 13\|50 | 6\|50 | 10\|50 | 18\|50 | 25\|50 | 31\|50 |
| **2** | 15\|50 | 7\|50 | 15\|50 | 21\|50 | 29\|50 | 37\|50 |
| **2.1** | 16\|50 | 9\|50 | 19\|50 | 28\|50 | 33\|50 | 43\|50 |
| **2.2** | 18\|50 | 11\|50 | 23\|50 | 33\|50 | 38\|50 | 48\|50 |
| **2.3** | 19\|50 | 14\|50 | 27\|50 | 38\|50 | 45\|50 | Fail |
| **2.4** | 20\|50 | 28\|50 | 31\|50 | 44\|50 | Fail | Fail |
| **2.5** | Fail | 36\|50 | 34\|50 | 49\|50 | Fail | Fail |
| **2.6** | Fail | 40\|50 | 37\|50 | Fail | Fail | Fail |
| **2.7** | Fail | 43\|50 | 41\|50 | Fail | Fail | Fail |
| **2.8** | Fail | 46\|50 | 44\|50 | Fail | Fail | Fail |
| **2.9** | Fail | 48\|50 | 49\|50 | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table E-13. Acceptable Two-Span Negative Moment Single-lane Headways (CoV= 0.14)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.4** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.5** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.6** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.7** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.8** | 9\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.9** | 11\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2** | 13\|50 | 6\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.1** | 15\|50 | 7\|50 | 7\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.2** | 16\|50 | 9\|50 | 13\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.3** | 17\|50 | 11\|50 | 15\|50 | 20\|50 | 5\|50 | 5\|50 |
| **2.4** | 19\|50 | 14\|50 | 17\|50 | 26\|50 | 5\|50 | 5\|50 |
| **2.5** | 19\|50 | 19\|50 | 19\|50 | 30\|50 | 37\|50 | 5\|50 |
| **2.6** | Fail | 34\|50 | 21\|50 | 32\|50 | 43\|50 | 5\|50 |
| **2.7** | Fail | 39\|50 | 23\|50 | 35\|50 | 47\|50 | 5\|50 |
| **2.8** | Fail | 42\|50 | 24\|50 | 37\|50 | 50\|50 | 8\|27 |
| **2.9** | Fail | 45\|50 | 26\|50 | 39\|50 | Fail | 10\|18 |
| **3** | Fail | 47\|50 | 27\|50 | 41\|50 | Fail | Fail |
| **3.1** | Fail | 49\|50 | 29\|50 | 42\|50 | Fail | Fail |
| **3.2** | Fail | Fail | 31\|50 | 44\|50 | Fail | Fail |
| **3.3** | Fail | Fail | 33\|50 | 46\|50 | Fail | Fail |
| **3.4** | Fail | Fail | Fail | 47\|50 | Fail | Fail |
| **3.5** | Fail | Fail | Fail | 49\|50 | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table E-14. Acceptable Two-Span Shear Single-lane Headways (CoV= 0.14)

| α / Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 6 | 8 |
| **1.6** | 5 | 5 | 5 | 5 | 9 | 14 |
| **1.7** | 5 | 5 | 5 | 7 | 12 | 19 |
| **1.8** | 5 | 5 | 6 | 12 | 16 | 23 |
| **1.9** | 5 | 5 | 8 | 15 | 21 | 26 |
| **2** | 5 | 5 | 11 | 18 | 25 | 32 |
| **2.1** | 5 | 5 | 15 | 21 | 29 | 38 |
| **2.2** | 5 | 7 | 19 | 28 | 33 | 44 |
| **2.3** | 5 | 9 | 23 | 33 | 38 | 48 |
| **2.4** | 5 | 12 | 26 | 38 | 45 | Fail |
| **2.5** | 5 | 13 | 30 | 43 | Fail | Fail |
| **2.6** | 5 | 16 | 33 | 48 | Fail | Fail |
| **2.7** | 5 | 18 | 36 | Fail | Fail | Fail |
| **2.8** | 5 | 22 | 39 | Fail | Fail | Fail |
| **2.9** | 6 | 26 | 42 | Fail | Fail | Fail |
| **3** | 10 | 35 | 46 | Fail | Fail | Fail |
| **3.1** | 21 | 46 | 50 | Fail | Fail | Fail |
| **3.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table E-15. Acceptable Two-Span Moment and Shear Single-lane Headways (CoV= 0.14)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.4** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.5** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 8\|50 |
| **1.6** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 9\|50 | 14\|50 |
| **1.7** | 5\|50 | 5\|50 | 5\|50 | 7\|50 | 12\|50 | 19\|50 |
| **1.8** | 9\|50 | 5\|50 | 6\|50 | 12\|50 | 16\|50 | 23\|50 |
| **1.9** | 11\|50 | 5\|50 | 8\|50 | 15\|50 | 21\|50 | 26\|50 |
| **2** | 13\|50 | 6\|50 | 11\|50 | 18\|50 | 25\|50 | 32\|50 |
| **2.1** | 15\|50 | 7\|50 | 15\|50 | 21\|50 | 29\|50 | 38\|50 |
| **2.2** | 16\|50 | 9\|50 | 19\|50 | 28\|50 | 33\|50 | 44\|50 |
| **2.3** | 17\|50 | 11\|50 | 23\|50 | 33\|50 | 38\|50 | 48\|50 |
| **2.4** | 19\|50 | 14\|50 | 26\|50 | 38\|50 | 45\|50 | Fail |
| **2.5** | 19\|50 | 19\|50 | 30\|50 | 43\|50 | Fail | Fail |
| **2.6** | Fail | 34\|50 | 33\|50 | 48\|50 | Fail | Fail |
| **2.7** | Fail | 39\|50 | 36\|50 | Fail | Fail | Fail |
| **2.8** | Fail | 42\|50 | 39\|50 | Fail | Fail | Fail |
| **2.9** | Fail | 45\|50 | 42\|50 | Fail | Fail | Fail |
| **3** | Fail | 47\|50 | 46\|50 | Fail | Fail | Fail |
| **3.1** | Fail | 49\|50 | 50\|50 | Fail | Fail | Fail |
| **3.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table E-16. Acceptable Two-Span Negative Moment Single-lane Headways (CoV= 0.12)

| α / Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| 0.8 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 0.9 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.1 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.2 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.3 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.4 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.5 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.6 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.7 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.8 | 7\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.9 | 10\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 2 | 12\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 2.1 | 14\|50 | 7\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 2.2 | 15\|50 | 8\|50 | 10\|50 | 5\|50 | 5\|50 | 5\|50 |
| 2.3 | 17\|50 | 10\|50 | 14\|50 | 5\|50 | 5\|50 | 5\|50 |
| 2.4 | 18\|50 | 12\|50 | 16\|50 | 23\|50 | 5\|50 | 5\|50 |
| 2.5 | 19\|50 | 15\|50 | 18\|50 | 27\|50 | 5\|50 | 5\|50 |
| 2.6 | 20\|50 | 31\|50 | 20\|50 | 31\|50 | 40\|50 | 5\|50 |
| 2.7 | Fail | 36\|50 | 22\|50 | 33\|50 | 44\|50 | 5\|50 |
| 2.8 | Fail | 40\|50 | 23\|50 | 36\|50 | 49\|50 | 6\|50 |
| 2.9 | Fail | 44\|50 | 25\|50 | 38\|50 | Fail | 9\|22 |
| 3 | Fail | 46\|50 | 26\|50 | 39\|50 | Fail | Fail |
| 3.1 | Fail | 48\|50 | 28\|50 | 41\|50 | Fail | Fail |
| 3.2 | Fail | 49\|50 | 29\|50 | 43\|50 | Fail | Fail |
| 3.3 | Fail | Fail | 32\|50 | 44\|50 | Fail | Fail |
| 3.4 | Fail | Fail | 35\|50 | 46\|50 | Fail | Fail |
| 3.5 | Fail | Fail | Fail | 48\|50 | Fail | Fail |
| 3.6 | Fail | Fail | Fail | 50\|50 | Fail | Fail |
| 3.7 | Fail | Fail | Fail | Fail | Fail | Fail |

Table E-17. Acceptable Two-Span Shear Single-lane Headways (CoV= 0.12)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 6 |
| **1.6** | 5 | 5 | 5 | 5 | 8 | 12 |
| **1.7** | 5 | 5 | 5 | 6 | 11 | 17 |
| **1.8** | 5 | 5 | 5 | 10 | 14 | 21 |
| **1.9** | 5 | 5 | 7 | 14 | 19 | 25 |
| **2** | 5 | 5 | 10 | 17 | 24 | 29 |
| **2.1** | 5 | 5 | 13 | 20 | 28 | 34 |
| **2.2** | 5 | 6 | 17 | 25 | 32 | 41 |
| **2.3** | 5 | 8 | 21 | 30 | 35 | 46 |
| **2.4** | 5 | 10 | 24 | 35 | 42 | Fail |
| **2.5** | 5 | 12 | 27 | 40 | 47 | Fail |
| **2.6** | 5 | 14 | 31 | 45 | Fail | Fail |
| **2.7** | 5 | 16 | 34 | 50 | Fail | Fail |
| **2.8** | 5 | 19 | 37 | Fail | Fail | Fail |
| **2.9** | 5 | 24 | 41 | Fail | Fail | Fail |
| **3** | 6 | 28 | 44 | Fail | Fail | Fail |
| **3.1** | 11 | 38 | 48 | Fail | Fail | Fail |
| **3.2** | Fail | 50 | Fail | Fail | Fail | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.7** | Fail | Fail | Fail | Fail | Fail | Fail |

Table E-18. Acceptable Two-Span Moment and Shear Single-lane Headways (CoV= 0.12)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.4** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.5** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 |
| **1.6** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 8\|50 | 12\|50 |
| **1.7** | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 11\|50 | 17\|50 |
| **1.8** | 7\|50 | 5\|50 | 5\|50 | 10\|50 | 14\|50 | 21\|50 |
| **1.9** | 10\|50 | 5\|50 | 7\|50 | 14\|50 | 19\|50 | 25\|50 |
| **2** | 12\|50 | 5\|50 | 10\|50 | 17\|50 | 24\|50 | 29\|50 |
| **2.1** | 14\|50 | 7\|50 | 13\|50 | 20\|50 | 28\|50 | 34\|50 |
| **2.2** | 15\|50 | 8\|50 | 17\|50 | 25\|50 | 32\|50 | 41\|50 |
| **2.3** | 17\|50 | 10\|50 | 21\|50 | 30\|50 | 35\|50 | 46\|50 |
| **2.4** | 18\|50 | 12\|50 | 24\|50 | 35\|50 | 42\|50 | Fail |
| **2.5** | 19\|50 | 15\|50 | 27\|50 | 40\|50 | 47\|50 | Fail |
| **2.6** | 20\|50 | 31\|50 | 31\|50 | 45\|50 | Fail | Fail |
| **2.7** | Fail | 36\|50 | 34\|50 | 50\|50 | Fail | Fail |
| **2.8** | Fail | 40\|50 | 37\|50 | Fail | Fail | Fail |
| **2.9** | Fail | 44\|50 | 41\|50 | Fail | Fail | Fail |
| **3** | Fail | 46\|50 | 44\|50 | Fail | Fail | Fail |
| **3.1** | Fail | 48\|50 | 48\|50 | Fail | Fail | Fail |
| **3.2** | Fail | 50\|50 | Fail | Fail | Fail | Fail |
| **3.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.7** | Fail | Fail | Fail | Fail | Fail | Fail |

Table E-19. Acceptable Two-Span Negative Moment Single-lane Headways (CoV= 0.07)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.4** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.5** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.6** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.7** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.9** | 7\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2** | 10\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.1** | 12\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.2** | 14\|50 | 6\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.3** | 15\|50 | 8\|50 | 10\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.4** | 17\|50 | 9\|50 | 13\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.5** | 18\|50 | 11\|50 | 16\|50 | 23\|50 | 5\|50 | 5\|50 |
| **2.6** | 19\|50 | 14\|50 | 18\|50 | 28\|50 | 5\|50 | 5\|50 |
| **2.7** | 19\|50 | 27\|50 | 20\|50 | 31\|50 | 39\|50 | 5\|50 |
| **2.8** | Fail | 35\|50 | 22\|50 | 33\|50 | 44\|50 | 5\|50 |
| **2.9** | Fail | 39\|50 | 23\|50 | 36\|50 | 47\|50 | 5\|50 |
| **3** | Fail | 42\|50 | 24\|50 | 37\|50 | Fail | 9\|20 |
| **3.1** | Fail | 44\|50 | 26\|50 | 39\|50 | Fail | 11\|11 |
| **3.2** | Fail | 47\|50 | 27\|50 | 40\|50 | Fail | Fail |
| **3.3** | Fail | 48\|50 | 28\|50 | 43\|50 | Fail | Fail |
| **3.4** | Fail | 50\|50 | 30\|50 | 44\|50 | Fail | Fail |
| **3.5** | Fail | Fail | 32\|50 | 45\|50 | Fail | Fail |
| **3.6** | Fail | Fail | 38\|38 | 47\|50 | Fail | Fail |
| **3.7** | Fail | Fail | Fail | 49\|50 | Fail | Fail |
| **3.8** | Fail | Fail | Fail | Fail | Fail | Fail |

Table E-20. Acceptable Two-Span Shear Single-lane Headways (CoV= 0.07)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 9 |
| **1.7** | 5 | 5 | 5 | 5 | 9 | 14 |
| **1.8** | 5 | 5 | 5 | 7 | 11 | 18 |
| **1.9** | 5 | 5 | 5 | 10 | 14 | 22 |
| **2** | 5 | 5 | 8 | 14 | 19 | 26 |
| **2.1** | 5 | 5 | 10 | 17 | 24 | 30 |
| **2.2** | 5 | 5 | 13 | 20 | 28 | 36 |
| **2.3** | 5 | 5 | 17 | 24 | 32 | 41 |
| **2.4** | 5 | 7 | 20 | 30 | 34 | 47 |
| **2.5** | 5 | 9 | 23 | 34 | 41 | 50 |
| **2.6** | 5 | 11 | 27 | 40 | 46 | Fail |
| **2.7** | 5 | 13 | 30 | 44 | Fail | Fail |
| **2.8** | 5 | 15 | 33 | 48 | Fail | Fail |
| **2.9** | 5 | 17 | 36 | Fail | Fail | Fail |
| **3** | 5 | 20 | 39 | Fail | Fail | Fail |
| **3.1** | 5 | 25 | 42 | Fail | Fail | Fail |
| **3.2** | 7 | 29 | 45 | Fail | Fail | Fail |
| **3.3** | 11 | 40 | 49 | Fail | Fail | Fail |
| **3.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.7** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.8** | Fail | Fail | Fail | Fail | Fail | Fail |

Table E-21. Acceptable Two-Span Moment and Shear Single-lane Headways (CoV= 0.07)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.4** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.5** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.6** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 9\|50 |
| **1.7** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 9\|50 | 14\|50 |
| **1.8** | 5\|50 | 5\|50 | 5\|50 | 7\|50 | 11\|50 | 18\|50 |
| **1.9** | 7\|50 | 5\|50 | 5\|50 | 10\|50 | 14\|50 | 22\|50 |
| **2** | 10\|50 | 5\|50 | 8\|50 | 14\|50 | 19\|50 | 26\|50 |
| **2.1** | 12\|50 | 5\|50 | 10\|50 | 17\|50 | 24\|50 | 30\|50 |
| **2.2** | 14\|50 | 6\|50 | 13\|50 | 20\|50 | 28\|50 | 36\|50 |
| **2.3** | 15\|50 | 8\|50 | 17\|50 | 24\|50 | 32\|50 | 41\|50 |
| **2.4** | 17\|50 | 9\|50 | 20\|50 | 30\|50 | 34\|50 | 47\|50 |
| **2.5** | 18\|50 | 11\|50 | 23\|50 | 34\|50 | 41\|50 | 50\|50 |
| **2.6** | 19\|50 | 14\|50 | 27\|50 | 40\|50 | 46\|50 | Fail |
| **2.7** | 19\|50 | 27\|50 | 30\|50 | 44\|50 | Fail | Fail |
| **2.8** | Fail | 35\|50 | 33\|50 | 48\|50 | Fail | Fail |
| **2.9** | Fail | 39\|50 | 36\|50 | Fail | Fail | Fail |
| **3** | Fail | 42\|50 | 39\|50 | Fail | Fail | Fail |
| **3.1** | Fail | 44\|50 | 42\|50 | Fail | Fail | Fail |
| **3.2** | Fail | 47\|50 | 45\|50 | Fail | Fail | Fail |
| **3.3** | Fail | 48\|50 | 49\|50 | Fail | Fail | Fail |
| **3.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.7** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.8** | Fail | Fail | Fail | Fail | Fail | Fail |

Table E-22. Acceptable Two-Span Negative Moment Single-lane Headways (CoV= 0)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.4** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.5** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.6** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.7** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2** | 8\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.1** | 10\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.2** | 13\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.3** | 14\|50 | 7\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.4** | 15\|50 | 8\|50 | 11\|50 | 5\|50 | 5\|50 | 5\|50 |
| **2.5** | 17\|50 | 10\|50 | 14\|50 | 9\|50 | 5\|50 | 5\|50 |
| **2.6** | 18\|50 | 12\|50 | 17\|50 | 25\|50 | 5\|50 | 5\|50 |
| **2.7** | 19\|50 | 14\|50 | 18\|50 | 29\|50 | 37\|50 | 5\|50 |
| **2.8** | 20\|50 | 29\|50 | 20\|50 | 32\|50 | 42\|50 | 5\|50 |
| **2.9** | 20\|50 | 35\|50 | 21\|50 | 34\|50 | 45\|50 | 5\|50 |
| **3** | Fail | 39\|50 | 23\|50 | 36\|50 | 49\|50 | 7\|29 |
| **3.1** | Fail | 42\|50 | 25\|50 | 38\|50 | Fail | 11\|17 |
| **3.2** | Fail | 44\|50 | 26\|50 | 39\|50 | Fail | Fail |
| **3.3** | Fail | 46\|50 | 27\|50 | 41\|50 | Fail | Fail |
| **3.4** | Fail | 48\|50 | 29\|50 | 42\|50 | Fail | Fail |
| **3.5** | Fail | 50\|50 | 30\|50 | 44\|50 | Fail | Fail |
| **3.6** | Fail | Fail | 32\|50 | 46\|50 | Fail | Fail |
| **3.7** | Fail | Fail | 36\|44 | 47\|50 | Fail | Fail |
| **3.8** | Fail | Fail | Fail | 49\|50 | Fail | Fail |
| **3.9** | Fail | Fail | Fail | Fail | Fail | Fail |

Table E-23. Acceptable Two-Span Shear Single-lane Headways (CoV= 0)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 6 |
| **1.7** | 5 | 5 | 5 | 5 | 7 | 12 |
| **1.8** | 5 | 5 | 5 | 5 | 10 | 16 |
| **1.9** | 5 | 5 | 5 | 8 | 13 | 21 |
| **2** | 5 | 5 | 6 | 12 | 17 | 24 |
| **2.1** | 5 | 5 | 8 | 15 | 22 | 27 |
| **2.2** | 5 | 5 | 10 | 18 | 26 | 32 |
| **2.3** | 5 | 5 | 13 | 21 | 29 | 38 |
| **2.4** | 5 | 5 | 17 | 26 | 32 | 43 |
| **2.5** | 5 | 7 | 21 | 31 | 36 | 48 |
| **2.6** | 5 | 10 | 24 | 35 | 43 | Fail |
| **2.7** | 5 | 12 | 27 | 40 | 48 | Fail |
| **2.8** | 5 | 13 | 30 | 44 | Fail | Fail |
| **2.9** | 5 | 15 | 33 | 49 | Fail | Fail |
| **3** | 5 | 17 | 36 | Fail | Fail | Fail |
| **3.1** | 5 | 20 | 39 | Fail | Fail | Fail |
| **3.2** | 5 | 24 | 42 | Fail | Fail | Fail |
| **3.3** | 6 | 30 | 45 | Fail | Fail | Fail |
| **3.4** | 9 | 38 | 49 | Fail | Fail | Fail |
| **3.5** | 20 | 49 | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.7** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.8** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.9** | Fail | Fail | Fail | Fail | Fail | Fail |

Table E-24. Acceptable Two-Span Moment and Shear Single-lane Headways (CoV= 0)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.4** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.5** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.6** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 |
| **1.7** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 7\|50 | 12\|50 |
| **1.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 10\|50 | 16\|50 |
| **1.9** | 5\|50 | 5\|50 | 5\|50 | 8\|50 | 13\|50 | 21\|50 |
| **2** | 8\|50 | 5\|50 | 6\|50 | 12\|50 | 17\|50 | 24\|50 |
| **2.1** | 10\|50 | 5\|50 | 8\|50 | 15\|50 | 22\|50 | 27\|50 |
| **2.2** | 13\|50 | 5\|50 | 10\|50 | 18\|50 | 26\|50 | 32\|50 |
| **2.3** | 14\|50 | 7\|50 | 13\|50 | 21\|50 | 29\|50 | 38\|50 |
| **2.4** | 15\|50 | 8\|50 | 17\|50 | 26\|50 | 32\|50 | 43\|50 |
| **2.5** | 17\|50 | 10\|50 | 21\|50 | 31\|50 | 36\|50 | 48\|50 |
| **2.6** | 18\|50 | 12\|50 | 24\|50 | 35\|50 | 43\|50 | Fail |
| **2.7** | 19\|50 | 14\|50 | 27\|50 | 40\|50 | 48\|50 | Fail |
| **2.8** | 20\|50 | 29\|50 | 30\|50 | 44\|50 | Fail | Fail |
| **2.9** | 20\|50 | 35\|50 | 33\|50 | 49\|50 | Fail | Fail |
| **3** | Fail | 39\|50 | 36\|50 | Fail | Fail | Fail |
| **3.1** | Fail | 42\|50 | 39\|50 | Fail | Fail | Fail |
| **3.2** | Fail | 44\|50 | 42\|50 | Fail | Fail | Fail |
| **3.3** | Fail | 46\|50 | 45\|50 | Fail | Fail | Fail |
| **3.4** | Fail | 48\|50 | 49\|50 | Fail | Fail | Fail |
| **3.5** | Fail | 50\|50 | Fail | Fail | Fail | Fail |
| **3.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.7** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.8** | Fail | Fail | Fail | Fail | Fail | Fail |
| **3.9** | Fail | Fail | Fail | Fail | Fail | Fail |

## Appendix F. Two-Span LRFD Bridge Headway Tables for Two-lane, Fully-Correlated Platoon-only Loading ($\beta_{target}$ = 2.5)

Table F-1. Negative Moment (-M) Safe Headways, Two-lanes Fully-Correlated Platoons, 60-ft Two-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.8 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 0.9 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.1 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 |
| 1.2 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 7\|50 | 8\|50 | 8\|50 |
| 1.3 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 6\|50 | 7\|50 | 8\|50 | 9\|50 | 9\|50 | 11\|50 | 12\|50 |
| 1.4 | 8\|50 | 8\|50 | 8\|50 | 8\|50 | 9\|50 | 10\|50 | 11\|50 | 12\|50 | 14\|50 | 16\|50 | 29\|50 |
| 1.5 | 10\|50 | 10\|50 | 11\|50 | 11\|50 | 12\|50 | 14\|50 | 16\|50 | 28\|50 | 33\|50 | 37\|50 | 39\|50 |
| 1.6 | 14\|50 | 14\|50 | 16\|50 | 17\|50 | 27\|50 | 31\|50 | 36\|50 | 38\|50 | 40\|50 | 43\|50 | 45\|50 |
| 1.7 | 32\|50 | 33\|50 | 34\|50 | 36\|50 | 38\|50 | 40\|50 | 42\|50 | 43\|50 | 45\|50 | 47\|50 | 49\|50 |
| 1.8 | 39\|50 | 40\|50 | 40\|50 | 42\|50 | 43\|50 | 45\|50 | 46\|50 | 48\|50 | 49\|50 | 50\|50 | Fail |
| 1.9 | 44\|50 | 44\|50 | 45\|50 | 45\|50 | 47\|50 | 48\|50 | 50\|50 | Fail | Fail | Fail | Fail |
| 2 | 47\|50 | 48\|50 | 48\|50 | 49\|50 | 50\|50 | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.1 | 50\|50 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.2 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.3 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.4 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.5 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.6 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table F-2. Middle Support Shear (V) Safe Headways, Two-lanes Fully-Correlated Platoons, 60-ft Two-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 9 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 8 | 9 | 11 | 12 |
| **1.6** | 6 | 6 | 6 | 7 | 8 | 9 | 10 | 11 | 13 | 14 | 15 |
| **1.7** | 9 | 9 | 9 | 10 | 11 | 12 | 13 | 15 | 15 | 17 | 20 |
| **1.8** | 12 | 12 | 12 | 13 | 14 | 15 | 16 | 18 | 20 | 24 | 28 |
| **1.9** | 14 | 14 | 15 | 16 | 17 | 18 | 21 | 24 | 29 | 36 | 43 |
| **2** | 17 | 17 | 18 | 19 | 22 | 25 | 28 | 35 | 42 | Fail | Fail |
| **2.1** | 22 | 23 | 24 | 26 | 29 | 36 | 42 | Fail | Fail | Fail | Fail |
| **2.2** | 30 | 30 | 34 | 37 | 44 | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | 42 | 45 | 49 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table F-3. Negative Moment (-M) and Middle Support Shear (V) Safe Headways, Two-lanes Fully-Correlated Platoons, 60-ft Two-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 7\|50 | 8\|50 | 8\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 6\|50 | 7\|50 | 8\|50 | 9\|50 | 9\|50 | 11\|50 | 12\|50 |
| **1.4** | 8\|50 | 8\|50 | 8\|50 | 8\|50 | 9\|50 | 10\|50 | 11\|50 | 12\|50 | 14\|50 | 16\|50 | 29\|50 |
| **1.5** | 10\|50 | 10\|50 | 11\|50 | 11\|50 | 12\|50 | 14\|50 | 16\|50 | 28\|50 | 33\|50 | 37\|50 | 39\|50 |
| **1.6** | 14\|50 | 14\|50 | 16\|50 | 17\|50 | 27\|50 | 31\|50 | 36\|50 | 38\|50 | 40\|50 | 43\|50 | 45\|50 |
| **1.7** | 32\|50 | 33\|50 | 34\|50 | 36\|50 | 38\|50 | 40\|50 | 42\|50 | 43\|50 | 45\|50 | 47\|50 | 49\|50 |
| **1.8** | 39\|50 | 40\|50 | 40\|50 | 42\|50 | 43\|50 | 45\|50 | 46\|50 | 48\|50 | 49\|50 | 50\|50 | Fail |
| **1.9** | 44\|50 | 44\|50 | 45\|50 | 45\|50 | 47\|50 | 48\|50 | 50\|50 | Fail | Fail | Fail | Fail |
| **2** | 47\|50 | 48\|50 | 48\|50 | 49\|50 | 50\|50 | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.1** | 50\|50 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table F-4. Negative Moment (-M) Safe Headways, Two-lanes Fully-Correlated Platoons, 90-ft Two-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 9\|50 | 11\|50 | 13\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 8\|50 | 10\|50 | 12\|50 | 14\|50 | 15\|50 | 17\|50 | 18\|50 |
| **1.4** | 12\|50 | 12\|50 | 13\|50 | 14\|50 | 14\|50 | 16\|50 | 17\|50 | 18\|50 | 19\|50 | 20\|50 | 21\|50 |
| **1.5** | 16\|50 | 17\|50 | 17\|50 | 17\|50 | 18\|50 | 19\|50 | 20\|50 | 21\|50 | 22\|50 | 23\|50 | 24\|50 |
| **1.6** | 20\|50 | 20\|50 | 20\|50 | 21\|50 | 21\|50 | 22\|50 | 23\|50 | 24\|50 | 25\|50 | 26\|50 | 27\|50 |
| **1.7** | 23\|50 | 22\|50 | 23\|50 | 23\|50 | 24\|50 | 25\|50 | 25\|50 | 26\|50 | 27\|50 | 29\|50 | 30\|50 |
| **1.8** | 25\|50 | 25\|50 | 25\|50 | 26\|50 | 26\|50 | 27\|50 | 28\|50 | 29\|50 | 31\|50 | 32\|50 | 36\|49 |
| **1.9** | 27\|50 | 27\|50 | 28\|50 | 28\|50 | 29\|50 | 30\|50 | 31\|50 | 33\|50 | 39\|50 | Fail | Fail |
| **2** | 30\|50 | 30\|50 | 30\|50 | 31\|50 | 33\|50 | 34\|50 | 42\|50 | Fail | Fail | Fail | Fail |
| **2.1** | 33\|50 | 33\|50 | 34\|50 | 37\|50 | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table F-5. Middle Support Shear (V) Safe Headways, Two-lanes Fully-Correlated Platoons, 90-ft Two-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 8 | 9 |
| **1.3** | 5 | 5 | 5 | 6 | 7 | 8 | 8 | 9 | 11 | 13 | 15 |
| **1.4** | 8 | 8 | 9 | 9 | 10 | 11 | 13 | 15 | 17 | 19 | 21 |
| **1.5** | 11 | 12 | 13 | 14 | 15 | 17 | 19 | 21 | 23 | 24 | 27 |
| **1.6** | 17 | 18 | 19 | 19 | 21 | 22 | 24 | 26 | 28 | 30 | 33 |
| **1.7** | 22 | 22 | 24 | 24 | 26 | 27 | 29 | 31 | 33 | 35 | 38 |
| **1.8** | 27 | 27 | 28 | 29 | 30 | 32 | 35 | 36 | 39 | 41 | 43 |
| **1.9** | 31 | 32 | 33 | 33 | 35 | 37 | 39 | 41 | 43 | 47 | 49 |
| **2** | 36 | 37 | 37 | 38 | 40 | 42 | 42 | 46 | 50 | Fail | Fail |
| **2.1** | 40 | 41 | 41 | 42 | 44 | 47 | 50 | Fail | Fail | Fail | Fail |
| **2.2** | 45 | 45 | 46 | 47 | 50 | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table F-6. Negative Moment (-M) and Middle Support Shear (V) Safe Headways, Two-lanes Fully-Correlated Platoons, 90-ft Two-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.8 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 0.9 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.1 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.2 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 9\|50 | 11\|50 | 13\|50 |
| 1.3 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 8\|50 | 10\|50 | 12\|50 | 14\|50 | 15\|50 | 17\|50 | 18\|50 |
| 1.4 | 12\|50 | 12\|50 | 13\|50 | 14\|50 | 14\|50 | 16\|50 | 17\|50 | 18\|50 | 19\|50 | 20\|50 | 21\|50 |
| 1.5 | 16\|50 | 17\|50 | 17\|50 | 17\|50 | 18\|50 | 19\|50 | 20\|50 | 21\|50 | 23\|50 | 24\|50 | 27\|50 |
| 1.6 | 20\|50 | 20\|50 | 20\|50 | 21\|50 | 21\|50 | 22\|50 | 24\|50 | 26\|50 | 28\|50 | 30\|50 | 33\|50 |
| 1.7 | 23\|50 | 22\|50 | 24\|50 | 24\|50 | 26\|50 | 27\|50 | 29\|50 | 31\|50 | 33\|50 | 35\|50 | 38\|50 |
| 1.8 | 27\|50 | 27\|50 | 28\|50 | 29\|50 | 30\|50 | 32\|50 | 35\|50 | 36\|50 | 39\|50 | 41\|50 | 43\|49 |
| 1.9 | 31\|50 | 32\|50 | 33\|50 | 33\|50 | 35\|50 | 37\|50 | 39\|50 | 41\|50 | 43\|50 | Fail | Fail |
| 2 | 36\|50 | 37\|50 | 37\|50 | 38\|50 | 40\|50 | 42\|50 | 42\|50 | Fail | Fail | Fail | Fail |
| 2.1 | 40\|50 | 41\|50 | 41\|50 | 42\|50 | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.2 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.3 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.4 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.5 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.6 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table F-7. Negative Moment (-M) Safe Headways, Two-lanes Fully-Correlated Platoons, 120-ft Two-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.8 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 0.9 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.1 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.2 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.3 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 20\|50 | 23\|50 | 26\|50 | 28\|50 |
| 1.4 | 5\|50 | 5\|50 | 18\|50 | 22\|50 | 23\|50 | 25\|50 | 27\|50 | 29\|50 | 31\|50 | 32\|50 | 34\|50 |
| 1.5 | 27\|50 | 27\|50 | 28\|50 | 29\|50 | 30\|50 | 32\|50 | 32\|50 | 34\|50 | 35\|50 | 37\|50 | 38\|50 |
| 1.6 | 32\|50 | 32\|50 | 33\|50 | 33\|50 | 34\|50 | 36\|50 | 37\|50 | 38\|50 | 39\|50 | 40\|50 | 41\|50 |
| 1.7 | 36\|50 | 36\|50 | 37\|50 | 37\|50 | 38\|50 | 39\|50 | 40\|50 | 41\|50 | 42\|50 | 43\|50 | 44\|50 |
| 1.8 | 40\|50 | 40\|50 | 40\|50 | 40\|50 | 41\|50 | 42\|50 | 43\|50 | 44\|50 | 45\|50 | 46\|50 | 48\|50 |
| 1.9 | 42\|50 | 42\|50 | 42\|50 | 43\|50 | 44\|50 | 45\|50 | 46\|50 | 47\|50 | 48\|50 | 50\|50 | Fail |
| 2 | 45\|50 | 45\|50 | 45\|50 | 46\|50 | 47\|50 | 48\|50 | 49\|50 | Fail | Fail | Fail | Fail |
| 2.1 | 48\|50 | 47\|50 | 48\|50 | 49\|50 | 50\|50 | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.2 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.3 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.4 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.5 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.6 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table F-8. Middle Support Shear (V) Safe Headways, Two-lanes Fully-Correlated Platoons, 120-ft Two-Span Bridge

| α CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 9 | 10 |
| **1.2** | 5 | 6 | 6 | 6 | 7 | 9 | 10 | 11 | 13 | 15 | 16 |
| **1.3** | 10 | 10 | 11 | 11 | 13 | 14 | 15 | 17 | 18 | 20 | 22 |
| **1.4** | 15 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 25 | 28 | 31 |
| **1.5** | 19 | 20 | 20 | 21 | 23 | 25 | 27 | 31 | 33 | 36 | 38 |
| **1.6** | 26 | 26 | 28 | 29 | 31 | 33 | 35 | 37 | 40 | 43 | 47 |
| **1.7** | 33 | 34 | 35 | 36 | 38 | 41 | 42 | 46 | 48 | Fail | Fail |
| **1.8** | 40 | 41 | 41 | 43 | 45 | 47 | 50 | Fail | Fail | Fail | Fail |
| **1.9** | 47 | 47 | 48 | 49 | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.1** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table F-9. Negative Moment (-M) and Middle Support Shear (V) Safe Headways, Two-lanes Fully-Correlated Platoons, 120-ft Two-Span Bridge

| α CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 7\|50 | 9\|50 | 10\|50 |
| **1.2** | 5\|50 | 6\|50 | 6\|50 | 6\|50 | 7\|50 | 9\|50 | 10\|50 | 11\|50 | 13\|50 | 15\|50 | 16\|50 |
| **1.3** | 10\|50 | 10\|50 | 11\|50 | 11\|50 | 13\|50 | 14\|50 | 15\|50 | 20\|50 | 23\|50 | 26\|50 | 28\|50 |
| **1.4** | 15\|50 | 15\|50 | 18\|50 | 22\|50 | 23\|50 | 25\|50 | 27\|50 | 29\|50 | 31\|50 | 32\|50 | 34\|50 |
| **1.5** | 27\|50 | 27\|50 | 28\|50 | 29\|50 | 30\|50 | 32\|50 | 32\|50 | 34\|50 | 35\|50 | 37\|50 | 38\|50 |
| **1.6** | 32\|50 | 32\|50 | 33\|50 | 33\|50 | 34\|50 | 36\|50 | 37\|50 | 38\|50 | 40\|50 | 43\|50 | 47\|50 |
| **1.7** | 36\|50 | 36\|50 | 37\|50 | 37\|50 | 38\|50 | 41\|50 | 42\|50 | 46\|50 | 48\|50 | Fail | Fail |
| **1.8** | 40\|50 | 41\|50 | 41\|50 | 43\|50 | 45\|50 | 47\|50 | 50\|50 | Fail | Fail | Fail | Fail |
| **1.9** | 47\|50 | 47\|50 | 48\|50 | 49\|50 | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.1** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table F-10. Acceptable Two-Span Negative Moment Two-lanes Fully-Correlated Headways (CoV= 0.18)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 9\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 13\|50 | 8\|50 | 11\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 16\|50 | 11\|50 | 17\|50 | 26\|50 | 5\|50 | 5\|50 |
| **1.4** | 18\|50 | 16\|50 | 20\|50 | 32\|50 | 44\|50 | 5\|50 |
| **1.5** | 19\|50 | 37\|50 | 23\|50 | 37\|50 | 50\|50 | 10\|19 |
| **1.6** | Fail | 43\|50 | 26\|50 | 40\|50 | Fail | Fail |
| **1.7** | Fail | 47\|50 | 29\|50 | 43\|50 | Fail | Fail |
| **1.8** | Fail | 50\|50 | 32\|50 | 46\|50 | Fail | Fail |
| **1.9** | Fail | Fail | Fail | 50\|50 | Fail | Fail |
| **2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table F-11. Acceptable Two-Span Shear Two-lanes Fully-Correlated Headways (CoV= 0.18)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 8 | 12 |
| **1.1** | 5 | 5 | 5 | 9 | 13 | 19 |
| **1.2** | 5 | 5 | 8 | 15 | 20 | 26 |
| **1.3** | 5 | 5 | 13 | 20 | 27 | 34 |
| **1.4** | 5 | 7 | 19 | 28 | 33 | 44 |
| **1.5** | 5 | 11 | 24 | 36 | 42 | Fail |
| **1.6** | 5 | 14 | 30 | 43 | Fail | Fail |
| **1.7** | 5 | 17 | 35 | Fail | Fail | Fail |
| **1.8** | 5 | 24 | 41 | Fail | Fail | Fail |
| **1.9** | 10 | 36 | 47 | Fail | Fail | Fail |
| **2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table F-12. Acceptable Two-Span Moment and Shear Two-lanes Fully-Correlated Headways (CoV= 0.18)

| α Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 8\|50 | 12\|50 |
| **1.1** | 9\|50 | 5\|50 | 5\|50 | 9\|50 | 13\|50 | 19\|50 |
| **1.2** | 13\|50 | 8\|50 | 11\|50 | 15\|50 | 20\|50 | 26\|50 |
| **1.3** | 16\|50 | 11\|50 | 17\|50 | 26\|50 | 27\|50 | 34\|50 |
| **1.4** | 18\|50 | 16\|50 | 20\|50 | 32\|50 | 44\|50 | 44\|50 |
| **1.5** | 19\|50 | 37\|50 | 24\|50 | 37\|50 | 50\|50 | Fail |
| **1.6** | Fail | 43\|50 | 30\|50 | 43\|50 | Fail | Fail |
| **1.7** | Fail | 47\|50 | 35\|50 | Fail | Fail | Fail |
| **1.8** | Fail | 50\|50 | 41\|50 | Fail | Fail | Fail |
| **1.9** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table F-13. Acceptable Two-Span Negative Moment Two-lanes Fully-Correlated Headways (CoV= 0.14)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 6\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 11\|50 | 6\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 14\|50 | 9\|50 | 14\|50 | 20\|50 | 5\|50 | 5\|50 |
| **1.4** | 16\|50 | 12\|50 | 18\|50 | 29\|50 | 38\|50 | 5\|50 |
| **1.5** | 18\|50 | 28\|50 | 21\|50 | 34\|50 | 47\|50 | 7\|39 |
| **1.6** | 20\|50 | 38\|50 | 24\|50 | 38\|50 | Fail | Fail |
| **1.7** | Fail | 43\|50 | 26\|50 | 41\|50 | Fail | Fail |
| **1.8** | Fail | 48\|50 | 29\|50 | 44\|50 | Fail | Fail |
| **1.9** | Fail | Fail | 33\|50 | 47\|50 | Fail | Fail |
| **2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table F-14. Acceptable Two-Span Shear Two-lanes Fully-Correlated Headways (CoV= 0.14)

| **α \ Span** | **30 ft** | **60 ft** | **90 ft** | **120 ft** | **150 ft** | **200 ft** |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 6 | 8 |
| **1.1** | 5 | 5 | 5 | 6 | 10 | 16 |
| **1.2** | 5 | 5 | 6 | 11 | 16 | 23 |
| **1.3** | 5 | 5 | 9 | 17 | 23 | 28 |
| **1.4** | 5 | 5 | 15 | 21 | 30 | 37 |
| **1.5** | 5 | 8 | 21 | 31 | 35 | 46 |
| **1.6** | 5 | 11 | 26 | 37 | 45 | Fail |
| **1.7** | 5 | 15 | 31 | 46 | Fail | Fail |
| **1.8** | 5 | 18 | 36 | Fail | Fail | Fail |
| **1.9** | 5 | 24 | 41 | Fail | Fail | Fail |
| **2** | 9 | 35 | 46 | Fail | Fail | Fail |
| **2.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table F-15. Acceptable Two-Span Moment and Shear Two-lanes Fully-Correlated Headways (CoV= 0.14)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 8\|50 |
| **1.1** | 6\|50 | 5\|50 | 5\|50 | 6\|50 | 10\|50 | 16\|50 |
| **1.2** | 11\|50 | 6\|50 | 6\|50 | 11\|50 | 16\|50 | 23\|50 |
| **1.3** | 14\|50 | 9\|50 | 14\|50 | 20\|50 | 23\|50 | 28\|50 |
| **1.4** | 16\|50 | 12\|50 | 18\|50 | 29\|50 | 38\|50 | 37\|50 |
| **1.5** | 18\|50 | 28\|50 | 21\|50 | 34\|50 | 47\|50 | 46\|39 |
| **1.6** | 20\|50 | 38\|50 | 26\|50 | 38\|50 | Fail | Fail |
| **1.7** | Fail | 43\|50 | 31\|50 | 46\|50 | Fail | Fail |
| **1.8** | Fail | 48\|50 | 36\|50 | Fail | Fail | Fail |
| **1.9** | Fail | Fail | 41\|50 | Fail | Fail | Fail |
| **2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table F-16. Acceptable Two-Span Negative Moment Two-lanes Fully-Correlated Headways (CoV= 0.12)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 9\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 13\|50 | 8\|50 | 12\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.4** | 16\|50 | 11\|50 | 17\|50 | 27\|50 | 5\|50 | 5\|50 |
| **1.5** | 18\|50 | 16\|50 | 20\|50 | 32\|50 | 44\|50 | 6\|50 |
| **1.6** | 19\|50 | 36\|50 | 23\|50 | 37\|50 | 50\|50 | 11\|11 |
| **1.7** | Fail | 42\|50 | 25\|50 | 40\|50 | Fail | Fail |
| **1.8** | Fail | 46\|50 | 28\|50 | 43\|50 | Fail | Fail |
| **1.9** | Fail | 50\|50 | 31\|50 | 46\|50 | Fail | Fail |
| **2** | Fail | Fail | 42\|50 | 49\|50 | Fail | Fail |
| **2.1** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table F-17. Acceptable Two-Span Shear Two-lanes Fully-Correlated Headways (CoV= 0.12)

| α / Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 6 |
| **1.1** | 5 | 5 | 5 | 5 | 10 | 15 |
| **1.2** | 5 | 5 | 5 | 10 | 14 | 21 |
| **1.3** | 5 | 5 | 8 | 15 | 21 | 27 |
| **1.4** | 5 | 5 | 13 | 20 | 27 | 36 |
| **1.5** | 5 | 7 | 19 | 27 | 33 | 43 |
| **1.6** | 5 | 10 | 24 | 35 | 42 | Fail |
| **1.7** | 5 | 13 | 29 | 42 | 50 | Fail |
| **1.8** | 5 | 16 | 35 | 50 | Fail | Fail |
| **1.9** | 5 | 21 | 39 | Fail | Fail | Fail |
| **2** | 7 | 28 | 43 | Fail | Fail | Fail |
| **2.1** | 15 | 42 | 50 | Fail | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table F-18. Acceptable Two-Span Moment and Shear Two-lanes Fully-Correlated Headways (CoV= 0.12)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| 0.8 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 0.9 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 |
| 1.1 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 10\|50 | 15\|50 |
| 1.2 | 9\|50 | 5\|50 | 5\|50 | 10\|50 | 14\|50 | 21\|50 |
| 1.3 | 13\|50 | 8\|50 | 12\|50 | 15\|50 | 21\|50 | 27\|50 |
| 1.4 | 16\|50 | 11\|50 | 17\|50 | 27\|50 | 27\|50 | 36\|50 |
| 1.5 | 18\|50 | 16\|50 | 20\|50 | 32\|50 | 44\|50 | 43\|50 |
| 1.6 | 19\|50 | 36\|50 | 24\|50 | 37\|50 | 50\|50 | Fail |
| 1.7 | Fail | 42\|50 | 29\|50 | 42\|50 | Fail | Fail |
| 1.8 | Fail | 46\|50 | 35\|50 | 50\|50 | Fail | Fail |
| 1.9 | Fail | 50\|50 | 39\|50 | Fail | Fail | Fail |
| 2 | Fail | Fail | 43\|50 | Fail | Fail | Fail |
| 2.1 | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.2 | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.3 | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.4 | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.5 | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.6 | Fail | Fail | Fail | Fail | Fail | Fail |

Table F-19. Acceptable Two-Span Negative Moment Two-lanes Fully-Correlated Headways (CoV= 0.07)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 7\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 11\|50 | 6\|50 | 6\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.4** | 14\|50 | 9\|50 | 14\|50 | 22\|50 | 5\|50 | 5\|50 |
| **1.5** | 16\|50 | 12\|50 | 18\|50 | 29\|50 | 41\|50 | 5\|50 |
| **1.6** | 18\|50 | 19\|50 | 21\|50 | 34\|50 | 47\|50 | 8\|50 |
| **1.7** | 19\|50 | 37\|50 | 24\|50 | 38\|50 | Fail | Fail |
| **1.8** | Fail | 43\|50 | 26\|50 | 41\|50 | Fail | Fail |
| **1.9** | Fail | 46\|50 | 28\|50 | 43\|50 | Fail | Fail |
| **2** | Fail | 49\|50 | 32\|50 | 46\|50 | Fail | Fail |
| **2.1** | Fail | Fail | Fail | 49\|50 | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table F-20. Acceptable Two-Span Shear Two-lanes Fully-Correlated Headways (CoV= 0.07)

| α / Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 7 | 11 |
| **1.2** | 5 | 5 | 5 | 7 | 12 | 18 |
| **1.3** | 5 | 5 | 6 | 12 | 17 | 24 |
| **1.4** | 5 | 5 | 9 | 17 | 24 | 30 |
| **1.5** | 5 | 5 | 15 | 21 | 29 | 39 |
| **1.6** | 5 | 7 | 20 | 30 | 35 | 46 |
| **1.7** | 5 | 10 | 25 | 38 | 44 | Fail |
| **1.8** | 5 | 13 | 30 | 43 | Fail | Fail |
| **1.9** | 5 | 16 | 35 | 50 | Fail | Fail |
| **2** | 5 | 21 | 39 | Fail | Fail | Fail |
| **2.1** | 6 | 27 | 43 | Fail | Fail | Fail |
| **2.2** | 12 | 41 | 49 | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table F-21. Acceptable Two-Span Moment and Shear Two-lanes Fully-Correlated Headways (CoV= 0.07)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| 0.8 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 0.9 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.1 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 7\|50 | 11\|50 |
| 1.2 | 7\|50 | 5\|50 | 5\|50 | 7\|50 | 12\|50 | 18\|50 |
| 1.3 | 11\|50 | 6\|50 | 6\|50 | 12\|50 | 17\|50 | 24\|50 |
| 1.4 | 14\|50 | 9\|50 | 14\|50 | 22\|50 | 24\|50 | 30\|50 |
| 1.5 | 16\|50 | 12\|50 | 18\|50 | 29\|50 | 41\|50 | 39\|50 |
| 1.6 | 18\|50 | 19\|50 | 21\|50 | 34\|50 | 47\|50 | 46\|50 |
| 1.7 | 19\|50 | 37\|50 | 25\|50 | 38\|50 | Fail | Fail |
| 1.8 | Fail | 43\|50 | 30\|50 | 43\|50 | Fail | Fail |
| 1.9 | Fail | 46\|50 | 35\|50 | 50\|50 | Fail | Fail |
| 2 | Fail | 49\|50 | 39\|50 | Fail | Fail | Fail |
| 2.1 | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.2 | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.3 | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.4 | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.5 | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.6 | Fail | Fail | Fail | Fail | Fail | Fail |

Table F-22. Acceptable Two-Span Negative Moment Two-lanes Fully-Correlated Headways (CoV= 0)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 9\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.4** | 13\|50 | 8\|50 | 12\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.5** | 15\|50 | 10\|50 | 16\|50 | 27\|50 | 38\|50 | 5\|50 |
| **1.6** | 17\|50 | 14\|50 | 20\|50 | 32\|50 | 45\|50 | 7\|50 |
| **1.7** | 18\|50 | 32\|50 | 23\|50 | 36\|50 | 50\|50 | Fail |
| **1.8** | 20\|50 | 39\|50 | 25\|50 | 40\|50 | Fail | Fail |
| **1.9** | Fail | 44\|50 | 27\|50 | 42\|50 | Fail | Fail |
| **2** | Fail | 47\|50 | 30\|50 | 45\|50 | Fail | Fail |
| **2.1** | Fail | 50\|50 | 33\|50 | 48\|50 | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table F-23. Acceptable Two-Span Shear Two-lanes Fully-Correlated Headways (CoV= 0)

| α / Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 6 | 9 |
| **1.2** | 5 | 5 | 5 | 5 | 10 | 17 |
| **1.3** | 5 | 5 | 5 | 10 | 14 | 22 |
| **1.4** | 5 | 5 | 8 | 15 | 21 | 27 |
| **1.5** | 5 | 5 | 11 | 19 | 27 | 36 |
| **1.6** | 5 | 6 | 17 | 26 | 32 | 44 |
| **1.7** | 5 | 9 | 22 | 33 | 40 | 50 |
| **1.8** | 5 | 12 | 27 | 40 | 49 | Fail |
| **1.9** | 5 | 14 | 31 | 47 | Fail | Fail |
| **2** | 5 | 17 | 36 | Fail | Fail | Fail |
| **2.1** | 5 | 22 | 40 | Fail | Fail | Fail |
| **2.2** | 6 | 30 | 45 | Fail | Fail | Fail |
| **2.3** | 15 | 42 | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table F-24. Acceptable Two-Span Moment and Shear Two-lanes Fully-Correlated Headways (CoV= 0)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 9\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 10\|50 | 17\|50 |
| **1.3** | 9\|50 | 5\|50 | 5\|50 | 10\|50 | 14\|50 | 22\|50 |
| **1.4** | 13\|50 | 8\|50 | 12\|50 | 15\|50 | 21\|50 | 27\|50 |
| **1.5** | 15\|50 | 10\|50 | 16\|50 | 27\|50 | 38\|50 | 36\|50 |
| **1.6** | 17\|50 | 14\|50 | 20\|50 | 32\|50 | 45\|50 | 44\|50 |
| **1.7** | 18\|50 | 32\|50 | 23\|50 | 36\|50 | 50\|50 | Fail |
| **1.8** | 20\|50 | 39\|50 | 27\|50 | 40\|50 | Fail | Fail |
| **1.9** | Fail | 44\|50 | 31\|50 | 47\|50 | Fail | Fail |
| **2** | Fail | 47\|50 | 36\|50 | Fail | Fail | Fail |
| **2.1** | Fail | 50\|50 | 40\|50 | Fail | Fail | Fail |
| **2.2** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |

# Appendix G. Two-Span LRFD Bridge Headway Tables for Platoons Adjacent to Routine Traffic ($\beta_{target}$ = 2.5)

Table G-1. Negative Moment (-M) Safe Headways, Platoons & Routine Traffic, 60-ft Two-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.4** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.5** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 6\|50 | 7\|50 |
| **1.6** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 6\|50 | 7\|50 | 8\|50 | 9\|50 | 9\|50 |
| **1.7** | 6\|50 | 6\|50 | 7\|50 | 7\|50 | 7\|50 | 8\|50 | 8\|50 | 9\|50 | 10\|50 | 11\|50 | 12\|50 |
| **1.8** | 8\|50 | 8\|50 | 8\|50 | 9\|50 | 9\|50 | 10\|50 | 11\|50 | 12\|50 | 13\|50 | 15\|50 | 19\|50 |
| **1.9** | 10\|50 | 10\|50 | 11\|50 | 11\|50 | 12\|50 | 13\|50 | 14\|50 | 16\|50 | 30\|50 | 33\|50 | 36\|50 |
| **2** | 13\|50 | 14\|50 | 14\|50 | 14\|50 | 17\|50 | 21\|50 | 31\|50 | 34\|50 | 37\|50 | 39\|50 | 41\|50 |
| **2.1** | 20\|50 | 21\|50 | 30\|50 | 31\|50 | 33\|50 | 36\|50 | 38\|50 | 39\|50 | 42\|50 | 43\|50 | 46\|50 |
| **2.2** | 35\|50 | 36\|50 | 37\|50 | 38\|50 | 39\|50 | 41\|50 | 42\|50 | 44\|50 | 45\|50 | 47\|50 | 48\|50 |
| **2.3** | 41\|50 | 41\|50 | 41\|50 | 42\|50 | 43\|50 | 44\|50 | 46\|50 | 47\|50 | 48\|50 | 49\|50 | Fail |
| **2.4** | 44\|50 | 44\|50 | 45\|50 | 45\|50 | 46\|50 | 47\|50 | 48\|50 | 50\|50 | Fail | Fail | Fail |
| **2.5** | 47\|50 | 47\|50 | 48\|50 | 48\|50 | 49\|50 | 50\|50 | Fail | Fail | Fail | Fail | Fail |
| **2.6** | 49\|50 | 49\|50 | 50\|50 | 50\|50 | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.7** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.8** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.9** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table G-2. Middle Support Shear (V) Safe Headways, Platoons & Routine Traffic, 60-ft Two-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.5** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.6** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 |
| **1.7** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 7 | 8 | 9 |
| **1.8** | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 8 | 10 | 11 | 12 |
| **1.9** | 6 | 6 | 7 | 8 | 8 | 9 | 10 | 11 | 13 | 13 | 15 |
| **2** | 9 | 9 | 10 | 10 | 11 | 12 | 12 | 14 | 15 | 16 | 18 |
| **2.1** | 11 | 12 | 12 | 13 | 13 | 14 | 15 | 16 | 18 | 21 | 24 |
| **2.2** | 13 | 14 | 14 | 15 | 16 | 17 | 18 | 20 | 24 | 28 | 33 |
| **2.3** | 16 | 16 | 16 | 17 | 18 | 21 | 24 | 26 | 30 | 38 | 45 |
| **2.4** | 19 | 19 | 20 | 22 | 24 | 26 | 29 | 37 | 44 | Fail | Fail |
| **2.5** | 25 | 25 | 26 | 28 | 32 | 36 | 42 | Fail | Fail | Fail | Fail |
| **2.6** | 31 | 31 | 35 | 38 | 43 | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.7** | 45 | 45 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.8** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.9** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table G-3. Negative Moment (-M) and Middle Support Shear (V) Safe Headways, Platoons & Routine Traffic, 90-ft Two-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.4** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.5** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 6\|50 | 7\|50 |
| **1.6** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 6\|50 | 7\|50 | 8\|50 | 9\|50 | 9\|50 |
| **1.7** | 6\|50 | 6\|50 | 7\|50 | 7\|50 | 7\|50 | 8\|50 | 8\|50 | 9\|50 | 10\|50 | 11\|50 | 12\|50 |
| **1.8** | 8\|50 | 8\|50 | 8\|50 | 9\|50 | 9\|50 | 10\|50 | 11\|50 | 12\|50 | 13\|50 | 15\|50 | 19\|50 |
| **1.9** | 10\|50 | 10\|50 | 11\|50 | 11\|50 | 12\|50 | 13\|50 | 14\|50 | 16\|50 | 30\|50 | 33\|50 | 36\|50 |
| **2** | 13\|50 | 14\|50 | 14\|50 | 14\|50 | 17\|50 | 21\|50 | 31\|50 | 34\|50 | 37\|50 | 39\|50 | 41\|50 |
| **2.1** | 20\|50 | 21\|50 | 30\|50 | 31\|50 | 33\|50 | 36\|50 | 38\|50 | 39\|50 | 42\|50 | 43\|50 | 46\|50 |
| **2.2** | 35\|50 | 36\|50 | 37\|50 | 38\|50 | 39\|50 | 41\|50 | 42\|50 | 44\|50 | 45\|50 | 47\|50 | 48\|50 |
| **2.3** | 41\|50 | 41\|50 | 41\|50 | 42\|50 | 43\|50 | 44\|50 | 46\|50 | 47\|50 | 48\|50 | 49\|50 | Fail |
| **2.4** | 44\|50 | 44\|50 | 45\|50 | 45\|50 | 46\|50 | 47\|50 | 48\|50 | 50\|50 | Fail | Fail | Fail |
| **2.5** | 47\|50 | 47\|50 | 48\|50 | 48\|50 | 49\|50 | 50\|50 | Fail | Fail | Fail | Fail | Fail |
| **2.6** | 49\|50 | 49\|50 | 50\|50 | 50\|50 | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.7** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.8** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.9** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table G-4. Negative Moment (-M) Safe Headways, Platoons & Routine Traffic, 90-ft Two-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.8 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 0.9 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.1 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.2 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.3 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 8\|50 | 10\|50 | 11\|50 |
| 1.4 | 7\|50 | 6\|50 | 7\|50 | 8\|50 | 10\|50 | 10\|50 | 12\|50 | 14\|50 | 14\|50 | 15\|50 | 16\|50 |
| 1.5 | 13\|50 | 14\|50 | 14\|50 | 14\|50 | 15\|50 | 16\|50 | 17\|50 | 17\|50 | 18\|50 | 19\|50 | 20\|50 |
| 1.6 | 17\|50 | 17\|50 | 18\|50 | 18\|50 | 19\|50 | 19\|50 | 19\|50 | 20\|50 | 21\|50 | 22\|50 | 23\|50 |
| 1.7 | 20\|50 | 20\|50 | 20\|50 | 21\|50 | 21\|50 | 22\|50 | 23\|50 | 23\|50 | 24\|50 | 24\|50 | 25\|50 |
| 1.8 | 23\|50 | 22\|50 | 23\|50 | 23\|50 | 23\|50 | 24\|50 | 25\|50 | 25\|50 | 26\|50 | 27\|50 | 28\|50 |
| 1.9 | 25\|50 | 25\|50 | 26\|50 | 25\|50 | 25\|50 | 27\|50 | 27\|50 | 28\|50 | 28\|50 | 29\|50 | 30\|50 |
| 2 | 27\|50 | 27\|50 | 28\|50 | 28\|50 | 28\|50 | 29\|50 | 30\|50 | 30\|50 | 31\|50 | 33\|50 | 36\|36 |
| 2.1 | 30\|50 | 29\|50 | 30\|50 | 30\|50 | 31\|50 | 33\|50 | 33\|50 | 35\|44 | Fail | Fail | Fail |
| 2.2 | 33\|50 | 33\|50 | 33\|50 | 34\|50 | 37\|38 | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.3 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.4 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.5 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.6 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.7 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.8 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.9 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 3 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table G-5. Middle Support Shear (V) Safe Headways, Platoons & Routine Traffic, 90-ft Two-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.4** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 8 |
| **1.5** | 5 | 5 | 5 | 5 | 6 | 6 | 7 | 8 | 9 | 10 | 11 |
| **1.6** | 7 | 7 | 8 | 8 | 8 | 9 | 10 | 11 | 14 | 14 | 17 |
| **1.7** | 10 | 10 | 10 | 10 | 12 | 13 | 15 | 17 | 18 | 20 | 22 |
| **1.8** | 14 | 14 | 15 | 16 | 18 | 18 | 20 | 21 | 23 | 25 | 27 |
| **1.9** | 19 | 19 | 20 | 20 | 22 | 23 | 24 | 26 | 28 | 30 | 31 |
| **2** | 23 | 23 | 24 | 25 | 26 | 27 | 29 | 30 | 32 | 34 | 36 |
| **2.1** | 27 | 27 | 28 | 29 | 29 | 31 | 33 | 34 | 37 | 38 | 40 |
| **2.2** | 31 | 31 | 32 | 32 | 34 | 35 | 37 | 38 | 41 | 43 | 45 |
| **2.3** | 35 | 35 | 35 | 36 | 38 | 39 | 41 | 43 | 45 | 47 | 50 |
| **2.4** | 38 | 39 | 39 | 40 | 42 | 43 | 45 | 47 | 50 | Fail | Fail |
| **2.5** | 42 | 43 | 43 | 43 | 46 | 48 | 50 | Fail | Fail | Fail | Fail |
| **2.6** | 46 | 47 | 46 | 48 | 50 | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.7** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.8** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.9** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table G-6. Negative Moment (-M) and Middle Support Shear (V) Safe Headways, Platoons & Routine Traffic, 90-ft Two-Span Bridge

| α CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.8 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 0.9 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.1 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.2 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.3 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 8\|50 | 10\|50 | 11\|50 |
| 1.4 | 7\|50 | 6\|50 | 7\|50 | 8\|50 | 10\|50 | 10\|50 | 12\|50 | 14\|50 | 14\|50 | 15\|50 | 16\|50 |
| 1.5 | 13\|50 | 14\|50 | 14\|50 | 14\|50 | 15\|50 | 16\|50 | 17\|50 | 17\|50 | 18\|50 | 19\|50 | 20\|50 |
| 1.6 | 17\|50 | 17\|50 | 18\|50 | 18\|50 | 19\|50 | 19\|50 | 19\|50 | 20\|50 | 21\|50 | 22\|50 | 23\|50 |
| 1.7 | 20\|50 | 20\|50 | 20\|50 | 21\|50 | 21\|50 | 22\|50 | 23\|50 | 23\|50 | 24\|50 | 24\|50 | 25\|50 |
| 1.8 | 23\|50 | 22\|50 | 23\|50 | 23\|50 | 23\|50 | 24\|50 | 25\|50 | 25\|50 | 26\|50 | 27\|50 | 28\|50 |
| 1.9 | 25\|50 | 25\|50 | 26\|50 | 25\|50 | 25\|50 | 27\|50 | 27\|50 | 28\|50 | 28\|50 | 30\|50 | 31\|50 |
| 2 | 27\|50 | 27\|50 | 28\|50 | 28\|50 | 28\|50 | 29\|50 | 30\|50 | 30\|50 | 32\|50 | 34\|50 | 36\|36 |
| 2.1 | 30\|50 | 29\|50 | 30\|50 | 30\|50 | 31\|50 | 33\|50 | 33\|50 | 35\|44 | Fail | Fail | Fail |
| 2.2 | 33\|50 | 33\|50 | 33\|50 | 34\|50 | 37\|38 | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.3 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.4 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.5 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.6 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.7 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.8 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.9 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 3 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table G-7. Negative Moment (-M) Safe Headways, Platoons & Routine Traffic, 120-ft Two-Span Bridge

| α / CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.4** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.5** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 7\|50 | 21\|50 | 24\|50 |
| **1.6** | 5\|50 | 5\|50 | 5\|50 | 8\|50 | 19\|50 | 21\|50 | 24\|50 | 26\|50 | 27\|50 | 28\|50 | 30\|50 |
| **1.7** | 26\|50 | 26\|50 | 26\|50 | 26\|50 | 27\|50 | 29\|50 | 30\|50 | 31\|50 | 31\|50 | 33\|50 | 34\|50 |
| **1.8** | 30\|50 | 30\|50 | 31\|50 | 32\|50 | 32\|50 | 33\|50 | 34\|50 | 35\|50 | 36\|50 | 37\|50 | 37\|50 |
| **1.9** | 34\|50 | 35\|50 | 35\|50 | 35\|50 | 36\|50 | 36\|50 | 37\|50 | 37\|50 | 39\|50 | 40\|50 | 40\|50 |
| **2** | 37\|50 | 37\|50 | 38\|50 | 38\|50 | 38\|50 | 39\|50 | 40\|50 | 41\|50 | 41\|50 | 42\|50 | 43\|50 |
| **2.1** | 40\|50 | 40\|50 | 40\|50 | 41\|50 | 41\|50 | 41\|50 | 42\|50 | 43\|50 | 44\|50 | 45\|50 | 46\|50 |
| **2.2** | 42\|50 | 43\|50 | 43\|50 | 43\|50 | 43\|50 | 44\|50 | 45\|50 | 45\|50 | 46\|50 | 48\|50 | 48\|50 |
| **2.3** | 44\|50 | 45\|50 | 45\|50 | 46\|50 | 46\|50 | 46\|50 | 47\|50 | 48\|50 | 49\|50 | Fail | Fail |
| **2.4** | 47\|50 | 47\|50 | 47\|50 | 48\|50 | 49\|50 | 49\|50 | Fail | Fail | Fail | Fail | Fail |
| **2.5** | 50\|50 | 50\|50 | 50\|50 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.7** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.8** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.9** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table G-8. Middle Support Shear (V) Safe Headways, Platoons & Routine Traffic, 120-ft Two-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.8 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 0.9 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 1 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 1.1 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 1.2 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 1.3 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 8 | 10 |
| 1.4 | 5 | 6 | 6 | 6 | 7 | 8 | 9 | 11 | 12 | 13 | 15 |
| 1.5 | 9 | 10 | 11 | 11 | 12 | 13 | 14 | 16 | 17 | 18 | 19 |
| 1.6 | 14 | 14 | 15 | 15 | 16 | 17 | 18 | 19 | 21 | 22 | 26 |
| 1.7 | 18 | 18 | 19 | 19 | 20 | 21 | 22 | 26 | 28 | 31 | 33 |
| 1.8 | 22 | 22 | 23 | 24 | 25 | 28 | 30 | 31 | 34 | 36 | 40 |
| 1.9 | 28 | 29 | 30 | 31 | 33 | 34 | 37 | 38 | 40 | 43 | 47 |
| 2 | 35 | 35 | 36 | 37 | 38 | 41 | 43 | 45 | 47 | 50 | Fail |
| 2.1 | 40 | 41 | 42 | 43 | 45 | 47 | 49 | 50 | Fail | Fail | Fail |
| 2.2 | 46 | 46 | 47 | 49 | 50 | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.3 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.4 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.5 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.6 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.7 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.8 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.9 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| 3 | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table G-9. Negative Moment (-M) and Middle Support Shear (V) Safe Headways, Platoons & Routine Traffic, 120-ft Two-Span Bridge

| α \ CoV | 0 | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 | 0.12 | 0.14 | 0.16 | 0.18 | 0.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 7\|50 | 8\|50 | 10\|50 |
| **1.4** | 5\|50 | 6\|50 | 6\|50 | 6\|50 | 7\|50 | 8\|50 | 9\|50 | 11\|50 | 12\|50 | 13\|50 | 15\|50 |
| **1.5** | 9\|50 | 10\|50 | 11\|50 | 11\|50 | 12\|50 | 13\|50 | 14\|50 | 16\|50 | 17\|50 | 21\|50 | 24\|50 |
| **1.6** | 14\|50 | 14\|50 | 15\|50 | 15\|50 | 19\|50 | 21\|50 | 24\|50 | 26\|50 | 27\|50 | 28\|50 | 30\|50 |
| **1.7** | 26\|50 | 26\|50 | 26\|50 | 26\|50 | 27\|50 | 29\|50 | 30\|50 | 31\|50 | 31\|50 | 33\|50 | 34\|50 |
| **1.8** | 30\|50 | 30\|50 | 31\|50 | 32\|50 | 32\|50 | 33\|50 | 34\|50 | 35\|50 | 36\|50 | 37\|50 | 40\|50 |
| **1.9** | 34\|50 | 35\|50 | 35\|50 | 35\|50 | 36\|50 | 36\|50 | 37\|50 | 38\|50 | 40\|50 | 43\|50 | 47\|50 |
| **2** | 37\|50 | 37\|50 | 38\|50 | 38\|50 | 38\|50 | 41\|50 | 43\|50 | 45\|50 | 47\|50 | 50\|50 | Fail |
| **2.1** | 40\|50 | 41\|50 | 42\|50 | 43\|50 | 45\|50 | 47\|50 | 49\|50 | 50\|50 | Fail | Fail | Fail |
| **2.2** | 46\|50 | 46\|50 | 47\|50 | 49\|50 | 50\|50 | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.7** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.8** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.9** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |
| **3** | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail | Fail |

Table G-10. Acceptable Two-Span Negative Moment Platoons & Routine Traffic Headways (CoV= 0.18)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 5\|50 | 5\|50 | 10\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.4** | 8\|50 | 5\|50 | 15\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.5** | 11\|50 | 6\|50 | 19\|50 | 21\|50 | 5\|50 | 5\|50 |
| **1.6** | 14\|50 | 9\|50 | 22\|50 | 28\|50 | 5\|10 | 5\|50 |
| **1.7** | 16\|50 | 11\|50 | 24\|50 | 33\|50 | 41\|50 | 5\|50 |
| **1.8** | 17\|50 | 15\|50 | 27\|50 | 37\|50 | 47\|50 | 5\|50 |
| **1.9** | 19\|50 | 33\|50 | 29\|50 | 40\|50 | Fail | 9\|23 |
| **2** | 20\|50 | 39\|50 | 33\|50 | 42\|50 | Fail | Fail |
| **2.1** | Fail | 43\|50 | Fail | 45\|50 | Fail | Fail |
| **2.2** | Fail | 47\|50 | Fail | 48\|50 | Fail | Fail |
| **2.3** | Fail | 49\|50 | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table G-11. Acceptable Two-Span Shear Platoons & Routine Traffic Headways (CoV= 0.18)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 6 |
| **1.2** | 5 | 5 | 5 | 5 | 9 | 14 |
| **1.3** | 5 | 5 | 5 | 8 | 13 | 19 |
| **1.4** | 5 | 5 | 7 | 13 | 20 | 25 |
| **1.5** | 5 | 5 | 10 | 18 | 26 | 30 |
| **1.6** | 5 | 5 | 14 | 22 | 31 | 40 |
| **1.7** | 5 | 8 | 20 | 31 | 35 | 47 |
| **1.8** | 5 | 11 | 25 | 36 | 46 | Fail |
| **1.9** | 5 | 13 | 30 | 43 | Fail | Fail |
| **2** | 5 | 16 | 34 | 50 | Fail | Fail |
| **2.1** | 5 | 21 | 38 | Fail | Fail | Fail |
| **2.2** | 8 | 28 | 43 | Fail | Fail | Fail |
| **2.3** | 23 | 38 | 47 | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table G-12. Acceptable Two-Span Moment and Shear Platoons & Routine Traffic Headways (CoV= 0.18)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 9\|50 | 14\|50 |
| **1.3** | 5\|50 | 5\|50 | 10\|50 | 8\|50 | 13\|50 | 19\|50 |
| **1.4** | 8\|50 | 5\|50 | 15\|50 | 13\|50 | 20\|50 | 25\|50 |
| **1.5** | 11\|50 | 6\|50 | 19\|50 | 21\|50 | 26\|50 | 30\|50 |
| **1.6** | 14\|50 | 9\|50 | 22\|50 | 28\|50 | 31\|10 | 40\|50 |
| **1.7** | 16\|50 | 11\|50 | 24\|50 | 33\|50 | 41\|50 | 47\|50 |
| **1.8** | 17\|50 | 15\|50 | 27\|50 | 37\|50 | 47\|50 | Fail |
| **1.9** | 19\|50 | 33\|50 | 30\|50 | 43\|50 | Fail | Fail |
| **2** | 20\|50 | 39\|50 | 34\|50 | 50\|50 | Fail | Fail |
| **2.1** | Fail | 43\|50 | Fail | Fail | Fail | Fail |
| **2.2** | Fail | 47\|50 | Fail | Fail | Fail | Fail |
| **2.3** | Fail | 49\|50 | Fail | Fail | Fail | Fail |
| **2.4** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table G-13. Acceptable Two-Span Negative Moment Platoons & Routine Traffic Headways (CoV= 0.14)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.4** | 5\|50 | 5\|50 | 14\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.5** | 9\|50 | 5\|50 | 17\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.6** | 12\|50 | 7\|50 | 20\|50 | 26\|50 | 5\|50 | 5\|50 |
| **1.7** | 15\|50 | 9\|50 | 23\|50 | 31\|50 | 36\|50 | 5\|50 |
| **1.8** | 16\|50 | 12\|50 | 25\|50 | 35\|50 | 44\|50 | 5\|50 |
| **1.9** | 18\|50 | 16\|50 | 28\|50 | 37\|50 | 49\|50 | 6\|50 |
| **2** | 19\|50 | 34\|50 | 30\|50 | 41\|50 | Fail | 10\|13 |
| **2.1** | 20\|50 | 39\|50 | 35\|44 | 43\|50 | Fail | Fail |
| **2.2** | Fail | 44\|50 | Fail | 45\|50 | Fail | Fail |
| **2.3** | Fail | 47\|50 | Fail | 48\|50 | Fail | Fail |
| **2.4** | Fail | 50\|50 | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table G-14. Acceptable Two-Span Shear Platoons & Routine Traffic Headways (CoV= 0.14)

| α \ CoV | 0.14 | 0.14 | 0.14 | 0.14 | 0.14 | 0.14 |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 7 | 10 |
| **1.3** | 5 | 5 | 5 | 6 | 11 | 17 |
| **1.4** | 5 | 5 | 5 | 11 | 16 | 22 |
| **1.5** | 5 | 5 | 8 | 16 | 22 | 27 |
| **1.6** | 5 | 5 | 11 | 19 | 27 | 35 |
| **1.7** | 5 | 5 | 17 | 26 | 32 | 42 |
| **1.8** | 5 | 8 | 21 | 31 | 39 | 49 |
| **1.9** | 5 | 11 | 26 | 38 | 47 | Fail |
| **2** | 5 | 14 | 30 | 45 | Fail | Fail |
| **2.1** | 5 | 16 | 34 | 50 | Fail | Fail |
| **2.2** | 5 | 20 | 38 | Fail | Fail | Fail |
| **2.3** | 8 | 26 | 43 | Fail | Fail | Fail |
| **2.4** | 21 | 37 | 47 | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table G-15. Acceptable Two-Span Moment and Shear Platoons & Routine Traffic Headways (CoV= 0.14)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 7\|50 | 10\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 11\|50 | 17\|50 |
| **1.4** | 5\|50 | 5\|50 | 14\|50 | 11\|50 | 16\|50 | 22\|50 |
| **1.5** | 9\|50 | 5\|50 | 17\|50 | 16\|50 | 22\|50 | 27\|50 |
| **1.6** | 12\|50 | 7\|50 | 20\|50 | 26\|50 | 27\|50 | 35\|50 |
| **1.7** | 15\|50 | 9\|50 | 23\|50 | 31\|50 | 36\|50 | 42\|50 |
| **1.8** | 16\|50 | 12\|50 | 25\|50 | 35\|50 | 44\|50 | 49\|50 |
| **1.9** | 18\|50 | 16\|50 | 28\|50 | 38\|50 | 49\|50 | Fail |
| **2** | 19\|50 | 34\|50 | 30\|50 | 45\|50 | Fail | Fail |
| **2.1** | 20\|50 | 39\|50 | 35\|44 | 50\|50 | Fail | Fail |
| **2.2** | Fail | 44\|50 | Fail | Fail | Fail | Fail |
| **2.3** | Fail | 47\|50 | Fail | Fail | Fail | Fail |
| **2.4** | Fail | 50\|50 | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table G-16. Acceptable Two-Span Negative Moment Platoons & Routine Traffic Headways (CoV= 0.12)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.4** | 5\|50 | 5\|50 | 12\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.5** | 8\|50 | 5\|50 | 17\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.6** | 11\|50 | 6\|50 | 19\|50 | 24\|50 | 5\|50 | 5\|50 |
| **1.7** | 14\|50 | 8\|50 | 23\|50 | 30\|50 | 6\|50 | 5\|50 |
| **1.8** | 16\|50 | 11\|50 | 25\|50 | 34\|50 | 43\|50 | 5\|50 |
| **1.9** | 17\|50 | 14\|50 | 27\|50 | 37\|50 | 47\|50 | 5\|50 |
| **2** | 18\|50 | 31\|50 | 30\|50 | 40\|50 | Fail | 10\|19 |
| **2.1** | 20\|50 | 38\|50 | 33\|50 | 42\|50 | Fail | Fail |
| **2.2** | Fail | 42\|50 | Fail | 45\|50 | Fail | Fail |
| **2.3** | Fail | 46\|50 | Fail | 47\|50 | Fail | Fail |
| **2.4** | Fail | 48\|50 | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table G-17. Acceptable Two-Span Shear Platoons & Routine Traffic Headways (CoV= 0.12)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 6 | 9 |
| **1.3** | 5 | 5 | 5 | 5 | 10 | 16 |
| **1.4** | 5 | 5 | 5 | 9 | 14 | 21 |
| **1.5** | 5 | 5 | 7 | 14 | 21 | 26 |
| **1.6** | 5 | 5 | 10 | 18 | 26 | 32 |
| **1.7** | 5 | 5 | 15 | 22 | 31 | 40 |
| **1.8** | 5 | 7 | 20 | 30 | 35 | 46 |
| **1.9** | 5 | 10 | 24 | 37 | 44 | Fail |
| **2** | 5 | 12 | 29 | 43 | Fail | Fail |
| **2.1** | 5 | 15 | 33 | 49 | Fail | Fail |
| **2.2** | 5 | 18 | 37 | Fail | Fail | Fail |
| **2.3** | 6 | 24 | 41 | Fail | Fail | Fail |
| **2.4** | 12 | 29 | 45 | Fail | Fail | Fail |
| **2.5** | Fail | 42 | 50 | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table G-18. Acceptable Two-Span Moment and Shear Platoons & Routine Traffic Headways (CoV= 0.12)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 | 9\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 10\|50 | 16\|50 |
| **1.4** | 5\|50 | 5\|50 | 12\|50 | 9\|50 | 14\|50 | 21\|50 |
| **1.5** | 8\|50 | 5\|50 | 17\|50 | 14\|50 | 21\|50 | 26\|50 |
| **1.6** | 11\|50 | 6\|50 | 19\|50 | 24\|50 | 26\|50 | 32\|50 |
| **1.7** | 14\|50 | 8\|50 | 23\|50 | 30\|50 | 31\|50 | 40\|50 |
| **1.8** | 16\|50 | 11\|50 | 25\|50 | 34\|50 | 43\|50 | 46\|50 |
| **1.9** | 17\|50 | 14\|50 | 27\|50 | 37\|50 | 47\|50 | Fail |
| **2** | 18\|50 | 31\|50 | 30\|50 | 43\|50 | Fail | Fail |
| **2.1** | 20\|50 | 38\|50 | 33\|50 | 49\|50 | Fail | Fail |
| **2.2** | Fail | 42\|50 | Fail | Fail | Fail | Fail |
| **2.3** | Fail | 46\|50 | Fail | Fail | Fail | Fail |
| **2.4** | Fail | 48\|50 | Fail | Fail | Fail | Fail |
| **2.5** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |

Table G-19. Acceptable Two-Span Negative Moment Platoons & Routine Traffic Headways (CoV= 0.07)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.4** | 5\|50 | 5\|50 | 9\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.5** | 5\|50 | 5\|50 | 15\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.6** | 9\|50 | 5\|50 | 18\|50 | 7\|50 | 5\|50 | 5\|50 |
| **1.7** | 12\|50 | 7\|50 | 21\|50 | 27\|50 | 5\|50 | 5\|50 |
| **1.8** | 14\|50 | 9\|50 | 23\|50 | 31\|50 | 39\|50 | 5\|50 |
| **1.9** | 16\|50 | 12\|50 | 25\|50 | 35\|50 | 45\|50 | 5\|50 |
| **2** | 17\|50 | 15\|50 | 28\|50 | 38\|50 | 50\|50 | 7\|31 |
| **2.1** | 19\|50 | 33\|50 | 30\|50 | 41\|50 | Fail | 11\|12 |
| **2.2** | 19\|50 | 39\|50 | 37\|48 | 43\|50 | Fail | Fail |
| **2.3** | Fail | 43\|50 | Fail | 45\|50 | Fail | Fail |
| **2.4** | Fail | 46\|50 | Fail | 47\|47 | Fail | Fail |
| **2.5** | Fail | 49\|50 | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.7** | Fail | Fail | Fail | Fail | Fail | Fail |

Table G-20. Acceptable Two-Span Shear Platoons & Routine Traffic Headways (CoV= 0.07)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 6 |
| **1.3** | 5 | 5 | 5 | 5 | 8 | 13 |
| **1.4** | 5 | 5 | 5 | 6 | 12 | 19 |
| **1.5** | 5 | 5 | 5 | 11 | 18 | 24 |
| **1.6** | 5 | 5 | 8 | 15 | 23 | 28 |
| **1.7** | 5 | 5 | 11 | 19 | 28 | 36 |
| **1.8** | 5 | 5 | 17 | 25 | 33 | 43 |
| **1.9** | 5 | 8 | 21 | 31 | 38 | 49 |
| **2** | 5 | 11 | 25 | 37 | 47 | Fail |
| **2.1** | 5 | 13 | 29 | 43 | Fail | Fail |
| **2.2** | 5 | 15 | 33 | 49 | Fail | Fail |
| **2.3** | 5 | 17 | 37 | Fail | Fail | Fail |
| **2.4** | 5 | 23 | 40 | Fail | Fail | Fail |
| **2.5** | 10 | 30 | 44 | Fail | Fail | Fail |
| **2.6** | Fail | 42 | 50 | Fail | Fail | Fail |
| **2.7** | Fail | Fail | Fail | Fail | Fail | Fail |

Table G-21. Acceptable Two-Span Moment and Shear Platoons & Routine Traffic Headways (CoV= 0.07)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 6\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 8\|50 | 13\|50 |
| **1.4** | 5\|50 | 5\|50 | 9\|50 | 6\|50 | 12\|50 | 19\|50 |
| **1.5** | 5\|50 | 5\|50 | 15\|50 | 11\|50 | 18\|50 | 24\|50 |
| **1.6** | 9\|50 | 5\|50 | 18\|50 | 15\|50 | 23\|50 | 28\|50 |
| **1.7** | 12\|50 | 7\|50 | 21\|50 | 27\|50 | 28\|50 | 36\|50 |
| **1.8** | 14\|50 | 9\|50 | 23\|50 | 31\|50 | 39\|50 | 43\|50 |
| **1.9** | 16\|50 | 12\|50 | 25\|50 | 35\|50 | 45\|50 | 49\|50 |
| **2** | 17\|50 | 15\|50 | 28\|50 | 38\|50 | 50\|50 | Fail |
| **2.1** | 19\|50 | 33\|50 | 30\|50 | 43\|50 | Fail | Fail |
| **2.2** | 19\|50 | 39\|50 | 37\|48 | 49\|50 | Fail | Fail |
| **2.3** | Fail | 43\|50 | Fail | Fail | Fail | Fail |
| **2.4** | Fail | 46\|50 | Fail | Fail | Fail | Fail |
| **2.5** | Fail | 49\|50 | Fail | Fail | Fail | Fail |
| **2.6** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.7** | Fail | Fail | Fail | Fail | Fail | Fail |

Table G-22. Acceptable Two-Span Negative Moment Platoons & Routine Traffic Headways (CoV= 0)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **0.9** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.1** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.2** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.3** | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.4** | 5\|50 | 5\|50 | 7\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.5** | 5\|50 | 5\|50 | 13\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.6** | 8\|50 | 5\|50 | 17\|50 | 5\|50 | 5\|50 | 5\|50 |
| **1.7** | 11\|50 | 6\|50 | 20\|50 | 26\|50 | 5\|22 | 5\|50 |
| **1.8** | 13\|50 | 8\|50 | 23\|50 | 30\|50 | 38\|50 | 5\|50 |
| **1.9** | 15\|50 | 10\|50 | 25\|50 | 34\|50 | 44\|50 | 5\|50 |
| **2** | 16\|50 | 13\|50 | 27\|50 | 37\|50 | 49\|50 | 6\|29 |
| **2.1** | 18\|50 | 20\|50 | 30\|50 | 40\|50 | Fail | 10\|18 |
| **2.2** | 19\|50 | 35\|50 | 33\|50 | 42\|50 | Fail | Fail |
| **2.3** | 20\|50 | 41\|50 | Fail | 44\|50 | Fail | Fail |
| **2.4** | Fail | 44\|50 | Fail | 47\|50 | Fail | Fail |
| **2.5** | Fail | 47\|50 | Fail | 50\|50 | Fail | Fail |
| **2.6** | Fail | 49\|50 | Fail | Fail | Fail | Fail |
| **2.7** | Fail | Fail | Fail | Fail | Fail | Fail |
| **2.8** | Fail | Fail | Fail | Fail | Fail | Fail |

Table G-23. Acceptable Two-Span Shear Platoons & Routine Traffic Headways (CoV= 0)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| **0.8** | 5 | 5 | 5 | 5 | 5 | 5 |
| **0.9** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.1** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.2** | 5 | 5 | 5 | 5 | 5 | 5 |
| **1.3** | 5 | 5 | 5 | 5 | 7 | 12 |
| **1.4** | 5 | 5 | 5 | 5 | 11 | 17 |
| **1.5** | 5 | 5 | 5 | 9 | 15 | 22 |
| **1.6** | 5 | 5 | 7 | 14 | 21 | 27 |
| **1.7** | 5 | 5 | 10 | 18 | 26 | 33 |
| **1.8** | 5 | 5 | 14 | 22 | 31 | 41 |
| **1.9** | 5 | 6 | 19 | 28 | 35 | 46 |
| **2** | 5 | 9 | 23 | 35 | 44 | Fail |
| **2.1** | 5 | 11 | 27 | 40 | 50 | Fail |
| **2.2** | 5 | 13 | 31 | 46 | Fail | Fail |
| **2.3** | 5 | 16 | 35 | Fail | Fail | Fail |
| **2.4** | 5 | 19 | 38 | Fail | Fail | Fail |
| **2.5** | 6 | 25 | 42 | Fail | Fail | Fail |
| **2.6** | 11 | 31 | 46 | Fail | Fail | Fail |
| **2.7** | Fail | 45 | Fail | Fail | Fail | Fail |
| **2.8** | Fail | Fail | Fail | Fail | Fail | Fail |

Table G-24. Acceptable Two-Span Moment and Shear Platoons & Routine Traffic Headways (CoV= 0)

| α \ Span | 30 ft | 60 ft | 90 ft | 120 ft | 150 ft | 200 ft |
|---|---|---|---|---|---|---|
| 0.8 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 0.9 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.1 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.2 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 5\|50 |
| 1.3 | 5\|50 | 5\|50 | 5\|50 | 5\|50 | 7\|50 | 12\|50 |
| 1.4 | 5\|50 | 5\|50 | 7\|50 | 5\|50 | 11\|50 | 17\|50 |
| 1.5 | 5\|50 | 5\|50 | 13\|50 | 9\|50 | 15\|50 | 22\|50 |
| 1.6 | 8\|50 | 5\|50 | 17\|50 | 14\|50 | 21\|50 | 27\|50 |
| 1.7 | 11\|50 | 6\|50 | 20\|50 | 26\|50 | 26\|22 | 33\|50 |
| 1.8 | 13\|50 | 8\|50 | 23\|50 | 30\|50 | 38\|50 | 41\|50 |
| 1.9 | 15\|50 | 10\|50 | 25\|50 | 34\|50 | 44\|50 | 46\|50 |
| 2 | 16\|50 | 13\|50 | 27\|50 | 37\|50 | 49\|50 | Fail |
| 2.1 | 18\|50 | 20\|50 | 30\|50 | 40\|50 | Fail | Fail |
| 2.2 | 19\|50 | 35\|50 | 33\|50 | 46\|50 | Fail | Fail |
| 2.3 | 20\|50 | 41\|50 | Fail | Fail | Fail | Fail |
| 2.4 | Fail | 44\|50 | Fail | Fail | Fail | Fail |
| 2.5 | Fail | 47\|50 | Fail | Fail | Fail | Fail |
| 2.6 | Fail | 49\|50 | Fail | Fail | Fail | Fail |
| 2.7 | Fail | Fail | Fail | Fail | Fail | Fail |
| 2.8 | Fail | Fail | Fail | Fail | Fail | Fail |

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