RECOMMENDATIONS OF BRIDGE DISTRIBUTION FACTORS FOR MILITARY VEHICLES ON STEEL BEAM BRIDGES

By

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ABSTRACT

Analyses were carried out to develop live load distribution factors for the seven most common US Army military vehicles on ninety steel multi-beam bridges. The bridges were analyzed by the finite element method (FEM) to obtain distribution factors. The study included load testing of a steel bridge using a dump truck. The experimental results were used to assess the reliability of the FEM. Results showed that the FEM is effective to calculate the bridge behavior when it is subjected to moving loads. From the results, 56 regression formulas were developed, eight for each of the seven vehicles considered. The live-load distribution factors calculated with the proposed formulas compared well with FEM results. These formulas resulted in less conservative distribution factors than those prescribed by AASHTO and previous studies. The new formulas will result in more accurate, less conservative and more efficient bridge load ratings for bridges on US Army garrisons.

RESUMEN

Se realizaron análisis para obtener factores de distribución para siete de los vehículos más comunes del Ejército de los Estados Unidos en noventa puentes de vigas de acero. Estos puentes fueron analizados utilizando el método de elementos finitos (MEF). El estudio incluye una prueba de carga utilizando un camión de acarreo. Los resultados experimentales se utilizaron para verificar la confiabilidad de los modelos. Los resultados muestran que el MEF es efectivo para calcular la respuesta del puente cuando se somete a cargas móviles. De los resultados obtenidos se desarrollaron 56 fórmulas, ocho para cada vehículo. Los factores de distribución calculados con las fórmulas propuestas compararon bien con los resultados del MEF. Estas fórmulas resultaron en factores de distribución menos conservadores que los sugeridos por AASHTO y estudios previos. Las nuevas fórmulas permitirán realizar análisis de carga más exactos, menos conservadores y más eficientes para puentes de vigas en bases militares.

Dedicated to the three women in my life
Carmen Y. Lugo Cintrón
Elba L. Ortiz Marrero
Carmen Ortiz Marrero

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CHAPTER 1 INTRODUCTION

1.1 Problem Statement

The US Army currently owns approximately 1500 vehicle bridges on public roadways within its garrison boundaries. The majority of the traffic on these bridges is normal passenger vehicles and trucks; however the military also uses these bridges to transport its unique military equipment from maintenance and storage areas to training and deployment marshaling areas.

Because the military has a large inventory of very different vehicles, a simple process is required for the operators to know if the vehicle they are operating can safely cross an upcoming bridge. In order for military vehicle operators to know if they can cross a bridge, the Military Garrisons Director of Public Works determines and posts the Military Load Classification (MLC) of each bridge. The bridge MLC is determined using current AASHTO load rating procedures and standardized military vehicular loadings. All military vehicles are assigned a MLC number as they are brought into the military's inventory. This MLC number is determined by comparing the moments and shears that the specific military vehicle produces on a range of spans with tables for standard MLC vehicles.

In order to obtain the live load effects in the supporting members of a bridge, a distribution factor is used by design codes such as "*Standard Specifications of the American Association of State Highway and Transportation Officials*" (*Standard*). The distribution factor greatly affects a beam design or rating because it determines the percentage of vehicular load (moment or shear) that must be carried by the beam. It is used as a multiplier to the bending moment and shear force, calculated for the entire vehicle load applied to the girder as a line load, to obtain the design values of the bending moment and shear force. For multi-beam bridges, the distribution factor depends upon the relative stiffness characteristics of the deck-slab, supporting beams, and very importantly on the loading pattern and position of the vehicle on the bridge. Distribution factors can be obtained through numerous means, ranging from simple statics to rigorous closed-form solutions, and of course finite element methods hand themselves well to this problem. Even better, bridge field testing can provide a real evaluation of the bridge behavior since it includes all the parameters that affect the behavior of the bridge and can be used to calibrate analytical models.

The vehicle considered for the development of the AASHTO (*Standard* & *LRFD*) formulas was the HS-20 truck with only two sets of wheel line loads with a six feet transverse spacing. However, some military vehicles have more than two sets of wheel line loads, transverse spacings that can go up to nine feet and axle loads very different from those of an HS-20 truck. In addition, the load distribution patterns of the tracked military vehicle are quite different from that of an HS-20 truck. These different loading characteristics of military vehicles are likely to cause different distributions of bending moments and shear forces in a bridge than those caused by an HS-20 vehicle.

Distribution factors developed by AASHTO are good for civilian design and rating purposes since they were developed for a civilian highway traffic, however for military vehicles they can be overly conservative, imposing a more severe maximum bending moment or shear on the bridge, restricting the military vehicles that may cross a bridge. On the other hand, they can be underestimated potentially allowing the use of a relatively weak bridge for a heavy military vehicle that can overload the bridge. Therefore, it is desirable to obtain more accurate distribution factors for military vehicles on multi-beam bridges.

1.2 Related Studies

The live load distribution factor is a topic that can be found in many publications and studies and they are specifically used for design and load rating purposes. The AASHTO "*Standard Specifications for Highway Bridges*" (2002) contains simplified procedures to be used in the analysis and design of bridges. The analysis of a bridge superstructure is reduced to the analysis of single member with the introduction of wheel load distribution factors. This design code assumes that the wheel load distribution factors are only a function of the girder spacing. Since their inception, these distribution factors have evolved or changed very little. These distribution factors have been criticized for being overly conservative.

Therefore, Zokaie et al. (1991) introduced new wheel load distribution factors as part of National Cooperative Highway Research Program (NCHRP). These factors were based on analytical and experimental research performed and published in the last two decades. They introduced new distribution-affecting parameters including span lengths, girder spacing and girder stiffness. They use the "AASHTO HS family" of trucks as the vehicle loads in the analysis. Their study is the basis for the distribution factor formulas in the LRFD code.

Mabsout et al. (1998) analyzed a total of 78 bridges using the finite-element method to study the effect of span continuity on wheel load distribution factors. A typical two-equal-span, two-lane, straight, composite steel girder bridge configuration was selected for the study. They varied the bridge parameters such as span length and girder spacing to investigate their influence on the bridge continuity. In general the values obtained were less than those obtained with the empirical formula provided in AASHTO (*Standard*). They recommend an average of 15% reduction when using the AASHTO standard factors to analyze continuous bridges. Mabsout et al. (1999) analyzed a total of 144 bridges using the finite-element method. SAP90 was the computer program used to model the concrete slab as quadrilateral shell elements, the steel girders as space frame members and simple supports as boundary conditions. AASHTO HS-20 design trucks were positioned in all lanes of the one-span and two-span bridges to produce the maximum bending moments. The research found that the load distribution factors obtained with the finite element method was less than the empirical formula provided in AASHTO (*Standard*) for span lengths greater than 15.25 m (50 ft) and girder spacing greater than 1.8 m (6 ft).

Tabsh and Tabatabai (2001) used the finite element method to develop modification factors for the AASHTO load distribution factors of girder bridges subject to oversized trucks. According to them, AASHTO load distribution factors cannot be used to accurately estimate the live load in the girders when a truck with a wheel gauge larger than the standard 1.83m (6ft) gauge is used. The results of the analysis showed that the use of the proposed modification factors with the specification-based girder distribution factors can help increase the allowable loads on slab-on-girder bridges.

Because the database used in this study was so limited, nine different steel bridges, their results were not considered to be applied to military vehicles.

Fu et al. (1996) conducted field tests to determine the effect of live load for the slab and beam of four existing steel I-girder bridges. From the field testing, the live load distribution factors were deducted from the measured strain gauge values. The distribution factor of the code methods produced higher distribution factors. Since the study was limited to one type of bridge, final values were selected just for the purpose of calibrating the mathematical model, not to establish a new distribution factor.

Barker (2001) compares analytical rating and field test rating and shows that the structure usually exhibits field test capacities higher than the analytical load capacity rating predictions. Field testing is valuable for evaluating existing bridges. It allows the owner to reduce the conservatism of analytical rating methods and safely rate the bridge for higher loads. Many factors such as bearing restraint effects, unaccounted system stiffness, and actual lateral live load distributions not considered in the design contribute to the response of a tested bridge.

Arguably, the study by Zokaie et al. (1991) is the most comprehensive study conducted so far on the lateral load distribution factor analysis. The consideration of girder spacing, girder span, deck-girder stiffness, and the number of loaded lanes led to new and more accurate formulas for calculating the load distribution factors. Interestingly, this study indicated that the distribution factors were insensitive to different vehicle types and loading patterns. This is quite contrary to the findings of Tabsh and Tabatabai (2001). However, it must be remembered that Zokaie's study was focused on the more common truck types which do not have much variation in load pattern, while the Tabsh and Tabatabai (2001) study focused on uncommon and much larger vehicles.

To address the issue of the distribution load effects by military vehicles, the Military Traffic Management Command and the Federal Highway Administration Bridge Division sponsored an initial study in the nineties. The initial phase of this study was to evaluate 539 bridges in New Mexico from the National Bridge Inventory (NBI) for different military vehicle including the Heavy Equipment Transporter System (HETS) using the program OVLOAD. This program was developed by the New Mexico State Highway and Transportation Department. Results show that several bridges in this database were not passable by some loaded military vehicles including HETS. The apparent deficiency was attributed to inadequate consideration of the lateral load distribution of military vehicles by the OVLOAD program. Therefore, this phase was followed by a more comprehensive study started in October 1998 by the New Mexico State University (NMSU). The purpose of this follow-up study was to develop a more accurate computer program to evaluate the passability of the bridges in the NBI database, and to verify the findings with the field test on a few selected bridges. The HETS vehicle was the primary focus of this study, as this particular vehicle was observed to place the most demand on the bridge systems. The details of this NMSU study are provided in the report by Minor and Woodward (2001). The study consisted of finite element analyses of Zokaie’s database with the HETS. Also, field tests were performed on multi-girder bridges. The study did not directly result in distribution factors for the HETS. Instead, it related the HETS to an “equivalent HS vehicle”. For most bridges, it was found that the HETS actually produce a load effect in a single girder approximately the same as an

HS20 truck for which the bridges were designed. This of course was attributed to the better load distribution from the HETS.

This study was followed by a complete study developed by Piñero et al. (2001) to develop distribution factor formulas for military vehicles on multi-girder deck slab bridge systems. In this study the harmonic analysis approach was followed to develop 56 formulas for the military vehicles on multi-girder deck slab bridge systems. During the first part of the study a distribution factor formula was developed for each military vehicle for the bending moment analyses of interior beams with a single lane loading. Then, distribution factor formulas were developed for the bending moment analyses of exterior beams with single and double lane loadings and for shear force analyses but these formulas were developed for the military vehicles considered as a group and not individually. These formulas do not address the difference in the distribution factors of the individual military vehicles since they have a large variation in their loading patterns. Also, these formulas were developed for the design purposes and not for load rating purposes.

1.3 Research Objectives

The goal of this research is to develop a simple approach to calculate the load effects by military vehicles on simply supported steel multi-beam bridge systems. This is intended to provide a quick, convenient, and accurate method for rating capacity analysis and evaluation of a bridge for military vehicle loading. Also, an overview of the military load classification procedure is presented. Specifically the objectives are:

1. Provide a detailed explanation of the current procedure for determining the wheeled and tracked MLC for single span bridge.
    1.1. Reason for MLC system
    1.2. Vehicle MLC determination
    1.3. Bridge MLC determination for military combat area
    1.4. Bridge MLC determination for US Army Garrisons with public bridges
2. Determine the live load bending moments and shears for specific military vehicles considered in the study, for simple span steel multi-beam bridges with spans between 5 and 300 feet.
3. Compare the wheeled and tracked MLC of bridge #2 using the allowable stress, load factor and load and resistance factor load rating methods.
4. Compare the Load Rating of bridge #2 using the allowable stress, load factor and load and resistance factor load rating methods with the specific vehicles.
5. Conduct load proof testing on bridge #2 with a civilian vehicle to calibrate a 3D finite element model and obtain load distribution factors for military wheeled and tracked vehicles.
6. Construct a 3D finite element model of bridge #2 for the determination of the bridge distribution factors of the specific vehicles.
7. Compare the distribution factors for military wheeled and tracked vehicles obtained by the analytical model with the values suggested by design codes (AASHTO).
8. Develop recommendations for distribution factors for military vehicles.

1.4 Methodology

The methodology used in this research project can be divided in three stages. The first stage consists in a computational analysis to determine the bridge and vehicles MLC classification as well as the bridge load rating. Once the load rating of the bridge is known, load test can be performed using lightweight vehicles, for the bridge to remain in the elastic range. The second stage involves the load testing of the bridge to determine its properties to calibrate the finite element analysis model. The third stage interprets the finite element analyses to determine the distribution factors for specific military vehicles. A summary of each step is presented below.

1.4.1 Computational Analysis

Determination of live load bending moments and shears for the current inventory of military vehicles for simple span bridges with spans between 5 and 300 feet was achieved using a routine developed in Excel by the Tank Automotive Research, Development, and Engineering Center (TARDEC). This routine consider axle loads and spacing for wheeled vehicles and uniform loads along with the loading length for military vehicles, as well as the width and maximum tire load for both military vehicles. The program generates a set of shear and moment charts and tables for a simple span bridge for the military vehicle in consideration and correlate the results with the values produced by standard MLC vehicles to assign a properly MLC classification to the vehicle as defined by the Standard NATO Agreement (STANAG) 2021. The program assigns the maximum MLC classification obtained for any span to the vehicle. Also a bridge load rating analysis was performed following the AASHTO procedures to determine the bridge load rating and MLC classification. Appendix A shows the load rating analysis as well as the MLC classification for the bridge in consideration.

1.4.2 Bridge Load Testing

To obtain the necessary data to calibrate the finite element model, static and moving load tests were performed at the Engineering Research and Development Center (ERDC) in Vicksburg, Mississippi. In coordination with the Department of Public Works (DPW), bridge #2 was selected for the research. The test was performed on a three simple span bridge. The bridge has two approach slab concrete spans and an intermediate steel beam span. Only the intermediate span was tested because steel beam bridges are the only type of bridges considered in this research.

In order to collect the data for the bridges, the Bridge Diagnostic Inc. (BDI) structural testing system (STS) was used. This is a non-destructive system, which consists of a data acquisition system (computer, STS boxes, cables and strain transducers) that will not harm the structure. The hardware utilizes Motorola 68H16C microprocessors to control the recording, filtering, and amplification of the measurements. The digitized data is simultaneously downloaded to a notebook PC via the standard RS-232 serial interface. Since all data transfer is digital, electronic noise and lead-wire effects are minimized. Each strain transducer has an EEPROM chip which stores the transducer ID number and identifies itself to the structural testing system (STS) to apply the proper calibration factor. The sample rates vary from 0.1 to 100 Hz and can measure a range up to 1500 micro-strain. A sample rate of 30 Hz was used in the test.

A dump truck vehicle was used during the field test performed. Three tactical vehicle locations were chosen to calibrate the finite element model. Maximum strains were determined from the finite element model. Twenty strain gages were used during the test to monitor the bending moment and shear strains on the structure. More details of the procedure, equipment, and theory for the load test are given in Chapter 4.

1.4.3 Finite Element Analysis

An important part of the research is to properly model the steel bridge using the finite element method, to calculate the strains on the beams using different load cases. The structural components of the bridges did not experience inelastic deformations during the load cases due to the weight of the test vehicle and thus it is appropriate to use linear elastic models for the components. The analyses were performed using the bridge module integrated into the nonlinear analysis program SAP2000. The model includes standard linear frame elements and elastic finite elements for static and dynamic analysis. The bridge model was based on a combination of quadrilateral shell elements to idealize the concrete slabs and spaced frame member to represent the steel beams. The computed strains by the model were compared with the recorded strains from the load test to assess the effectiveness of the analysis methods.

After calibrating the bridge model, strains were obtained for each beam. Using these strains an experimental distribution factor for the load test vehicle was calculated for the bridge. Calibration of the finite element model to this load test provided the confidence to extend the finite element analysis method to address a total of ninety different steel beam bridges chosen from the NMSU study. The results from this large sample of bridge analyses were used to determine distributions factors for seven military vehicles on steel beam bridges.

In order to obtain the distribution factor for each military vehicle, first the maximum load effects, bending moments and shear forces, were calculated by the finite element analysis approach for each of the ninety steel beam bridge systems positioning the military vehicles in strategic position to develop a maximum response on the beams. The finite element analysis appropriately considers the interaction between the military loads, the beams and the supporting deck, and thus provides more accurate load distribution and thus more accurate maximum load effects. The calculated maximum load effect value on each beam was divided by the total maximum values to obtain the distribution factor for each beam. Then, the maximum values for interior and exterior beams were selected as the bridge distribution factors. A statistics analysis was performed to obtain nonlinear multiple regression equations that “best fit” the results.

1.5 Thesis Organization

An overview of the military load classification system for military vehicles and bridges within the US Army garrisons and military combat areas is presented in Chapter 2. Chapter 3 presents a summary of the results for the load rating and military load classification analyses performed on bridge #2. A discussion on the difference in the AASHTO methods to load rate a bridge is also presented.

The load testing procedure on bridge #2 is described on Chapter 4. This chapter also provides the equipment description, the recorded data, and the civilian vehicle used to perform the test. The recorded data on bridge #2 is analyzed on Chapter 5. Here a finite element analysis model is calibrated with the load testing results and live load distribution factors are calculated for the civilian vehicle and the military vehicles. In Chapter 6, finite element analyses are perform for 90 steel beam bridges to obtain bending moment and shear force live load distribution factors for the military vehicles. Finally, the conclusions and recommendations of the study are presented on Chapter 7.

CHAPTER 2 MILITARY LOAD CLASSIFICATION SYSTEM

2.1 Reason for MLC System

Military vehicles are quite different from civilian vehicles. They include both wheeled or rubber tired trucks and tracked vehicles such as tanks. Because bridges on military installations must often carry high volumes of these vehicles, the Military Load Classification (MLC) must be determined in addition to the civilian vehicles to load rate a bridge. The MLC does not represent the actual weight of a vehicle. It represents the loading effects that military vehicles have on bridges. It also describes the maximum type and size of military vehicle that may safely use the bridge. As with civilian vehicles, the hypothetical military vehicles shown in Figure 2.1.1 have been defined according to a Standard NATO Agreement (STANAG) 2021. They were developed to represent all military vehicles used by the participating NATO countries.

All real vehicles are related to the hypothetical vehicles through an analytical process involving the comparison of the bending moments and shears produced by the actual vehicle on various span lengths to those produced by the hypothetical vehicles. The real vehicle's MLC is placarded on its front grill in a specific location. The allowable MLC is also posted on all bridges that must carry military traffic. A specific vehicle may cross all bridges that have higher posted MLC than itself. The hypothetical vehicles in Figure 2.1.1 are grouped according to their “Class” defined in column 1. For each Class, there is an associated hypothetical wheeled and tracked vehicle. For tracked vehicles, the Class directly relates to its total weight in tons. For wheeled vehicles, the Class is not exactly the same as the weight, but represents a wheeled vehicle that produces a similar load effect, span moment or shear, to that of the same Class tracked vehicle. Specific axle loadings and spacing for these vehicles are shown in columns 2 and 3 of Figure 2.1.1. The maximum load to be expected for any axle on the vehicle is shown in column 4. Columns 5 thru 7 show the minimum wheel spacing and tire sizes of critical axles. The maximum tire load and minimum tire size is shown on column 8.

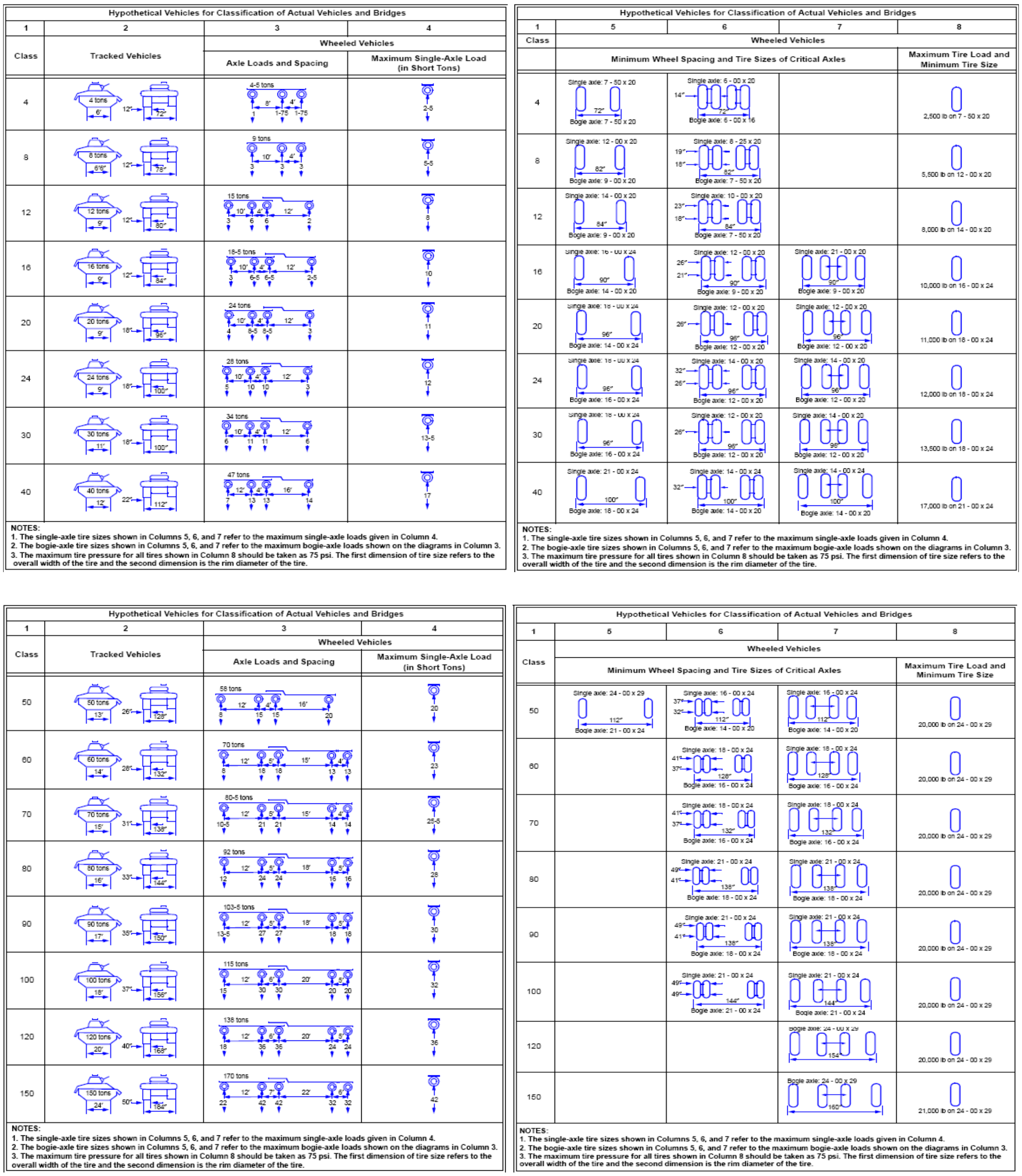


Figure 2.1.1 Hypothetical Military Vehicles

2.2 Vehicle's MLC Determination

A routine was developed in Excel by TARDEC to determine the maximum bending moment and shear force for a given military vehicle on different spans. The calculations were performed for each span as outlined in STANAG 2021. In order to determine the military load classification of the military vehicles the resulting numbers from the routine are compared against the hypothetical bending moments and shear forces at the same respective spans to give an initial MLC number to the military vehicle. The highest of these initial numbers will then have a correction factor applied to it to arrive at a final MLC. The correction factor depends on the width of the vehicles as it compares the actual and the hypothetical widths to increase or decrease the class number. This process is demonstrated in section 2.5.1

2.3 Bridge MLC Determination for US Army Garrisons

There are numerous guidelines and criteria for the load rating of bridges. For military installations, specific doctrine for this purpose is found in Army Regulation (AR) 420-72, entitled, "*Surfaced Areas, Railroad Tracks, Bridges, Dams and Associated Appurtenances*." This regulation should always be the starting point for any load rating analysis. It will provide the necessary references to follow. For vehicular bridges, the AR stipulates the use of the analytical criteria set forth by the American Association of State Highway and Transportation Officials, specifically, that in the "*Manual for Condition Evaluation of Bridges*". This manual contains the criteria for highway bridges and has been adopted for military installations. For steel and concrete vehicular bridges, the AR recommends the use of the "*Load and Resistance Factor Rating*" (LRFR) method, as opposed to the more familiar "Allowable Stress" method or "Load Factor" method.

Guidelines for the *LRFR* method are provided in the AASHTO manual entitled, "*Guide Specifications for Strength Evaluation of Existing Steel and Concrete Bridges*". The Manual for condition and Evaluation of Bridges and the Guide Specifications for Strength Evaluation of Existing Steel and Concrete Bridges provide only a limited amount of detailed analytical criteria. For detailed criteria, these references refer the user to the AASHTO design manual entitled, "*Standard Specifications for Highway Bridges*". The Guide Specifications for Strength Evaluation of Existing Steel and Concrete Bridges has recently been superceded by a complete specification (*LRFD*) but the Army has yet to make the transformation to the new criteria.

Specific vehicular live loadings to be used with the above criteria must be found in three different locations: *Standard* and *LRFD* AASHTO manuals specify the civilian vehicular loadings and FM3-34.343 specifies the military wheeled and tracked vehicular loadings. It is very important to emphasize that only the vehicular loading and not the analytical method in FM3-34.343 should be used. The analytical criteria in this reference are intended for temporary bridges and thus have reduced safety margins that are not applicable to permanent bridges on military installations. For railroad bridges, both analytical criteria and train loadings come from the American Railway Engineering Association (AREA) manual entitled, "*Manual for Railway Engineering*". Much of its analytical criteria are very similar to that for vehicular bridges as discussed above. All of the above-mentioned references were adopted or modified from industry specific criteria such as "*Steel Manual*", "*Timber Bridge Manual*" and "*American Concrete Institute Code*". While not specifically required for the load rating procedures discussed herein, they can provide greater insight to the origins of the criteria used in load ratings.

2.4 Bridge MLC Determination for Military Combat Area

The process for bridge MLC determination in military combat is defined in Field Manual (FM) 3-34.343 "*Military Nonstandard Fixed Bridging*". It uses the same basic structural approaches as previously discussed except many simplifying assumptions are made in order to produce rapid combat-level assessments such as:

1. The bridge superstructure will always control the rating.

This assumption was make due to AASHTO said that decks generally do not control the rating and *Manual* stipulates that all connections must be designed to be stronger than the members they support.

2. Serviceability and fatigue life should not be a concern.

Since Theater of Operation (TO) bridges are usually only active for 5 years or less. Under normal loading conditions, fatigue only occurs after millions of stress cycles, which can take 20 to 50 years to accumulate even under heavy traffic.

3. Midspan is the controlling location for bending moment calculations on beams.

Even though the midspan moment may not always be the limiting case, it should still provide a reasonable load rating location since superstructure elements, at all locations, are generally of balanced design. That means that all locations are efficiently designed to carry the maximum possible loading at that location. If the rating is based upon one location of balanced design, it should effectively reflect the necessary conditions for similar vehicles at all other locations along its length.

4. Interior stringers control the rating.

This assumption was made because military convoy loadings are generally concentrated toward the center of a bridge.

5. The impact factor used to account for the bouncing application of vehicular loadings and the dynamic increase in live loads due to the rate at which the moving loads are applied to the bridge is 15 percent.

Since military vehicle are well spaced, 100 ft apart, and maintain relatively slow speeds, compared to civilian trucks on highways, the recommended value of 15 percent should be conservative.

6. Load distribution is not determined by the distribution factor where it represents a fraction of a wheel line load that is carried by a single stringer; instead it is represented by the number of effective components sharing the total load.
7. Continuous span bridges are rated approximately using the concept of equivalent simple span.

Equivalent span length is the length of a simple span that would receive the same maximum live load moment that would be produced on a continuous span by the same loading. For simplicity and expediency 0.80 times the length of the end span and 0.70 times the length of the interior span were chosen. These factors address the variation in different load types and different span length combination calculated in FM 3-34.343 within 14 percent. These assumptions are well documented in the Technical Report (TR) 02-15 that is a commentary of FM 3-34.343.

2.5 Military Vehicles

Seven different types of military vehicles were considered in this study. These vehicles are considered the most common and/or important military vehicles used by the US Army. The military vehicles can be divided into wheeled or tracked categories as follows:

Tracked Military Vehicles:

M113: This military vehicle is the smallest tank considered in the study. It consists of two separate wheel lines of loading, a total of five axles, and a total weight of 23 kips. The transverse and longitudinal load configurations are shown in Figure and Table 2.5.1.

M2-BRADLEY: This military vehicle is considered as the intermediate tank in the study. It has two separate wheel lines of loading, a total of six axles, and a total weight of 50 kips. The transverse and longitudinal load configurations are shown in Figure and Table 2.5.2.

M1-ABRAMS: This is the biggest tracked vehicle considered in the study. It consists of two separate wheel lines of loading, a total of seven axles, and a total weight of 140 kips. The transverse and longitudinal load configurations are shown in Figure and Table 2.5.3.

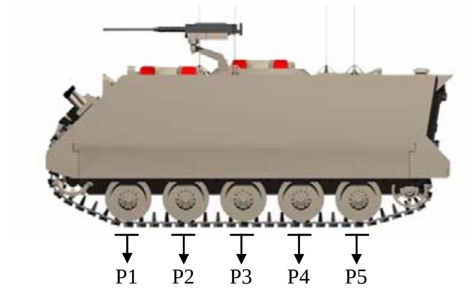
Wheeled Military Vehicles:

LAVIII-STRYKER: This military vehicle is similar to the future combat system vehicle and that was the main reason to consider it in the study. It consists of two separate wheel lines of loading, a total of four axles, and a total weight of 41 kips. The transverse and longitudinal load configurations are shown in Figure and Table 2.5.4.

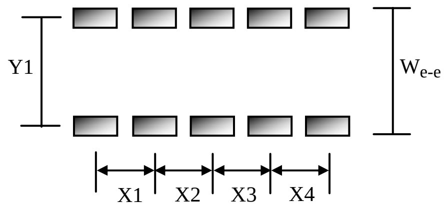
HEMTT: This military vehicle by itself has two separate wheel lines of loading and a total of four axles, but in this study is considered along with his tractor that also has two separate wheel lines of loading and three axles. The total weight for the vehicle with the tractor is 112 kips. The transverse and longitudinal load configurations are shown in Figure and Table 2.5.5.

PLS: This military vehicle by itself has two separate wheel lines of loading and a total of five axles, but in this study is considered along with his tractor that also has two separate wheel lines of loading and three axles. The total weight for the vehicle with the tractor is 137 kips. The transverse and longitudinal load configurations are shown in Figure and Table 2.5.6.

HETS: This military vehicle is the biggest vehicle considered in this study. By itself it has two separate wheel lines of loading and a total of four axles, but in this study is considered along with his tractor that has four separate wheel lines of loading and five axles. This is the main reason why this military vehicle is the main focus on this study. The total weight for the vehicle with the tractor is 230 kips. The transverse and longitudinal load configurations are shown in Figure and Table 2.5.7.



a) Side View

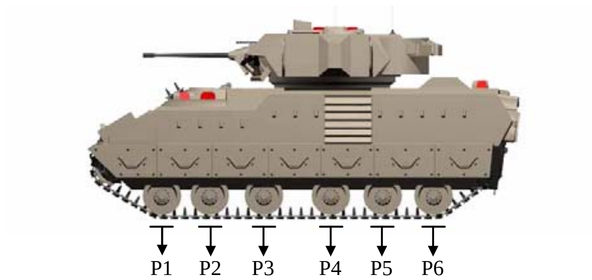


b) Top View

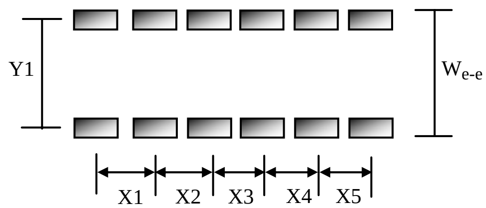
Figure 2.5.1 Configuration of M113 Vehicle Load Distribution

Table 2.5.1 Loading Data and Dimensions of M113

Loading Data					
Axle Weights (k)	P1	P2	P3	P4	P5
	4.6	4.6	4.6	4.6	4.6
Dimensions					
Transverse Spacing (ft)	$W_{e\text{-}e}$	Y1			
	8.75	7.08			
Longitudinal Spacing (ft)	X1	X2	X3	X4	
	2.19	2.19	2.19	2.19	



a) Side View

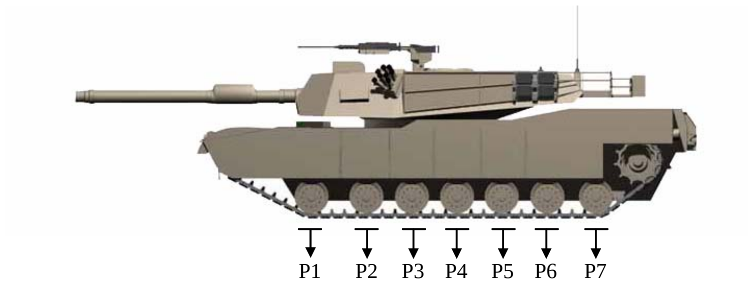


b) Top View

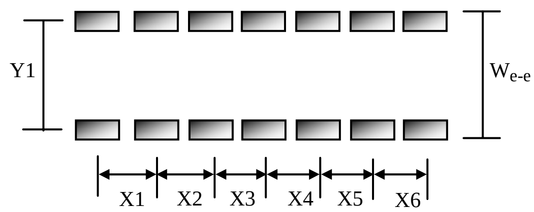
Figure 2.5.2 Configuration of M2-BRADLEY Vehicle Load Distribution

Table 2.5.2 Loading Data and Dimensions of M2-BRADLEY

Loading Data						
Axle Weights (k)	P1	P2	P3	P4	P5	P6
	8.4	8.4	8.4	8.4	8.4	8.4
Dimensions						
Transverse Spacing (ft)	W_{e-e}	Y1				
	10.5	8.75				
Longitudinal Spacing (ft)	X1	X2	X3	X4	X5	
	2.57	2.57	2.57	2.57	2.57	



a) Side View

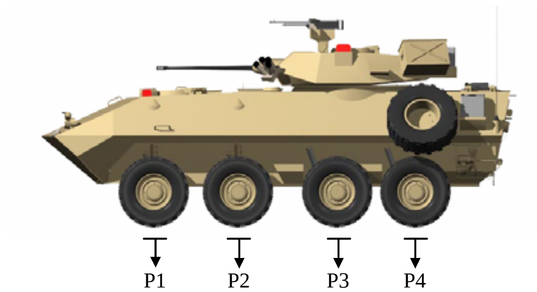


b) Top View

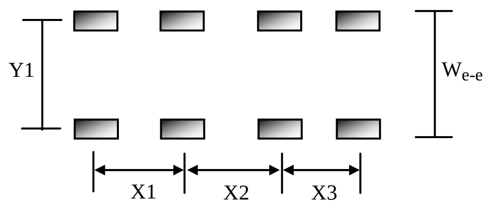
Figure 2.5.3 Configuration of M1-ABRAMS Vehicle Load Distribution

Table 2.5.3 Loading Data and Dimensions of M1-ABRAMS

Loading Data							
Axle Weights (k)	P1	P2	P3	P4	P5	P6	P7
	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Dimensions							
Transverse Spacing (ft)	$W_{e\text{-}e}$	Y1					
	11.42	9.34					
Longitudinal Spacing (ft)	X1	X2	X3	X4	X5	X6	
	3.0	2.4	2.4	2.4	2.4	2.44	



a) Side View

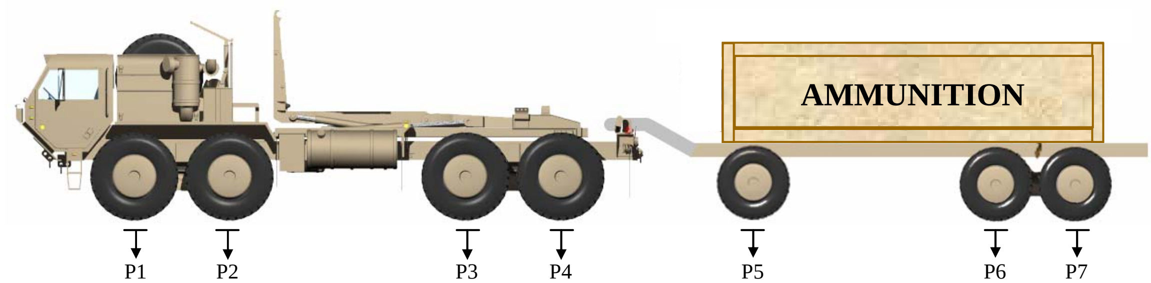


b) Top View

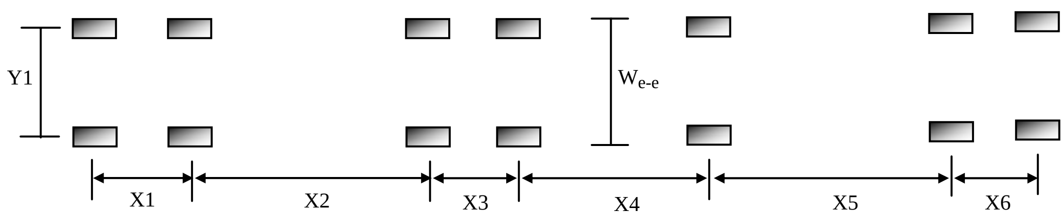
Figure 2.5.4 Configuration of LAVIII-STRYKER Vehicle Load Distribution

Table 2.5.4 Loading Data and Dimensions of LAVIII-STRYKER

Loading Data				
Axle Weights (k)	P1	P2	P3	P4
	9.8	9.8	10.9	10.7
Dimensions				
Transverse Spacing (ft)	$W_{e\text{-}e}$	Y1		
	8.97	7.25		
Longitudinal Spacing (ft)	X1	X2	X3	
	4.0	4.67	4.0	



a) Side View

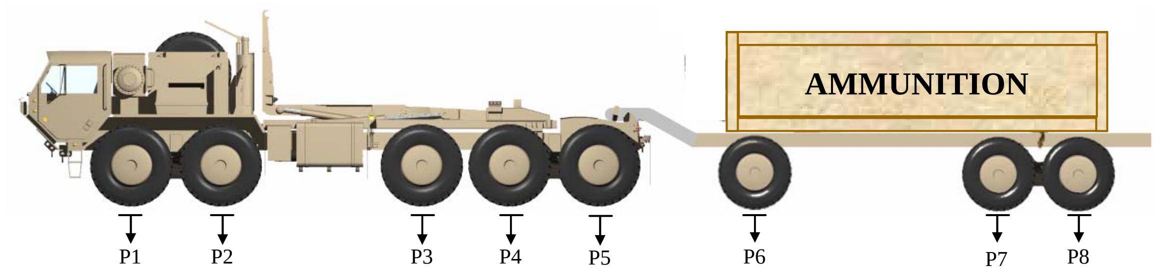


b) Top View

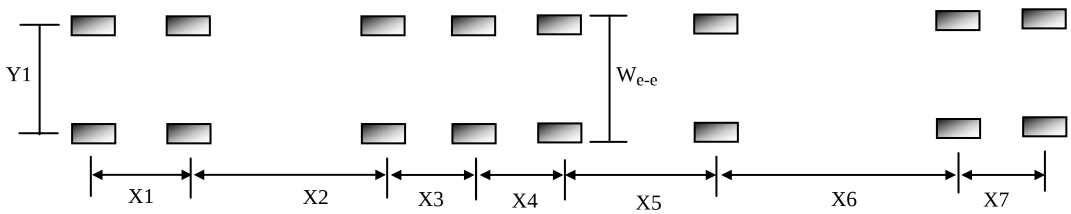
Figure 2.5.5 Configuration of HEMTT Vehicle Load Distribution

Table 2.5.5 Loading Data and Dimensions of HEMTT

Loading Data							
Axle Weights (k)	P1	P2	P3	P4	P5	P6	P7
	14.0	14.0	16.4	16.4	9.8	20.6	20.6
Dimensions							
Transverse Spacing (ft)	$W_{e\text{-}e}$	Y1					
	8.0	6.5					
Longitudinal Spacing (ft)	X1	X2	X3	X4	X5	X6	
	5.0	12.5	5.0	8.0	10.0	4.6	



a) Side View

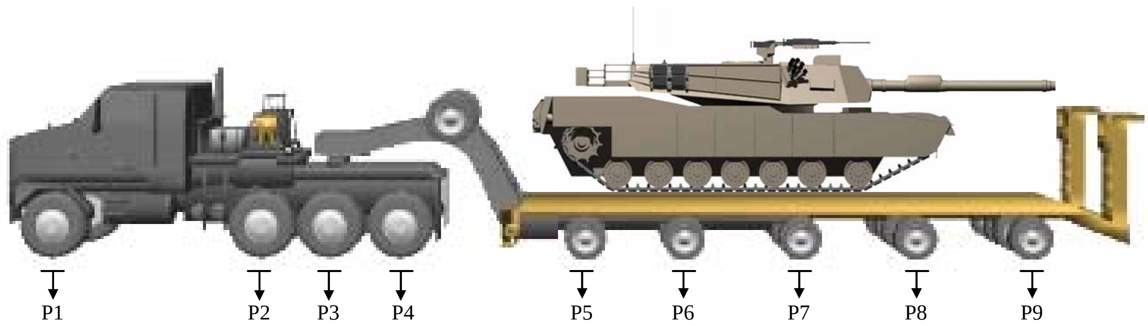


b) Top View

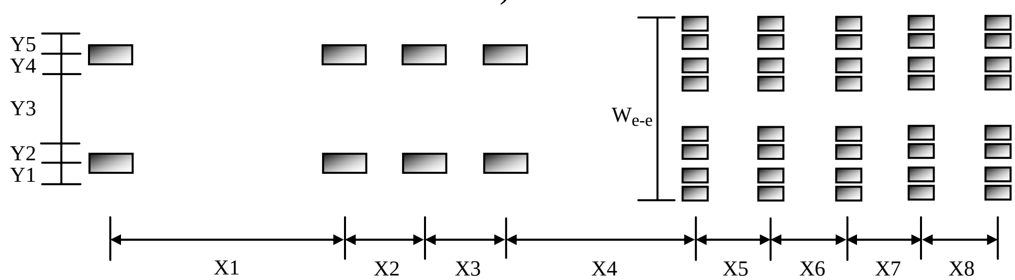
Figure 2.5.6 Configuration of PLS Vehicle Load Distribution

Table 2.5.6 Loading Data and Dimensions of PLS

Loading Data								
Axle Loads (k)	P1	P2	P3	P4	P5	P6	P7	P8
	11.4	11.4	21.2	21.2	21.2	9.8	20.6	20.6
Dimensions								
Transverse Spacing (ft)	$W_{e\text{-}e}$	Y1						
	8.0	6.67						
Longitudinal Spacing (ft)	X1	X2	X3	X4	X5	X6	X7	
	5.0	11.2	5.0	5.0	8.5	10.0	4.6	



a) Side View



b) Top View

Figure 2.5.7 Configuration of HETS Vehicle Load Distribution

Table 2.5.7 Loading Data and Dimensions of HETS

Loading Data									
Axle Loads (k)	P1	P2	P3	P4	P5	P6	P7	P8	P9
	21.7	22.3	21.7	19.9	27.0	29.7	28.0	28.0	31.4
Dimensions									
Transverse Spacing (ft)	W_{e-e}	Y1	Y2	Y3	Y4	Y5			
	12.0	1.67	1.12	4.85	1.12	1.67			
Longitudinal Spacing (ft)	X1	X2	X3	X4	X5	X6	X7	X8	
	12.92	5.0	5.0	15.94	5.94	5.94	5.94	5.94	

2.5.1 MLC Computation for Military Vehicles

Military Load Classification for the seven specific vehicles was performed using the procedure outline in STANAG 2021. The first step to determine the military load classification is to obtain the maximum bending moments and shear forces for each span for the hypothetical vehicles and the military vehicle in consideration. Maximum bending moments and shear forces are shown on Figures 2.5.8 and 2.5.9 respectively for the M113 military vehicles. As outline in STANAG 2021 the spacing between consecutive military vehicles is 100 feet. The next step consists in the comparison of bending moments and shear forces between the current military vehicle and the hypothetical vehicles. Finally, a width correction factor is applied to determine the final MLC classification for the military vehicle. Here the military vehicle width is compared with the width of the hypothetical vehicles for the MLC value obtained to apply the width correction factor. Vehicle's width for the hypothetical vehicles is shown in columns 5 thru 7 on Figure 2.1.1. Note that in Figures 2.5.8 and 2.5.9 the highest MLC number is the MLC assigned to the current vehicle since these charts already include the width correction factor.

Based on the assumption that the MLC assigned to the vehicle is the maximum MLC obtained for any span, it is possible that a military vehicle that is safe to cross a bridge could be restricted. Also the width correction factor for the classification of the military vehicles is assuming the role of the distribution factor for military vehicles because they impose a factor comparing the width of the military vehicle with the hypothetical vehicles. Basically, the width correction factor is assuming how the military vehicle is going to distribute the load on the bridge. If the military vehicle is narrower than the hypothetical vehicle, the MLC value is increased to account for the fact that narrower vehicles will tend to laterally distribute loads less. On the other hand, if the military vehicle is wider that the hypothetical vehicle the MLC value is decreased since wider vehicles should better distribute loads laterally. Therefore, it is recommended that if a military vehicle necessary to complete a mission is restricted to cross a bridge based on the MLC on its front grill, it should be analyzed for the specific bridge span instead of the conservative assumption.

Figure 2.5.10 shows the maximum MLC variation for moment or shear, for each of the specific military vehicles from 0 to 300 ft. The width correction factor is shown on Figure 2.5.11. Tables 2.5.8 and 2.5.9 show bending moment and shear values for each of the specific military vehicles from 0 to 300 ft.

The MLC values shown in Tables 2.5.8 and 2.5.9 corresponds to the maximum value for moment or shear with the width correction factor applied to each vehicle. As the MLC value usually change with the span length as shown in Figure 2.5.10, the MLC was calculated for each military vehicle for the span length of bridge #2.

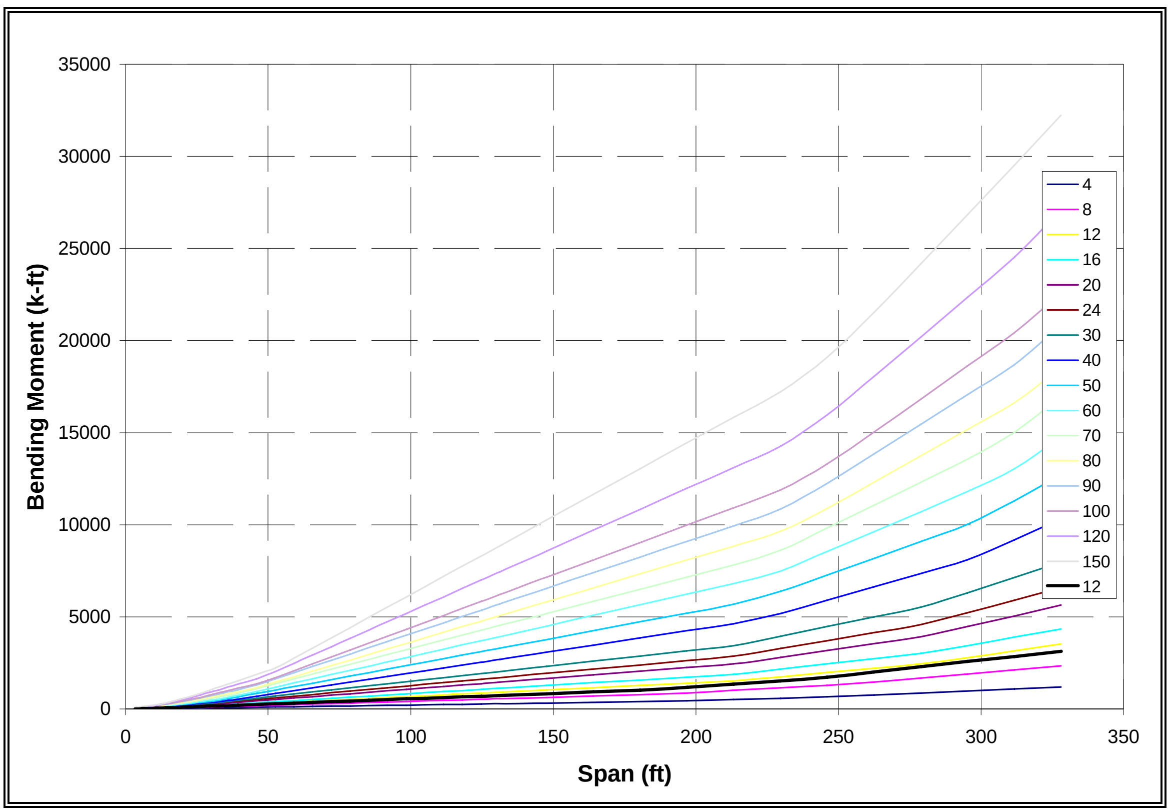


Figure 2.5.8 Input Vehicle Vs. Hypothetical Tracked Vehicles – Bending Moment (M113)

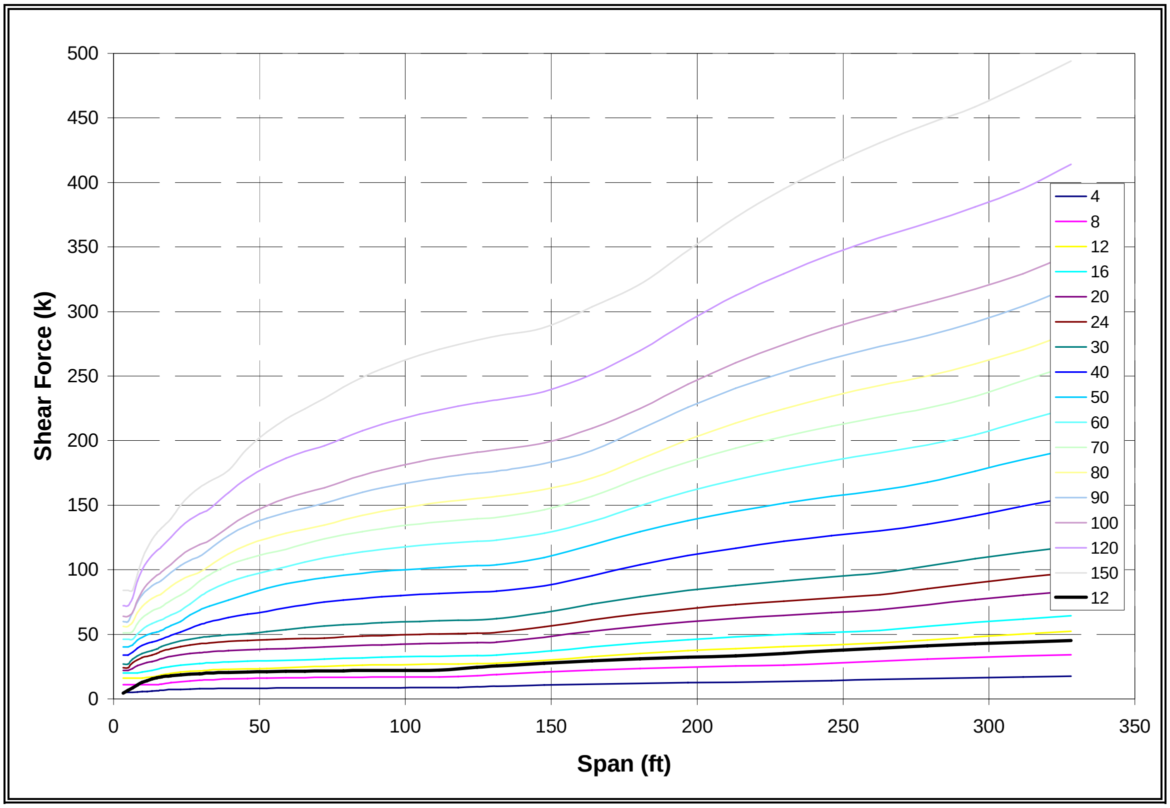


Figure 2.5.9 Input Vehicle Vs. Hypothetical Tracked Vehicle – Shear (M113)

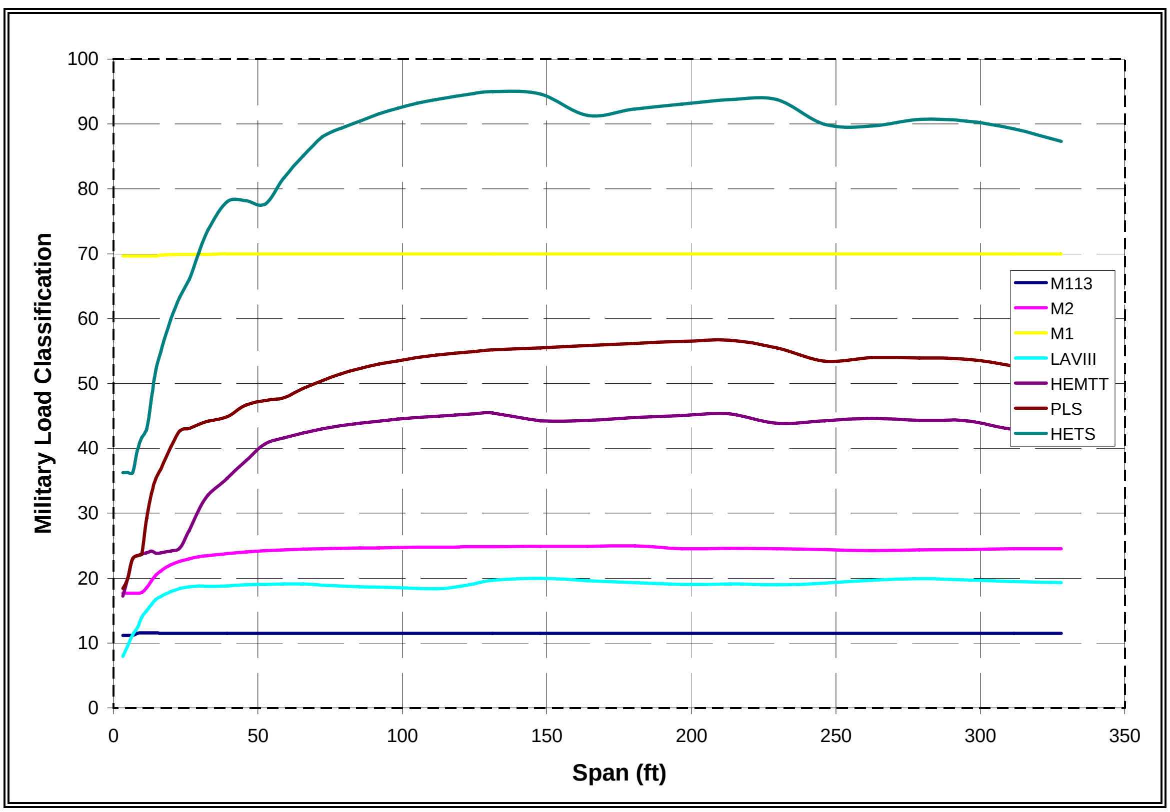


Figure 2.5.10 Military Load Classification for Military Vehicles

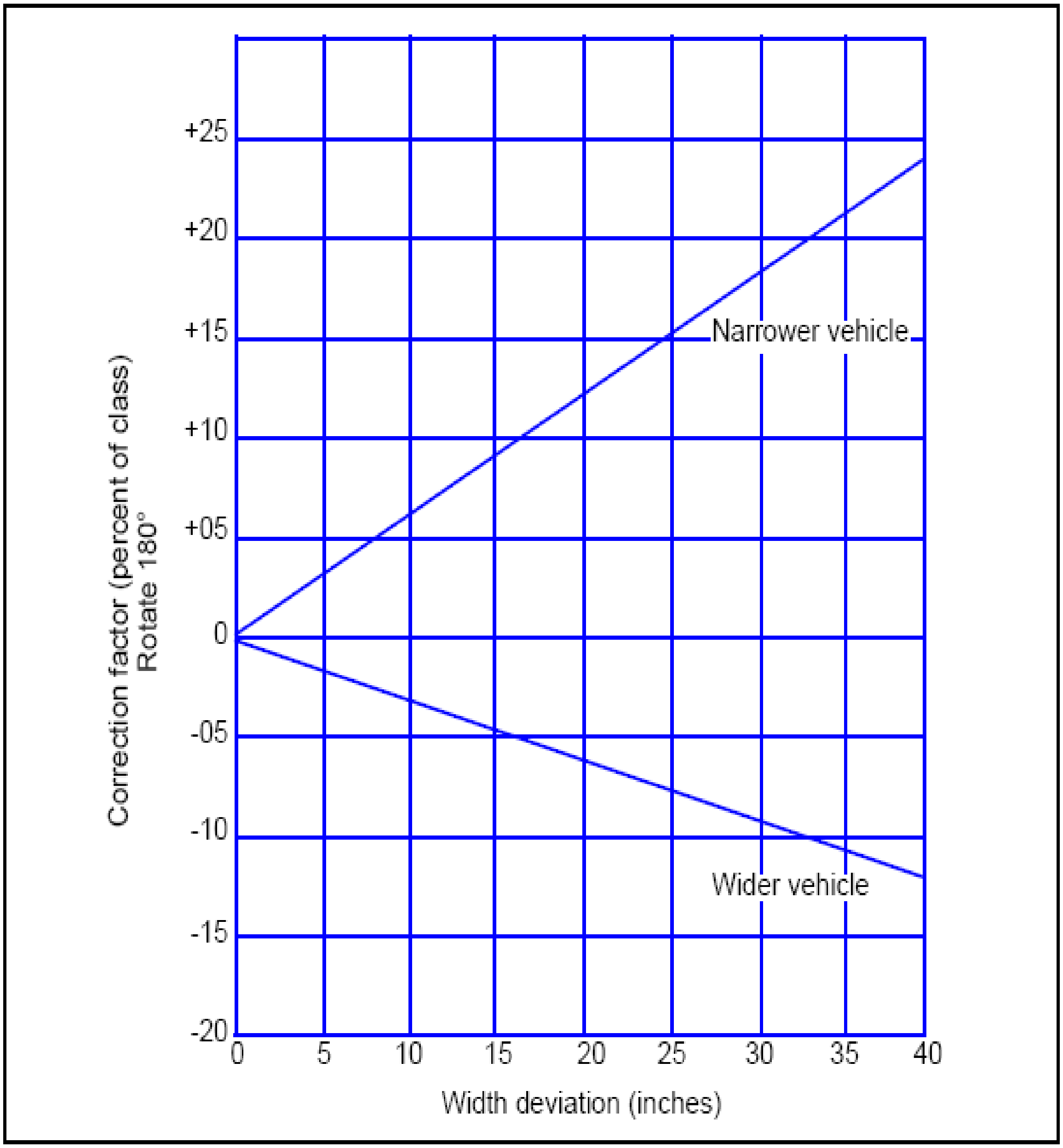


Figure 2.5.11 Width Correction Factor

Table 2.5.8 Bending Moment for Specific Military Vehicles

Span (ft)	Military Vehicle Moment (k-ft)						
	Tracked Vehicles			Wheeled Vehicles			
	M113	M1	M2	FCV	HEMTT	PLS	HETS
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	8.24	29.23	12.32	13.62	25.75	26.50	39.25
10	32.31	116.62	49.14	35.05	61.07	61.16	79.20
15	61.06	261.85	108.03	73.55	110.75	132.49	154.27
20	89.81	436.76	171.03	121.57	161.80	211.98	261.03
25	118.55	611.74	234.02	172.60	222.35	291.74	390.26
30	147.30	786.72	297.02	223.78	286.09	380.30	562.53
35	176.05	961.71	360.01	275.06	357.25	477.97	742.63
40	204.80	1136.69	423.00	326.38	440.38	585.08	922.72
45	233.54	1311.67	486.00	377.74	540.61	702.31	1102.82
50	262.29	1486.66	548.99	429.14	642.21	838.73	1282.92
55	291.04	1661.64	611.99	480.54	762.52	993.34	1472.07
60	319.78	1836.62	674.98	531.97	901.31	1162.22	1678.50
65	348.53	2011.61	737.97	583.40	1040.83	1333.55	1920.45
70	377.28	2186.59	800.97	634.84	1180.39	1505.22	2177.43
75	406.03	2361.57	863.96	686.29	1319.97	1676.94	2436.61
80	434.77	2536.56	926.96	737.75	1459.56	1848.67	2697.50
85	463.52	2711.54	989.95	789.21	1599.17	2020.39	2963.30
90	492.27	2886.52	1052.94	840.68	1738.80	2192.12	3246.98
95	521.02	3061.51	1115.94	892.14	1878.44	2363.84	3532.01
100	549.76	3236.49	1178.93	943.61	2018.09	2535.57	3817.23
105	578.51	3411.47	1241.93	995.09	2157.75	2707.30	4102.61
110	607.26	3586.46	1304.92	1046.56	2297.41	2879.03	4388.20
115	636.00	3761.44	1367.91	1098.04	2437.08	3050.75	4673.90
120	664.75	3936.42	1430.91	1149.52	2576.76	3222.48	4959.71
125	693.50	4111.41	1493.90	1200.99	2716.44	3394.21	5245.61
130	722.25	4286.39	1556.90	1252.48	2856.13	3565.94	5531.63
135	750.99	4461.37	1619.89	1303.96	2995.82	3737.67	5817.77
140	779.74	4636.36	1682.88	1355.44	3135.51	3909.40	6103.95
145	808.49	4811.34	1745.88	1406.92	3275.21	4081.13	6390.14
150	837.23	4986.32	1808.87	1458.41	3414.90	4252.86	6676.41
160	894.73	5336.29	1934.86	1561.38	3694.31	4596.33	7249.14
170	952.22	5686.26	2060.85	1664.35	3973.72	4939.79	7822.03
180	1009.72	6036.22	2186.84	1767.33	4253.14	5283.25	8395.03
190	1067.21	6386.19	2312.82	1870.30	4532.56	5626.72	8968.22
200	1124.71	6736.15	2438.81	1973.28	4811.99	5970.18	9541.47
210	1182.20	7086.12	2564.80	2076.26	5091.43	6313.64	10114.82
220	1239.70	7436.09	2690.79	2179.24	5370.86	6657.11	10688.25
230	1297.19	7786.05	2816.78	2282.22	5650.30	7000.57	11261.73
240	1354.69	8136.02	2942.76	2385.20	5929.75	7344.04	11835.30
250	1412.18	8485.99	3068.75	2488.18	6209.19	7687.50	12408.89
260	1469.67	8835.95	3194.74	2591.17	6488.64	8030.97	12982.54
270	1527.17	9185.92	3320.73	2694.15	6768.09	8374.43	13556.24
280	1584.66	9535.89	3446.71	2797.13	7047.54	8717.90	14129.95
290	1642.16	9885.85	3572.70	2900.12	7326.99	9061.36	14703.72
300	1699.65	10235.82	3698.69	3003.10	7606.45	9404.83	15277.51
MLC	**12**	**70**	**25**	**19**	**48**	**66**	**95**
MLC (31 ft)	**12**	**70**	**23**	**19**	**34**	**45**	**72**

Table 2.5.9 Shear for Specific Military Vehicles

Span (ft)	Military Vehicle Shear (tons)						
	Tracked Vehicles			Wheeled Vehicles			
	M113	M1	M2	FCV	HEMTT	PLS	HETS
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	3.28	11.63	4.90	6.50	11.09	11.09	15.76
10	6.45	23.27	9.80	9.26	15.85	16.02	21.36
15	8.14	34.87	14.39	12.16	17.56	21.18	27.04
20	8.98	43.62	17.09	14.27	19.55	24.19	32.79
25	9.48	48.85	18.69	15.52	21.48	26.67	38.69
30	9.82	52.42	19.79	16.38	24.19	28.92	44.18
35	10.05	54.84	20.54	16.96	26.63	31.91	48.02
40	10.24	56.81	21.14	17.43	28.70	35.15	51.29
45	10.38	58.26	21.59	17.78	30.94	37.59	54.85
50	10.49	59.42	21.95	18.06	33.26	39.54	58.77
55	10.58	60.39	22.24	18.29	35.34	41.24	62.60
60	10.66	61.21	22.50	18.49	37.09	42.89	66.20
65	10.72	61.89	22.70	18.65	38.54	44.89	69.50
70	10.78	62.46	22.88	18.79	39.76	46.57	72.64
75	10.83	62.96	23.03	18.91	40.84	48.04	75.46
80	10.87	63.41	23.17	19.02	41.79	49.35	77.95
85	10.91	63.80	23.29	19.11	42.63	50.50	80.14
90	10.94	64.14	23.40	19.19	43.36	51.50	82.04
95	10.97	64.45	23.49	19.27	44.02	52.40	83.77
100	10.99	64.73	23.58	19.33	44.62	53.22	85.33
105	11.02	64.98	23.66	19.39	45.16	53.97	86.76
110	11.04	65.21	23.72	19.45	45.64	54.63	88.02
115	11.06	65.41	23.79	19.50	46.09	55.24	89.18
120	11.08	65.60	23.85	19.54	46.50	55.80	90.26
125	11.10	65.78	23.90	19.59	46.88	56.32	91.25
130	11.11	65.94	23.95	19.63	47.22	56.80	92.15
135	11.12	66.08	24.00	19.66	47.53	57.21	92.95
140	11.14	66.22	24.04	19.69	47.82	57.61	93.71
145	11.15	66.36	24.08	19.72	48.11	58.01	94.47
150	11.16	66.48	24.12	19.75	48.37	58.37	95.16
160	11.18	66.70	24.18	19.81	48.84	59.01	96.37
170	11.20	66.89	24.24	19.85	49.25	59.58	97.46
180	11.22	67.07	24.30	19.90	49.63	60.10	98.46
190	11.23	67.22	24.34	19.93	49.95	60.54	99.29
200	11.25	67.36	24.39	19.97	50.25	60.96	100.08
210	11.26	67.48	24.43	20.00	50.52	61.32	100.79
220	11.27	67.60	24.46	20.02	50.77	61.66	101.42
230	11.28	67.70	24.49	20.05	50.99	61.97	102.02
240	11.29	67.80	24.52	20.07	51.19	62.25	102.54
250	11.30	67.89	24.55	20.09	51.38	62.51	103.04
260	11.31	67.97	24.57	20.11	51.56	62.74	103.49
270	11.31	68.04	24.60	20.13	51.72	62.96	103.91
280	11.32	68.11	24.62	20.15	51.87	63.17	104.31
290	11.33	68.18	24.64	20.16	52.01	63.36	104.67
300	11.33	68.24	24.66	20.18	52.14	63.54	105.01
MLC	**12**	**70**	**25**	**19**	**48**	**66**	**95**
MLC (31 ft)	**12**	**70**	**23**	**19**	**34**	**45**	**72**

CHAPTER 3 LOAD RATING AND MLC ANALYSIS OF BRIDGE #2

3.1 Introduction

Bridge load rating analyses and military load classifications were determined using AASHTO procedures. Bridge load rating analysis can be performed using any of the three rating methods developed by AASHTO. These methods are: Allowable Stress Rating (ASR), Load Factor Rating (LFR), and Load and Resistance Factor Rating (LRFR). Each of these methods considers two different levels of safety, the inventory level and the operating level. The inventory level corresponds to the customary design level of stresses but reflects the existing bridge and material conditions with regard to deterioration and loss of section. This level allows comparisons with the capacity for new structures and therefore, results in a live load which can safely utilize an existing structure for an indefinite period of time. Operating level describe the maximum permissible live load to which the structure may be subjected. Allowing unlimited numbers of vehicles to use the bridge at operating level may shorten the life of the bridge.

3.2 Allowable Stress Rating (ASR)

The ASR method is a service level rating method which is based on the allowable stress design method that historically has been the standard design method for most structures. The method proportions structural members using design loads and forces, allowable stresses, and design limitations for the material of interest under service conditions. For example, a steel multi-beam bridge with a concrete slab connected by shear connectors, the composite section is designed and the stresses computed by the composite moment of inertia shall be consistent with the predetermined properties of the various materials. The Allowable Stress approach is to ensure that the material limit states (i.e. yield) are not reached by limiting the “allowable stress” to levels below the limit state. ASR puts safety on the response side of the equation. In the allowable stress method, the capacity of a member is based on the rating level evaluated.

3.3 Load Factor Rating (LFR)

LFR method is an alternative method for the rating of simple and continuous structures that is based on the load factor design method. This rating method give emphasis to the ultimate limit state but the serviceability limit state is typically checked for compliance. The nominal capacity of the structural member should be the same as specified in the load factor section of the AASHTO Design Specifications. The nominal strength calculations should take into consideration the observable effects of deterioration. The resistance factors depend on the type of the load effects (e.g., flexure, shear, torsion, etc.) and on the special characteristics of the loaded member (e.g., reinforced concrete, pre-stressed concrete, pre-cast, cast-in-place, etc.). The LF approaches safety on the load side of the equation.

3.4 Load and Resistance Factor Rating (LRFR)

The LRFR methodology is a modified version of the LFR methodology where each component and connection must satisfy the design procedures. LRFR incorporates state-of-the-art analysis and design methodologies with load and resistance factors based on the known variability of applied loads and material properties. These load and resistance factors are calibrated from actual bridge statistics to ensure a uniform level of safety. LRFR focuses on a design objective or limit state, which can lead to a similar probability of failure in each component. Bridges rated with the LRFR specifications should have more uniform safety levels, which should ensure superior serviceability and long-term maintainability. Each component and connection shall satisfy the rating equation for each limit state, unless otherwise specified.

3.5 Description of Bridge #2

Bridge #2 is a structure along the Mississippi road over Durden creek spillway at the Engineering Research and Development Center in Vicksburg, Mississippi. The bridge consists of two slab approach spans that are seventeen and a half feet long and an intermediate span that is a concrete deck on steel multi-beams. The intermediate span is thirty two feet long. Figure 3.5.1 show an elevation view of the bridge where the three spans can be appreciated. The intermediate span, the only span considered in the study, consists of four rolled steel beams. The interior and exterior beams are W24X68. These beams have two end diaphragms and an intermediate diaphragm. All the diaphragms are W8X28 sections. Figure 3.5.2 shows the steel beams and diaphragms.

The concrete deck is approximately seven and a half inches thick and is lined on each side by concrete curbs and the railings consist of concrete post and steel as shown on Figure 3.5.3. The roadway is twenty two feet and two inches wide and the sidewalks are three and a half feet wide. The concrete is in good condition with minor abrasion and minor spalling on the curbs. The concrete walls that support the intermediate abutments are in good condition, with no concrete section loss. There appear to be no signs of scour, mainly because is a concrete channel that is still in fair condition. The abutments on both, the east and west ends are in fair condition, with concrete spalling and horizontal cracks as shown in Figure 3.5.4.

Figure 3.5.1 Elevation View of Bridge #2

Figure 3.5.2 Steel Beams and Diaphragms of Bridge #2

Figure 3.5.3 Longitudinal View of Bridge #2


Figure 3.5.4 Spalling and Horizontal cracks on East Abutment

3.6 Load Rating and MLC of Bridge #2

A load rating analysis and military load classification was performed for bridge #2 following the AASHTO procedures for the three rating methods discussed in previous sections. Tables 3.6.1, 3.6.2, and 3.6.3 show the results of the load rating analysis and the military load classification performed. Figure 3.6.1 shows the posting sign with the LRFR specification. Detailed calculations for the load rating analysis and military load classification of bridge #2 are shown in Appendix A.

Table 3.6.1 Rating Factor for Different Vehicle Types in Inventory Level

Bridge Element	Rating Vehicle							
	HS20	Type 3	Type 3-S2	Type 3-3	MS1	MS2	MS3	HL-93
I-Beams (ASR)	0.44	0.56	0.57	0.68	0.44	0.37	0.44	----
I-Beams (LFR)	0.52	0.65	0.66	0.79	0.51	0.43	0.51	----
I-Beams (LRFR)	----	0.76	0.77	0.93	0.59	0.50	0.58	0.45
Vehicle Weight (tons)	36	25	36	40	25.5	42.4	42.4	----
Load Rating* ASR (tons)	15.8	14.0	20.5	27.2	11.2	15.7	18.6	----
Load Rating* LFR (tons)	18.7	16.2	23.7	31.6	13.0	18.2	21.6	----
Load Rating* LRFR (tons)	----	19.0	27.7	37.2	15.0	21.2	24.6	----

* Load Rating = (Element Rating) × (Vehicle Wt. in tons)

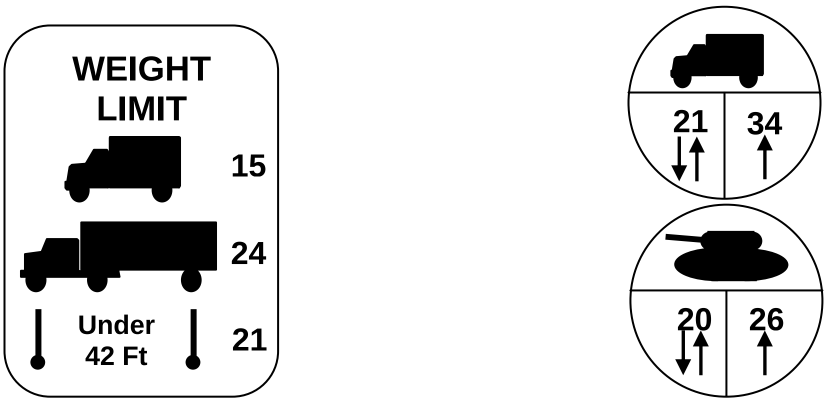
Table 3.6.2 Bridge Rating Factor for Different Vehicle Types in Operating Level

Bridge Element	Rating Vehicle							
	HS20	Type 3	Type 3-S2	Type 3-3	MS1	MS2	MS3	HL-93
I-Beams (ASR)	0.78	0.98	1.00	1.20	0.77	0.65	0.77	----
I-Beams (LFR)	0.87	1.09	1.10	1.32	0.85	0.72	0.85	----
I-Beams (LRFR)	----	0.76	0.77	0.93	0.59	0.50	0.58	0.62
Vehicle Weight (tons)	36	25	36	40	25.5	42.4	42.4	----
Load Rating* ASR (tons)	28.0	24.5	36.0	48.0	19.6	27.5	32.6	----
Load Rating* LFR (tons)	31.3	27.2	39.6	52.8	21.6	30.5	36.0	----
Load Rating* LRFR (tons)	----	19.0	27.7	37.2	15.0	21.2	24.6	----

* Load Rating = (Element Rating) × (Vehicle Wt. in tons)

Table 3.6.3 Bridge MLC Determination

MLC		ASR	LFR		LRFR	
		Design	Design	Serviceability	Strength I	Service II
Wheeled	One way	24W	44W	32W	38W	34W
	Two way	19W	26W	21W	23W	21W
Tracked	One way	23T	31T	26T	28T	26T
	Two way	18T	23T	20T	21T	20T



a) State Legal Loads b) MLC Vehicles

Figure 3.6.1 Bridge Posting Sign for State Legal Loads and MLC by LRFR

For this bridge assessment, the resulting LRFR rating factors were equal to or greater than LFR and ASR ratings factors for the legal load vehicles in the inventory level. The live load factor is the main reason why the LRFR rating factors were higher for the inventory level. The maximum live load factor for legal loads in the LRFR is 1.80, while the LFR has a constant value of 2.17. The ASR has a constant value of 1.0, but the capacity is reduced to 55 percent. On the other hand, for the legal load vehicles in the operating level the LFR rating factor is greater than LRFR and ASR due to the live load factor. In the operating level the live load factor for the LFR is constant at 1.3, while in the LRFR the live load factor varies from 1.3 to 1.8 with the limit state and the average daily traffic. The ASR live load factor is constant at 1.0, but the capacity of the member is set to 75 percent. LRFR method was selected for posting because it provides a uniform safety level, a superior serviceability and a long-term maintainability.

CHAPTER 4 LOAD TESTING OF BRIDGE #2

4.1 Introduction

Previous studies (Barker 2001, Chajes et al. 1997) have shown that analytical rating procedures are based on conservative design assumptions that do not always represent the true bridge behavior. Therefore, when bridge load tests are used, steel girder bridges usually exhibit capacities higher than analytical load capacity rating predicts. Bridge load tests have demonstrated this additional capacity and have become an acceptable means to determine a more accurate estimate of a bridge safe capacity as stated in AASHTO.

A bridge is a complicated system where all the bridge components respond together when a live load is applied. In most cases, bridge load tests show an increase in capacity because they account for different factors that tend to make bridge responses less than those predicted by design or analysis procedures. The measured response corresponds to the bridge behavior when all the components act together to resist load applied to the bridge. These effects include:

1. Actual lateral live load distribution
2. Actual longitudinal live load distribution
3. Actual impact factor
4. Unintended or additional composite action
5. Bearing restraint effects
6. Unaccounted system stiffness such as curbs and railings

As bridge load testing measures the aggregate sum response from all effects of the structure to load, they give a more accurate estimate of the bridge's load carrying capacity. While some of the factors like live load distribution and unaccounted system stiffness are benefits that the engineer feels comfortable in using to determine a safe load rating capacity, other factors like unintended composite action and bearing restraint effects, cannot be counted on trough out the service life of the bridge. Increased capacity from these two factors can be attributed to friction resistance that may not be dependable at higher load levels over time. Therefore, to obtain a reliable and safe load rating, these unreliable contributions should be identified and factored out of the load test results.

4.2 Load Testing of Bridge #2

4.2.1 Introduction

A diagnostic load test was conducted on bridge #2 in June, 2005. Experimental bridge load testing can be categorized as either diagnostic or proof load test. In a diagnostic test, a predetermined load below the bridge rated capacity, is placed at several different locations transversely and along the bridge, measuring the bridge response at each location. The measured response is then used to develop a numerical model of the bridge. The bridge model can then be used to evaluate the bridge behavior to different moving load case scenarios.

In a proof test, incremental loads are applied to the bridge until either the target load is reached or a predetermined limit state is exceeded. In this type of test, the maximum load reached is useful to determine the capacity of the bridge. While diagnostic test provide only an estimate of the bridge's capacity, they have several practical advantages, compare to the proof load test, as shorter testing time, less disruption to the traffic, and lower cost. Due to these advantages, the non-availability of military vehicles, and the fact that the load-carrying capacity was not as important as the bridge response for this investigation, diagnostic testing was used on this test.

No as-built drawings were available to determine if composite action is present on the bridge. However, the top flanges of the steel beams were embedded in the concrete haunch, making the possibility of at least some partial composite action. Therefore, the load test was also used to determine if composite action was present on the bridge.

4.2.2 Instrumentation

Preliminary analyses clearly indicated that moment would control over shear. Therefore, the high moment sections were heavily instrumented on three of the beams, while shear was instrumented only for one of the beams. To gather data, reusable strain transducer with a gauge length of 3 in were attached to the first three beams at one third of the span length and at midspan to measure the flexure strain, while one of the ends of the second beam was instrumented to measure the shear strain. In all the cases for flexure, transducers were attached to the top and bottom flanges of the beams at each location, while beams 2 and 3 had additional strain transducer on the deck, one inch from the edge of the flange as shown in Figure 4.2.1. Beam 2 was also instruments for shear strains. The transducers were positioned strategically to follow two different approaches. The north side of the beam was instrumented using the strain rosette method where the transducers are aligned at 45° with respect to the x and y axis as shown in Figure 4.2.2. The south side of the beam was instrumented using only one strain gage at 135° degrees as shown in Figure 4.2.3. That gage was used in combination with the rosette strain gages to measure the shear strain in the other direction (135°). The vertical stiffeners at the end were also instrumented.

The strain transducers were connected to a digital acquisition system, which recorded strain histories caused by the loading vehicle. Each transducer has a unique number that identifies itself from the rest of the transducers, allowing it to be identified and recognized by the acquisition system. From this unique number, the system has the ability to calibrate and zero the gage using a pre-stored gage calibration factor. All transducers were mounted using either c-clamps or a quick-setting adhesive applied to mounting tabs. The location and number assigned to each transducer are shown on Figure 4.2.4. For the numbering, S signifies that the transducer is attached to the slab, T to the top of the girder, and B to the bottom of the girder.

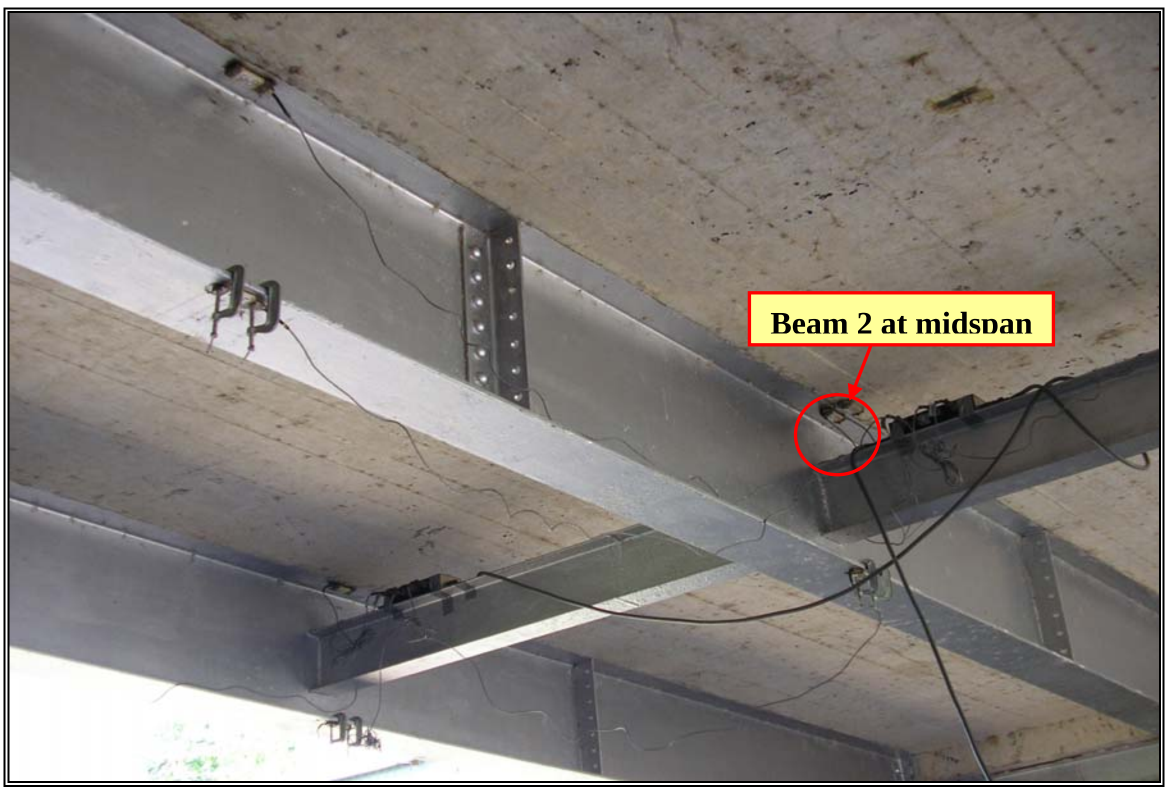


Figure 4.2.1 Flexure Strain Transducers Location

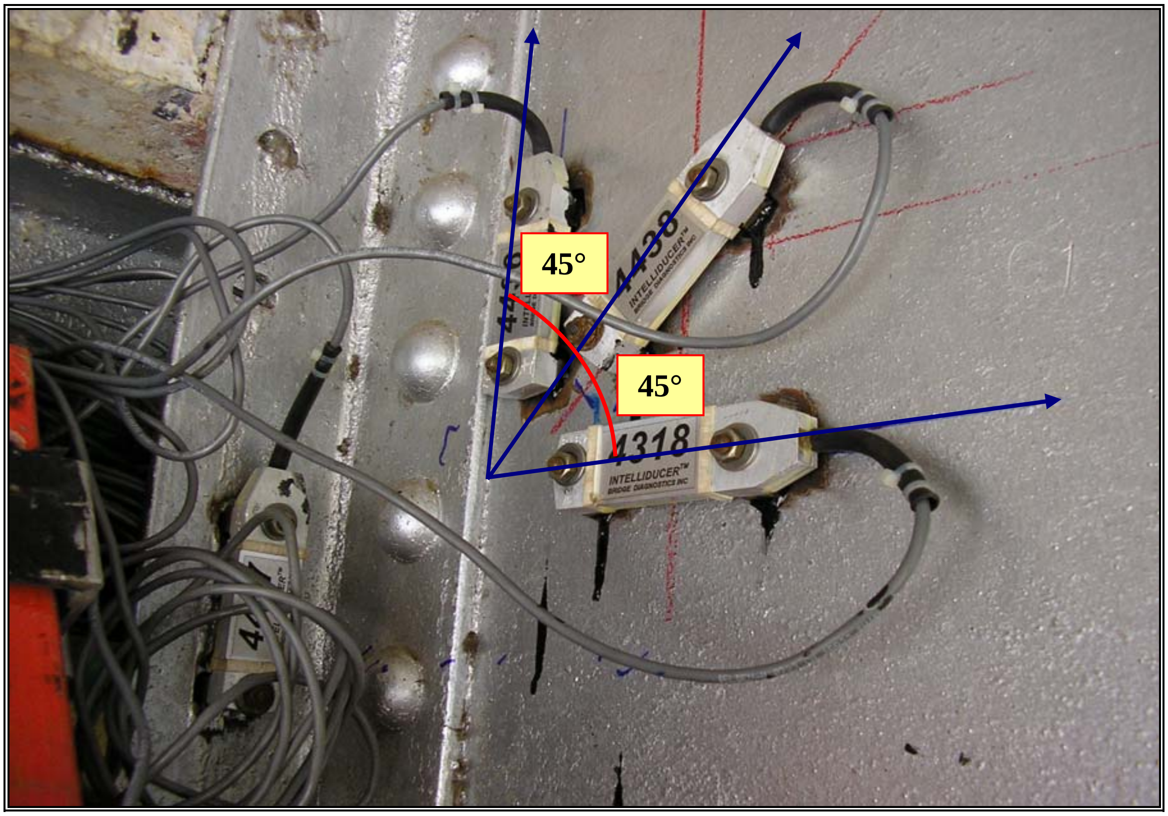


Figure 4.2.2 Forty Five Degrees Strain Rosette Layout at North Side of Beam 2

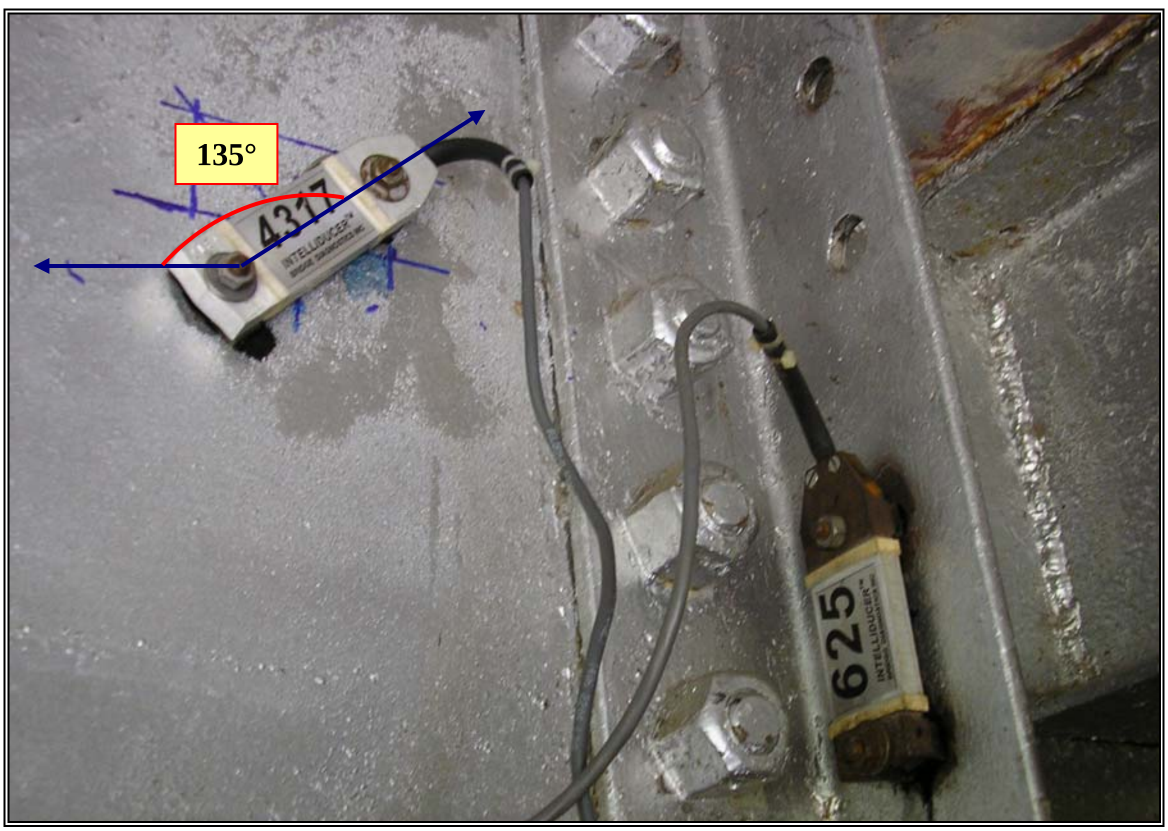


Figure 4.2.3 One Hundred and Thirty Five Degrees Strain Transducer at South Side of Beam 2

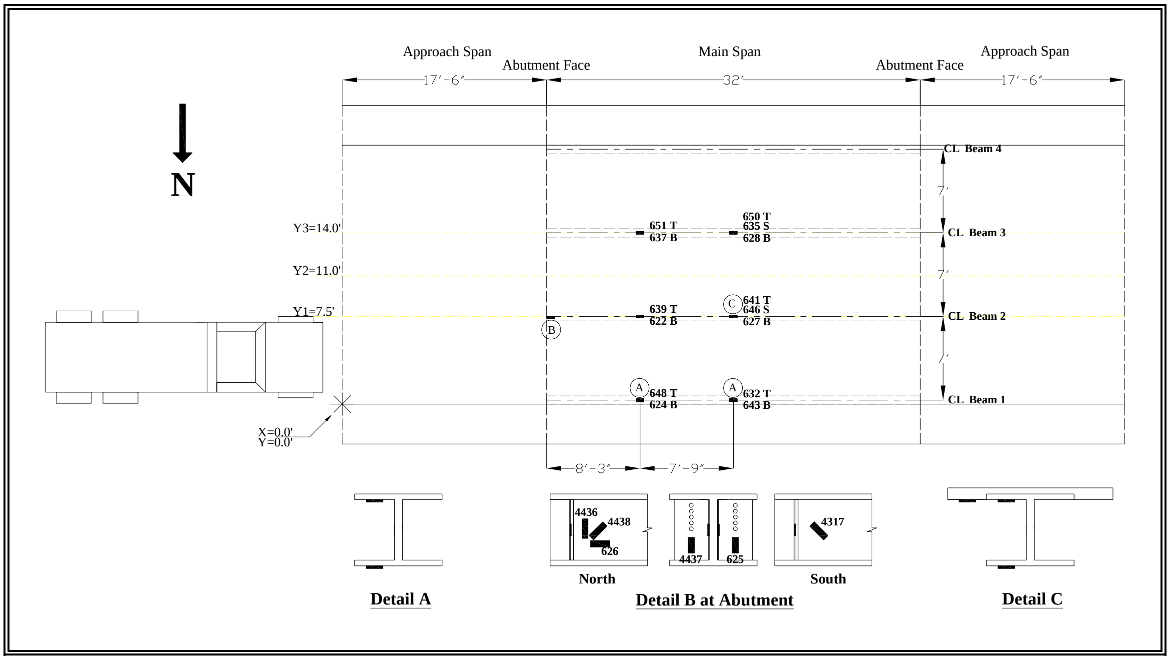
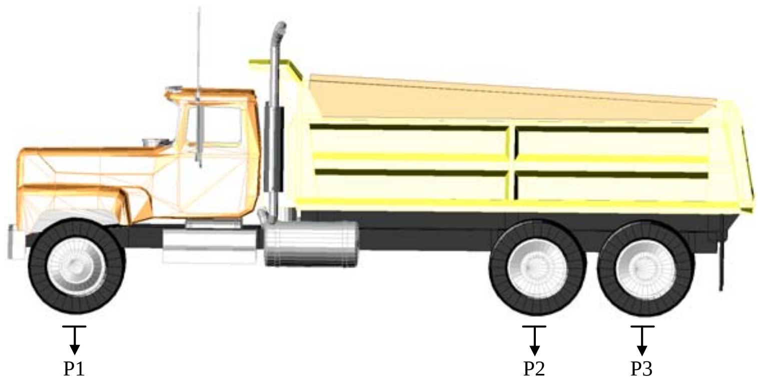


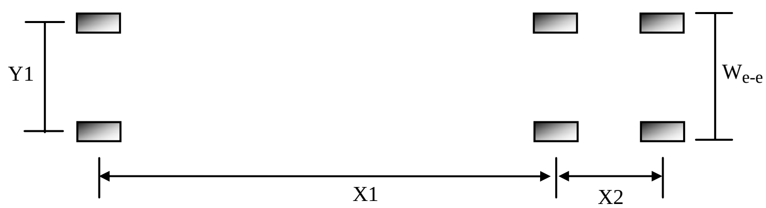
Figure 4.2.4 Load Path and Strain Gages Configuration Plan

4.2.3 Loading

The bridge was temporarily closed to traffic while a loading vehicle of known weight was driven across the deck and strain data was recorded for each channel at 31 Hz. The loading vehicle was a three axle, single unit truck weighing 27 k (13.5 tons). The measured weight and wheel load distribution are shown in Figure 4.2.5 and Table 4.2.1. This weight was less than the rated posting for the three axle configuration and therefore, the bridge was expected to behave in the linear-elastic range. In order to verify that the structure remained in the linear-elastic range, strains were monitored to ensure that they did go back to zero. To obtain meaningful data regarding both transverse and longitudinal load distribution, three load paths were defined for the load test as shown in Figure 4.2.4, where Y refers to the distance between the driver's side front wheel and the north curb. Two passes along each path were conducted to ensure consistent results. Three different passes or speeds were performed for each path. The first test was a quasi-static test where the vehicle was moved along the bridge and then stopped at desirable locations (at the ends, third points and middle span). In the second test the vehicle was driven at crawl speed (5 mph), and in the third test the vehicle was driven at the speed limit (15 mph).



a) Side View



b) Top View

Figure 4.2.5Configuration of Dump Truck Vehicle Load Distribution

Table 4.2.1 Loading Data and Dimensions of Dump Truck

Loading Data			
Axle Loads (k)	P1	P2	P3
	7.44	10.4	9.12
Dimensions			
Transverse Spacing (ft)	$W_{e\text{-}e}$	Y1	
	7.42	6.71	
Longitudinal Spacing (ft)	X1	X2	
	11.33	4.38	

4.2.4 Recorded Data

Eighteen passes of the truck were performed to collect all the data. During each pass the traffic was stopped for approximately 2 min. This allowed the driver to position the vehicle and cross the bridge at the required speed. A manual clicker was used to correlate the strain readings with the longitudinal position of the truck's center of gravity.

The maximum strain recorded during the test was 58 $\mu\varepsilon$. The maximum strain occurred at transducer 643 when the loading vehicle passes along path Y1 at 15 mph. This strain value corresponds to a tensile stress value of 1.7 ksi, which is well below the yield stress of the beams (36 ksi). Typical strain history plots measured by transducers on the beams top and bottom flanges at midspan are shown on Figure 4.2.6, while typical strain history plots measured by strain transducers on the beams top and bottom flanges at quarter points are shown on Figure 4.2.7. Based on the strain histories obtained from the entire test, the bridge showed composite action at midspan and non-composite action at quarter points. This behavior is shown on Figures 4.2.6 and 4.2.7, respectively. Figure 4.2.6 shows the composite action when the strains on the bottom flange measured tension, but the top flange measured a the transition from tension to compression showing that the neutral axis of the beams moved to the top, while Figure 4.2.7 shows the non-composite action when the strains on the bottom flange measured tension and the top flange measured almost the same values but in compression showing that the neutral axis almost coincide with the centroid of the steel beams. The partially composite action can likely be attributed to the horizontal shear developed from the friction forces between the steel beams and the concrete deck, because the beams are embedded in concrete. However, this friction may not continue at higher loads.

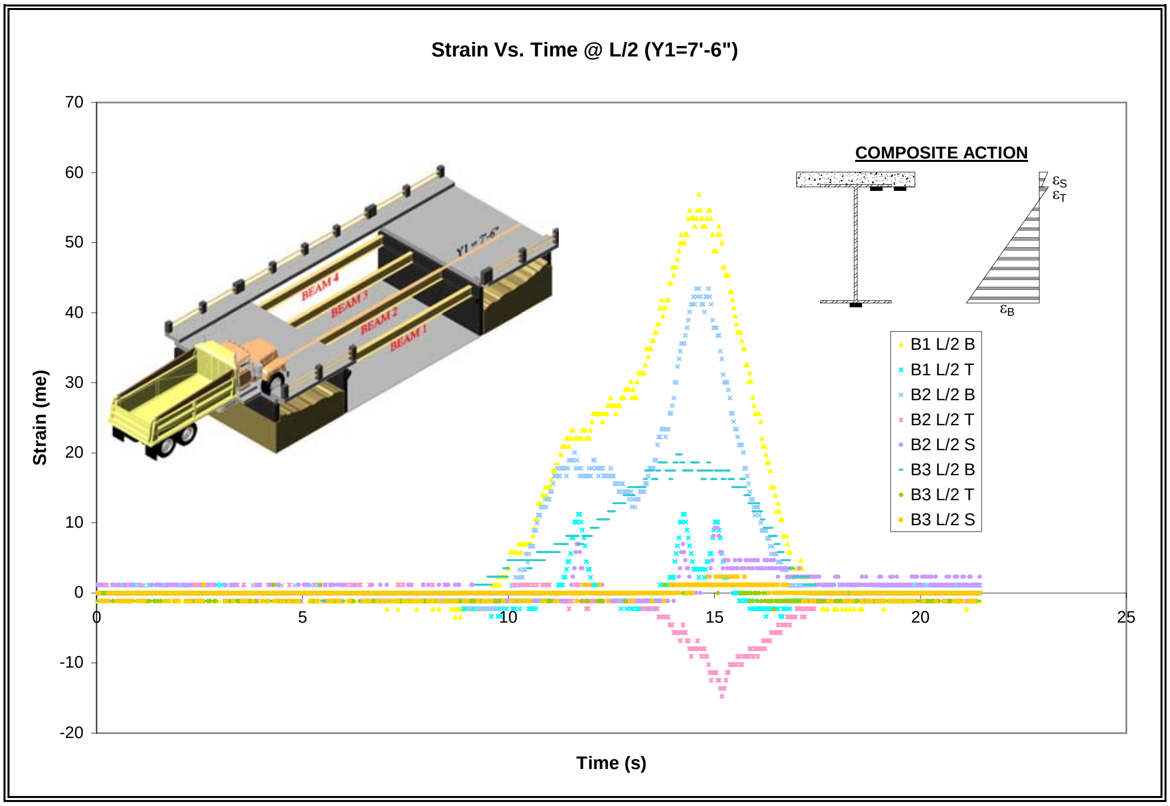


Figure 4.2.6 Recorded Strains at Midspan due to Loading Vehicle on Path Y1

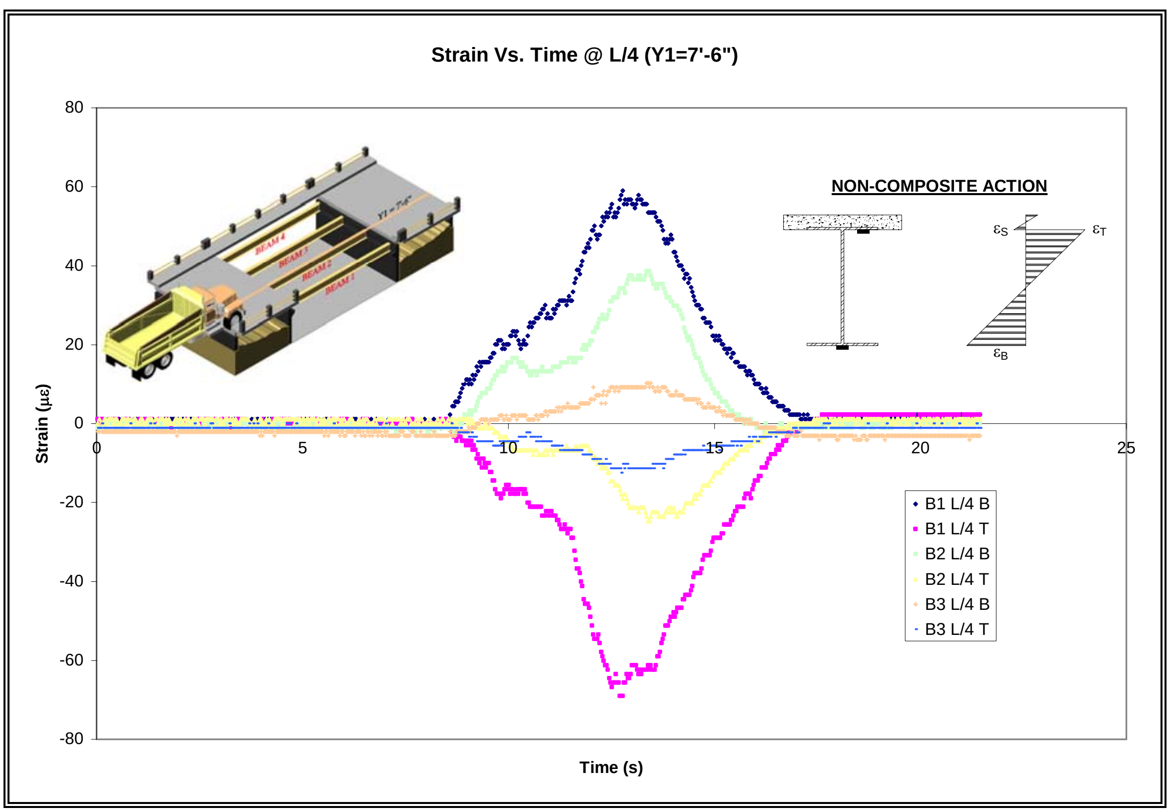


Figure 4.2.7 Recorded Strains at Quarter Point due to Loading Vehicle on Path Y1

CHAPTER 5 ANALYSIS OF BRIDGE #2

5.1 Development and Calibration of the 3D Model

The load test results were used to refine and calibrate a finite element model of the steel multi-beam bridge span. The finite element model was then used to develop load distribution factors for each of the military vehicles. While the model was created, the objective was to keep the finite element model as simple as possible, but capturing the bridge behavior. A three-dimensional model of the main structural members was used. Three element types were used to model the geometry of the bridge. Two-node frame elements with six degrees of freedom at each node were used to model the beams and diaphragms. The geometric and stiffness properties of the frame elements are lumped at the centroid of the beams and diaphragms. The deck slab was modeled using four-node rectangular shell elements with six degrees of freedom per node. The bridge supports were modeled in a simple manner, restraining the translations on the three axles at one end and the upward direction at the other end.

An important characteristic of the bridge response was identified from the measured data. Under the applied moving load it was evident that unintended composite action between the beams and the deck was occurring at mid-span as shown in Figure 4.2.6. On the other hand, non-composite action between the beams and the deck was present at quarter span as shown in Figure 4.2.7. To generate an accurate numerical model, these conditions needed to be accounted for. Three different models were formulated to properly model the bridge response. The first model incorporated the composite action between the bridge deck and the beams along the bridge. In the second model the interaction between the bridge deck and the beams along the bridge was modeled as non-composite. The third model, adopted to represent the bridge response, modeled the interaction between the bridge deck and the beams as composite along the middle of the span and non-composite along the rest of the bridge span. Two different joint constraints were used to properly model the bridge response. To account for the composite action, rigid-body constraints were used near middle of the bridge, in which the constrained joints translate and rotate together as if connected by rigid links. The rest of the beam-deck connections were modeled by diaphragm constraints which causes of all its constrained joints to move together as a planar diaphragm that is rigid against membrane deformation. Effectively, all constrained joints were connected to each other by links that are rigid in the plane, but do not affect out-of-plane (plate) deformation achieving the non-composite behavior.

The truck moving loads were applied to the model in a manner consistent with the actual load test. A three-dimensional model of the loading truck with the same wheel configurations and loads was established. Bridge lanes, consistent with the loading paths on the load test, were established on the model. Figure 5.1.1 shows the finite element model with all of its components and the lane definitions. Note that the lanes defined in the model represent the middle point between the truck wheels and not the driver's side as it was defined in the load test paths.

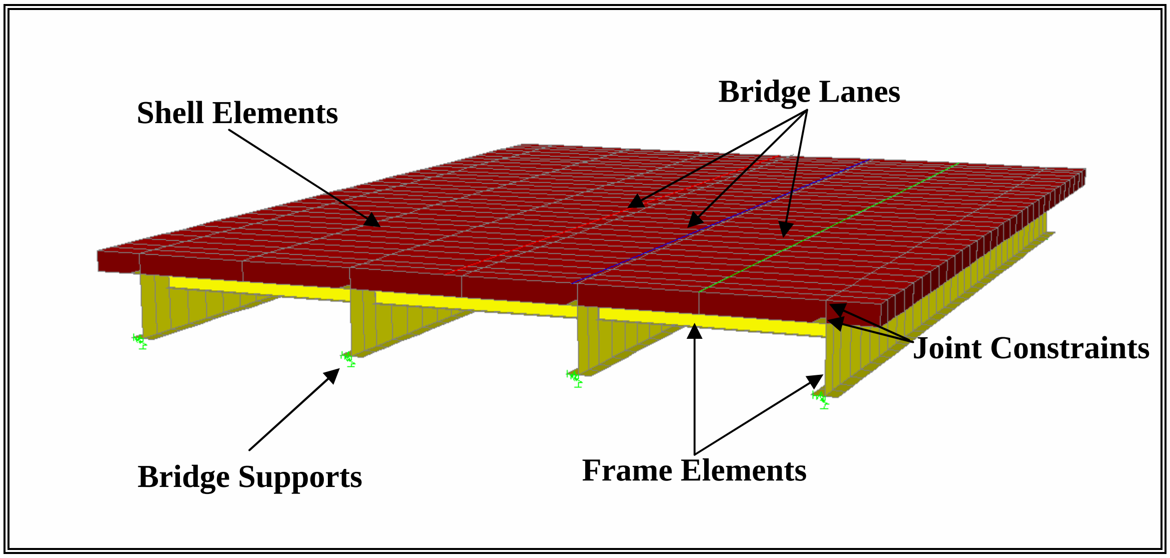


Figure 5.1.1 Finite Element Model of Multi-Beam Span

An analysis was performed for each of the eighteen loading cases to calibrate the 3D finite element model. In order to compare the computed results to the strains measured on the field, computed moments were used to find strains at each of the transducers in the flexure locations. The conversion of moment to strains involved the assumptions that plane sections remain plane and that all stresses were in the linear-elastic region.

Figures 5.1.2 to 5.1.4 compare measured strains and computed strains along the bottom flange of the beams for the three paths at crawl speed (5 mph). These figures show the accuracy of the model in predicting the longitudinal live load distribution as well as the transverse live load distribution for flexure. In a similar way, measured shear strains and computed shear strains at the east web beam end for the three paths at crawl speed (5 mph) are shown on Figures 5.1.5 to 5.1.7. Both cases, flexure and shear, show that the finite element model captured the recorded bridge response quite well once the partial composite action was taken into account.

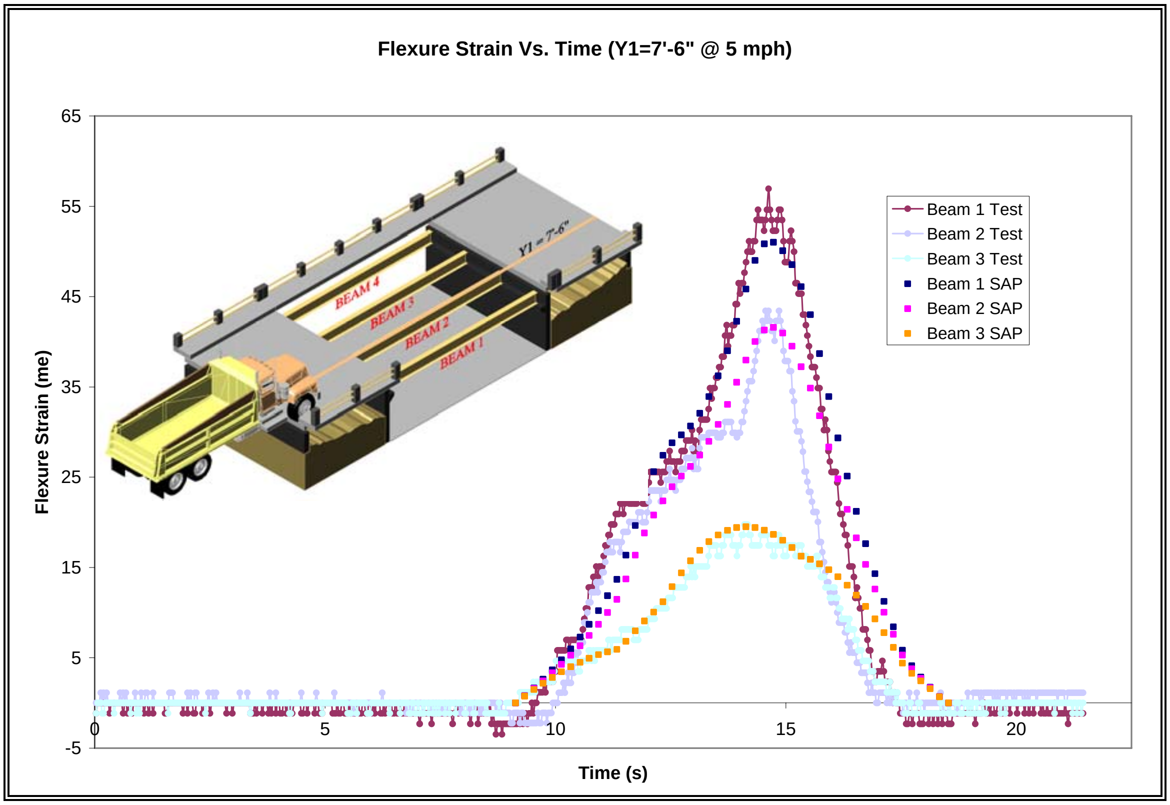


Figure 5.1.2 Measured Flexure Strains Vs. Analytical Flexure Strains for Y1 at Crawl Speed

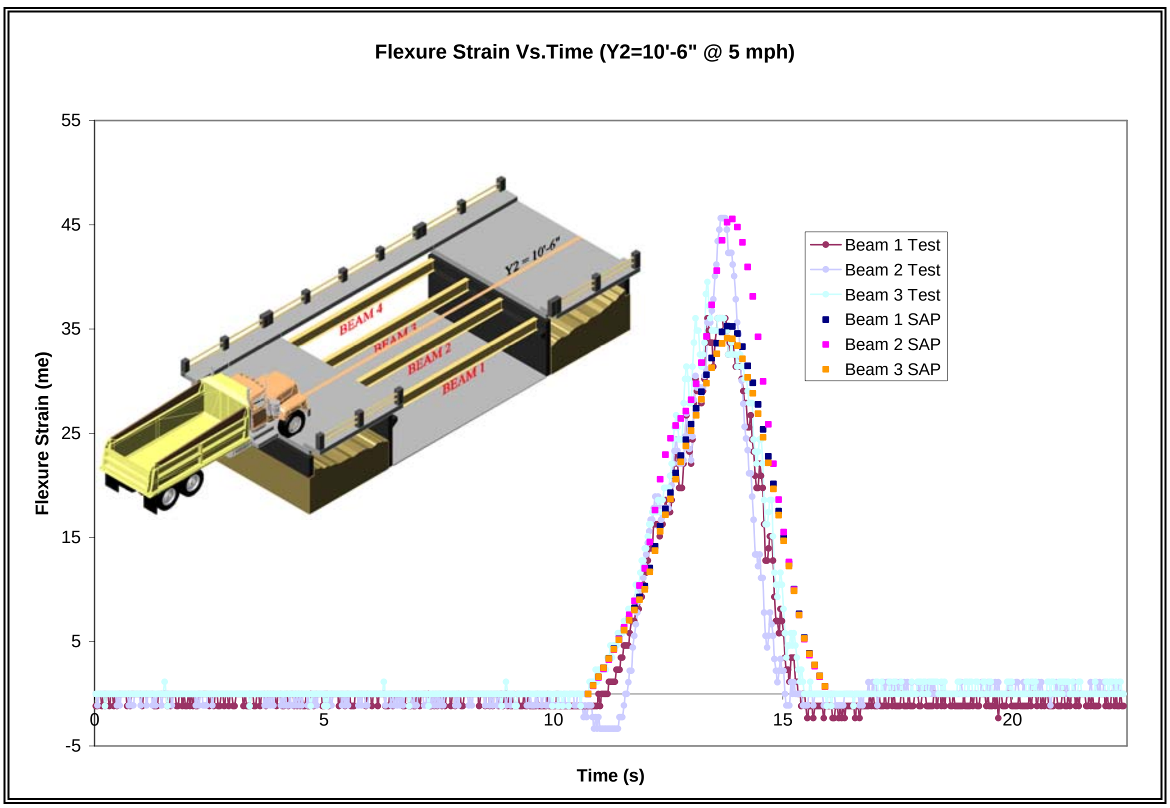


Figure 5.1.3 Measured Flexure Strains Vs. Analytical Flexure Strains for Y2 at Crawl Speed

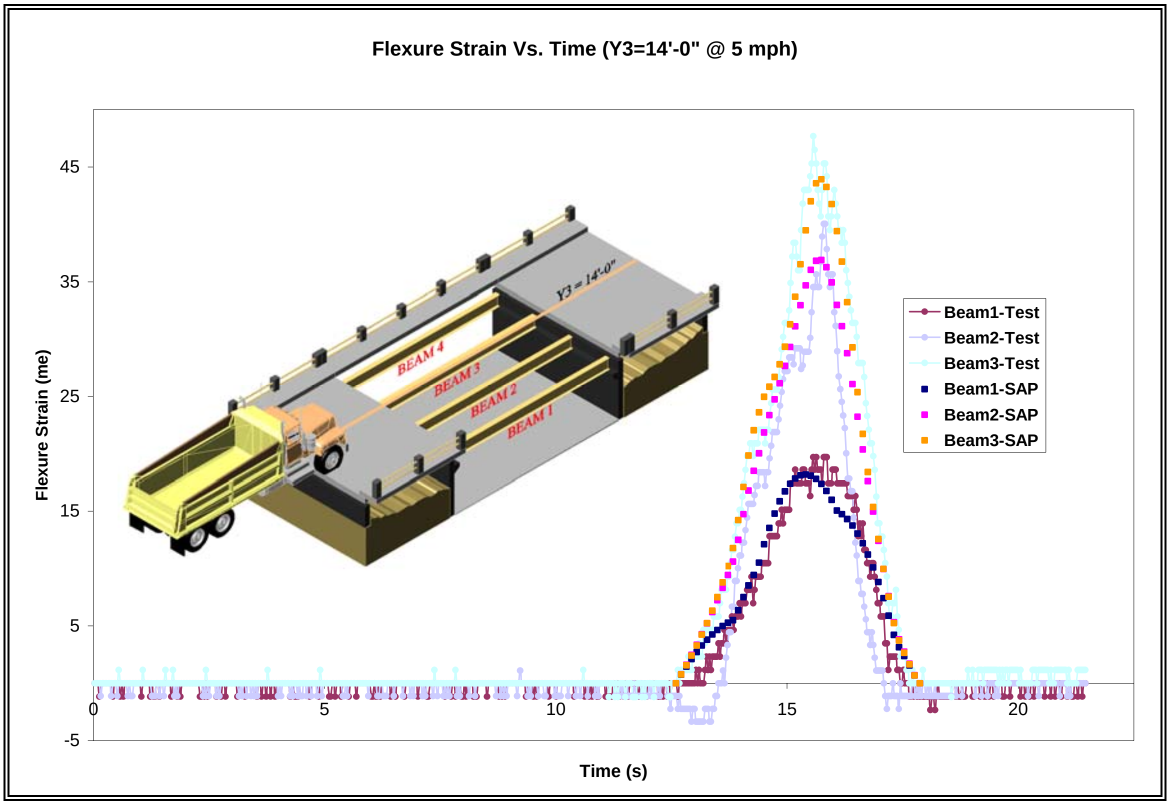


Figure 5.1.4 Measured Flexure Strains Vs. Analytical Flexure Strains for Y3 at Crawl Speed

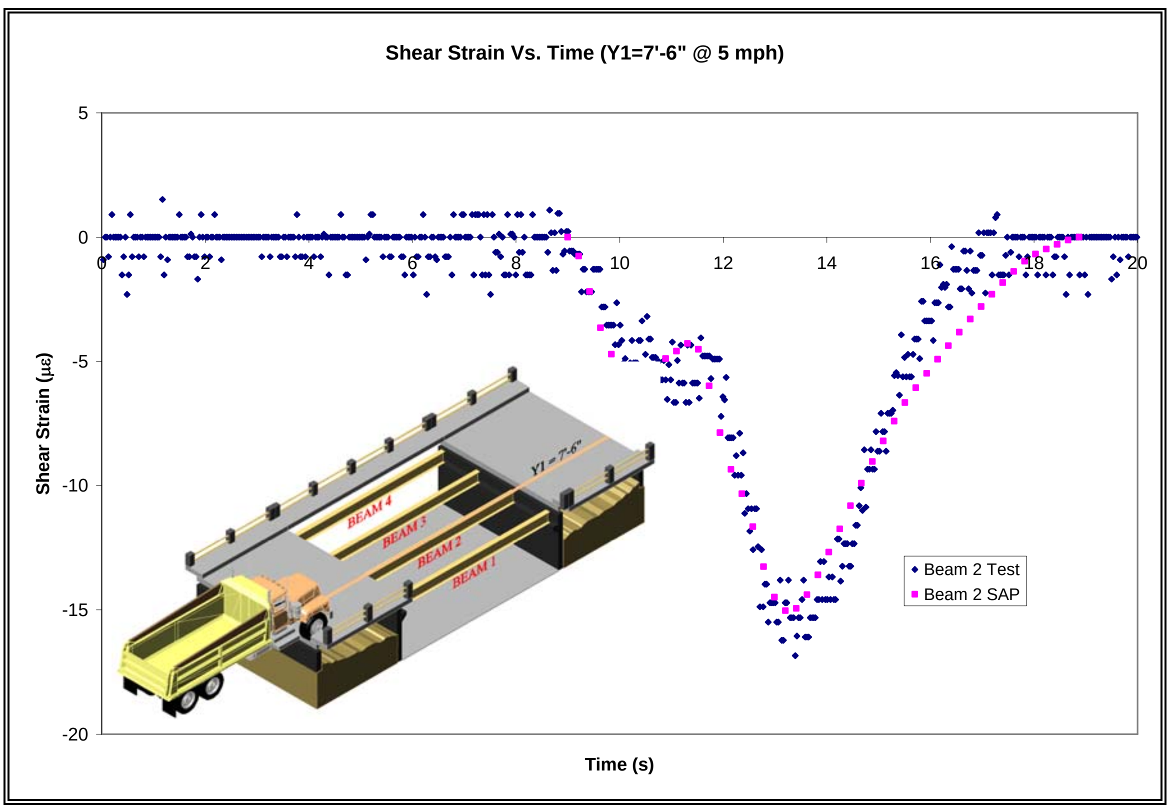


Figure 5.1.5 Measured Shear Strains Vs. Analytical Shear Strains for Y1 at Crawl Speed

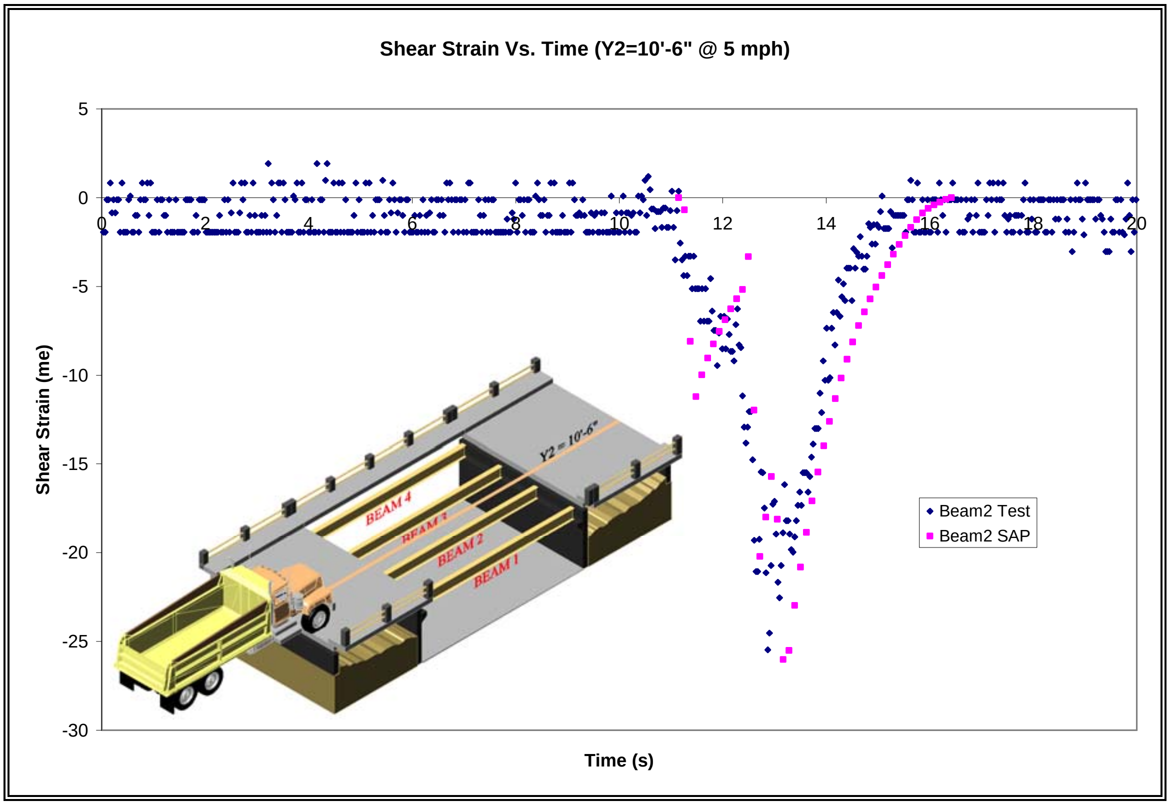


Figure 5.1.6 Measured Shear Strains Vs. Analytical Shear Strains for Y2 at Crawl Speed

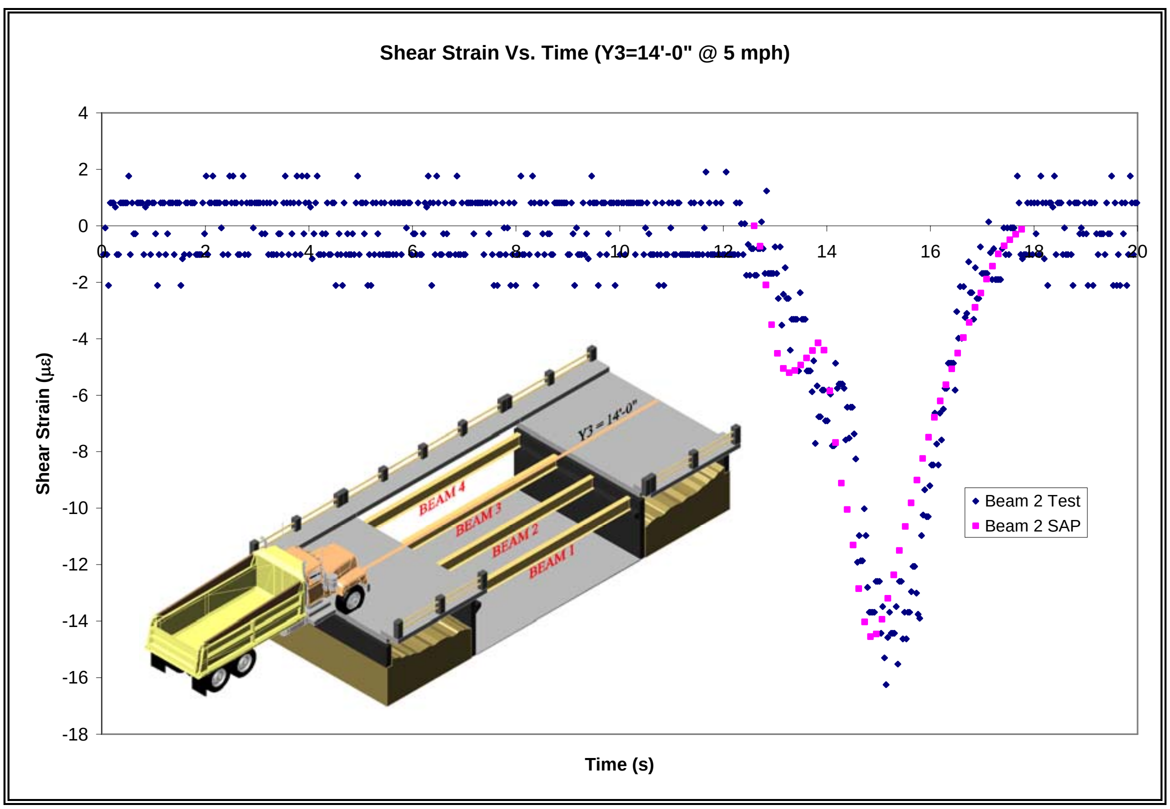


Figure 5.1.7 Measured Shear Strains Vs. Analytical Shear Strains for Y3 at Crawl Speed

5.2 Transverse Load Distribution

For this investigation, one of the most useful and important pieces of information provided by the load testing data and the calibrated finite element model is the actual transverse live load distribution. Figures 5.1.2 to 5.1.4 show a general idea of how the live load was transversely distributed. The calibrated finite element model was used to compare computed distribution factors to the standard distribution factors used in the design, analysis and rating of bridges.

In order to get the corresponding distribution factors for bridge #2, the calibrated finite element model developed from the test data was used. The first step is to find the maximum possible moment or shear on the interior and exterior beams due to single-lane or multiple-lane loading using the finite element model. The software (SAP2000) used to develop the finite element model has the capability to generate influence lines (an envelope) for single or multiple lanes to know exactly the transverse and longitudinal position where the maximum stress occurs. After the exact position is known, a lane with the same vehicle width is generated to run the vehicle thru the path where the maximum stress occurs for the given beam of concern to obtain the maximum distribution factor. Figure 5.2.1 shows the lane definition to obtain the maximum flexure and shear stresses on the interior and exterior beams. The lane definition for the exterior beams is consistent with the design codes where the vehicle wheel should be as close as two feet from the bridge curb. In order to find the maximum stresses for a two-lane analysis a clear spacing of four feet between the lanes is considered, to be consisted with the codes, to obtain the maximum stresses for two lanes as shown in Figure 5.2.2. As the loading points represent the center of the vehicles, the vehicle width was also considered when the lanes were defined. Figures 5.2.3 and 5.2.4 show the influence line for the interior girder to obtain the exact location where the maximum flexure stress occurs for one and two lanes respectively.

After the maximum stresses on the interior and exterior beams due to single-lane and multiple-lane loadings have been establish using the finite element model, the transverse load distribution factor can be establish. The distribution factor is defined as:

$$DF = \frac{F_{i_{\max}}}{\sum_{i=1}^{n} F_i}$$

$F_{i_{max}}$ = Maximum response (moment or shear) on beam i

n = Number of beams

The analytical distribution factors from the bridge model, for the interior and exterior beams using single-lane and multiple-lane definitions are shown on Table 5.2.1. This table also has the distribution factors based on AASHTO (*Standard and LRFD*). Distribution factors computation by AASHTO are shown on Appendix B. The results from this table show that the distribution factors for the dump truck are lower than the AASHTO distribution factors. This supports previous assertions that the distribution factors by AASHTO are generally overly conservative. This of course is good for design, but is restrictive for the load rating analyses. Table 5.2.2 shows the calculated distribution factors for the military vehicles with the finite element model, the AASHTO formulas, and the formulas developed by Piñero et al. (2001). This table does not include the distribution factors for two lanes for the M2-BRADLEY, M1-ABRAMS, and HETS military vehicles since they do not fit on the bridge in a two-lane configuration.

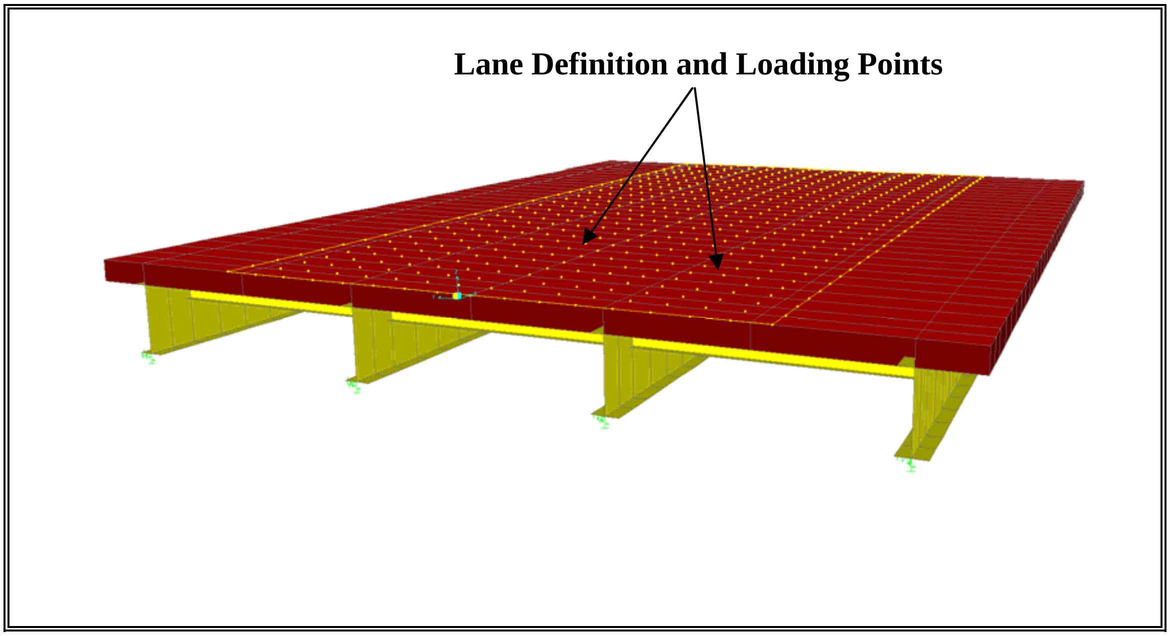


Figure 5.2.1 Lane and Loading Points Definition for Single-Lane Analysis

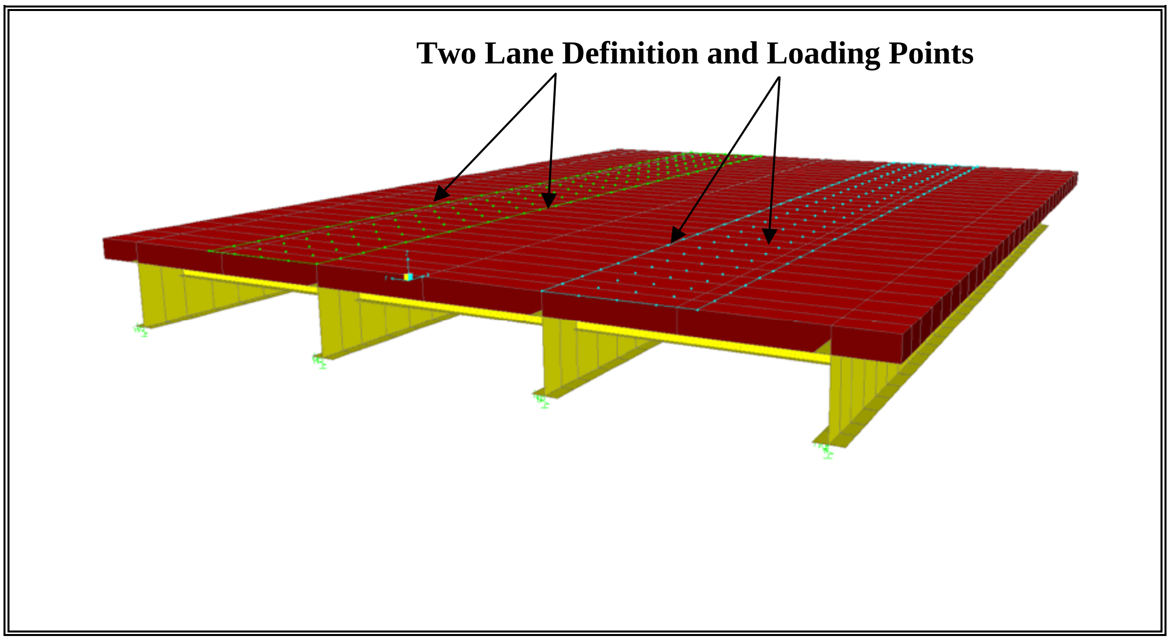


Figure 5.2.2 Lane and Loading Points Definition for Two-Lane Analysis

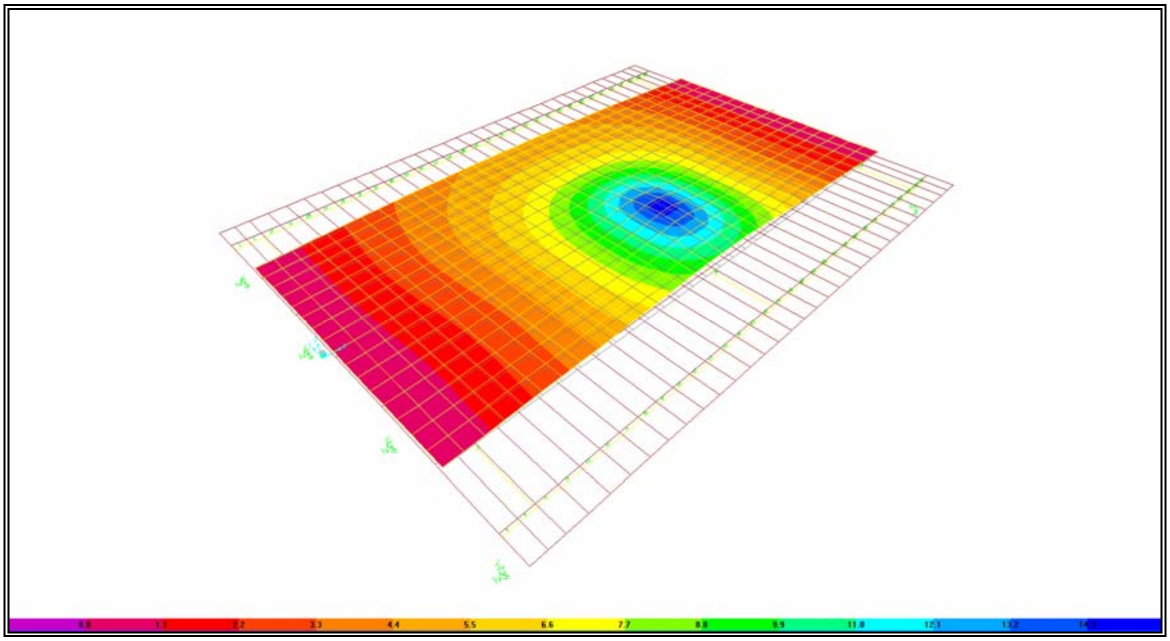


Figure 5.2.3 Flexure Influence Line for Single-Lane Analysis on an Interior Beam

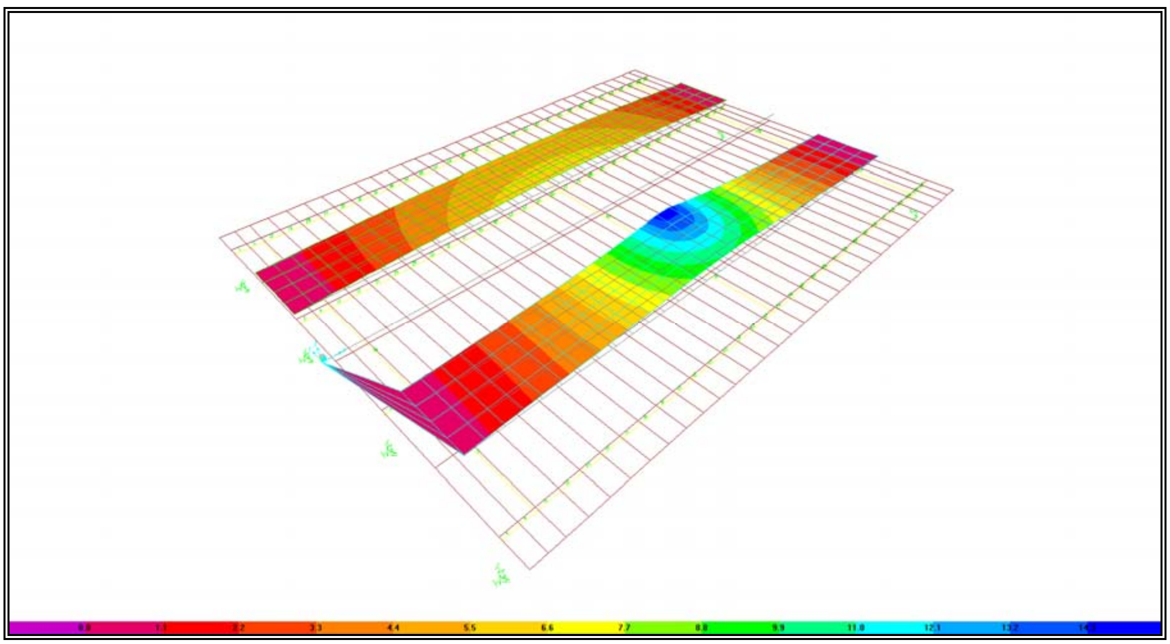


Figure 5.2.4 Flexure Influence Line for Two-Lane Analysis on an Interior Beam

Table 5.2.1 Transverse Load Distribution Factor by FEM and AASHTO for Test Vehicle

Vehicle Type	Traffic Lanes	Load Case	Beam Type	FEM DF	AASHTO DF Standard	AASHTO DF LRFD
Dump Truck	Single Lane	Moment	Interior	0.332	0.512	0.491
			Exterior	0.317	0.381	0.604
		Shear	Interior	0.520	0.581	0.647
			Exterior	0.379	0.381	0.604
	Two Lanes	Moment	Interior	0.539	0.652	0.626
			Exterior	0.466	0.381	0.516
		Shear	Interior	0.612	0.748	0.755
			Exterior	0.400	0.381	0.491

Table 5.2.2 Transverse Load Distribution Factor by FEM and AASHTO for Military Vehicles

Vehicle Type	Traffic Lanes	Load Case	Beam Type	FEM DF	AASHTO DF Standard	AASHTO DF LRFD	Piñero (2001)
M113	Single Lane	Moment	Interior	0.350	0.512	0.491	0.408
			Exterior	0.331	0.381	0.604	0.522
		Shear	Interior	0.530	0.581	0.647	0.510
			Exterior	0.372	0.381	0.604	0.567
	Two Lanes	Moment	Interior	0.547	0.652	0.626	0.595
			Exterior	0.460	0.381	0.516	0.609
		Shear	Interior	0.622	0.748	0.755	0.573
			Exterior	0.395	0.381	0.491	0.549
M2 - BRADLEY	Single Lane	Moment	Interior	0.306	0.512	0.491	0.408
			Exterior	0.303	0.381	0.604	0.522
		Shear	Interior	0.431	0.581	0.647	0.510
			Exterior	0.360	0.381	0.604	0.567
M1 - ABRAMS	Single Lane	Moment	Interior	0.296	0.512	0.491	0.386
			Exterior	0.299	0.381	0.604	0.522
		Shear	Interior	0.404	0.581	0.647	0.510
			Exterior	0.353	0.381	0.604	0.567
LAVIII - STRYKER	Single Lane	Moment	Interior	0.323	0.512	0.491	0.411
			Exterior	0.311	0.381	0.604	0.522
		Shear	Interior	0.506	0.581	0.647	0.510
			Exterior	0.374	0.381	0.604	0.567
	Two Lanes	Moment	Interior	0.534	0.652	0.626	0.595
			Exterior	0.473	0.381	0.516	0.609
		Shear	Interior	0.591	0.748	0.755	0.573
			Exterior	0.428	0.381	0.491	0.549
HEMTT	Single Lane	Moment	Interior	0.341	0.512	0.491	0.741
			Exterior	0.323	0.381	0.604	0.522
		Shear	Interior	0.543	0.581	0.647	0.510
			Exterior	0.389	0.381	0.604	0.567

	Two Lanes	Moment	Interior	0.559	0.652	0.626	0.605
			Exterior	0.470	0.381	0.516	0.609
		Shear	Interior	0.656	0.748	0.755	0.573
			Exterior	0.433	0.381	0.491	0.549
PLS	Single Lane	Moment	Interior	0.332	0.512	0.491	0.741
			Exterior	0.319	0.381	0.604	0.522
		Shear	Interior	0.533	0.581	0.647	0.510
			Exterior	0.393	0.381	0.604	0.567
	Two Lanes	Moment	Interior	0.614	0.652	0.626	0.605
			Exterior	0.491	0.381	0.516	0.609
		Shear	Interior	0.649	0.748	0.755	0.573
			Exterior	0.436	0.381	0.491	0.549
HETS	Single Lane	Moment	Interior	0.309	0.512	0.491	0.411
			Exterior	0.273	0.381	0.604	0.522
		Shear	Interior	0.444	0.581	0.647	0.510
			Exterior	0.296	0.381	0.604	0.567

In general, live load distribution factors for military vehicles obtained with the finite element model are lower than the live load distribution factors for civilian vehicles proposed by AASHTO (*Standard* & *LRFD*). Because most military vehicles are wider than civilian vehicles, they better distribute the load between beams. The only case where the live load distribution factor for military vehicles was greater than the live load distribution factors provided by AASHTO was for the exterior beams usually when two lanes were loaded, as shown on Figures 5.2.5 thru 5.2.11, compared to *Standard* where the lever rule is used for exterior beams. These results showed the lever rule to be un-conservative and this is consistent with the findings of other users as well. For that reason the lever rule was addressed in *LRFD* C4.6.2.2.2d where they assume that the cross section deflect and rotate as a rigid unit.

The live load distribution factors obtained with the finite element model are similar to the distribution factors obtained with the formulas developed by Piñero et al.

(2001) for the interior beams for both bending moment and shear forces. The distribution factors obtained with the finite element model for the exterior beams were lower than those obtained with the formulas developed by Piñero et al. (2001), especially for the two-way traffic loading condition in both bending moment and shear force. For this condition, the distribution factors obtained with the formula developed by Pinero (2001) were not only higher than those obtained in the finite element analysis but they were also higher than those obtained by AASHTO. Figures 5.2.12 and 5.2.13 show the live load distribution factors obtained from the finite element analysis for military vehicles on bridge #2 for single lane and double lane respectively. Figure 5.2.13 does not show the live load distribution factors for M2-BRADLEY, M1-ABRAMS, and HETS military vehicles, because the bridge width restricts two-way traffic for these vehicles.

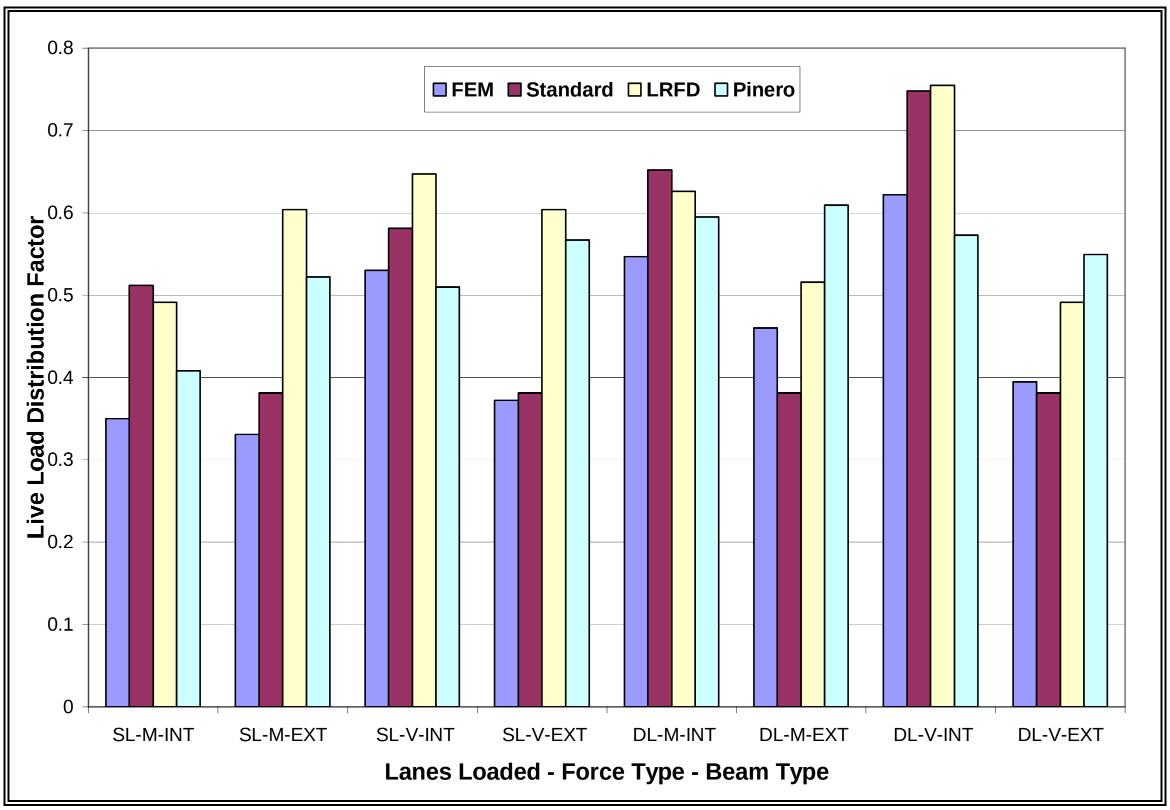


Figure 5.2.5 Comparison of Live Load Distribution Factors on Bridge #2 for M113

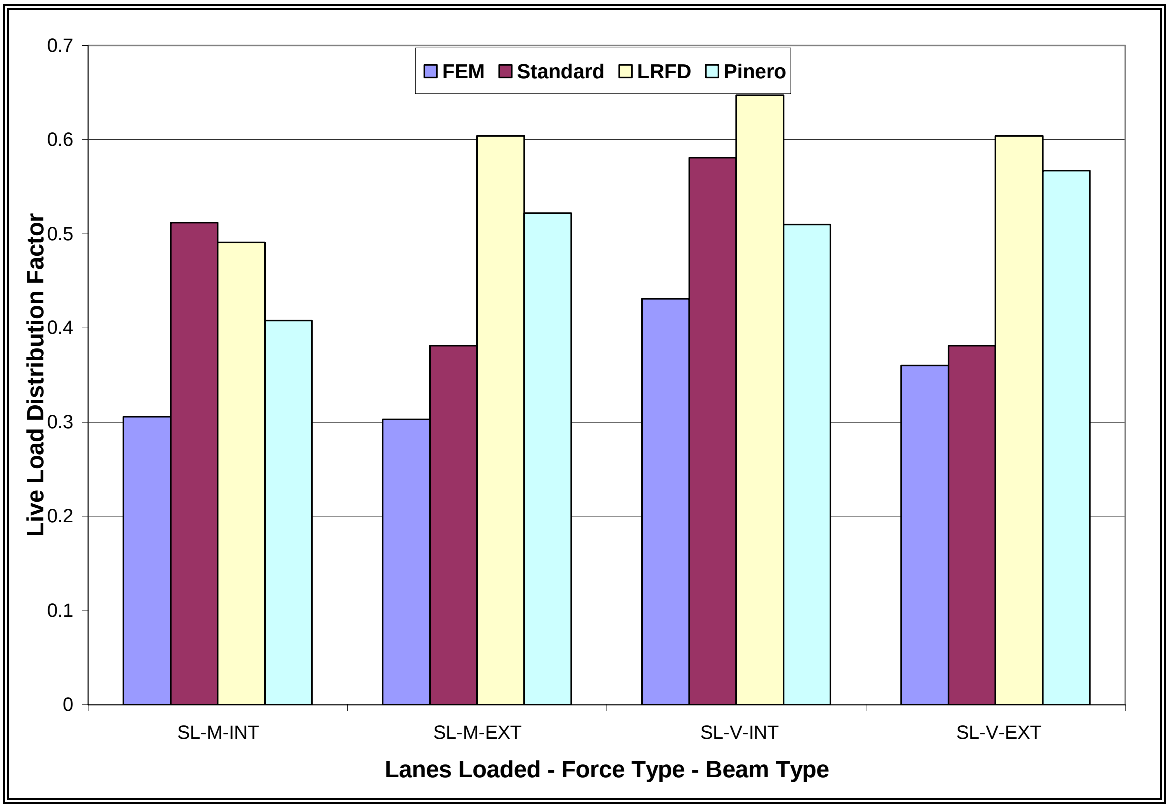


Figure 5.2.6 Comparison of Live Load Distribution Factors on Bridge #2 for M2-BRADLEY

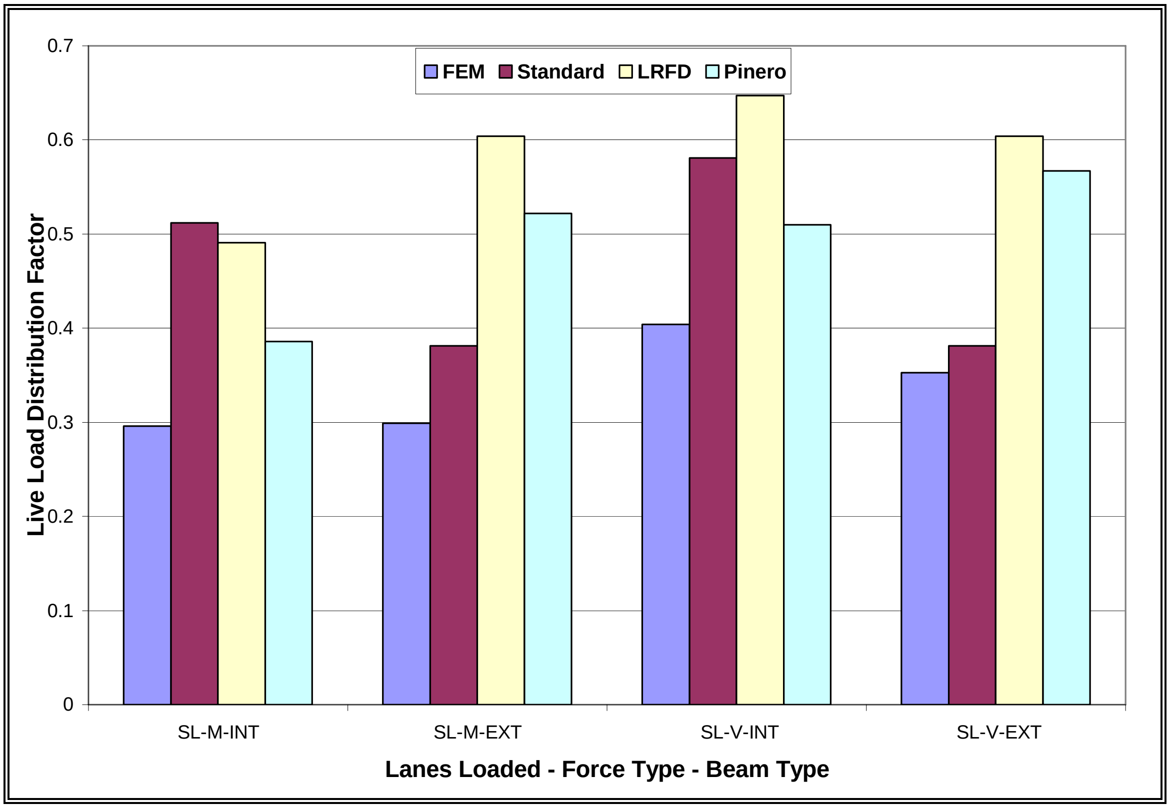


Figure 5.2.7 Comparison of Live Load Distribution Factors on Bridge #2 for M1-ABRAMS

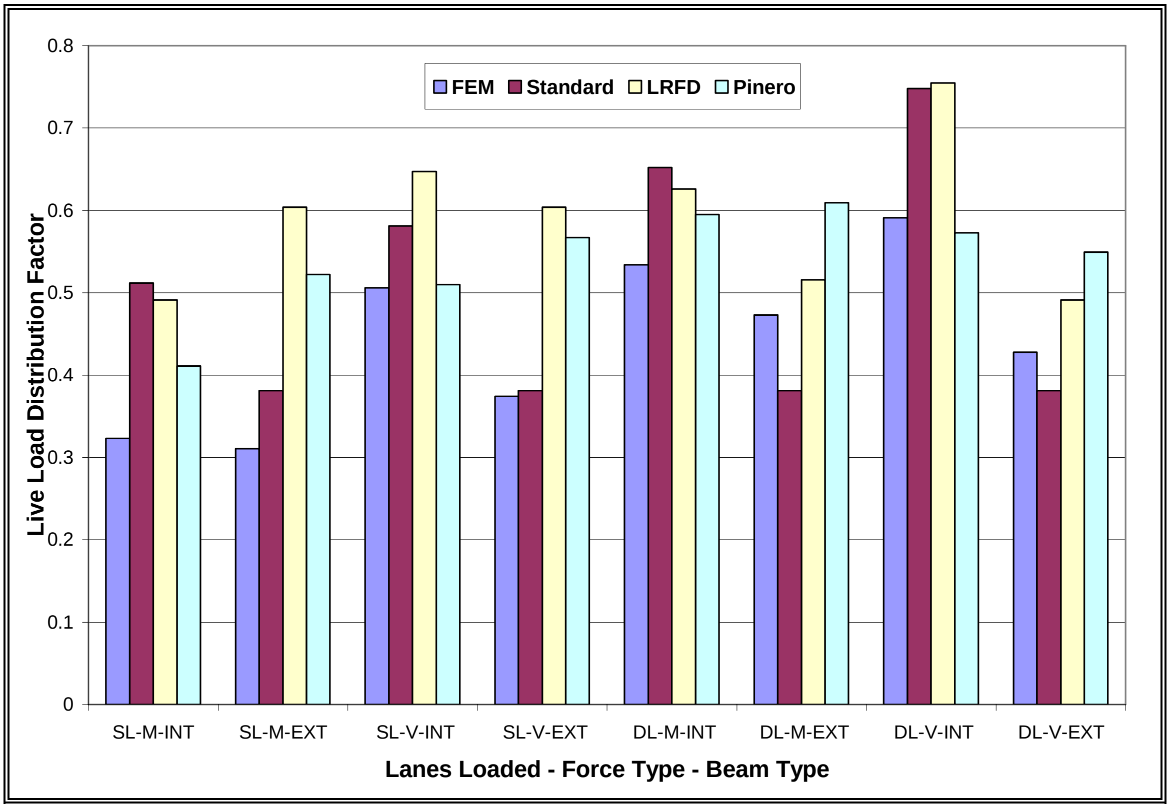


Figure 5.2.8 Comparison of Live Load Distribution Factors on Bridge #2 for LAVIII-STRYKER

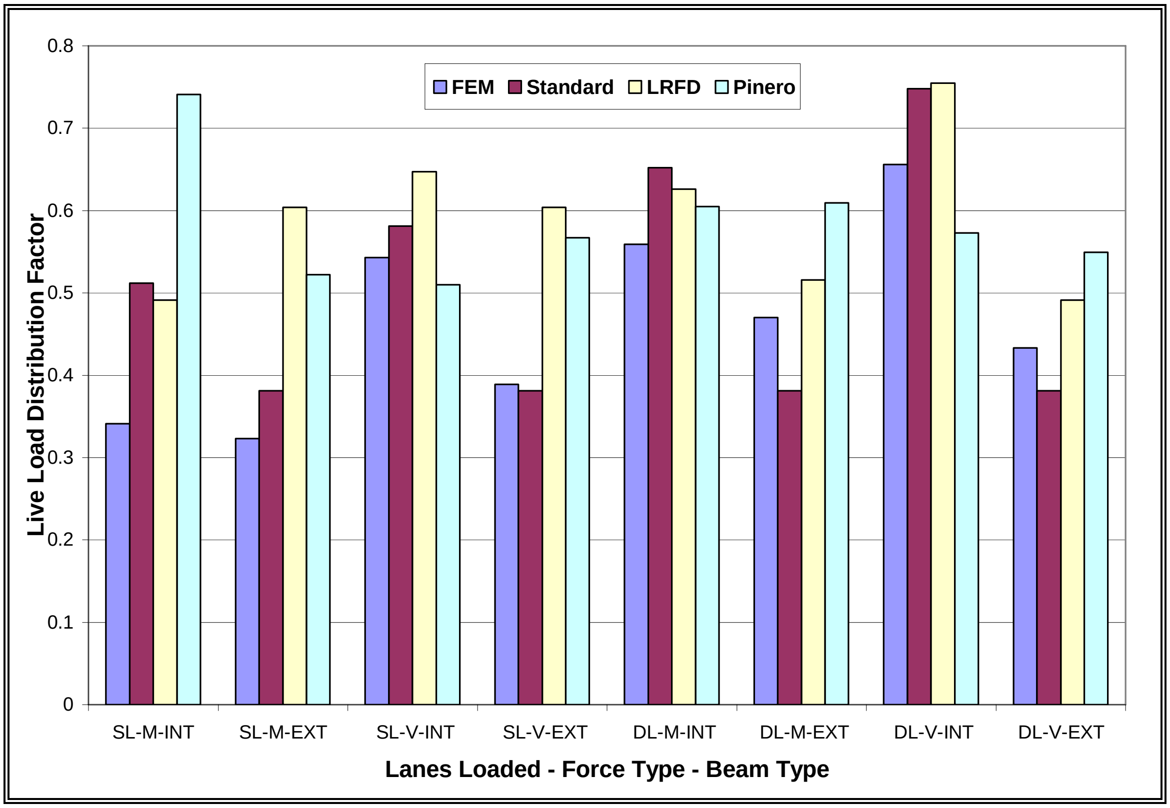


Figure 5.2.9 Comparison of Live Load Distribution Factors on Bridge #2 for HEMTT

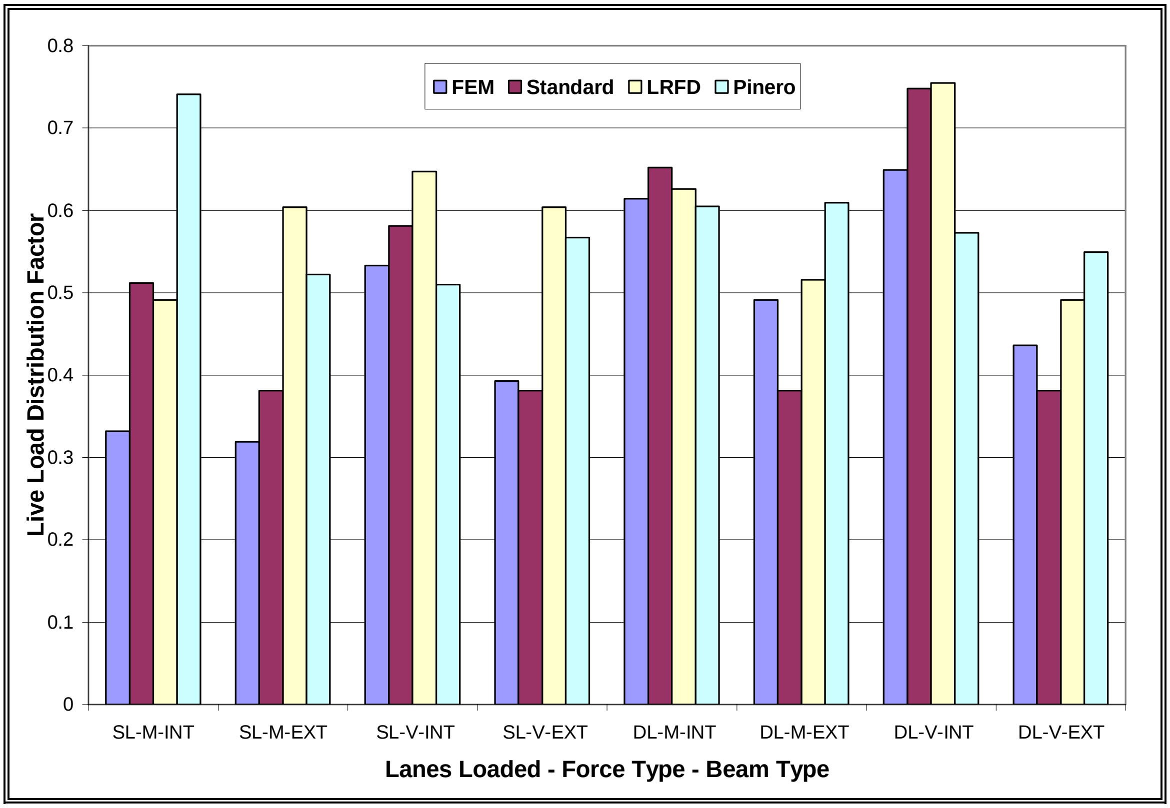


Figure 5.2.10 Comparison of Live Load Distribution Factors on Bridge #2 for PLS

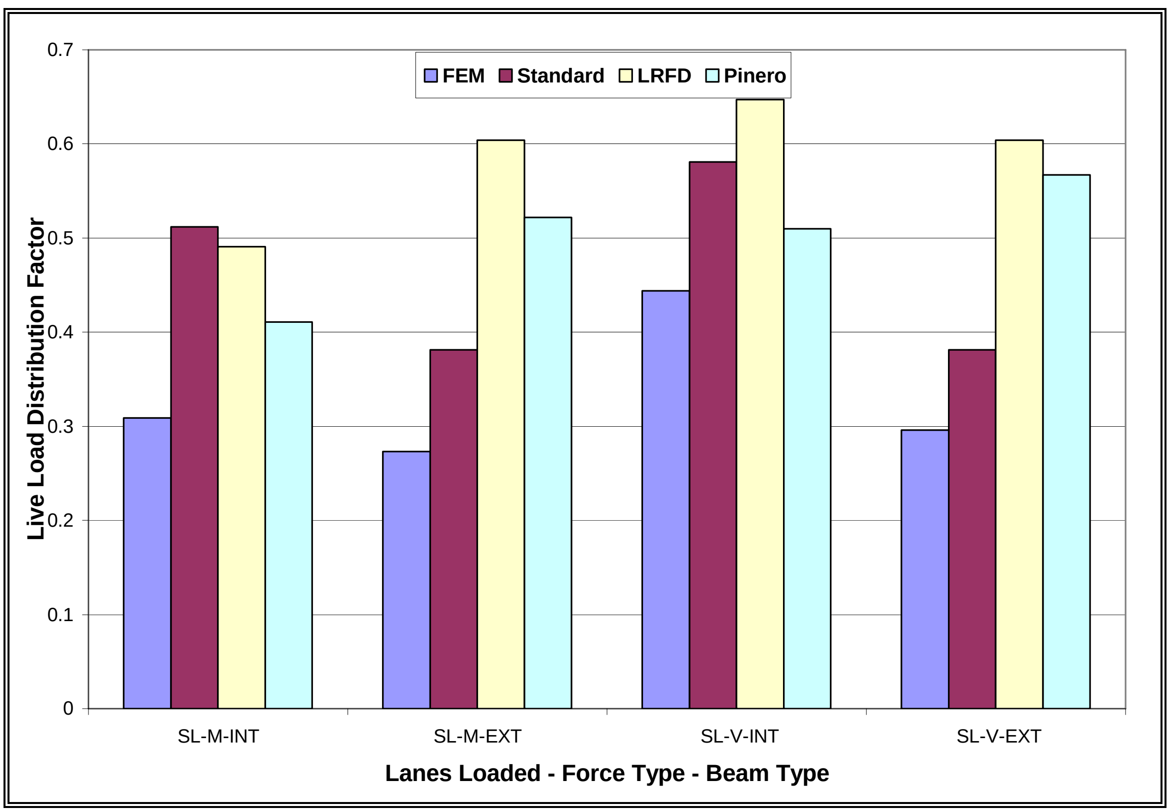


Figure 5.2.11 Comparison of Live Load Distribution Factors on Bridge #2 for HETS

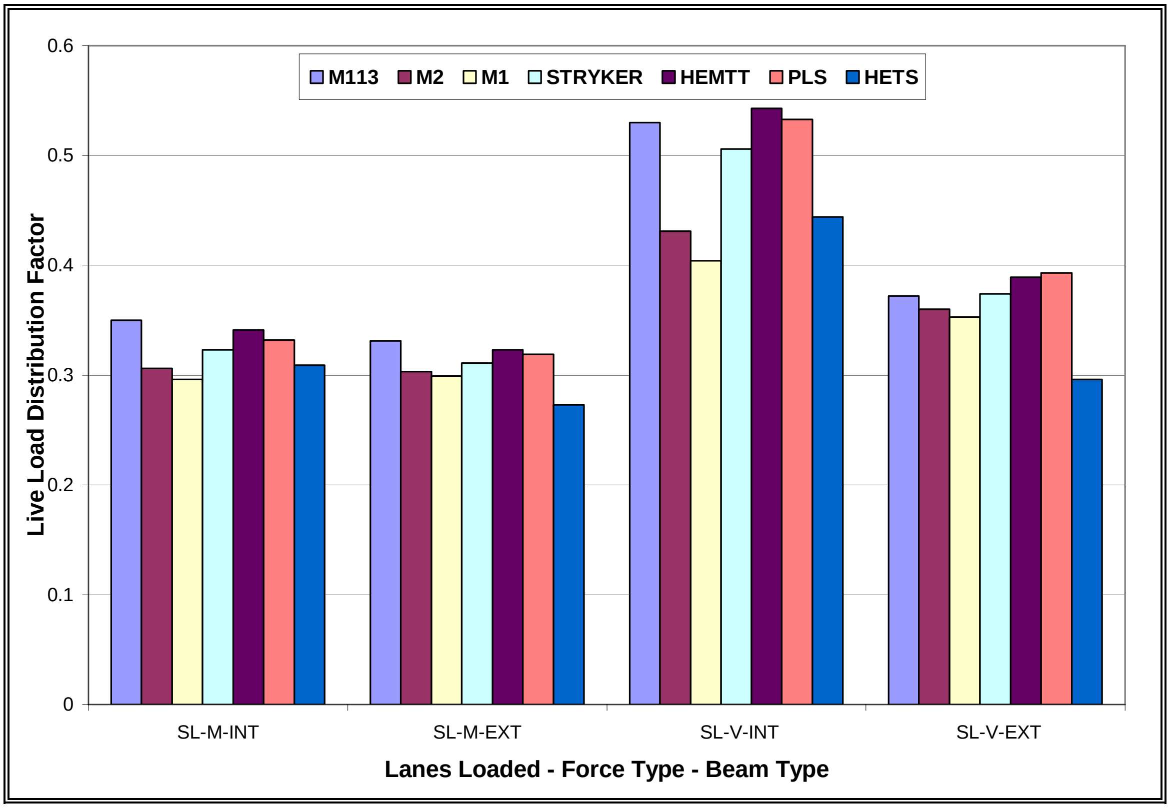


Figure 5.2.12 Comparison of Live Load Distribution Factors for Military Vehicles on Bridge #2 – SL

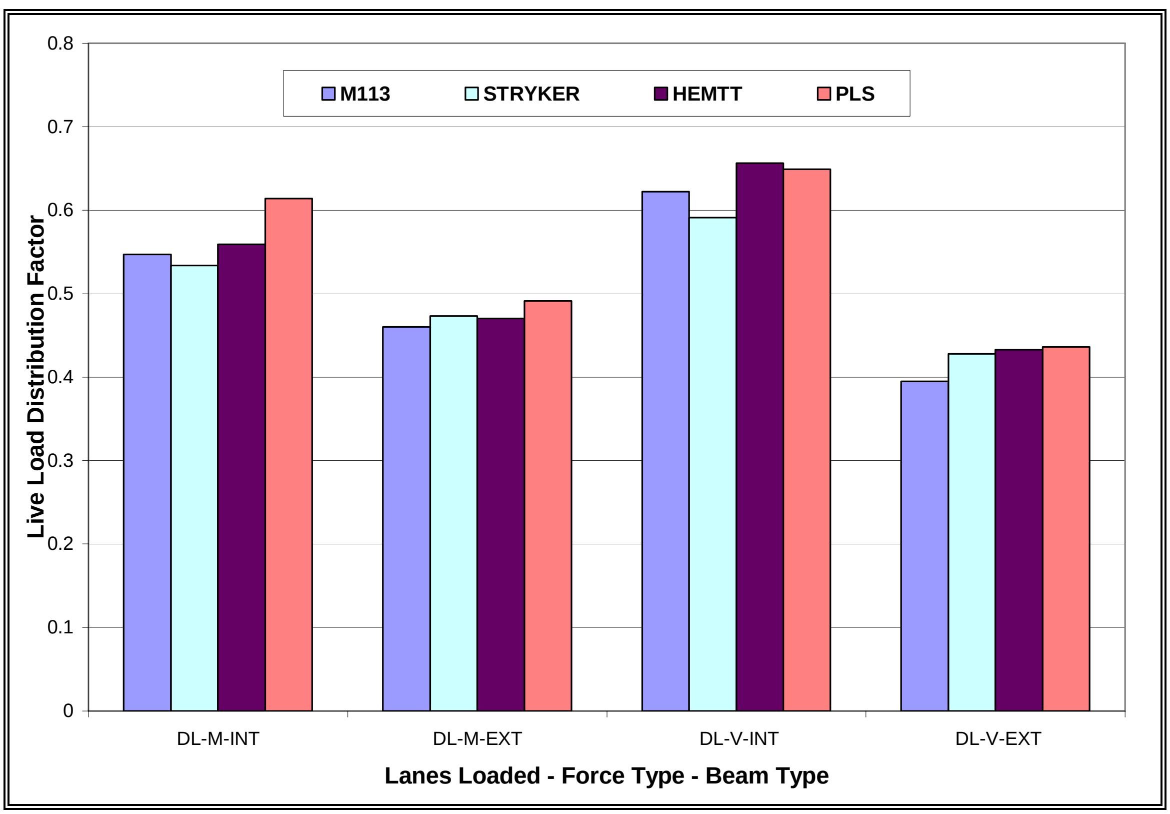


Figure 5.2.13 Comparison of Live Load Distribution Factors for Military Vehicles on Bridge #2 – DL

CHAPTER 6 DISTRIBUTION FACTORS FOR MILITARY VEHCLES

6.1 Introduction

Load test results in combination with 3D analyses presented in Chapter 5 shows that distribution factors for military vehicles are different than the formulas proposed by AASHTO (*Standard* and *LRFD*). For this reason, 3D finite element analyses of simple span steel bridges were performed for the military vehicles presented in Chapter 2 to obtain new live load distribution factor for these vehicles using the 3D analysis procedure defined on section 5.2. Live load distribution factors obtained in this chapter are not intended to be used for design, because they are not conservative. These factors are intended for use in the load rating analysis of military vehicles on steel multi-beam bridges were less conservatism is desirable in order to maximize Forces mobility.

6.2 Steel Beam Bridges

The research considers the generic sample of steel multi-beam bridges used in the NMSU study (Minor and Woodward 2001). This sample was developed from the database of actual steel multi-beam bridges considered by Zokaie et al. (1991) for the NCHRP project. The generic sample of steel multi-beam bridges were created to represent the full range of span, beam spacing, moment of inertia, and deck thickness of the steel beam bridges in the Zokaie's database. A total of ninety steel beam bridges were considered in this research. The properties of the typical steel beam bridges developed in the NMSU study are presented on Table 6.2.1.

Table 6.2.1 Properties of Steel Beam Bridges based on NMSU Study*

Span (ft)	**Beam Spacing (ft)**				
	4	**5**	**6**	**7**	**8**
	Moment of Inertia (in^4)				
50	3842	4620	5556	6682	8035
70	5864	7052	8480	10198	12264
90	8950	10763	12943	15565	18718
110	13659	16426	19754	23756	28568
130	20848	25071	30150	36258	43603
140	25756	30973	37248	44793	53868
Number of Beams	**7**	**6**	**5**	**5**	**4**

* Deck thickness of 7, 8, and 9 in have been considered for each bridge.

The NMSU study obtained the values shown in Table 6.2.1 by regression analysis of the Zokaie et al. (1991) database for steel beam bridges. The regression equation was given as:

$$Ln(I) = 6.4588 + 0.021141L + 0.184468S$$

I = Moment of inertia (in^4)

L = Span length (ft)

S = Beam spacing (ft)

This regression equation has been used to define the moments of inertia for the typical set of steel beam bridges foe each set of span and beam spacing values indicated on Table 6.2.1.

6.3 Sensitivity Study on Steel Beam Bridges

In order to identify those parameters that are most important in the distribution factor analysis, a sensitivity study was performed. The bridge parameters considered for the sensitivity study were the bridge span, beam spacing, deck thickness, and moment of inertia as these were the main parameters defined on Table 6.2.1.

An average steel beam bridge was obtained by calculating the average value of each parameter shown on Table 6.2.1. The average steel beam bridge was considered for the sensitivity analysis. The properties of the average bridge are shown on Table 6.3.1. The HS20 was the vehicle considered for the sensitivity study where one traffic lane and two traffic lanes were both considered for interior beams.

Table 6.3.1 Parameter Values for the Average Steel Beam Bridge

Average Steel Beam Bridge Parameters			
Span (ft)	**Beam Spacing (ft)**	**Deck Thickness (in)**	**Moment of Inertia (in^4)**
98.33	6.00	8.00	19675

6.3.1 Sensitivity Study Results

Figures 6.3.1 through 6.3.4 show the results of the sensitivity study performed for the different parameters affecting distribution factor. Figures 6.3.1 and 6.3.2 show the results for bending moment distribution factors by one traffic lane and two traffic lanes, respectively; while Figures 6.3.3 and 6.3.4 show the results for shear force distribution factors by one traffic lane and two traffic lanes, respectively. All the figures show the distribution factor values plotted against a normalized parameter value, where the parameter value was normalized by dividing the actual value with the average value of the parameter.

The sensitivity results show that the beam spacing is the most important parameter in the live load distribution factor analysis. As the beam spacing increases, the live load distribution factor increase representing that the beam has to carry more load. The second most important parameter is the bridge span. As the bridge span increases, the live load distribution factor decreases showing that for longer bridges the live load is better distributed than for shorter bridges. The results on Figures 6.3.1 through 6.3.4 show that deck thickness is more sensitive for shear force distribution factor than for bending moment distribution factor. In fact, Figure 6.3.3 shows that deck thickness has a high impact on the shear force live load distribution factor. The live load on steel beam bridges is better distributed when thicker decks are used. The moment of inertia is not as important as the other parameters, but it also should be considered to obtain an appropriate live load distribution factor that represents the true bridge behavior. As the moment of inertia increases, the live load distribution factor increases showing that stiffer beams tend to attract more load.

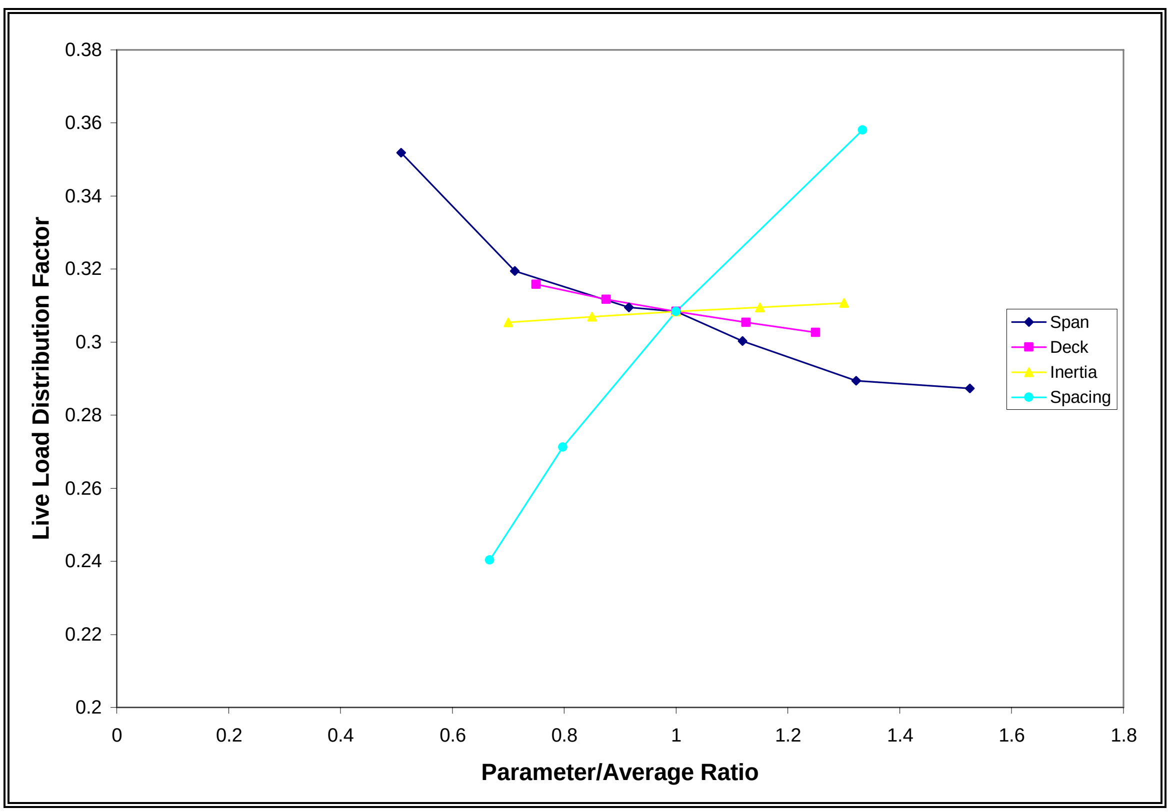


Figure 6.3.1 Sensitivity on Bending Moment Distribution Factors – One Traffic Lane

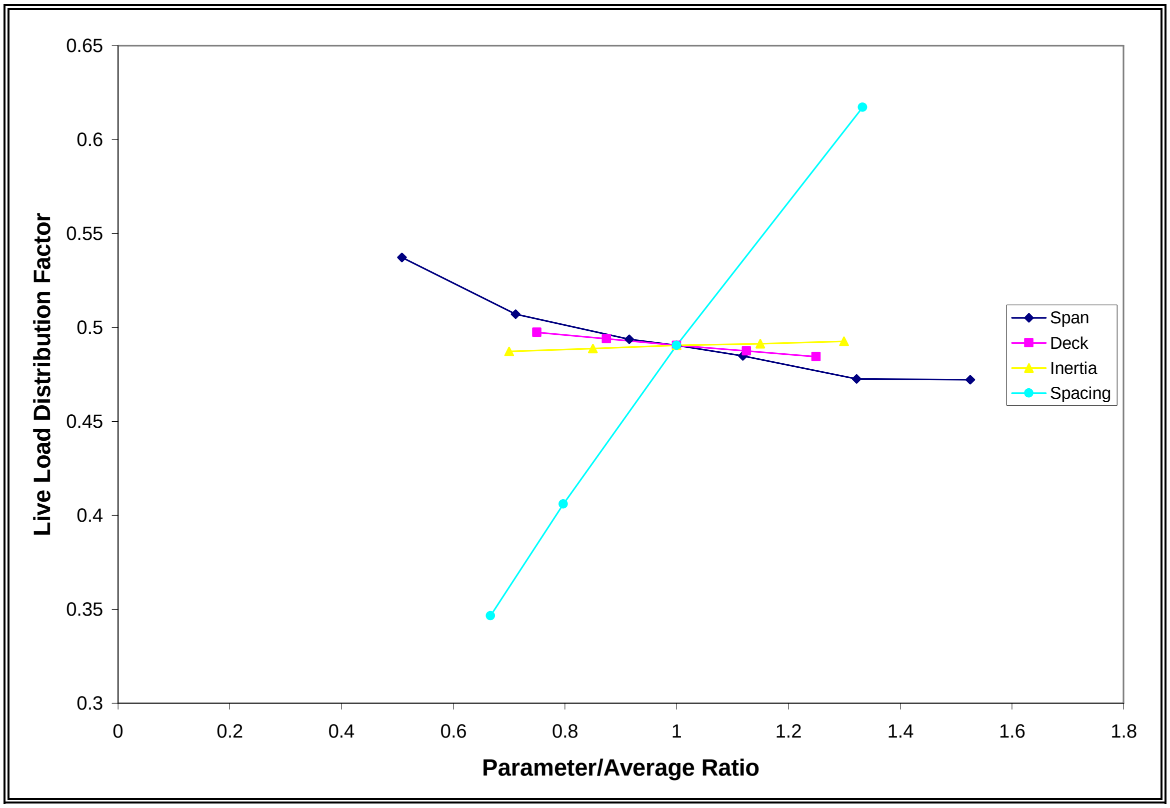


Figure 6.3.2 Sensitivity on Bending Moment Distribution Factors – Two Traffic Lanes

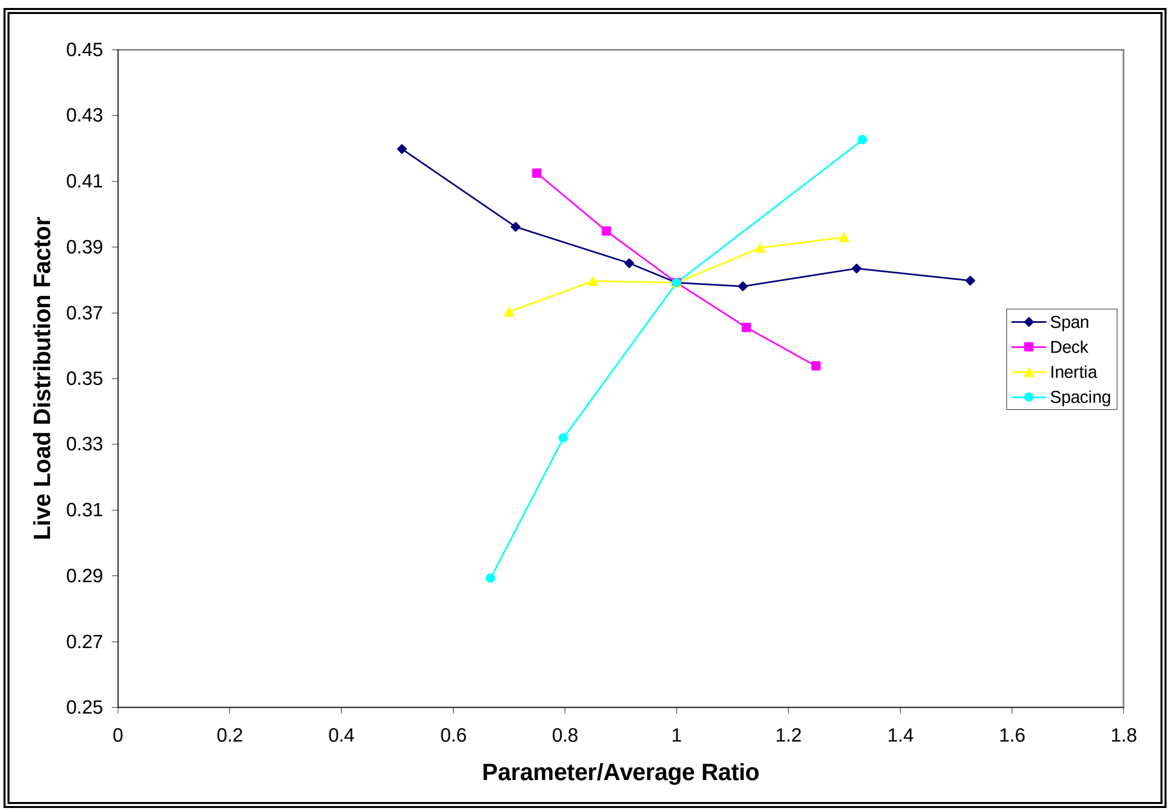


Figure 6.3.3 Sensitivity on Shear Force Distribution Factors – One Traffic Lane

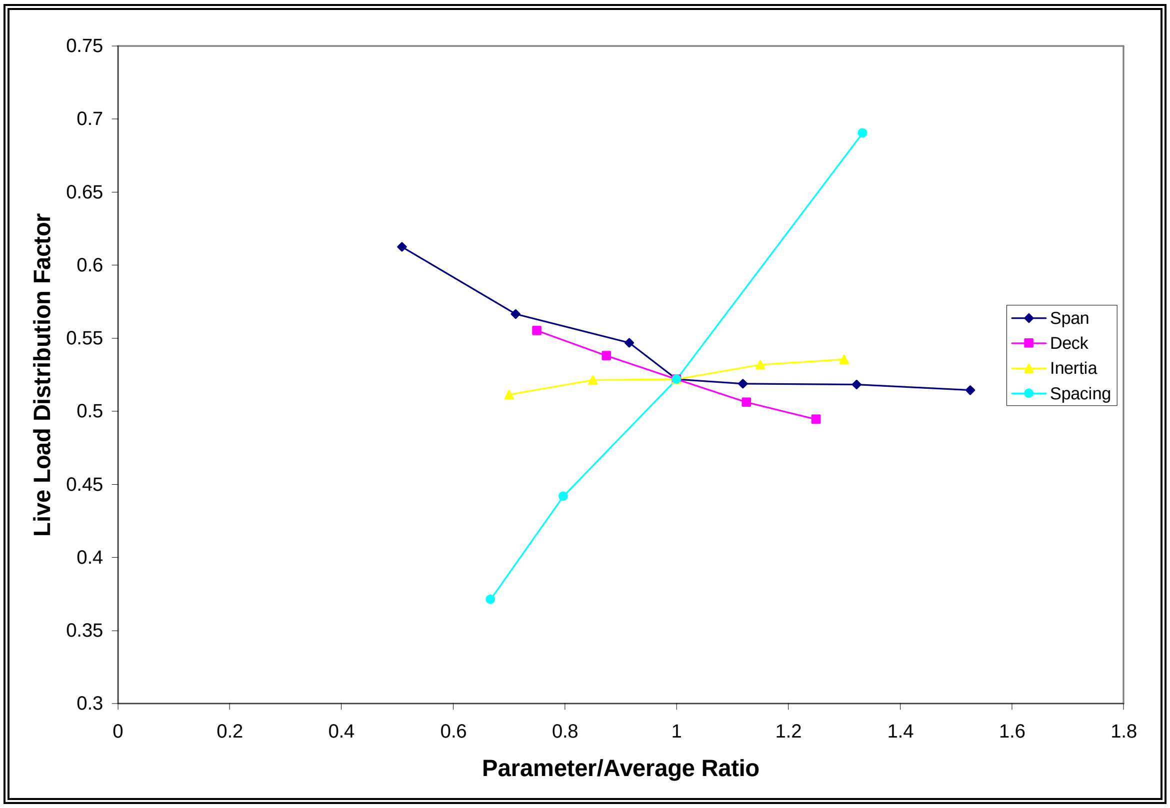


Figure 6.3.4 Sensitivity on Shear Force Distribution Factors – Two Traffic Lanes

6.4 Development of Live Load Distribution Factors for Military Vehicles

In this research the main focus was to obtain live load distribution factors for military vehicles. The steel beam bridges considered in the research to obtain the live load distribution factors are shown on Table 6.2.1. Section 2.5 defined the following military vehicles considered in the study to obtain the live load distribution factors:

1. M113
2. M2-BRADLEY
3. M1-ABRAMS
4. LAVIII-STRYKER
5. HEMTT
6. PLS

7. HETS

The parameters considered in the determination of the live load distribution factors for military vehicles were the same considered by *LRFD* for civilian vehicles:

1. S = Spacing between beams
2. L = Span length
3. t = Deck thickness
4. Kg = Longitudinal stiffness parameter

The longitudinal stiffness parameter, Kg, considers the modulus of elasticity of the beam, E_B, the modulus of elasticity of the deck, E_D, the moment of inertia of the beam, I, and the distance between the centers of gravity of the basic beam and deck, e_g, as shown in the following equation:

$$K_g = \frac{E_B}{E_D}\left(I + Ae_g^2\right)$$

Three dimensional finite element analyses were performed to obtain the live load distribution factors for military vehicles using the same procedure outline on section 5.2, with the difference that these bridges were modeled as non-composite because they are a generic sample of actual steel multi-beam bridges. The scenarios analyzed to obtain the live load distributions factors were the same as for bridge #2 presented on Table 5.2.2 as:

1. Traffic lanes : One-way traffic and Two-way traffic
2. Load Case : Bending moment and Shear force
3. Beam Type : Interior and Exterior Beams

Results from the finite element analyses for the different scenarios for each military vehicle are presented as tables on Appendix C. From these results live load distribution factor formulas were developed for each of the military vehicles. These formulas were developed in a similar manner as the *LRFD* formulas considering the parameters and scenarios mention above. There are a total of fifty six formulas, eight for each military vehicle, presented on Tables 6.4.1 thru 6.4.4. Tables 6.4.1 and 6.4.2 show the live load distribution factor formulas for bending moment on interior and exterior beams respectively, while Tables 6.4.3 and 6.4.4 show the live load distribution factor formulas for shear force on interior and exterior beams respectively. The expression OH in the live load distribution factor formulas for exterior beams for bending moment and shear force on Tables 6.4.2 and 6.4.4 respectively, represents the overhang to the outside beam.

Table 6.4.1 Bending Moment Live Load Distribution Factor Formulas on Interior Beams

Military Vehicle	Loading Condition	Distribution Factor Formula	Recommended Range of Applicability
M113	Single Lane Loading	$0.051+\left(\frac{S}{18.57}\right)^{0.516}\left(\frac{S}{L}\right)^{0.172}\left(\frac{K_g}{12Lt_s^3}\right)^{0.031}$	$3\,ft \le S \le 12\,ft$ $20\,ft \le L \le 160\,ft$ $4.5in \le t_s \le 12in$ $5.0E04 \le K_g \le 3.0E06$
	Double Lane Loading	$0.022+\left(\frac{S}{10.27}\right)^{0.846}\left(\frac{S}{L}\right)^{0.134}\left(\frac{K_g}{12Lt_s^3}\right)^{0.031}$	
M2	Single Lane Loading	$0.110+\left(\frac{S}{25.58}\right)^{0.477}\left(\frac{S}{L}\right)^{0.095}\left(\frac{K_g}{12Lt_s^3}\right)^{0.017}$	
	Double Lane Loading	$0.058+\left(\frac{S}{13.57}\right)^{0.939}\left(\frac{S}{L}\right)^{0.086}\left(\frac{K_g}{12Lt_s^3}\right)^{0.025}$	
M1	Single Lane Loading	$-0.241+\left(\frac{S}{25.36}\right)^{0.383}\left(\frac{S}{L}\right)^{0.043}\left(\frac{K_g}{12Lt_s^3}\right)^{0.004}$	
	Double Lane Loading	$0.036+\left(\frac{S}{14.15}\right)^{0.910}\left(\frac{S}{L}\right)^{0.061}\left(\frac{K_g}{12Lt_s^3}\right)^{0.017}$	
LAVIII	Single Lane Loading	$-0.228+\left(\frac{S}{18.70}\right)^{0.315}\left(\frac{S}{L}\right)^{0.106}\left(\frac{K_g}{12Lt_s^3}\right)^{0.025}$	
	Double Lane Loading	$0.004+\left(\frac{S}{10.75}\right)^{0.806}\left(\frac{S}{L}\right)^{0.114}\left(\frac{K_g}{12Lt_s^3}\right)^{0.027}$	
HEMTT	Single Lane Loading	$0.035+\left(\frac{S}{17.64}\right)^{0.610}\left(\frac{S}{L}\right)^{0.275}\left(\frac{K_g}{12Lt_s^3}\right)^{0.047}$	
	Double Lane Loading	$0.019+\left(\frac{S}{10.62}\right)^{0.803}\left(\frac{S}{L}\right)^{0.136}\left(\frac{K_g}{12Lt_s^3}\right)^{0.034}$	
PLS	Single Lane Loading	$0.040+\left(\frac{S}{18.24}\right)^{0.619}\left(\frac{S}{L}\right)^{0.262}\left(\frac{K_g}{12Lt_s^3}\right)^{0.041}$	
	Double Lane Loading	$0.132+\left(\frac{S}{9.90}\right)^{1.078}\left(\frac{S}{L}\right)^{0.215}\left(\frac{K_g}{12Lt_s^3}\right)^{0.053}$	
HETS	Single Lane Loading	$-0.023+\left(\frac{S}{21.10}\right)^{0.531}\left(\frac{S}{L}\right)^{0.211}\left(\frac{K_g}{12Lt_s^3}\right)^{0.033}$	
	Double Lane Loading	$-0.010+\left(\frac{S}{17.43}\right)^{0.775}\left(\frac{S}{L}\right)^{0.015}\left(\frac{K_g}{12Lt_s^3}\right)^{0.004}$	

Table 6.4.2 Bending Moment Live Load Distribution Factor Formulas on Exterior Beams

Military Vehicle	Loading Condition	Distribution Factor Formula	Recommended Range of Applicability
M113	Single Lane Loading	$\left(0.380+\left(\frac{S}{8.12}\right)^{0.402}\left(\frac{S}{L}\right)^{0.0275}\left(\frac{K_g}{12Lt_s^3}\right)^{-0.003}\right)\times\left(0.77+\frac{OH}{14.25}\right)$	$3\,ft \le S \le 12\,ft$ $20\,ft \le L \le 160\,ft$ $4.5in \le t_s \le 12in$ $5.0E04 \le K_g \le 3.0E$ $0\,ft \le OH \le 3\,ft$
	Double Lane Loading	$\left(-0.105+\left(\frac{S}{14.05}\right)^{0.732}\left(\frac{S}{L}\right)^{-0.065}\left(\frac{K_g}{12Lt_s^3}\right)^{-0.019}\right)\times\left(0.77+\frac{OH}{13.10}\right)$	
M2	Single Lane Loading	$\left(-0.454+\left(\frac{S}{7.71}\right)^{0.376}\left(\frac{S}{L}\right)^{0.017}\left(\frac{K_g}{12Lt_s^3}\right)^{-0.003}\right)\times\left(0.77+\frac{OH}{15.13}\right)$	
	Double Lane Loading	$\left(0.006+\left(\frac{S}{15.15}\right)^{0.863}\left(\frac{S}{L}\right)^{-0.035}\left(\frac{K_g}{12Lt_s^3}\right)^{-0.013}\right)\times\left(0.77+\frac{OH}{17.52}\right)$	
M1	Single Lane Loading	$\left(-0.473+\left(\frac{S}{7.42}\right)^{0.364}\left(\frac{S}{L}\right)^{0.019}\left(\frac{K_g}{12Lt_s^3}\right)^{-0.001}\right)\times\left(0.77+\frac{OH}{15.15}\right)$	
	Double Lane Loading	$\left(-0.236+\left(\frac{S}{9.67}\right)^{0.524}\left(\frac{S}{L}\right)^{0.004}\left(\frac{K_g}{12Lt_s^3}\right)^{-0.001}\right)\times\left(0.77+\frac{OH}{32.81}\right)$	
LAVIII	Single Lane Loading	$\left(-0.387+\left(\frac{S}{8.18}\right)^{0.403}\left(\frac{S}{L}\right)^{0.025}\left(\frac{K_g}{12Lt_s^3}\right)^{-0.003}\right)\times\left(0.77+\frac{OH}{14.75}\right)$	
	Double Lane Loading	$\left(-0.138+\left(\frac{S}{13.92}\right)^{0.694}\left(\frac{S}{L}\right)^{-0.066}\left(\frac{K_g}{12Lt_s^3}\right)^{-0.020}\right)\times\left(0.77+\frac{OH}{13.22}\right)$	
HEMTT	Single Lane Loading	$\left(-0.451+\left(\frac{S}{6.86}\right)^{0.369}\left(\frac{S}{L}\right)^{0.026}\left(\frac{K_g}{12Lt_s^3}\right)^{-0.001}\right)\times\left(0.77+\frac{OH}{18.50}\right)$	
	Double Lane Loading	$\left(-0.045+\left(\frac{S}{14.57}\right)^{0.854}\left(\frac{S}{L}\right)^{-0.090}\left(\frac{K_g}{12Lt_s^3}\right)^{-0.032}\right)\times\left(0.77+\frac{OH}{14.60}\right)$	
PLS	Single Lane Loading	$\left(-0.387+\left(\frac{S}{8.16}\right)^{0.413}\left(\frac{S}{L}\right)^{0.026}\left(\frac{K_g}{12Lt_s^3}\right)^{-0.005}\right)\times\left(0.77+\frac{OH}{17}\right)$	
	Double Lane Loading	$\left(-0.041+\left(\frac{S}{14.49}\right)^{0.841}\left(\frac{S}{L}\right)^{-0.081}\left(\frac{K_g}{12Lt_s^3}\right)^{-0.028}\right)\times\left(0.77+\frac{OH}{14.27}\right)$	
HETS	Single Lane Loading	$\left(-0.521+\left(\frac{S}{9.29}\right)^{0.384}\left(\frac{S}{L}\right)^{-0.015}\left(\frac{K_g}{12Lt_s^3}\right)^{-0.013}\right)\times\left(0.77+\frac{OH}{15.89}\right)$	
	Double Lane Loading	$\left(-0.311+\left(\frac{S}{9}\right)^{0.561}\left(\frac{S}{L}\right)^{0.009}\left(\frac{K_g}{12Lt_s^3}\right)^{0.001}\right)\times\left(0.77+\frac{OH}{39}\right)$	

Table 6.4.3 Shear Force Live Load Distribution Factor Formulas on Interior Beams

Military Vehicle	Loading Condition	Distribution Factor Formula	Recommended Range of Applicability
M113	Single Lane Loading	$-0.110+\left(\frac{S}{16.87}\right)^{0.511}\left(\frac{S}{L}\right)^{0.054}\left(\frac{K_g}{12Lt_s^3}\right)^{0.069}$	$3\,ft \le S \le 12\,ft$ $20\,ft \le L \le 160\,ft$ $4.5in \le t_s \le 12in$ $5.0E04 \le K_g \le 3.0E06$
	Double Lane Loading	$0.019+\left(\frac{S}{12.14}\right)^{0.717}\left(\frac{S}{L}\right)^{0.060}\left(\frac{K_g}{12Lt_s^3}\right)^{0.073}$	
M2	Single Lane Loading	$-0.860+\left(\frac{S}{1.87}\right)^{0.186}\left(\frac{S}{L}\right)^{0.013}\left(\frac{K_g}{12Lt_s^3}\right)^{0.019}$	
	Double Lane Loading	$-0.390+\left(\frac{S}{9.55}\right)^{0.352}\left(\frac{S}{L}\right)^{-0.004}\left(\frac{K_g}{12Lt_s^3}\right)^{0.023}$	
M1	Single Lane Loading	$-0.785+\left(\frac{S}{2.60}\right)^{0.178}\left(\frac{S}{L}\right)^{0.016}\left(\frac{K_g}{12Lt_s^3}\right)^{0.022}$	
	Double Lane Loading	$-0.258+\left(\frac{S}{10.79}\right)^{0.383}\left(\frac{S}{L}\right)^{0.031}\left(\frac{K_g}{12Lt_s^3}\right)^{0.033}$	
LAVIII	Single Lane Loading	$-0.501+\left(\frac{S}{7.36}\right)^{0.295}\left(\frac{S}{L}\right)^{0.021}\left(\frac{K_g}{12Lt_s^3}\right)^{0.030}$	
	Double Lane Loading	$-0.079+\left(\frac{S}{11.66}\right)^{0.604}\left(\frac{S}{L}\right)^{0.042}\left(\frac{K_g}{12Lt_s^3}\right)^{0.059}$	
HEMTT	Single Lane Loading	$-0.423+\left(\frac{S}{6.98}\right)^{0.196}\left(\frac{S}{L}\right)^{0.069}\left(\frac{K_g}{12Lt_s^3}\right)^{0.049}$	
	Double Lane Loading	$-0.257+\left(\frac{S}{5.60}\right)^{0.420}\left(\frac{S}{L}\right)^{0.094}\left(\frac{K_g}{12Lt_s^3}\right)^{0.063}$	
PLS	Single Lane Loading	$-0.398+\left(\frac{S}{8.25}\right)^{0.204}\left(\frac{S}{L}\right)^{0.071}\left(\frac{K_g}{12Lt_s^3}\right)^{0.049}$	
	Double Lane Loading	$-0.101+\left(\frac{S}{7.91}\right)^{0.533}\left(\frac{S}{L}\right)^{0.114}\left(\frac{K_g}{12Lt_s^3}\right)^{0.079}$	
HETS	Single Lane Loading	$-0.778+\left(\frac{S}{1.92}\right)^{0.189}\left(\frac{S}{L}\right)^{0.042}\left(\frac{K_g}{12Lt_s^3}\right)^{0.030}$	
	Double Lane Loading	$-0.060+\left(\frac{S}{14.70}\right)^{0.570}\left(\frac{S}{L}\right)^{0.083}\left(\frac{K_g}{12Lt_s^3}\right)^{0.040}$	

Table 6.4.4 Shear Force Live Load Distribution Factor Formulas on Exterior Beams

Military Vehicle	Loading Condition	Distribution Factor Formula	Recommended Range of Applicability
M113	Single Lane Loading	$\left(0.075+\left(\frac{S}{14.57}\right)^{0.585}\left(\frac{S}{L}\right)^{0.0252}\left(\frac{K_g}{12Lt_s^3}\right)^{-0.068}\right)\times\left(0.77+\frac{OH}{9.08}\right)$	$3\,ft \le S \le 12\,ft$ $20\,ft \le L \le 160\,ft$ $4.5in \le t_s \le 12in$ $5.0E04 \le K_g \le 3.0E$ $0\,ft \le OH \le 3\,ft$
	Double Lane Loading	$\left(0.022+\left(\frac{S}{12.86}\right)^{0.933}\left(\frac{S}{L}\right)^{0.003}\left(\frac{K_g}{12Lt_s^3}\right)^{-0.114}\right)\times\left(0.77+\frac{OH}{8.59}\right)$	
M2	Single Lane Loading	$\left(0.303+\left(\frac{S}{14.07}\right)^{1.892}\left(\frac{S}{L}\right)^{0.095}\left(\frac{K_g}{12Lt_s^3}\right)^{-0.186}\right)\times\left(0.77+\frac{OH}{10.77}\right)$	
	Double Lane Loading	$\left(0.293+\left(\frac{S}{16.83}\right)^{1.430}\left(\frac{S}{L}\right)^{-0.015}\left(\frac{K_g}{12Lt_s^3}\right)^{-0.112}\right)\times\left(0.77+\frac{OH}{18.37}\right)$	
M1	Single Lane Loading	$\left(0.301+\left(\frac{S}{14.13}\right)^{1.856}\left(\frac{S}{L}\right)^{0.115}\left(\frac{K_g}{12Lt_s^3}\right)^{-0.172}\right)\times\left(0.77+\frac{OH}{11.16}\right)$	
	Double Lane Loading	$\left(0.097+\left(\frac{S}{16.54}\right)^{0.957}\left(\frac{S}{L}\right)^{-0.027}\left(\frac{K_g}{12Lt_s^3}\right)^{-0.042}\right)\times\left(0.77+\frac{OH}{29.15}\right)$	
LAVIII	Single Lane Loading	$\left(0.138+\left(\frac{S}{16}\right)^{0.909}\left(\frac{S}{L}\right)^{0.066}\left(\frac{K_g}{12Lt_s^3}\right)^{-0.110}\right)\times\left(0.77+\frac{OH}{9.59}\right)$	
	Double Lane Loading	$\left(0.082+\left(\frac{S}{13.43}\right)^{1.031}\left(\frac{S}{L}\right)^{0.004}\left(\frac{K_g}{12Lt_s^3}\right)^{-0.132}\right)\times\left(0.77+\frac{OH}{9.19}\right)$	
HEMTT	Single Lane Loading	$\left(-0.365+\left(\frac{S}{8.49}\right)^{0.429}\left(\frac{S}{L}\right)^{-0.005}\left(\frac{K_g}{12Lt_s^3}\right)^{-0.054}\right)\times\left(0.77+\frac{OH}{9.61}\right)$	
	Double Lane Loading	$\left(-0.085+\left(\frac{S}{14.96}\right)^{1.033}\left(\frac{S}{L}\right)^{-0.067}\left(\frac{K_g}{12Lt_s^3}\right)^{-0.135}\right)\times\left(0.77+\frac{OH}{9.07}\right)$	
PLS	Single Lane Loading	$\left(-0.201+\left(\frac{S}{12.43}\right)^{0.518}\left(\frac{S}{L}\right)^{-0.014}\left(\frac{K_g}{12Lt_s^3}\right)^{-0.066}\right)\times\left(0.77+\frac{OH}{10}\right)$	
	Double Lane Loading	$\left(-0.028+\left(\frac{S}{14.46}\right)^{0.841}\left(\frac{S}{L}\right)^{-0.076}\left(\frac{K_g}{12Lt_s^3}\right)^{-0.111}\right)\times\left(0.77+\frac{OH}{9.14}\right)$	
HETS	Single Lane Loading	$\left(0.235+\left(\frac{S}{18.53}\right)^{1.910}\left(\frac{S}{L}\right)^{-0.126}\left(\frac{K_g}{12Lt_s^3}\right)^{-0.223}\right)\times\left(0.77+\frac{OH}{10}\right)$	
	Double Lane Loading	$\left(0.167+\left(\frac{S}{21.44}\right)^{1.098}\left(\frac{S}{L}\right)^{-0.120}\left(\frac{K_g}{12Lt_s^3}\right)^{-0.026}\right)\times\left(0.77+\frac{OH}{23.5}\right)$	

6.5 Comparison of Distribution Factors Formulas for Military Vehicles

6.5.1 Proposed Formulas versus Finite Element Analysis

Figures 1 thru 54 on Appendix D were created to test the accuracy of the proposed formulas with respect to the finite element analyses performed for each military vehicle. Each figure represents the accuracy of the formulas presented on Tables 6.4.1 thru 6.4.4. These figures were identified by vehicle type, loading condition, and beam location. Two charts were included on each figure to perform a statistical analysis.

The first chart plots the live load distribution factors calculated by the proposed formulas against the values obtained in the finite element analyses. Here each point in the plot represents a bridge on the database presented on Table 6.2.1. A perfect straight line at 45 degrees will imply a perfect fit between the proposed formula and the finite element analyses. The second chart plots the histogram for the variable ratio between the live load distribution factors calculated by the proposed formulas and the finite element analyses. The mean and the coefficient of variation values of the ratio have been included in this chart. The mean represents the arithmetic average of the sample, while the coefficient of variation is a dimensionless quantity that measures the amount of variability relatively to the value of the mean.

6.5.2 Proposed Formulas versus Previous Formulas

The main interest in this study was to compare the values of the distribution factors formulas obtained with the finite element analyses with previous formulas according to AASHTO (*Standard* & *LRFD*) and those developed by Piñero et al. (2001). Tables 6.5.1 and 6.5.2 show the live load distribution factor formulas for bending moment in an interior beam given by AASHTO (*Standard* & *LRFD*) and Piñero et al. (2001) respectively. No comparison was made for the exterior beams or the shear force live load distribution factors since these factors are calculated by the lever rule in at least one of the cases which can be complex for the ninety bridges.

Table 6.5.1 Bending Moment Live Load Distribution Factors for Interior Beams by AASHTO

Loading Condition	Standard	LRFD
Single Lane Loading	$\frac{S}{7}$	$0.06+\left(\frac{S}{14}\right)^{0.4}\left(\frac{S}{L}\right)^{0.3}\left(\frac{K_g}{12Lt_s^3}\right)^{0.1}$
Double Lane Loading	$\frac{S}{5.5}$	$0.075+\left(\frac{S}{9.5}\right)^{0.6}\left(\frac{S}{L}\right)^{0.2}\left(\frac{K_g}{12Lt_s^3}\right)^{0.1}$

Table 6.5.2 Bending Moment Live Load Distribution Factors for Interior Beams by Piñero (2001)

Military Vehicle	Loading Condition	Piñero (2001)
M113	Single Lane Loading	$0.27+\left(\frac{S}{22.8}\right)^{0.86}\left(\frac{S}{L}\right)^{0.30}\left(\frac{n\times I}{12Lt_s^3}\right)^{0.23}$
	Double Lane Loading	$0.05+\left(\frac{S}{11}\right)^{0.56}\left(\frac{S}{L}\right)^{0.14}\left(\frac{n\times I}{12Lt_s^3}\right)^{0.068}$
M2	Single Lane Loading	$0.27+\left(\frac{S}{22.8}\right)^{0.86}\left(\frac{S}{L}\right)^{0.30}\left(\frac{n\times I}{12Lt_s^3}\right)^{0.23}$
	Double Lane Loading	$0.05+\left(\frac{S}{11}\right)^{0.56}\left(\frac{S}{L}\right)^{0.14}\left(\frac{n\times I}{12Lt_s^3}\right)^{0.068}$
M1	Single Lane Loading	$0.095+\left(\frac{S}{69.36}\right)^{0.46}\left(\frac{S}{L}\right)^{0.05}\left(\frac{n\times I}{12Lt_s^3}\right)^{0.05}$
	Double Lane Loading	$0.05+\left(\frac{S}{11}\right)^{0.56}\left(\frac{S}{L}\right)^{0.14}\left(\frac{n\times I}{12Lt_s^3}\right)^{0.068}$
LAVIII	Single Lane Loading	$0.30+\left(\frac{S}{18.2}\right)\left(\frac{S}{L}\right)^{0.41}\left(\frac{n\times I}{12Lt_s^3}\right)^{0.28}$
	Double Lane Loading	$0.05+\left(\frac{S}{11}\right)^{0.56}\left(\frac{S}{L}\right)^{0.14}\left(\frac{n\times I}{12Lt_s^3}\right)^{0.068}$
HEMTT	Single Lane Loading	$0.22+\left(\frac{S}{7.96}\right)^{0.23}\left(\frac{S}{L}\right)^{0.17}\left(\frac{n\times I}{12Lt_s^3}\right)^{0.16}$

	Double Lane Loading	$0.16+\left(\frac{S}{13.45}\right)^{0.59}\left(\frac{S}{L}\right)^{0.17}\left(\frac{n\times I}{12Lt_s^3}\right)^{0.08}$
PLS	Single Lane Loading	$0.22+\left(\frac{S}{7.96}\right)^{0.23}\left(\frac{S}{L}\right)^{0.17}\left(\frac{n\times I}{12Lt_s^3}\right)^{0.16}$
	Double Lane Loading	$0.16+\left(\frac{S}{13.45}\right)^{0.59}\left(\frac{S}{L}\right)^{0.17}\left(\frac{n\times I}{12Lt_s^3}\right)^{0.08}$
HETS	Single Lane Loading	$0.27+\left(\frac{S}{16}\right)^{0.93}\left(\frac{S}{L}\right)^{0.44}\left(\frac{n\times I}{12Lt_s^3}\right)^{0.24}$
	Double Lane Loading	$0.05+\left(\frac{S}{11}\right)^{0.56}\left(\frac{S}{L}\right)^{0.14}\left(\frac{n\times I}{12Lt_s^3}\right)^{0.068}$

The live load distribution factors obtained with the finite element analyses were compared in a tabular and graphical form with the AASHTO and Piñero et al. (2001) values. Tables 6.5.3 and 6.5.4 show the mean and coefficient of variation values calculated by the finite element analyses, the proposed formulas, *Standard* and *LRFD* AASHTO codes, and Piñero et al. (2001) for single lane and double lanes scenarios respectively.

Table 6.5.3 Mean and Coefficient of Variation for Bending Moment on Interior Beams Single Lane

Military Vehicle	Coefficient	Finite Element Analysis	Proposed Formulas	Standard	LRFD	Piñero (2001)
M113	Mean	0.294	0.293	0.429	0.364	0.372
	C.O.V	0.216	0.212	0.236	0.176	0.092
M2	Mean	0.273	0.272	0.429	0.364	0.372
	C.O.V	0.209	0.203	0.236	0.176	0.092
M1	Mean	0.267	0.266	0.429	0.364	0.356
	C.O.V	0.206	0.200	0.236	0.176	0.100
LAVIII	Mean	0.289	0.288	0.429	0.364	0.374
	C.O.V	0.213	0.201	0.236	0.176	0.081
HEMTT	Mean	0.276	0.276	0.429	0.364	0.682
	C.O.V	0.212	0.208	0.236	0.176	0.100
PLS	Mean	0.281	0.282	0.429	0.364	0.682
	C.O.V	0.212	0.202	0.236	0.176	0.100
HETS	Mean	0.261	0.261	0.429	0.364	0.357
	C.O.V	0.225	0.215	0.236	0.176	0.097

Table 6.5.4 Mean and Coefficient of Variation for Bending Moment on Interior Beams Double Lanes

Military Vehicle	Coefficient	Finite Element Analysis	Proposed Formulas	Standard	LRFD	Piñero (2001)
M113	Mean	0.456	0.458	0.545	0.501	0.487
	C.O.V	0.230	0.231	0.236	0.188	0.169
M2	Mean	0.425	0.423	0.545	0.501	0.487
	C.O.V	0.213	0.214	0.236	0.188	0.169
M1	Mean	0.420	0.422	0.545	0.501	0.487
	C.O.V	0.212	0.214	0.236	0.188	0.169
LAVIII	Mean	0.448	0.449	0.545	0.501	0.487
	C.O.V	0.228	0.229	0.236	0.188	0.169
HEMTT	Mean	0.451	0.451	0.545	0.501	0.506
	C.O.V	0.227	0.224	0.236	0.188	0.141
PLS	Mean	0.454	0.455	0.545	0.501	0.506
	C.O.V	0.230	0.228	0.236	0.188	0.141
HETS	Mean	0.407	0.407	0.545	0.501	0.487
	C.O.V	0.195	0.194	0.236	0.188	0.169

The mean values of the live load distribution factors presented on Tables 6.5.3 and 6.5.4 for single lane and double lanes respectively are presented graphically on Figures 6.5.1 and 6.5.2. Both figures show that the mean values obtained by the finite element analyses and the proposed formulas are close to each other as expected. On the other hand the mean values obtained by the AASHTO formulas, *Standard* and *LRFD*, and those obtained using the formulas developed by Piñero et al. (2001) tend to overestimate the distribution factors compared to the bridge analyses. These formulas tend to be conservative for the load rating purposes since they were developed for design analyses.

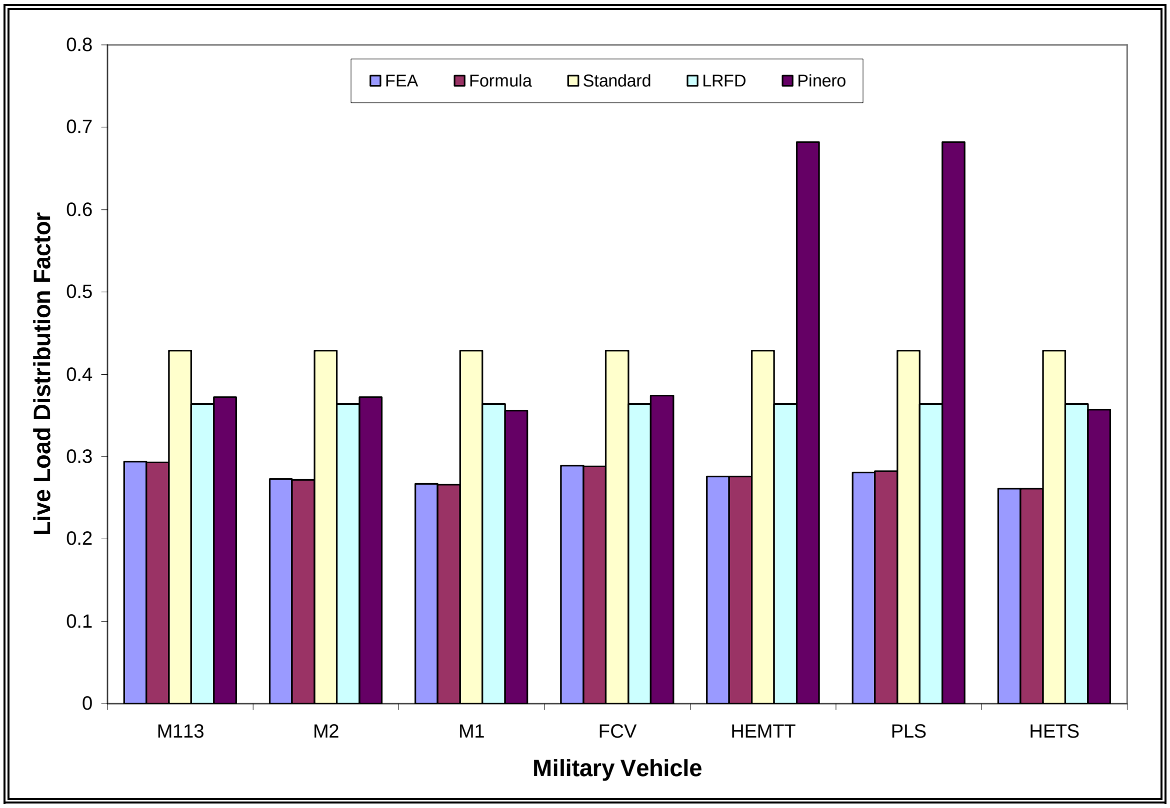


Figure 6.5.1Mean Values of Distribution Factors for Bending Moment on Interior Beams Single Lane

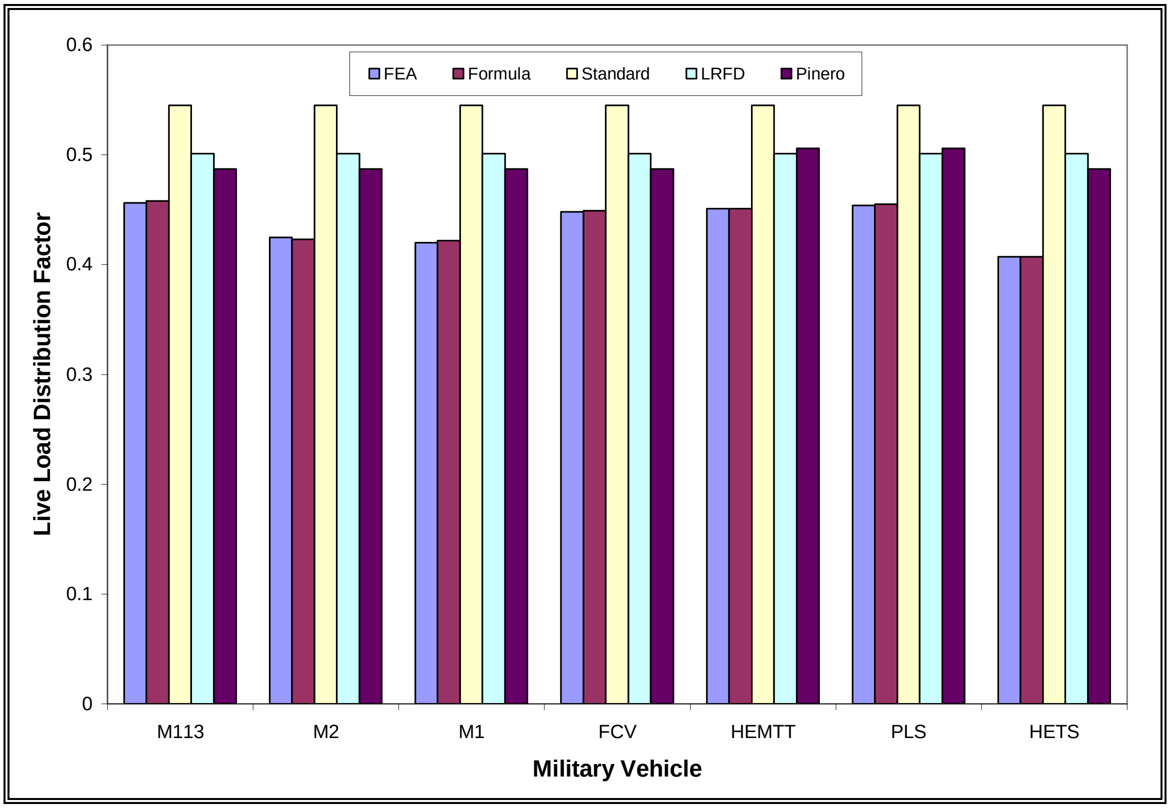


Figure 6.5.2Mean Values of Distribution Factors for Bending Moment on Interior Beams Double Lanes

CHAPTER 7 CONCLUSIONS AND RECCOMENDATIONS

This thesis focuses on the determination of live load distribution factors for military vehicles. Prior to focus on the main objective, a detailed explanation along with calculations of the current procedure to determine the military load classification for bridges and vehicles was provided to familiarize the lector with the US Army procedures. While the determination of the bridge's MLC is considered adequate, the military vehicle's MLC can be controversial since they are conservative because they are calculated as the maximum MLC on any bridge span from 0 to 300 feet. For the determination of the military vehicle's MLC a width correction factor is used. If the MLC calculation is based on the maximum bending moments or shear forces on simple spans, then it should be appropriate that the load effects that a military vehicle can cause to a particular bridge be addressed on the live load distribution factor for the military vehicle and not for the width correction factor.

A load rating analysis was performed for bridge #2 using the different AASHTO codes to determine the differences between the codes. The load rating was also performed to determine a safe load carrying capacity. Using a civilian vehicle a diagnostic load test was performed on bridge #2 to calibrate a finite element analysis model. From the calibrated model live load distribution factors were determined for military vehicles. In general, live load distribution factors for military vehicles were lower than the live load distribution factors for civilian vehicles proposed by AASHTO and Piñero et al. (2001).

Finally, using a generic sample of steel multi-beam bridges based on the NMSU study, live load distribution factors were determined for the seven military vehicles considered in the study. Live load distribution factors obtained from the finite element analyses for the military vehicles are presented on Appendix C as tables. From these results 56 different proposed formulas, 8 for each military vehicle, were developed. These proposed formulas cover different loading conditions, bending moment or shear force, loading case, single lane or double lanes, and beam location, interior beam or exterior beam, for each military vehicle. The accuracy of each of the proposed formulas with respect to the finite element analyses was also evaluated. Also a comparison of the distribution factors obtained by the finite element analysis, the proposed formulas, the AASHTO equations, and those developed by Piñero et al. (2001) was made. Even though the accuracy of the proposed formulas is adequate, when the MLC of the vehicle that is required to cross is close to the MLC determined for the bridge, it is recommended to use live load distribution factors determined from the finite element analyses since they represent the values from the direct analyses of the bridges. In conclusion, the live load distribution factors developed by AASHTO and Piñero et al. (2001) tend to be conservative for military vehicles compared with the finite element analyses since they were developed for design purposes. Therefore, the live load distribution factors developed in this study should be used for the load rating of steel beam bridges on US Army Garrisons for military vehicles. In this study the live load distribution factors were developed with the intention to be used for load rating of steel beam bridges and not for design purposes.

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APPENDIX A LOAD RATING AND MLC OF TARGET BRIDGE

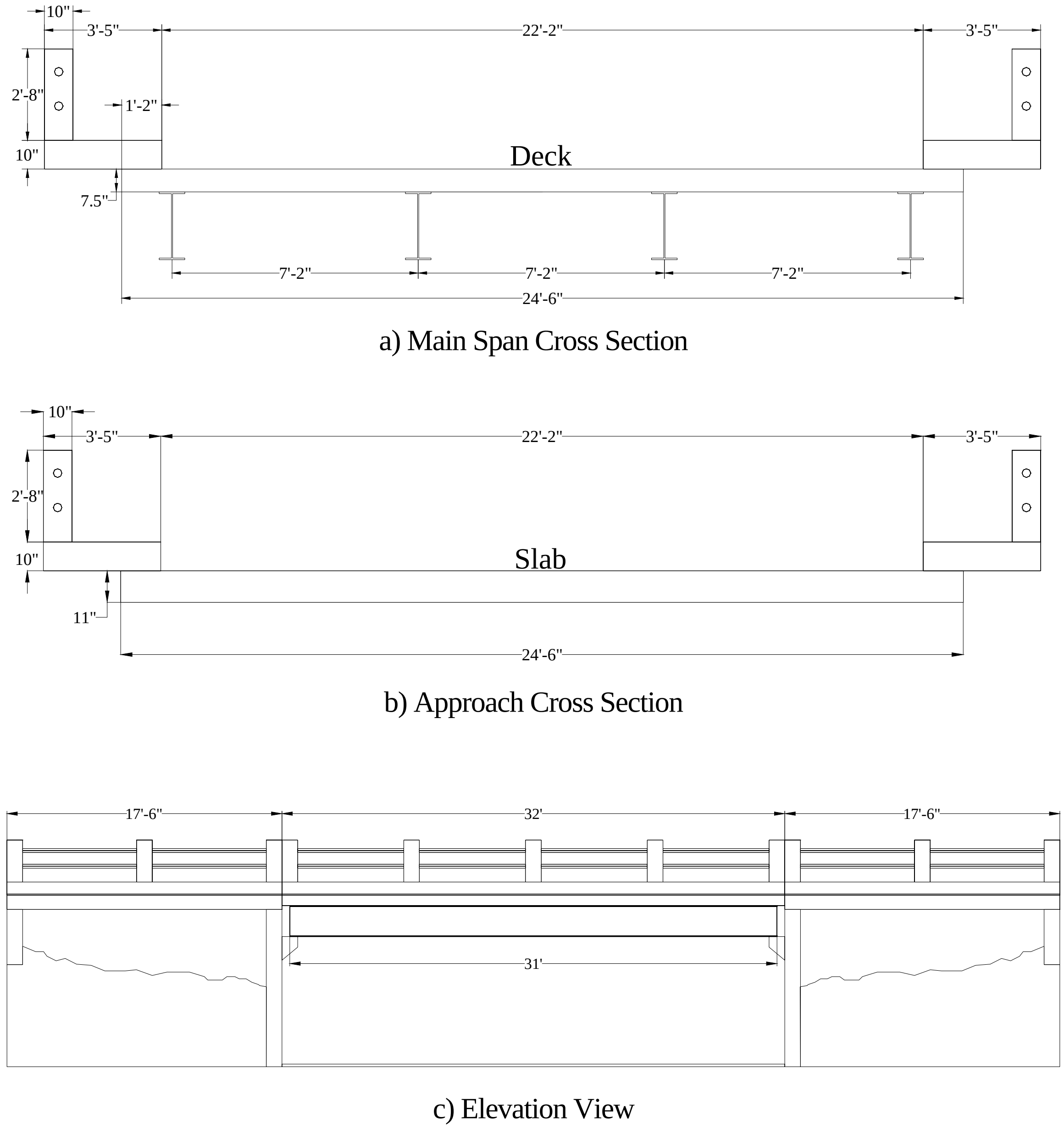


Figure A. 1 Field Drawings of Waterways Experiment Station Bridge

Deck Rating

No reinforcing details were available for the deck or the approach slabs at each end of the bridge. Paragraph 6.7.2.1 of *Manual* states that, "In general, stresses in the deck do not control the rating except in special cases." Paragraph 7.4.1 further states that "a concrete bridge need not be posted for restricted loading when it has been carrying normal traffic for an appreciable length of time and shows no distress. This general rule may apply to bridges for which details of the reinforcement are not known."

Beam Rating

- Interior beams generally control the rating and this will be assumed for this rating and will be confirm on the test.
- Sufficiency of connections and bearings are generally not considered in load ratings since by design, they are stronger than the supported members. The inspection realized in December 2004 shows no deficiency in bearings and connections because there is no measurable section loss.

Nominal Capacities of Beams

- Paragraph 3.3.2.4 of *Guide* refers to *Standard* for calculation of nominal resistance. It also states that the calculations should account for observable effects of deterioration, such as loss of steel cross-section area. The beams are in fair condition with no measurable section loss.
- The presence of shear connectors on top of the beams could not be verified. Therefore, the deck is assumed <u>non-composite</u> with the beams. The test will confirm if there is composite action between the deck and the beams.
- The beams are W24X68 without cover plates or web stiffeners. From *Steel Manual*:

$$A = 20.1in^2,\ d = 23.7in,\ t_w = 0.415\text{ in},\ t_f = 0.585\text{ in},\ b_f = 8.97\text{ in}$$

$$I_x = 1830\text{ in}^4$$

$$S_x = 154\text{ in}^3$$

$$Z_x = 177\text{ in}^3$$

$$r_x = 9.55\text{ in}$$

- The steel section described above comes from the current AISC manual where A36 steel has a F_y = 36ksi. However, the yield strength could not be verified. For that case, Paragraph 6.6.2.1 of *Manual* allows determination of yield strength based on the date built of the bridge. Since this bridge was built somewhere around 1960, Table 6.6.2.1-1 of *Manual* specifies F_y = 33ksi.

Applied Loading Effects on Beams

Dead Load (ω_D)

- Concrete Deck: $\omega_D = \text{thickness(t)} \times \text{concrete unit wt.}(\gamma) \times \text{Stringer Spacing(S)}$

$$\omega_D = (8.0in)\left(150\frac{lb}{ft^3}\right)(86.0in)\left(\frac{ft^2}{144in^2}\right)\left(\frac{1kip}{1000lb}\right) = 0.720\frac{kip}{ft}$$

- Beams: From *Steel Manual* for a W24x68 shape,

$$\omega_D = 0.068\frac{kip}{ft}$$

- Diaphragms: Tree diaphragms per beam. From *Steel Manual* for a W8x28 shape,

$$\omega_D = \frac{3 \times 0.028\frac{kip}{ft} \times \frac{86in}{12\,in/ft}}{31\,ft} = 0.019\frac{kip}{ft}$$

- Total ω_D $per\ stringer = 0.780\frac{kip}{ft}$
- Dead Load Moment (M_D)
    - For a simple span beam, uniformly distributed load

$$M_D = \frac{\omega l^2}{8} = \frac{\left(0.780\frac{kip}{ft}\right)(31.0\,ft)^2}{8} = 93.7\,ft \cdot kip$$

- Dead Load Shear (V_D)
    - For a simple span beam, uniformly distributed load

$$V_D = \frac{\omega l}{2} = \frac{\left(0.780\frac{kip}{ft}\right)(31.0\,ft)}{2} = 12.1kip$$

Superimposed Dead Load (ω_{SD})

- Sidewalks: $\omega_{SD} = \frac{2 \times \text{thickness(t)} \times width(b) \times \text{concrete unit wt.}(\gamma)}{\text{\# of stringers}}$

$$\omega_{SD} = \frac{2 \times \frac{10in}{12\,in/ft} \times 3.5\,ft \times 0.150\frac{kip}{ft^3}}{4} = 0.219\frac{kip}{ft}$$

- Railing: Assume 20 plf

$$\omega_{SD} = \frac{2 \times 0.020\frac{kip}{ft}}{4} = 0.010\frac{kip}{ft}$$

- Total ω_{SD} $per\ stringer = 0.229\frac{kip}{ft}$
- Superimposed Dead Load Moment (M_{SD})
  - For a simple span beam, uniformly distributed load

$$M_{SD} = \frac{\omega l^2}{8} = \frac{\left(0.229\frac{kip}{ft}\right)(31.0\,ft)^2}{8} = 27.5\,ft \cdot kip$$

- Superimposed Dead Load Shear (V_{SD})
  - For a simple span beam, uniformly distributed load

$$V_{SD} = \frac{\omega l}{2} = \frac{\left(0.229\frac{kip}{ft}\right)(31.0\,ft)}{2} = 3.55 kip$$

Live Load (ω_L)

- Live load moments and shears are those produced from the wheel lines of the rating vehicles on a 31.0ft simple span. The routine developed in Microsoft Excel was used to produce the following values. Also, similar results can be obtained from *Manual*, Appendix A3 for AASHTO Design and Legal Loads:

$M_{L_{HS20}} = 148.7\,ft \cdot kip$ per wheel line

$M_{L_3} = 119.1\,ft \cdot kip$ per wheel line

$M_{L_{3S2}} = 116.0\,ft \cdot kip$ per wheel line

$M_{L_{3-3}} = 97.0\,ft \cdot kip$ per wheel line

$M_{L_{MS!}} = 150.6\,ft \cdot kip$ per wheel line

$M_{L_{MS2}} = 178.5\,ft \cdot kip$ per wheel line

$M_{L_{MS3}} = 150.6\,ft \cdot kip$ per wheel line

$V_{L_{HS20}} = 25.1 kip$ per wheel line

$V_{L_3} = 19.0 kip$ per wheel line

$V_{L_{3S2}} = 17.1 kip$ per wheel line

$V_{L_{3-3}} = 15.9 kip$ per wheel line

$V_{L_{MS!}} = 21.9 kip$ per wheel line

$V_{L_{MS2}} = 28.0 kip$ per wheel line

$V_{L_{MS3}} = 22.0 kip$ per wheel line

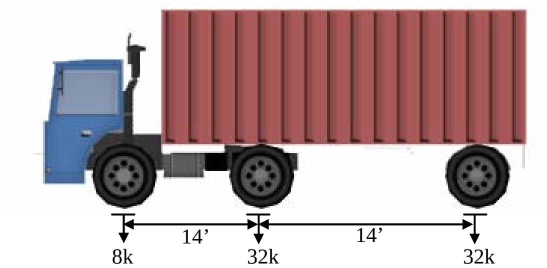
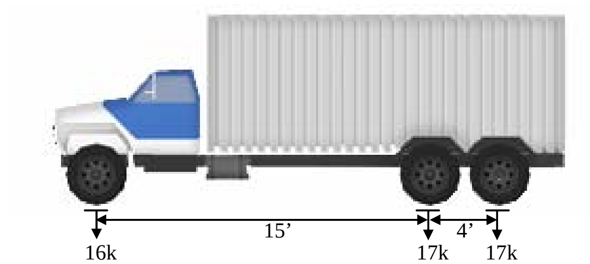
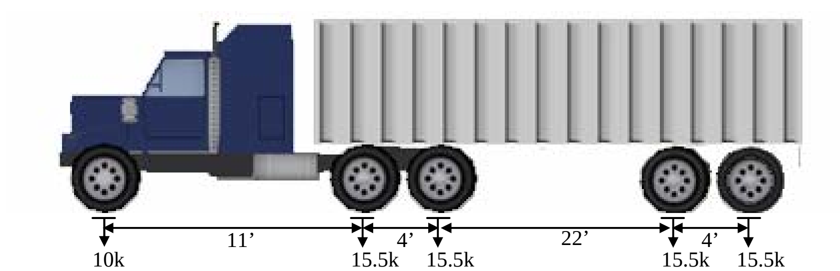


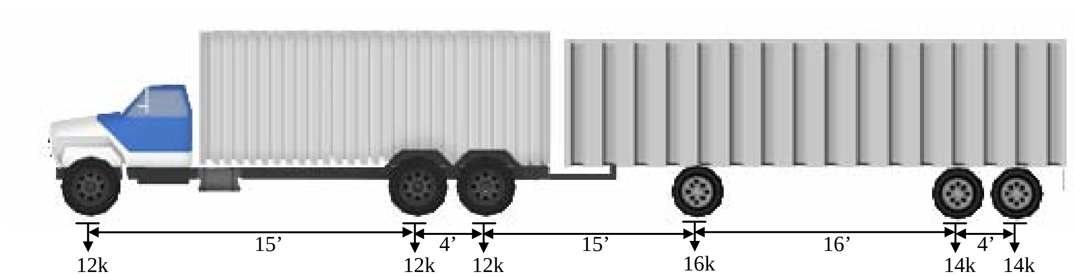
Figure A. 2 AASHTO Design Live Load (HS20)



a) Type 3

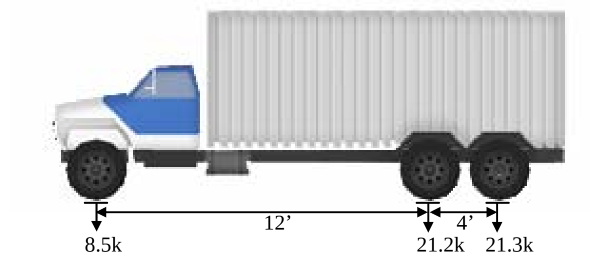


b) Type 3-S2

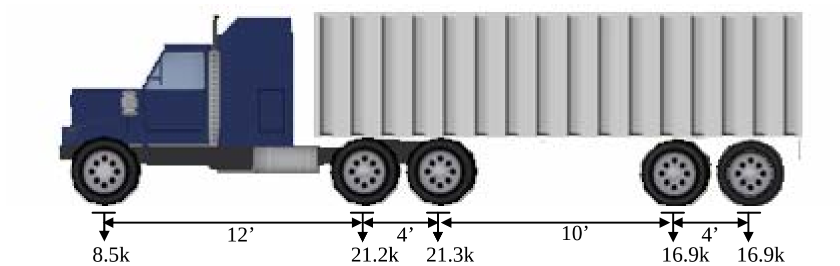


c) Type 3-3

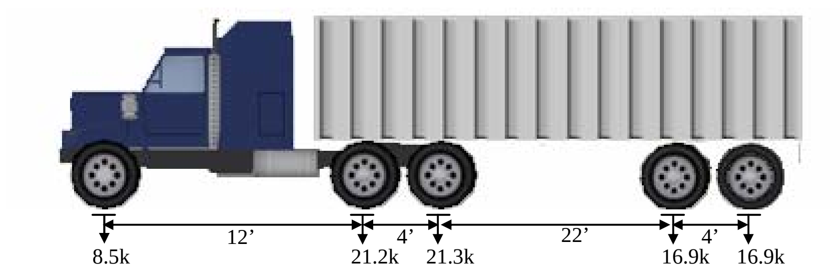
Figure A. 3 AASHTO Legal Loads



a) MS1

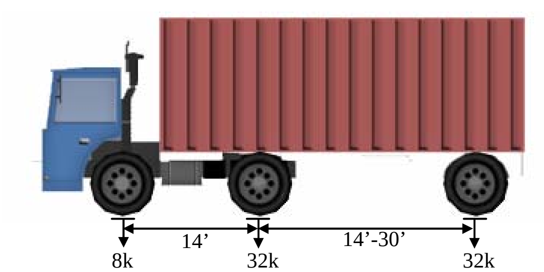


b) MS2



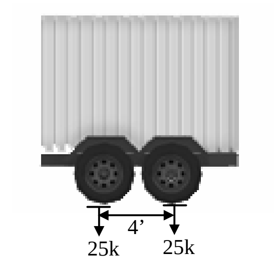
c) MS3

Figure A. 4 Mississippi State Legal Loads



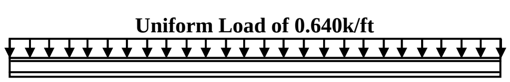
a) Design Truck

Greater of two



b) Design Tandem

Plus



c) Design Lane Load

Figure A. 5 LRFD Design Live Load

Allowable Stress Method

$$RF = \frac{C - A_1 D}{A_2 L(1+I)DF}$$

Impact and Distribution Factors

- Impact: Paragraph 6.7.4 of *Manual* refers to Par. 3.8.2.1 of *Standard*.

$$I = \frac{50}{L+125} \le 0.3$$
$$I = \frac{50}{31+125} = 0.32 \le 0.3$$
$$\therefore I = 0.30$$

- Distribution Factor of Wheel Loads: *Standard* Sec.3.23 and Table 3.23.1

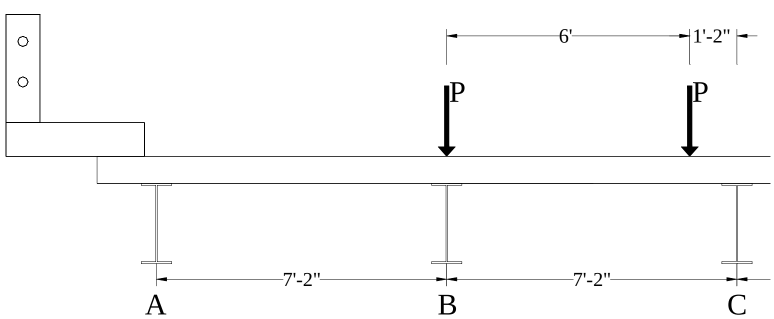
- Moment

$$One\ Traffic\ Lane: DF = \frac{S}{7.0} = \frac{7.17}{7} = 1.02$$
$$Two\ or\ more\ Traffic\ Lanes: DF = \frac{S}{5.5} = \frac{7.17}{5.5} = 1.30$$

- Shear

Assume that the flooring act as a simple span between beams as specified in *Standard* 3.23.1.2.

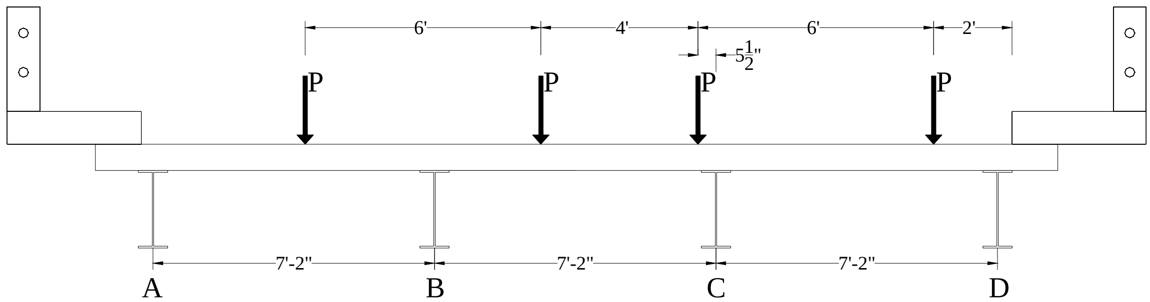
For one lane traffic:



Using statics, we sum moments about beam C:

$$\sum M_C = P \times 86in + P \times 14in - R_B \times 86in = 0$$
$$R_B = 1.16P$$

$$One\ Traffic\ Lane: DF = 1.16$$



For two lanes traffic:

Using statics, we sum moments about beam B to obtain the reaction for the left side:

$$\sum M_B = P \times 80.5in + P \times 32.5in - R_C \times 86in = 0$$
$$R_{C_{LEFT}} = 1.31P$$

Using statics, we sum moments about beam D to obtain the reaction for the right side:

$$\sum M_D = P \times 19.5in - R_C \times 86in = 0$$
$$R_{C_{RIGHT}} = 0.23P$$

$$R_C = R_{C_{LEFT}} + R_{C_{RIGHT}}$$
$$R_C = 1.31P + 0.23P$$
$$R_C = 1.54P$$

$$Two\ or\ more\ Traffic\ Lanes: DF = 1.54$$

- Thus

$$M_{L+I} = M_L \times (1 + I) \times DF$$
$$V_{L+I} = V_L \times (1 + I) \times DF$$

- For One Traffic Lane

$$M_{L+I} = M_L \times 1.3 \times 1.02$$
$$V_{L+I} = V_L \times 1.3 \times 1.16$$

$M_{(L+I)HS20} = 197.2\ ft \cdot kip$

$M_{(L+I)3} = 157.9\ ft \cdot kip$

$M_{(L+I)3S2} = 153.8\ ft \cdot kip$

$M_{(L+I)3-3} = 128.6\ ft \cdot kip$

$M_{(L+I)MS1} = 199.7\ ft \cdot kip$

$M_{(L+I)MS2} = 236.0\ ft \cdot kip$

$M_{(L+I)MS3} = 199.7\ ft \cdot kip$

$V_{(L+I)_{HS20}} = 37.9kip$

$V_{(L+I)_3} = 28.7kip$

$V_{(L+I)_{3S2}} = 25.8kip$

$V_{(L+I)_{3-3}} = 24.0kip$

$V_{(L+I)_{MS1}} = 33.0kip$

$V_{(L+I)_{MS2}} = 42.2kip$

$V_{(L+I)_{MS3}} = 33.2kip$

- For Two or More Traffic Lanes

$$M_{L+I} = M_L \times 1.3 \times 1.30$$
$$V_{L+I} = V_L \times 1.3 \times 1.54$$

$M_{(L+I)_{HS20}} = 251.3\,ft \cdot kip$

$M_{(L+I)_3} = 201.3\,ft \cdot kip$

$M_{(L+I)_{3S2}} = 196.0\,ft \cdot kip$

$M_{(L+I)_{3-3}} = 163.9\,ft \cdot kip$

$M_{(L+I)_{MS1}} = 254.5\,ft \cdot kip$

$M_{(L+I)_{MS2}} = 301.7\,ft \cdot kip$

$M_{(L+I)_{MS3}} = 254.5\,ft \cdot kip$

$V_{(L+I)_{HS20}} = 50.2\,ft \cdot kip$

$V_{(L+I)_3} = 38.0\,ft \cdot kip$

$V_{(L+I)_{3S2}} = 34.2\,ft \cdot kip$

$V_{(L+I)_{3-3}} = 31.9\,ft \cdot kip$

$V_{(L+I)_{MS1}} = 43.8\,ft \cdot kip$

$V_{(L+I)_{MS2}} = 56.0\,ft \cdot kip$

$V_{(L+I)_{MS3}} = 44.1\,ft \cdot kip$

Moment Rating Factor

Inventory Level

- From Paragraph 6.6.2.1 and Table 6.6.2.1-1 of *Manual*

- Since this bridge was built somewhere around 1960, Table 6.6.2.1-1 of *Manual* specifies F_y = 33ksi.

$$f_I = 0.55 f_y$$
$$f_I = 0.55 \times 33 = 18.15ksi$$

- The Resisting Capacity

$$C = f_I S_x$$
$$C = 18.15ksi \times 154in^3 = 2795.1in \cdot kip = 232.93\,ft \cdot kip$$

- Then

$$RF = \frac{C - A_1 D}{A_2 L(1 + I)DF}$$

- From Par. 6.5.2 of *Manual*, for the allowable stress method $A_1 = A_2 = 1.0$

$$RF_I = \frac{232.93 - 1.0 \times (93.7 + 27.5)}{1.0 \times L(1+I)DF} = \frac{111.73}{M_{(L+I)}}$$

- For One Traffic Lane

$$RF_{I_{HS20}} = \frac{111.73}{M_{(L+I)_{HS20}}} = \frac{111.73}{197.2} = 0.57$$

$$RF_{I_{MS1}} = \frac{111.73}{M_{(L+I)_{MS1}}} = \frac{111.73}{199.7} = 0.56$$

$$RF_{I_3} = \frac{111.73}{M_{(L+I)_3}} = \frac{111.73}{157.9} = 0.71$$

$$RF_{I_{MS2}} = \frac{111.73}{M_{(L+I)_{MS2}}} = \frac{111.73}{236.0} = 0.47$$

$$RF_{I_{3S2}} = \frac{111.73}{M_{(L+I)_{3S2}}} = \frac{111.73}{153.8} = 0.73$$

$$RF_{I_{MS3}} = \frac{111.73}{M_{(L+I)_{MS3}}} = \frac{111.73}{199.7} = 0.56$$

$$RF_{I_{3-3}} = \frac{111.73}{M_{(L+I)_{3-3}}} = \frac{111.73}{128.6} = 0.87$$

- For Two or More Traffic Lanes

$$RF_{I_{HS20}} = \frac{111.73}{M_{(L+I)_{HS20}}} = \frac{111.73}{251.3} = 0.44$$

$$RF_{I_{MS1}} = \frac{111.73}{M_{(L+I)_{MS1}}} = \frac{111.73}{254.5} = 0.44$$

$$RF_{I_3} = \frac{111.73}{M_{(L+I)_3}} = \frac{111.73}{201.3} = 0.56$$

$$RF_{I_{MS2}} = \frac{111.73}{M_{(L+I)_{MS2}}} = \frac{111.73}{301.7} = 0.37$$

$$RF_{I_{3S2}} = \frac{111.73}{M_{(L+I)_{3S2}}} = \frac{111.73}{196.0} = 0.57$$

$$RF_{I_{MS3}} = \frac{111.73}{M_{(L+I)_{MS3}}} = \frac{111.73}{254.5} = 0.44$$

$$RF_{I_{3-3}} = \frac{111.73}{M_{(L+I)_{3-3}}} = \frac{111.73}{163.9} = 0.68$$

Operating Level

- From Paragraph 6.6.2.1 and Table 6.6.2.1-1 of *Manual*

- Since this bridge was built somewhere around 1960, Table 6.6.2.1-1 of *Manual* specifies F_y = 33ksi.

$$f_O = 0.75 f_y$$

$$f_O = 0.75 \times 33 = 24.75 ksi$$

- The Resisting Capacity

$$C = f_I S_x$$

$$C = 24.75ksi \times 154in^3 = 3811.5in \cdot kip = 317.63\,ft \cdot kip$$

- Then

$$RF = \frac{C - A_1 D}{A_2 L(1+I)DF}$$

- From Par. 6.5.2 of *Manual*, for the allowable stress method $A_1 = A_2 = 1.0$

$$RF_I = \frac{317.63 - 1.0 \times (93.7 + 27.5)}{1.0 \times L(1+I)DF} = \frac{196.43}{M_{(L+I)}}$$

- For One Traffic Lane

$$RF_{O_{HS20}} = \frac{196.43}{M_{(L+I)_{HS20}}} = \frac{196.43}{197.2} = 1.00 \qquad RF_{O_{MS1}} = \frac{196.43}{M_{(L+I)_{MS1}}} = \frac{196.43}{199.7} = 0.98$$

$$RF_{O_3} = \frac{196.43}{M_{(L+I)_3}} = \frac{196.43}{157.9} = 1.24 \qquad RF_{O_{MS2}} = \frac{196.43}{M_{(L+I)_{MS2}}} = \frac{196.43}{236.0} = 0.83$$

$$RF_{O_{3S2}} = \frac{196.43}{M_{(L+I)_{3S2}}} = \frac{196.43}{153.8} = 1.28 \qquad RF_{O_{MS3}} = \frac{196.43}{M_{(L+I)_{MS3}}} = \frac{196.43}{200.1} = 0.98$$

$$RF_{O_{3-3}} = \frac{196.43}{M_{(L+I)_{3-3}}} = \frac{196.43}{128.6} = 1.53$$

- For Two or More Traffic Lanes

$$RF_{O_{HS20}} = \frac{196.43}{M_{(L+I)_{HS20}}} = \frac{196.43}{251.3} = 0.78 \qquad RF_{O_{MS1}} = \frac{196.43}{M_{(L+I)_{MS1}}} = \frac{196.43}{254.5} = 0.77$$

$$RF_{O_3} = \frac{196.43}{M_{(L+I)_3}} = \frac{196.43}{201.3} = 0.98 \qquad RF_{O_{MS2}} = \frac{196.43}{M_{(L+I)_{MS2}}} = \frac{196.43}{301.7} = 0.65$$

$$RF_{O_{3S2}} = \frac{196.43}{M_{(L+I)_{3S2}}} = \frac{196.43}{196.0} = 1.00 \qquad RF_{O_{MS3}} = \frac{196.43}{M_{(L+I)_{MS3}}} = \frac{196.43}{254.5} = 0.77$$

$$RF_{O_{3-3}} = \frac{196.43}{M_{(L+I)_{3-3}}} = \frac{196.43}{163.9} = 1.20$$

Shear Rating Factor

Inventory Level

- From Paragraph 6.6.2.1 and Table 6.6.2.1-1 of *Manual*

- Since this bridge was built somewhere around 1960, Table 6.6.2.1-1 of *Manual* specifies

$$f_{S_I} = 11.00ksi$$

- Then

$$RF = \frac{C - A_1 D}{A_2 L(1+I)DF}$$

- Working with Shear Stress

$$f_{DL+SDL} = \frac{V_D + V_{SD}}{A_{Web}} = \frac{12.1 + 3.55}{0.415 \times 20.75} = 1.81ksi$$

- For One Traffic Lane

$$f_{(L+I)HS20} = \frac{37.9}{0.415 \times 20.75} = 4.40ksi$$

$$f_{(L+I)3} = \frac{28.7}{0.415 \times 20.75} = 3.33ksi$$

$$f_{(L+I)3S2} = \frac{25.8}{0.415 \times 20.75} = 3.00ksi$$

$$f_{(L+I)3-3} = \frac{24.0}{0.415 \times 20.75} = 2.79ksi$$

$$f_{(L+I)MS1} = \frac{33.0}{0.415 \times 20.75} = 3.83ksi$$

$$f_{(L+I)MS2} = \frac{42.2}{0.415 \times 20.75} = 4.90ksi$$

$$f_{(L+I)MS3} = \frac{33.2}{0.415 \times 20.75} = 3.86ksi$$

- For Two or More Traffic Lanes

$$f_{(L+I)HS20} = \frac{50.2}{0.415 \times 20.75} = 5.83ksi$$

$$f_{(L+I)3} = \frac{38.0}{0.415 \times 20.75} = 4.41ksi$$

$$f_{(L+I)3S2} = \frac{34.2}{0.415 \times 20.75} = 3.97ksi$$

$$f_{(L+I)3-3} = \frac{31.9}{0.415 \times 20.75} = 3.70ksi$$

$$f_{(L+I)MS1} = \frac{43.8}{0.415 \times 20.75} = 5.09ksi$$

$$f_{(L+I)MS2} = \frac{56.0}{0.415 \times 20.75} = 6.50ksi$$

$$f_{(L+I)MS3} = \frac{44.1}{0.415 \times 20.75} = 5.12ksi$$

- From Par. 6.5.2 of *Manual*, for the allowable stress method $A_1 = A_2 = 1.0$

$$RF_I = \frac{11 - 1.0 \times (1.81)}{1.0 \times L(1+I)DF} = \frac{9.19}{f_{s(L+I)}}$$

- For One Traffic Lane

$$RF_{I_{HS20}} = \frac{9.19}{f_{s(L+I)_{HS20}}} = \frac{9.19}{4.40} = 2.09 \qquad RF_{I_{MS1}} = \frac{9.19}{f_{s(L+I)_{MS1}}} = \frac{9.19}{3.83} = 2.40$$

$$RF_{I_3} = \frac{9.19}{f_{s(L+I)_3}} = \frac{9.19}{3.33} = 2.76 \qquad RF_{I_{MS2}} = \frac{9.19}{f_{s(L+I)_{MS2}}} = \frac{9.19}{4.90} = 1.88$$

$$RF_{I_{3S2}} = \frac{9.19}{f_{s(L+I)_{3S2}}} = \frac{9.19}{3.00} = 3.06 \qquad RF_{I_{MS3}} = \frac{9.19}{f_{s(L+I)_{MS3}}} = \frac{9.19}{3.86} = 2.38$$

$$RF_{I_{3-3}} = \frac{9.19}{f_{s(L+I)_{3-3}}} = \frac{9.19}{2.79} = 3.29$$

- For Two or More Traffic Lanes

$$RF_{I_{HS20}} = \frac{9.19}{f_{s(L+I)_{HS20}}} = \frac{9.19}{5.83} = 1.58 \qquad RF_{I_{MS1}} = \frac{9.19}{f_{s(L+I)_{MS1}}} = \frac{9.19}{5.09} = 1.81$$

$$RF_{I_3} = \frac{9.19}{f_{s(L+I)_3}} = \frac{9.19}{4.41} = 2.08 \qquad RF_{I_{MS2}} = \frac{9.19}{f_{s(L+I)_{MS2}}} = \frac{9.19}{6.50} = 1.41$$

$$RF_{I_{3S2}} = \frac{9.19}{f_{s(L+I)_{3S2}}} = \frac{9.19}{3.97} = 2.31 \qquad RF_{I_{MS3}} = \frac{9.19}{f_{s(L+I)_{MS3}}} = \frac{9.19}{5.12} = 1.79$$

$$RF_{I_{3-3}} = \frac{9.19}{f_{s(L+I)_{3-3}}} = \frac{9.19}{3.70} = 2.48$$

Operating Level

- From Paragraph 6.6.2.1 and Table 6.6.2.1-1 of *Manual*

- Since this bridge was built somewhere around 1960, Table 6.6.2.1-1 of *Manual* specifies

$$f_{S_I} = 15.00 ksi$$

- Then

$$RF = \frac{C - A_1 D}{A_2 L(1+I)DF}$$

- Working with Shear Stress

$$f_{DL+SDL} = \frac{V_D + V_{SD}}{A_{Web}} = \frac{12.1 + 3.55}{0.415 \times 20.75} = 1.81ksi$$

- From Par. 6.5.2 of *Manual*, for the allowable stress method $A_1 = A_2 = 1.0$

$$RF_I = \frac{15 - 1.0 \times (1.81)}{1.0 \times L(1+I)DF} = \frac{13.19}{f_{s(L+I)}}$$

- For One Traffic Lane

$$RF_{O_{HS20}} = \frac{13.19}{f_{s(L+I)_{HS20}}} = \frac{13.19}{4.40} = 3.00$$

$$RF_{O_{MS1}} = \frac{13.19}{f_{s(L+I)_{MS1}}} = \frac{13.19}{3.83} = 3.44$$

$$RF_{O_3} = \frac{13.19}{f_{s(L+I)_3}} = \frac{13.19}{3.33} = 3.96$$

$$RF_{O_{MS2}} = \frac{13.19}{f_{s(L+I)_{MS2}}} = \frac{13.19}{4.90} = 2.69$$

$$RF_{O_{3S2}} = \frac{13.19}{f_{s(L+I)_{3S2}}} = \frac{13.19}{3.00} = 4.40$$

$$RF_{O_{MS3}} = \frac{13.19}{f_{s(L+I)_{MS3}}} = \frac{13.19}{3.86} = 3.42$$

$$RF_{O_{3-3}} = \frac{13.19}{f_{s(L+I)_{3-3}}} = \frac{13.19}{2.79} = 4.73$$

- For Two or More Traffic Lanes

$$RF_{O_{HS20}} = \frac{13.19}{f_{s(L+I)_{HS20}}} = \frac{13.19}{5.83} = 2.26$$

$$RF_{O_{MS1}} = \frac{13.19}{f_{s(L+I)_{MS1}}} = \frac{13.19}{5.09} = 2.59$$

$$RF_{O_3} = \frac{13.19}{f_{s(L+I)_3}} = \frac{13.19}{4.41} = 2.99$$

$$RF_{O_{MS2}} = \frac{13.19}{f_{s(L+I)_{MS2}}} = \frac{13.19}{6.50} = 2.03$$

$$RF_{O_{3S2}} = \frac{13.19}{f_{s(L+I)_{3S2}}} = \frac{13.19}{3.97} = 3.32$$

$$RF_{O_{MS3}} = \frac{13.19}{f_{s(L+I)_{MS3}}} = \frac{13.19}{5.12} = 2.58$$

$$RF_{O_{3-3}} = \frac{13.19}{f_{s(L+I)_{3-3}}} = \frac{13.19}{3.70} = 3.56$$

Military Load Classification (MLC) for Beams

- Note that from sections 1.2.3.2 and 1.2.3.3 moment controlled the civilian vehicles beam rating. Thus, only moment will be considered for the MLC determination. In addition only the Operating Rating will be considered for MLC since military loading frequencies are generally low. These decisions must be made on a case by case basis.

- Since a rating factor greater than 1.0 is satisfactory, the MLC can be obtained by setting the RF equation to 1.0 and solving for M_L.

$$RF = \frac{C - A_1 D}{A_2 L(1+I)DF} = 1.0$$

$$RF_I = \frac{317.63 - 1.0 \times (93.7 + 27.5)}{1.0 \times M_L (1+0.30)DF} = \frac{151.1}{M_L \times DF} = 1.0$$

- For One Traffic Lane DF = 1.02

$$M_L = \frac{151.1}{1.0 \times 1.02} = 148.1\, ft \cdot kip$$

  - Since the MLC moment tables and curves are for the total vehicle or axle loads, the M_L value must be multiplied by 2 since it represents the moment from a wheel line.

$$M_{L_{Total}} = 2 \times 148.1 = 296.2\, ft \cdot kip$$

  - Using $M_{L_{Total}}$ to enter the wheeled and tracked vehicle moment on Table B-2 of FM3-34.343 for 31 ft, the MLC for one way traffic is MLC 24 for a wheeled vehicle and MLC 23 for a tracked vehicle. The appropriate symbols are 24W and 23T respectively.

  - A final check on Table 3-4 of FM3-34.343 shows that the bridge has the required width for these MLC.

- For Two or More Traffic Lanes DF = 1.30

$$M_L = \frac{151.1}{1.0 \times 1.30} = 116.2\, ft \cdot kip$$

  - Since the MLC moment tables and curves are for the total vehicle or axle loads, the M_L value must be multiplied by 2 since it represents the moment from a wheel line.

$$M_{L_{Total}} = 2 \times 116.2 = 232.4\, ft \cdot kip$$

  - Using $M_{L_{Total}}$ to enter the wheeled and tracked vehicle moment on Table B-2 of FM3-34.343 for 31 ft, the MLC for two way traffic is MLC 19 for a wheeled vehicle and MLC 18 for a tracked vehicle. The appropriate symbols are 19W and 18T respectively.

- A final check on Table 3-4 of FM3-34.343 shows that the bridge has the required width for these MLC.

Load Factor Method

$$RF = \frac{C - A_1 D}{A_2 L(1 + I)DF}$$

Impact and Distribution Factors

- Impact: Paragraph 6.7.4 of *Manual* refers to Par. 3.8.2.1 of *Standard*.

$$I = \frac{50}{L + 125} \leq 0.3$$
$$I = \frac{50}{31 + 125} = 0.32 \leq 0.3$$
$$\therefore I = 0.30$$

- Distribution Factor of Wheel Loads: *Standard* Sec.3.23 and Table 3.23.1

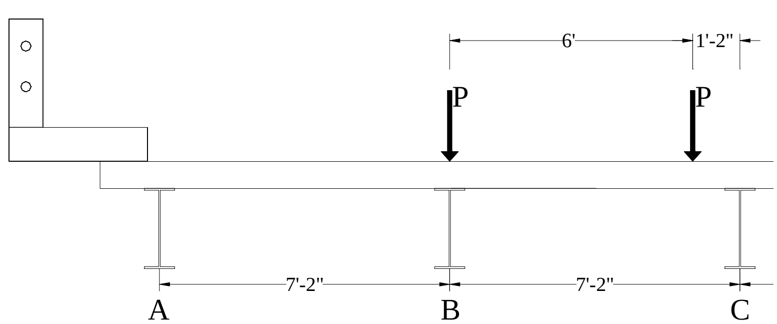
- Moment

$$\textit{One Traffic Lane}: DF = \frac{S}{7.0} = \frac{7.17}{7} = 1.02$$
$$\textit{Two or more Traffic Lanes}: DF = \frac{S}{5.5} = \frac{7.17}{5.5} = 1.30$$

- Shear

Assume that the flooring act as a simple span between beams as specified in *Standard* 3.23.1.2.

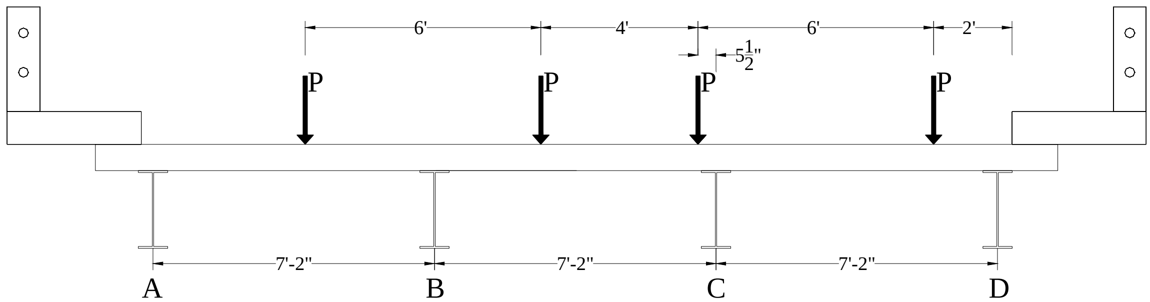
For one lane traffic:



Using statics, we sum moments about beam C:

$$\sum M_C = P \times 86in + P \times 14in - R_B \times 86in = 0$$
$$R_A = 1.16P$$

$$One\ Traffic\ Lane: DF = 1.16$$



For two lanes traffic:

Using statics, we sum moments about beam B to obtain the reaction for the left side:

$$\sum M_B = P \times 80.5in + P \times 32.5in - R_C \times 86in = 0$$
$$R_{C_{LEFT}} = 1.31P$$

Using statics, we sum moments about beam D to obtain the reaction for the right side:

$$\sum M_D = P \times 19.5in - R_C \times 86in = 0$$
$$R_{C_{RIGHT}} = 0.23P$$

$$R_C = R_{C_{LEFT}} + R_{C_{RIGHT}}$$
$$R_C = 1.31P + 0.23P$$
$$R_C = 1.54P$$

$$Two\ or\ more\ Traffic\ Lanes: DF = 1.54$$

- Thus

$$M_{L+I} = M_L \times (1+I) \times DF$$
$$V_{L+I} = V_L \times (1+I) \times DF$$

- For One Traffic Lane

$$M_{L+I} = M_L \times 1.3 \times 1.02$$
$$V_{L+I} = V_L \times 1.3 \times 1.16$$

$M_{(L+I)_{HS20}} = 197.2\,ft \cdot kip$

$M_{(L+I)_3} = 157.9\,ft \cdot kip$

$M_{(L+I)_{3S2}} = 153.8\,ft \cdot kip$

$M_{(L+I)_{3-3}} = 128.6\,ft \cdot kip$

$M_{(L+I)_{MS1}} = 199.7\,ft \cdot kip$

$M_{(L+I)_{MS2}} = 236.0\,ft \cdot kip$

$M_{(L+I)_{MS3}} = 200.1\,ft \cdot kip$

$V_{(L+I)_{HS20}} = 37.9 kip$

$V_{(L+I)_3} = 28.7 kip$

$V_{(L+I)_{3S2}} = 25.8 kip$

$V_{(L+I)_{3-3}} = 24.0 kip$

$V_{(L+I)_{MS1}} = 33.0 kip$

$V_{(L+I)_{MS2}} = 42.2 kip$

$V_{(L+I)_{MS3}} = 33.2 kip$

- For Two or More Traffic Lanes

$$M_{L+I} = M_L \times 1.3 \times 1.30$$
$$V_{L+I} = V_L \times 1.3 \times 1.54$$

$M_{(L+I)_{HS20}} = 251.3\,ft \cdot kip$

$M_{(L+I)_3} = 201.3\,ft \cdot kip$

$M_{(L+I)_{3S2}} = 196.0\,ft \cdot kip$

$M_{(L+I)_{3-3}} = 163.9\,ft \cdot kip$

$M_{(L+I)_{MS1}} = 254.5\,ft \cdot kip$

$M_{(L+I)_{MS2}} = 301.7\,ft \cdot kip$

$M_{(L+I)_{MS3}} = 254.5\,ft \cdot kip$

$V_{(L+I)_{HS20}} = 50.2\,ft \cdot kip$

$V_{(L+I)_3} = 38.0\,ft \cdot kip$

$V_{(L+I)_{3S2}} = 34.2\,ft \cdot kip$

$V_{(L+I)_{3-3}} = 31.9\,ft \cdot kip$

$V_{(L+I)_{MS1}} = 43.8\,ft \cdot kip$

$V_{(L+I)_{MS2}} = 56.0\,ft \cdot kip$

$V_{(L+I)_{MS3}} = 44.1\,ft \cdot kip$

Moment Rating Factor

Nominal Moment Capacity, M_n

- Check compact section criteria of Par. 10.48.1, *Standard*:

  (a) Projecting compression flange element: Check that $\frac{b}{t} \le \frac{4110}{\sqrt{F_y}}$

  where b is the flange width and t is the flange thickness

$$\frac{b}{t} = \frac{8.97}{0.585} = 15.33 \quad < \quad \frac{4110}{\sqrt{F_y}} = \frac{4110}{\sqrt{33{,}000}} = 22.62 \quad \Rightarrow \text{Good}$$

(b) Web Thickness: Check that $\frac{D}{t_w} \leq \frac{19,230}{\sqrt{F_y}}$

where $D = d - 2t_f = 23.7 - 2(0.585) = 22.53in$

$$\frac{D}{t_w} = \frac{22.53}{0.415} = 54.29 \quad < \quad \frac{19,230}{\sqrt{F_y}} = \frac{19,230}{\sqrt{33,000}} = 105.9 \quad \Rightarrow \text{Good}$$

(c) Lateral Bracing: Top flanges embedded in concrete, therefore fully braced.
(d) Maximum Axial Compression

$$P \leq 0.15 F_y A$$

As the analysis is performed by gravity loads and based on the beam supports, the axial compression on the beam is cero.

- Because all of the above criteria are true, the beams can be treated as braced and compact. Therefore:

$$M_n = M_u = F_y \cdot Z_x = (33ksi)(177in^3)\left(\frac{ft}{12in}\right) = 487\,ft \cdot kip \leq 1.5M_y = 635\,ft \cdot kip$$

$$M_n = 487\,ft \cdot kip$$

Inventory Level

- From Paragraph 6.5.1 of *Manual*

$$RF = \frac{C - A_1 D}{A_2 L(1+I)DF}$$

- From Par. 6.5.3 of *Manual*, for the load factor method $A_1 = 1.3; A_2 = 2.17$ for the inventory level

$$RF_I = \frac{487 - 1.3 \times (93.7 + 27.5)}{2.17 \times L(1+I)DF} = \frac{151.82}{M_{(L+I)}}$$

- For One Traffic Lane

$$RF_{I_{HS20}} = \frac{151.82}{M_{(L+I)_{HS20}}} = \frac{151.82}{197.2} = 0.77 \qquad RF_{I_{MS1}} = \frac{151.82}{M_{(L+I)_{MS1}}} = \frac{151.82}{199.7} = 0.76$$

$$RF_{I_3} = \frac{151.82}{M_{(L+I)_3}} = \frac{151.82}{157.9} = 0.96 \qquad RF_{I_{MS2}} = \frac{151.82}{M_{(L+I)_{MS2}}} = \frac{151.82}{235.1} = 0.65$$

$$RF_{I_{3S2}} = \frac{151.82}{M_{(L+I)_{3S2}}} = \frac{151.82}{153.8} = 0.99$$

$$RF_{I_{MS3}} = \frac{151.82}{M_{(L+I)_{MS3}}} = \frac{151.82}{200.1} = 0.76$$

$$RF_{I_{3-3}} = \frac{151.82}{M_{(L+I)_{3-3}}} = \frac{151.82}{128.6} = 1.18$$

- For Two or More Traffic Lanes

$$RF_{I_{HS20}} = \frac{151.82}{M_{(L+I)_{HS20}}} = \frac{151.82}{251.3} = 0.60$$

$$RF_{I_{MS1}} = \frac{151.82}{M_{(L+I)_{MS1}}} = \frac{151.82}{254.5} = 0.60$$

$$RF_{I_3} = \frac{151.82}{M_{(L+I)_3}} = \frac{151.82}{201.3} = 0.75$$

$$RF_{I_{MS2}} = \frac{151.82}{M_{(L+I)_{MS2}}} = \frac{151.82}{301.7} = 0.50$$

$$RF_{I_{3S2}} = \frac{151.82}{M_{(L+I)_{3S2}}} = \frac{151.82}{196.0} = 0.77$$

$$RF_{I_{MS3}} = \frac{151.82}{M_{(L+I)_{MS3}}} = \frac{151.82}{254.5} = 0.60$$

$$RF_{I_{3-3}} = \frac{151.82}{M_{(L+I)_{3-3}}} = \frac{151.82}{163.9} = 0.93$$

Operating Level

- From Paragraph 6.5.1 of *Manual*

$$RF = \frac{C - A_1 D}{A_2 L(1+I)DF}$$

- From Par. 6.5.3 of *Manual*, for the load factor method $A_1 = 1.3; A_2 = 1.3$ for the operating level

$$RF_O = \frac{487 - 1.3 \times (93.7 + 27.5)}{1.3 \times L(1+I)DF} = \frac{253.42}{M_{(L+I)}}$$

- For One Traffic Lane

$$RF_{O_{HS20}} = \frac{253.42}{M_{(L+I)_{HS20}}} = \frac{253.42}{197.2} = 1.29$$

$$RF_{O_{MS1}} = \frac{253.42}{M_{(L+I)_{MS1}}} = \frac{253.42}{199.7} = 1.27$$

$$RF_{O_3} = \frac{253.42}{M_{(L+I)_3}} = \frac{253.42}{157.9} = 1.60$$

$$RF_{O_{MS2}} = \frac{253.42}{M_{(L+I)_{MS2}}} = \frac{253.42}{236.0} = 1.07$$

$$RF_{O_{3S2}} = \frac{253.42}{M_{(L+I)_{3S2}}} = \frac{253.42}{128.6} = 1.97$$

$$RF_{O_{MS3}} = \frac{253.42}{M_{(L+I)_{MS3}}} = \frac{253.42}{199.7} = 1.27$$

$$RF_{O_{3-3}} = \frac{253.42}{M_{(L+I)_{3-3}}} = \frac{253.42}{126.9} = 2.00$$

- For Two or More Traffic Lanes:

$$RF_{O_{HS20}} = \frac{253.42}{M_{(L+I)_{HS20}}} = \frac{253.42}{251.3} = 1.01$$

$$RF_{O_3} = \frac{253.42}{M_{(L+I)_3}} = \frac{253.42}{201.3} = 1.26$$

$$RF_{O_{3S2}} = \frac{253.42}{M_{(L+I)_{3S2}}} = \frac{253.42}{196.0} = 1.29$$

$$RF_{O_{3-3}} = \frac{253.42}{M_{(L+I)_{3-3}}} = \frac{253.42}{163.9} = 1.55$$

$$RF_{O_{MS1}} = \frac{253.42}{M_{(L+I)_{MS1}}} = \frac{253.42}{254.5} = 1.00$$

$$RF_{O_{MS2}} = \frac{253.42}{M_{(L+I)_{MS2}}} = \frac{253.42}{301.7} = 0.84$$

$$RF_{O_{MS3}} = \frac{253.42}{M_{(L+I)_{MS3}}} = \frac{253.42}{254.5} = 1.00$$

Shear Rating Factor

Nominal Shear Capacity, V_n

- From Paragraph 10.48.8.1 of *Standard*, for sections without web stiffeners

$$V_u = CV_p$$

$$V_p = 0.58 F_y D t_w$$

$$V_p = 0.58(33{,}000\,psi)(21.83in)(0.415in)\left(\frac{kip}{1000lb}\right) = 173.40kip$$

- Check that $\frac{D}{t_w} \le \frac{6000\sqrt{k}}{\sqrt{F_y}}$, where k= 5 for unstiffened beams

$$\frac{D}{t_w} = \frac{21.83}{0.415} = 52.60 \quad < \quad \frac{6000\sqrt{k}}{\sqrt{F_y}} = \frac{6000\sqrt{5}}{\sqrt{33{,}000}} = 73.9 \quad \Rightarrow \therefore \text{C} = 1.0$$

$$V_n = V_u = CV_p = (1.0)(173.40) = 173.4kip$$

Inventory Level

- From Paragraph 6.5.1 of *Manual*

$$RF = \frac{C - A_1 D}{A_2 L(1+I)DF}$$

- From Paragraph 6.5.3 of *Manual*, for the load factor method $A_1 = 1.3; A_2 = 2.17$ for the inventory level

$$RF_I = \frac{173.4 - 1.3 \times (12.1 + 3.55)}{2.17 \times L(1+I)DF} = \frac{70.53}{V_{(L+I)}}$$

- For One Traffic Lane

$$RF_{I_{HS20}} = \frac{70.53}{V_{(L+I)_{HS20}}} = \frac{70.53}{37.9} = 1.86 \qquad RF_{I_{MS1}} = \frac{70.53}{V_{(L+I)_{MS1}}} = \frac{70.53}{33.0} = 2.14$$

$$RF_{I_3} = \frac{70.53}{V_{(L+I)_3}} = \frac{70.53}{28.7} = 2.46 \qquad RF_{I_{MS2}} = \frac{70.53}{V_{(L+I)_{MS2}}} = \frac{70.53}{42.2} = 1.67$$

$$RF_{I_{3S2}} = \frac{70.53}{V_{(L+I)_{3S2}}} = \frac{70.53}{25.8} = 2.73 \qquad RF_{I_{MS3}} = \frac{70.53}{V_{(L+I)_{MS3}}} = \frac{70.53}{33.2} = 2.12$$

$$RF_{I_{3-3}} = \frac{70.53}{V_{(L+I)_{3-3}}} = \frac{70.53}{24.0} = 2.94$$

- For Two or More Traffic Lanes

$$RF_{I_{HS20}} = \frac{70.53}{V_{(L+I)_{HS20}}} = \frac{70.53}{50.2} = 1.40 \qquad RF_{I_{MS1}} = \frac{70.53}{V_{(L+I)_{MS1}}} = \frac{70.53}{43.8} = 1.61$$

$$RF_{I_3} = \frac{70.53}{V_{(L+I)_3}} = \frac{70.53}{38.0} = 1.86 \qquad RF_{I_{MS2}} = \frac{70.53}{V_{(L+I)_{MS2}}} = \frac{70.53}{56.0} = 1.26$$

$$RF_{I_{3S2}} = \frac{70.53}{V_{(L+I)_{3S2}}} = \frac{70.53}{34.2} = 2.06 \qquad RF_{I_{MS3}} = \frac{70.53}{V_{(L+I)_{MS3}}} = \frac{70.53}{44.1} = 1.60$$

$$RF_{I_{3-3}} = \frac{70.53}{V_{(L+I)_{3-3}}} = \frac{70.53}{31.9} = 2.21$$

Operating Level

- From Paragraph 6.5.1 of *Manual*

$$RF = \frac{C - A_1 D}{A_2 L(1+I)DF}$$

- From Par. 6.5.3 of *Manual*, for the load factor method $A_1 = 1.3; A_2 = 1.3$ for the operating level

$$RF_O = \frac{173.4 - 1.3 \times (12.1 + 3.55)}{1.3 \times L(1+I)DF} = \frac{117.74}{V_{(L+I)}}$$

- For One Traffic Lane

$$RF_{O_{HS20}} = \frac{117.74}{V_{(L+I)_{HS20}}} = \frac{117.74}{37.9} = 3.11$$

$$RF_{O_3} = \frac{117.74}{V_{(L+I)_3}} = \frac{117.74}{28.7} = 4.10$$

$$RF_{O_{3S2}} = \frac{117.74}{V_{(L+I)_{3S2}}} = \frac{117.74}{25.8} = 4.56$$

$$RF_{O_{3-3}} = \frac{117.74}{V_{(L+I)_{3-3}}} = \frac{117.74}{24.0} = 4.91$$

$$RF_{O_{MS1}} = \frac{117.74}{V_{(L+I)_{MS1}}} = \frac{117.74}{33.0} = 3.57$$

$$RF_{O_{MS2}} = \frac{117.74}{V_{(L+I)_{MS2}}} = \frac{117.74}{42.2} = 2.79$$

$$RF_{O_{MS3}} = \frac{117.74}{V_{(L+I)_{MS3}}} = \frac{117.74}{33.2} = 3.55$$

For Two or More Traffic Lanes:

$$RF_{O_{HS20}} = \frac{117.74}{V_{(L+I)_{HS20}}} = \frac{117.74}{50.2} = 2.35$$

$$RF_{O_3} = \frac{117.74}{V_{(L+I)_3}} = \frac{117.74}{38.0} = 3.10$$

$$RF_{O_{3S2}} = \frac{117.74}{V_{(L+I)_{3S2}}} = \frac{117.74}{34.2} = 3.44$$

$$RF_{O_{3-3}} = \frac{117.74}{V_{(L+I)_{3-3}}} = \frac{117.74}{31.9} = 3.69$$

$$RF_{O_{MS1}} = \frac{117.74}{V_{(L+I)_{MS1}}} = \frac{117.74}{43.8} = 2.69$$

$$RF_{O_{MS2}} = \frac{117.74}{V_{(L+I)_{MS2}}} = \frac{117.74}{56.0} = 2.10$$

$$RF_{O_{MS3}} = \frac{117.74}{V_{(L+I)_{MS3}}} = \frac{117.74}{44.1} = 2.67$$

Check Serviceability Criteria (Overload)

- From Paragraph 10.57 and 10.57.1 of *Standard*

- Inventory Level

$$M_D + 1.67\left(RF_{I_{HS20}}\right)\left(M_{(L+I)_{HS20}}\right) \le Serv.\ Strength = S\left(0.8F_y\right)$$

- Thus

$$RF_{I_{HS20}} = \frac{0.8F_y S - M_D - M_{SD}}{1.67\left(M_{(L+I)_{HS20}}\right)}$$

$$RF_{I_{HS20}} = \frac{0.8 \times 33ksi \times \dfrac{154in^3}{12\,{}^{in}\!/\!_{ft}} - 93.7 - 27.5}{1.67\left(M_{(L+I)_{HS20}}\right)} = \frac{130.3}{\left(M_{(L+I)_{HS20}}\right)}$$

$$RF_{I_{HS20}} = \frac{130.3}{251.3} = 0.52$$

$$RF_{I_3} = \frac{130.3}{M_{(L+I)_3}} = \frac{130.3}{201.3} = 0.65$$

$$RF_{I_{3S2}} = \frac{130.3}{M_{(L+I)_{3S2}}} = \frac{130.3}{196.0} = 0.66$$

$$RF_{I_{3-3}} = \frac{130.3}{M_{(L+I)_{3-3}}} = \frac{130.3}{163.9} = 0.79$$

$$RF_{I_{MS1}} = \frac{130.3}{M_{(L+I)_{MS1}}} = \frac{130.3}{254.5} = 0.51$$

$$RF_{I_{MS2}} = \frac{130.3}{M_{(L+I)_{MS2}}} = \frac{130.3}{301.7} = 0.43$$

$$RF_{I_{MS3}} = \frac{130.3}{M_{(L+I)_{MS3}}} = \frac{130.3}{254.5} = 0.51$$

- Operating Level

$$M_D + \left(RF_{O_{HS20}}\right)\left(M_{(L+I)_{HS20}}\right) \leq Serv.\ Strength = S\left(0.8F_y\right)$$

- Thus

$$RF_{O_{HS20}} = RF_{I_{HS20}} \times 1.67$$
$$RF_{O_{HS20}} = 0.52 \times 1.67$$
$$RF_{O_{HS20}} = 0.87$$

$$RF_{O_3} = 0.65 \times 1.67 = 1.09$$
$$RF_{O_{3S2}} = 0.66 \times 1.67 = 1.10$$
$$RF_{O_{3-3}} = 0.79 \times 1.67 = 1.32$$
$$RF_{O_{MS1}} = 0.51 \times 1.67 = 0.85$$
$$RF_{O_{MS2}} = 0.43 \times 1.67 = 0.72$$
$$RF_{O_{MS3}} = 0.51 \times 1.67 = 0.85$$

- Serviceability criteria for the Federal Legal Loads and the State Legal Loads was check only to compare those values with the values obtained by LRFR method, because Paragraph 10.57 of AASHTO check overload only for the design vehicle HS20.

Military Load Classification (MLC) for Beams

MLC Design Criteria

- Note that from sections 1.2.4.2 and 1.2.4.3 moment controlled the civilian vehicles beam rating. Thus, only moment will be considered for the MLC determination. In addition only the Operating Rating will be considered for MLC since military loading frequencies are generally low. These decisions must be made on a case by case basis.
- Since a rating factor greater than 1.0 is satisfactory, the MLC can be obtained by setting the RF equation to 1.0 and solving for M_L.

$$RF = \frac{C - A_1 D}{A_2 L(1 + I)DF} = 1.0$$

$$RF_I = \frac{487 - 1.3 \times (93.7 + 27.5)}{1.3 \times M_L (1 + 0.30)DF} = \frac{194.9}{M_L \times DF} = 1.0$$

- For One Traffic Lane DF = 1.02

$$M_L = \frac{194.9}{1.0 \times 1.02} = 191.1\, ft \cdot kip$$

  - Since the MLC moment tables and curves are for the total vehicle or axle loads, the M_L value must be multiplied by 2 since it represents the moment from a wheel line.

$$M_{L_{Total}} = 2 \times 191.1 = 382.2\, ft \cdot kip$$

  - Using $M_{L_{Total}}$ to enter the wheeled and tracked vehicle moment on Table B-2 of FM3-34.343 for 31 ft, the MLC for one way traffic is MLC 44 for a wheeled vehicle and MLC 31 for a tracked vehicle. The appropriate symbols are 44W and 31T respectively.

  - A final check on Table 3-4 of FM3-34.343 shows that the bridge has the required width for these MLC.

- For Two or More Traffic Lanes DF = 1.30

$$M_L = \frac{194.9}{1.0 \times 1.30} = 149.9\, ft \cdot kip$$

  - Since the MLC moment tables and curves are for the total vehicle or axle loads, the M_L value must be multiplied by 2 since it represents the moment from a wheel line.

$$M_{L_{Total}} = 2 \times 149.9 = 299.8\, ft \cdot kip$$

- Using $M_{L_{Total}}$ to enter the wheeled and tracked vehicle moment on Table B-2 of FM3-34.343 for 31 ft, the MLC for two way traffic is MLC 26 for a wheeled vehicle and MLC 23 for a tracked vehicle. The appropriate symbols are 26W and 23T respectively.

- A final check on Table 3-4 of FM3-34.343 shows that the bridge has the required width for these MLC.

MLC Serviceability Criteria

- Note that from sections 1.2.4.2 and 1.2.4.3 moment controlled the civilian vehicles beam rating. Thus, only moment will be considered for the MLC determination. In addition only the Operating Rating will be considered for MLC since military loading frequencies are generally low. These decisions must be made on a case by case basis.
- Since a rating factor greater than 1.0 is satisfactory, the MLC can be obtained by setting the RF equation to 1.0 and solving for M_L.

$$RF_I = \frac{0.8F_y S - M_D - M_{SD}}{1.0\left(M_{(L+I)}\right)}$$

$$RF_{I_{HS20}} = \frac{0.8 \times 33ksi \times \dfrac{154in^3}{12\, {}^{in}\!/\!_{ft}} - 93.7 - 27.5}{1.0 \times M_L(1+0.30)DF} = \frac{167.4}{M_L \times DF}$$

- For One Traffic Lane DF = 1.02

$$M_L = \frac{167.4}{1.0 \times 1.02} = 164.1\, ft \cdot kip$$

- Since the MLC moment tables and curves are for the total vehicle or axle loads, the M_L value must be multiplied by 2 since it represents the moment from a wheel line.

$$M_{L_{Total}} = 2 \times 164.1 = 328.2\, ft \cdot kip$$

- Using $M_{L_{Total}}$ to enter the wheeled and tracked vehicle moment on Table B-2 of FM3-34.343 for 31 ft, the MLC for one way traffic is MLC 32 for a wheeled vehicle and MLC 26 for a tracked vehicle. The appropriate symbols are 32W and 26T respectively.

- A final check on Table 3-4 of FM3-34.343 shows that the bridge has the required width for these MLC.

- For Two or More Traffic Lanes DF = 1.30

$$M_L = \frac{167.4}{1.0 \times 1.30} = 128.8\, ft \cdot kip$$

- Since the MLC moment tables and curves are for the total vehicle or axle loads, the M_L value must be multiplied by 2 since it represents the moment from a wheel line.

$$M_{L_{Total}} = 2 \times 128.8 = 257.5\, ft \cdot kip$$

- Using $M_{L_{Total}}$ to enter the wheeled and tracked vehicle moment on Table B-2 of FM3-34.343 for 31 ft, the MLC for two way traffic is MLC 21 for a wheeled vehicle and MLC 20 for a tracked vehicle. The appropriate symbols are 21W and 20T respectively.

- A final check on Table 3-4 of FM3-34.343 shows that the bridge has the required width for these MLC.

Load and Resistance Factor Method

Dynamic Load Allowance and Distribution Factors

- Dynamic Load Allowance: Paragraph 3.6.2.1 of LRFD refers to Table 3.6.2.1-1
  - Dynamic Load Allowance: IM = 0.33

- Distribution Factor for Moment per lane: Table 4.6.2.2.2b-1 of LRFD, Assume f'c = 5000psi and E_D = 4030.5ksi

$$K_g = \frac{E_B\left(I + Ae_g^2\right)}{E_D} = \frac{29000\left(1830 + 20.1 \times 15.85^2\right)}{4030.5} = 49499.5 in^4$$

- One Lane Loaded

$$gm_1 = 0.06 + \left(\frac{S}{14}\right)^{0.4}\left(\frac{S}{L}\right)^{0.3}\left(\frac{K_g}{12Lt_s^3}\right)^{0.1}$$

$$gm_1 = 0.06 + \left(\frac{7.17}{14}\right)^{0.4}\left(\frac{7.17}{31}\right)^{0.3}\left(\frac{49499.5}{12\times 31\times 8^3}\right)^{0.1}$$

$$gm_1 = 0.49$$

- Two or More Lanes Loaded

$$gm_2 = 0.075 + \left(\frac{S}{9.5}\right)^{0.6}\left(\frac{S}{L}\right)^{0.2}\left(\frac{K_g}{12Lt_s^3}\right)^{0.1}$$

$$gm_2 = 0.075 + \left(\frac{7.17}{9.5}\right)^{0.6}\left(\frac{7.17}{31}\right)^{0.2}\left(\frac{49499.5}{12\times 31\times 8^3}\right)^{0.1}$$

$$gm_2 = 0.63$$

$$\therefore Use\ gm = 0.63$$

- Distribution Factor for Shear: Table 4.6.2.2.3a-1 of *LRFD*

- One Lane Loaded

$$gv_1 = 0.36 + \left(\frac{S}{25}\right)$$

$$gv_1 = 0.36 + \left(\frac{7.17}{25}\right)$$

$$gv_1 = 0.65$$

- Two or More Lanes Loaded

$$gv_2 = 0.2 + \left(\frac{S}{12}\right) - \left(\frac{S}{35}\right)^{2.0}$$

$$gv_2 = 0.2 + \left(\frac{7.17}{12}\right) - \left(\frac{7.17}{35}\right)^{2.0}$$

$$gv_2 = 0.76$$

$$\therefore Use\ gv = 0.76$$

Compute Maximum Live Load Effects

- Vehicle Live Load Moments and Shear, M_L are those obtained by the routine developed in Excel. Also we will include the *LRFD* vehicle, HL-93, and remember that now we are working per lane instead of per wheel

  - Maximum Design Live Load (HL-93) Moment at midspan

    Design Lane Load Moment $= 76.9\, ft \cdot kip$
    Design Truck Moment $= 297\, ft \cdot kip$
    Tandem Axles Moment $= 339\, ft \cdot kip$ Governs

    $$M_{L_{HL-93}} = 76.9 + 339 = 415.9\, ft \cdot kip$$
    $$M_{(L+I)_{HL-93}} = 76.9 + 339 \times 1.33 = 527.8\, ft \cdot kip$$

  - Using the same procedure, but not the design lane load moment

    $M_{(L+I)_{HS20}} = 395.0\, ft \cdot kip$
    $M_{(L+I)_{3}} = 310.7\, ft \cdot kip$
    $M_{(L+I)_{3S2}} = 308.3\, ft \cdot kip$
    $M_{(L+I)_{3-3}} = 254.6\, ft \cdot kip$
    $M_{(L+I)_{MS1}} = 402.2\, ft \cdot kip$
    $M_{(L+I)_{MS2}} = 471.6\, ft \cdot kip$
    $M_{(L+I)_{MS3}} = 401.4\, ft \cdot kip$

  - Maximum Design Live Load (HL-93) Shear at beam ends

    Design Lane Load Shear $= 9.9 kip$
    Design Truck Shear $= 50.4 kip$ Governs
    Tandem Axles Shear $= 46.8 kip$

    $$V_{L_{HL-93}} = 9.9 + 50.4 = 60.3 kip$$
    $$V_{(L+I)_{HL-93}} = 9.9 + 50.4 \times 1.33 = 76.9 kip$$

  - Using the same procedure, but not the design lane load shear

    $V_{(L+I)_{HS20}} = 67.0 kip$
    $V_{(L+I)_{3}} = 50.5 kip$
    $V_{(L+I)_{3S2}} = 45.5 kip$
    $V_{(L+I)_{3-3}} = 42.3 kip$
    $V_{(L+I)_{MS1}} = 58.5 kip$
    $V_{(L+I)_{MS2}} = 74.5 kip$
    $V_{(L+I)_{MS3}} = 58.2 kip$

- Distributed Live Load Moments and Shears

$$M_{L+I} = M_L \times (1 + IM) \times DF$$

- For Two or More Traffic Lanes (Distribution factor governs for two traffic lanes)

$$M_{L+I} = M_{L+I} \times 0.71$$

$M_{(L+I)_{HS20}} = 280.5\, ft \cdot kip$

$M_{(L+I)_{3}} = 220.6\, ft \cdot kip$

$M_{(L+I)_{3S2}} = 218.9\, ft \cdot kip$

$M_{(L+I)_{3-3}} = 180.8\, ft \cdot kip$

$M_{(L+I)_{MS1}} = 285.6\, ft \cdot kip$

$M_{(L+I)_{MS2}} = 334.8\, ft \cdot kip$

$M_{(L+I)_{MS3}} = 285.0\, ft \cdot kip$

$M_{(L+I)_{HL-93}} = 374.7\, ft \cdot kip$

$$V_{L+I} = V_{L+I} \times 0.76$$

$V_{(L+I)_{HS20}} = 50.9 kip$

$V_{(L+I)_{3}} = 38.4 kip$

$V_{(L+I)_{3S2}} = 34.6 kip$

$V_{(L+I)_{3-3}} = 32.1 kip$

$V_{(L+I)_{MS1}} = 44.5 kip$

$V_{(L+I)_{MS2}} = 56.6 kip$

$V_{(L+I)_{MS3}} = 44.2 kip$

$V_{(L+I)_{HL-93}} = 58.4 kip$

Compute Nominal Resistance of Section

Nominal Moment Capacity, M_n

- Check compact section criteria of Paragraph 6.10.4.1 of *LRFD*
  - Compact-Section Web Slenderness: Check that $\frac{2D_{cp}}{t_w} \leq 3.76\sqrt{\frac{E}{F_{yc}}}$

    where D_{cp} is the depth of the web in compression at the plastic moment

$$\frac{2D_{cp}}{t_w} = \frac{2 \times \frac{23.7}{2}}{0.415} = 57.11 \ \leq \ 3.76\sqrt{\frac{29000}{33}} = 111.46 \ \Rightarrow Good$$

  - Compact-Section Compression Flange Slenderness: Check $\frac{b_f}{2t_f} \leq 0.382\sqrt{\frac{E}{F_{yc}}}$

$$\frac{b_f}{2t_f} = \frac{8.97}{2 \times 0.585} = 7.67 \ \leq \ 0.382\sqrt{\frac{29000}{33}} = 11.32 \ \Rightarrow Good$$

- Compact-Section Web and Compression-Flange Slenderness Interaction: Check that

$$\frac{2D_{cp}}{t_w} \le (0.75)3.76\sqrt{\frac{E}{F_{yc}}}$$

where D_{cp} is the depth of the web in compression at the plastic moment

$$\frac{2D_{cp}}{t_w} = \frac{2\times\frac{23.7}{2}}{0.415} = 57.11 \le (0.75)\,3.76\sqrt{\frac{29000}{33}} = 83.60 \Rightarrow \textit{Good}$$

$$\frac{b_f}{2t_f} = \frac{8.97}{2\times 0.585} = 7.67 \le (0.75)\,0.382\sqrt{\frac{29000}{33}} = 8.49 \Rightarrow \textit{Good}$$

- Compact-Section Compression Flange Bracing:

$$L_b \le \left[0.124 - 0.0759\left(\frac{M_I}{M_p}\right)\right]\left[\frac{r_y E}{F_{yc}}\right]$$

where L_b is the unbraced length (in)

- Top flanges embedded in concrete, therefore fully braced. Therefore, the compression flange is deemed compact, and the flexural resistance is controlled by Paragraph 6.10.4.2.1 of *LRFD.*

$$M_n = M_u = F_y \cdot Z_x = (33ksi)(177in^3)\left(\frac{ft}{12in}\right) = 487\,ft\cdot kip \le 1.5M_y = 635\,ft\cdot kip$$

$$M_n = 487\,ft\cdot kip$$

Nominal Shear Capacity, V_n

- From Paragraph 6.10.7.2 of *LRFD*, for sections without web stiffeners

$$V_n = CV_p$$

$$V_p = 0.58F_y D t_w$$

- Check that $\frac{D}{t_w} \le 1.10\sqrt{\frac{Ek}{F_{yw}}}$, where k= 5 for unstiffened beams

$$\frac{D}{t_w} = \frac{22.53}{0.415} = 54.29 \le 1.10\sqrt{\frac{29000\times 5}{33}} = 72.91 \Rightarrow C = 1.0$$

$$V_n = CV_p$$
$$V_p = 0.58 F_y D t_w$$
$$V_p = 0.58(33{,}000\,psi)(21.83in)(0.415in)\left(\frac{kip}{1000lb}\right) = 173.40kip$$
$$V_n = CV_p = (1.0)(173.40) = 173.4kip$$

General Load Rating Equation

- From Paragraph 6.4.2.1 of *LRFR*

$$RF = \frac{C - \gamma_{DC} DC - \gamma_{DW} DW \pm \gamma_P P}{\gamma_L (LL + IM)}$$

Evaluation Factors for Strength Limit States

- Resistance Factor φ (6.5.4.2 of *LRFD*)
  $\varphi = 1.00$ for flexure and shear
- Condition Factor φ_c (6.4.2.3 of *LRFR*)
  $\varphi_c = 0.95$ Member in fair condition based on the rust present in the element
- System Factor φ_s (6.4.2.4 and C6.4.2.4 of *LRFR*)
  $\varphi_s = 1.00$ Multi-beam bridge for flexure and shear

Design Load Rating

- Strength I Limit State

$$RF = \frac{(\varphi_c)(\varphi_s)(\varphi) R_n - \gamma_{DC} DC - \gamma_{DW} DW \pm \gamma_P P}{\gamma_L (LL + IM)}$$

  - Inventory Level: Table 6-1 of *LRFR*

Load	Load Factor
DC	1.25
LL	1.75

  - Flexure: $RF = \dfrac{(0.95)(1.0)(1.0)487 - 1.25 \times (93.7 + 27.5)}{1.75 \times M_{(L+I)}} = \dfrac{177.8}{M_{(L+I)}}$

$$RF_{I_{HL-93}} = \frac{177.8}{374.7} = 0.47$$

- Shear: $$RF = \frac{(0.95)(1.0)(1.0)173.4 - 1.25 \times (12.1 + 3.55)}{1.75 \times V_{(L+I)}} = \frac{82.95}{V_{(L+I)}}$$

$$RF_{I_{HL-93}} = \frac{82.95}{58.4} = 1.42$$

- Operating Level: Table 6-1 of *LRFR*

Load	Load Factor
DC	1.25
LL	1.35

- Flexure: $$RF = \frac{(0.95)(1.0)(1.0)487 - 1.25 \times (93.7 + 27.5)}{1.35 \times M_{(L+I)}} = \frac{230.5}{M_{(L+I)}}$$

$$RF_{I_{HL-93}} = \frac{230.5}{374.7} = 0.62$$

- Shear: $$RF = \frac{(0.95)(1.0)(1.0)173.4 - 1.25 \times (12.1 + 3.55)}{1.35 \times V_{(L+I)}} = \frac{107.5}{V_{(L+I)}}$$

$$RF_{I_{HL-93}} = \frac{107.5}{58.4} = 1.84$$

Strength I MLC determination for beams

- Note that moment controlled the Strength I beam rating. Thus, only moment will be considered for the MLC determination. In addition only the Operating Rating will be considered for MLC since military loading frequencies are generally low. These decisions must be made on a case by case basis.

- Since a rating factor greater than 1.0 is satisfactory, the MLC can be obtained by setting the RF equation to 1.0 and solving for M_L.

$$RF = \frac{C - A_1 D}{A_2 L(1 + I)DF} = 1.0$$

$$RF_I = \frac{0.95 \times 487 - 1.25 \times (93.7 + 27.5)}{1.35 \times M_L (1 + 0.33) DF} = \frac{173.3}{M_L \times DF} = 1.0$$

- For One Traffic Lane DF = 0.49

$$M_{L_{Total}} = \frac{173.3}{1.0 \times 0.49} = 353.7\, ft \cdot kip$$

  - Since the distributions factors for the LRFR method are per lane instead of per wheel, they are consistent with the MLC moment tables and curves, therefore the M_L value must not be multiplied by 2 since it represents the moment from axle.

  - Using $M_{L_{Total}}$ to enter the wheeled and tracked vehicle moment on Table B-2 of FM3-34.343 for 31 ft, the MLC for one way traffic is MLC 38 for a wheeled vehicle and MLC 28 for a tracked vehicle. The appropriate symbols are 38W and 28T respectively.

  - A final check on Table 3-4 of FM3-34.343 shows that the bridge has the required width for these MLC.

- For Two or More Traffic Lanes DF = 0.63

$$M_{L_{Total}} = \frac{173.3}{1.0 \times 0.63} = 275.1\, ft \cdot kip$$

  - Since the distributions factors for the LRFR method are per lane instead of per wheel, they are consistent with the MLC moment tables and curves, therefore the M_L value must not be multiplied by 2 since it represents the moment from axle.

  - Using $M_{L_{Total}}$ to enter the wheeled and tracked vehicle moment on Table B-2 of FM3-34.343 for 31 ft, the MLC for two way traffic is MLC 23 for a wheeled vehicle and MLC 21 for a tracked vehicle. The appropriate symbols are 23W and 21T respectively.

  - A final check on Table 3-4 of FM3-34.343 shows that the bridge has the required width for these MLC.

Service II Limit State

$$RF = \frac{f_R - \gamma_D f_D}{\gamma_L \left(f_{L+IM} \right)}$$

- **Inventory Level**

  - Allowable Flange Stress $f_R \leq 0.80F_{yf}$ (Par. 6.10.5.2 of *LRFD*)

$$f_R = 0.80 \times 33 = 26.4ksi$$

$$f_D = f_D + f_{SD}$$
$$f_D = \frac{(93.7 + 27.5) \times 12}{154} = 9.4ksi$$

$$f_{L+IM_{HL-93}} = \frac{374.7 \times 12}{154} = 29.2ksi$$

  - From Table 6-1 of *LRFR*

Load	Load Factor
DC	1.00
LL	1.30

$$RF = \frac{f_R - \gamma_D f_D}{\gamma_L (f_{L+IM})}$$
$$RF = \frac{26.4 - 1.0 \times 9.4}{1.3(f_{L+IM})} = 13.1ksi$$

$$RF_{I_{HL-93}} = \frac{13.1}{29.2} = 0.45$$

- **Operating Level**

  - From Table 6-1 of *LRFR*

Load	Load Factor
DC	1.00
LL	1.00

$$RF = \frac{f_R - \gamma_D f_D}{\gamma_L (f_{L+IM})}$$
$$RF = \frac{26.4 - 1.0 \times 9.4}{1.0(f_{L+IM})} = 17ksi$$

$$RF_{O_{HL-93}} = \frac{17.0}{29.2} = 0.58$$

Service II MLC determination for beams

- Note that allowable flange stress controlled the Service II beam rating. Thus, only allowable flange stress will be considered for the MLC determination. In addition only the Operating Rating will be considered for MLC since military loading frequencies are generally low. These decisions must be made on a case by case basis.

- Since a rating factor greater than 1.0 is satisfactory, the MLC can be obtained by setting the RF equation to 1.0 and solving for M_L.

$$RF = \frac{f_R - \gamma_D f_D}{\gamma_L \left(f_{L+IM} \right)} = 1.0$$

$$RF = \frac{26.4 - 1.0 \times 9.4}{1.0 \times f_L (1 + 0.33) \times DF} = 1.0$$

- For One Traffic Lane DF = 0.49

$$f_{L_{Total}} = \frac{12.78}{1.0 \times 0.49} = 26.1 ksi$$

$$M_{L_{Total}} = \frac{26.1 \times 154}{12} = 334.9\, ft \cdot kip$$

  - Since the distributions factors for the LRFR method are per lane instead of per wheel, they are consistent with the MLC moment tables and curves, therefore the M_L value must not be multiplied by 2 since it represents the moment from axle.

  - Using $M_{L_{Total}}$ to enter the wheeled and tracked vehicle moment on Table B-2 of FM3-34.343 for 31 ft, the MLC for one way traffic is MLC 34 for a wheeled vehicle and MLC 26 for a tracked vehicle. The appropriate symbols are 34W and 26T respectively.

  - A final check on Table 3-4 of FM3-34.343 shows that the bridge has the required width for these MLC.

- For Two or More Traffic Lanes DF = 0.63

$$f_{L_{Total}} = \frac{12.78}{1.0 \times 0.63} = 20.3 ksi$$

$$M_{L_{Total}} = \frac{20.3 \times 154}{12} = 260.3\, ft \cdot kip$$

- Since the distributions factors for the LRFR method are per lane instead of per wheel, they are consistent with the MLC moment tables and curves, therefore the M_L value must not be multiplied by 2 since it represents the moment from axle.

- Using $M_{L_{Total}}$ to enter the wheeled and tracked vehicle moment on Table B-2 of FM3-34.343 for 31 ft, the MLC for two way traffic is MLC 21 for a wheeled vehicle and MLC 20 for a tracked vehicle. The appropriate symbols are 21W and 20T respectively.

- A final check on Table 3-4 of FM3-34.343 shows that the bridge has the required width for these MLC.

Fatigue Limit State

- Based on Paragraph 6.6.4.1 of *LRFR* determined if the bridge has any fatigue prone details (Category C or lower), but based on the description of Table 6.6.1.2.3-1 of *LRFD* the Category is higher than C, therefore the bridge does not has any fatigue prone details.

Legal Load Rating

- From Appendix A.6.1 of *LRFR*, as Rating Factor for Design Load is less than 1.0 for inventory and operating levels, therefore Legal Load Rating is required.

- Strength I Limit State

$$RF = \frac{(\varphi_c)(\varphi_s)(\varphi)R_n - \gamma_{DC} DC - \gamma_{DW} DW \pm \gamma_P P}{\gamma_L (LL + IM)}$$

- Generalized Live Load Factor: Table 6-1 and Table 6-5 of *LRFR* for an ADTT of 1000 based on inspection of November 2003.

Load	Load Factor
DC	1.25
LL	1.65

- Flexure: $RF = \dfrac{(0.95)(1.0)(1.0)487 - 1.25 \times (93.7 + 27.5)}{1.65 \times M_{(L+I)}} = \dfrac{185.8}{M_{(L+I)}}$

$$RF_{I_3} = \frac{185.8}{220.6} = 0.84 \qquad RF_{I_{MS1}} = \frac{185.8}{285.6} = 0.65$$

$$RF_{I_{3S2}} = \frac{185.8}{218.9} = 0.85 \qquad RF_{I_{MS2}} = \frac{185.8}{334.8} = 0.55$$

$$RF_{I_{3-3}} = \frac{185.8}{180.8} = 1.03 \qquad RF_{I_{MS3}} = \frac{185.8}{285.0} = 0.65$$

- Shear: $RF = \frac{(0.95)(1.0)(1.0)173.4 - 1.25 \times (12.1 + 3.55)}{1.65 \times V_{(L+I)}} = \frac{88.0}{V_{(L+I)}}$

$$RF_{I_3} = \frac{88.0}{38.4} = 2.29 \qquad RF_{I_{MS1}} = \frac{88.0}{44.5} = 1.98$$

$$RF_{I_{3S2}} = \frac{88.0}{34.6} = 2.54 \qquad RF_{I_{MS2}} = \frac{88.0}{56.6} = 1.55$$

$$RF_{I_{3-3}} = \frac{88.0}{32.1} = 2.74 \qquad RF_{I_{MS3}} = \frac{88.0}{44.2} = 1.99$$

- Service II Limit State

$$RF = \frac{f_R - \gamma_D f_D}{\gamma_L \left(f_{L+IM} \right)}$$

- Allowable Flange Stress $f_R \le 0.80 F_{yf}$ (Par. 6.10.5.2 of *LRFD*)

$$f_R = 0.80 \times 33 = 26.4 ksi$$

$$f_D = f_D + f_{SD}$$

$$f_D = \frac{(93.7 + 27.5) \times 12}{154} = 9.4 ksi$$

$$f_{L+IM_3} = \frac{220.6 \times 12}{154} = 17.2 ksi \qquad f_{L+IM_{MS1}} = \frac{285.6 \times 12}{154} = 22.3 ksi$$

$$f_{L+IM_{3S2}} = \frac{218.9 \times 12}{154} = 17.1 ksi \qquad f_{L+IM_{MS2}} = \frac{334.8 \times 12}{154} = 26.1 ksi$$

$$f_{L+IM_{3-3}} = \frac{180.8 \times 12}{154} = 14.1 ksi \qquad f_{L+IM_{MS3}} = \frac{285.0 \times 12}{154} = 22.2 ksi$$

- From Table 6-1 of *LRFR*

Load	Load Factor
DC	1.00
LL	1.30

$$RF = \frac{f_R - \gamma_D f_D}{\gamma_L \left(f_{L+IM} \right)}$$

$$RF = \frac{26.4 - 1.0 \times 9.4}{1.3\left(f_{L+IM} \right)} = 13.1ksi$$

$$RF_{I_3} = \frac{13.1}{17.2} = 0.76 \qquad RF_{I_{MS1}} = \frac{13.1}{22.3} = 0.59$$

$$RF_{I_{3-S2}} = \frac{13.1}{17.1} = 0.77 \qquad RF_{I_{MS2}} = \frac{13.1}{26.1} = 0.50$$

$$RF_{I_{3-3}} = \frac{13.1}{14.1} = 0.93 \qquad RF_{I_{MS3}} = \frac{13.1}{22.2} = 0.59$$

- Therefore, **posting** is required.

MLC determination for beams in Legal Load Rating

- As the Rating Factor for Design Load was set to 1.0 to determine the MLC for the bridge, no Legal Load MLC determination is required.

Posting, MLC and Rating Summary

- The results shown on Tables 1.2.6.1 and 1.2.6.2 consider the inventory and operating levels with two or more traffic lanes loaded.

Table A. 1 Rating Factor for Different Vehicle Types in Inventory Level

Bridge Element	**Rating Vehicle**							
	HS20	**Type 3**	**Type 3-S2**	**Type 3-3**	**MS1**	**MS2**	**MS3**	**HL-93**
I-Beams (ASR)	0.44	0.56	0.57	0.68	0.44	0.37	0.44	----
I-Beams (LFR)	0.52	0.65	0.66	0.79	0.51	0.43	0.51	----
I-Beams (LRFR)	----	0.76	0.77	0.93	0.59	0.50	0.58	0.45
Vehicle Weight (tons)	36	25	36	40	25.5	42.4	42.4	----
Load Rating* ASR (tons)	15.8	14.0	20.5	27.2	11.2	15.7	18.6	----
Load Rating* LFR (tons)	18.7	16.2	23.7	31.6	13.0	18.2	21.6	----
Load Rating* LRFR (tons)	----	19.0	27.7	37.2	15.0	21.2	24.6	----

* Load Rating = (Element Rating) $\times$ (Vehicle Wt. in tons)

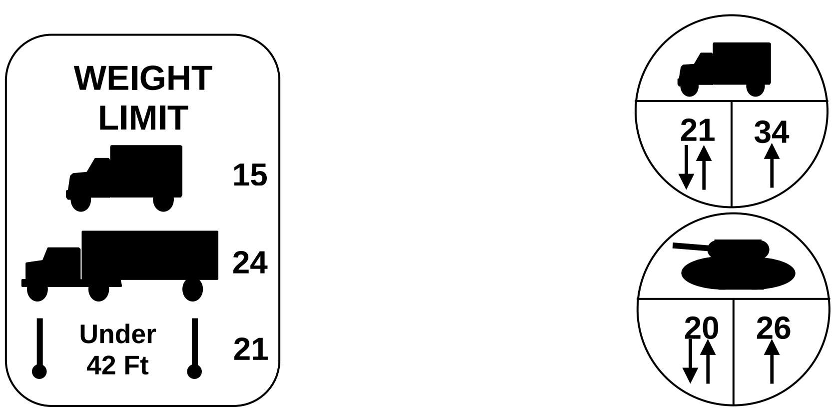
Table A. 2 Rating Factor for Different Vehicle Types in Operating Level

Bridge Element	Rating Vehicle							
	HS20	Type 3	Type 3-S2	Type 3-3	MS1	MS2	MS3	HL-93
I-Beams (ASR)	0.78	0.98	1.00	1.20	0.77	0.65	0.77	----
I-Beams (LFR)	0.87	1.09	1.10	1.32	0.85	0.72	0.85	----
I-Beams (LRFR)	----	0.76	0.77	0.93	0.59	0.50	0.58	0.62
Vehicle Weight (tons)	36	25	36	40	25.5	42.4	42.4	----
Load Rating* ASR (tons)	28.0	24.5	36.0	48.0	19.6	27.5	32.6	----
Load Rating* LFR (tons)	31.3	27.2	39.6	52.8	21.6	30.5	36.0	----
Load Rating* LRFR (tons)	----	19.0	27.7	37.2	15.0	21.2	24.6	----

* Load Rating = (Element Rating) $\times$ (Vehicle Wt. in tons)

Table A. 3 Bridge Military Load Classification

MLC		ASR	LFR		LRFR	
		Design	Design	Serviceability	Strength I	Service II
Wheeled	One way	24W	44W	32W	38W	34W
	Two way	19W	26W	21W	23W	21W
Tracked	One way	23T	31T	26T	28T	26T
	Two way	18T	23T	20T	21T	20T



a) State Legal Loads b) MLC Vehicles

Figure A. 6 Posting Sign for State Legal Loads and MLC by LRFR*

* Note that the posting example in Figure 1.2.6.1 does not follow the guidelines in Paragraph 6.8.3 of *LRFR* that recommends

$$\text{Safe Posting Load} = \frac{W}{0.7}\left(RF - 0.3\right)$$

APPENDIX B DISTRIBUTION FACTORS BY AASHTO (STANDARD & LRFD)

- Moment Single Lane Interior

  - Distribution Factor of Wheel Loads: *Standard* Table 3.23.1

    Concrete on steel I-beams

    For one traffic lane:

$$DF = \frac{S}{7}$$
$$DF = \frac{7.17}{7}$$
$$DF = 1.02 \ per \ wheel$$
$$DF = 0.512 \ per \ lane$$

  - Distribution Factor of Wheel Loads: *LRFD* Table 4.6.2.2.2b-1

    Concrete on steel I-beams

    For one traffic lane:

$$K_g = \frac{E_B\left(I + Ae_g^2\right)}{E_D} = \frac{29000\left(1830 + 20.1 \times 15.85^2\right)}{4030.5} = 49499.5in^4$$

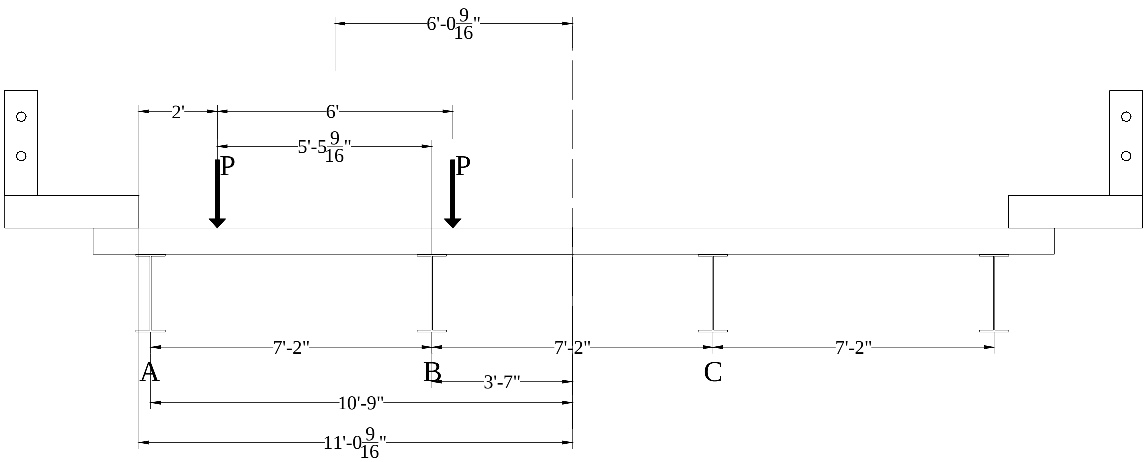
$$gm_1 = 0.06 + \left(\frac{S}{14}\right)^{0.4}\left(\frac{S}{L}\right)^{0.3}\left(\frac{K_g}{12Lt_s^3}\right)^{0.1}$$
$$gm_1 = 0.06 + \left(\frac{7.17}{14}\right)^{0.4}\left(\frac{7.17}{31}\right)^{0.3}\left(\frac{49499.5}{12 \times 31 \times 8^3}\right)^{0.1}$$
$$gm_1 = 0.491 \ per \ lane$$

- Moment Single Lane Exterior

  - Distribution Factor of Wheel Loads: *Standard* Sec.3.23.2.3.1.2

    Assume that the flooring act as a simple span between beams as specified in *Standard* Sec.3.23.2.3.1.2.

    For one traffic lane:



    Using statics, we sum moments about beam B:

$$\sum M_B = P \times 65.6in - R_A \times 86in = 0$$
$$R_A = 0.762P$$
$$One\ Traffic\ Lane : DF = 0.762\ per\ wheel$$
$$One\ Traffic\ Lane : DF = 0.381\ per\ lane$$

  - Distribution Factor of Lane Load: *LRFD* Table 4.6.2.2.2d-1

    Use Lever Rule, same as *Standard*, but check rigid method as specified in the commentary C4.6.2.2.2d.

    For slab on girder bridges with diaphragms, the distribution factor for exterior beams must not be less that which would be obtained assuming the cross section deflects and rotates as a rigid unit.

$$DF = m \times R$$

$$R = \frac{N_L}{N_b} + \frac{X_{ext}\sum^{N_L} e}{\sum^{N_b} x^2}$$

R = reaction on exterior beam in terms of lanes
N_L = number of lanes loaded under consideration
e = eccentricity of a design truck or a design lane load from the center of gravity of the pattern of girder
x = horizontal distance from the center of gravity of the pattern of girders to each girder
x_{ext} = horizontal distance from the center of gravity of the pattern of girders to the exterior girder
N_b = number of girders
m = multiple presence factor in article 3.6.1.1.2

For one traffic lane:

$$m = 1.2$$

$$R = \frac{1}{4} + \frac{129in(72.6in)}{2\left[(129in)^2 + (43in)^2\right]}$$
$$R = 0.503$$

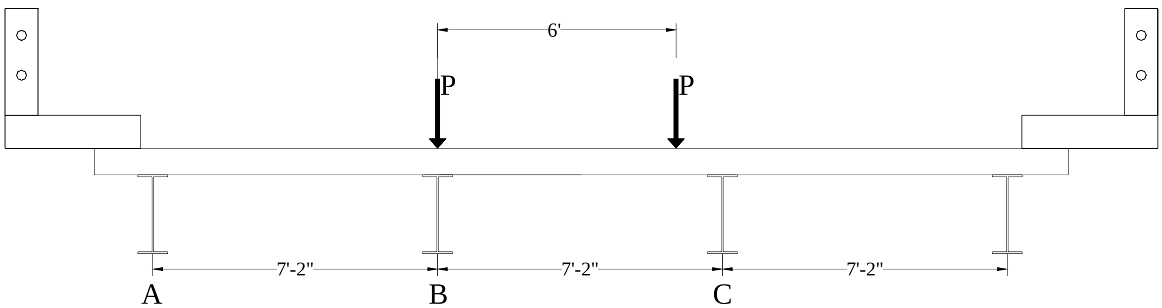
$$DF = m \times R$$
$$DF = 1.2 \times 0.503 = 0.604$$

- Shear Single Lane Interior

  - Distribution Factor of Wheel Loads: *Standard* Sec.3.23.1.2

    Assume that the flooring act as a simple span between beams as specified in *Standard* Sec.3.23.1.2.

    For one traffic lane:



    Using statics, we sum moments about beam C:

$$\sum M_C = P \times 86in + P \times 14 - R_B \times 86in = 0$$
$$R_A = 1.163P$$
$$One\ Traffic\ Lane : DF = 1.163\ per\ wheel$$
$$One\ Traffic\ Lane : DF = 0.581\ per\ lane$$

  - Distribution Factor of Wheel Loads: *LRFD* Table 4.6.2.2.3a-1

    Concrete on steel I-beams

    For one traffic lane:

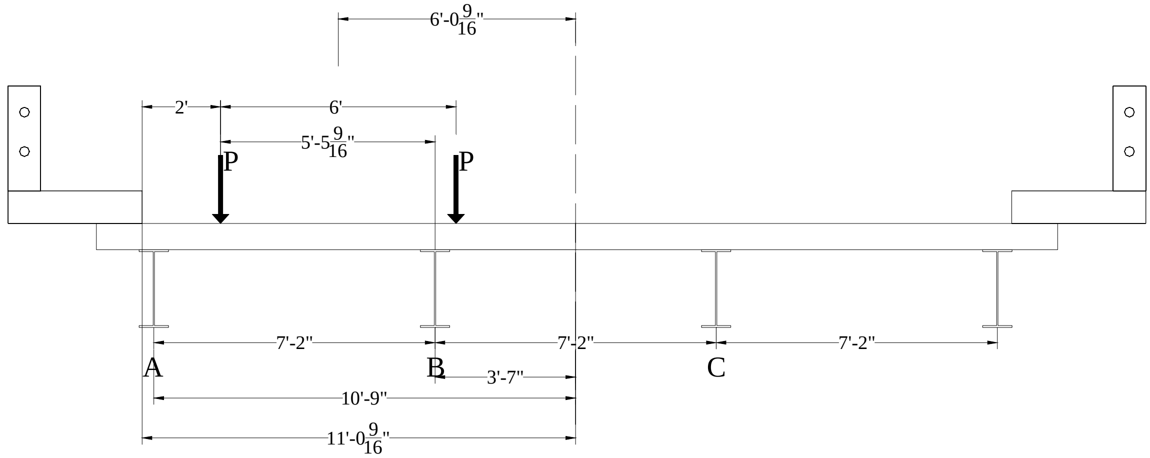
$$gv_1 = 0.36 + \frac{S}{25}$$
$$gv_1 = 0.36 + \frac{7.17}{25}$$
$$gv_1 = 0.647\ per\ lane$$

- Shear Single Lane Exterior

  - Distribution Factor of Wheel Loads: *Standard* Sec.3.23.1.2

    Assume that the flooring act as a simple span between beams as specified in *Standard* Sec.3.23.1.2.

    For one traffic lane:



Using statics, we sum moments about beam B:

$$\sum M_B = P \times 65.6in - R_A \times 86in = 0$$
$$R_A = 0.762P$$

$$One\ Traffic\ Lane: DF = 0.762\ per\ wheel$$
$$One\ Traffic\ Lane: DF = 0.381\ per\ lane$$

  - Distribution Factor of Lane Load: *LRFD* Table 4.6.2.2.2d-1

    Use Lever Rule, same as *Standard*, but check rigid method as specified in the commentary C4.6.2.2.2d.

    For slab on girder bridges with diaphragms, the distribution factor for exterior beams must not be less that which would be obtained assuming the cross section deflects and rotates as a rigid unit.

$$DF = m \times R$$

$$R = \frac{N_L}{N_b} + \frac{X_{ext} \sum^{N_L} e}{\sum^{N_b} x^2}$$

R = reaction on exterior beam in terms of lanes
N_L = number of lanes loaded under consideration
e = eccentricity of a design truck or a design lane load from the center of gravity of the pattern of girder
x = horizontal distance from the center of gravity of the pattern of girders to each girder
x_{ext} = horizontal distance from the center of gravity of the pattern of girders to the exterior girder
N_b = number of girders
m = multiple presence factor in article 3.6.1.1.2

For one traffic lane:

$$m = 1.2$$

$$R = \frac{1}{4} + \frac{129in(72.6in)}{2\left[(129in)^2 + (43in)^2\right]}$$
$$R = 0.503$$

$$DF = m \times R$$
$$DF = 1.2 \times 0.503 = 0.604$$

- Moment Double Lane Interior

    - Distribution Factor of Wheel Loads: *Standard* Table 3.23.1

Concrete on steel I-beams

For one traffic lane:

$$DF = \frac{S}{5.5}$$
$$DF = \frac{7.17}{5.5}$$
$$DF = 1.304 \ per\ wheel$$
$$DF = 0.652 \ per\ lane$$

- Distribution Factor of Wheel Loads: *LRFD* Table 4.6.2.2.2b-1

  Concrete on steel I-beams

  For two traffic lanes:

$$K_g = \frac{E_B\left(I + Ae_g^2\right)}{E_D} = \frac{29000\left(1830 + 20.1 \times 15.85^2\right)}{4030.5} = 49499.5in^4$$

$$gm_2 = 0.075 + \left(\frac{S}{9.5}\right)^{0.6}\left(\frac{S}{L}\right)^{0.2}\left(\frac{K_g}{12Lt_s^3}\right)^{0.1}$$

$$gm_2 = 0.075 + \left(\frac{7.17}{9.5}\right)^{0.6}\left(\frac{7.17}{31}\right)^{0.2}\left(\frac{49499.5}{12 \times 31 \times 8^3}\right)^{0.1}$$

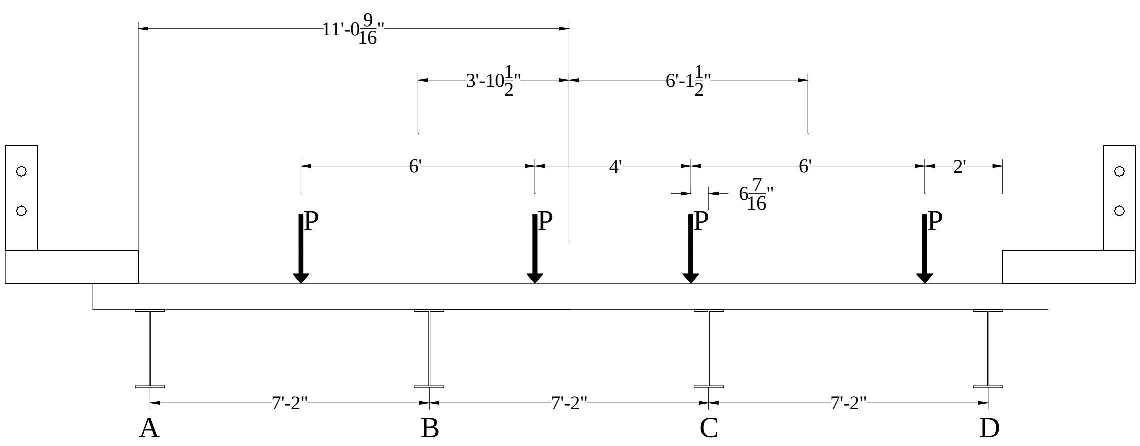
$$gm_2 = 0.626$$

- Moment Double Lane Exterior

  - Distribution Factor of Wheel Loads: *Standard* Sec.3.23.2.3.1.2

    Assume that the flooring act as a simple span between beams as specified in *Standard* Sec.3.23.2.3.1.2.

    For two traffic lanes:



Using statics, we sum moments about beam C:

$$\sum M_C = P \times 65.6in - R_D \times 86in = 0$$

$$R_D = 0.762P$$

$$Two\ Traffic\ Lanes: DF = 0.762\ per\ wheel$$
$$Two\ Traffic\ Lanes: DF = 0.381\ per\ lane$$

- Distribution Factor of Wheel Loads: *LRFD* Table 4.6.2.2.2d-1

  Concrete on steel I-beams

  For two traffic lanes:

$$e = 0.77 + \frac{de}{9.1} = 0.77 + \frac{0.5}{9.1} = 0.824$$

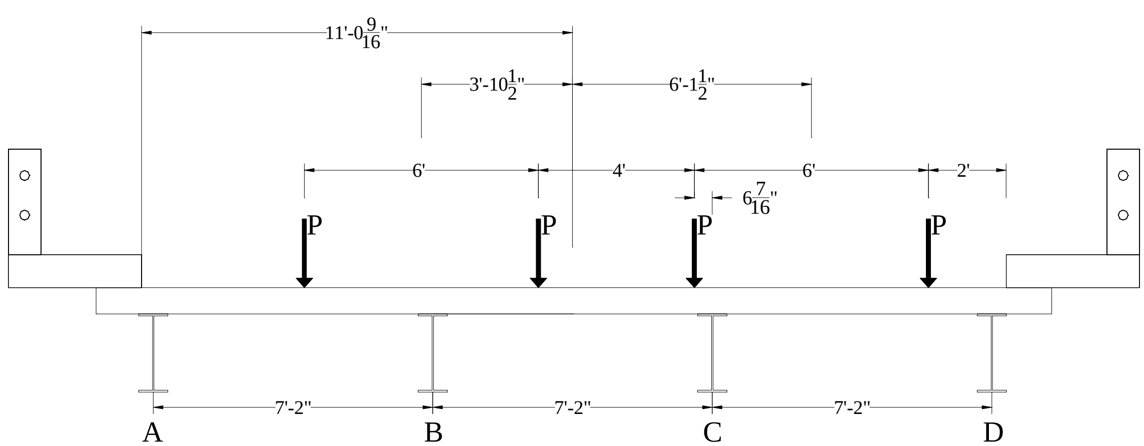
$$g = e \times g_{interior}$$
$$g = 0.824 \times 0.626$$
$$g_{exterior} = 0.516$$

- Shear Double Lane Interior

  - Distribution Factor of Wheel Loads: *Standard* Sec.3.23.1.2

    Assume that the flooring act as a simple span between beams as specified in *Standard* Sec.3.23.1.2.

    For two traffic lanes:



Using statics, we sum moments to obtain the reactions from the left and right sides:

$$\sum M_B = P \times 31.6in + P \times 79.6in - R_{C_{LEFT}} \times 86in = 0$$
$$R_{C_{LEFT}} = 1.293P$$

$$\sum M_D = P \times 17.5in - R_{C_{RIGHT}} \times 86in = 0$$
$$R_{C_{LEFT}} = 0.203P$$

$$R_C = 1.293 + 0.203$$
$$R_C = 1.496$$

$$Two\ Traffic\ Lanes: DF = 1.496\ per\ wheel$$
$$Two\ Traffic\ Lanes: DF = 0.748\ per\ lane$$

- Distribution Factor of Wheel Loads: *LRFD* Table 4.6.2.2.3a-1

Concrete on steel I-beams

For two traffic lanes:

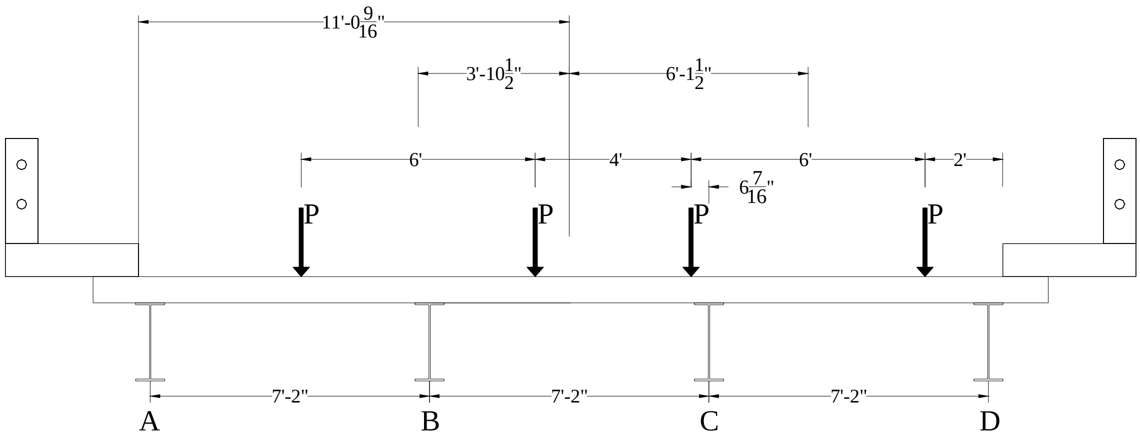
$$gv_1 = 0.2 + \frac{S}{12} - \left(\frac{S}{35}\right)^2$$
$$gv_1 = 0.2 + \frac{7.17}{12} - \left(\frac{7.17}{35}\right)^2$$
$$gv_1 = 0.755\ per\ lane$$

- Shear Double Lane Exterior

  - Distribution Factor of Wheel Loads: *Standard* Sec.3.23.2.3.1.2

    Assume that the flooring act as a simple span between beams as specified in *Standard* Sec.3.23.2.3.1.2.

    For two traffic lanes:



Using statics, we sum moments about beam C:

$$\sum M_C = P \times 65.6in - R_D \times 86in = 0$$
$$R_D = 0.762P$$

$$Two\ Traffic\ Lanes: DF = 0.762\ per\ wheel$$
$$Two\ Traffic\ Lanes: DF = 0.381\ per\ lane$$

  - Distribution Factor of Wheel Loads: *LRFD* Table 4.6.2.2.3a-1

    Concrete on steel I-beams

    For two traffic lanes:

$$e = 0.6 + \frac{de}{10} = 0.6 + \frac{0.5}{10} = 0.65$$

$$g = e \times g_{interior}$$
$$g = 0.65 \times 0.755$$
$$gv_1 = 0.491\ per\ lane$$

APPENDIX C DISTRIBUTION FACTOR TABLES FOR MILITARY VEHICLES

This appendix contains the results from the finite element analyses of the ninety hypothetical steel beam bridges for the seven military vehicles. The results were obtained from the finite element analysis program SAP 2000. These results are the basis for the live load distribution factor formulas presented in Chapter 6 for each military vehicle. The results are presented as tables for each of the military vehicles. The tables contain the all the bridge parameters along with their correspondent values used in the analysis. Also the scenarios considered to obtain the live load distribution factor formulas for each military vehicle are presented in the tables. These scenarios consist in the traffic lanes loaded (single lane or double lane), load case (bending moment or shear force), and the type of beam considered (interior or exterior). The live load distribution factors tables are divided in bending moment or shear force for each military vehicle.

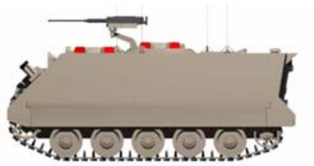
Table C. 1 Bending Moment Live Load Distribution Factor for M113

 **MILITARY VEHICLE : M113**							M113	M113	M113				M113			
							SL-M	DL-M	SL-M				DL-M			
							Interior	Interior	Exterior				Exterior			
							OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)
Spacing (ft)	Span (ft)	thickness (in)	Inertia (in^4)	Area (in^2)	eg (in)	Kg	0	0	0	1	2	3	0	1	2	3
4	50	7	3846	36.98	15.65	103943	0.201	0.322	0.217	0.241	0.266	0.285	0.293	0.322	0.351	0.373
		8	3846	36.98	16.15	108679	0.200	0.318	0.217	0.239	0.263	0.280	0.294	0.322	0.351	0.372
		9	3846	36.98	16.65	113565	0.199	0.315	0.217	0.237	0.260	0.276	0.296	0.323	0.350	0.371
	70	7	5865	45.11	17.20	154750	0.200	0.313	0.218	0.237	0.256	0.275	0.298	0.323	0.348	0.372
		8	5865	45.11	17.50	158533	0.199	0.310	0.217	0.234	0.253	0.270	0.300	0.324	0.348	0.371
		9	5865	45.11	18.20	167614	0.198	0.307	0.216	0.232	0.249	0.265	0.301	0.324	0.347	0.370
	90	7	8964	64.44	17.70	234839	0.197	0.310	0.217	0.235	0.252	0.268	0.300	0.325	0.350	0.370
		8	8964	64.44	18.20	244157	0.196	0.307	0.216	0.232	0.248	0.263	0.301	0.325	0.349	0.368
		9	8964	64.44	18.70	253734	0.194	0.304	0.215	0.229	0.245	0.258	0.302	0.325	0.348	0.366
	110	7	13640	79.61	19.30	348757	0.197	0.308	0.216	0.232	0.245	0.259	0.305	0.325	0.344	0.365
		8	13640	79.61	19.80	361294	0.195	0.306	0.214	0.229	0.241	0.254	0.306	0.325	0.343	0.364
		9	13640	79.61	20.30	374152	0.194	0.305	0.213	0.227	0.237	0.249	0.306	0.325	0.342	0.362
	130	7	20833	90.14	21.85	514491	0.195	0.304	0.213	0.227	0.246	0.259	0.302	0.325	0.351	0.371
		8	20833	90.14	22.35	530539	0.193	0.302	0.211	0.224	0.242	0.254	0.303	0.324	0.350	0.369
		9	20833	90.14	22.85	546949	0.192	0.302	0.209	0.222	0.238	0.249	0.303	0.324	0.349	0.367
	140	7	25799	95.63	23.60	636881	0.195	0.306	0.214	0.228	0.243	0.255	0.304	0.326	0.347	0.366
		8	25799	95.63	24.10	655254	0.193	0.304	0.212	0.226	0.239	0.252	0.305	0.325	0.346	0.364
		9	25799	95.63	24.60	674012	0.192	0.303	0.210	0.223	0.236	0.247	0.305	0.324	0.344	0.362
5	50	7	4633	43.50	15.85	125354	0.279	0.417	0.310	0.352	0.397	0.440	0.343	0.391	0.441	0.489
		8	4633	43.50	16.35	130996	0.278	0.411	0.312	0.351	0.395	0.436	0.346	0.393	0.445	0.492
		9	4633	43.50	16.85	136813	0.276	0.406	0.312	0.350	0.392	0.431	0.349	0.396	0.446	0.493
	70	7	7042	62.90	16.35	192178	0.270	0.395	0.306	0.339	0.375	0.411	0.352	0.396	0.442	0.486
		8	7042	62.90	16.85	200589	0.268	0.391	0.306	0.337	0.371	0.405	0.355	0.398	0.443	0.486
		9	7042	62.90	17.35	209254	0.266	0.386	0.305	0.335	0.367	0.399	0.358	0.399	0.443	0.486
	90	7	10751	64.63	18.95	273565	0.265	0.388	0.302	0.334	0.365	0.394	0.358	0.399	0.437	0.476

		8	10751	64.63	19.45	283561	0.263	0.383	0.301	0.331	0.360	0.388	0.361	0.400	0.442	0.482
		9	10751	64.63	19.95	293818	0.261	0.379	0.300	0.328	0.355	0.382	0.363	0.401	0.442	0.481
		7	16376	72.84	21.55	404414	0.260	0.379	0.297	0.324	0.351	0.381	0.357	0.396	0.443	0.484
	110	8	16376	72.84	22.05	417205	0.258	0.375	0.295	0.321	0.348	0.376	0.359	0.397	0.440	0.481
		9	16376	72.84	22.55	430290	0.256	0.372	0.294	0.318	0.344	0.370	0.361	0.398	0.439	0.480
		7	25002	93.24	23.60	619738	0.255	0.373	0.291	0.317	0.343	0.367	0.358	0.398	0.439	0.474
	130	8	25002	93.24	24.10	637651	0.253	0.370	0.290	0.314	0.338	0.361	0.360	0.398	0.439	0.473
		9	25002	93.24	24.60	655941	0.251	0.367	0.288	0.310	0.333	0.355	0.361	0.398	0.438	0.471
		7	30911	97.85	25.43	758746	0.254	0.378	0.292	0.317	0.343	0.366	0.360	0.397	0.435	0.469
	140	8	30911	97.85	25.93	778988	0.252	0.374	0.290	0.314	0.338	0.360	0.362	0.398	0.434	0.467
		9	30911	97.85	26.43	799624	0.250	0.371	0.288	0.310	0.333	0.355	0.363	0.397	0.433	0.466
		7	5578	50.98	16.10	151384	0.336	0.506	0.363	0.411	0.451	0.496	0.403	0.459	0.513	0.564
	50	8	5578	50.98	16.60	158099	0.331	0.499	0.365	0.411	0.450	0.493	0.407	0.462	0.513	0.564
		9	5578	50.98	17.10	165019	0.326	0.492	0.366	0.410	0.448	0.489	0.411	0.465	0.515	0.566
		7	8449	61.26	17.70	222665	0.319	0.479	0.355	0.395	0.434	0.472	0.408	0.460	0.517	0.565
	70	8	8449	61.26	18.20	231523	0.314	0.472	0.356	0.394	0.431	0.468	0.412	0.464	0.520	0.563
		9	8449	61.26	18.70	240628	0.311	0.465	0.356	0.392	0.428	0.462	0.416	0.467	0.522	0.565
		7	12964	66.12	20.45	327181	0.311	0.468	0.353	0.389	0.422	0.451	0.420	0.471	0.513	0.556
	90	8	12964	66.12	20.95	338206	0.308	0.461	0.353	0.387	0.418	0.446	0.424	0.473	0.511	0.550
6		9	12964	66.12	21.45	349498	0.305	0.456	0.352	0.385	0.414	0.440	0.427	0.475	0.513	0.551
		7	19747	75.02	23.20	484346	0.303	0.459	0.348	0.379	0.409	0.441	0.424	0.467	0.514	0.565
	110	8	19747	75.02	23.70	498518	0.300	0.453	0.348	0.376	0.405	0.436	0.427	0.470	0.516	0.563
		9	19747	75.02	24.20	512992	0.297	0.449	0.346	0.373	0.401	0.430	0.430	0.471	0.516	0.563
		7	30171	95.60	25.50	743809	0.296	0.452	0.342	0.371	0.399	0.430	0.425	0.470	0.514	0.568
	130	8	30171	95.60	26.00	763639	0.293	0.446	0.340	0.368	0.394	0.424	0.427	0.471	0.514	0.563
		9	30171	95.60	26.50	783855	0.290	0.442	0.339	0.365	0.390	0.419	0.429	0.472	0.514	0.562
		7	37210	122.00	25.50	938798	0.294	0.448	0.340	0.368	0.397	0.420	0.421	0.465	0.511	0.546
	140	8	31032	97.70	26.00	782011	0.291	0.443	0.338	0.365	0.392	0.414	0.424	0.466	0.511	0.545
		9	31032	97.70	26.50	802670	0.288	0.439	0.336	0.361	0.388	0.409	0.426	0.467	0.511	0.544
7		7	6665	49.90	17.40	175391	0.378	0.578	0.392	0.438	0.487	0.542	0.441	0.494	0.548	0.615
	50	8	6665	49.90	17.90	182486	0.370	0.571	0.395	0.439	0.487	0.540	0.446	0.498	0.554	0.620
		9	6665	49.90	18.40	189782	0.364	0.563	0.397	0.440	0.486	0.537	0.452	0.503	0.559	0.624
	70	7	10257	61.84	19.00	262460	0.351	0.541	0.388	0.427	0.470	0.516	0.457	0.506	0.555	0.618

		8	10257	61.84	19.50	272049	0.344	0.532	0.389	0.427	0.468	0.512	0.463	0.511	0.559	0.620
		9	10257	61.84	20.00	281888	0.339	0.525	0.390	0.426	0.465	0.507	0.468	0.516	0.563	0.622
	90	7	15622	76.60	20.75	391525	0.336	0.519	0.383	0.418	0.450	0.488	0.463	0.511	0.544	0.598
		8	15622	76.60	21.25	404483	0.331	0.511	0.383	0.416	0.446	0.483	0.469	0.514	0.548	0.600
		9	15622	76.60	21.75	417750	0.326	0.508	0.383	0.414	0.442	0.477	0.474	0.518	0.551	0.601
	110	7	23722	89.58	23.40	586222	0.325	0.509	0.377	0.408	0.443	0.477	0.470	0.514	0.565	0.610
		8	23722	89.58	23.90	603289	0.320	0.506	0.376	0.406	0.439	0.472	0.475	0.518	0.567	0.611
		9	23722	89.58	24.40	620716	0.316	0.502	0.376	0.404	0.436	0.466	0.479	0.521	0.569	0.611
	130	7	36261	98.40	27.50	891557	0.319	0.503	0.373	0.402	0.433	0.465	0.473	0.519	0.562	0.606
		8	36261	98.40	28.00	913553	0.315	0.500	0.372	0.400	0.429	0.460	0.477	0.522	0.564	0.607
		9	36261	98.40	28.50	935946	0.311	0.496	0.371	0.397	0.425	0.454	0.480	0.524	0.565	0.607
	140	7	44826	117.37	28.50	1129065	0.316	0.501	0.371	0.401	0.428	0.458	0.475	0.516	0.549	0.594
		8	44826	117.37	29.00	1156247	0.311	0.497	0.370	0.399	0.424	0.453	0.479	0.518	0.551	0.594
		9	44826	117.37	29.50	1183903	0.308	0.494	0.368	0.396	0.420	0.447	0.482	0.520	0.552	0.594
8	50	7	8024	50.04	18.70	205598	0.433	0.654	0.427	0.479	0.535	0.589	0.479	0.545	0.604	0.672
		8	8024	50.04	19.20	213237	0.424	0.648	0.430	0.481	0.535	0.588	0.484	0.550	0.608	0.681
		9	8024	50.04	19.70	221077	0.415	0.642	0.433	0.482	0.534	0.585	0.490	0.555	0.613	0.685
	70	7	12249	57.56	21.75	318021	0.404	0.629	0.430	0.475	0.525	0.571	0.494	0.553	0.618	0.682
		8	12249	57.56	22.25	328222	0.395	0.622	0.432	0.475	0.523	0.568	0.500	0.558	0.622	0.690
		9	12249	57.56	22.75	338655	0.387	0.616	0.433	0.475	0.521	0.564	0.506	0.563	0.627	0.693
	90	7	18704	81.11	21.75	459764	0.377	0.607	0.423	0.462	0.499	0.538	0.507	0.564	0.605	0.659
		8	15599	69.21	22.25	401668	0.370	0.601	0.424	0.461	0.496	0.532	0.513	0.570	0.614	0.666
		9	15599	69.21	22.75	414213	0.364	0.595	0.424	0.459	0.492	0.527	0.518	0.575	0.616	0.667
	110	7	28568	91.18	25.50	707743	0.364	0.593	0.420	0.456	0.495	0.532	0.511	0.568	0.629	0.687
		8	28568	91.18	26.00	726657	0.357	0.587	0.420	0.454	0.491	0.526	0.516	0.572	0.631	0.686
		9	28568	91.18	26.50	745938	0.351	0.581	0.419	0.452	0.487	0.521	0.520	0.575	0.633	0.687
	130	7	43605	101.06	29.50	1059728	0.360	0.593	0.416	0.451	0.484	0.517	0.525	0.569	0.616	0.676
		8	43605	101.06	30.00	1083948	0.354	0.587	0.416	0.449	0.480	0.511	0.529	0.572	0.617	0.680
		9	43605	101.06	30.50	1108574	0.348	0.582	0.415	0.446	0.476	0.506	0.532	0.574	0.619	0.680
	140	7	53928	121.04	30.50	1341455	0.356	0.588	0.414	0.448	0.479	0.510	0.525	0.569	0.614	0.671
		8	53928	121.04	31.00	1371438	0.350	0.582	0.414	0.445	0.475	0.505	0.529	0.572	0.615	0.674
		9	53928	121.04	31.50	1401908	0.345	0.577	0.412	0.443	0.471	0.499	0.532	0.574	0.616	0.674

Table C. 2 Shear Force Live Load Distribution Factor for M113



MILITARY VEHICLE : M113

Spacing (ft)	Span (ft)	thickness (in)	Inertia (in^4)	Area (in^2)	eg (in)	Kg	M113	M113	M113				M113			
							SL-V	DL-V	SL-V				DL-V			
							Interior	Interior	Exterior				Exterior			
							OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)
							0	0	0	1	2	3	0	1	2	3
4	50	7	3846	36.98	15.65	103943	0.294	0.383	0.295	0.354	0.407	0.456	0.294	0.370	0.437	0.444
		8	3846	36.98	16.15	108679	0.286	0.372	0.304	0.360	0.404	0.446	0.307	0.376	0.433	0.434
		9	3846	36.98	16.65	113565	0.280	0.362	0.314	0.364	0.402	0.437	0.320	0.381	0.431	0.426
	70	7	5865	45.11	17.20	154750	0.281	0.388	0.291	0.358	0.402	0.450	0.290	0.358	0.430	0.455
		8	5865	45.11	17.50	158533	0.275	0.377	0.301	0.363	0.401	0.441	0.303	0.365	0.428	0.447
		9	5865	45.11	18.20	167614	0.269	0.364	0.311	0.367	0.399	0.433	0.316	0.372	0.427	0.441
	90	7	8964	64.44	17.70	234839	0.281	0.386	0.282	0.351	0.416	0.469	0.279	0.354	0.436	0.473
		8	8964	64.44	18.20	244157	0.274	0.376	0.293	0.355	0.414	0.460	0.293	0.362	0.436	0.467
		9	8964	64.44	18.70	253734	0.268	0.367	0.303	0.359	0.413	0.451	0.306	0.369	0.436	0.460
	110	7	13640	79.61	19.30	348757	0.275	0.379	0.293	0.324	0.402	0.463	0.275	0.347	0.434	0.472
		8	13640	79.61	19.80	361294	0.267	0.370	0.302	0.330	0.402	0.455	0.290	0.355	0.434	0.467
		9	13640	79.61	20.30	374152	0.260	0.362	0.311	0.335	0.401	0.447	0.304	0.362	0.433	0.460
	130	7	20833	90.14	21.85	514491	0.287	0.384	0.274	0.341	0.401	0.456	0.270	0.364	0.431	0.476
		8	20833	90.14	22.35	530539	0.278	0.374	0.282	0.347	0.400	0.448	0.283	0.373	0.431	0.470
		9	20833	90.14	22.85	546949	0.270	0.364	0.290	0.351	0.398	0.441	0.295	0.379	0.430	0.464
	140	7	25799	95.63	23.60	636881	0.288	0.386	0.272	0.311	0.371	0.410	0.267	0.347	0.411	0.434
		8	25799	95.63	24.10	655254	0.281	0.376	0.280	0.347	0.397	0.453	0.279	0.360	0.439	0.467
		9	25799	95.63	24.60	674012	0.274	0.366	0.287	0.352	0.396	0.445	0.291	0.366	0.438	0.462
5	50	7	4633	43.50	15.85	125354	0.352	0.446	0.328	0.399	0.458	0.487	0.361	0.432	0.459	0.489
		8	4633	43.50	16.35	130996	0.343	0.435	0.340	0.405	0.457	0.481	0.375	0.440	0.460	0.487
		9	4633	43.50	16.85	136813	0.335	0.425	0.351	0.409	0.455	0.475	0.389	0.447	0.460	0.483
	70	7	7042	62.90	16.35	192178	0.322	0.453	0.315	0.393	0.457	0.490	0.343	0.411	0.467	0.498
		8	7042	62.90	16.85	200589	0.313	0.442	0.328	0.398	0.455	0.484	0.357	0.418	0.460	0.488
		9	7042	62.90	17.35	209254	0.305	0.432	0.339	0.403	0.453	0.479	0.371	0.426	0.463	0.484
	90	7	10751	64.63	18.95	273565	0.334	0.458	0.316	0.391	0.455	0.503	0.341	0.404	0.469	0.515

		8	10751	64.63	19.45	283561	0.323	0.447	0.328	0.395	0.453	0.497	0.353	0.413	0.472	0.513
		9	10751	64.63	19.95	293818	0.314	0.435	0.339	0.400	0.452	0.492	0.368	0.422	0.475	0.509
	110	7	16376	72.84	21.55	404414	0.326	0.449	0.303	0.386	0.458	0.490	0.324	0.404	0.458	0.525
		8	16376	72.84	22.05	417205	0.315	0.436	0.313	0.391	0.456	0.485	0.339	0.414	0.474	0.524
		9	16376	72.84	22.55	430290	0.310	0.425	0.324	0.395	0.455	0.481	0.353	0.421	0.477	0.521
	130	7	25002	93.24	23.60	619738	0.335	0.447	0.296	0.382	0.454	0.492	0.333	0.402	0.490	0.533
		8	25002	93.24	24.10	637651	0.324	0.436	0.305	0.386	0.452	0.489	0.346	0.410	0.472	0.533
		9	25002	93.24	24.60	655941	0.314	0.427	0.316	0.390	0.450	0.484	0.360	0.417	0.475	0.531
	140	7	30911	97.85	25.43	758746	0.325	0.462	0.296	0.380	0.452	0.491	0.323	0.397	0.458	0.509
		8	30911	97.85	25.93	778988	0.314	0.450	0.306	0.385	0.450	0.488	0.335	0.405	0.456	0.503
		9	30911	97.85	26.43	799624	0.306	0.438	0.315	0.388	0.448	0.483	0.347	0.413	0.459	0.500
6	50	7	5578	50.98	16.10	151384	0.408	0.542	0.396	0.459	0.511	0.532	0.416	0.480	0.531	0.562
		8	5578	50.98	16.60	158099	0.399	0.525	0.409	0.465	0.513	0.531	0.433	0.490	0.536	0.562
		9	5578	50.98	17.10	165019	0.390	0.511	0.422	0.471	0.514	0.529	0.449	0.500	0.541	0.562
	70	7	8449	61.26	17.70	222665	0.409	0.552	0.383	0.455	0.508	0.555	0.399	0.481	0.526	0.581
		8	8449	61.26	18.20	231523	0.399	0.536	0.397	0.461	0.510	0.553	0.417	0.491	0.536	0.583
		9	8449	61.26	18.70	240628	0.389	0.521	0.410	0.466	0.512	0.551	0.434	0.501	0.543	0.584
	90	7	12964	66.12	20.45	327181	0.383	0.540	0.385	0.449	0.488	0.544	0.402	0.467	0.520	0.581
		8	12964	66.12	20.95	338206	0.373	0.524	0.397	0.455	0.491	0.544	0.417	0.478	0.533	0.590
		9	12964	66.12	21.45	349498	0.364	0.510	0.408	0.461	0.493	0.543	0.432	0.488	0.540	0.591
	110	7	19747	75.02	23.20	484346	0.395	0.533	0.375	0.447	0.484	0.522	0.401	0.485	0.520	0.582
		8	19747	75.02	23.70	498518	0.387	0.519	0.388	0.453	0.487	0.522	0.419	0.496	0.527	0.585
		9	19747	75.02	24.20	512992	0.379	0.505	0.400	0.458	0.489	0.522	0.436	0.507	0.533	0.588
	130	7	30171	95.60	25.50	743809	0.400	0.534	0.363	0.441	0.482	0.534	0.388	0.461	0.532	0.592
		8	30171	95.60	26.00	763639	0.393	0.517	0.373	0.447	0.485	0.535	0.403	0.472	0.528	0.582
		9	30171	95.60	26.50	783855	0.385	0.502	0.383	0.452	0.487	0.534	0.418	0.483	0.534	0.584
	140	7	37210	122.00	25.50	938798	0.406	0.558	0.357	0.438	0.490	0.538	0.374	0.457	0.517	0.580
		8	31032	97.70	26.00	782011	0.399	0.542	0.366	0.442	0.493	0.540	0.387	0.466	0.524	0.600
		9	31032	97.70	26.50	802670	0.391	0.528	0.375	0.446	0.495	0.540	0.400	0.474	0.530	0.603
7	50	7	6665	49.90	17.40	175391	0.434	0.614	0.430	0.481	0.533	0.590	0.472	0.532	0.578	0.630
		8	6665	49.90	17.90	182486	0.421	0.602	0.444	0.489	0.536	0.589	0.493	0.545	0.585	0.640
		9	6665	49.90	18.40	189782	0.409	0.591	0.456	0.495	0.539	0.587	0.512	0.558	0.593	0.642
	70	7	10257	61.84	19.00	262460	0.431	0.608	0.423	0.473	0.519	0.585	0.459	0.521	0.569	0.637

		8	10257	61.84	19.50	272049	0.417	0.595	0.436	0.480	0.523	0.584	0.479	0.534	0.579	0.639
		9	10257	61.84	20.00	281888	0.404	0.582	0.447	0.487	0.526	0.583	0.498	0.547	0.588	0.642
	90	7	15622	76.60	20.75	391525	0.426	0.604	0.415	0.464	0.510	0.580	0.446	0.513	0.565	0.636
		8	15622	76.60	21.25	404483	0.411	0.589	0.428	0.472	0.514	0.579	0.466	0.526	0.574	0.640
		9	15622	76.60	21.75	417750	0.397	0.574	0.440	0.478	0.517	0.578	0.485	0.540	0.583	0.644
	110	7	23722	89.58	23.40	586222	0.431	0.602	0.406	0.457	0.509	0.580	0.437	0.508	0.568	0.642
		8	23722	89.58	23.90	603289	0.418	0.586	0.417	0.463	0.512	0.580	0.456	0.523	0.579	0.647
		9	23722	89.58	24.40	620716	0.405	0.571	0.428	0.469	0.515	0.579	0.474	0.537	0.589	0.651
	130	7	36261	98.40	27.50	891557	0.439	0.596	0.402	0.451	0.502	0.574	0.439	0.503	0.566	0.648
		8	36261	98.40	28.00	913553	0.428	0.581	0.413	0.457	0.504	0.574	0.458	0.517	0.576	0.654
		9	36261	98.40	28.50	935946	0.417	0.566	0.424	0.462	0.507	0.573	0.478	0.530	0.586	0.659
	140	7	44826	117.37	28.50	1129065	0.443	0.599	0.390	0.446	0.500	0.575	0.419	0.490	0.562	0.647
		8	44826	117.37	29.00	1156247	0.432	0.584	0.399	0.450	0.503	0.577	0.434	0.510	0.572	0.643
		9	44826	117.37	29.50	1183903	0.422	0.570	0.408	0.456	0.505	0.576	0.450	0.523	0.582	0.647
8	50	7	8024	50.04	18.70	205598	0.497	0.661	0.458	0.518	0.589	0.644	0.507	0.576	0.652	0.696
		8	8024	50.04	19.20	213237	0.481	0.643	0.472	0.526	0.591	0.644	0.528	0.591	0.661	0.702
		9	8024	50.04	19.70	221077	0.468	0.627	0.484	0.533	0.593	0.643	0.545	0.605	0.670	0.706
	70	7	12249	57.56	21.75	318021	0.503	0.671	0.442	0.501	0.580	0.643	0.494	0.562	0.644	0.700
		8	12249	57.56	22.25	328222	0.487	0.653	0.456	0.509	0.583	0.644	0.515	0.578	0.657	0.706
		9	12249	57.56	22.75	338655	0.473	0.637	0.468	0.517	0.586	0.644	0.533	0.592	0.667	0.711
	90	7	18704	81.11	21.75	459764	0.498	0.669	0.437	0.503	0.576	0.638	0.492	0.562	0.642	0.700
		8	15599	69.21	22.25	401668	0.482	0.650	0.451	0.512	0.580	0.638	0.513	0.579	0.652	0.705
		9	15599	69.21	22.75	414213	0.467	0.633	0.464	0.520	0.583	0.638	0.531	0.593	0.661	0.711
	110	7	28568	91.18	25.50	707743	0.506	0.673	0.424	0.487	0.571	0.632	0.475	0.551	0.631	0.700
		8	28568	91.18	26.00	726657	0.491	0.656	0.437	0.495	0.574	0.634	0.494	0.565	0.646	0.712
		9	28568	91.18	26.50	745938	0.476	0.639	0.449	0.502	0.578	0.633	0.511	0.578	0.655	0.719
	130	7	43605	101.06	29.50	1059728	0.505	0.679	0.418	0.482	0.568	0.631	0.475	0.544	0.633	0.695
		8	43605	101.06	30.00	1083948	0.490	0.662	0.430	0.489	0.572	0.632	0.492	0.557	0.643	0.717
		9	43605	101.06	30.50	1108574	0.476	0.645	0.442	0.496	0.575	0.632	0.510	0.569	0.652	0.723
	140	7	53928	121.04	30.50	1341455	0.513	0.683	0.411	0.477	0.565	0.631	0.462	0.538	0.628	0.707
		8	53928	121.04	31.00	1371438	0.500	0.666	0.422	0.484	0.568	0.633	0.479	0.549	0.637	0.710
		9	53928	121.04	31.50	1401908	0.485	0.649	0.433	0.490	0.570	0.633	0.496	0.561	0.646	0.716

Table C. 3 Bending Moment Live Load Distribution Factor for M2-BRADLEY

MILITARY VEHICLE : M2-BRADLEY

							M2	M2		M2				M2			
							SL-M	DL-M		SL-M				DL-M			
							Interior	Interior		Exterior				Exterior			
							OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)
Spacing (ft)	Span (ft)	thickness (in)	Inertia (in^4)	Area (in^2)	eg (in)	Kg	0	0	1	0	1	2	3	0	1	2	3
4	50	7	3846	36.98	15.65	103943	0.187	-----	0.303	0.205	0.225	0.244	0.262	-----	0.304	0.327	0.347
		8	3846	36.98	16.15	108679	0.187	-----	0.300	0.205	0.223	0.241	0.258	-----	0.303	0.325	0.345
		9	3846	36.98	16.65	113565	0.186	-----	0.297	0.204	0.222	0.238	0.254	-----	0.303	0.324	0.344
	70	7	5865	45.11	17.20	154750	0.187	-----	0.299	0.206	0.222	0.240	0.256	-----	0.302	0.324	0.346
		8	5865	45.11	17.50	158533	0.187	-----	0.296	0.205	0.220	0.236	0.251	-----	0.301	0.323	0.344
		9	5865	45.11	18.20	167614	0.186	-----	0.295	0.204	0.218	0.234	0.248	-----	0.301	0.323	0.343
	90	7	8964	64.44	17.70	234839	0.187	-----	0.296	0.207	0.222	0.235	0.251	-----	0.307	0.326	0.344
		8	8964	64.44	18.20	244157	0.186	-----	0.295	0.205	0.220	0.232	0.246	-----	0.306	0.325	0.342
		9	8964	64.44	18.70	253734	0.185	-----	0.294	0.204	0.217	0.228	0.242	-----	0.306	0.324	0.341
	110	7	13640	79.61	19.30	348757	0.186	-----	0.295	0.206	0.220	0.231	0.244	-----	0.305	0.321	0.338
		8	13640	79.61	19.80	361294	0.185	-----	0.293	0.204	0.218	0.228	0.240	-----	0.304	0.320	0.337
		9	13640	79.61	20.30	374152	0.184	-----	0.293	0.203	0.215	0.224	0.236	-----	0.304	0.319	0.335
	130	7	20833	90.14	21.85	514491	0.185	-----	0.296	0.203	0.217	0.232	0.244	-----	0.299	0.323	0.343
		8	20833	90.14	22.35	530539	0.184	-----	0.294	0.202	0.214	0.229	0.240	-----	0.299	0.321	0.342
		9	20833	90.14	22.85	546949	0.183	-----	0.293	0.200	0.211	0.225	0.236	-----	0.298	0.320	0.340
	140	7	25799	95.63	23.60	636881	0.185	-----	0.297	0.204	0.217	0.230	0.240	-----	0.301	0.320	0.340
		8	25799	95.63	24.10	655254	0.184	-----	0.295	0.202	0.215	0.226	0.237	-----	0.300	0.319	0.338
		9	25799	95.63	24.60	674012	0.183	-----	0.294	0.201	0.212	0.223	0.234	-----	0.300	0.318	0.336
5	50	7	4633	43.50	15.85	125354	0.250	-----	0.376	0.289	0.333	0.371	0.405	-----	0.359	0.401	0.442
		8	4633	43.50	16.35	130996	0.251	-----	0.371	0.290	0.332	0.368	0.401	-----	0.359	0.401	0.442
		9	4633	43.50	16.85	136813	0.251	-----	0.368	0.290	0.330	0.365	0.397	-----	0.359	0.400	0.442
	70	7	7042	62.90	16.35	192178	0.246	-----	0.366	0.286	0.322	0.352	0.380	-----	0.358	0.397	0.436
		8	7042	62.90	16.85	200589	0.246	-----	0.362	0.286	0.320	0.348	0.375	-----	0.358	0.397	0.433
		9	7042	62.90	17.35	209254	0.245	-----	0.359	0.286	0.317	0.344	0.370	-----	0.358	0.396	0.432
	90	7	10751	64.63	18.95	273565	0.243	-----	0.362	0.283	0.316	0.343	0.367	-----	0.360	0.396	0.430

		8	10751	64.63	19.45	283561	0.242	-----	0.359	0.283	0.313	0.339	0.362	-----	0.360	0.395	0.428
		9	10751	64.63	19.95	293818	0.241	-----	0.356	0.282	0.310	0.334	0.356	-----	0.360	0.394	0.426
	110	7	16376	72.84	21.55	404414	0.240	-----	0.357	0.279	0.308	0.332	0.356	-----	0.354	0.394	0.430
		8	16376	72.84	22.05	417205	0.239	-----	0.354	0.278	0.305	0.328	0.351	-----	0.354	0.391	0.427
		9	16376	72.84	22.55	430290	0.238	-----	0.352	0.276	0.302	0.324	0.346	-----	0.354	0.391	0.426
	130	7	25002	93.24	23.60	619738	0.238	-----	0.354	0.275	0.301	0.325	0.347	-----	0.354	0.392	0.427
		8	25002	93.24	24.10	637651	0.237	-----	0.351	0.273	0.298	0.321	0.342	-----	0.354	0.391	0.426
		9	25002	93.24	24.60	655941	0.236	-----	0.349	0.271	0.294	0.316	0.336	-----	0.354	0.390	0.424
	140	7	30911	97.85	25.43	758746	0.236	-----	0.359	0.275	0.303	0.325	0.345	-----	0.361	0.391	0.423
		8	30911	97.85	25.93	778988	0.235	-----	0.356	0.274	0.299	0.320	0.340	-----	0.360	0.390	0.421
		9	30911	97.85	26.43	799624	0.233	-----	0.354	0.272	0.296	0.316	0.335	-----	0.360	0.389	0.420
6	50	7	5578	50.98	16.10	151384	0.294	-----	0.462	0.338	0.380	0.419	0.455	-----	0.419	0.465	0.507
		8	5578	50.98	16.60	158099	0.293	-----	0.455	0.339	0.379	0.418	0.452	-----	0.420	0.465	0.509
		9	5578	50.98	17.10	165019	0.292	-----	0.449	0.340	0.379	0.416	0.449	-----	0.420	0.466	0.510
	70	7	8449	61.26	17.70	222665	0.291	-----	0.446	0.333	0.365	0.401	0.436	-----	0.413	0.459	0.506
		8	8449	61.26	18.20	231523	0.289	-----	0.441	0.334	0.364	0.398	0.432	-----	0.414	0.460	0.507
		9	8449	61.26	18.70	240628	0.288	-----	0.436	0.334	0.363	0.396	0.428	-----	0.416	0.461	0.507
	90	7	12964	66.12	20.45	327181	0.285	-----	0.440	0.332	0.363	0.394	0.420	-----	0.420	0.464	0.495
		8	12964	66.12	20.95	338206	0.283	-----	0.435	0.332	0.361	0.391	0.416	-----	0.421	0.465	0.495
		9	12964	66.12	21.45	349498	0.282	-----	0.431	0.331	0.359	0.387	0.411	-----	0.422	0.465	0.495
	110	7	19747	75.02	23.20	484346	0.280	-----	0.436	0.328	0.357	0.383	0.411	-----	0.418	0.455	0.506
		8	19747	75.02	23.70	498518	0.278	-----	0.432	0.328	0.355	0.379	0.407	-----	0.419	0.456	0.506
		9	19747	75.02	24.20	512992	0.276	-----	0.428	0.326	0.352	0.375	0.402	-----	0.420	0.456	0.505
	130	7	30171	95.60	25.50	743809	0.277	-----	0.432	0.323	0.348	0.374	0.401	-----	0.415	0.459	0.504
		8	30171	95.60	26.00	763639	0.275	-----	0.428	0.322	0.346	0.370	0.397	-----	0.415	0.459	0.504
		9	30171	95.60	26.50	783855	0.273	-----	0.425	0.321	0.343	0.367	0.392	-----	0.416	0.458	0.503
	140	7	37210	122.00	25.50	938798	0.275	-----	0.429	0.321	0.346	0.373	0.394	-----	0.416	0.460	0.493
		8	31032	97.70	26.00	782011	0.273	-----	0.426	0.320	0.343	0.369	0.389	-----	0.416	0.460	0.492
		9	31032	97.70	26.50	802670	0.271	-----	0.423	0.318	0.340	0.365	0.384	-----	0.417	0.460	0.491
7	50	7	6665	49.90	17.40	175391	0.337	0.525	0.531	0.367	0.409	0.449	0.486	0.402	0.452	0.500	0.542
		8	6665	49.90	17.90	182486	0.333	0.517	0.524	0.369	0.410	0.450	0.486	0.404	0.455	0.501	0.547
		9	6665	49.90	18.40	189782	0.329	0.511	0.516	0.370	0.411	0.449	0.484	0.407	0.457	0.503	0.551
	70	7	10257	61.84	19.00	262460	0.323	0.500	0.503	0.360	0.399	0.436	0.469	0.405	0.456	0.505	0.546

		8	10257	61.84	19.50	272049	0.319	0.493	0.495	0.361	0.399	0.434	0.467	0.409	0.459	0.508	0.546
		9	10257	61.84	20.00	281888	0.315	0.486	0.488	0.362	0.398	0.432	0.464	0.413	0.462	0.510	0.549
	90	7	15622	76.60	20.75	391525	0.312	0.483	0.486	0.359	0.393	0.424	0.450	0.417	0.463	0.505	0.539
		8	15622	76.60	21.25	404483	0.308	0.476	0.479	0.359	0.392	0.422	0.447	0.421	0.466	0.505	0.538
		9	15622	76.60	21.75	417750	0.306	0.470	0.472	0.359	0.390	0.419	0.443	0.425	0.469	0.508	0.540
	110	7	23722	89.58	23.40	586222	0.305	0.474	0.475	0.354	0.385	0.413	0.441	0.417	0.464	0.506	0.549
		8	23722	89.58	23.90	603289	0.302	0.468	0.469	0.354	0.383	0.410	0.437	0.420	0.467	0.508	0.551
		9	23722	89.58	24.40	620716	0.300	0.462	0.465	0.353	0.381	0.407	0.433	0.424	0.469	0.510	0.552
	130	7	36261	98.40	27.50	891557	0.302	0.465	0.466	0.351	0.380	0.407	0.431	0.424	0.467	0.509	0.542
		8	36261	98.40	28.00	913553	0.299	0.458	0.464	0.350	0.378	0.404	0.427	0.427	0.469	0.510	0.544
		9	36261	98.40	28.50	935946	0.297	0.453	0.463	0.349	0.376	0.400	0.423	0.430	0.471	0.511	0.545
	140	7	44826	117.37	28.50	1129065	0.299	0.466	0.466	0.349	0.377	0.405	0.426	0.420	0.462	0.506	0.541
		8	44826	117.37	29.00	1156247	0.297	0.460	0.460	0.348	0.375	0.402	0.422	0.423	0.464	0.507	0.542
		9	44826	117.37	29.50	1183903	0.294	0.455	0.458	0.347	0.373	0.398	0.418	0.426	0.465	0.508	0.542
8	50	7	8024	50.04	18.70	205598	0.386	-----	0.571	0.404	0.446	0.482	0.531	-----	0.494	0.538	0.596
		8	8024	50.04	19.20	213237	0.380	-----	0.568	0.406	0.448	0.484	0.532	-----	0.496	0.542	0.598
		9	8024	50.04	19.70	221077	0.375	-----	0.565	0.408	0.449	0.485	0.531	-----	0.499	0.545	0.601
	70	7	12249	57.56	21.75	318021	0.368	-----	0.563	0.405	0.444	0.478	0.521	-----	0.502	0.544	0.601
		8	12249	57.56	22.25	328222	0.362	-----	0.560	0.407	0.444	0.478	0.520	-----	0.505	0.548	0.606
		9	12249	57.56	22.75	338655	0.357	-----	0.556	0.408	0.444	0.477	0.517	-----	0.508	0.552	0.609
	90	7	18704	81.11	21.75	459764	0.349	-----	0.555	0.400	0.434	0.461	0.497	-----	0.517	0.551	0.594
		8	15599	69.21	22.25	401668	0.344	-----	0.552	0.401	0.433	0.460	0.494	-----	0.520	0.554	0.595
		9	15599	69.21	22.75	414213	0.339	-----	0.549	0.401	0.432	0.457	0.490	-----	0.523	0.556	0.597
	110	7	28568	91.18	25.50	707743	0.341	-----	0.544	0.397	0.428	0.457	0.489	-----	0.506	0.552	0.605
		8	28568	91.18	26.00	726657	0.336	-----	0.541	0.397	0.427	0.455	0.486	-----	0.509	0.555	0.604
		9	28568	91.18	26.50	745938	0.332	-----	0.538	0.396	0.425	0.452	0.482	-----	0.511	0.557	0.606
	130	7	43605	101.06	29.50	1059728	0.337	-----	0.546	0.394	0.424	0.449	0.479	-----	0.518	0.555	0.600
		8	43605	101.06	30.00	1083948	0.332	-----	0.543	0.394	0.423	0.447	0.476	-----	0.520	0.557	0.604
		9	43605	101.06	30.50	1108574	0.329	-----	0.540	0.393	0.421	0.444	0.472	-----	0.521	0.559	0.605
	140	7	53928	121.04	30.50	1341455	0.334	-----	0.543	0.392	0.422	0.446	0.475	-----	0.516	0.553	0.598
		8	53928	121.04	31.00	1371438	0.330	-----	0.540	0.392	0.420	0.443	0.471	-----	0.518	0.555	0.601
		9	53928	121.04	31.50	1401908	0.326	-----	0.537	0.391	0.417	0.440	0.467	-----	0.519	0.556	0.601

Table C. 4 Shear Force Live Load Distribution Factor for M2-BRADLEY

MILITARY VEHICLE : M2-BRADLEY

							M2	M2		M2				M2			
							SL-V	DL-V		SL-V				DL-V			
							Interior	Interior		Exterior				Exterior			
							OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)
Spacing (ft)	Span (ft)	thickness (in)	Inertia (in^4)	Area (in^2)	eg (in)	Kg	0	0	1	0	1	2	3	0	1	2	3
4	50	7	3846	36.98	15.65	103943	0.236	-----	0.342	0.308	0.350	0.361	0.389	-----	0.373	0.386	0.378
		8	3846	36.98	16.15	108679	0.231	-----	0.333	0.317	0.352	0.360	0.382	-----	0.374	0.384	0.372
		9	3846	36.98	16.65	113565	0.227	-----	0.325	0.324	0.354	0.358	0.377	-----	0.377	0.382	0.366
	70	7	5865	45.11	17.20	154750	0.234	-----	0.351	0.300	0.342	0.349	0.390	-----	0.363	0.369	0.381
		8	5865	45.11	17.50	158533	0.230	-----	0.342	0.308	0.345	0.349	0.384	-----	0.365	0.369	0.376
		9	5865	45.11	18.20	167614	0.226	-----	0.335	0.315	0.348	0.348	0.379	-----	0.368	0.368	0.373
	90	7	8964	64.44	17.70	234839	0.240	-----	0.352	0.292	0.339	0.371	0.419	-----	0.358	0.373	0.395
		8	8964	64.44	18.20	244157	0.235	-----	0.344	0.299	0.341	0.371	0.411	-----	0.361	0.374	0.390
		9	8964	64.44	18.70	253734	0.230	-----	0.336	0.306	0.344	0.370	0.405	-----	0.365	0.375	0.386
	110	7	13640	79.61	19.30	348757	0.236	-----	0.347	0.285	0.338	0.345	0.394	-----	0.356	0.371	0.403
		8	13640	79.61	19.80	361294	0.231	-----	0.339	0.291	0.341	0.346	0.390	-----	0.360	0.373	0.402
		9	13640	79.61	20.30	374152	0.226	-----	0.331	0.297	0.343	0.346	0.386	-----	0.364	0.374	0.399
	130	7	20833	90.14	21.85	514491	0.242	-----	0.357	0.281	0.331	0.337	0.396	-----	0.352	0.356	0.392
		8	20833	90.14	22.35	530539	0.235	-----	0.350	0.286	0.333	0.338	0.393	-----	0.356	0.360	0.391
		9	20833	90.14	22.85	546949	0.230	-----	0.344	0.292	0.336	0.338	0.389	-----	0.360	0.362	0.390
	140	7	25799	95.63	23.60	636881	0.233	-----	0.352	0.279	0.304	0.326	0.361	-----	0.347	0.356	0.383
		8	25799	95.63	24.10	655254	0.228	-----	0.351	0.284	0.331	0.340	0.391	-----	0.364	0.364	0.392
		9	25799	95.63	24.60	674012	0.224	-----	0.344	0.288	0.333	0.341	0.388	-----	0.368	0.367	0.391
5	50	7	4633	43.50	15.85	125354	0.297	-----	0.404	0.327	0.369	0.421	0.461	-----	0.394	0.442	0.469
		8	4633	43.50	16.35	130996	0.290	-----	0.396	0.337	0.377	0.422	0.455	-----	0.400	0.441	0.448
		9	4633	43.50	16.85	136813	0.284	-----	0.388	0.347	0.382	0.422	0.449	-----	0.405	0.441	0.444
	70	7	7042	62.90	16.35	192178	0.285	-----	0.394	0.314	0.365	0.413	0.464	-----	0.384	0.446	0.460
		8	7042	62.90	16.85	200589	0.278	-----	0.386	0.324	0.372	0.415	0.459	-----	0.390	0.447	0.453
		9	7042	62.90	17.35	209254	0.272	-----	0.378	0.334	0.378	0.415	0.453	-----	0.396	0.448	0.451
	90	7	10751	64.63	18.95	273565	0.276	-----	0.402	0.322	0.357	0.409	0.456	-----	0.380	0.439	0.464

		8	10751	64.63	19.45	283561	0.268	-----	0.393	0.331	0.364	0.411	0.450	-----	0.387	0.441	0.486
		9	10751	64.63	19.95	293818	0.262	-----	0.386	0.340	0.370	0.412	0.446	-----	0.394	0.443	0.483
	110	7	16376	72.84	21.55	404414	0.285	-----	0.408	0.319	0.345	0.403	0.469	-----	0.372	0.433	0.463
		8	16376	72.84	22.05	417205	0.278	-----	0.401	0.328	0.352	0.405	0.462	-----	0.380	0.436	0.465
		9	16376	72.84	22.55	430290	0.271	-----	0.394	0.336	0.357	0.406	0.457	-----	0.387	0.438	0.463
	130	7	25002	93.24	23.60	619738	0.285	-----	0.419	0.305	0.338	0.416	0.476	-----	0.375	0.451	0.497
		8	25002	93.24	24.10	637651	0.279	-----	0.411	0.313	0.345	0.418	0.471	-----	0.382	0.454	0.482
		9	25002	93.24	24.60	655941	0.273	-----	0.404	0.320	0.350	0.420	0.466	-----	0.389	0.458	0.479
	140	7	30911	97.85	25.43	758746	0.283	-----	0.405	0.295	0.345	0.399	0.462	-----	0.372	0.439	0.466
		8	30911	97.85	25.93	778988	0.276	-----	0.397	0.302	0.352	0.402	0.459	-----	0.380	0.443	0.463
		9	30911	97.85	26.43	799624	0.270	-----	0.390	0.310	0.358	0.404	0.455	-----	0.387	0.446	0.462
6	50	7	5578	50.98	16.10	151384	0.349	-----	0.497	0.361	0.425	0.478	0.510	-----	0.437	0.492	0.522
		8	5578	50.98	16.60	158099	0.339	-----	0.483	0.373	0.431	0.478	0.507	-----	0.446	0.496	0.520
		9	5578	50.98	17.10	165019	0.330	-----	0.470	0.385	0.437	0.478	0.503	-----	0.453	0.499	0.519
	70	7	8449	61.26	17.70	222665	0.359	-----	0.477	0.350	0.419	0.476	0.511	-----	0.445	0.491	0.535
		8	8449	61.26	18.20	231523	0.348	-----	0.462	0.362	0.426	0.477	0.508	-----	0.455	0.496	0.535
		9	8449	61.26	18.70	240628	0.339	-----	0.449	0.375	0.433	0.478	0.505	-----	0.464	0.500	0.535
	90	7	12964	66.12	20.45	327181	0.334	-----	0.487	0.358	0.420	0.470	0.511	-----	0.434	0.485	0.534
		8	12964	66.12	20.95	338206	0.323	-----	0.475	0.371	0.426	0.471	0.509	-----	0.443	0.491	0.536
		9	12964	66.12	21.45	349498	0.313	-----	0.463	0.383	0.432	0.472	0.506	-----	0.453	0.497	0.537
	110	7	19747	75.02	23.20	484346	0.352	-----	0.497	0.341	0.414	0.470	0.501	-----	0.416	0.489	0.546
		8	19747	75.02	23.70	498518	0.341	-----	0.483	0.353	0.420	0.470	0.500	-----	0.428	0.495	0.549
		9	19747	75.02	24.20	512992	0.330	-----	0.470	0.364	0.425	0.471	0.498	-----	0.438	0.501	0.551
	130	7	30171	95.60	25.50	743809	0.353	-----	0.494	0.329	0.409	0.467	0.507	-----	0.434	0.489	0.545
		8	30171	95.60	26.00	763639	0.342	-----	0.481	0.340	0.414	0.468	0.506	-----	0.445	0.496	0.548
		9	30171	95.60	26.50	783855	0.331	-----	0.469	0.351	0.420	0.468	0.504	-----	0.454	0.502	0.550
	140	7	37210	122.00	25.50	938798	0.357	-----	0.500	0.321	0.402	0.466	0.506	-----	0.425	0.483	0.541
		8	31032	97.70	26.00	782011	0.347	-----	0.486	0.331	0.406	0.466	0.506	-----	0.435	0.489	0.545
		9	31032	97.70	26.50	802670	0.336	-----	0.473	0.341	0.411	0.466	0.504	-----	0.444	0.494	0.546
7	50	7	6665	49.90	17.40	175391	0.382	0.572	0.567	0.409	0.465	0.505	0.521	0.434	0.495	0.542	0.551
		8	6665	49.90	17.90	182486	0.374	0.553	0.554	0.422	0.473	0.507	0.523	0.450	0.506	0.548	0.551
		9	6665	49.90	18.40	189782	0.366	0.536	0.544	0.434	0.479	0.510	0.523	0.465	0.516	0.554	0.554
	70	7	10257	61.84	19.00	262460	0.386	0.566	0.559	0.401	0.464	0.498	0.511	0.427	0.494	0.524	0.547

		8	10257	61.84	19.50	272049	0.378	0.547	0.546	0.413	0.470	0.501	0.512	0.443	0.506	0.535	0.548
		9	10257	61.84	20.00	281888	0.370	0.531	0.534	0.425	0.476	0.503	0.512	0.460	0.516	0.542	0.553
	90	7	15622	76.60	20.75	391525	0.380	0.569	0.562	0.391	0.463	0.495	0.501	0.410	0.488	0.524	0.544
		8	15622	76.60	21.25	404483	0.373	0.551	0.549	0.403	0.470	0.498	0.503	0.427	0.499	0.538	0.552
		9	15622	76.60	21.75	417750	0.364	0.534	0.538	0.415	0.476	0.501	0.503	0.443	0.510	0.546	0.557
	110	7	23722	89.58	23.40	586222	0.379	0.573	0.568	0.386	0.451	0.491	0.503	0.407	0.491	0.521	0.545
		8	23722	89.58	23.90	603289	0.371	0.555	0.556	0.397	0.457	0.494	0.505	0.422	0.502	0.530	0.562
		9	23722	89.58	24.40	620716	0.364	0.539	0.545	0.408	0.463	0.497	0.507	0.437	0.514	0.538	0.568
	130	7	36261	98.40	27.50	891557	0.378	0.565	0.563	0.378	0.442	0.488	0.494	0.406	0.467	0.531	0.551
		8	36261	98.40	28.00	913553	0.370	0.547	0.551	0.387	0.448	0.490	0.496	0.419	0.478	0.528	0.561
		9	36261	98.40	28.50	935946	0.363	0.529	0.539	0.397	0.454	0.493	0.498	0.434	0.490	0.536	0.568
	140	7	44826	117.37	28.50	1129065	0.386	0.589	0.574	0.372	0.442	0.485	0.497	0.393	0.466	0.510	0.543
		8	44826	117.37	29.00	1156247	0.380	0.573	0.563	0.380	0.446	0.488	0.501	0.404	0.475	0.520	0.549
		9	44826	117.37	29.50	1183903	0.372	0.556	0.553	0.389	0.451	0.491	0.504	0.418	0.485	0.528	0.555
8	50	7	8024	50.04	18.70	205598	0.409	-----	0.554	0.452	0.497	0.526	0.555	-----	0.530	0.565	0.598
		8	8024	50.04	19.20	213237	0.399	-----	0.542	0.466	0.505	0.531	0.558	-----	0.542	0.575	0.606
		9	8024	50.04	19.70	221077	0.388	-----	0.531	0.478	0.513	0.535	0.559	-----	0.552	0.583	0.612
	70	7	12249	57.56	21.75	318021	0.414	-----	0.559	0.438	0.492	0.506	0.550	-----	0.534	0.560	0.598
		8	12249	57.56	22.25	328222	0.403	-----	0.547	0.452	0.500	0.511	0.554	-----	0.546	0.571	0.613
		9	12249	57.56	22.75	338655	0.393	-----	0.537	0.464	0.507	0.517	0.556	-----	0.556	0.580	0.620
	90	7	18704	81.11	21.75	459764	0.414	-----	0.557	0.434	0.487	0.506	0.550	-----	0.525	0.561	0.606
		8	15599	69.21	22.25	401668	0.402	-----	0.546	0.449	0.495	0.512	0.553	-----	0.536	0.572	0.620
		9	15599	69.21	22.75	414213	0.390	-----	0.535	0.463	0.503	0.518	0.555	-----	0.547	0.583	0.627
	110	7	28568	91.18	25.50	707743	0.422	-----	0.566	0.423	0.478	0.492	0.545	-----	0.516	0.541	0.602
		8	28568	91.18	26.00	726657	0.410	-----	0.555	0.436	0.486	0.499	0.550	-----	0.528	0.554	0.613
		9	28568	91.18	26.50	745938	0.398	-----	0.544	0.447	0.493	0.504	0.552	-----	0.539	0.566	0.620
	130	7	43605	101.06	29.50	1059728	0.420	-----	0.573	0.421	0.474	0.502	0.553	-----	0.520	0.551	0.611
		8	43605	101.06	30.00	1083948	0.409	-----	0.562	0.431	0.481	0.509	0.558	-----	0.532	0.564	0.628
		9	43605	101.06	30.50	1108574	0.398	-----	0.551	0.441	0.486	0.514	0.561	-----	0.543	0.574	0.635
	140	7	53928	121.04	30.50	1341455	0.426	-----	0.574	0.412	0.469	0.488	0.540	-----	0.509	0.544	0.600
		8	53928	121.04	31.00	1371438	0.416	-----	0.564	0.421	0.475	0.494	0.545	-----	0.520	0.556	0.614
		9	53928	121.04	31.50	1401908	0.405	-----	0.553	0.430	0.481	0.498	0.548	-----	0.530	0.566	0.623

Table C. 5 Bending Moment Live Load Distribution Factor for M1-ABRAMS

MILITARY VEHICLE : M1-ABRAMS							M1	M1			M1				M1			
							SL-M	DL-M			SL-M				DL-M			
							Interior	Interior			Exterior				Exterior			
							OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)
Spacing (ft)	Span (ft)	thickness (in)	Inertia (in^4)	Area (in^2)	eg (in)	Kg	0	0	1	2	0	1	2	3	0	1	2	3
4	50	7	3846	36.98	15.65	103943	0.183	-----	-----	0.301	0.202	0.220	0.238	0.254	-----	-----	0.320	0.339
		8	3846	36.98	16.15	108679	0.183	-----	-----	0.298	0.201	0.218	0.235	0.251	-----	-----	0.318	0.338
		9	3846	36.98	16.65	113565	0.183	-----	-----	0.295	0.201	0.217	0.232	0.247	-----	-----	0.317	0.336
	70	7	5865	45.11	17.20	154750	0.184	-----	-----	0.297	0.202	0.218	0.234	0.249	-----	-----	0.317	0.337
		8	5865	45.11	17.50	158533	0.183	-----	-----	0.294	0.202	0.216	0.231	0.245	-----	-----	0.316	0.335
		9	5865	45.11	18.20	167614	0.183	-----	-----	0.293	0.201	0.214	0.228	0.241	-----	-----	0.315	0.333
	90	7	8964	64.44	17.70	234839	0.183	-----	-----	0.296	0.200	0.218	0.231	0.245	-----	-----	0.319	0.339
		8	8964	64.44	18.20	244157	0.183	-----	-----	0.296	0.199	0.215	0.228	0.240	-----	-----	0.318	0.337
		9	8964	64.44	18.70	253734	0.182	-----	-----	0.295	0.198	0.213	0.225	0.237	-----	-----	0.316	0.336
	110	7	13640	79.61	19.30	348757	0.183	-----	-----	0.295	0.201	0.216	0.229	0.239	-----	-----	0.316	0.332
		8	13640	79.61	19.80	361294	0.182	-----	-----	0.294	0.200	0.214	0.225	0.235	-----	-----	0.315	0.330
		9	13640	79.61	20.30	374152	0.181	-----	-----	0.294	0.199	0.211	0.222	0.231	-----	-----	0.314	0.329
	130	7	20833	90.14	21.85	514491	0.182	-----	-----	0.293	0.201	0.213	0.225	0.239	-----	-----	0.311	0.332
		8	20833	90.14	22.35	530539	0.182	-----	-----	0.292	0.200	0.210	0.221	0.235	-----	-----	0.310	0.331
		9	20833	90.14	22.85	546949	0.180	-----	-----	0.292	0.198	0.208	0.218	0.231	-----	-----	0.308	0.329
	140	7	25799	95.63	23.60	636881	0.182	-----	-----	0.295	0.201	0.213	0.225	0.236	-----	-----	0.313	0.330
		8	25799	95.63	24.10	655254	0.181	-----	-----	0.293	0.200	0.211	0.222	0.233	-----	-----	0.311	0.329
		9	25799	95.63	24.60	674012	0.180	-----	-----	0.292	0.198	0.209	0.219	0.229	-----	-----	0.310	0.327
5	50	7	4633	43.50	15.85	125354	0.242	-----	-----	0.367	0.284	0.319	0.355	0.390	-----	-----	0.390	0.430
		8	4633	43.50	16.35	130996	0.243	-----	-----	0.363	0.284	0.318	0.352	0.386	-----	-----	0.388	0.429
		9	4633	43.50	16.85	136813	0.244	-----	-----	0.359	0.284	0.317	0.350	0.382	-----	-----	0.387	0.427
	70	7	7042	62.90	16.35	192178	0.240	-----	-----	0.360	0.280	0.309	0.339	0.367	-----	-----	0.384	0.421
		8	7042	62.90	16.85	200589	0.240	-----	-----	0.356	0.280	0.307	0.335	0.363	-----	-----	0.383	0.420
		9	7042	62.90	17.35	209254	0.239	-----	-----	0.354	0.279	0.305	0.332	0.358	-----	-----	0.382	0.418
	90	7	10751	64.63	18.95	273565	0.237	-----	-----	0.359	0.277	0.304	0.331	0.355	-----	-----	0.382	0.416

		8	10751	64.63	19.45	283561	0.237	-----	-----	0.356	0.277	0.302	0.327	0.350	-----	-----	0.381	0.413
		9	10751	64.63	19.95	293818	0.236	-----	-----	0.353	0.275	0.299	0.323	0.345	-----	-----	0.380	0.411
		7	16376	72.84	21.55	404414	0.235	-----	-----	0.353	0.273	0.298	0.321	0.345	-----	-----	0.376	0.415
	110	8	16376	72.84	22.05	417205	0.234	-----	-----	0.352	0.272	0.295	0.318	0.340	-----	-----	0.377	0.412
		9	16376	72.84	22.55	430290	0.233	-----	-----	0.350	0.271	0.293	0.314	0.336	-----	-----	0.376	0.411
		7	25002	93.24	23.60	619738	0.233	-----	-----	0.353	0.269	0.292	0.315	0.336	-----	-----	0.378	0.412
	130	8	25002	93.24	24.10	637651	0.232	-----	-----	0.351	0.268	0.289	0.311	0.331	-----	-----	0.376	0.410
		9	25002	93.24	24.60	655941	0.231	-----	-----	0.349	0.266	0.286	0.307	0.326	-----	-----	0.375	0.408
		7	30911	97.85	25.43	758746	0.231	-----	-----	0.355	0.270	0.293	0.315	0.335	-----	-----	0.380	0.408
	140	8	30911	97.85	25.93	778988	0.230	-----	-----	0.353	0.268	0.290	0.310	0.330	-----	-----	0.378	0.407
		9	30911	97.85	26.43	799624	0.229	-----	-----	0.351	0.267	0.287	0.306	0.325	-----	-----	0.377	0.405
		7	5578	50.98	16.10	151384	0.283	-----	-----	0.451	0.330	0.371	0.408	0.443	-----	-----	0.452	0.493
	50	8	5578	50.98	16.60	158099	0.282	-----	-----	0.444	0.332	0.371	0.406	0.441	-----	-----	0.452	0.493
		9	5578	50.98	17.10	165019	0.282	-----	-----	0.438	0.332	0.370	0.404	0.438	-----	-----	0.452	0.493
		7	8449	61.26	17.70	222665	0.281	-----	-----	0.437	0.327	0.359	0.390	0.425	-----	-----	0.443	0.489
	70	8	8449	61.26	18.20	231523	0.281	-----	-----	0.432	0.327	0.358	0.387	0.421	-----	-----	0.443	0.489
		9	8449	61.26	18.70	240628	0.279	-----	-----	0.427	0.327	0.356	0.385	0.417	-----	-----	0.444	0.489
		7	12964	66.12	20.45	327181	0.277	-----	-----	0.432	0.325	0.355	0.383	0.413	-----	-----	0.447	0.486
	90	8	12964	66.12	20.95	338206	0.275	-----	-----	0.427	0.325	0.353	0.381	0.408	-----	-----	0.447	0.486
6		9	12964	66.12	21.45	349498	0.274	-----	-----	0.424	0.324	0.351	0.377	0.404	-----	-----	0.447	0.486
		7	19747	75.02	23.20	484346	0.272	-----	-----	0.429	0.322	0.350	0.373	0.400	-----	-----	0.439	0.479
	110	8	19747	75.02	23.70	498518	0.270	-----	-----	0.425	0.321	0.348	0.370	0.396	-----	-----	0.439	0.479
		9	19747	75.02	24.20	512992	0.269	-----	-----	0.422	0.320	0.345	0.367	0.392	-----	-----	0.439	0.478
		7	30171	95.60	25.50	743809	0.270	-----	-----	0.426	0.317	0.342	0.366	0.391	-----	-----	0.438	0.480
	130	8	30171	95.60	26.00	763639	0.269	-----	-----	0.423	0.316	0.339	0.362	0.386	-----	-----	0.438	0.479
		9	30171	95.60	26.50	783855	0.267	-----	-----	0.420	0.314	0.337	0.358	0.382	-----	-----	0.437	0.479
		7	37210	122.00	25.50	938798	0.268	-----	-----	0.424	0.315	0.340	0.362	0.388	-----	-----	0.438	0.480
	140	8	31032	97.70	26.00	782011	0.267	-----	-----	0.421	0.314	0.337	0.358	0.383	-----	-----	0.438	0.479
		9	31032	97.70	26.50	802670	0.265	-----	-----	0.418	0.312	0.334	0.355	0.378	-----	-----	0.438	0.478
7		7	6665	49.90	17.40	175391	0.319	0.568	0.573	0.497	0.359	0.398	0.439	0.475	0.393	0.438	0.485	0.527
	50	8	6665	49.90	17.90	182486	0.317	0.561	0.566	0.486	0.361	0.399	0.439	0.475	0.395	0.440	0.487	0.530
		9	6665	49.90	18.40	189782	0.315	0.553	0.558	0.480	0.362	0.400	0.438	0.473	0.397	0.442	0.490	0.533
	70	7	10257	61.84	19.00	262460	0.312	0.485	0.488	0.477	0.352	0.388	0.425	0.459	0.394	0.439	0.487	0.531
		8	10257	61.84	19.50	272049	0.310	0.478	0.481	0.484	0.354	0.388	0.424	0.457	0.397	0.441	0.489	0.531

		9	10257	61.84	20.00	281888	0.307	0.472	0.474	0.477	0.355	0.387	0.422	0.454	0.400	0.444	0.491	0.532
	90	7	15622	76.60	20.75	391525	0.303	0.471	0.474	0.477	0.351	0.383	0.415	0.441	0.403	0.447	0.490	0.523
		8	15622	76.60	21.25	404483	0.301	0.464	0.467	0.470	0.352	0.383	0.412	0.437	0.407	0.449	0.492	0.522
		9	15622	76.60	21.75	417750	0.298	0.458	0.461	0.468	0.352	0.381	0.410	0.434	0.410	0.452	0.494	0.523
	110	7	23722	89.58	23.40	586222	0.298	0.464	0.465	0.467	0.347	0.376	0.405	0.432	0.404	0.445	0.488	0.532
		8	23722	89.58	23.90	603289	0.296	0.457	0.458	0.466	0.347	0.375	0.402	0.428	0.407	0.447	0.490	0.533
		9	23722	89.58	24.40	620716	0.294	0.452	0.453	0.465	0.346	0.373	0.399	0.424	0.409	0.449	0.491	0.534
	130	7	36261	98.40	27.50	891557	0.295	0.456	0.457	0.465	0.344	0.372	0.399	0.423	0.409	0.450	0.490	0.526
		8	36261	98.40	28.00	913553	0.293	0.450	0.451	0.465	0.344	0.370	0.395	0.419	0.412	0.452	0.491	0.527
		9	36261	98.40	28.50	935946	0.291	0.445	0.446	0.464	0.343	0.368	0.392	0.415	0.414	0.453	0.492	0.528
	140	7	44826	117.37	28.50	1129065	0.293	0.457	0.457	0.464	0.343	0.369	0.397	0.418	0.406	0.445	0.489	0.524
		8	44826	117.37	29.00	1156247	0.291	0.451	0.451	0.463	0.342	0.367	0.394	0.414	0.409	0.447	0.490	0.525
		9	44826	117.37	29.50	1183903	0.289	0.446	0.446	0.462	0.341	0.365	0.391	0.410	0.411	0.449	0.491	0.525
8	50	7	8024	50.04	18.70	205598	0.374	-----	-----	0.569	0.395	0.437	0.474	0.512	-----	-----	0.529	0.567
		8	8024	50.04	19.20	213237	0.370	-----	-----	0.565	0.397	0.439	0.476	0.513	-----	-----	0.532	0.572
		9	8024	50.04	19.70	221077	0.365	-----	-----	0.562	0.399	0.439	0.476	0.513	-----	-----	0.535	0.576
	70	7	12249	57.56	21.75	318021	0.359	-----	-----	0.559	0.396	0.434	0.469	0.504	-----	-----	0.533	0.577
		8	12249	57.56	22.25	328222	0.354	-----	-----	0.556	0.397	0.435	0.469	0.503	-----	-----	0.536	0.579
		9	12249	57.56	22.75	338655	0.349	-----	-----	0.553	0.398	0.434	0.468	0.502	-----	-----	0.538	0.582
	90	7	18704	81.11	21.75	459764	0.340	-----	-----	0.553	0.391	0.425	0.455	0.483	-----	-----	0.545	0.579
		8	15599	69.21	22.25	401668	0.335	-----	-----	0.550	0.392	0.425	0.454	0.481	-----	-----	0.547	0.581
		9	15599	69.21	22.75	414213	0.331	-----	-----	0.547	0.393	0.424	0.451	0.478	-----	-----	0.549	0.583
	110	7	28568	91.18	25.50	707743	0.334	-----	-----	0.544	0.388	0.420	0.448	0.476	-----	-----	0.533	0.577
		8	28568	91.18	26.00	726657	0.330	-----	-----	0.541	0.388	0.418	0.446	0.473	-----	-----	0.535	0.582
		9	28568	91.18	26.50	745938	0.326	-----	-----	0.538	0.388	0.417	0.444	0.470	-----	-----	0.537	0.583
	130	7	43605	101.06	29.50	1059728	0.330	-----	-----	0.545	0.386	0.416	0.443	0.467	-----	-----	0.542	0.572
		8	43605	101.06	30.00	1083948	0.326	-----	-----	0.542	0.386	0.415	0.440	0.464	-----	-----	0.544	0.573
		9	43605	101.06	30.50	1108574	0.322	-----	-----	0.540	0.385	0.413	0.437	0.460	-----	-----	0.545	0.574
	140	7	53928	121.04	30.50	1341455	0.327	-----	-----	0.543	0.384	0.414	0.439	0.462	-----	-----	0.541	0.570
		8	53928	121.04	31.00	1371438	0.324	-----	-----	0.540	0.384	0.412	0.437	0.459	-----	-----	0.542	0.572
		9	53928	121.04	31.50	1401908	0.320	-----	-----	0.538	0.383	0.410	0.434	0.455	-----	-----	0.543	0.573

Table C. 6 Shear Force Live Load Distribution Factor for M1-ABRAMS

MILITARY VEHICLE : M1-ABRAMS							M1	M1			M1				M1			
							SL-V	DL-V			SL-V				DL-V			
							Interior	Interior			Exterior				Exterior			
							OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)
Spacing (ft)	Span (ft)	thickness (in)	Inertia (in^4)	Area (in^2)	eg (in)	Kg	0	0	1	2	0	1	2	3	0	1	2	3
4	50	7	3846	36.98	15.65	103943	0.244	-----	-----	0.361	0.302	0.354	0.363	0.371	-----	-----	0.382	0.386
		8	3846	36.98	16.15	108679	0.238	-----	-----	0.354	0.311	0.356	0.360	0.366	-----	-----	0.379	0.379
		9	3846	36.98	16.65	113565	0.232	-----	-----	0.347	0.319	0.356	0.358	0.360	-----	-----	0.376	0.373
	70	7	5865	45.11	17.20	154750	0.224	-----	-----	0.355	0.293	0.344	0.352	0.365	-----	-----	0.377	0.375
		8	5865	45.11	17.50	158533	0.219	-----	-----	0.348	0.302	0.346	0.351	0.360	-----	-----	0.375	0.370
		9	5865	45.11	18.20	167614	0.215	-----	-----	0.342	0.310	0.348	0.349	0.355	-----	-----	0.373	0.365
	90	7	8964	64.44	17.70	234839	0.235	-----	-----	0.361	0.286	0.335	0.349	0.399	-----	-----	0.375	0.392
		8	8964	64.44	18.20	244157	0.230	-----	-----	0.353	0.293	0.336	0.350	0.395	-----	-----	0.374	0.390
		9	8964	64.44	18.70	253734	0.225	-----	-----	0.347	0.301	0.338	0.348	0.388	-----	-----	0.374	0.385
	110	7	13640	79.61	19.30	348757	0.236	-----	-----	0.352	0.278	0.343	0.347	0.371	-----	-----	0.377	0.390
		8	13640	79.61	19.80	361294	0.229	-----	-----	0.345	0.284	0.345	0.347	0.368	-----	-----	0.378	0.389
		9	13640	79.61	20.30	374152	0.225	-----	-----	0.338	0.291	0.347	0.347	0.364	-----	-----	0.378	0.386
	130	7	20833	90.14	21.85	514491	0.236	-----	-----	0.355	0.275	0.334	0.362	0.378	-----	-----	0.379	0.385
		8	20833	90.14	22.35	530539	0.230	-----	-----	0.351	0.281	0.335	0.362	0.375	-----	-----	0.379	0.385
		9	20833	90.14	22.85	546949	0.225	-----	-----	0.346	0.288	0.337	0.361	0.371	-----	-----	0.379	0.383
	140	7	25799	95.63	23.60	636881	0.229	-----	-----	0.346	0.270	0.300	0.325	0.342	-----	-----	0.368	0.365
		8	25799	95.63	24.10	655254	0.224	-----	-----	0.344	0.276	0.332	0.344	0.367	-----	-----	0.382	0.384
		9	25799	95.63	24.60	674012	0.219	-----	-----	0.338	0.281	0.334	0.344	0.364	-----	-----	0.383	0.383
5	50	7	4633	43.50	15.85	125354	0.266	-----	-----	0.408	0.332	0.355	0.397	0.436	-----	-----	0.424	0.452
		8	4633	43.50	16.35	130996	0.259	-----	-----	0.399	0.342	0.360	0.399	0.432	-----	-----	0.425	0.440
		9	4633	43.50	16.85	136813	0.254	-----	-----	0.391	0.351	0.365	0.399	0.427	-----	-----	0.425	0.435
	70	7	7042	62.90	16.35	192178	0.272	-----	-----	0.407	0.318	0.346	0.390	0.430	-----	-----	0.421	0.462
		8	7042	62.90	16.85	200589	0.266	-----	-----	0.399	0.328	0.352	0.392	0.426	-----	-----	0.422	0.448
		9	7042	62.90	17.35	209254	0.260	-----	-----	0.392	0.337	0.357	0.393	0.422	-----	-----	0.422	0.444
	90	7	10751	64.63	18.95	273565	0.264	-----	-----	0.407	0.321	0.347	0.384	0.429	-----	-----	0.413	0.455

		8	10751	64.63	19.45	283561	0.257	-----	-----	0.400	0.330	0.353	0.387	0.425	-----	-----	0.415	0.469
		9	10751	64.63	19.95	293818	0.251	-----	-----	0.393	0.337	0.358	0.388	0.422	-----	-----	0.417	0.467
	110	7	16376	72.84	21.55	404414	0.268	-----	-----	0.413	0.317	0.336	0.378	0.438	-----	-----	0.413	0.458
		8	16376	72.84	22.05	417205	0.262	-----	-----	0.406	0.325	0.342	0.381	0.435	-----	-----	0.417	0.468
		9	16376	72.84	22.55	430290	0.257	-----	-----	0.399	0.333	0.346	0.383	0.432	-----	-----	0.420	0.465
	130	7	25002	93.24	23.60	619738	0.269	-----	-----	0.416	0.301	0.330	0.378	0.442	-----	-----	0.422	0.485
		8	25002	93.24	24.10	637651	0.263	-----	-----	0.408	0.308	0.335	0.381	0.440	-----	-----	0.426	0.474
		9	25002	93.24	24.60	655941	0.258	-----	-----	0.400	0.316	0.340	0.383	0.437	-----	-----	0.428	0.472
	140	7	30911	97.85	25.43	758746	0.270	-----	-----	0.412	0.301	0.328	0.376	0.428	-----	-----	0.415	0.468
		8	30911	97.85	25.93	778988	0.264	-----	-----	0.404	0.307	0.334	0.379	0.427	-----	-----	0.419	0.463
		9	30911	97.85	26.43	799624	0.258	-----	-----	0.398	0.314	0.339	0.382	0.425	-----	-----	0.422	0.462
6	50	7	5578	50.98	16.10	151384	0.343	-----	-----	0.503	0.352	0.416	0.461	0.503	-----	-----	0.466	0.500
		8	5578	50.98	16.60	158099	0.333	-----	-----	0.491	0.365	0.423	0.461	0.499	-----	-----	0.470	0.500
		9	5578	50.98	17.10	165019	0.324	-----	-----	0.481	0.376	0.430	0.463	0.496	-----	-----	0.474	0.499
	70	7	8449	61.26	17.70	222665	0.325	-----	-----	0.476	0.341	0.411	0.458	0.504	-----	-----	0.496	0.505
		8	8449	61.26	18.20	231523	0.314	-----	-----	0.464	0.354	0.419	0.460	0.501	-----	-----	0.501	0.505
		9	8449	61.26	18.70	240628	0.305	-----	-----	0.454	0.366	0.426	0.462	0.498	-----	-----	0.505	0.505
	90	7	12964	66.12	20.45	327181	0.318	-----	-----	0.497	0.353	0.406	0.454	0.494	-----	-----	0.460	0.503
		8	12964	66.12	20.95	338206	0.307	-----	-----	0.486	0.367	0.414	0.456	0.491	-----	-----	0.467	0.505
		9	12964	66.12	21.45	349498	0.298	-----	-----	0.476	0.378	0.420	0.457	0.489	-----	-----	0.473	0.507
	110	7	19747	75.02	23.20	484346	0.339	-----	-----	0.500	0.331	0.406	0.453	0.494	-----	-----	0.462	0.510
		8	19747	75.02	23.70	498518	0.329	-----	-----	0.490	0.342	0.413	0.455	0.492	-----	-----	0.470	0.513
		9	19747	75.02	24.20	512992	0.319	-----	-----	0.480	0.354	0.419	0.455	0.489	-----	-----	0.476	0.515
	130	7	30171	95.60	25.50	743809	0.335	-----	-----	0.490	0.320	0.393	0.452	0.504	-----	-----	0.465	0.527
		8	30171	95.60	26.00	763639	0.326	-----	-----	0.477	0.330	0.399	0.453	0.502	-----	-----	0.472	0.530
		9	30171	95.60	26.50	783855	0.317	-----	-----	0.466	0.340	0.406	0.454	0.499	-----	-----	0.479	0.532
	140	7	37210	122.00	25.50	938798	0.330	-----	-----	0.492	0.310	0.390	0.447	0.502	-----	-----	0.475	0.514
		8	31032	97.70	26.00	782011	0.320	-----	-----	0.481	0.319	0.395	0.449	0.500	-----	-----	0.483	0.518
		9	31032	97.70	26.50	802670	0.312	-----	-----	0.471	0.329	0.401	0.450	0.498	-----	-----	0.490	0.522
7	50	7	6665	49.90	17.40	175391	0.393	0.610	0.619	0.555	0.404	0.455	0.503	0.515	0.431	0.480	0.532	0.544
		8	6665	49.90	17.90	182486	0.384	0.597	0.609	0.544	0.416	0.463	0.506	0.515	0.445	0.491	0.537	0.550
		9	6665	49.90	18.40	189782	0.375	0.584	0.599	0.535	0.427	0.469	0.508	0.514	0.459	0.500	0.542	0.552
	70	7	10257	61.84	19.00	262460	0.385	0.537	0.555	0.549	0.394	0.456	0.496	0.512	0.420	0.485	0.527	0.538
		8	10257	61.84	19.50	272049	0.374	0.519	0.539	0.538	0.406	0.462	0.498	0.512	0.434	0.496	0.533	0.540

		9	10257	61.84	20.00	281888	0.365	0.502	0.524	0.528	0.417	0.468	0.500	0.512	0.449	0.505	0.538	0.544
	90	7	15622	76.60	20.75	391525	0.364	0.537	0.554	0.546	0.386	0.452	0.491	0.506	0.409	0.478	0.522	0.536
		8	15622	76.60	21.25	404483	0.353	0.519	0.537	0.536	0.397	0.459	0.493	0.507	0.423	0.489	0.528	0.544
		9	15622	76.60	21.75	417750	0.343	0.502	0.523	0.527	0.408	0.466	0.495	0.507	0.438	0.500	0.535	0.548
	110	7	23722	89.58	23.40	586222	0.372	0.547	0.561	0.554	0.376	0.443	0.487	0.504	0.395	0.468	0.529	0.539
		8	23722	89.58	23.90	603289	0.361	0.529	0.546	0.544	0.386	0.448	0.489	0.506	0.409	0.478	0.537	0.557
		9	23722	89.58	24.40	620716	0.350	0.513	0.532	0.535	0.397	0.454	0.492	0.506	0.423	0.489	0.545	0.562
	130	7	36261	98.40	27.50	891557	0.380	0.543	0.552	0.552	0.370	0.431	0.484	0.500	0.399	0.455	0.516	0.552
		8	36261	98.40	28.00	913553	0.369	0.527	0.535	0.543	0.380	0.437	0.487	0.502	0.412	0.466	0.524	0.559
		9	36261	98.40	28.50	935946	0.359	0.511	0.524	0.534	0.390	0.443	0.489	0.503	0.427	0.477	0.532	0.564
	140	7	44826	117.37	28.50	1129065	0.382	0.565	0.574	0.558	0.364	0.433	0.482	0.502	0.387	0.458	0.511	0.536
		8	44826	117.37	29.00	1156247	0.372	0.550	0.560	0.549	0.372	0.438	0.484	0.505	0.398	0.467	0.518	0.542
		9	44826	117.37	29.50	1183903	0.361	0.535	0.545	0.541	0.382	0.442	0.486	0.506	0.412	0.476	0.525	0.547
8	50	7	8024	50.04	18.70	205598	0.397	-----	-----	0.558	0.445	0.492	0.525	0.541	-----	-----	0.558	0.572
		8	8024	50.04	19.20	213237	0.388	-----	-----	0.548	0.459	0.500	0.530	0.544	-----	-----	0.566	0.581
		9	8024	50.04	19.70	221077	0.380	-----	-----	0.540	0.471	0.508	0.534	0.546	-----	-----	0.573	0.587
	70	7	12249	57.56	21.75	318021	0.395	-----	-----	0.569	0.431	0.491	0.512	0.521	-----	-----	0.556	0.569
		8	12249	57.56	22.25	328222	0.386	-----	-----	0.559	0.445	0.499	0.517	0.525	-----	-----	0.565	0.575
		9	12249	57.56	22.75	338655	0.376	-----	-----	0.551	0.457	0.507	0.522	0.528	-----	-----	0.572	0.582
	90	7	18704	81.11	21.75	459764	0.397	-----	-----	0.570	0.427	0.480	0.508	0.520	-----	-----	0.549	0.575
		8	15599	69.21	22.25	401668	0.388	-----	-----	0.560	0.440	0.488	0.513	0.525	-----	-----	0.558	0.584
		9	15599	69.21	22.75	414213	0.378	-----	-----	0.552	0.452	0.496	0.518	0.528	-----	-----	0.567	0.592
	110	7	28568	91.18	25.50	707743	0.397	-----	-----	0.574	0.415	0.474	0.502	0.514	-----	-----	0.545	0.567
		8	28568	91.18	26.00	726657	0.388	-----	-----	0.564	0.427	0.481	0.508	0.520	-----	-----	0.555	0.577
		9	28568	91.18	26.50	745938	0.378	-----	-----	0.555	0.438	0.487	0.512	0.523	-----	-----	0.565	0.586
	130	7	43605	101.06	29.50	1059728	0.398	-----	-----	0.577	0.415	0.473	0.499	0.527	-----	-----	0.551	0.579
		8	43605	101.06	30.00	1083948	0.389	-----	-----	0.567	0.424	0.479	0.504	0.533	-----	-----	0.561	0.588
		9	43605	101.06	30.50	1108574	0.380	-----	-----	0.558	0.433	0.484	0.507	0.536	-----	-----	0.570	0.597
	140	7	53928	121.04	30.50	1341455	0.402	-----	-----	0.580	0.406	0.470	0.496	0.509	-----	-----	0.541	0.567
		8	53928	121.04	31.00	1371438	0.394	-----	-----	0.571	0.414	0.474	0.500	0.515	-----	-----	0.551	0.577
		9	53928	121.04	31.50	1401908	0.384	-----	-----	0.561	0.422	0.479	0.504	0.519	-----	-----	0.560	0.585

Table C. 7 Bending Moment Live Load Distribution Factor for LAVIII-STRYKER

MILITARY VEHICLE : LAVIII-STRYKER							LAVIII	LAVIII	LAVIII				LAVIII			
							SL-M	DL-M	SL-M				DL-M			
							Interior	Interior	Exterior				Exterior			
							OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)
Spacing (ft)	Span (ft)	thickness (in)	Inertia (in^4)	Area (in^2)	eg (in)	Kg	0	0	0	1	2	3	0	1	2	3
4	50	7	3846	36.98	15.65	103943	0.197	0.313	0.212	0.233	0.256	0.274	0.291	0.317	0.343	0.365
		8	3846	36.98	16.15	108679	0.196	0.310	0.212	0.231	0.252	0.270	0.293	0.317	0.343	0.364
		9	3846	36.98	16.65	113565	0.195	0.308	0.212	0.230	0.249	0.265	0.295	0.318	0.342	0.363
	70	7	5865	45.11	17.20	154750	0.197	0.308	0.214	0.231	0.250	0.267	0.296	0.319	0.343	0.367
		8	5865	45.11	17.50	158533	0.196	0.305	0.213	0.229	0.246	0.263	0.297	0.320	0.343	0.365
		9	5865	45.11	18.20	167614	0.194	0.303	0.212	0.227	0.243	0.258	0.298	0.320	0.342	0.364
	90	7	8964	64.44	17.70	234839	0.195	0.305	0.214	0.230	0.246	0.260	0.299	0.321	0.344	0.364
		8	8964	64.44	18.20	244157	0.194	0.303	0.213	0.228	0.242	0.255	0.300	0.321	0.343	0.363
		9	8964	64.44	18.70	253734	0.192	0.301	0.212	0.225	0.239	0.251	0.301	0.321	0.342	0.361
	110	7	13640	79.61	19.30	348757	0.194	0.304	0.213	0.228	0.241	0.254	0.302	0.322	0.341	0.362
		8	13640	79.61	19.80	361294	0.193	0.303	0.212	0.225	0.237	0.249	0.303	0.322	0.340	0.360
		9	13640	79.61	20.30	374152	0.191	0.302	0.210	0.223	0.233	0.245	0.303	0.321	0.339	0.358
	130	7	20833	90.14	21.85	514491	0.193	0.301	0.211	0.224	0.241	0.253	0.300	0.321	0.346	0.365
		8	20833	90.14	22.35	530539	0.192	0.300	0.209	0.221	0.237	0.248	0.301	0.321	0.344	0.363
		9	20833	90.14	22.85	546949	0.190	0.300	0.207	0.219	0.233	0.244	0.301	0.320	0.343	0.361
	140	7	25799	95.63	23.60	636881	0.193	0.303	0.211	0.226	0.238	0.250	0.301	0.323	0.343	0.361
		8	25799	95.63	24.10	655254	0.191	0.301	0.210	0.222	0.235	0.246	0.302	0.322	0.341	0.359
		9	25799	95.63	24.60	674012	0.190	0.300	0.208	0.220	0.231	0.242	0.302	0.321	0.340	0.357
5	50	7	4633	43.50	15.85	125354	0.274	0.405	0.304	0.345	0.388	0.430	0.338	0.386	0.435	0.483
		8	4633	43.50	16.35	130996	0.273	0.400	0.306	0.345	0.385	0.426	0.341	0.388	0.438	0.486
		9	4633	43.50	16.85	136813	0.271	0.395	0.307	0.344	0.383	0.421	0.344	0.390	0.440	0.486
	70	7	7042	62.90	16.35	192178	0.266	0.388	0.302	0.334	0.368	0.402	0.348	0.391	0.436	0.479
		8	7042	62.90	16.85	200589	0.264	0.383	0.302	0.332	0.364	0.396	0.352	0.393	0.436	0.479
		9	7042	62.90	17.35	209254	0.262	0.379	0.302	0.329	0.359	0.390	0.354	0.395	0.437	0.478
	90	7	10751	64.63	18.95	273565	0.261	0.380	0.298	0.328	0.358	0.387	0.353	0.394	0.434	0.473

		8	10751	64.63	19.45	283561	0.259	0.376	0.298	0.326	0.353	0.381	0.356	0.395	0.436	0.475
		9	10751	64.63	19.95	293818	0.257	0.372	0.296	0.323	0.349	0.375	0.358	0.396	0.436	0.475
	110	7	16376	72.84	21.55	404414	0.257	0.374	0.294	0.320	0.346	0.375	0.354	0.392	0.435	0.477
		8	16376	72.84	22.05	417205	0.255	0.370	0.292	0.317	0.343	0.370	0.356	0.393	0.433	0.474
		9	16376	72.84	22.55	430290	0.253	0.367	0.291	0.314	0.338	0.364	0.358	0.393	0.433	0.473
	130	7	25002	93.24	23.60	619738	0.253	0.368	0.289	0.314	0.338	0.362	0.354	0.393	0.433	0.469
		8	25002	93.24	24.10	637651	0.250	0.365	0.287	0.310	0.333	0.356	0.356	0.394	0.432	0.467
		9	25002	93.24	24.60	655941	0.248	0.362	0.285	0.307	0.329	0.350	0.357	0.394	0.431	0.465
	140	7	30911	97.85	25.43	758746	0.251	0.371	0.289	0.313	0.337	0.360	0.356	0.393	0.430	0.464
		8	30911	97.85	25.93	778988	0.249	0.368	0.287	0.310	0.333	0.354	0.358	0.394	0.430	0.463
		9	30911	97.85	26.43	799624	0.247	0.365	0.285	0.306	0.328	0.349	0.359	0.394	0.428	0.461
6	50	7	5578	50.98	16.10	151384	0.327	0.493	0.356	0.402	0.442	0.485	0.398	0.452	0.505	0.556
		8	5578	50.98	16.60	158099	0.322	0.487	0.358	0.402	0.441	0.482	0.402	0.455	0.506	0.558
		9	5578	50.98	17.10	165019	0.317	0.480	0.359	0.402	0.439	0.478	0.405	0.458	0.509	0.560
	70	7	8449	61.26	17.70	222665	0.313	0.470	0.351	0.389	0.427	0.464	0.405	0.456	0.510	0.557
		8	8449	61.26	18.20	231523	0.309	0.463	0.351	0.388	0.424	0.459	0.409	0.460	0.513	0.558
		9	8449	61.26	18.70	240628	0.306	0.457	0.352	0.386	0.421	0.454	0.413	0.463	0.515	0.559
	90	7	12964	66.12	20.45	327181	0.305	0.460	0.349	0.384	0.416	0.445	0.414	0.464	0.509	0.548
		8	12964	66.12	20.95	338206	0.302	0.454	0.349	0.382	0.412	0.439	0.418	0.467	0.508	0.547
		9	12964	66.12	21.45	349498	0.299	0.448	0.348	0.379	0.408	0.433	0.422	0.469	0.510	0.547
	110	7	19747	75.02	23.20	484346	0.299	0.453	0.344	0.375	0.404	0.434	0.416	0.463	0.509	0.557
		8	19747	75.02	23.70	498518	0.296	0.447	0.344	0.372	0.400	0.429	0.420	0.465	0.510	0.555
		9	19747	75.02	24.20	512992	0.293	0.442	0.342	0.369	0.396	0.423	0.422	0.466	0.510	0.555
	130	7	30171	95.60	25.50	743809	0.293	0.446	0.339	0.368	0.394	0.422	0.420	0.464	0.508	0.556
		8	30171	95.60	26.00	763639	0.290	0.441	0.337	0.364	0.390	0.417	0.422	0.466	0.508	0.553
		9	30171	95.60	26.50	783855	0.287	0.438	0.335	0.361	0.385	0.411	0.425	0.467	0.508	0.552
	140	7	37210	122.00	25.50	938798	0.291	0.443	0.337	0.364	0.392	0.415	0.418	0.461	0.505	0.542
		8	31032	97.70	26.00	782011	0.288	0.438	0.335	0.361	0.388	0.409	0.421	0.463	0.506	0.541
		9	31032	97.70	26.50	802670	0.285	0.434	0.333	0.358	0.383	0.403	0.423	0.463	0.505	0.540
7	50	7	6665	49.90	17.40	175391	0.367	0.565	0.386	0.431	0.476	0.530	0.437	0.489	0.540	0.605
		8	6665	49.90	17.90	182486	0.360	0.557	0.389	0.432	0.476	0.528	0.442	0.495	0.547	0.611
		9	6665	49.90	18.40	189782	0.354	0.550	0.392	0.433	0.475	0.524	0.447	0.500	0.552	0.614
	70	7	10257	61.84	19.00	262460	0.344	0.531	0.383	0.422	0.462	0.507	0.451	0.501	0.548	0.608

		8	10257	61.84	19.50	272049	0.338	0.522	0.384	0.422	0.460	0.502	0.456	0.506	0.553	0.612
		9	10257	61.84	20.00	281888	0.332	0.514	0.385	0.421	0.457	0.498	0.462	0.510	0.557	0.614
	90	7	15622	76.60	20.75	391525	0.329	0.510	0.379	0.413	0.443	0.481	0.460	0.508	0.542	0.593
		8	15622	76.60	21.25	404483	0.324	0.504	0.380	0.412	0.440	0.476	0.466	0.512	0.547	0.596
		9	15622	76.60	21.75	417750	0.319	0.500	0.379	0.410	0.436	0.470	0.471	0.516	0.550	0.597
	110	7	23722	89.58	23.40	586222	0.320	0.501	0.374	0.404	0.437	0.469	0.466	0.510	0.557	0.602
		8	23722	89.58	23.90	603289	0.315	0.498	0.373	0.402	0.433	0.464	0.471	0.513	0.559	0.603
		9	23722	89.58	24.40	620716	0.311	0.495	0.372	0.400	0.429	0.458	0.475	0.516	0.561	0.604
	130	7	36261	98.40	27.50	891557	0.315	0.496	0.370	0.399	0.427	0.459	0.469	0.514	0.555	0.599
		8	36261	98.40	28.00	913553	0.310	0.493	0.369	0.396	0.423	0.453	0.473	0.517	0.557	0.600
		9	36261	98.40	28.50	935946	0.307	0.490	0.368	0.393	0.420	0.448	0.476	0.519	0.559	0.600
	140	7	44826	117.37	28.50	1129065	0.312	0.494	0.368	0.397	0.423	0.452	0.470	0.511	0.546	0.591
		8	44826	117.37	29.00	1156247	0.308	0.491	0.367	0.395	0.419	0.447	0.474	0.514	0.547	0.591
		9	44826	117.37	29.50	1183903	0.305	0.488	0.365	0.392	0.415	0.441	0.477	0.516	0.549	0.591
8	50	7	8024	50.04	18.70	205598	0.424	0.635	0.423	0.469	0.525	0.577	0.476	0.537	0.600	0.667
		8	8024	50.04	19.20	213237	0.415	0.630	0.426	0.471	0.525	0.576	0.481	0.542	0.606	0.673
		9	8024	50.04	19.70	221077	0.406	0.624	0.429	0.473	0.524	0.573	0.486	0.547	0.610	0.677
	70	7	12249	57.56	21.75	318021	0.396	0.615	0.427	0.468	0.517	0.562	0.491	0.547	0.612	0.676
		8	12249	57.56	22.25	328222	0.387	0.608	0.429	0.469	0.515	0.559	0.496	0.553	0.617	0.681
		9	12249	57.56	22.75	338655	0.379	0.602	0.430	0.469	0.513	0.555	0.502	0.558	0.621	0.685
	90	7	18704	81.11	21.75	459764	0.364	0.595	0.420	0.456	0.493	0.530	0.504	0.560	0.605	0.659
		8	15599	69.21	22.25	401668	0.356	0.589	0.421	0.455	0.490	0.525	0.509	0.563	0.610	0.663
		9	15599	69.21	22.75	414213	0.352	0.583	0.421	0.453	0.486	0.520	0.514	0.568	0.612	0.664
	110	7	28568	91.18	25.50	707743	0.358	0.583	0.417	0.450	0.488	0.524	0.507	0.561	0.620	0.677
		8	28568	91.18	26.00	726657	0.351	0.577	0.417	0.449	0.485	0.519	0.512	0.565	0.623	0.676
		9	28568	91.18	26.50	745938	0.346	0.572	0.416	0.447	0.481	0.513	0.516	0.568	0.624	0.677
	130	7	43605	101.06	29.50	1059728	0.353	0.581	0.413	0.445	0.478	0.510	0.517	0.562	0.612	0.668
		8	43605	101.06	30.00	1083948	0.347	0.575	0.412	0.443	0.474	0.504	0.521	0.566	0.614	0.672
		9	43605	101.06	30.50	1108574	0.341	0.570	0.411	0.440	0.470	0.499	0.525	0.568	0.615	0.672
	140	7	53928	121.04	30.50	1341455	0.349	0.577	0.411	0.442	0.474	0.504	0.518	0.563	0.611	0.665
		8	53928	121.04	31.00	1371438	0.343	0.571	0.410	0.440	0.470	0.499	0.522	0.566	0.613	0.667
		9	53928	121.04	31.50	1401908	0.338	0.567	0.409	0.437	0.465	0.493	0.525	0.568	0.613	0.666

Table C. 8 Shear Force Live Load Distribution Factor for LAVIII-STRYKER

MILITARY VEHICLE : LAVIII-STRYKER

							LAVIII	LAVIII	LAVIII				LAVIII			
							SL-V	DL-V	SL-V				DL-V			
							Interior	Interior	Exterior				Exterior			
							OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)
Spacing (ft)	Span (ft)	thickness (in)	Inertia (in^4)	Area (in^2)	eg (in)	Kg	0	0	0	1	2	3	0	1	2	3
4	50	7	3846	36.98	15.65	103943	0.272	0.370	0.300	0.353	0.403	0.439	0.298	0.361	0.432	0.436
		8	3846	36.98	16.15	108679	0.266	0.359	0.309	0.358	0.400	0.429	0.311	0.368	0.429	0.426
		9	3846	36.98	16.65	113565	0.261	0.350	0.318	0.363	0.398	0.421	0.323	0.374	0.427	0.418
	70	7	5865	45.11	17.20	154750	0.273	0.371	0.296	0.357	0.399	0.447	0.299	0.351	0.426	0.459
		8	5865	45.11	17.50	158533	0.267	0.361	0.306	0.362	0.396	0.437	0.314	0.359	0.425	0.451
		9	5865	45.11	18.20	167614	0.262	0.352	0.316	0.366	0.394	0.429	0.328	0.366	0.423	0.444
	90	7	8964	64.44	17.70	234839	0.273	0.370	0.297	0.331	0.412	0.463	0.289	0.347	0.424	0.471
		8	8964	64.44	18.20	244157	0.266	0.360	0.307	0.335	0.410	0.454	0.303	0.354	0.424	0.464
		9	8964	64.44	18.70	253734	0.260	0.351	0.317	0.339	0.408	0.445	0.316	0.360	0.423	0.457
	110	7	13640	79.61	19.30	348757	0.267	0.366	0.296	0.326	0.400	0.457	0.282	0.344	0.431	0.476
		8	13640	79.61	19.80	361294	0.261	0.356	0.304	0.331	0.398	0.449	0.296	0.352	0.431	0.469
		9	13640	79.61	20.30	374152	0.254	0.348	0.314	0.334	0.396	0.441	0.310	0.359	0.430	0.462
	130	7	20833	90.14	21.85	514491	0.272	0.373	0.279	0.339	0.398	0.451	0.279	0.362	0.430	0.474
		8	20833	90.14	22.35	530539	0.265	0.363	0.287	0.345	0.397	0.443	0.291	0.370	0.429	0.468
		9	20833	90.14	22.85	546949	0.260	0.355	0.295	0.349	0.395	0.436	0.303	0.377	0.428	0.462
	140	7	25799	95.63	23.60	636881	0.279	0.366	0.278	0.308	0.363	0.403	0.276	0.341	0.404	0.435
		8	25799	95.63	24.10	655254	0.272	0.357	0.285	0.346	0.393	0.451	0.288	0.352	0.434	0.473
		9	25799	95.63	24.60	674012	0.265	0.349	0.292	0.350	0.392	0.443	0.300	0.359	0.434	0.467
5	50	7	4633	43.50	15.85	125354	0.344	0.439	0.329	0.398	0.456	0.485	0.362	0.431	0.451	0.484
		8	4633	43.50	16.35	130996	0.335	0.427	0.342	0.404	0.454	0.478	0.376	0.439	0.452	0.478
		9	4633	43.50	16.85	136813	0.327	0.417	0.353	0.409	0.452	0.472	0.390	0.446	0.453	0.474
	70	7	7042	62.90	16.35	192178	0.313	0.441	0.318	0.392	0.456	0.488	0.348	0.411	0.463	0.493
		8	7042	62.90	16.85	200589	0.304	0.430	0.331	0.398	0.454	0.482	0.363	0.419	0.458	0.483
		9	7042	62.90	17.35	209254	0.298	0.420	0.342	0.402	0.452	0.475	0.376	0.427	0.460	0.480
	90	7	10751	64.63	18.95	273565	0.323	0.445	0.318	0.388	0.453	0.500	0.344	0.405	0.467	0.512

		8	10751	64.63	19.45	283561	0.314	0.434	0.329	0.393	0.451	0.494	0.357	0.413	0.470	0.510
		9	10751	64.63	19.95	293818	0.305	0.423	0.341	0.398	0.449	0.488	0.371	0.422	0.473	0.507
	110	7	16376	72.84	21.55	404414	0.323	0.438	0.302	0.384	0.455	0.491	0.326	0.404	0.452	0.526
		8	16376	72.84	22.05	417205	0.313	0.426	0.314	0.389	0.453	0.486	0.341	0.413	0.470	0.524
		9	16376	72.84	22.55	430290	0.303	0.415	0.325	0.393	0.451	0.481	0.356	0.421	0.473	0.521
	130	7	25002	93.24	23.60	619738	0.325	0.445	0.298	0.379	0.450	0.494	0.336	0.420	0.486	0.535
		8	25002	93.24	24.10	637651	0.315	0.434	0.307	0.384	0.448	0.490	0.349	0.428	0.469	0.533
		9	25002	93.24	24.60	655941	0.305	0.423	0.317	0.387	0.447	0.485	0.363	0.436	0.472	0.531
	140	7	30911	97.85	25.43	758746	0.316	0.448	0.299	0.378	0.448	0.492	0.329	0.396	0.454	0.507
		8	30911	97.85	25.93	778988	0.305	0.437	0.309	0.382	0.447	0.488	0.341	0.404	0.452	0.502
		9	30911	97.85	26.43	799624	0.298	0.426	0.318	0.386	0.445	0.483	0.353	0.412	0.456	0.499
6	50	7	5578	50.98	16.10	151384	0.399	0.530	0.394	0.458	0.510	0.526	0.416	0.479	0.528	0.555
		8	5578	50.98	16.60	158099	0.389	0.514	0.408	0.465	0.511	0.524	0.433	0.490	0.533	0.556
		9	5578	50.98	17.10	165019	0.379	0.499	0.421	0.471	0.512	0.522	0.449	0.499	0.538	0.556
	70	7	8449	61.26	17.70	222665	0.400	0.538	0.383	0.455	0.507	0.537	0.400	0.484	0.522	0.568
		8	8449	61.26	18.20	231523	0.389	0.521	0.397	0.462	0.509	0.536	0.418	0.495	0.534	0.574
		9	8449	61.26	18.70	240628	0.379	0.507	0.410	0.468	0.511	0.534	0.436	0.506	0.540	0.575
	90	7	12964	66.12	20.45	327181	0.372	0.526	0.382	0.447	0.490	0.540	0.402	0.468	0.519	0.577
		8	12964	66.12	20.95	338206	0.362	0.510	0.395	0.454	0.492	0.539	0.419	0.479	0.532	0.583
		9	12964	66.12	21.45	349498	0.353	0.496	0.407	0.460	0.494	0.537	0.435	0.490	0.538	0.585
	110	7	19747	75.02	23.20	484346	0.385	0.536	0.375	0.445	0.489	0.517	0.392	0.483	0.518	0.564
		8	19747	75.02	23.70	498518	0.377	0.518	0.388	0.451	0.491	0.517	0.410	0.495	0.529	0.581
		9	19747	75.02	24.20	512992	0.368	0.503	0.400	0.456	0.493	0.516	0.426	0.505	0.535	0.583
	130	7	30171	95.60	25.50	743809	0.390	0.527	0.362	0.439	0.497	0.529	0.389	0.461	0.538	0.588
		8	30171	95.60	26.00	763639	0.382	0.510	0.372	0.445	0.499	0.530	0.404	0.472	0.532	0.578
		9	30171	95.60	26.50	783855	0.374	0.495	0.382	0.450	0.501	0.529	0.419	0.483	0.539	0.580
	140	7	37210	122.00	25.50	938798	0.396	0.548	0.356	0.436	0.492	0.525	0.376	0.458	0.515	0.570
		8	31032	97.70	26.00	782011	0.389	0.532	0.365	0.441	0.494	0.527	0.389	0.467	0.524	0.590
		9	31032	97.70	26.50	802670	0.381	0.517	0.374	0.445	0.496	0.526	0.403	0.476	0.530	0.594
7	50	7	6665	49.90	17.40	175391	0.425	0.607	0.432	0.486	0.524	0.582	0.471	0.534	0.574	0.623
		8	6665	49.90	17.90	182486	0.410	0.594	0.446	0.494	0.528	0.580	0.492	0.549	0.582	0.630
		9	6665	49.90	18.40	189782	0.397	0.582	0.458	0.500	0.530	0.578	0.512	0.561	0.591	0.633
	70	7	10257	61.84	19.00	262460	0.421	0.601	0.424	0.478	0.515	0.578	0.458	0.524	0.566	0.626

		8	10257	61.84	19.50	272049	0.406	0.588	0.438	0.485	0.519	0.577	0.478	0.540	0.576	0.631
		9	10257	61.84	20.00	281888	0.393	0.575	0.450	0.492	0.523	0.575	0.498	0.553	0.586	0.634
		7	15622	76.60	20.75	391525	0.418	0.598	0.417	0.469	0.504	0.575	0.447	0.515	0.558	0.630
	90	8	15622	76.60	21.25	404483	0.403	0.583	0.430	0.476	0.508	0.574	0.467	0.529	0.568	0.635
		9	15622	76.60	21.75	417750	0.389	0.568	0.442	0.483	0.511	0.573	0.487	0.544	0.578	0.639
		7	23722	89.58	23.40	586222	0.421	0.596	0.407	0.462	0.504	0.573	0.437	0.512	0.563	0.633
	110	8	23722	89.58	23.90	603289	0.408	0.580	0.419	0.468	0.508	0.573	0.456	0.527	0.575	0.638
		9	23722	89.58	24.40	620716	0.395	0.565	0.431	0.475	0.511	0.572	0.475	0.541	0.585	0.643
		7	36261	98.40	27.50	891557	0.428	0.592	0.403	0.456	0.495	0.569	0.439	0.506	0.559	0.642
	130	8	36261	98.40	28.00	913553	0.416	0.576	0.415	0.461	0.498	0.570	0.459	0.520	0.570	0.649
		9	36261	98.40	28.50	935946	0.406	0.561	0.426	0.467	0.501	0.569	0.478	0.534	0.580	0.655
		7	44826	117.37	28.50	1129065	0.432	0.593	0.392	0.450	0.494	0.569	0.418	0.492	0.556	0.637
	140	8	44826	117.37	29.00	1156247	0.421	0.578	0.401	0.455	0.497	0.570	0.434	0.513	0.567	0.635
		9	44826	117.37	29.50	1183903	0.410	0.563	0.411	0.461	0.499	0.569	0.450	0.527	0.576	0.640
8		7	8024	50.04	18.70	205598	0.485	0.644	0.461	0.513	0.581	0.639	0.506	0.568	0.644	0.691
	50	8	8024	50.04	19.20	213237	0.469	0.625	0.476	0.522	0.584	0.639	0.527	0.584	0.653	0.702
		9	8024	50.04	19.70	221077	0.454	0.609	0.489	0.530	0.586	0.637	0.545	0.598	0.662	0.706
		7	12249	57.56	21.75	318021	0.491	0.652	0.445	0.496	0.570	0.638	0.493	0.555	0.634	0.706
	70	8	12249	57.56	22.25	328222	0.475	0.634	0.459	0.504	0.573	0.639	0.513	0.571	0.646	0.705
		9	12249	57.56	22.75	338655	0.460	0.616	0.472	0.512	0.576	0.638	0.531	0.586	0.657	0.710
		7	18704	81.11	21.75	459764	0.486	0.645	0.444	0.490	0.569	0.633	0.495	0.553	0.636	0.698
	90	8	15599	69.21	22.25	401668	0.470	0.625	0.459	0.499	0.572	0.633	0.516	0.569	0.647	0.704
		9	15599	69.21	22.75	414213	0.454	0.607	0.472	0.506	0.576	0.632	0.535	0.583	0.656	0.709
		7	28568	91.18	25.50	707743	0.494	0.655	0.429	0.481	0.562	0.625	0.477	0.544	0.624	0.698
	110	8	28568	91.18	26.00	726657	0.478	0.637	0.442	0.489	0.566	0.627	0.496	0.559	0.640	0.709
		9	28568	91.18	26.50	745938	0.463	0.620	0.455	0.497	0.570	0.627	0.515	0.573	0.650	0.715
		7	43605	101.06	29.50	1059728	0.495	0.662	0.422	0.476	0.562	0.624	0.477	0.539	0.628	0.692
	130	8	43605	101.06	30.00	1083948	0.480	0.645	0.434	0.484	0.566	0.626	0.495	0.552	0.638	0.713
		9	43605	101.06	30.50	1108574	0.465	0.627	0.446	0.491	0.569	0.626	0.513	0.565	0.647	0.720
		7	53928	121.04	30.50	1341455	0.503	0.663	0.416	0.470	0.558	0.625	0.465	0.531	0.622	0.692
	140	8	53928	121.04	31.00	1371438	0.489	0.647	0.427	0.477	0.561	0.627	0.482	0.543	0.631	0.707
		9	53928	121.04	31.50	1401908	0.474	0.630	0.438	0.485	0.564	0.627	0.499	0.556	0.640	0.713

Table C. 9 Bending Moment Live Load Distribution Factor for HEMTT

 **MILITARY VEHICLE : HEMTT**							HEMTT	HEMTT	HEMTT				HEMTT			
							SL-M	DL-M	SL-M				DL-M			
							Interior	Interior	Exterior				Exterior			
							OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)
Spacing (ft)	Span (ft)	thickness (in)	Inertia (in^4)	Area (in^2)	eg (in)	Kg	0	0	0	1	2	3	0	1	2	3
4	50	7	3846	36.98	15.65	103943	0.189	0.315	0.203	0.228	0.243	0.262	0.298	0.328	0.347	0.371
		8	3846	36.98	16.15	108679	0.188	0.312	0.203	0.226	0.240	0.258	0.300	0.328	0.347	0.370
		9	3846	36.98	16.65	113565	0.187	0.310	0.203	0.224	0.238	0.253	0.302	0.329	0.347	0.368
	70	7	5865	45.11	17.20	154750	0.186	0.307	0.202	0.216	0.229	0.240	0.303	0.324	0.342	0.359
		8	5865	45.11	17.50	158533	0.185	0.306	0.201	0.214	0.225	0.235	0.305	0.325	0.342	0.358
		9	5865	45.11	18.20	167614	0.183	0.306	0.201	0.212	0.222	0.231	0.307	0.325	0.342	0.357
	90	7	8964	64.44	17.70	234839	0.186	0.307	0.205	0.215	0.226	0.237	0.308	0.325	0.343	0.360
		8	8964	64.44	18.20	244157	0.185	0.306	0.203	0.212	0.223	0.232	0.309	0.325	0.342	0.358
		9	8964	64.44	18.70	253734	0.183	0.306	0.202	0.210	0.219	0.227	0.310	0.325	0.341	0.356
	110	7	13640	79.61	19.30	348757	0.187	0.307	0.205	0.215	0.225	0.235	0.310	0.327	0.344	0.362
		8	13640	79.61	19.80	361294	0.185	0.307	0.203	0.212	0.221	0.230	0.311	0.327	0.343	0.359
		9	13640	79.61	20.30	374152	0.183	0.306	0.202	0.209	0.217	0.226	0.311	0.327	0.341	0.357
	130	7	20833	90.14	21.85	514491	0.187	0.308	0.205	0.216	0.225	0.233	0.310	0.330	0.346	0.362
		8	20833	90.14	22.35	530539	0.185	0.308	0.203	0.213	0.221	0.228	0.311	0.329	0.345	0.359
		9	20833	90.14	22.85	546949	0.183	0.307	0.201	0.210	0.217	0.224	0.312	0.329	0.344	0.357
	140	7	25799	95.63	23.60	636881	0.187	0.308	0.205	0.215	0.224	0.233	0.310	0.329	0.345	0.362
		8	25799	95.63	24.10	655254	0.185	0.307	0.203	0.212	0.220	0.229	0.311	0.328	0.343	0.359
		9	25799	95.63	24.60	674012	0.183	0.307	0.201	0.209	0.216	0.224	0.311	0.327	0.342	0.357
5	50	7	4633	43.50	15.85	125354	0.275	0.412	0.303	0.342	0.388	0.426	0.352	0.397	0.450	0.497
		8	4633	43.50	16.35	130996	0.273	0.407	0.305	0.343	0.386	0.422	0.356	0.403	0.455	0.502
		9	4633	43.50	16.85	136813	0.271	0.403	0.307	0.343	0.384	0.418	0.360	0.407	0.457	0.503
	70	7	7042	62.90	16.35	192178	0.256	0.385	0.295	0.320	0.350	0.378	0.367	0.403	0.444	0.487
		8	7042	62.90	16.85	200589	0.253	0.380	0.295	0.318	0.346	0.372	0.371	0.405	0.445	0.485
		9	7042	62.90	17.35	209254	0.251	0.379	0.295	0.316	0.341	0.366	0.375	0.408	0.446	0.485
	90	7	10751	64.63	18.95	273565	0.251	0.378	0.293	0.317	0.341	0.364	0.373	0.409	0.447	0.483
		8	10751	64.63	19.45	283561	0.248	0.377	0.292	0.314	0.336	0.357	0.376	0.414	0.450	0.486

		9	10751	64.63	19.95	293818	0.246	0.376	0.290	0.310	0.331	0.351	0.379	0.416	0.451	0.485
	110	7	16376	72.84	21.55	404414	0.248	0.376	0.289	0.310	0.331	0.354	0.375	0.411	0.447	0.485
		8	16376	72.84	22.05	417205	0.245	0.375	0.288	0.306	0.326	0.347	0.378	0.412	0.447	0.483
		9	16376	72.84	22.55	430290	0.243	0.373	0.285	0.303	0.321	0.341	0.380	0.413	0.446	0.481
	130	7	25002	93.24	23.60	619738	0.245	0.374	0.286	0.305	0.325	0.344	0.376	0.411	0.445	0.479
		8	25002	93.24	24.10	637651	0.242	0.373	0.284	0.301	0.319	0.337	0.379	0.412	0.444	0.477
		9	25002	93.24	24.60	655941	0.240	0.372	0.281	0.297	0.314	0.331	0.380	0.412	0.443	0.474
	140	7	30911	97.85	25.43	758746	0.244	0.374	0.285	0.304	0.323	0.342	0.377	0.410	0.443	0.476
		8	30911	97.85	25.93	778988	0.242	0.373	0.283	0.300	0.318	0.335	0.379	0.411	0.442	0.474
		9	30911	97.85	26.43	799624	0.239	0.372	0.280	0.296	0.312	0.329	0.380	0.411	0.441	0.471
6	50	7	5578	50.98	16.10	151384	0.328	0.502	0.357	0.402	0.437	0.485	0.414	0.475	0.519	0.578
		8	5578	50.98	16.60	158099	0.322	0.495	0.360	0.403	0.436	0.482	0.419	0.477	0.522	0.582
		9	5578	50.98	17.10	165019	0.317	0.488	0.361	0.403	0.435	0.478	0.424	0.481	0.527	0.584
	70	7	8449	61.26	17.70	222665	0.294	0.465	0.347	0.378	0.409	0.444	0.431	0.478	0.524	0.573
		8	8449	61.26	18.20	231523	0.291	0.462	0.348	0.377	0.406	0.438	0.436	0.483	0.528	0.574
		9	8449	61.26	18.70	240628	0.287	0.459	0.348	0.374	0.402	0.432	0.442	0.487	0.531	0.575
	90	7	12964	66.12	20.45	327181	0.288	0.459	0.345	0.373	0.397	0.426	0.440	0.483	0.522	0.569
		8	12964	66.12	20.95	338206	0.285	0.456	0.345	0.370	0.393	0.419	0.446	0.486	0.524	0.568
		9	12964	66.12	21.45	349498	0.282	0.453	0.343	0.367	0.388	0.412	0.450	0.489	0.525	0.568
	110	7	19747	75.02	23.20	484346	0.284	0.456	0.342	0.366	0.391	0.416	0.446	0.487	0.530	0.572
		8	19747	75.02	23.70	498518	0.281	0.453	0.340	0.362	0.385	0.409	0.450	0.490	0.531	0.571
		9	19747	75.02	24.20	512992	0.278	0.450	0.338	0.359	0.380	0.402	0.453	0.491	0.531	0.570
	130	7	30171	95.60	25.50	743809	0.279	0.451	0.337	0.359	0.383	0.406	0.447	0.487	0.528	0.568
		8	30171	95.60	26.00	763639	0.276	0.448	0.335	0.356	0.377	0.399	0.450	0.489	0.529	0.566
		9	30171	95.60	26.50	783855	0.273	0.446	0.332	0.352	0.372	0.392	0.453	0.489	0.528	0.564
	140	7	37210	122.00	25.50	938798	0.278	0.449	0.335	0.358	0.378	0.400	0.446	0.487	0.523	0.560
		8	31032	97.70	26.00	782011	0.275	0.446	0.333	0.354	0.372	0.392	0.450	0.488	0.523	0.559
		9	31032	97.70	26.50	802670	0.272	0.444	0.330	0.350	0.367	0.385	0.452	0.489	0.522	0.556
7	50	7	6665	49.90	17.40	175391	0.367	0.568	0.385	0.425	0.478	0.530	0.452	0.503	0.563	0.628
		8	6665	49.90	17.90	182486	0.359	0.561	0.389	0.428	0.478	0.528	0.459	0.509	0.570	0.632
		9	6665	49.90	18.40	189782	0.353	0.553	0.392	0.429	0.477	0.525	0.465	0.515	0.576	0.636
	70	7	10257	61.84	19.00	262460	0.318	0.524	0.376	0.408	0.446	0.485	0.470	0.514	0.566	0.623
		8	10257	61.84	19.50	272049	0.312	0.520	0.377	0.408	0.444	0.480	0.478	0.520	0.569	0.625

		9	10257	61.84	20.00	281888	0.308	0.515	0.378	0.406	0.440	0.474	0.484	0.526	0.573	0.628
	90	7	15622	76.60	20.75	391525	0.305	0.509	0.373	0.401	0.429	0.459	0.484	0.524	0.565	0.613
		8	15622	76.60	21.25	404483	0.301	0.504	0.373	0.399	0.424	0.452	0.490	0.530	0.568	0.614
		9	15622	76.60	21.75	417750	0.297	0.500	0.373	0.396	0.419	0.445	0.496	0.535	0.570	0.615
	110	7	23722	89.58	23.40	586222	0.299	0.502	0.370	0.394	0.423	0.450	0.490	0.529	0.574	0.616
		8	23722	89.58	23.90	603289	0.296	0.497	0.369	0.392	0.418	0.443	0.496	0.533	0.576	0.617
		9	23722	89.58	24.40	620716	0.292	0.493	0.367	0.388	0.413	0.436	0.500	0.537	0.578	0.617
	130	7	36261	98.40	27.50	891557	0.297	0.497	0.367	0.390	0.416	0.441	0.492	0.531	0.572	0.614
		8	36261	98.40	28.00	913553	0.293	0.493	0.365	0.387	0.411	0.434	0.497	0.535	0.573	0.614
		9	36261	98.40	28.50	935946	0.290	0.488	0.363	0.383	0.406	0.427	0.501	0.537	0.574	0.613
	140	7	44826	117.37	28.50	1129065	0.296	0.496	0.365	0.388	0.412	0.436	0.494	0.531	0.570	0.610
		8	44826	117.37	29.00	1156247	0.292	0.491	0.363	0.385	0.407	0.429	0.498	0.534	0.571	0.609
		9	44826	117.37	29.50	1183903	0.289	0.487	0.361	0.382	0.402	0.422	0.502	0.536	0.571	0.608
8	50	7	8024	50.04	18.70	205598	0.422	0.670	0.421	0.476	0.528	0.582	0.501	0.567	0.619	0.687
		8	8024	50.04	19.20	213237	0.412	0.663	0.425	0.478	0.528	0.581	0.508	0.573	0.625	0.697
		9	8024	50.04	19.70	221077	0.403	0.655	0.428	0.479	0.527	0.578	0.515	0.579	0.630	0.701
	70	7	12249	57.56	21.75	318021	0.370	0.624	0.424	0.464	0.505	0.546	0.523	0.582	0.641	0.699
		8	12249	57.56	22.25	328222	0.360	0.615	0.426	0.464	0.503	0.542	0.531	0.589	0.647	0.706
		9	12249	57.56	22.75	338655	0.352	0.606	0.427	0.463	0.500	0.537	0.538	0.595	0.652	0.709
	90	7	18704	81.11	21.75	459764	0.342	0.595	0.417	0.448	0.480	0.512	0.539	0.585	0.634	0.685
		8	15599	69.21	22.25	401668	0.334	0.587	0.418	0.447	0.476	0.505	0.546	0.593	0.642	0.690
		9	15599	69.21	22.75	414213	0.329	0.579	0.417	0.444	0.471	0.499	0.552	0.597	0.644	0.691
	110	7	28568	91.18	25.50	707743	0.333	0.584	0.416	0.446	0.476	0.506	0.544	0.597	0.647	0.697
		8	28568	91.18	26.00	726657	0.326	0.576	0.416	0.444	0.471	0.499	0.551	0.601	0.649	0.698
		9	28568	91.18	26.50	745938	0.322	0.569	0.414	0.440	0.466	0.493	0.555	0.604	0.651	0.698
	130	7	43605	101.06	29.50	1059728	0.329	0.579	0.412	0.440	0.468	0.495	0.547	0.596	0.643	0.691
		8	43605	101.06	30.00	1083948	0.324	0.571	0.411	0.437	0.463	0.488	0.552	0.599	0.645	0.692
		9	43605	101.06	30.50	1108574	0.321	0.565	0.409	0.434	0.458	0.481	0.556	0.601	0.645	0.692
	140	7	53928	121.04	30.50	1341455	0.327	0.575	0.410	0.438	0.464	0.490	0.547	0.596	0.642	0.689
		8	53928	121.04	31.00	1371438	0.322	0.568	0.409	0.434	0.459	0.483	0.552	0.599	0.643	0.689
		9	53928	121.04	31.50	1401908	0.319	0.562	0.407	0.431	0.454	0.476	0.556	0.601	0.644	0.688

Table C. 10 Shear Force Live Load Distribution Factor for HEMTT

MILITARY VEHICLE : HEMTT

							HEMTT	HEMTT	HEMTT				HEMTT			
							SL-V	DL-V	SL-V				DL-V			
							Interior	Interior	Exterior				Exterior			
							OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)
Spacing (ft)	Span (ft)	thickness (in)	Inertia (in^4)	Area (in^2)	eg (in)	Kg	0	0	0	1	2	3	0	1	2	3
4	50	7	3846	36.98	15.65	103943	0.304	0.393	0.301	0.378	0.430	0.460	0.315	0.411	0.438	0.440
		8	3846	36.98	16.15	108679	0.297	0.384	0.312	0.381	0.426	0.449	0.329	0.416	0.435	0.431
		9	3846	36.98	16.65	113565	0.291	0.376	0.322	0.385	0.422	0.439	0.342	0.422	0.434	0.425
	70	7	5865	45.11	17.20	154750	0.282	0.387	0.304	0.374	0.429	0.461	0.318	0.409	0.455	0.470
		8	5865	45.11	17.50	158533	0.275	0.376	0.315	0.377	0.423	0.449	0.335	0.416	0.454	0.463
		9	5865	45.11	18.20	167614	0.267	0.368	0.331	0.380	0.418	0.437	0.356	0.423	0.452	0.456
	90	7	8964	64.44	17.70	234839	0.278	0.377	0.298	0.370	0.431	0.476	0.316	0.417	0.453	0.498
		8	8964	64.44	18.20	244157	0.272	0.366	0.310	0.373	0.424	0.462	0.333	0.425	0.452	0.490
		9	8964	64.44	18.70	253734	0.267	0.358	0.320	0.376	0.418	0.450	0.350	0.432	0.451	0.482
	110	7	13640	79.61	19.30	348757	0.281	0.373	0.291	0.367	0.428	0.472	0.310	0.409	0.460	0.515
		8	13640	79.61	19.80	361294	0.274	0.365	0.301	0.370	0.423	0.460	0.326	0.417	0.460	0.509
		9	13640	79.61	20.30	374152	0.268	0.357	0.311	0.372	0.418	0.448	0.342	0.423	0.459	0.502
	130	7	20833	90.14	21.85	514491	0.275	0.384	0.291	0.364	0.424	0.471	0.324	0.406	0.465	0.509
		8	20833	90.14	22.35	530539	0.268	0.376	0.301	0.366	0.419	0.459	0.339	0.413	0.465	0.503
		9	20833	90.14	22.85	546949	0.263	0.368	0.311	0.368	0.415	0.448	0.355	0.419	0.465	0.497
	140	7	25799	95.63	23.60	636881	0.281	0.373	0.290	0.320	0.370	0.399	0.313	0.366	0.412	0.419
		8	25799	95.63	24.10	655254	0.274	0.365	0.300	0.364	0.420	0.462	0.328	0.414	0.462	0.496
		9	25799	95.63	24.60	674012	0.268	0.358	0.309	0.366	0.415	0.451	0.342	0.420	0.462	0.490
5	50	7	4633	43.50	15.85	125354	0.356	0.461	0.350	0.415	0.472	0.504	0.386	0.421	0.477	0.513
		8	4633	43.50	16.35	130996	0.347	0.450	0.362	0.419	0.469	0.496	0.403	0.429	0.478	0.505
		9	4633	43.50	16.85	136813	0.339	0.439	0.374	0.422	0.466	0.488	0.418	0.436	0.479	0.500
	70	7	7042	62.90	16.35	192178	0.328	0.443	0.350	0.416	0.471	0.497	0.369	0.439	0.481	0.528
		8	7042	62.90	16.85	200589	0.318	0.430	0.363	0.420	0.467	0.487	0.387	0.443	0.477	0.515
		9	7042	62.90	17.35	209254	0.310	0.419	0.374	0.424	0.463	0.479	0.404	0.452	0.479	0.510
	90	7	10751	64.63	18.95	273565	0.318	0.436	0.347	0.414	0.468	0.513	0.372	0.448	0.505	0.544
		8	10751	64.63	19.45	283561	0.309	0.424	0.360	0.418	0.463	0.502	0.391	0.458	0.506	0.532

		9	10751	64.63	19.95	293818	0.301	0.413	0.371	0.421	0.459	0.492	0.408	0.468	0.508	0.526
		7	16376	72.84	21.55	404414	0.330	0.432	0.334	0.411	0.465	0.494	0.368	0.441	0.516	0.558
	110	8	16376	72.84	22.05	417205	0.322	0.420	0.345	0.414	0.461	0.485	0.386	0.460	0.519	0.554
		9	16376	72.84	22.55	430290	0.314	0.408	0.356	0.417	0.457	0.476	0.402	0.469	0.521	0.550
		7	25002	93.24	23.60	619738	0.320	0.434	0.332	0.403	0.466	0.498	0.376	0.451	0.512	0.569
	130	8	25002	93.24	24.10	637651	0.311	0.423	0.343	0.406	0.462	0.489	0.393	0.446	0.515	0.565
		9	25002	93.24	24.60	655941	0.303	0.412	0.354	0.408	0.458	0.481	0.409	0.455	0.517	0.562
		7	30911	97.85	25.43	758746	0.315	0.431	0.333	0.403	0.465	0.497	0.360	0.432	0.497	0.566
	140	8	30911	97.85	25.93	778988	0.307	0.420	0.343	0.406	0.461	0.488	0.376	0.439	0.497	0.542
		9	30911	97.85	26.43	799624	0.300	0.410	0.353	0.409	0.457	0.480	0.392	0.447	0.499	0.538
		7	5578	50.98	16.10	151384	0.411	0.575	0.409	0.476	0.518	0.562	0.422	0.509	0.546	0.591
	50	8	5578	50.98	16.60	158099	0.397	0.558	0.423	0.483	0.519	0.556	0.441	0.521	0.553	0.591
		9	5578	50.98	17.10	165019	0.385	0.543	0.435	0.488	0.519	0.551	0.459	0.533	0.559	0.590
		7	8449	61.26	17.70	222665	0.398	0.548	0.409	0.473	0.516	0.561	0.424	0.507	0.555	0.607
	70	8	8449	61.26	18.20	231523	0.383	0.529	0.423	0.478	0.516	0.554	0.445	0.524	0.569	0.607
		9	8449	61.26	18.70	240628	0.371	0.512	0.435	0.483	0.516	0.547	0.464	0.537	0.576	0.607
		7	12964	66.12	20.45	327181	0.370	0.536	0.415	0.467	0.513	0.569	0.437	0.503	0.563	0.623
	90	8	12964	66.12	20.95	338206	0.357	0.518	0.428	0.473	0.513	0.562	0.459	0.523	0.571	0.622
6		9	12964	66.12	21.45	349498	0.346	0.501	0.440	0.478	0.512	0.555	0.478	0.536	0.577	0.622
		7	19747	75.02	23.20	484346	0.376	0.528	0.406	0.464	0.498	0.558	0.442	0.504	0.557	0.636
	110	8	19747	75.02	23.70	498518	0.363	0.511	0.418	0.469	0.498	0.551	0.464	0.520	0.579	0.628
		9	19747	75.02	24.20	512992	0.351	0.495	0.430	0.474	0.497	0.545	0.484	0.533	0.586	0.628
		7	30171	95.60	25.50	743809	0.381	0.521	0.394	0.459	0.505	0.565	0.431	0.511	0.577	0.648
	130	8	30171	95.60	26.00	763639	0.369	0.505	0.406	0.464	0.505	0.559	0.450	0.512	0.572	0.633
		9	30171	95.60	26.50	783855	0.357	0.490	0.417	0.469	0.505	0.553	0.468	0.524	0.578	0.634
		7	37210	122.00	25.50	938798	0.388	0.535	0.386	0.454	0.501	0.559	0.413	0.494	0.558	0.644
	140	8	31032	97.70	26.00	782011	0.376	0.519	0.397	0.459	0.501	0.553	0.431	0.508	0.583	0.646
		9	31032	97.70	26.50	802670	0.364	0.504	0.408	0.463	0.501	0.547	0.448	0.519	0.590	0.647
7		7	6665	49.90	17.40	175391	0.431	0.639	0.447	0.496	0.565	0.620	0.484	0.554	0.616	0.662
	50	8	6665	49.90	17.90	182486	0.414	0.626	0.462	0.504	0.566	0.615	0.508	0.567	0.625	0.664
		9	6665	49.90	18.40	189782	0.399	0.614	0.474	0.511	0.567	0.611	0.529	0.582	0.633	0.666
	70	7	10257	61.84	19.00	262460	0.412	0.618	0.448	0.494	0.558	0.614	0.491	0.552	0.617	0.676
		8	10257	61.84	19.50	272049	0.395	0.601	0.462	0.502	0.559	0.609	0.516	0.568	0.628	0.688

		9	10257	61.84	20.00	281888	0.380	0.585	0.474	0.507	0.559	0.604	0.539	0.584	0.637	0.691
	90	7	15622	76.60	20.75	391525	0.399	0.607	0.443	0.487	0.547	0.607	0.488	0.549	0.612	0.679
		8	15622	76.60	21.25	404483	0.382	0.589	0.456	0.494	0.547	0.601	0.514	0.566	0.622	0.688
		9	15622	76.60	21.75	417750	0.367	0.571	0.468	0.500	0.547	0.595	0.538	0.582	0.631	0.690
	110	7	23722	89.58	23.40	586222	0.405	0.600	0.434	0.480	0.546	0.603	0.489	0.549	0.621	0.684
		8	23722	89.58	23.90	603289	0.389	0.583	0.447	0.486	0.546	0.597	0.514	0.567	0.626	0.688
		9	23722	89.58	24.40	620716	0.375	0.565	0.459	0.492	0.546	0.591	0.538	0.584	0.636	0.691
	130	7	36261	98.40	27.50	891557	0.410	0.594	0.430	0.472	0.540	0.603	0.480	0.545	0.625	0.686
		8	36261	98.40	28.00	913553	0.394	0.576	0.442	0.479	0.540	0.597	0.504	0.562	0.637	0.690
		9	36261	98.40	28.50	935946	0.380	0.559	0.454	0.484	0.540	0.591	0.527	0.579	0.647	0.693
	140	7	44826	117.37	28.50	1129065	0.416	0.596	0.417	0.466	0.538	0.604	0.462	0.536	0.615	0.684
		8	44826	117.37	29.00	1156247	0.400	0.580	0.428	0.472	0.538	0.598	0.483	0.553	0.627	0.693
		9	44826	117.37	29.50	1183903	0.387	0.564	0.439	0.478	0.538	0.593	0.504	0.569	0.637	0.697
8	50	7	8024	50.04	18.70	205598	0.486	0.706	0.476	0.550	0.616	0.668	0.521	0.609	0.678	0.720
		8	8024	50.04	19.20	213237	0.466	0.685	0.491	0.558	0.618	0.664	0.545	0.625	0.688	0.722
		9	8024	50.04	19.70	221077	0.450	0.667	0.504	0.564	0.619	0.661	0.566	0.640	0.698	0.726
	70	7	12249	57.56	21.75	318021	0.474	0.705	0.466	0.544	0.608	0.664	0.517	0.618	0.689	0.729
		8	12249	57.56	22.25	328222	0.453	0.682	0.482	0.552	0.609	0.660	0.542	0.638	0.701	0.736
		9	12249	57.56	22.75	338655	0.436	0.660	0.495	0.558	0.609	0.655	0.565	0.654	0.712	0.741
	90	7	18704	81.11	21.75	459764	0.458	0.691	0.464	0.540	0.604	0.657	0.521	0.615	0.683	0.740
		8	15599	69.21	22.25	401668	0.437	0.668	0.479	0.548	0.605	0.652	0.546	0.634	0.695	0.747
		9	15599	69.21	22.75	414213	0.418	0.646	0.492	0.554	0.605	0.647	0.569	0.651	0.706	0.752
	110	7	28568	91.18	25.50	707743	0.458	0.691	0.455	0.531	0.597	0.655	0.515	0.601	0.677	0.757
		8	28568	91.18	26.00	726657	0.437	0.668	0.469	0.537	0.598	0.650	0.539	0.627	0.689	0.764
		9	28568	91.18	26.50	745938	0.418	0.646	0.482	0.544	0.598	0.645	0.562	0.643	0.699	0.770
	130	7	43605	101.06	29.50	1059728	0.467	0.693	0.446	0.524	0.595	0.651	0.508	0.600	0.679	0.743
		8	43605	101.06	30.00	1083948	0.447	0.671	0.460	0.531	0.595	0.647	0.532	0.616	0.690	0.767
		9	43605	101.06	30.50	1108574	0.429	0.650	0.474	0.537	0.596	0.642	0.554	0.632	0.701	0.774
	140	7	53928	121.04	30.50	1341455	0.476	0.702	0.438	0.520	0.592	0.652	0.498	0.595	0.674	0.757
		8	53928	121.04	31.00	1371438	0.457	0.680	0.451	0.527	0.593	0.648	0.520	0.611	0.685	0.765
		9	53928	121.04	31.50	1401908	0.439	0.660	0.463	0.533	0.593	0.643	0.541	0.626	0.696	0.771

Table C. 11 Bending Moment Live Load Distribution Factor for PLS

MILITARY VEHICLE : PLS

							PLS	PLS	PLS				PLS			
							SL-M	DL-M	SL-M				DL-M			
							Interior	Interior	Exterior				Exterior			
							OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)
Spacing (ft)	Span (ft)	thickness (in)	Inertia (in^4)	Area (in^2)	eg (in)	Kg	0	0	0	1	2	3	0	1	2	3
4	50	7	3846	36.98	15.65	103943	0.195	0.316	0.208	0.236	0.248	0.268	0.300	0.338	0.348	0.373
		8	3846	36.98	16.15	108679	0.194	0.314	0.208	0.234	0.246	0.263	0.302	0.338	0.348	0.372
		9	3846	36.98	16.65	113565	0.192	0.312	0.208	0.232	0.243	0.259	0.304	0.339	0.348	0.370
	70	7	5865	45.11	17.20	154750	0.190	0.310	0.206	0.225	0.235	0.249	0.304	0.334	0.344	0.365
		8	5865	45.11	17.50	158533	0.189	0.308	0.205	0.223	0.231	0.245	0.306	0.335	0.344	0.364
		9	5865	45.11	18.20	167614	0.187	0.307	0.205	0.221	0.228	0.240	0.308	0.335	0.344	0.363
	90	7	8964	64.44	17.70	234839	0.188	0.308	0.206	0.223	0.231	0.242	0.307	0.335	0.345	0.362
		8	8964	64.44	18.20	244157	0.187	0.306	0.205	0.220	0.227	0.237	0.309	0.336	0.345	0.361
		9	8964	64.44	18.70	253734	0.185	0.306	0.203	0.217	0.223	0.232	0.310	0.336	0.344	0.359
	110	7	13640	79.61	19.30	348757	0.189	0.308	0.207	0.221	0.228	0.239	0.310	0.336	0.345	0.363
		8	13640	79.61	19.80	361294	0.187	0.307	0.205	0.218	0.224	0.234	0.311	0.336	0.344	0.361
		9	13640	79.61	20.30	374152	0.185	0.307	0.203	0.215	0.220	0.229	0.311	0.335	0.343	0.359
	130	7	20833	90.14	21.85	514491	0.188	0.308	0.206	0.222	0.228	0.236	0.310	0.339	0.348	0.363
		8	20833	90.14	22.35	530539	0.186	0.308	0.204	0.219	0.224	0.231	0.311	0.338	0.346	0.361
		9	20833	90.14	22.85	546949	0.184	0.307	0.202	0.216	0.220	0.227	0.311	0.338	0.345	0.358
	140	7	25799	95.63	23.60	636881	0.188	0.308	0.206	0.221	0.227	0.236	0.310	0.338	0.346	0.364
		8	25799	95.63	24.10	655254	0.187	0.307	0.204	0.218	0.223	0.232	0.311	0.337	0.345	0.361
		9	25799	95.63	24.60	674012	0.185	0.307	0.202	0.215	0.219	0.228	0.311	0.336	0.343	0.359
5	50	7	4633	43.50	15.85	125354	0.278	0.416	0.306	0.344	0.390	0.431	0.355	0.398	0.449	0.498
		8	4633	43.50	16.35	130996	0.276	0.411	0.308	0.345	0.388	0.426	0.358	0.402	0.453	0.501
		9	4633	43.50	16.85	136813	0.274	0.406	0.310	0.345	0.385	0.421	0.362	0.406	0.456	0.503
	70	7	7042	62.90	16.35	192178	0.262	0.391	0.298	0.326	0.358	0.389	0.366	0.405	0.448	0.492
		8	7042	62.90	16.85	200589	0.259	0.386	0.299	0.324	0.354	0.383	0.370	0.407	0.449	0.491
		9	7042	62.90	17.35	209254	0.257	0.381	0.298	0.322	0.350	0.376	0.374	0.410	0.450	0.490
	90	7	10751	64.63	18.95	273565	0.255	0.380	0.295	0.320	0.346	0.371	0.371	0.408	0.447	0.485
		8	10751	64.63	19.45	283561	0.253	0.378	0.294	0.317	0.342	0.364	0.375	0.413	0.450	0.487

		9	10751	64.63	19.95	293818	0.250	0.377	0.292	0.314	0.337	0.358	0.378	0.414	0.450	0.486
	110	7	16376	72.84	21.55	404414	0.251	0.376	0.291	0.312	0.335	0.360	0.373	0.411	0.448	0.487
		8	16376	72.84	22.05	417205	0.248	0.375	0.289	0.309	0.331	0.353	0.376	0.412	0.447	0.485
		9	16376	72.84	22.55	430290	0.246	0.374	0.287	0.305	0.326	0.346	0.378	0.413	0.447	0.483
	130	7	25002	93.24	23.60	619738	0.247	0.375	0.287	0.307	0.328	0.348	0.375	0.411	0.446	0.480
		8	25002	93.24	24.10	637651	0.245	0.374	0.284	0.303	0.322	0.341	0.377	0.412	0.445	0.478
		9	25002	93.24	24.60	655941	0.242	0.373	0.282	0.299	0.317	0.335	0.378	0.412	0.444	0.476
	140	7	30911	97.85	25.43	758746	0.247	0.374	0.286	0.306	0.327	0.346	0.375	0.410	0.444	0.477
		8	30911	97.85	25.93	778988	0.244	0.373	0.284	0.302	0.322	0.340	0.377	0.411	0.443	0.475
		9	30911	97.85	26.43	799624	0.242	0.372	0.281	0.298	0.317	0.333	0.379	0.411	0.442	0.472
6	50	7	5578	50.98	16.10	151384	0.331	0.505	0.359	0.403	0.441	0.491	0.415	0.474	0.518	0.577
		8	5578	50.98	16.60	158099	0.325	0.498	0.361	0.404	0.440	0.487	0.420	0.475	0.521	0.580
		9	5578	50.98	17.10	165019	0.320	0.491	0.363	0.403	0.439	0.483	0.424	0.479	0.525	0.583
	70	7	8449	61.26	17.70	222665	0.303	0.470	0.350	0.383	0.417	0.455	0.429	0.477	0.524	0.575
		8	8449	61.26	18.20	231523	0.299	0.465	0.351	0.382	0.414	0.449	0.434	0.482	0.528	0.576
		9	8449	61.26	18.70	240628	0.296	0.463	0.351	0.380	0.410	0.443	0.439	0.486	0.531	0.577
	90	7	12964	66.12	20.45	327181	0.294	0.461	0.347	0.377	0.402	0.433	0.439	0.483	0.520	0.570
		8	12964	66.12	20.95	338206	0.291	0.458	0.347	0.374	0.397	0.426	0.444	0.485	0.522	0.568
		9	12964	66.12	21.45	349498	0.288	0.455	0.346	0.371	0.393	0.419	0.448	0.488	0.524	0.568
	110	7	19747	75.02	23.20	484346	0.289	0.458	0.343	0.368	0.394	0.422	0.444	0.486	0.530	0.573
		8	19747	75.02	23.70	498518	0.286	0.455	0.342	0.365	0.390	0.415	0.448	0.489	0.532	0.572
		9	19747	75.02	24.20	512992	0.283	0.453	0.340	0.361	0.385	0.408	0.451	0.490	0.532	0.571
	130	7	30171	95.60	25.50	743809	0.283	0.453	0.337	0.361	0.386	0.410	0.445	0.486	0.529	0.571
		8	30171	95.60	26.00	763639	0.280	0.450	0.336	0.357	0.381	0.403	0.448	0.487	0.529	0.568
		9	30171	95.60	26.50	783855	0.277	0.448	0.333	0.353	0.376	0.397	0.450	0.488	0.529	0.566
	140	7	37210	122.00	25.50	938798	0.282	0.450	0.336	0.360	0.380	0.403	0.444	0.486	0.520	0.560
		8	31032	97.70	26.00	782011	0.278	0.447	0.334	0.356	0.375	0.396	0.447	0.487	0.520	0.558
		9	31032	97.70	26.50	802670	0.275	0.445	0.331	0.352	0.370	0.389	0.449	0.488	0.520	0.556
7	50	7	6665	49.90	17.40	175391	0.368	0.572	0.387	0.430	0.483	0.535	0.452	0.501	0.562	0.628
		8	6665	49.90	17.90	182486	0.360	0.565	0.391	0.432	0.483	0.533	0.459	0.508	0.567	0.631
		9	6665	49.90	18.40	189782	0.353	0.557	0.393	0.433	0.482	0.529	0.465	0.514	0.572	0.635
	70	7	10257	61.84	19.00	262460	0.329	0.531	0.380	0.415	0.455	0.496	0.470	0.514	0.568	0.626
		8	10257	61.84	19.50	272049	0.323	0.526	0.382	0.415	0.453	0.491	0.477	0.521	0.571	0.629

		9	10257	61.84	20.00	281888	0.318	0.522	0.383	0.414	0.450	0.486	0.483	0.526	0.576	0.632
	90	7	15622	76.60	20.75	391525	0.313	0.515	0.375	0.404	0.434	0.466	0.482	0.523	0.562	0.612
		8	15622	76.60	21.25	404483	0.308	0.510	0.375	0.403	0.430	0.460	0.488	0.529	0.567	0.614
		9	15622	76.60	21.75	417750	0.305	0.506	0.375	0.400	0.425	0.453	0.494	0.534	0.570	0.615
	110	7	23722	89.58	23.40	586222	0.305	0.506	0.371	0.397	0.427	0.455	0.488	0.527	0.575	0.618
		8	23722	89.58	23.90	603289	0.301	0.501	0.370	0.394	0.423	0.448	0.493	0.532	0.577	0.618
		9	23722	89.58	24.40	620716	0.298	0.497	0.368	0.391	0.418	0.442	0.498	0.535	0.579	0.618
	130	7	36261	98.40	27.50	891557	0.302	0.501	0.368	0.392	0.419	0.446	0.490	0.530	0.572	0.615
		8	36261	98.40	28.00	913553	0.298	0.497	0.366	0.389	0.414	0.439	0.495	0.534	0.573	0.615
		9	36261	98.40	28.50	935946	0.295	0.492	0.364	0.386	0.409	0.432	0.498	0.536	0.574	0.614
	140	7	44826	117.37	28.50	1129065	0.300	0.499	0.366	0.391	0.415	0.440	0.492	0.529	0.569	0.609
		8	44826	117.37	29.00	1156247	0.296	0.495	0.364	0.387	0.410	0.433	0.496	0.532	0.570	0.609
		9	44826	117.37	29.50	1183903	0.293	0.491	0.362	0.384	0.405	0.427	0.500	0.534	0.571	0.607
8	50	7	8024	50.04	18.70	205598	0.421	0.673	0.425	0.481	0.534	0.587	0.499	0.565	0.622	0.690
		8	8024	50.04	19.20	213237	0.410	0.665	0.430	0.483	0.534	0.585	0.506	0.571	0.628	0.700
		9	8024	50.04	19.70	221077	0.401	0.657	0.433	0.484	0.532	0.582	0.512	0.576	0.632	0.705
	70	7	12249	57.56	21.75	318021	0.382	0.634	0.427	0.470	0.514	0.557	0.519	0.580	0.642	0.702
		8	12249	57.56	22.25	328222	0.372	0.625	0.429	0.470	0.512	0.553	0.527	0.587	0.648	0.708
		9	12249	57.56	22.75	338655	0.364	0.617	0.430	0.469	0.509	0.548	0.534	0.592	0.652	0.711
	90	7	18704	81.11	21.75	459764	0.351	0.602	0.418	0.452	0.486	0.519	0.535	0.582	0.633	0.684
		8	15599	69.21	22.25	401668	0.343	0.594	0.419	0.450	0.482	0.513	0.542	0.589	0.640	0.689
		9	15599	69.21	22.75	414213	0.337	0.586	0.419	0.448	0.477	0.507	0.548	0.593	0.642	0.690
	110	7	28568	91.18	25.50	707743	0.340	0.590	0.417	0.449	0.481	0.512	0.541	0.596	0.647	0.699
		8	28568	91.18	26.00	726657	0.333	0.582	0.416	0.447	0.476	0.506	0.547	0.600	0.650	0.699
		9	28568	91.18	26.50	745938	0.329	0.575	0.415	0.444	0.471	0.499	0.552	0.603	0.651	0.699
	130	7	43605	101.06	29.50	1059728	0.335	0.584	0.413	0.443	0.472	0.499	0.544	0.593	0.641	0.692
		8	43605	101.06	30.00	1083948	0.330	0.577	0.412	0.439	0.467	0.493	0.549	0.596	0.643	0.694
		9	43605	101.06	30.50	1108574	0.326	0.571	0.410	0.436	0.462	0.486	0.553	0.598	0.644	0.693
	140	7	53928	121.04	30.50	1341455	0.333	0.581	0.411	0.440	0.467	0.494	0.545	0.593	0.640	0.688
		8	53928	121.04	31.00	1371438	0.328	0.574	0.410	0.436	0.462	0.487	0.550	0.596	0.641	0.689
		9	53928	121.04	31.50	1401908	0.324	0.568	0.408	0.433	0.457	0.481	0.553	0.598	0.642	0.688

Table C. 12 Shear Force Live Load Distribution Factor for PLS

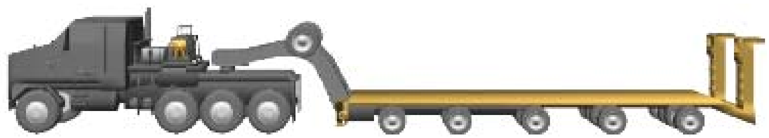
MILITARY VEHICLE : PLS

							PLS	PLS	PLS				PLS			
							SL-V	DL-V	SL-V				DL-V			
							Interior	Interior	Exterior				Exterior			
							OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)
Spacing (ft)	Span (ft)	thickness (in)	Inertia (in^4)	Area (in^2)	eg (in)	Kg	0	0	0	1	2	3	0	1	2	3
4	50	7	3846	36.98	15.65	103943	0.299	0.388	0.303	0.378	0.430	0.465	0.317	0.408	0.438	0.448
		8	3846	36.98	16.15	108679	0.291	0.379	0.314	0.381	0.425	0.453	0.331	0.413	0.435	0.439
		9	3846	36.98	16.65	113565	0.285	0.371	0.324	0.384	0.421	0.444	0.345	0.419	0.434	0.432
	70	7	5865	45.11	17.20	154750	0.276	0.379	0.308	0.374	0.426	0.460	0.324	0.411	0.454	0.472
		8	5865	45.11	17.50	158533	0.269	0.368	0.320	0.378	0.421	0.447	0.341	0.418	0.453	0.464
		9	5865	45.11	18.20	167614	0.260	0.359	0.335	0.381	0.416	0.435	0.362	0.425	0.451	0.456
	90	7	8964	64.44	17.70	234839	0.273	0.372	0.306	0.372	0.429	0.473	0.325	0.421	0.454	0.499
		8	8964	64.44	18.20	244157	0.267	0.361	0.317	0.375	0.422	0.459	0.342	0.430	0.453	0.491
		9	8964	64.44	18.70	253734	0.262	0.351	0.327	0.378	0.416	0.447	0.359	0.438	0.452	0.484
	110	7	13640	79.61	19.30	348757	0.275	0.366	0.297	0.369	0.427	0.470	0.319	0.413	0.462	0.518
		8	13640	79.61	19.80	361294	0.268	0.359	0.308	0.372	0.421	0.457	0.335	0.421	0.461	0.511
		9	13640	79.61	20.30	374152	0.263	0.351	0.317	0.374	0.416	0.445	0.351	0.428	0.461	0.504
	130	7	20833	90.14	21.85	514491	0.270	0.377	0.297	0.366	0.423	0.470	0.330	0.411	0.468	0.513
		8	20833	90.14	22.35	530539	0.265	0.369	0.307	0.368	0.418	0.457	0.347	0.418	0.468	0.507
		9	20833	90.14	22.85	546949	0.259	0.361	0.317	0.370	0.413	0.445	0.362	0.425	0.467	0.500
	140	7	25799	95.63	23.60	636881	0.276	0.367	0.295	0.317	0.367	0.398	0.319	0.366	0.411	0.424
		8	25799	95.63	24.10	655254	0.269	0.358	0.305	0.366	0.419	0.460	0.334	0.418	0.465	0.498
		9	25799	95.63	24.60	674012	0.264	0.351	0.315	0.368	0.414	0.448	0.349	0.424	0.465	0.492
5	50	7	4633	43.50	15.85	125354	0.350	0.457	0.349	0.413	0.472	0.508	0.386	0.419	0.476	0.519
		8	4633	43.50	16.35	130996	0.340	0.445	0.362	0.418	0.469	0.500	0.403	0.427	0.477	0.510
		9	4633	43.50	16.85	136813	0.332	0.434	0.374	0.421	0.467	0.492	0.418	0.435	0.478	0.506
	70	7	7042	62.90	16.35	192178	0.321	0.438	0.352	0.415	0.470	0.497	0.371	0.439	0.480	0.530
		8	7042	62.90	16.85	200589	0.311	0.425	0.364	0.419	0.465	0.487	0.389	0.444	0.476	0.516
		9	7042	62.90	17.35	209254	0.303	0.413	0.376	0.423	0.461	0.478	0.406	0.453	0.478	0.511
	90	7	10751	64.63	18.95	273565	0.312	0.431	0.352	0.414	0.467	0.510	0.378	0.451	0.509	0.544
		8	10751	64.63	19.45	283561	0.302	0.418	0.364	0.418	0.462	0.498	0.398	0.462	0.510	0.531

		9	10751	64.63	19.95	293818	0.294	0.407	0.375	0.421	0.458	0.488	0.415	0.471	0.512	0.526
	110	7	16376	72.84	21.55	404414	0.325	0.427	0.338	0.412	0.465	0.495	0.376	0.445	0.521	0.562
		8	16376	72.84	22.05	417205	0.317	0.415	0.350	0.415	0.461	0.484	0.394	0.465	0.523	0.558
		9	16376	72.84	22.55	430290	0.309	0.403	0.360	0.418	0.457	0.475	0.411	0.474	0.525	0.553
	130	7	25002	93.24	23.60	619738	0.317	0.429	0.337	0.405	0.465	0.499	0.383	0.455	0.515	0.573
		8	25002	93.24	24.10	637651	0.308	0.417	0.348	0.407	0.460	0.489	0.400	0.450	0.517	0.569
		9	25002	93.24	24.60	655941	0.300	0.407	0.358	0.410	0.456	0.480	0.417	0.459	0.519	0.564
	140	7	30911	97.85	25.43	758746	0.313	0.426	0.337	0.404	0.465	0.498	0.366	0.436	0.499	0.570
		8	30911	97.85	25.93	778988	0.305	0.415	0.348	0.407	0.460	0.488	0.382	0.443	0.499	0.545
		9	30911	97.85	26.43	799624	0.297	0.405	0.358	0.410	0.456	0.479	0.398	0.452	0.501	0.541
6	50	7	5578	50.98	16.10	151384	0.412	0.570	0.408	0.475	0.519	0.566	0.422	0.509	0.546	0.594
		8	5578	50.98	16.60	158099	0.398	0.553	0.422	0.482	0.520	0.561	0.441	0.521	0.554	0.595
		9	5578	50.98	17.10	165019	0.386	0.538	0.435	0.487	0.520	0.556	0.459	0.532	0.560	0.596
	70	7	8449	61.26	17.70	222665	0.395	0.541	0.407	0.472	0.515	0.561	0.422	0.507	0.553	0.610
		8	8449	61.26	18.20	231523	0.381	0.522	0.421	0.478	0.514	0.554	0.444	0.524	0.568	0.611
		9	8449	61.26	18.70	240628	0.369	0.505	0.434	0.483	0.513	0.547	0.464	0.537	0.575	0.610
	90	7	12964	66.12	20.45	327181	0.362	0.529	0.418	0.468	0.514	0.569	0.443	0.506	0.566	0.626
		8	12964	66.12	20.95	338206	0.349	0.509	0.431	0.473	0.513	0.561	0.465	0.527	0.574	0.623
		9	12964	66.12	21.45	349498	0.338	0.492	0.443	0.478	0.512	0.553	0.485	0.540	0.581	0.623
	110	7	19747	75.02	23.20	484346	0.371	0.520	0.409	0.465	0.500	0.558	0.448	0.508	0.562	0.641
		8	19747	75.02	23.70	498518	0.358	0.503	0.422	0.470	0.499	0.551	0.470	0.525	0.584	0.632
		9	19747	75.02	24.20	512992	0.346	0.486	0.433	0.475	0.499	0.544	0.490	0.538	0.591	0.632
	130	7	30171	95.60	25.50	743809	0.377	0.514	0.398	0.460	0.507	0.566	0.438	0.515	0.582	0.652
		8	30171	95.60	26.00	763639	0.364	0.498	0.409	0.465	0.507	0.559	0.457	0.516	0.577	0.638
		9	30171	95.60	26.50	783855	0.352	0.482	0.420	0.470	0.506	0.552	0.476	0.529	0.583	0.638
	140	7	37210	122.00	25.50	938798	0.383	0.529	0.390	0.456	0.505	0.560	0.419	0.499	0.563	0.648
		8	31032	97.70	26.00	782011	0.371	0.512	0.401	0.461	0.504	0.554	0.438	0.514	0.588	0.650
		9	31032	97.70	26.50	802670	0.360	0.497	0.411	0.465	0.504	0.547	0.455	0.525	0.595	0.651
7	50	7	6665	49.90	17.40	175391	0.431	0.633	0.445	0.495	0.564	0.621	0.484	0.551	0.612	0.666
		8	6665	49.90	17.90	182486	0.413	0.621	0.460	0.503	0.566	0.617	0.508	0.565	0.622	0.669
		9	6665	49.90	18.40	189782	0.398	0.609	0.474	0.510	0.567	0.613	0.529	0.580	0.631	0.671
	70	7	10257	61.84	19.00	262460	0.407	0.605	0.447	0.494	0.558	0.613	0.491	0.554	0.617	0.675
		8	10257	61.84	19.50	272049	0.390	0.588	0.461	0.501	0.558	0.607	0.517	0.570	0.628	0.685

		9	10257	61.84	20.00	281888	0.376	0.572	0.473	0.507	0.559	0.601	0.540	0.586	0.637	0.687
	90	7	15622	76.60	20.75	391525	0.391	0.601	0.446	0.491	0.550	0.605	0.495	0.555	0.618	0.681
		8	15622	76.60	21.25	404483	0.374	0.582	0.460	0.498	0.550	0.599	0.521	0.573	0.629	0.688
		9	15622	76.60	21.75	417750	0.359	0.563	0.473	0.504	0.549	0.592	0.546	0.590	0.639	0.691
	110	7	23722	89.58	23.40	586222	0.398	0.596	0.437	0.484	0.548	0.604	0.495	0.556	0.626	0.689
		8	23722	89.58	23.90	603289	0.381	0.577	0.450	0.490	0.547	0.597	0.520	0.575	0.630	0.693
		9	23722	89.58	24.40	620716	0.367	0.559	0.462	0.496	0.547	0.590	0.545	0.593	0.640	0.695
	130	7	36261	98.40	27.50	891557	0.402	0.589	0.433	0.476	0.540	0.603	0.485	0.551	0.628	0.690
		8	36261	98.40	28.00	913553	0.385	0.572	0.445	0.482	0.540	0.597	0.510	0.569	0.640	0.694
		9	36261	98.40	28.50	935946	0.371	0.554	0.457	0.488	0.539	0.590	0.533	0.587	0.650	0.697
	140	7	44826	117.37	28.50	1129065	0.409	0.592	0.420	0.470	0.541	0.605	0.466	0.542	0.618	0.687
		8	44826	117.37	29.00	1156247	0.394	0.575	0.431	0.476	0.541	0.599	0.488	0.560	0.633	0.698
		9	44826	117.37	29.50	1183903	0.379	0.558	0.442	0.482	0.540	0.593	0.509	0.576	0.643	0.701
8	50	7	8024	50.04	18.70	205598	0.487	0.699	0.473	0.549	0.617	0.669	0.517	0.607	0.679	0.725
		8	8024	50.04	19.20	213237	0.467	0.679	0.489	0.557	0.618	0.667	0.541	0.623	0.690	0.727
		9	8024	50.04	19.70	221077	0.450	0.661	0.503	0.563	0.618	0.663	0.562	0.639	0.699	0.732
	70	7	12249	57.56	21.75	318021	0.468	0.695	0.467	0.545	0.606	0.660	0.519	0.620	0.692	0.730
		8	12249	57.56	22.25	328222	0.447	0.672	0.482	0.553	0.607	0.655	0.544	0.641	0.704	0.736
		9	12249	57.56	22.75	338655	0.429	0.650	0.496	0.559	0.608	0.651	0.567	0.658	0.715	0.742
	90	7	18704	81.11	21.75	459764	0.448	0.684	0.469	0.542	0.602	0.655	0.528	0.619	0.687	0.745
		8	15599	69.21	22.25	401668	0.426	0.659	0.484	0.550	0.603	0.650	0.554	0.639	0.699	0.752
		9	15599	69.21	22.75	414213	0.407	0.637	0.498	0.556	0.603	0.645	0.578	0.656	0.710	0.757
	110	7	28568	91.18	25.50	707743	0.452	0.685	0.457	0.533	0.598	0.653	0.518	0.607	0.681	0.764
		8	28568	91.18	26.00	726657	0.430	0.661	0.472	0.540	0.598	0.649	0.543	0.633	0.693	0.771
		9	28568	91.18	26.50	745938	0.411	0.639	0.486	0.546	0.599	0.644	0.566	0.650	0.703	0.777
	130	7	43605	101.06	29.50	1059728	0.458	0.689	0.449	0.527	0.596	0.651	0.512	0.606	0.683	0.749
		8	43605	101.06	30.00	1083948	0.437	0.666	0.464	0.534	0.596	0.646	0.536	0.623	0.695	0.774
		9	43605	101.06	30.50	1108574	0.418	0.645	0.477	0.540	0.596	0.642	0.559	0.639	0.706	0.780
	140	7	53928	121.04	30.50	1341455	0.469	0.696	0.440	0.521	0.592	0.651	0.500	0.599	0.678	0.763
		8	53928	121.04	31.00	1371438	0.449	0.674	0.454	0.528	0.593	0.647	0.523	0.615	0.690	0.770
		9	53928	121.04	31.50	1401908	0.430	0.653	0.467	0.534	0.593	0.643	0.544	0.631	0.700	0.777

Table C. 13 Bending Moment Live Load Distribution Factor for HETS

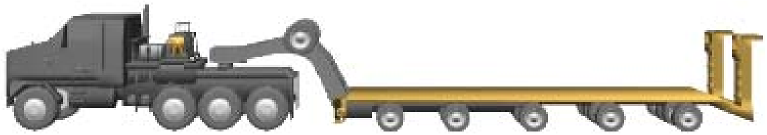


							HETS	HETS				HETS				HETS			
							SL-M	DL-M				SL-M				DL-M			
							Interior	Interior				Exterior				Exterior			
MILITARY VEHICLE : HETS							OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)
Spacing (ft)	Span (ft)	thickness (in)	Inertia (in^4)	Area (in^2)	eg (in)	Kg	0	0	1	2	3	0	1	2	3	0	1	2	3
4	50	7	3846	36.98	15.65	103943	0.180	-----	-----	-----	0.294	0.179	0.202	0.210	0.227	-----	-----	-----	0.315
		8	3846	36.98	16.15	108679	0.179	-----	-----	-----	0.295	0.180	0.202	0.209	0.225	-----	-----	-----	0.314
		9	3846	36.98	16.65	113565	0.178	-----	-----	-----	0.295	0.181	0.202	0.208	0.223	-----	-----	-----	0.313
	70	7	5865	45.11	17.20	154750	0.176	-----	-----	-----	0.296	0.180	0.200	0.204	0.218	-----	-----	-----	0.312
		8	5865	45.11	17.50	158533	0.175	-----	-----	-----	0.296	0.181	0.199	0.203	0.215	-----	-----	-----	0.311
		9	5865	45.11	18.20	167614	0.174	-----	-----	-----	0.296	0.181	0.199	0.202	0.213	-----	-----	-----	0.311
	90	7	8964	64.44	17.70	234839	0.173	-----	-----	-----	0.295	0.181	0.201	0.202	0.211	-----	-----	-----	0.308
		8	8964	64.44	18.20	244157	0.172	-----	-----	-----	0.295	0.181	0.200	0.200	0.209	-----	-----	-----	0.307
		9	8964	64.44	18.70	253734	0.171	-----	-----	-----	0.295	0.181	0.198	0.198	0.206	-----	-----	-----	0.307
	110	7	13640	79.61	19.30	348757	0.173	-----	-----	-----	0.296	0.183	0.201	0.201	0.209	-----	-----	-----	0.307
		8	13640	79.61	19.80	361294	0.172	-----	-----	-----	0.295	0.182	0.200	0.199	0.206	-----	-----	-----	0.306
		9	13640	79.61	20.30	374152	0.171	-----	-----	-----	0.295	0.181	0.198	0.197	0.203	-----	-----	-----	0.305
	130	7	20833	90.14	21.85	514491	0.173	-----	-----	-----	0.297	0.183	0.201	0.200	0.209	-----	-----	-----	0.309
		8	20833	90.14	22.35	530539	0.172	-----	-----	-----	0.297	0.182	0.200	0.197	0.206	-----	-----	-----	0.308
		9	20833	90.14	22.85	546949	0.171	-----	-----	-----	0.297	0.181	0.198	0.195	0.203	-----	-----	-----	0.307
	140	7	25799	95.63	23.60	636881	0.173	-----	-----	-----	0.296	0.183	0.202	0.200	0.209	-----	-----	-----	0.464
		8	25799	95.63	24.10	655254	0.172	-----	-----	-----	0.296	0.182	0.200	0.198	0.206	-----	-----	-----	0.306
		9	25799	95.63	24.60	674012	0.170	-----	-----	-----	0.296	0.181	0.198	0.196	0.203	-----	-----	-----	0.305
5	50	7	4633	43.50	15.85	125354	0.251	-----	-----	-----	0.339	0.243	0.277	0.309	0.348	-----	-----	-----	0.384
		8	4633	43.50	16.35	130996	0.249	-----	-----	-----	0.342	0.246	0.279	0.310	0.347	-----	-----	-----	0.383
		9	4633	43.50	16.85	136813	0.247	-----	-----	-----	0.345	0.249	0.280	0.310	0.345	-----	-----	-----	0.382
	70	7	7042	62.90	16.35	192178	0.238	-----	-----	-----	0.346	0.245	0.271	0.297	0.327	-----	-----	-----	0.380
		8	7042	62.90	16.85	200589	0.236	-----	-----	-----	0.347	0.247	0.272	0.297	0.324	-----	-----	-----	0.379
		9	7042	62.90	17.35	209254	0.234	-----	-----	-----	0.347	0.249	0.272	0.295	0.321	-----	-----	-----	0.378
	90	7	10751	64.63	18.95	273565	0.230	-----	-----	-----	0.349	0.245	0.268	0.290	0.314	-----	-----	-----	0.377
		8	10751	64.63	19.45	283561	0.228	-----	-----	-----	0.350	0.246	0.268	0.288	0.311	-----	-----	-----	0.376
		9	10751	64.63	19.95	293818	0.227	-----	-----	-----	0.350	0.247	0.267	0.286	0.307	-----	-----	-----	0.375

	110	7	16376	72.84	21.55	404414	0.225	-----	-----	-----	0.349	0.245	0.264	0.283	0.305	-----	-----	-----	0.373
		8	16376	72.84	22.05	417205	0.224	-----	-----	-----	0.349	0.245	0.263	0.281	0.301	-----	-----	-----	0.373
		9	16376	72.84	22.55	430290	0.222	-----	-----	-----	0.349	0.244	0.262	0.279	0.298	-----	-----	-----	0.372
	130	7	25002	93.24	23.60	619738	0.222	-----	-----	-----	0.350	0.244	0.262	0.280	0.298	-----	-----	-----	0.373
		8	25002	93.24	24.10	637651	0.220	-----	-----	-----	0.350	0.244	0.260	0.277	0.294	-----	-----	-----	0.372
		9	25002	93.24	24.60	655941	0.218	-----	-----	-----	0.350	0.243	0.258	0.274	0.290	-----	-----	-----	0.371
	140	7	30911	97.85	25.43	758746	0.222	-----	-----	-----	0.351	0.244	0.262	0.279	0.297	-----	-----	-----	0.373
		8	30911	97.85	25.93	778988	0.220	-----	-----	-----	0.351	0.243	0.260	0.276	0.293	-----	-----	-----	0.372
		9	30911	97.85	26.43	799624	0.219	-----	-----	-----	0.351	0.242	0.258	0.273	0.289	-----	-----	-----	0.371
6	50	7	5578	50.98	16.10	151384	0.303	-----	-----	-----	0.412	0.283	0.321	0.362	0.401	-----	-----	-----	0.446
		8	5578	50.98	16.60	158099	0.299	-----	-----	-----	0.412	0.288	0.324	0.363	0.401	-----	-----	-----	0.447
		9	5578	50.98	17.10	165019	0.295	-----	-----	-----	0.414	0.291	0.326	0.364	0.399	-----	-----	-----	0.447
	70	7	8449	61.26	17.70	222665	0.284	-----	-----	-----	0.415	0.289	0.319	0.351	0.382	-----	-----	-----	0.446
		8	8449	61.26	18.20	231523	0.280	-----	-----	-----	0.416	0.292	0.320	0.351	0.381	-----	-----	-----	0.446
		9	8449	61.26	18.70	240628	0.277	-----	-----	-----	0.416	0.294	0.321	0.350	0.378	-----	-----	-----	0.447
	90	7	12964	66.12	20.45	327181	0.272	-----	-----	-----	0.416	0.289	0.316	0.343	0.369	-----	-----	-----	0.444
		8	12964	66.12	20.95	338206	0.269	-----	-----	-----	0.416	0.291	0.316	0.341	0.366	-----	-----	-----	0.444
		9	12964	66.12	21.45	349498	0.266	-----	-----	-----	0.416	0.292	0.315	0.340	0.363	-----	-----	-----	0.444
	110	7	19747	75.02	23.20	484346	0.265	-----	-----	-----	0.415	0.289	0.312	0.336	0.359	-----	-----	-----	0.440
		8	19747	75.02	23.70	498518	0.262	-----	-----	-----	0.415	0.290	0.311	0.334	0.355	-----	-----	-----	0.440
		9	19747	75.02	24.20	512992	0.260	-----	-----	-----	0.414	0.290	0.310	0.332	0.351	-----	-----	-----	0.440
	130	7	30171	95.60	25.50	743809	0.259	-----	-----	-----	0.414	0.289	0.309	0.330	0.351	-----	-----	-----	0.439
		8	30171	95.60	26.00	763639	0.257	-----	-----	-----	0.414	0.289	0.308	0.328	0.347	-----	-----	-----	0.438
		9	30171	95.60	26.50	783855	0.255	-----	-----	-----	0.413	0.288	0.306	0.325	0.343	-----	-----	-----	0.438
	140	7	37210	122.00	25.50	938798	0.258	-----	-----	-----	0.416	0.288	0.308	0.328	0.349	-----	-----	-----	0.441
		8	31032	97.70	26.00	782011	0.255	-----	-----	-----	0.416	0.288	0.307	0.325	0.344	-----	-----	-----	0.441
		9	31032	97.70	26.50	802670	0.253	-----	-----	-----	0.416	0.287	0.304	0.322	0.340	-----	-----	-----	0.440
7	50	7	6665	49.90	17.40	175391	0.345	-----	0.464	0.470	0.469	0.309	0.352	0.394	0.436	-----	0.392	0.435	0.482
		8	6665	49.90	17.90	182486	0.338	-----	0.461	0.466	0.468	0.314	0.356	0.396	0.438	-----	0.394	0.437	0.486
		9	6665	49.90	18.40	189782	0.332	-----	0.458	0.462	0.466	0.319	0.359	0.397	0.437	-----	0.397	0.440	0.488
	70	7	10257	61.84	19.00	262460	0.315	-----	0.448	0.450	0.460	0.313	0.346	0.381	0.418	-----	0.399	0.440	0.485
		8	10257	61.84	19.50	272049	0.310	-----	0.444	0.448	0.459	0.317	0.348	0.382	0.416	-----	0.402	0.443	0.485
		9	10257	61.84	20.00	281888	0.305	-----	0.440	0.448	0.459	0.320	0.350	0.381	0.414	-----	0.406	0.446	0.487

	90	7	15622	76.60	20.75	391525	0.296	-----	0.433	0.445	0.457	0.314	0.342	0.371	0.400	-----	0.409	0.447	0.486
		8	15622	76.60	21.25	404483	0.292	-----	0.432	0.445	0.457	0.317	0.343	0.370	0.397	-----	0.412	0.450	0.488
		9	15622	76.60	21.75	417750	0.288	-----	0.430	0.443	0.457	0.318	0.343	0.368	0.394	-----	0.416	0.452	0.490
	110	7	23722	89.58	23.40	586222	0.287	-----	0.429	0.442	0.455	0.314	0.338	0.363	0.388	-----	0.411	0.446	0.485
		8	23722	89.58	23.90	603289	0.283	-----	0.427	0.441	0.455	0.316	0.338	0.361	0.385	-----	0.414	0.448	0.487
		9	23722	89.58	24.40	620716	0.280	-----	0.426	0.439	0.454	0.316	0.337	0.359	0.381	-----	0.417	0.451	0.489
	130	7	36261	98.40	27.50	891557	0.282	-----	0.429	0.442	0.453	0.315	0.337	0.359	0.382	-----	0.416	0.450	0.485
		8	36261	98.40	28.00	913553	0.278	-----	0.427	0.441	0.452	0.315	0.336	0.357	0.378	-----	0.419	0.452	0.486
		9	36261	98.40	28.50	935946	0.275	-----	0.426	0.439	0.451	0.315	0.334	0.354	0.375	-----	0.421	0.454	0.487
	140	7	44826	117.37	28.50	1129065	0.279	-----	0.425	0.440	0.454	0.315	0.336	0.359	0.381	-----	0.416	0.452	0.488
		8	44826	117.37	29.00	1156247	0.276	-----	0.424	0.439	0.453	0.315	0.335	0.356	0.376	-----	0.418	0.453	0.489
		9	44826	117.37	29.50	1183903	0.273	-----	0.423	0.438	0.452	0.315	0.333	0.353	0.372	-----	0.420	0.455	0.489
8	50	7	8024	50.04	18.70	205598	0.399	-----	-----	-----	0.537	0.345	0.393	0.436	0.477	-----	-----	-----	0.532
		8	8024	50.04	19.20	213237	0.390	-----	-----	-----	0.535	0.350	0.396	0.438	0.479	-----	-----	-----	0.532
		9	8024	50.04	19.70	221077	0.381	-----	-----	-----	0.534	0.354	0.399	0.440	0.479	-----	-----	-----	0.534
	70	7	12249	57.56	21.75	318021	0.365	-----	-----	-----	0.531	0.353	0.392	0.430	0.467	-----	-----	-----	0.539
		8	12249	57.56	22.25	328222	0.357	-----	-----	-----	0.528	0.357	0.394	0.431	0.467	-----	-----	-----	0.540
		9	12249	57.56	22.75	338655	0.350	-----	-----	-----	0.526	0.360	0.396	0.431	0.466	-----	-----	-----	0.542
	90	7	18704	81.11	21.75	459764	0.332	-----	-----	-----	0.522	0.353	0.384	0.415	0.442	-----	-----	-----	0.541
		8	15599	69.21	22.25	401668	0.326	-----	-----	-----	0.517	0.355	0.385	0.414	0.440	-----	-----	-----	0.535
		9	15599	69.21	22.75	414213	0.321	-----	-----	-----	0.515	0.357	0.385	0.413	0.438	-----	-----	-----	0.537
	110	7	28568	91.18	25.50	707743	0.321	-----	-----	-----	0.520	0.354	0.382	0.409	0.436	-----	-----	-----	0.540
		8	28568	91.18	26.00	726657	0.316	-----	-----	-----	0.519	0.355	0.381	0.407	0.433	-----	-----	-----	0.542
		9	28568	91.18	26.50	745938	0.312	-----	-----	-----	0.518	0.356	0.381	0.405	0.430	-----	-----	-----	0.543
	130	7	43605	101.06	29.50	1059728	0.316	-----	-----	-----	0.516	0.353	0.380	0.405	0.429	-----	-----	-----	0.538
		8	43605	101.06	30.00	1083948	0.311	-----	-----	-----	0.515	0.354	0.379	0.403	0.425	-----	-----	-----	0.539
		9	43605	101.06	30.50	1108574	0.308	-----	-----	-----	0.513	0.354	0.378	0.401	0.422	-----	-----	-----	0.540
	140	7	53928	121.04	30.50	1341455	0.313	-----	-----	-----	0.516	0.353	0.379	0.403	0.426	-----	-----	-----	0.539
		8	53928	121.04	31.00	1371438	0.308	-----	-----	-----	0.514	0.353	0.378	0.401	0.422	-----	-----	-----	0.539
		9	53928	121.04	31.50	1401908	0.305	-----	-----	-----	0.513	0.353	0.376	0.398	0.418	-----	-----	-----	0.540

Table C. 14 Shear Force Live Load Distribution Factor for HETS



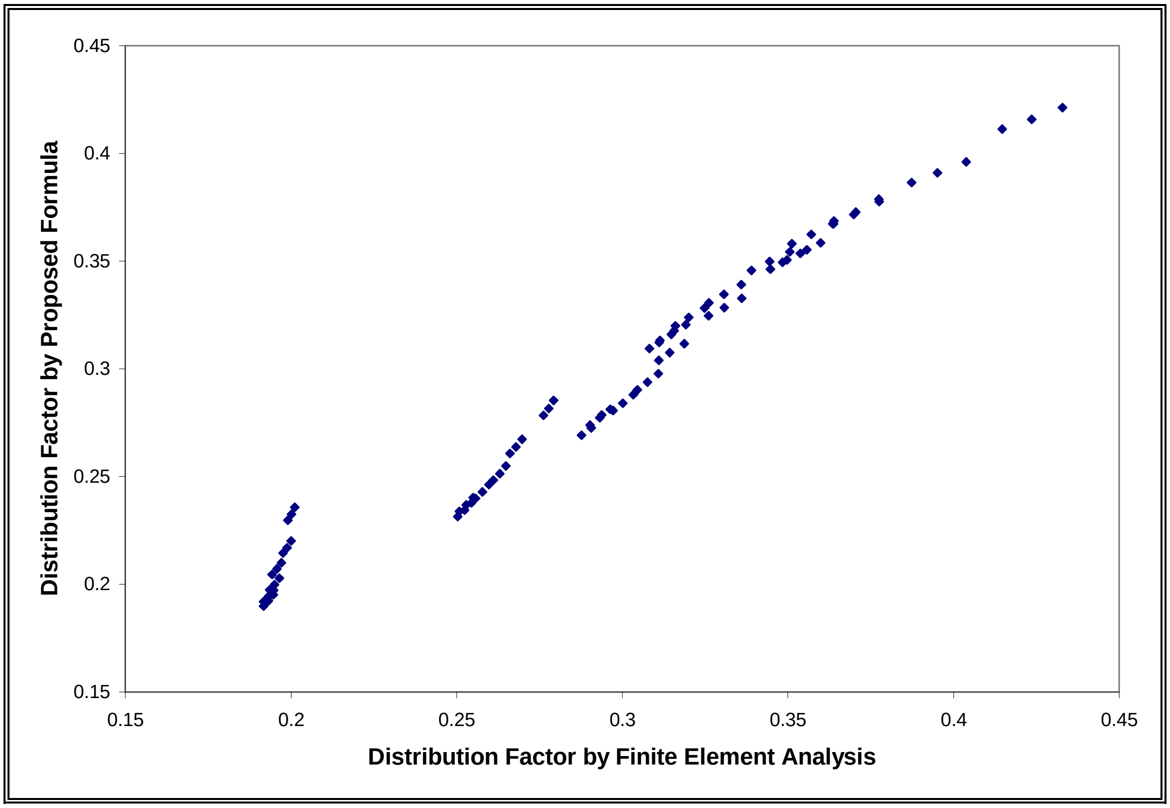
MILITARY VEHICLE : HETS							HETS	HETS				HETS				HETS			
							SL-V	DL-V				SL-V				DL-V			
							Interior	Interior				Exterior				Exterior			
							OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)	OH (ft)
Spacing (ft)	Span (ft)	thickness (in)	Inertia (in^4)	Area (in^2)	eg (in)	Kg	0	0	1	2	3	0	1	2	3	0	1	2	3
4	50	7	3846	36.98	15.65	103943	0.231	-----	-----	-----	0.315	0.252	0.287	0.311	0.327	-----	-----	-----	0.337
		8	3846	36.98	16.15	108679	0.226	-----	-----	-----	0.312	0.255	0.289	0.310	0.321	-----	-----	-----	0.331
		9	3846	36.98	16.65	113565	0.222	-----	-----	-----	0.309	0.260	0.292	0.309	0.316	-----	-----	-----	0.326
	70	7	5865	45.11	17.20	154750	0.221	-----	-----	-----	0.308	0.249	0.295	0.320	0.333	-----	-----	-----	0.349
		8	5865	45.11	17.50	158533	0.218	-----	-----	-----	0.313	0.256	0.297	0.318	0.327	-----	-----	-----	0.343
		9	5865	45.11	18.20	167614	0.217	-----	-----	-----	0.317	0.264	0.301	0.317	0.321	-----	-----	-----	0.338
	90	7	8964	64.44	17.70	234839	0.222	-----	-----	-----	0.305	0.249	0.299	0.324	0.342	-----	-----	-----	0.357
		8	8964	64.44	18.20	244157	0.218	-----	-----	-----	0.310	0.256	0.302	0.323	0.336	-----	-----	-----	0.353
		9	8964	64.44	18.70	253734	0.216	-----	-----	-----	0.313	0.264	0.304	0.321	0.330	-----	-----	-----	0.349
	110	7	13640	79.61	19.30	348757	0.217	-----	-----	-----	0.298	0.243	0.292	0.327	0.350	-----	-----	-----	0.367
		8	13640	79.61	19.80	361294	0.216	-----	-----	-----	0.302	0.250	0.294	0.325	0.345	-----	-----	-----	0.363
		9	13640	79.61	20.30	374152	0.215	-----	-----	-----	0.305	0.258	0.296	0.323	0.339	-----	-----	-----	0.359
	130	7	20833	90.14	21.85	514491	0.219	-----	-----	-----	0.304	0.243	0.291	0.325	0.350	-----	-----	-----	0.372
		8	20833	90.14	22.35	530539	0.217	-----	-----	-----	0.307	0.250	0.293	0.324	0.344	-----	-----	-----	0.368
		9	20833	90.14	22.85	546949	0.215	-----	-----	-----	0.310	0.258	0.296	0.322	0.339	-----	-----	-----	0.364
	140	7	25799	95.63	23.60	636881	0.214	-----	-----	-----	0.313	0.238	0.247	0.276	0.298	-----	-----	-----	0.330
		8	25799	95.63	24.10	655254	0.213	-----	-----	-----	0.308	0.244	0.293	0.322	0.350	-----	-----	-----	0.382
		9	25799	95.63	24.60	674012	0.212	-----	-----	-----	0.311	0.253	0.297	0.320	0.345	-----	-----	-----	0.378
5	50	7	4633	43.50	15.85	125354	0.265	-----	-----	-----	0.369	0.274	0.314	0.338	0.385	-----	-----	-----	0.387
		8	4633	43.50	16.35	130996	0.263	-----	-----	-----	0.361	0.285	0.319	0.339	0.381	-----	-----	-----	0.383
		9	4633	43.50	16.85	136813	0.261	-----	-----	-----	0.356	0.295	0.324	0.340	0.377	-----	-----	-----	0.380
	70	7	7042	62.90	16.35	192178	0.262	-----	-----	-----	0.364	0.272	0.317	0.341	0.385	-----	-----	-----	0.393
		8	7042	62.90	16.85	200589	0.260	-----	-----	-----	0.357	0.282	0.322	0.341	0.380	-----	-----	-----	0.389
		9	7042	62.90	17.35	209254	0.257	-----	-----	-----	0.353	0.291	0.326	0.341	0.375	-----	-----	-----	0.386
	90	7	10751	64.63	18.95	273565	0.259	-----	-----	-----	0.349	0.278	0.318	0.343	0.389	-----	-----	-----	0.399
		8	10751	64.63	19.45	283561	0.256	-----	-----	-----	0.343	0.287	0.323	0.343	0.384	-----	-----	-----	0.397

		9	10751	64.63	19.95	293818	0.253	-----	-----	-----	0.340	0.296	0.328	0.343	0.379	-----	-----	-----	0.395
	110	7	16376	72.84	21.55	404414	0.256	-----	-----	-----	0.346	0.283	0.320	0.350	0.394	-----	-----	-----	0.410
		8	16376	72.84	22.05	417205	0.253	-----	-----	-----	0.340	0.292	0.325	0.350	0.389	-----	-----	-----	0.408
		9	16376	72.84	22.55	430290	0.250	-----	-----	-----	0.337	0.300	0.330	0.350	0.384	-----	-----	-----	0.406
	130	7	25002	93.24	23.60	619738	0.258	-----	-----	-----	0.334	0.271	0.315	0.350	0.405	-----	-----	-----	0.426
		8	25002	93.24	24.10	637651	0.255	-----	-----	-----	0.329	0.279	0.319	0.350	0.400	-----	-----	-----	0.425
		9	25002	93.24	24.60	655941	0.252	-----	-----	-----	0.330	0.288	0.324	0.350	0.395	-----	-----	-----	0.422
	140	7	30911	97.85	25.43	758746	0.258	-----	-----	-----	0.341	0.269	0.315	0.346	0.398	-----	-----	-----	0.418
		8	30911	97.85	25.93	778988	0.255	-----	-----	-----	0.335	0.276	0.320	0.346	0.394	-----	-----	-----	0.416
		9	30911	97.85	26.43	799624	0.252	-----	-----	-----	0.330	0.286	0.325	0.347	0.389	-----	-----	-----	0.414
6	50	7	5578	50.98	16.10	151384	0.334	-----	-----	-----	0.438	0.302	0.352	0.404	0.441	-----	-----	-----	0.444
		8	5578	50.98	16.60	158099	0.326	-----	-----	-----	0.431	0.315	0.360	0.407	0.440	-----	-----	-----	0.444
		9	5578	50.98	17.10	165019	0.319	-----	-----	-----	0.426	0.326	0.367	0.410	0.439	-----	-----	-----	0.444
	70	7	8449	61.26	17.70	222665	0.321	-----	-----	-----	0.421	0.308	0.357	0.410	0.446	-----	-----	-----	0.470
		8	8449	61.26	18.20	231523	0.314	-----	-----	-----	0.414	0.320	0.364	0.413	0.444	-----	-----	-----	0.469
		9	8449	61.26	18.70	240628	0.308	-----	-----	-----	0.410	0.332	0.371	0.415	0.442	-----	-----	-----	0.469
	90	7	12964	66.12	20.45	327181	0.312	-----	-----	-----	0.416	0.319	0.361	0.411	0.449	-----	-----	-----	0.460
		8	12964	66.12	20.95	338206	0.305	-----	-----	-----	0.410	0.331	0.369	0.414	0.447	-----	-----	-----	0.462
		9	12964	66.12	21.45	349498	0.298	-----	-----	-----	0.405	0.343	0.375	0.415	0.445	-----	-----	-----	0.463
	110	7	19747	75.02	23.20	484346	0.311	-----	-----	-----	0.410	0.310	0.359	0.413	0.451	-----	-----	-----	0.470
		8	19747	75.02	23.70	498518	0.303	-----	-----	-----	0.404	0.322	0.366	0.414	0.448	-----	-----	-----	0.471
		9	19747	75.02	24.20	512992	0.297	-----	-----	-----	0.399	0.333	0.372	0.416	0.446	-----	-----	-----	0.472
	130	7	30171	95.60	25.50	743809	0.310	-----	-----	-----	0.404	0.311	0.354	0.410	0.455	-----	-----	-----	0.478
		8	30171	95.60	26.00	763639	0.303	-----	-----	-----	0.398	0.322	0.361	0.412	0.454	-----	-----	-----	0.480
		9	30171	95.60	26.50	783855	0.296	-----	-----	-----	0.393	0.333	0.368	0.413	0.451	-----	-----	-----	0.481
	140	7	37210	122.00	25.50	938798	0.312	-----	-----	-----	0.405	0.298	0.351	0.409	0.453	-----	-----	-----	0.483
		8	31032	97.70	26.00	782011	0.306	-----	-----	-----	0.399	0.309	0.359	0.411	0.451	-----	-----	-----	0.485
		9	31032	97.70	26.50	802670	0.299	-----	-----	-----	0.394	0.320	0.365	0.412	0.449	-----	-----	-----	0.486
7	50	7	6665	49.90	17.40	175391	0.392	-----	0.473	0.499	0.500	0.337	0.393	0.446	0.479	-----	0.407	0.461	0.483
		8	6665	49.90	17.90	182486	0.381	-----	0.463	0.491	0.491	0.352	0.402	0.451	0.477	-----	0.417	0.468	0.487
		9	6665	49.90	18.40	189782	0.371	-----	0.455	0.483	0.485	0.366	0.410	0.455	0.479	-----	0.427	0.475	0.492
	70	7	10257	61.84	19.00	262460	0.377	-----	0.464	0.491	0.489	0.342	0.401	0.446	0.480	-----	0.417	0.464	0.491
		8	10257	61.84	19.50	272049	0.364	-----	0.453	0.481	0.479	0.357	0.411	0.451	0.481	-----	0.429	0.472	0.503

		9	10257	61.84	20.00	281888	0.354	-----	0.444	0.472	0.472	0.371	0.419	0.455	0.481	-----	0.440	0.480	0.507
	90	7	15622	76.60	20.75	391525	0.364	-----	0.458	0.479	0.475	0.345	0.402	0.448	0.481	-----	0.418	0.468	0.506
		8	15622	76.60	21.25	404483	0.352	-----	0.447	0.469	0.470	0.359	0.411	0.453	0.483	-----	0.430	0.476	0.509
		9	15622	76.60	21.75	417750	0.342	-----	0.436	0.459	0.462	0.373	0.419	0.456	0.484	-----	0.442	0.485	0.514
	110	7	23722	89.58	23.40	586222	0.364	-----	0.454	0.478	0.469	0.341	0.399	0.443	0.484	-----	0.418	0.467	0.516
		8	23722	89.58	23.90	603289	0.353	-----	0.442	0.466	0.458	0.354	0.407	0.448	0.484	-----	0.431	0.477	0.520
		9	23722	89.58	24.40	620716	0.343	-----	0.431	0.456	0.450	0.367	0.415	0.451	0.485	-----	0.443	0.485	0.525
	130	7	36261	98.40	27.50	891557	0.363	-----	0.455	0.471	0.459	0.336	0.391	0.442	0.483	-----	0.415	0.465	0.523
		8	36261	98.40	28.00	913553	0.351	-----	0.443	0.459	0.462	0.350	0.399	0.446	0.484	-----	0.427	0.474	0.541
		9	36261	98.40	28.50	935946	0.340	-----	0.431	0.448	0.461	0.363	0.407	0.450	0.484	-----	0.439	0.482	0.546
	140	7	44826	117.37	28.50	1129065	0.368	-----	0.462	0.478	0.469	0.330	0.389	0.439	0.485	-----	0.411	0.466	0.519
		8	44826	117.37	29.00	1156247	0.357	-----	0.450	0.467	0.459	0.343	0.396	0.443	0.483	-----	0.422	0.475	0.519
		9	44826	117.37	29.50	1183903	0.346	-----	0.438	0.456	0.450	0.356	0.403	0.446	0.483	-----	0.433	0.482	0.523
8	50	7	8024	50.04	18.70	205598	0.453	-----	-----	-----	0.534	0.386	0.442	0.479	0.517	-----	-----	-----	0.536
		8	8024	50.04	19.20	213237	0.437	-----	-----	-----	0.524	0.400	0.453	0.485	0.519	-----	-----	-----	0.543
		9	8024	50.04	19.70	221077	0.423	-----	-----	-----	0.520	0.412	0.461	0.492	0.520	-----	-----	-----	0.547
	70	7	12249	57.56	21.75	318021	0.434	-----	-----	-----	0.528	0.377	0.440	0.479	0.516	-----	-----	-----	0.540
		8	12249	57.56	22.25	328222	0.416	-----	-----	-----	0.523	0.393	0.452	0.487	0.519	-----	-----	-----	0.545
		9	12249	57.56	22.75	338655	0.400	-----	-----	-----	0.517	0.407	0.462	0.493	0.520	-----	-----	-----	0.550
	90	7	18704	81.11	21.75	459764	0.417	-----	-----	-----	0.527	0.383	0.436	0.481	0.517	-----	-----	-----	0.548
		8	15599	69.21	22.25	401668	0.400	-----	-----	-----	0.516	0.398	0.446	0.488	0.519	-----	-----	-----	0.557
		9	15599	69.21	22.75	414213	0.384	-----	-----	-----	0.510	0.411	0.455	0.493	0.520	-----	-----	-----	0.563
	110	7	28568	91.18	25.50	707743	0.414	-----	-----	-----	0.520	0.380	0.431	0.479	0.515	-----	-----	-----	0.546
		8	28568	91.18	26.00	726657	0.397	-----	-----	-----	0.513	0.393	0.441	0.485	0.517	-----	-----	-----	0.553
		9	28568	91.18	26.50	745938	0.382	-----	-----	-----	0.506	0.405	0.450	0.490	0.518	-----	-----	-----	0.559
	130	7	43605	101.06	29.50	1059728	0.414	-----	-----	-----	0.516	0.375	0.430	0.478	0.521	-----	-----	-----	0.565
		8	43605	101.06	30.00	1083948	0.396	-----	-----	-----	0.510	0.388	0.439	0.483	0.522	-----	-----	-----	0.568
		9	43605	101.06	30.50	1108574	0.380	-----	-----	-----	0.505	0.401	0.447	0.488	0.524	-----	-----	-----	0.573
	140	7	53928	121.04	30.50	1341455	0.418	-----	-----	-----	0.522	0.367	0.426	0.474	0.518	-----	-----	-----	0.560
		8	53928	121.04	31.00	1371438	0.401	-----	-----	-----	0.515	0.379	0.435	0.480	0.520	-----	-----	-----	0.567
		9	53928	121.04	31.50	1401908	0.386	-----	-----	-----	0.509	0.391	0.442	0.485	0.521	-----	-----	-----	0.572

APPENDIX D COMPARISON BETWEEN PROPOSED FORMULAS AND FINITE ELEMENT ANALYSIS

This appendix presents the comparison of the distribution factors calculated by the Proposed Formulas and Bridge Analysis performed on SAP 2000. Each figure contains two charts where the first plots the value of the distribution factor calculated by the proposed formula against the value obtained by the finite element analysis. Each point in the plot represents a respective bridge on the database used for the analysis. The second chart in the figures plots the histograms for the ratio of the distribution factor calculated by the formula to the distribution factor calculated by the finite element analysis of the bridge. The mean and coefficient of variation values of this ratio were included on the second chart.



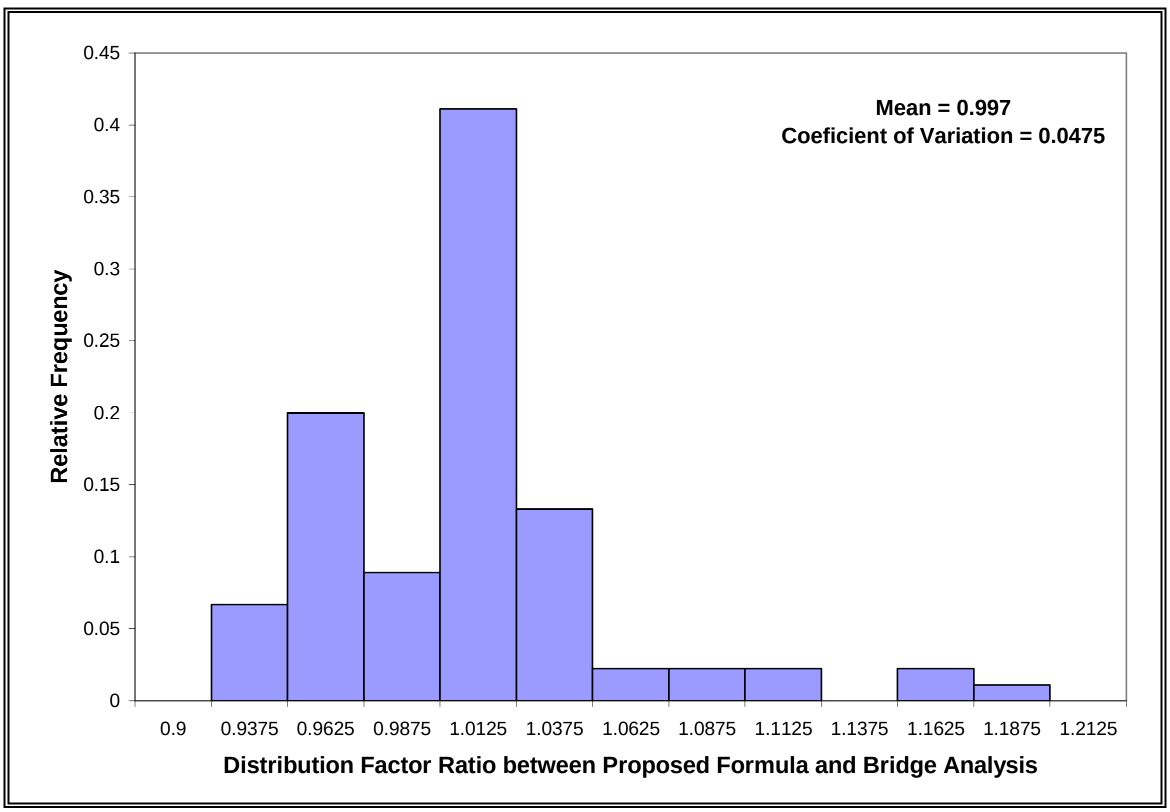
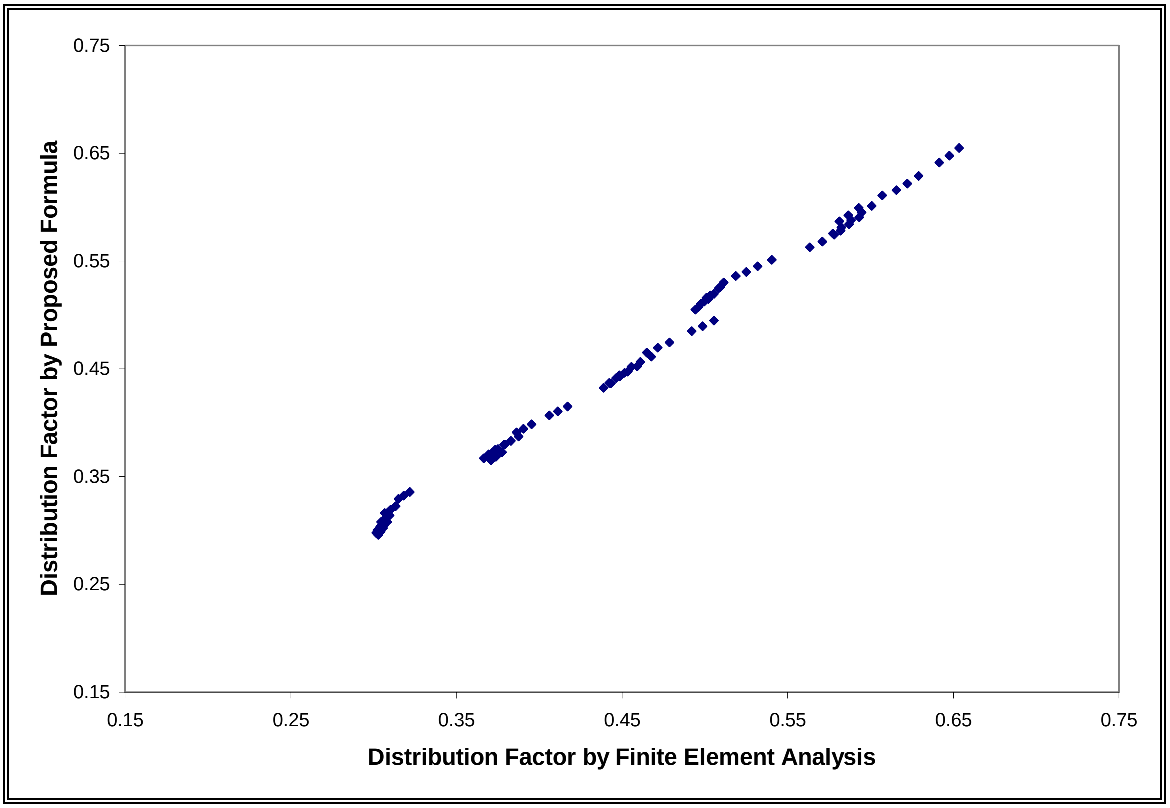


Figure D. 1Comparison of Proposed Formulas and Bridge Analysis for M113, Bending Moment on Interior Beams for Single Lane



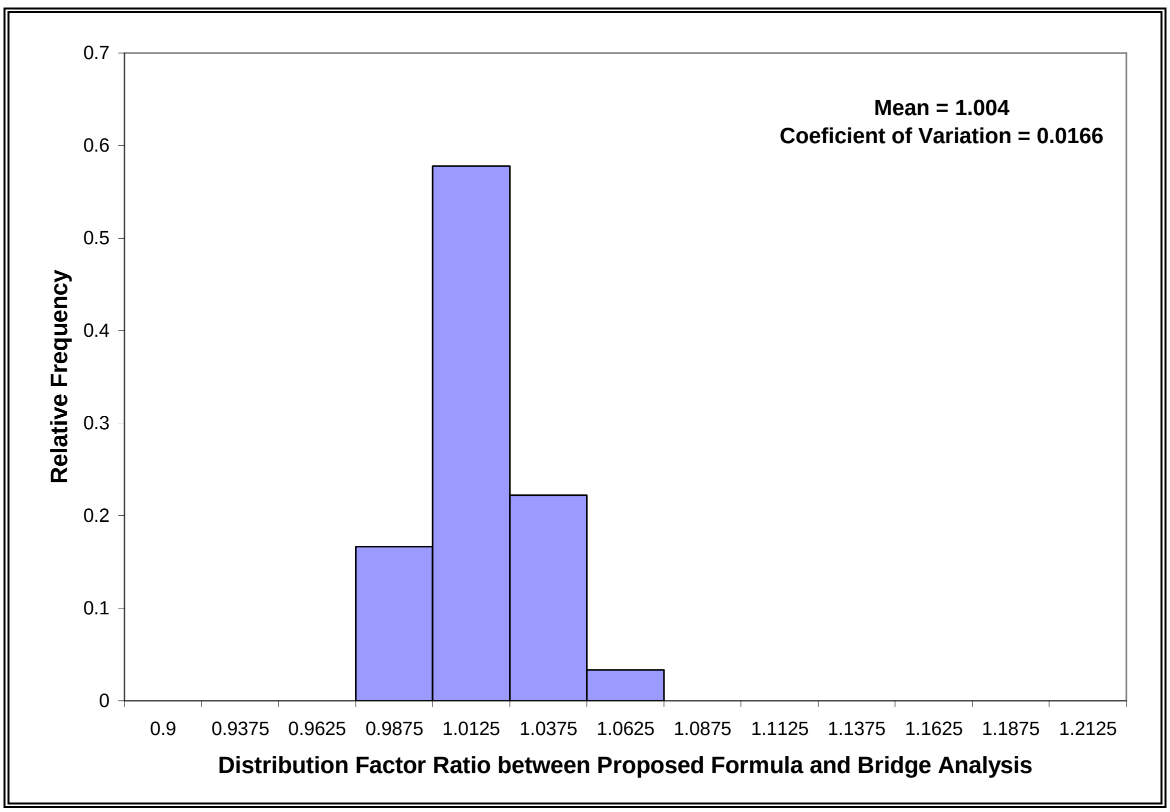
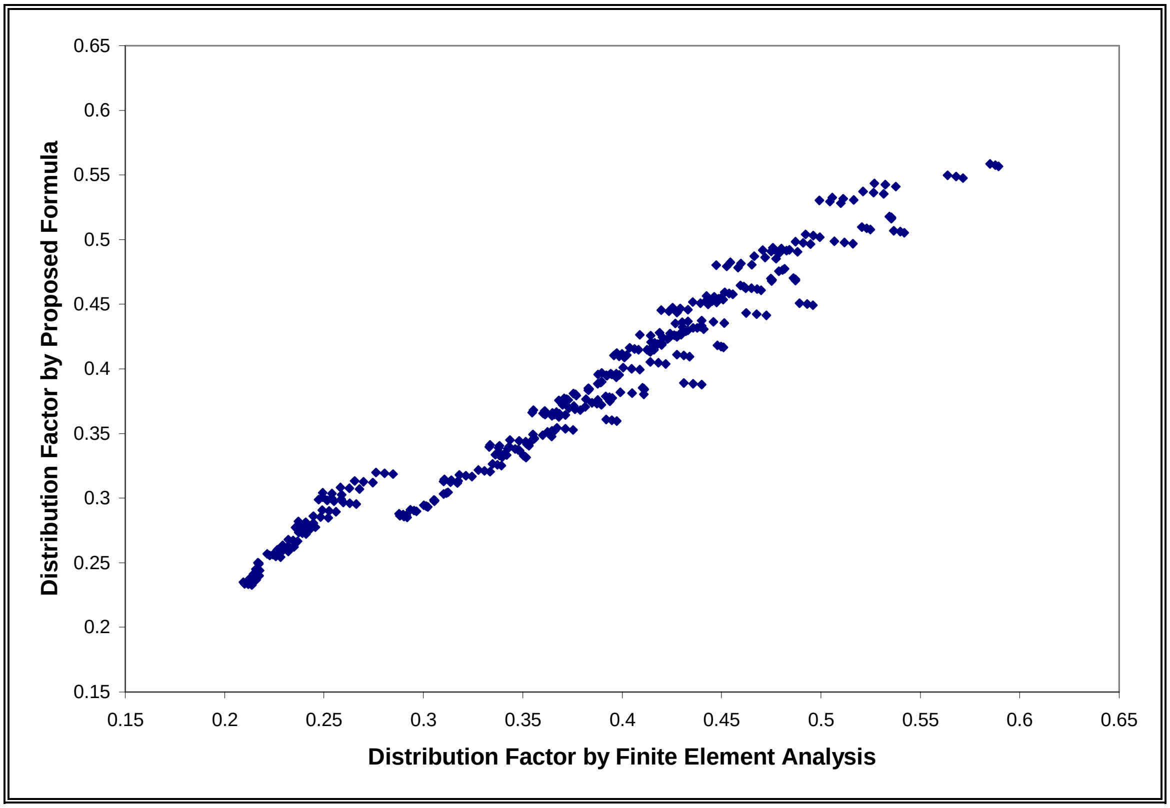


Figure D. 2Comparison of Proposed Formulas and Bridge Analysis for M113, Bending Moment on Interior Beams for Double Lanes



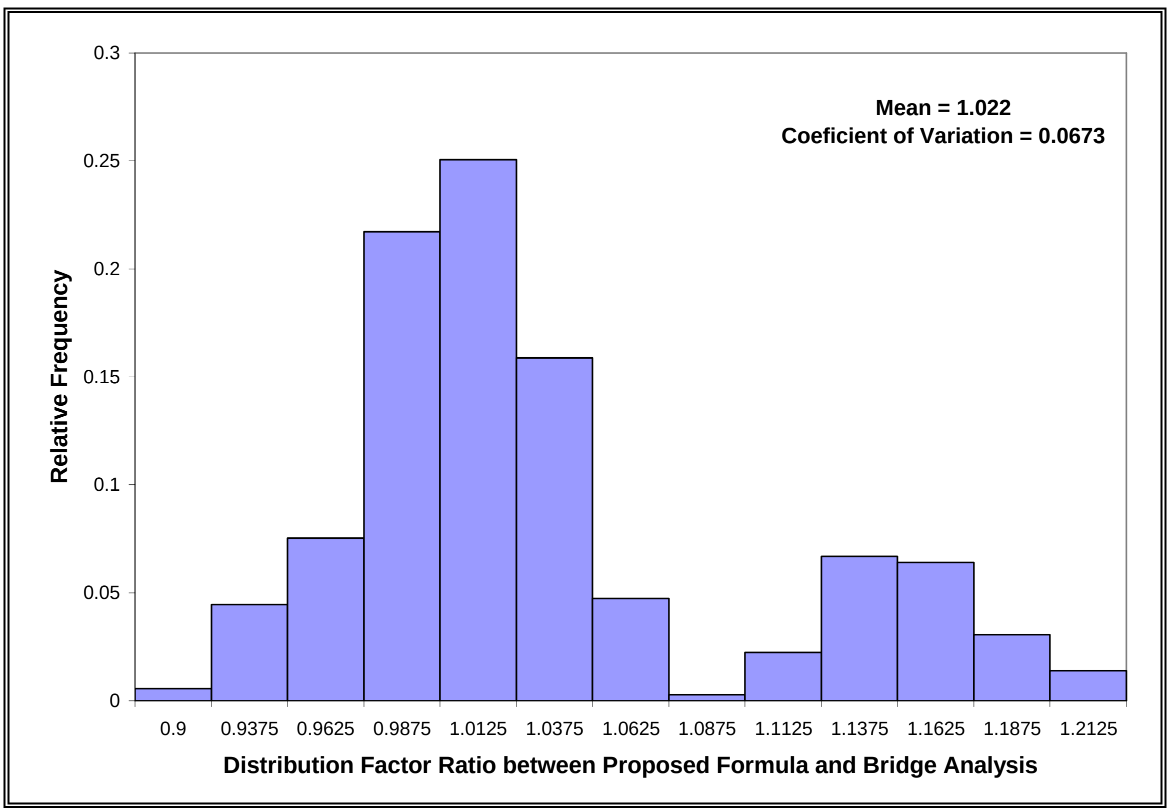
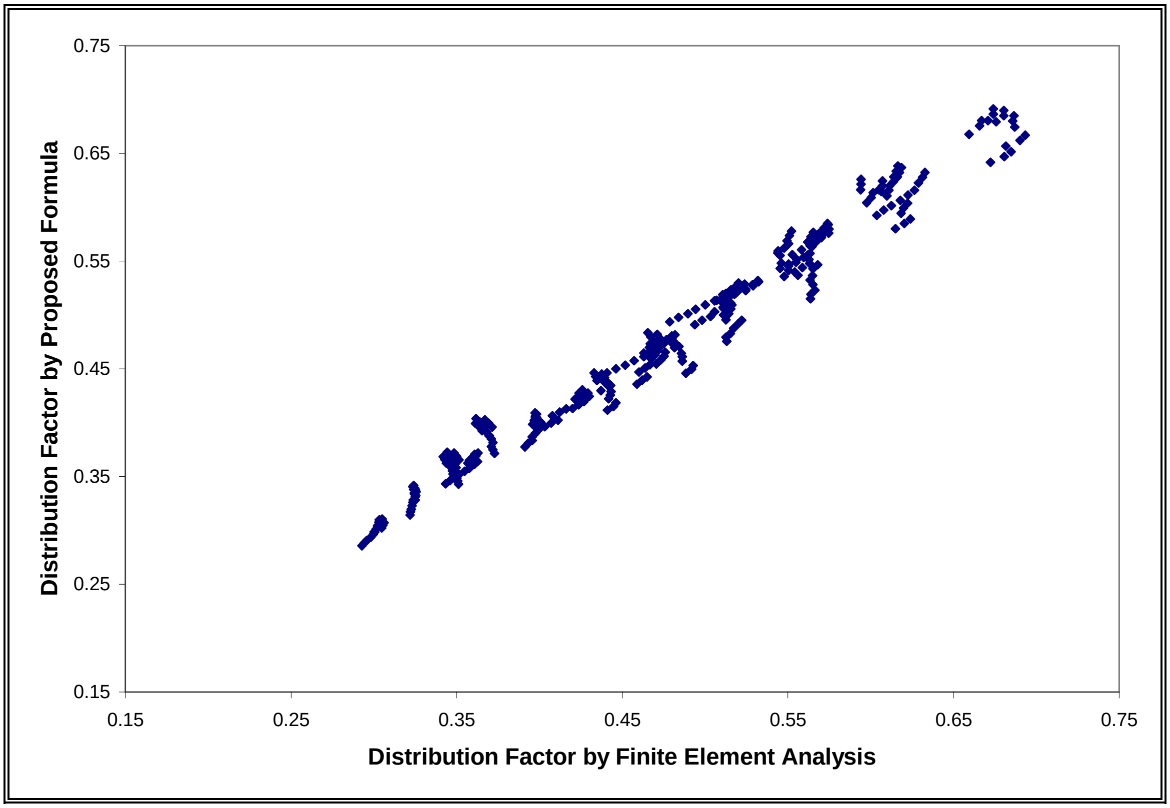


Figure D. 3Comparison of Proposed Formulas and Bridge Analysis for M113, Bending Moment on Exterior Beams for Single Lane



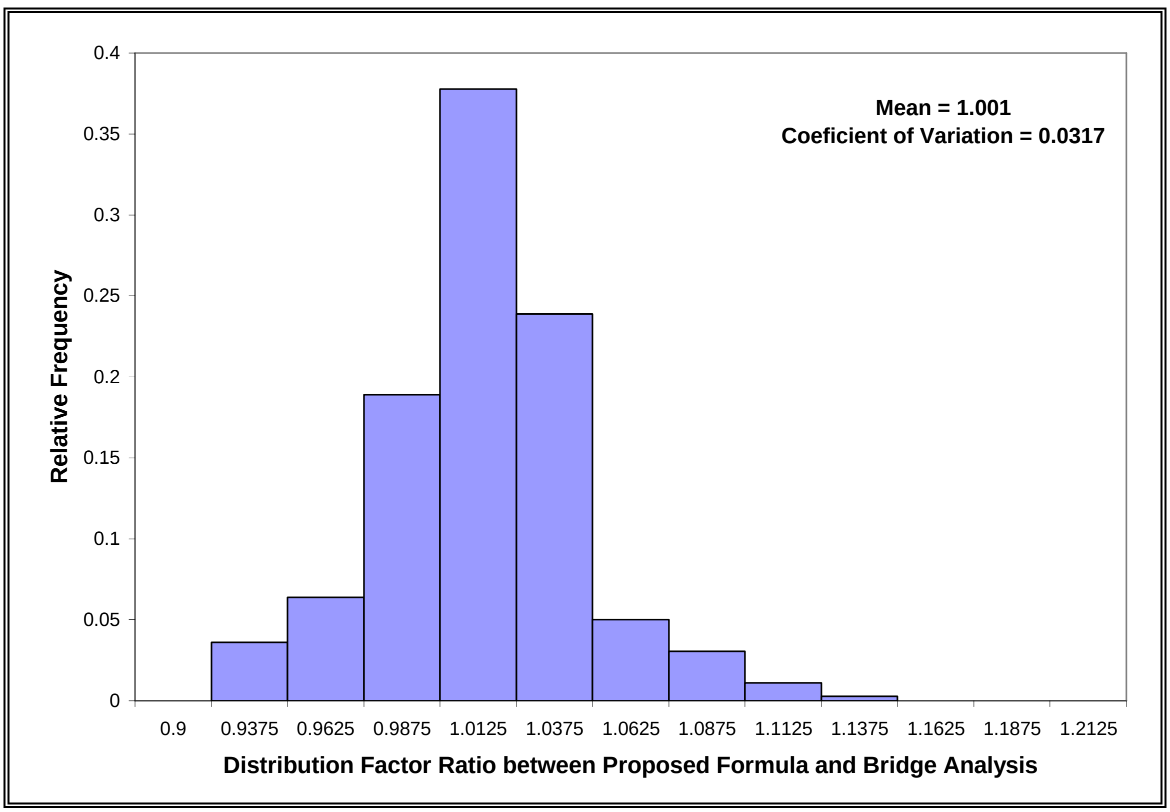
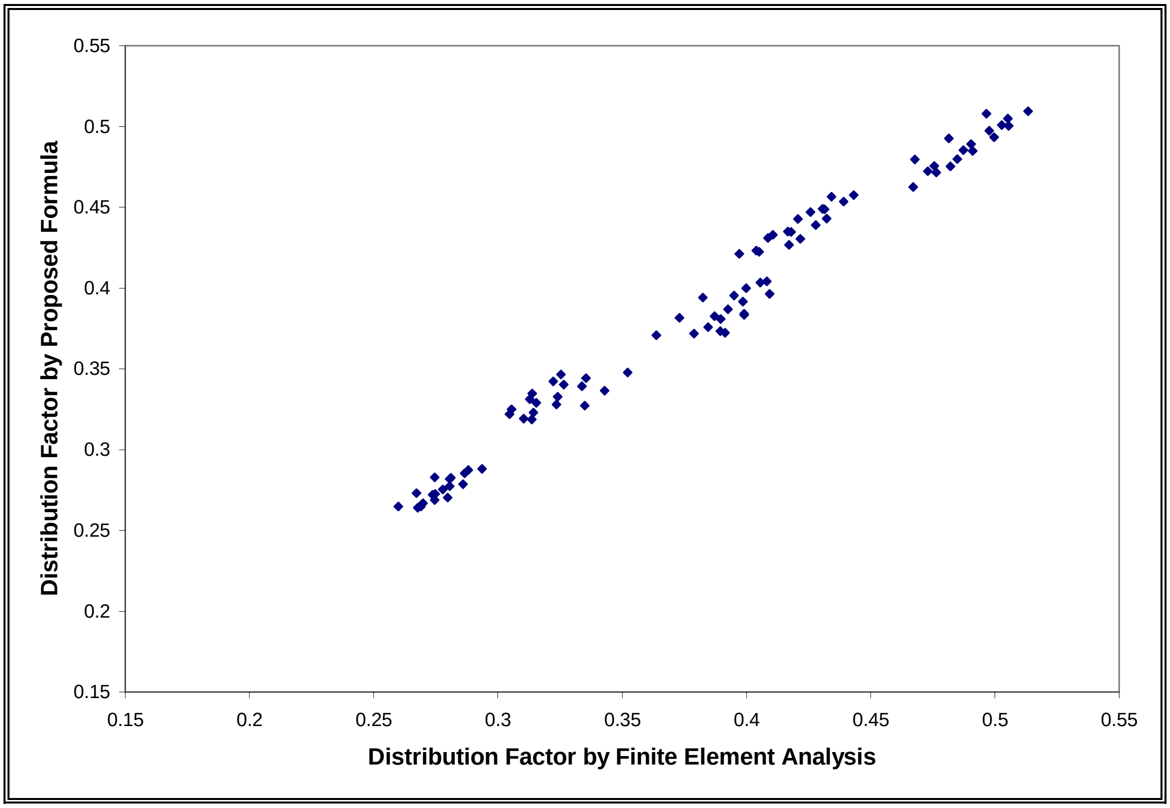


Figure D. 4Comparison of Proposed Formulas and Bridge Analysis for M113, Bending Moment on Exterior Beams for Double Lanes



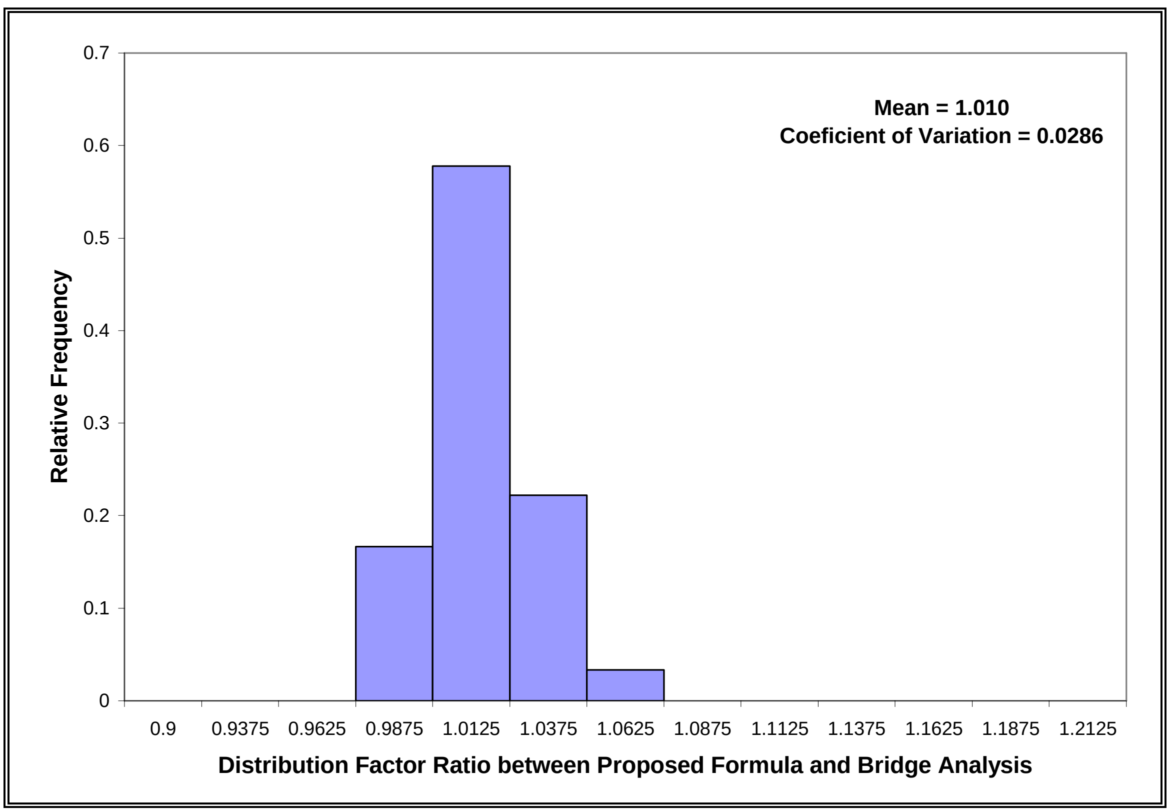
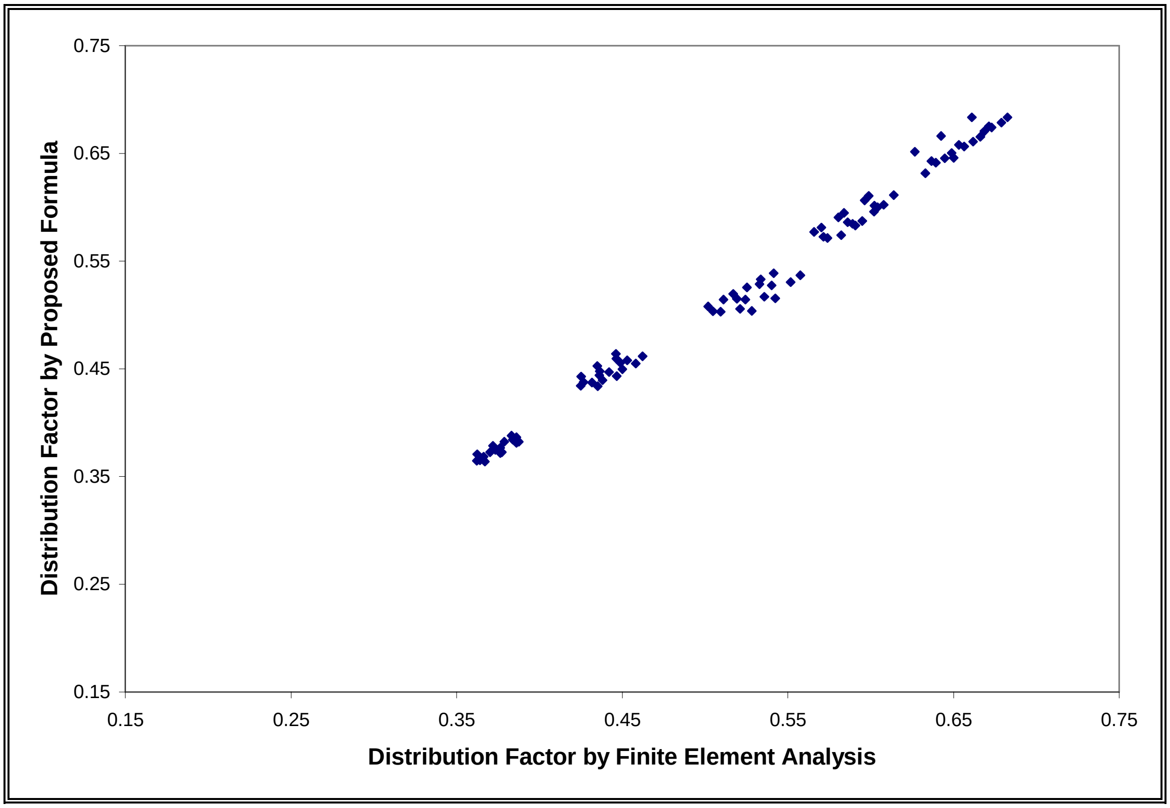


Figure D. 5Comparison of Proposed Formulas and Bridge Analysis for M113, Shear Force on Interior Beams for Single Lane



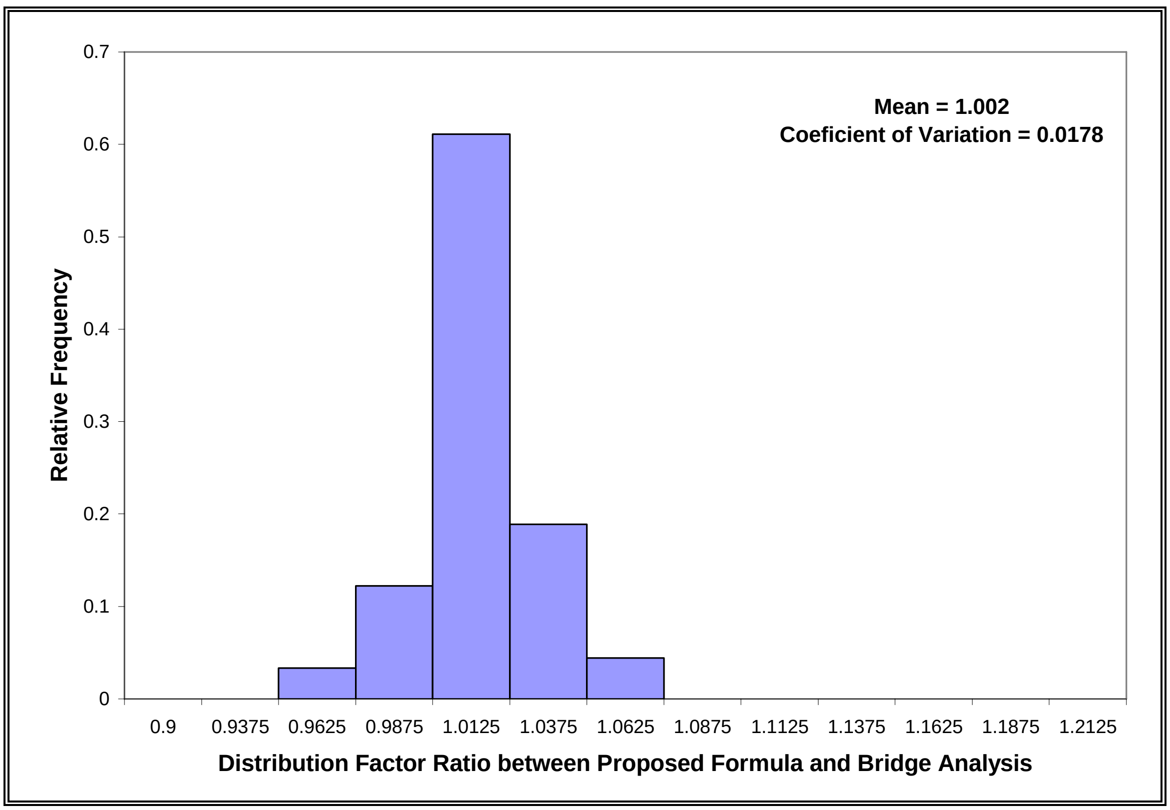
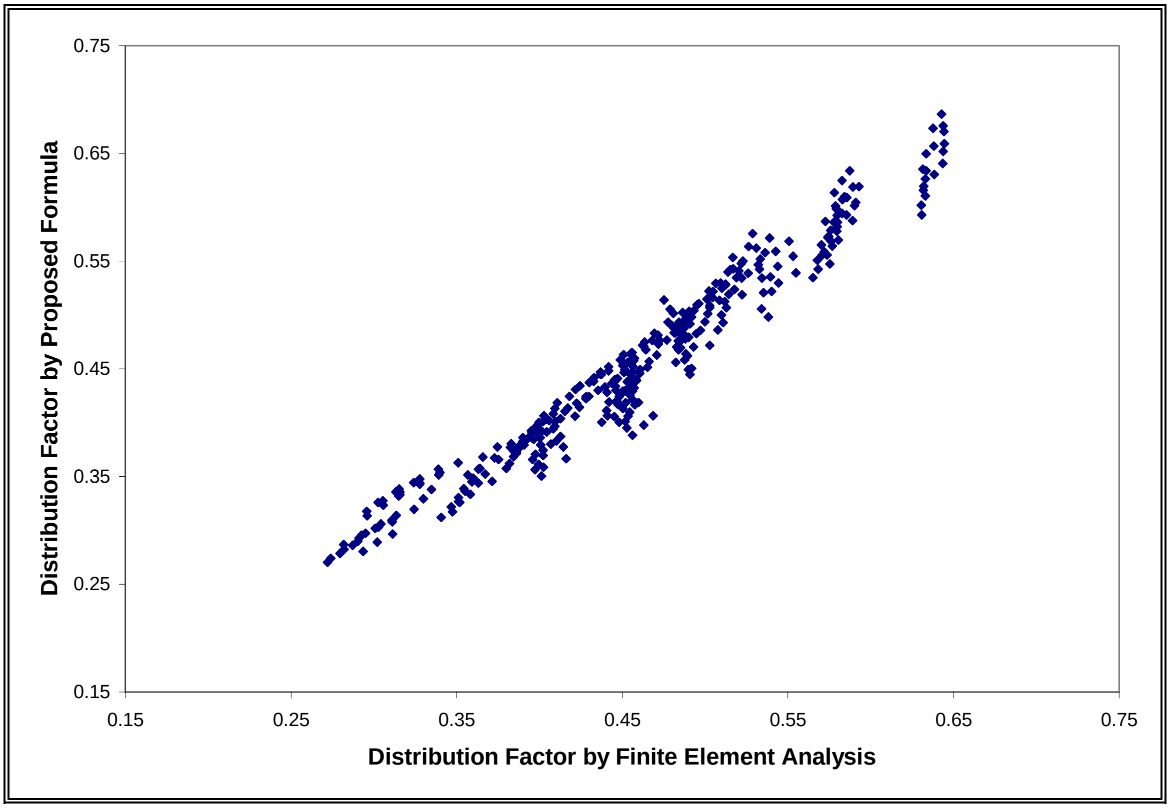


Figure D. 6Comparison of Proposed Formulas and Bridge Analysis for M113, Shear Force on Interior Beams for Double Lanes



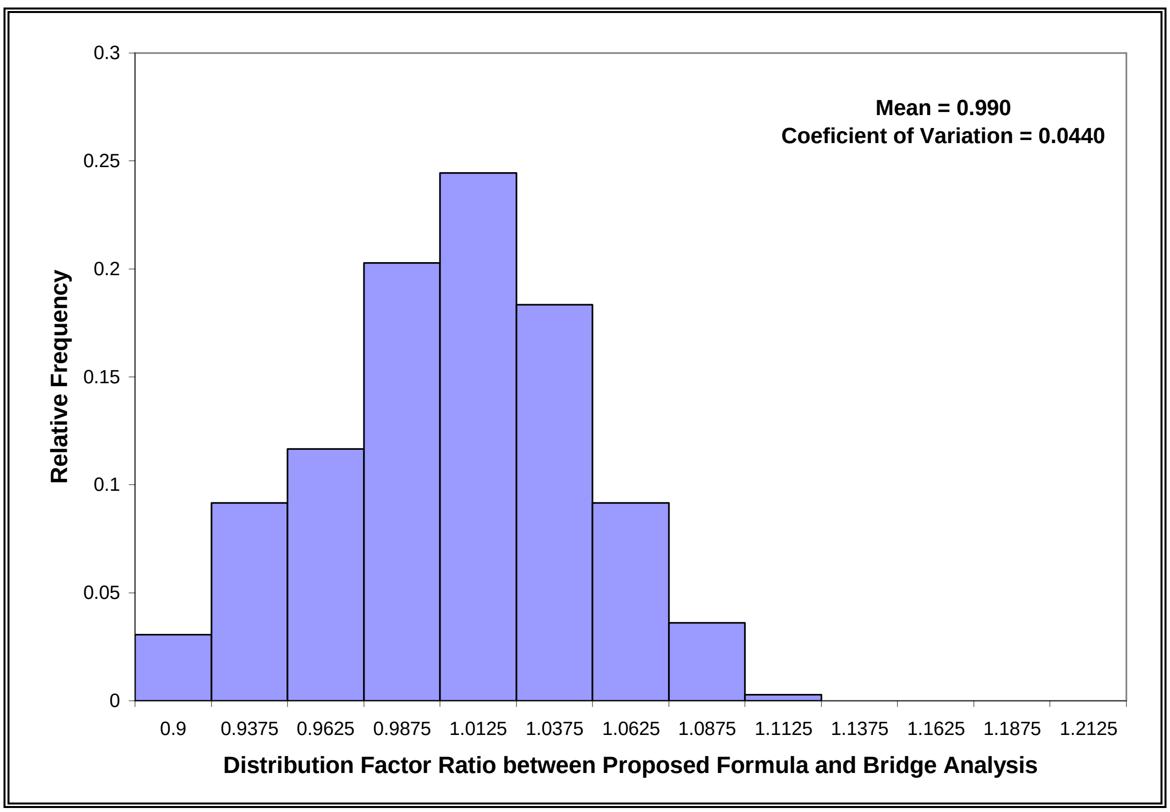
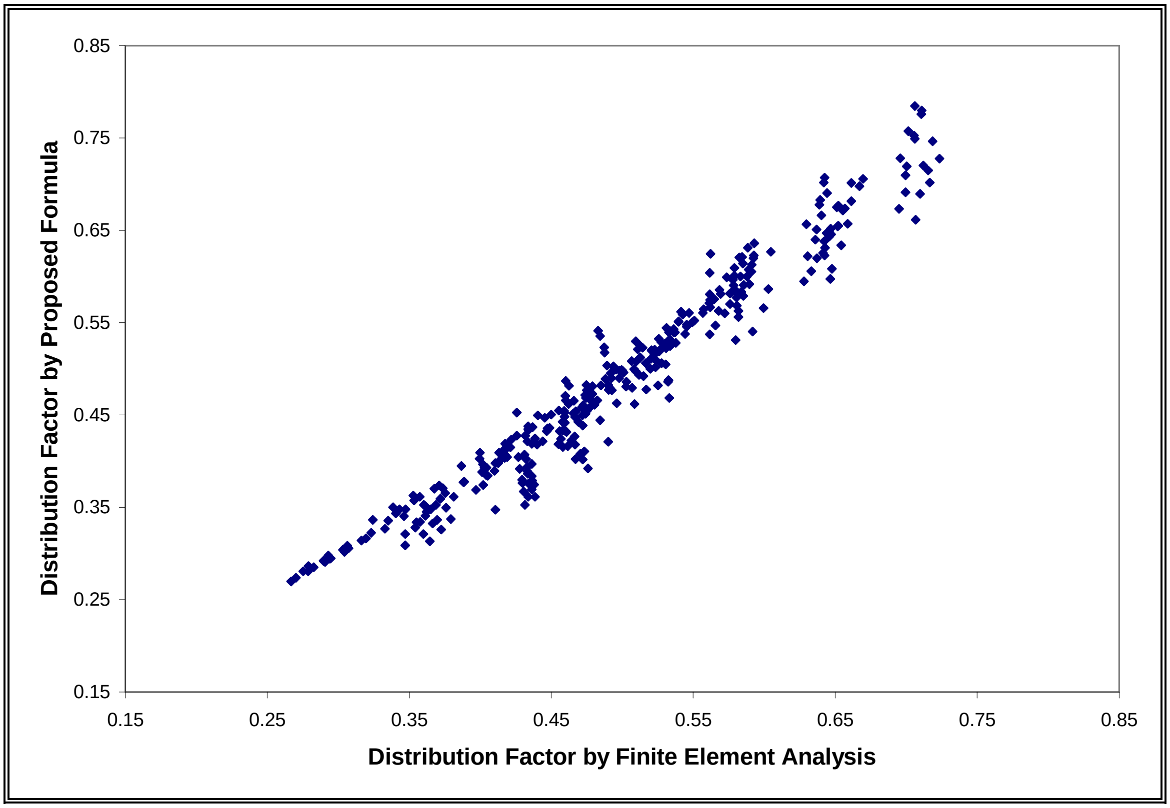


Figure D. 7Comparison of Proposed Formulas and Bridge Analysis for M113, Shear Force on Exterior Beams for Single Lane



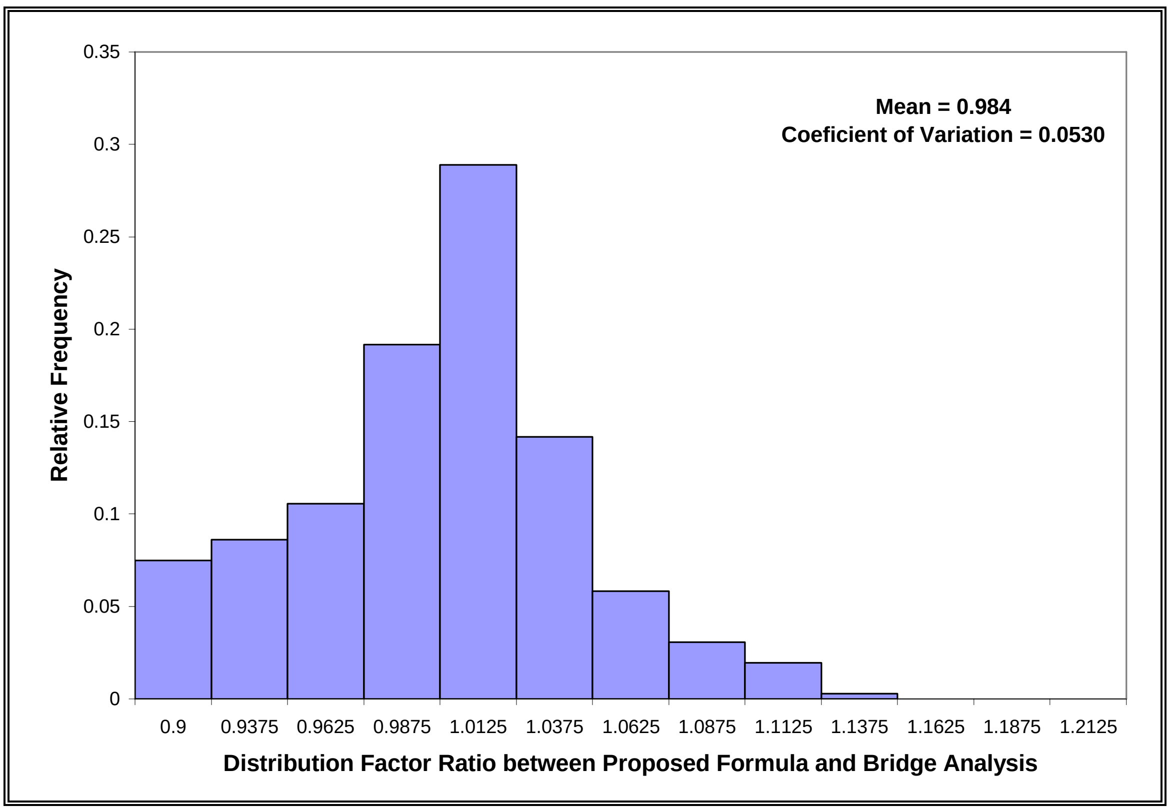
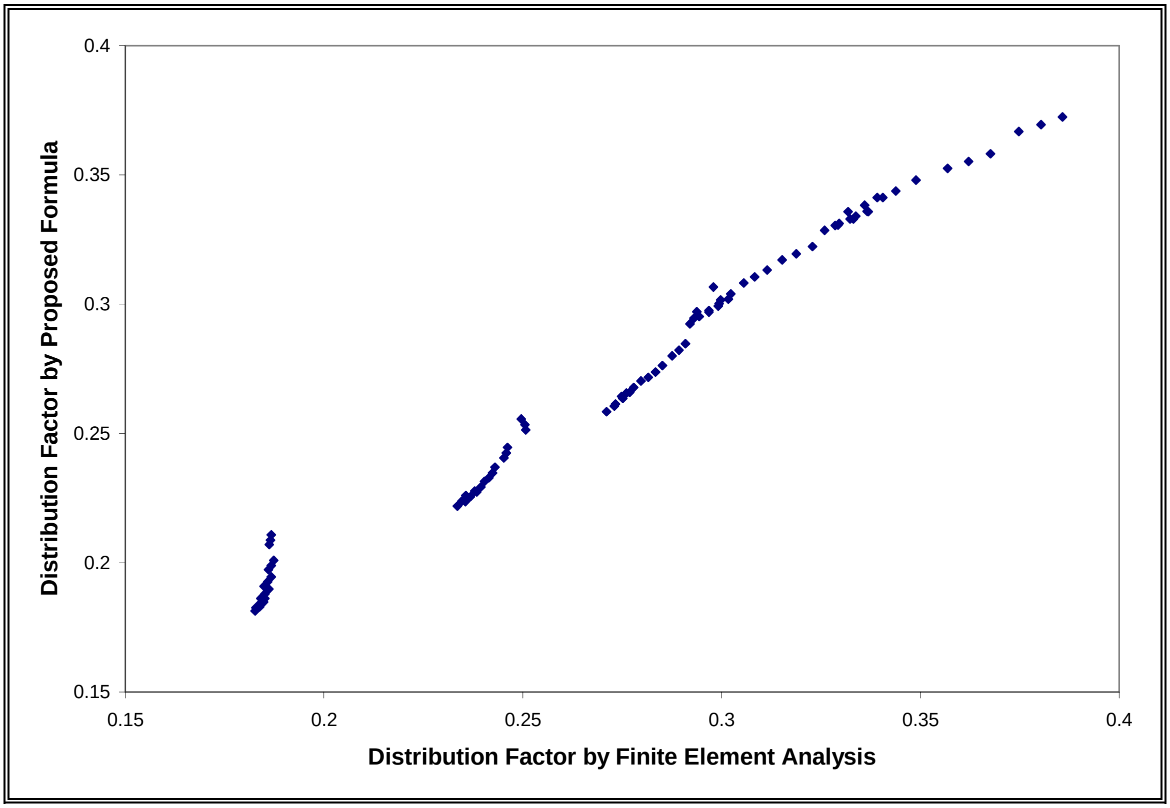


Figure D. 8Comparison of Proposed Formulas and Bridge Analysis for M113, Shear Force on Exterior Beams for Double Lanes



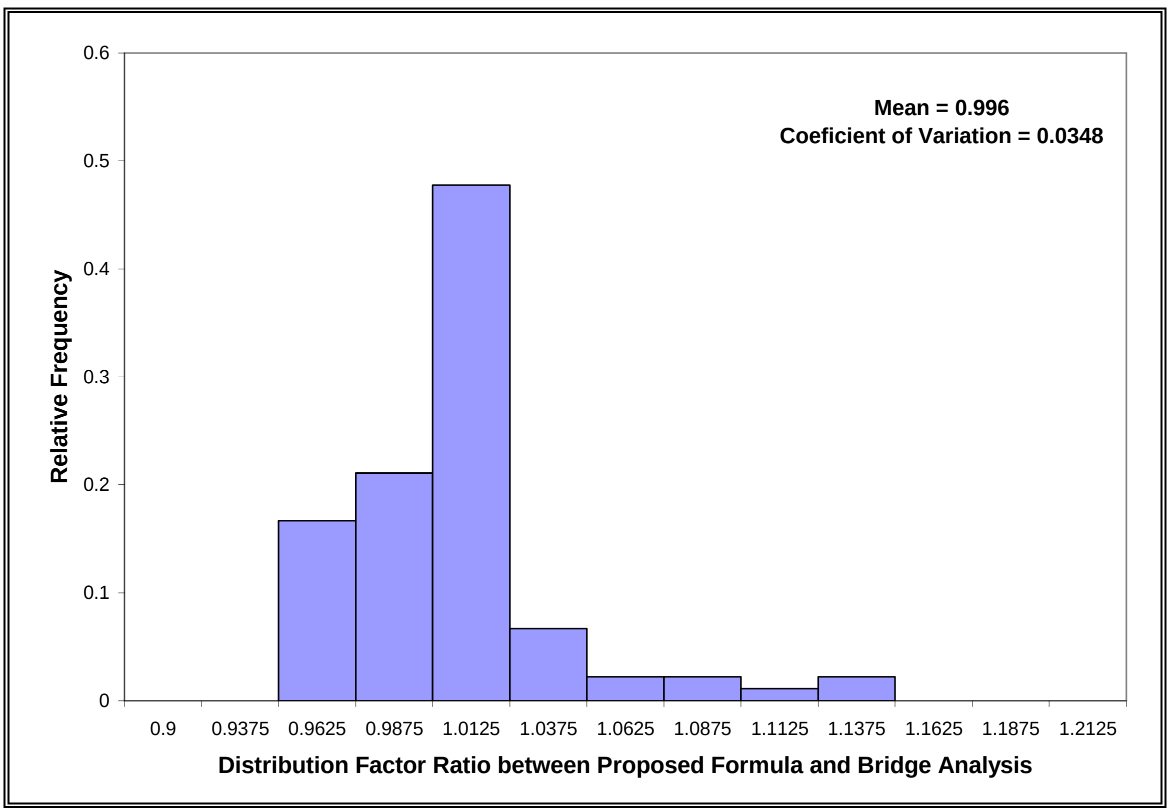
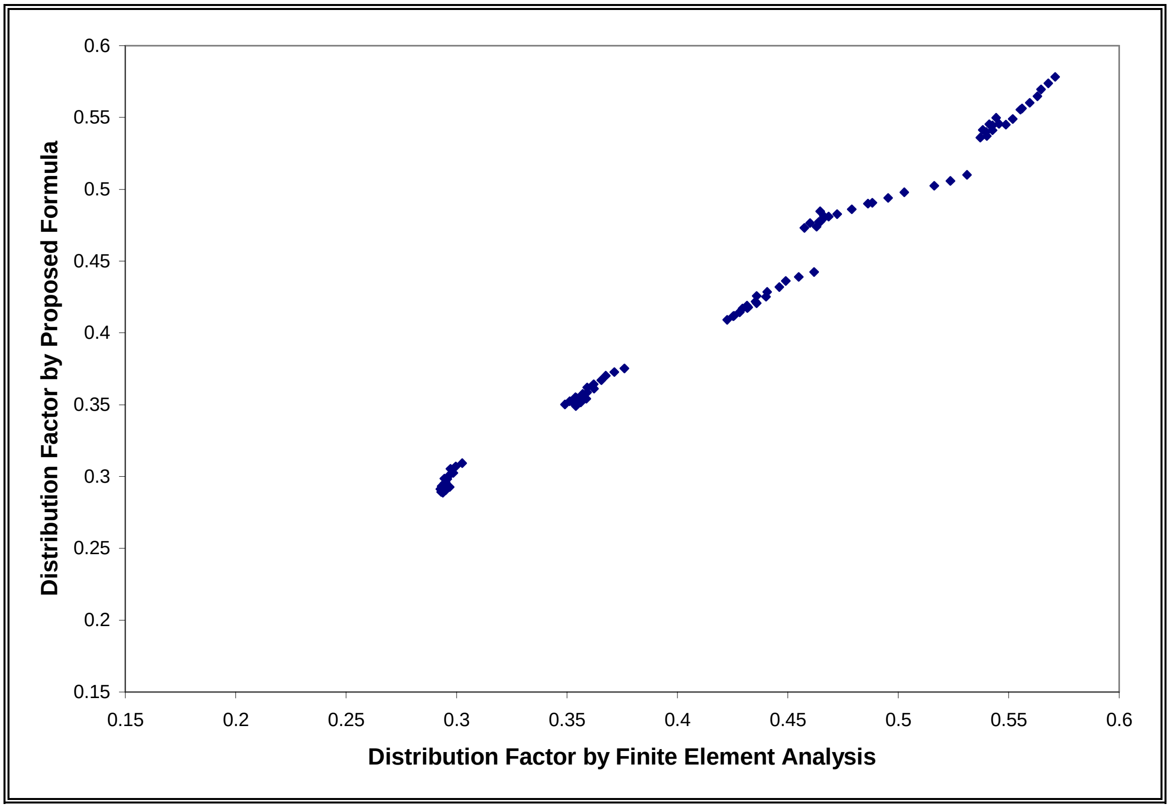


Figure D. 9Comparison of Proposed Formulas and Bridge Analysis for M2, Bending Moment on Interior Beams for Single Lane



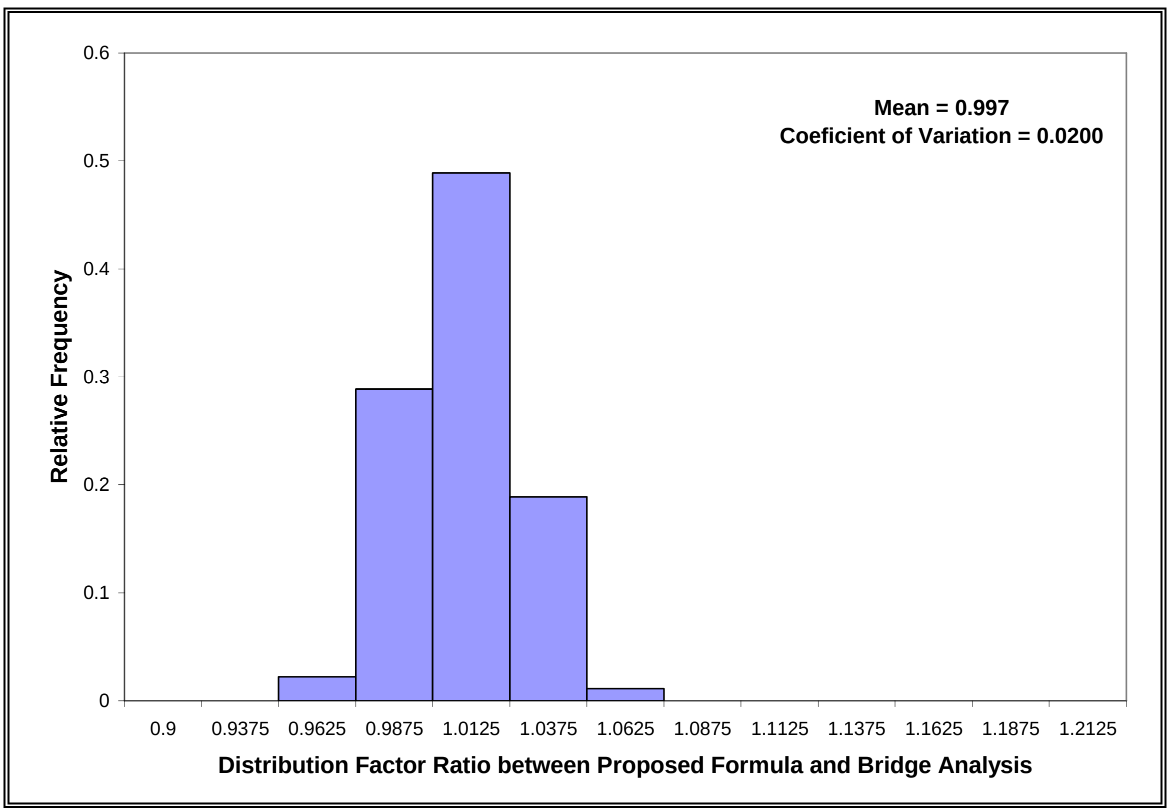
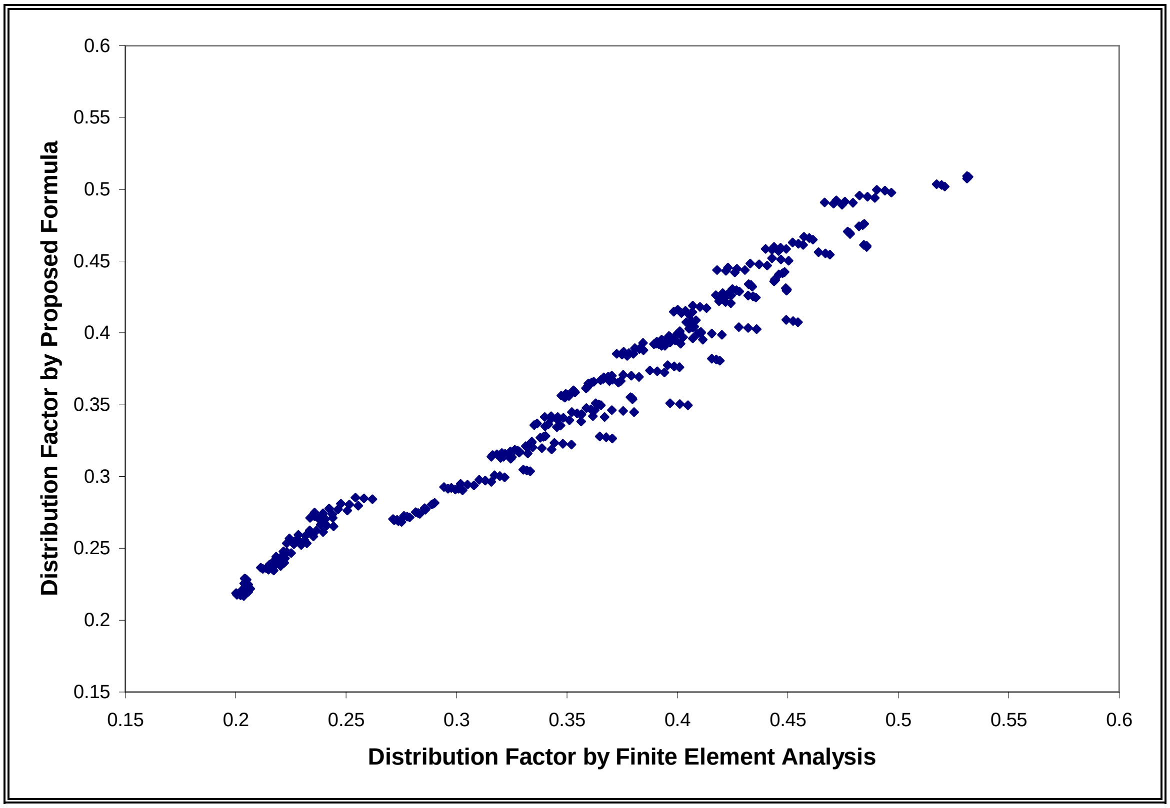


Figure D. 10Comparison of Proposed Formulas and Bridge Analysis for M2, Bending Moment on Interior Beams for Double Lanes



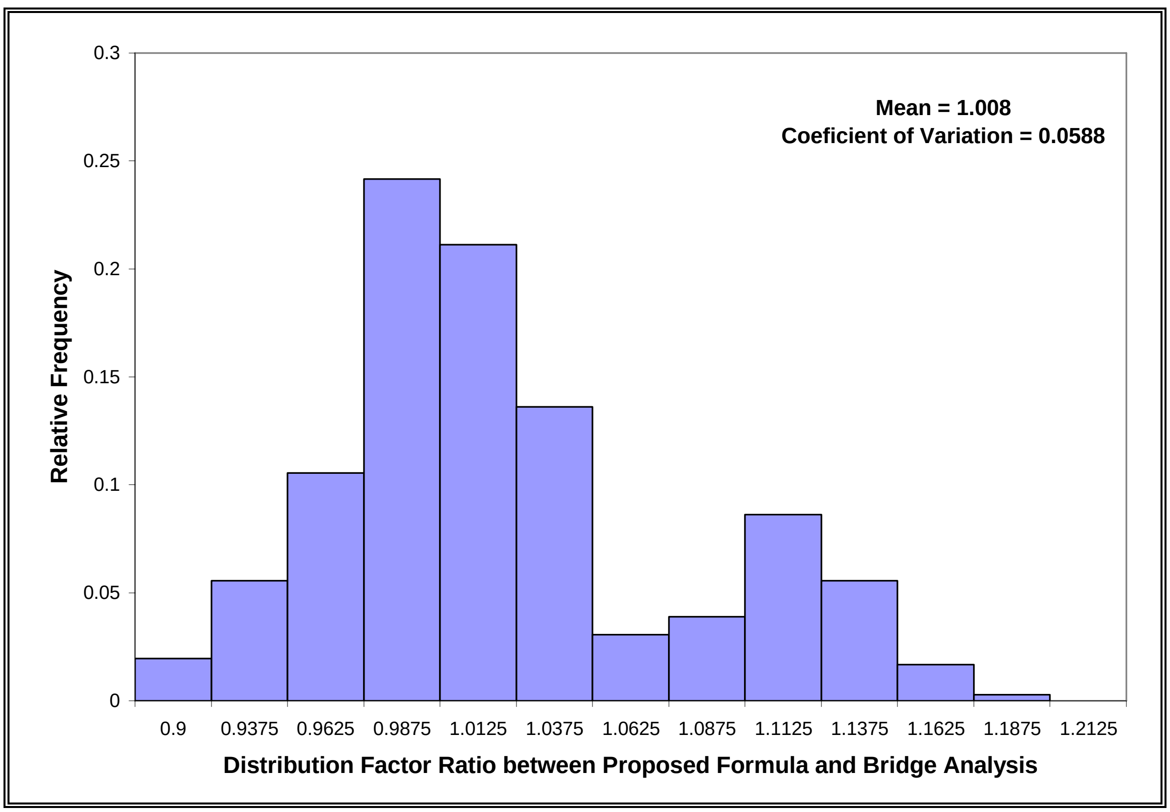
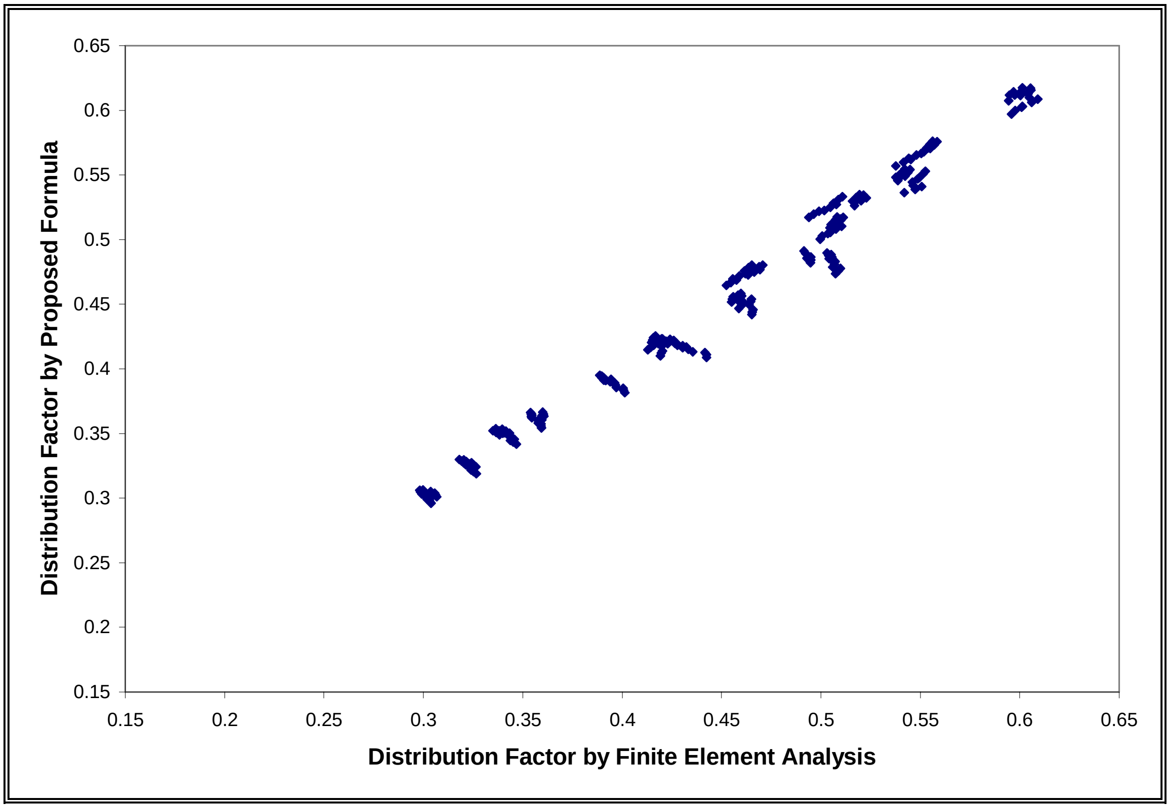


Figure D. 11Comparison of Proposed Formulas and Bridge Analysis for M2, Bending Moment on Exterior Beams for Single Lane



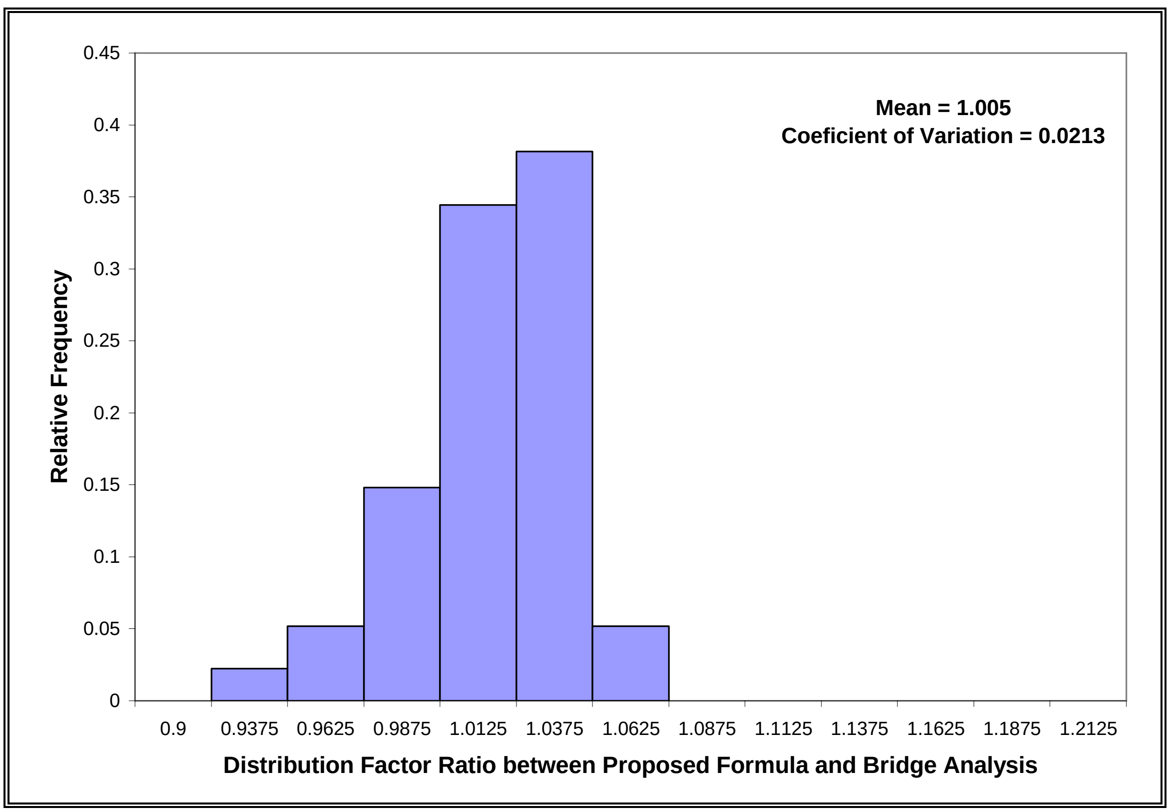
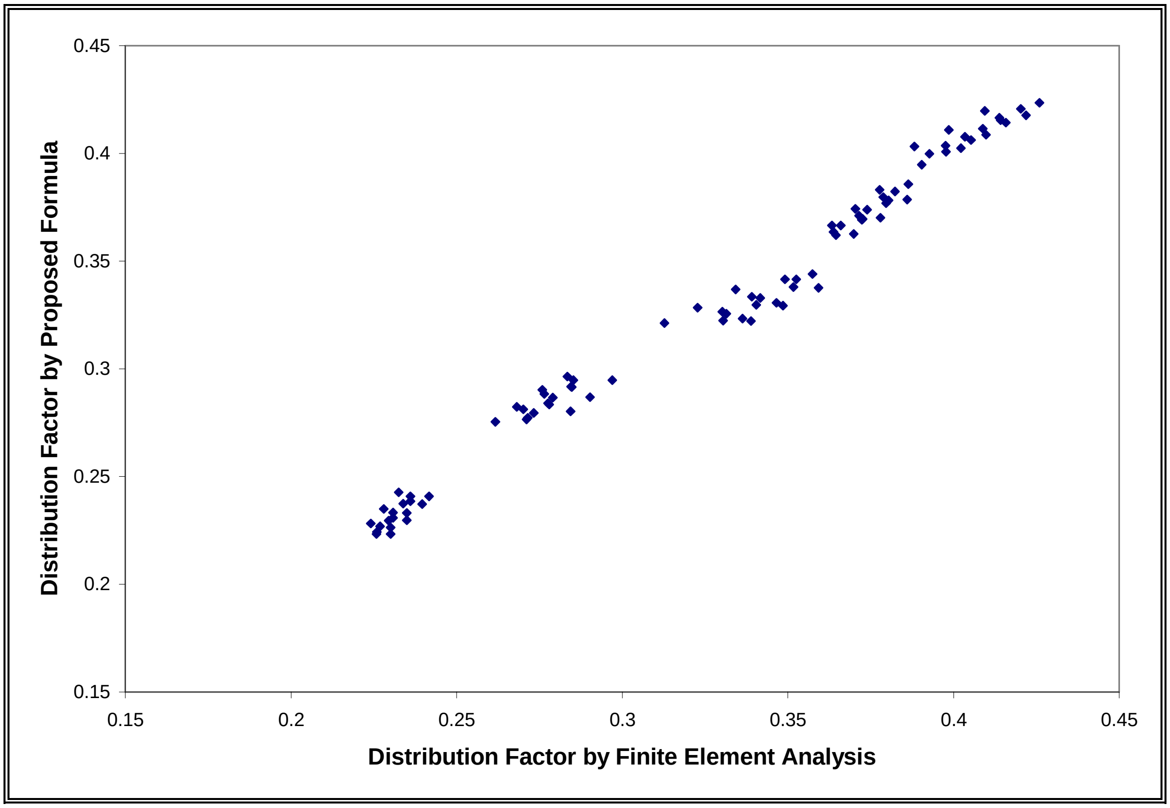


Figure D. 12Comparison of Proposed Formulas and Bridge Analysis for M2, Bending Moment on Exterior Beams for Double Lanes



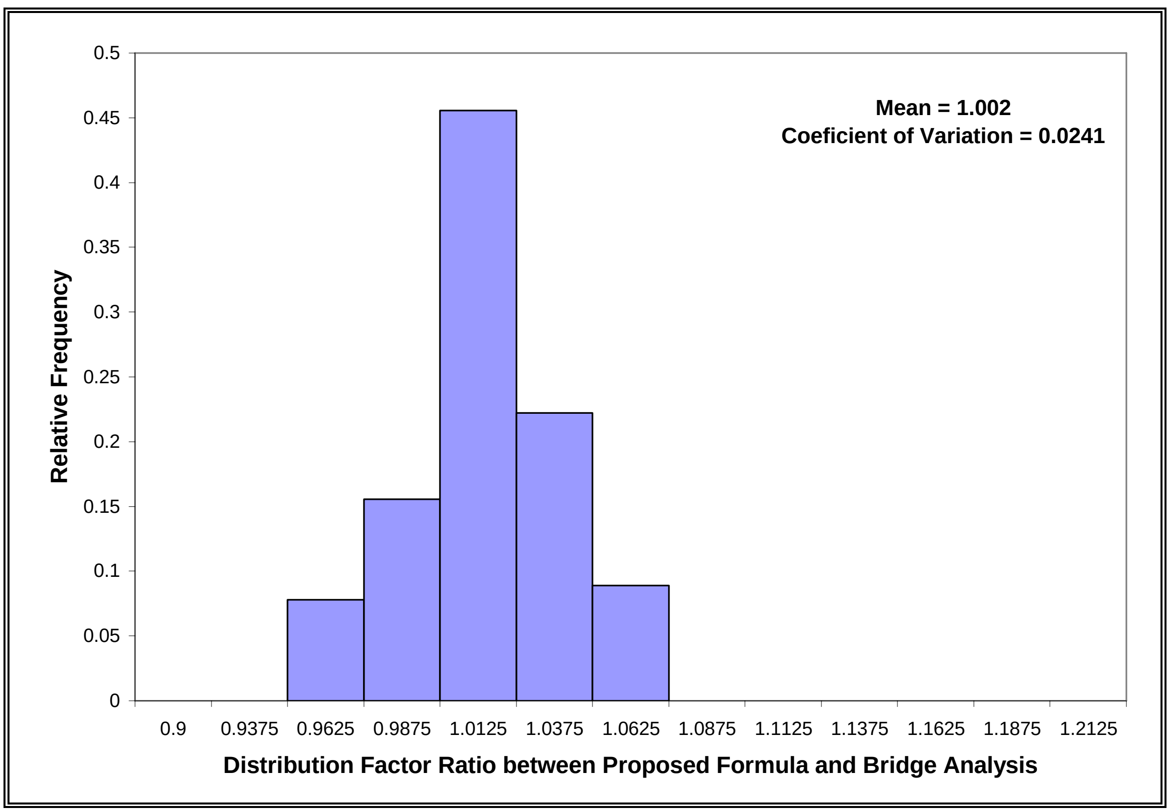
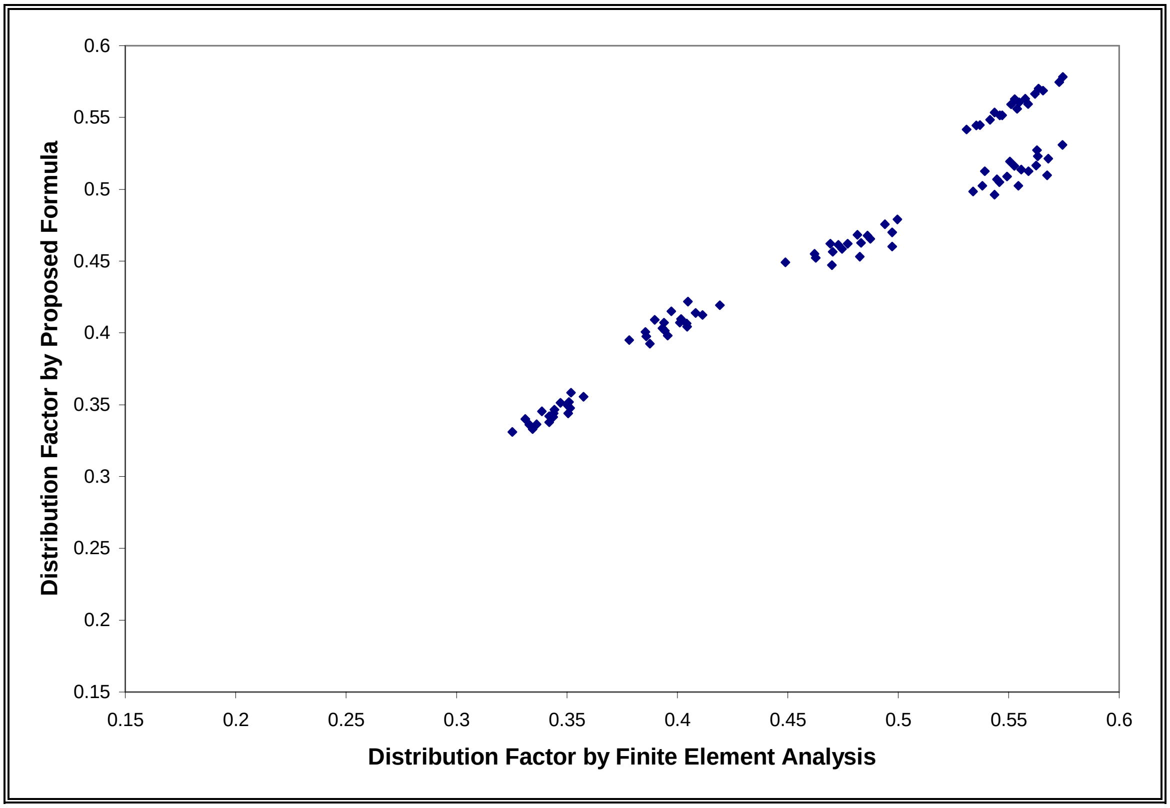


Figure D. 13Comparison of Proposed Formulas and Bridge Analysis for M2, Shear Force on Interior Beams for Single Lane



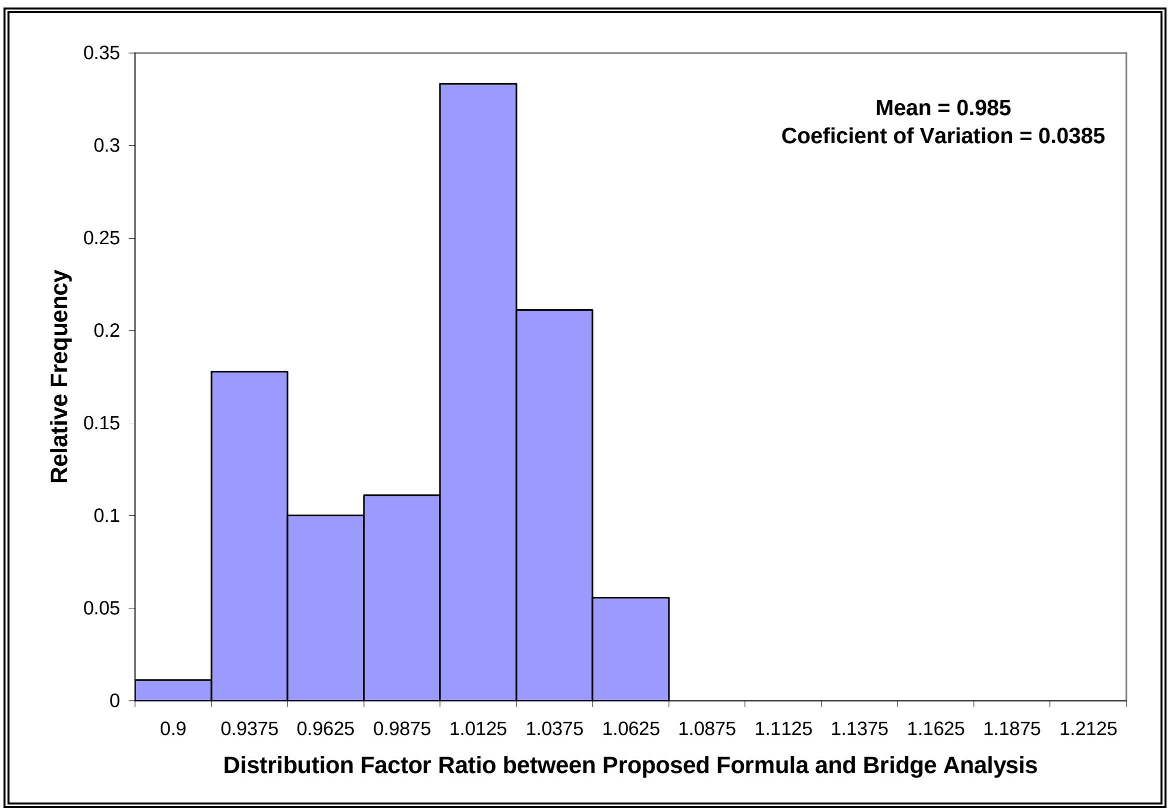
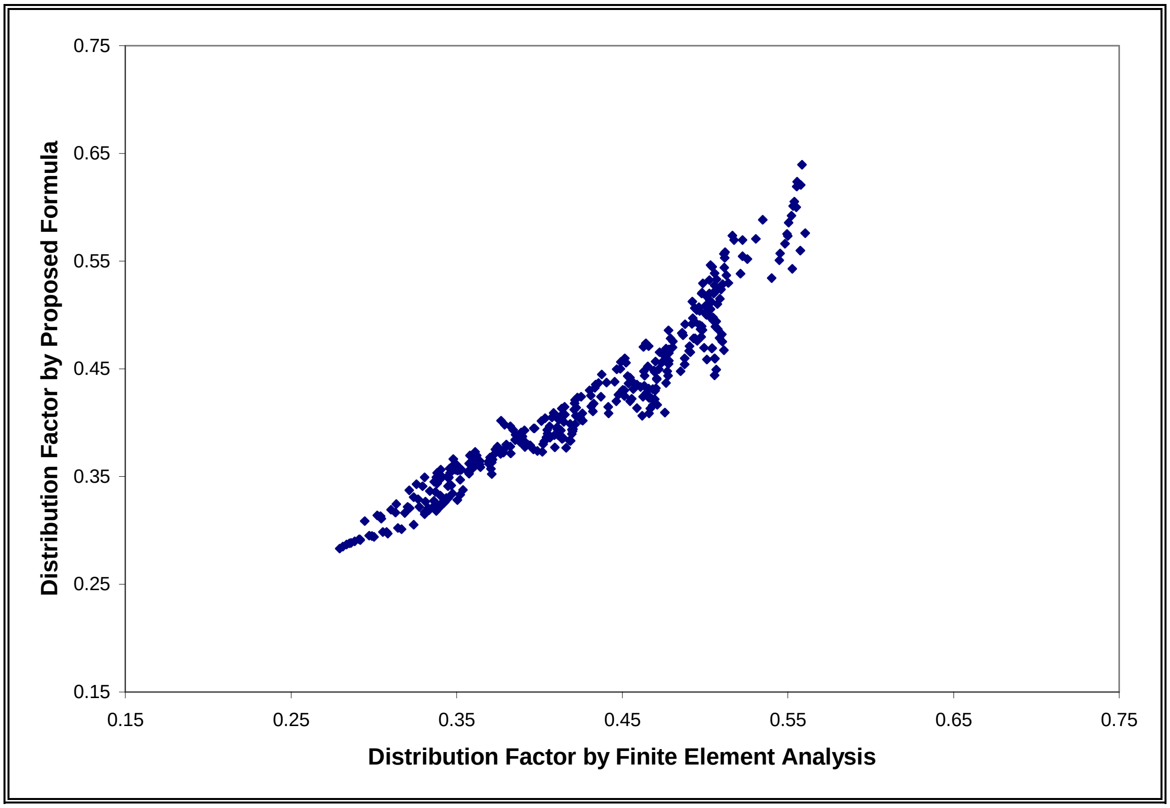


Figure D. 14Comparison of Proposed Formulas and Bridge Analysis for M2, Shear Force on Interior Beams for Double Lanes



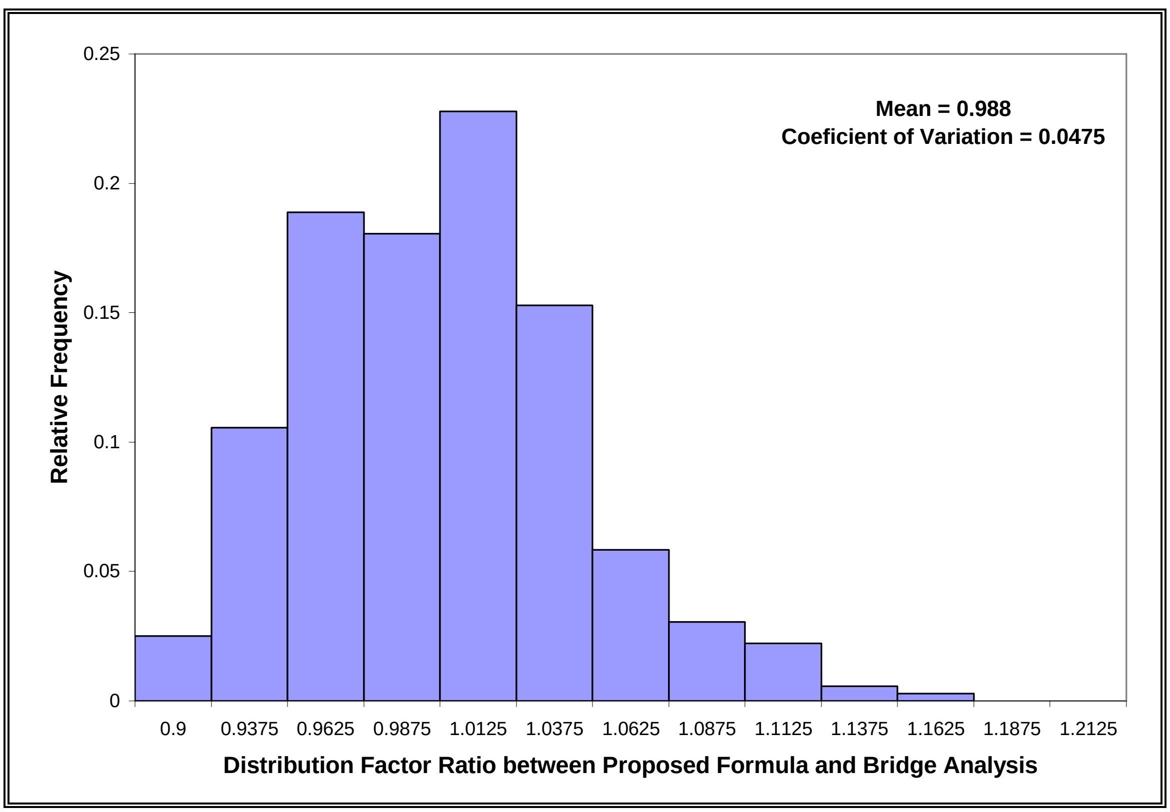
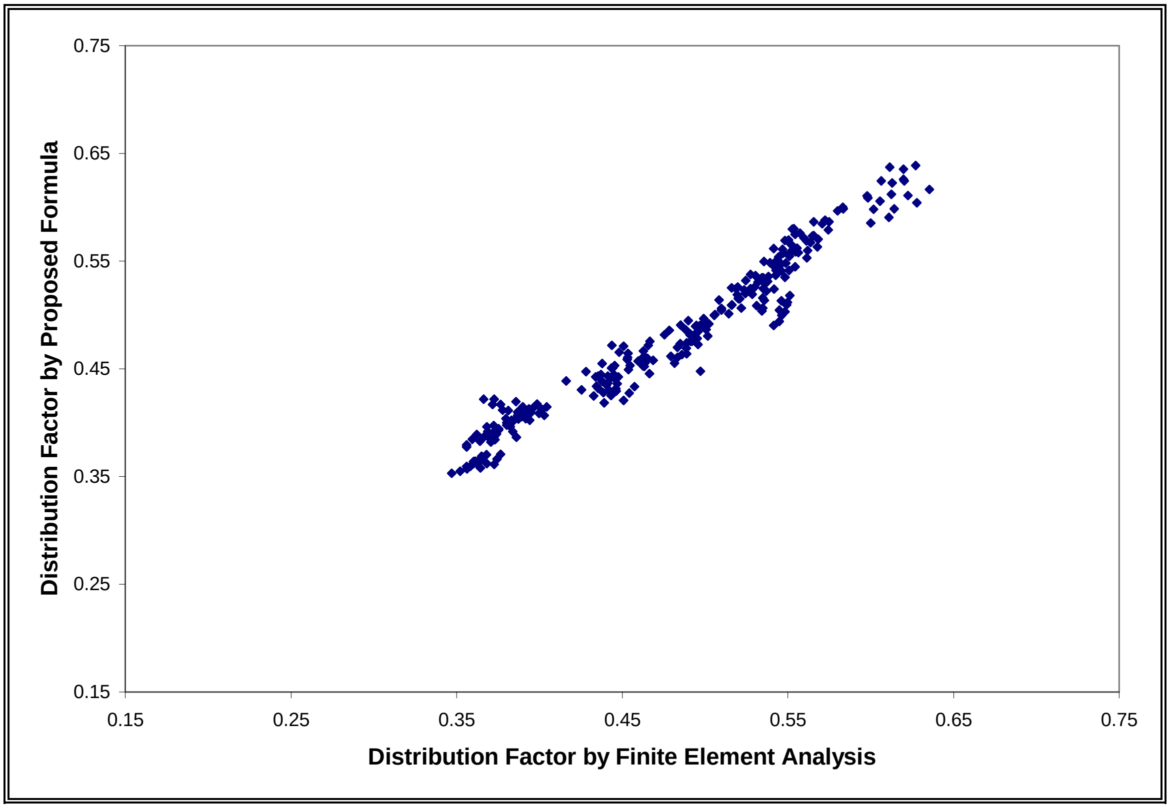


Figure D. 15Comparison of Proposed Formulas and Bridge Analysis for M2, Shear Force on Exterior Beams for Single Lane



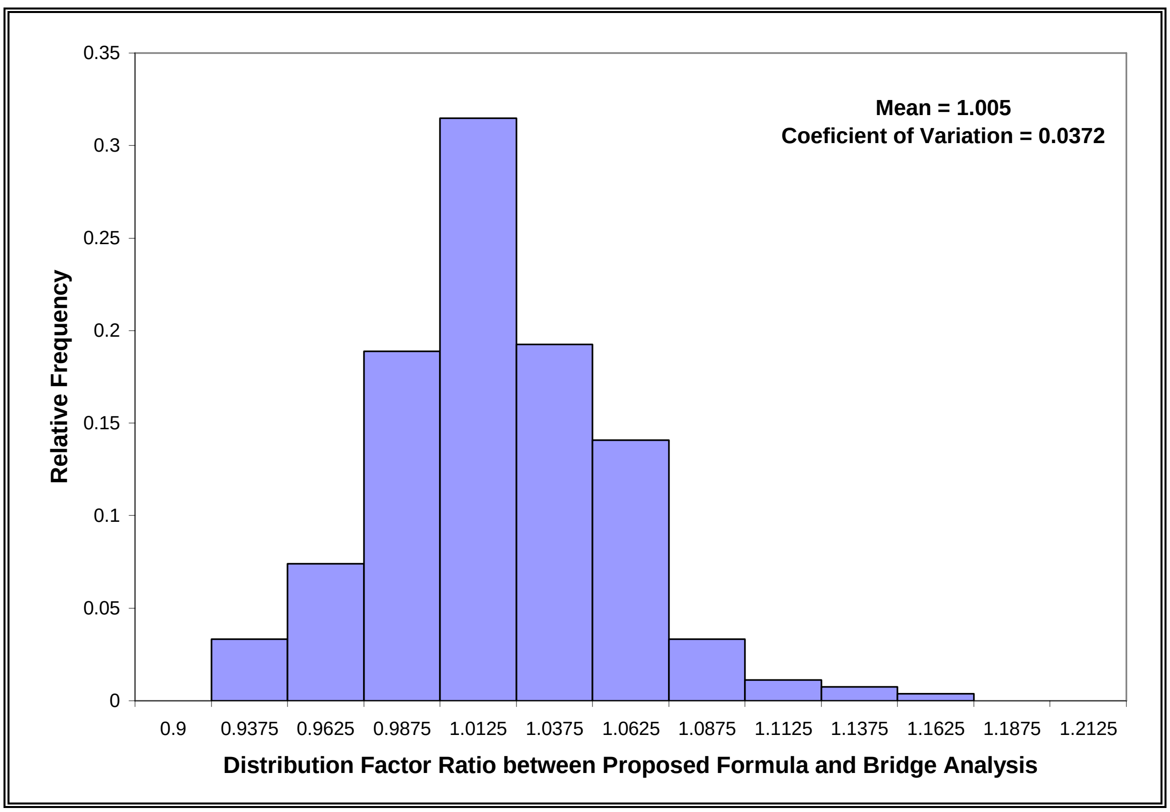
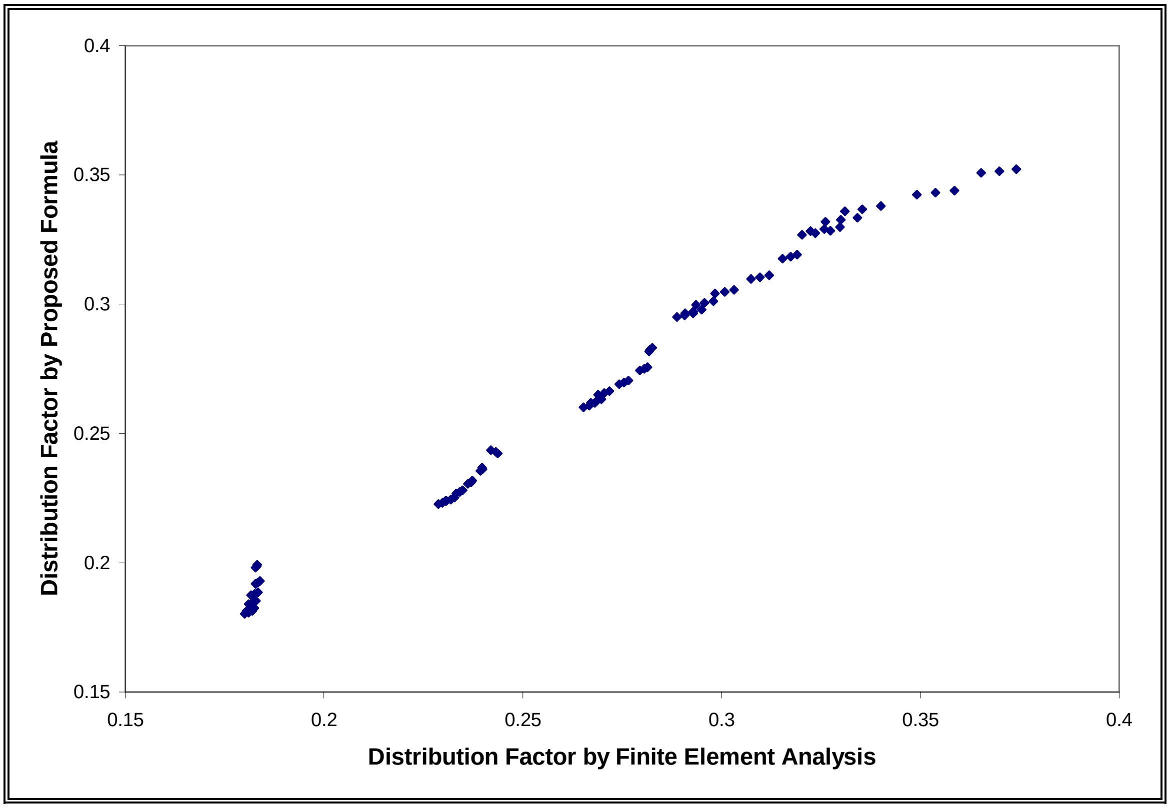


Figure D. 16Comparison of Proposed Formulas and Bridge Analysis for M2, Shear Force on Exterior Beams for Double Lanes



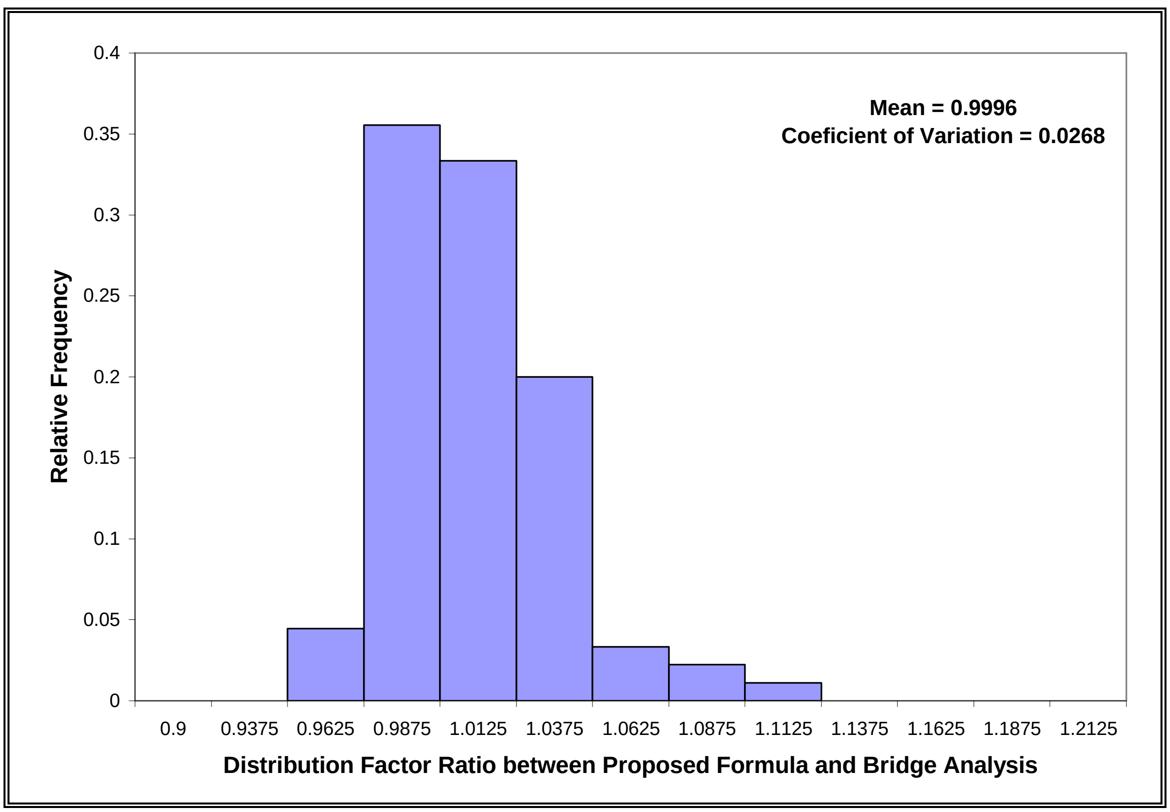
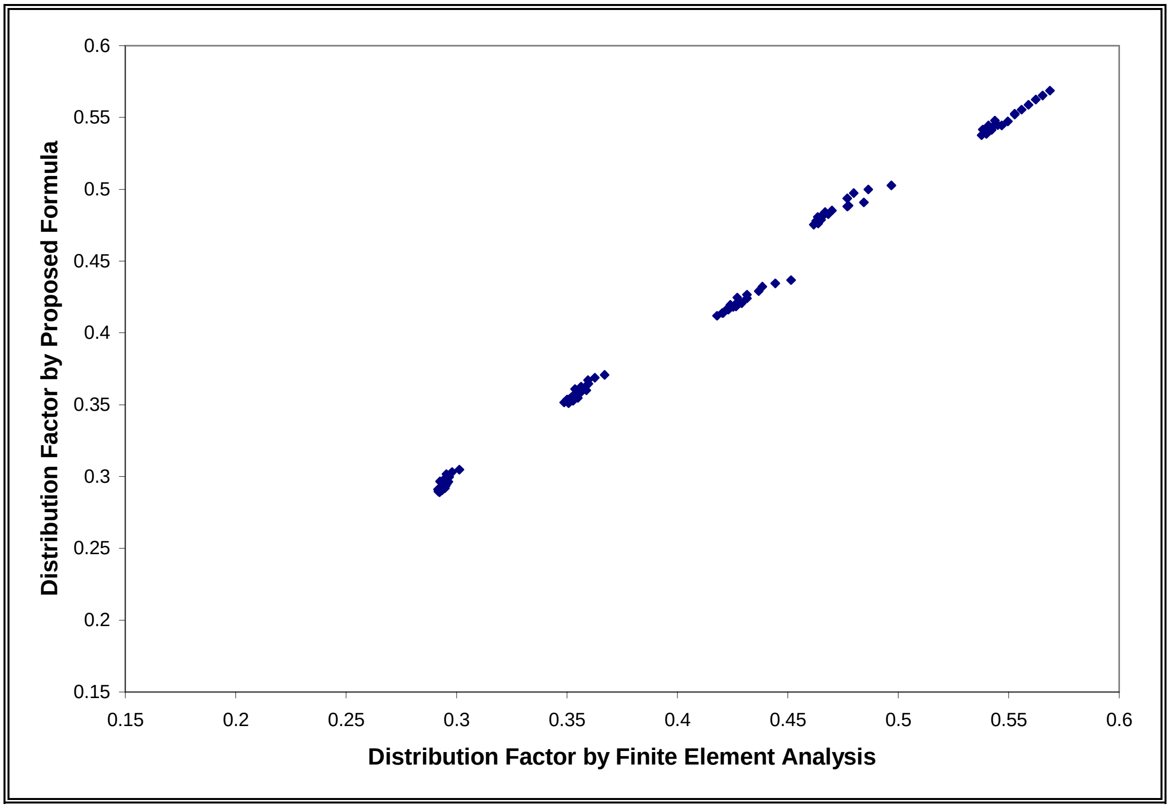


Figure D. 17Comparison of Proposed Formulas and Bridge Analysis for M1, Bending Moment on Interior Beams for Single Lane



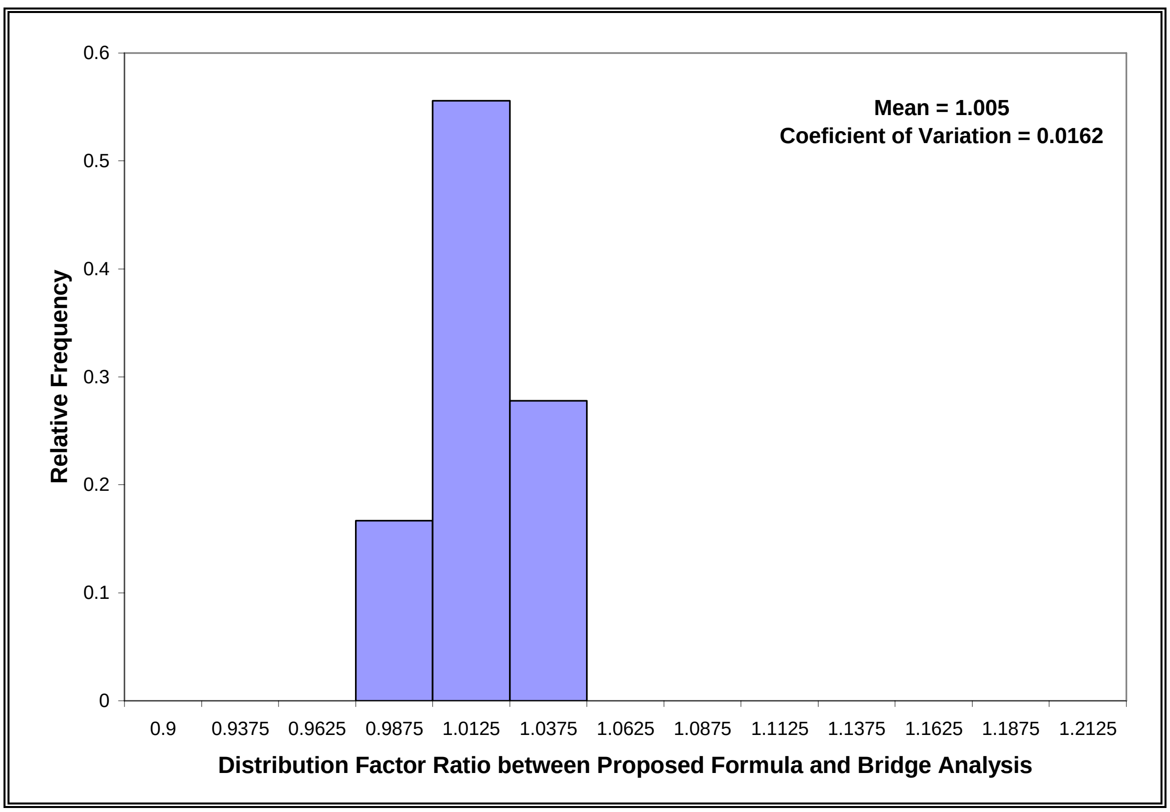
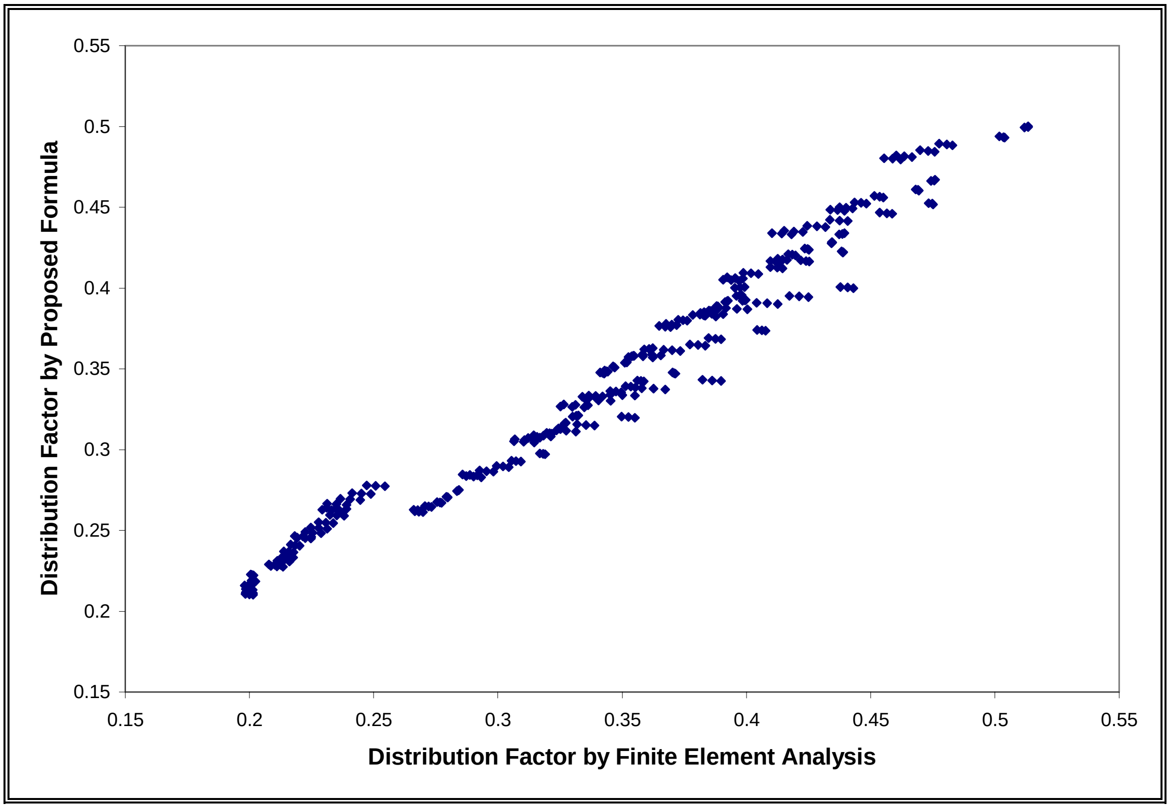


Figure D. 18Comparison of Proposed Formulas and Bridge Analysis for M1, Bending Moment on Interior Beams for Double Lanes



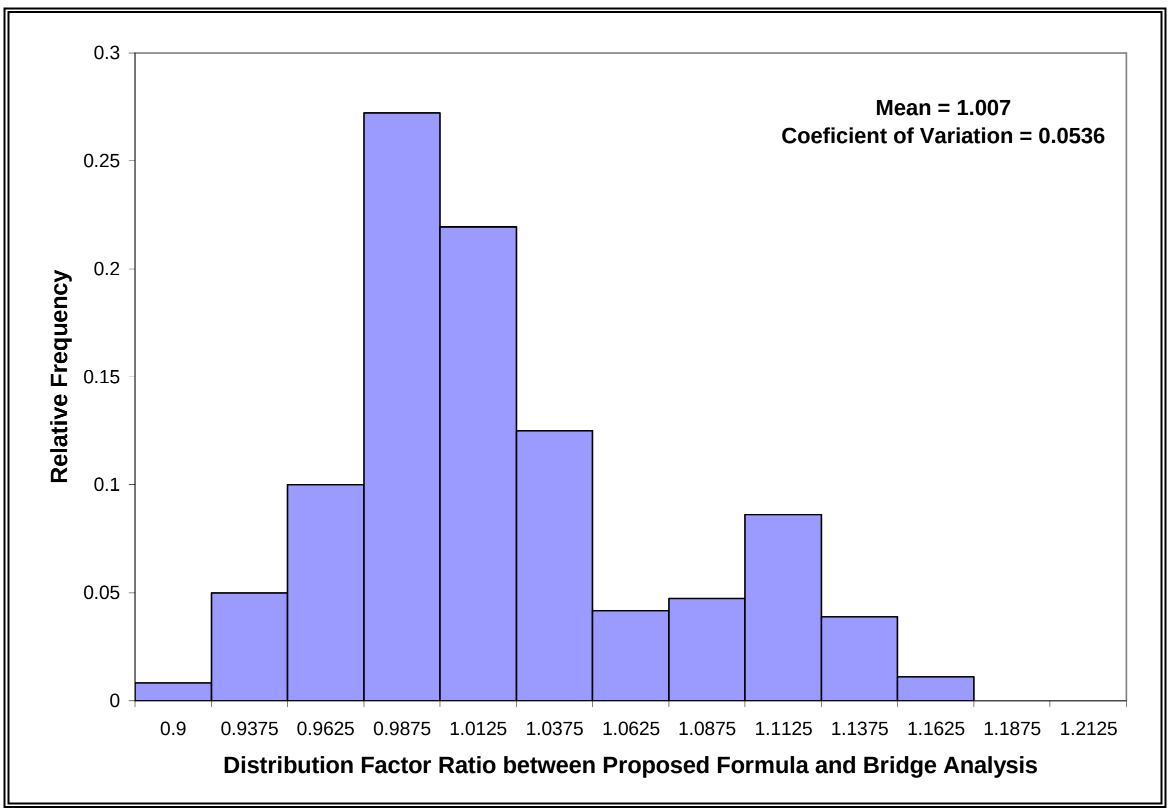
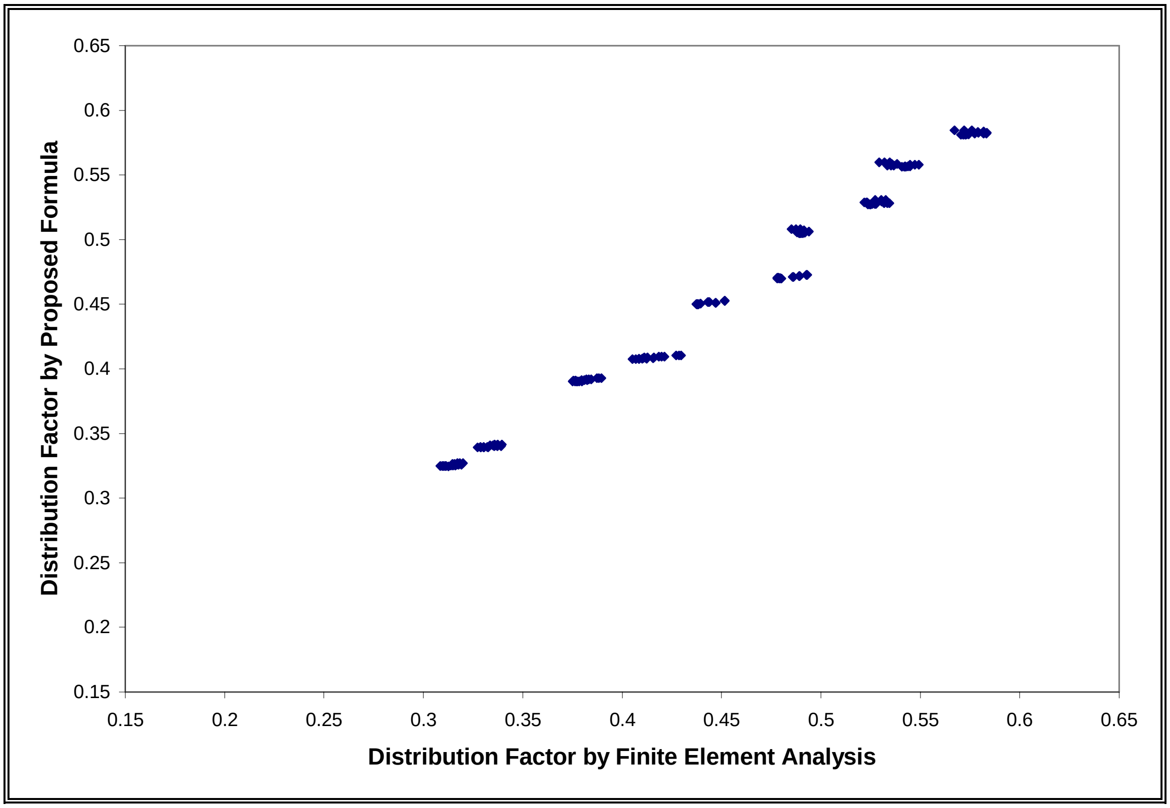


Figure D. 19Comparison of Proposed Formulas and Bridge Analysis for M1, Bending Moment on Exterior Beams for Single Lane



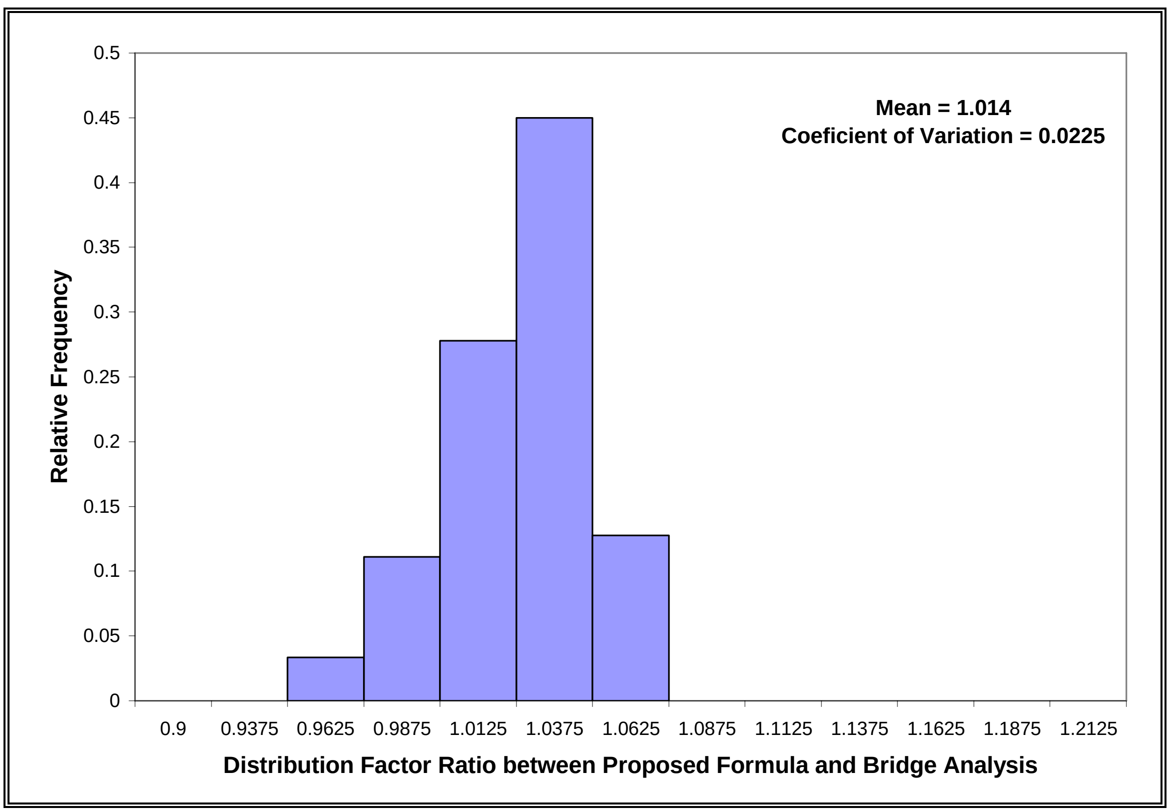
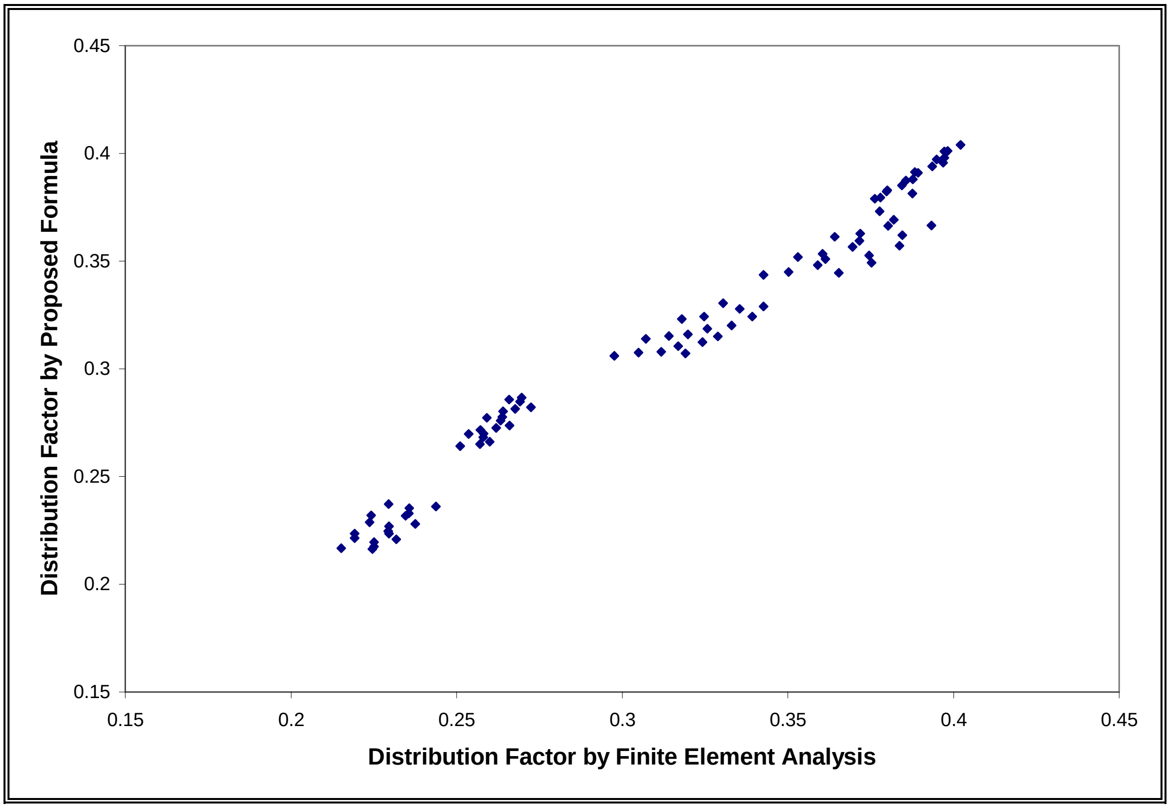


Figure D. 20Comparison of Proposed Formulas and Bridge Analysis for M1, Bending Moment on Exterior Beams for Double Lanes



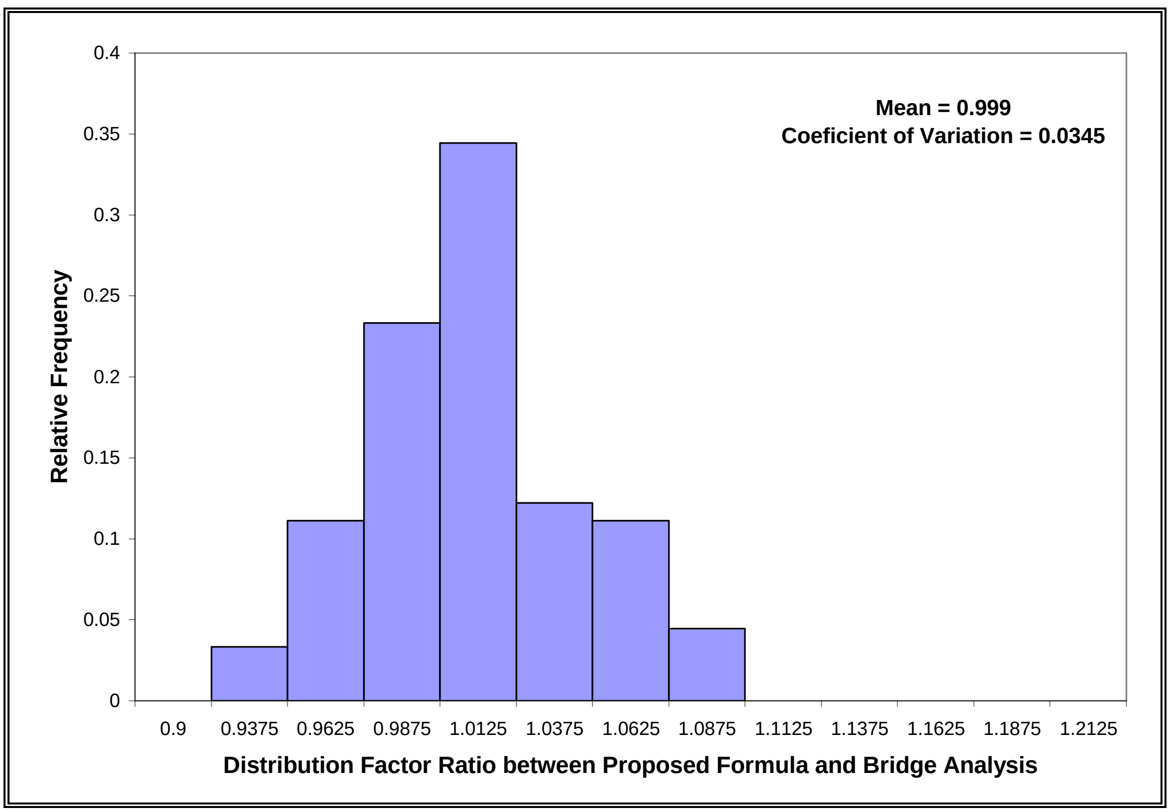
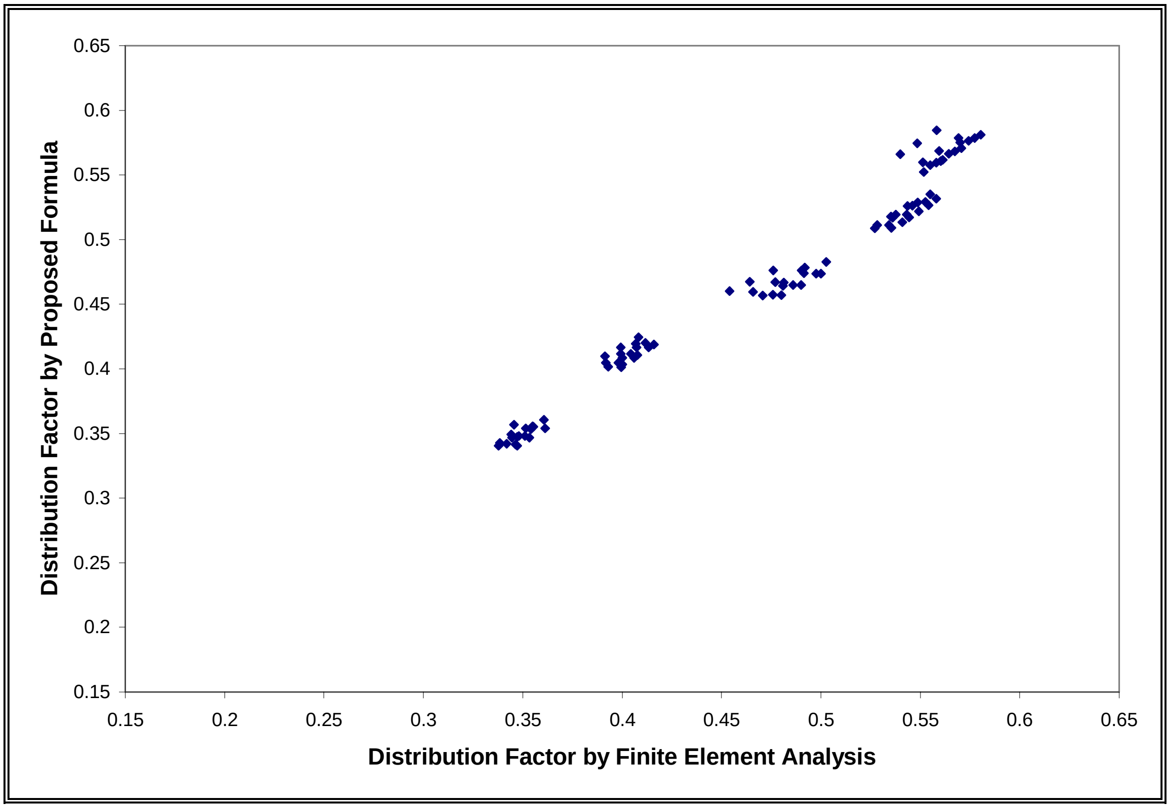


Figure D. 21Comparison of Proposed Formulas and Bridge Analysis for M1, Shear Force on Interior Beams for Single Lane



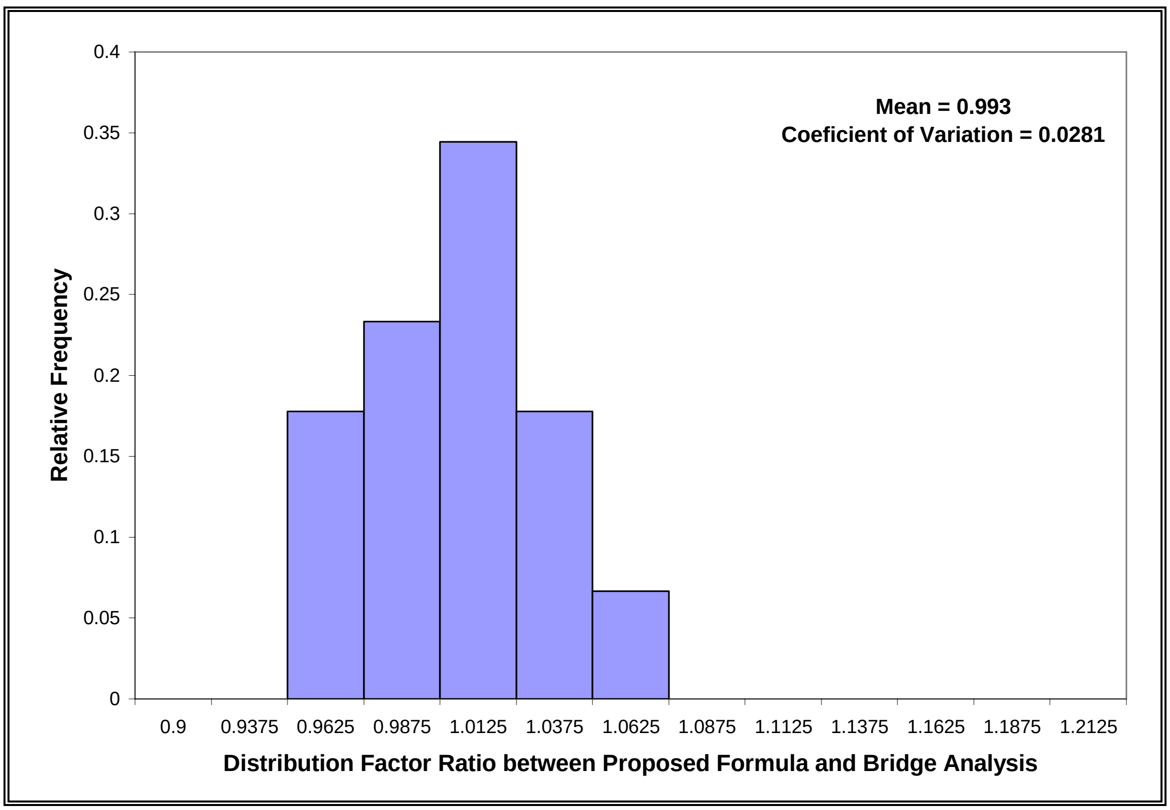
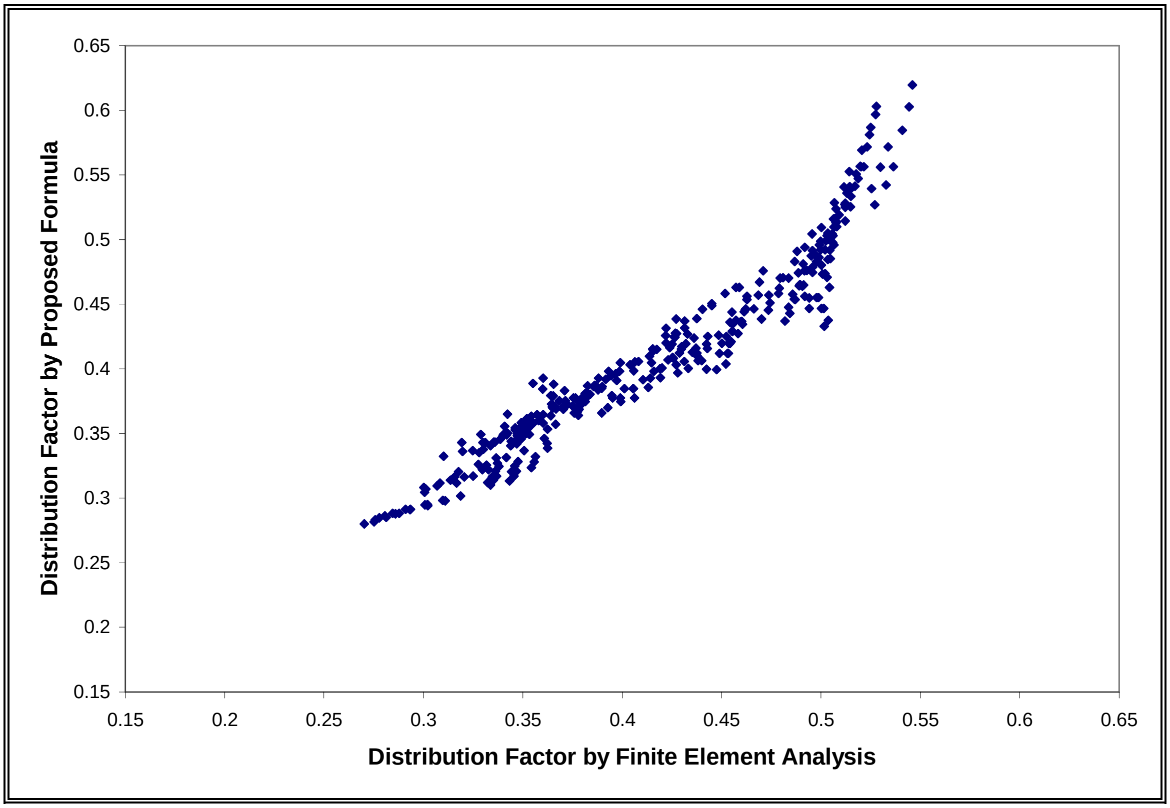


Figure D. 22Comparison of Proposed Formulas and Bridge Analysis for M1, Shear Force on Interior Beams for Double Lanes



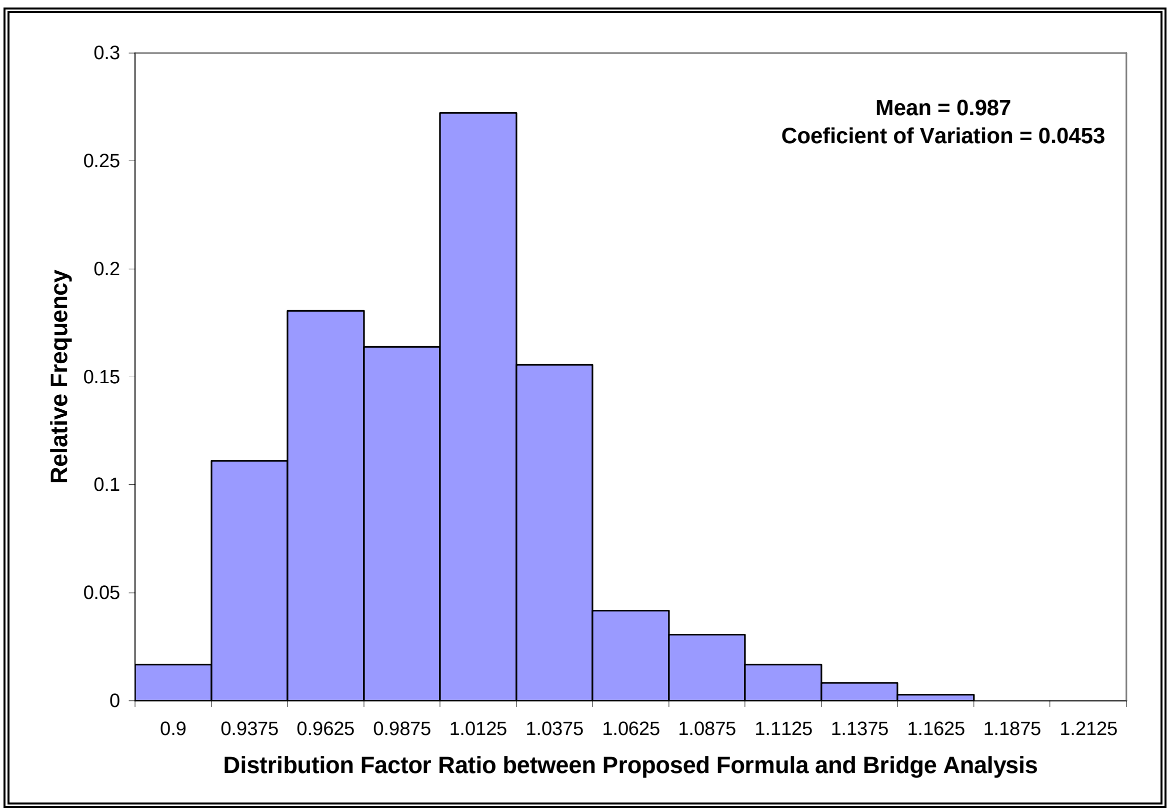
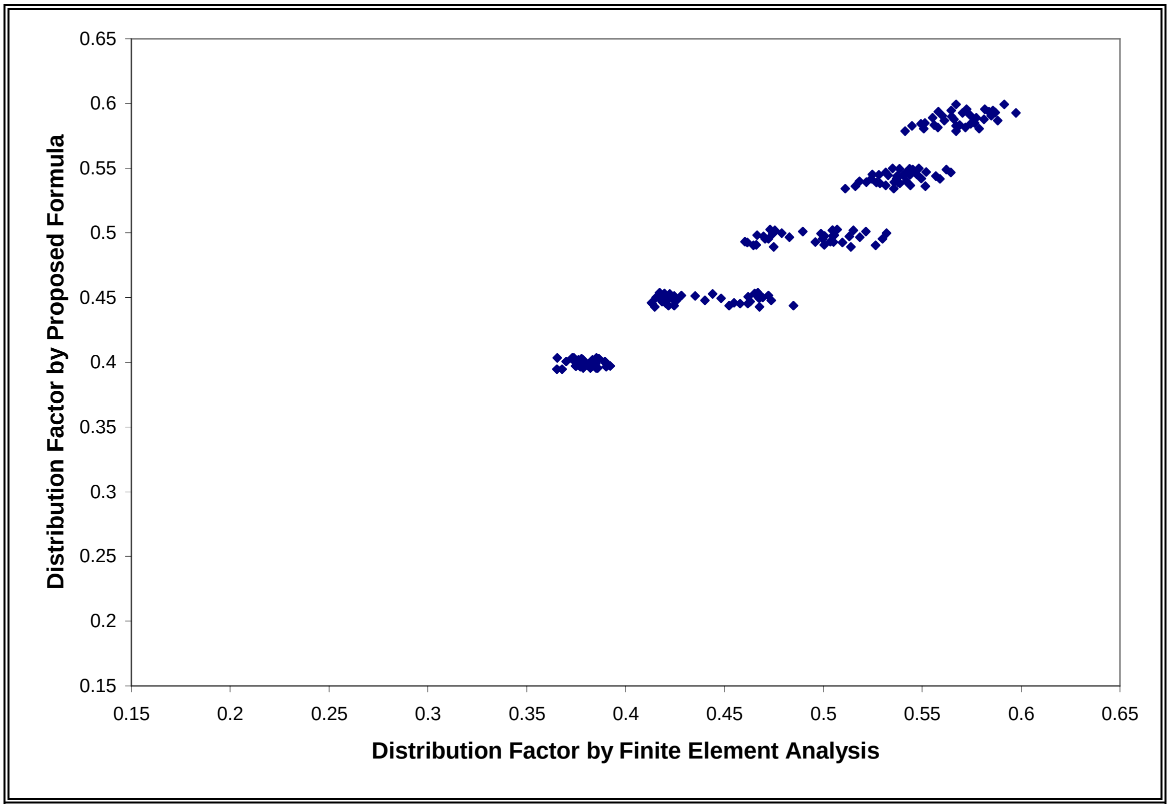


Figure D. 23Comparison of Proposed Formulas and Bridge Analysis for M1, Shear Force on Exterior Beams for Single Lane



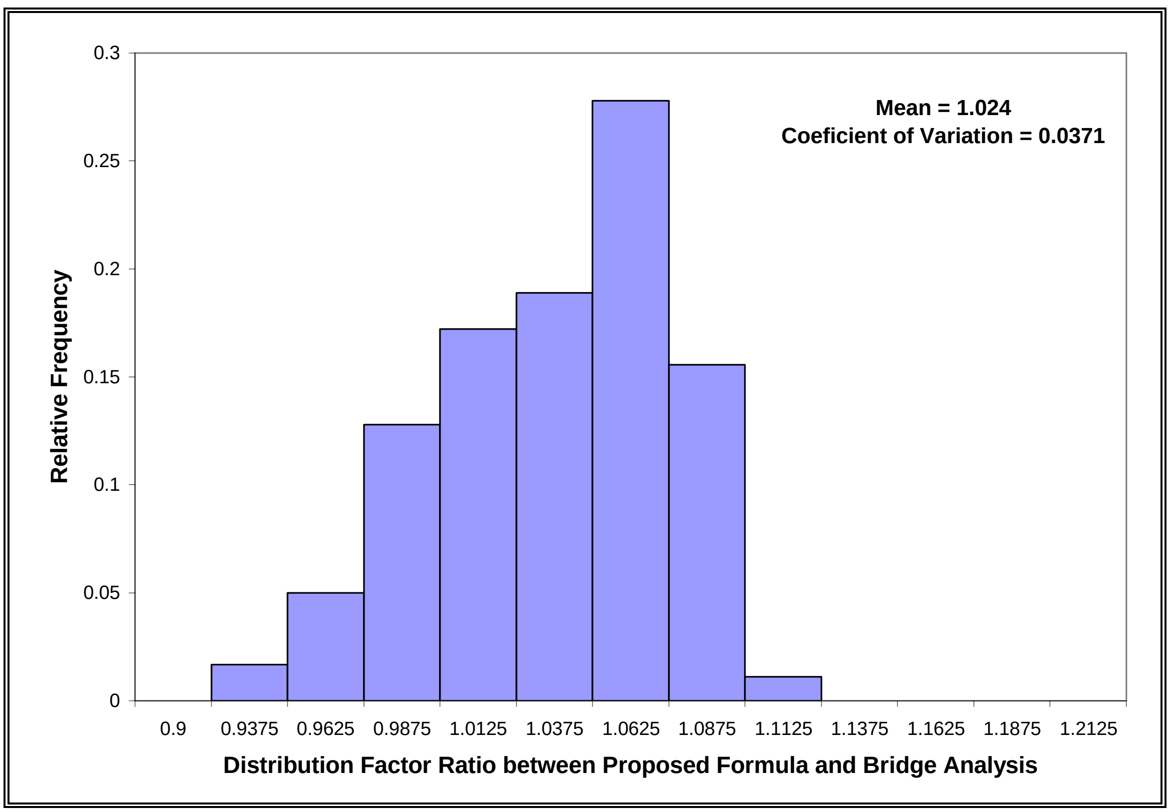
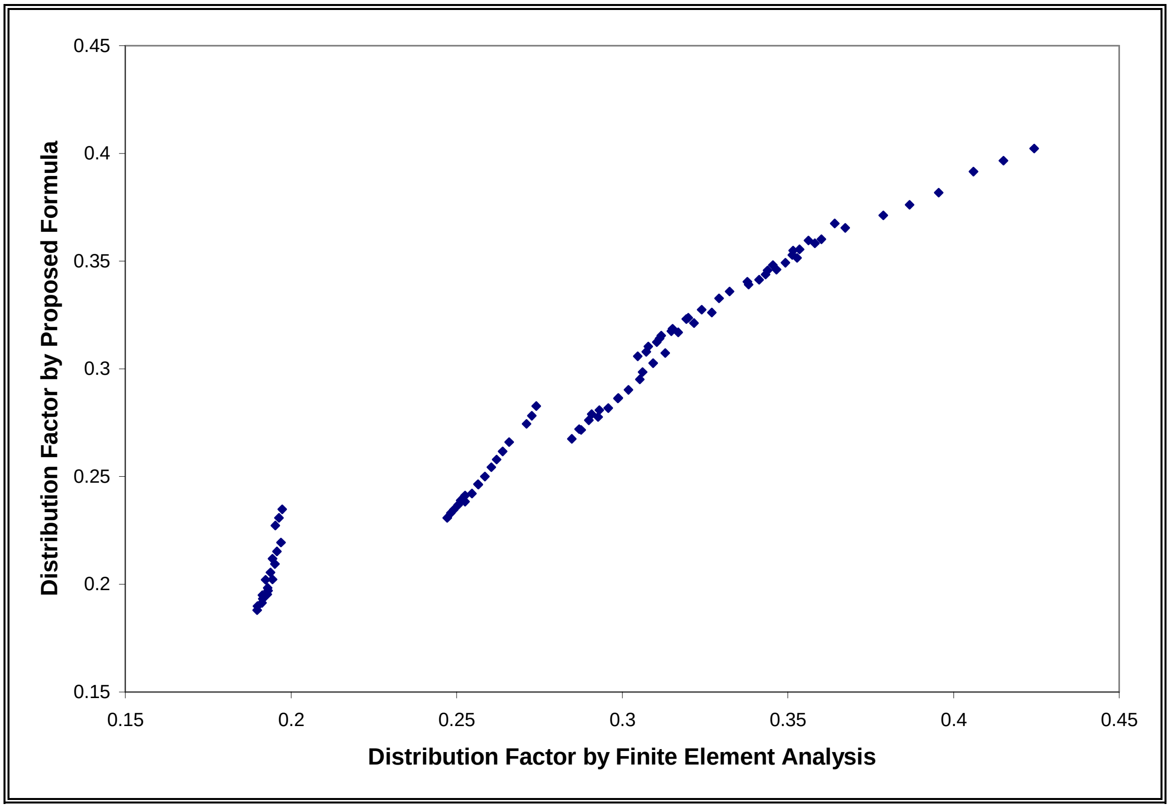


Figure D. 24Comparison of Proposed Formulas and Bridge Analysis for M1, Shear Force on Exterior Beams for Double Lanes



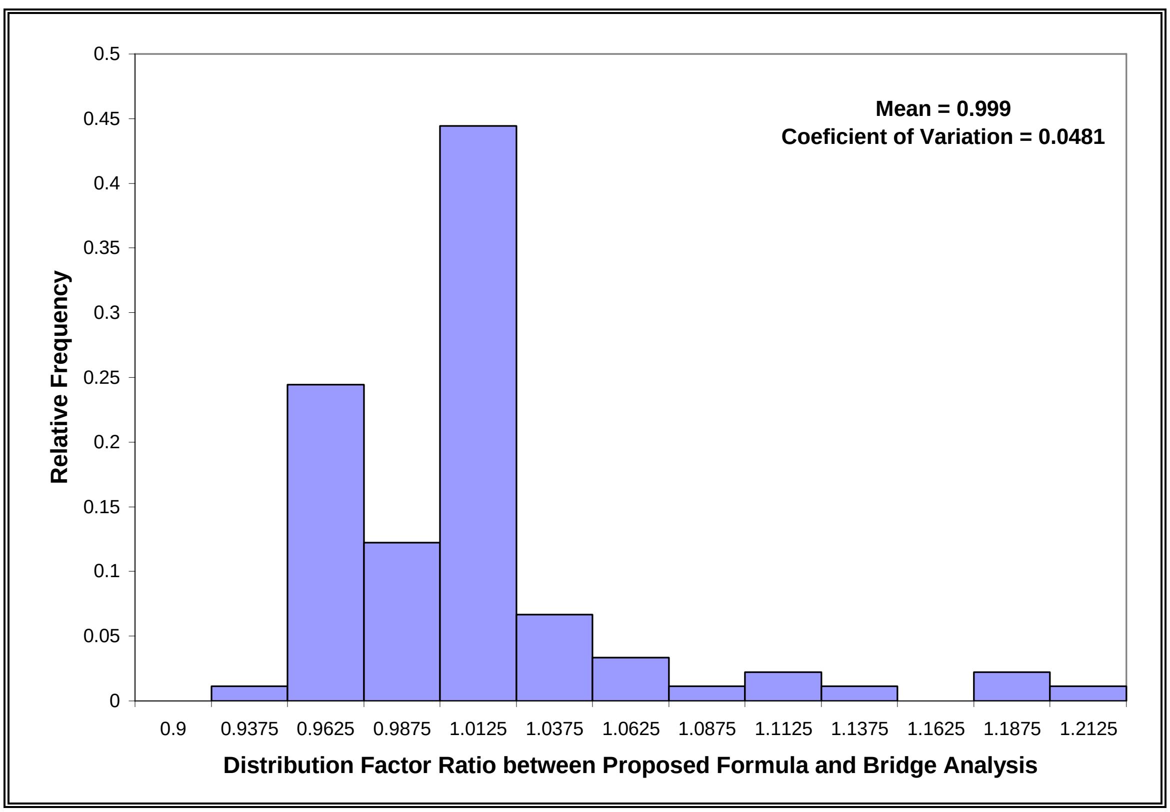
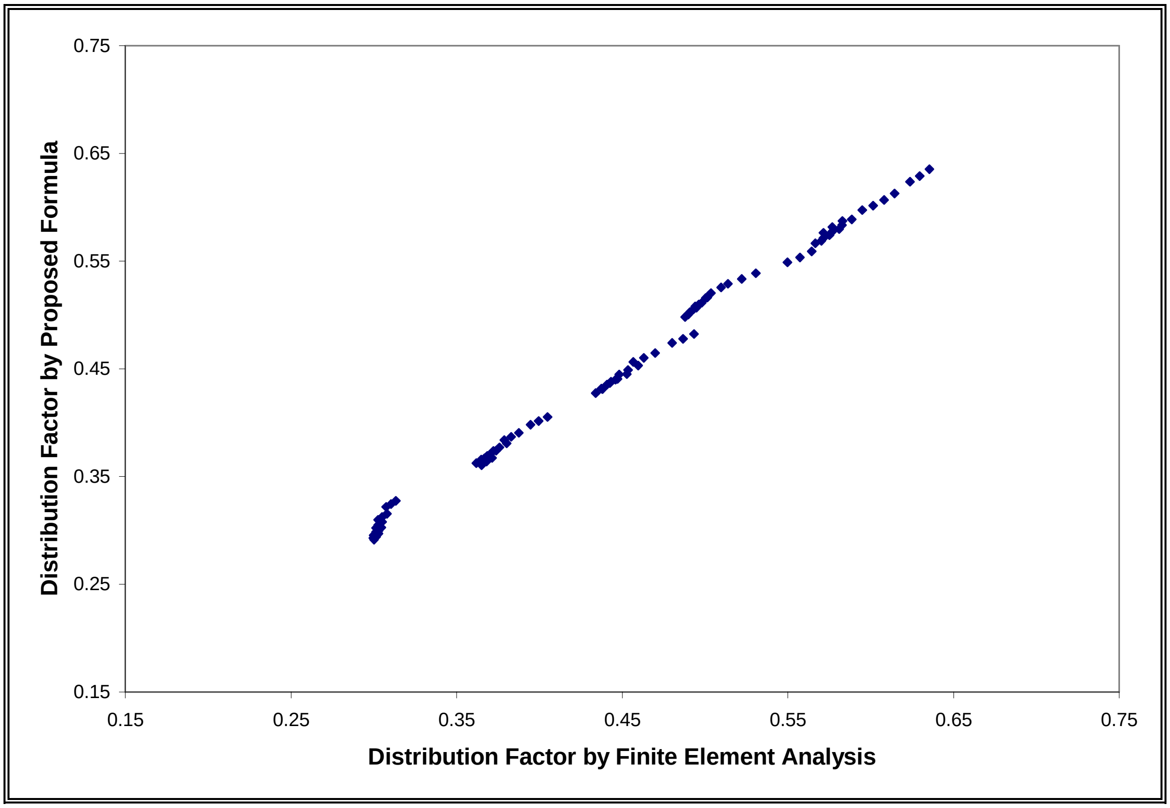


Figure D. 25Comparison of Proposed Formulas and Bridge Analysis for LAVIII, Bending Moment on Interior Beams for Single Lane



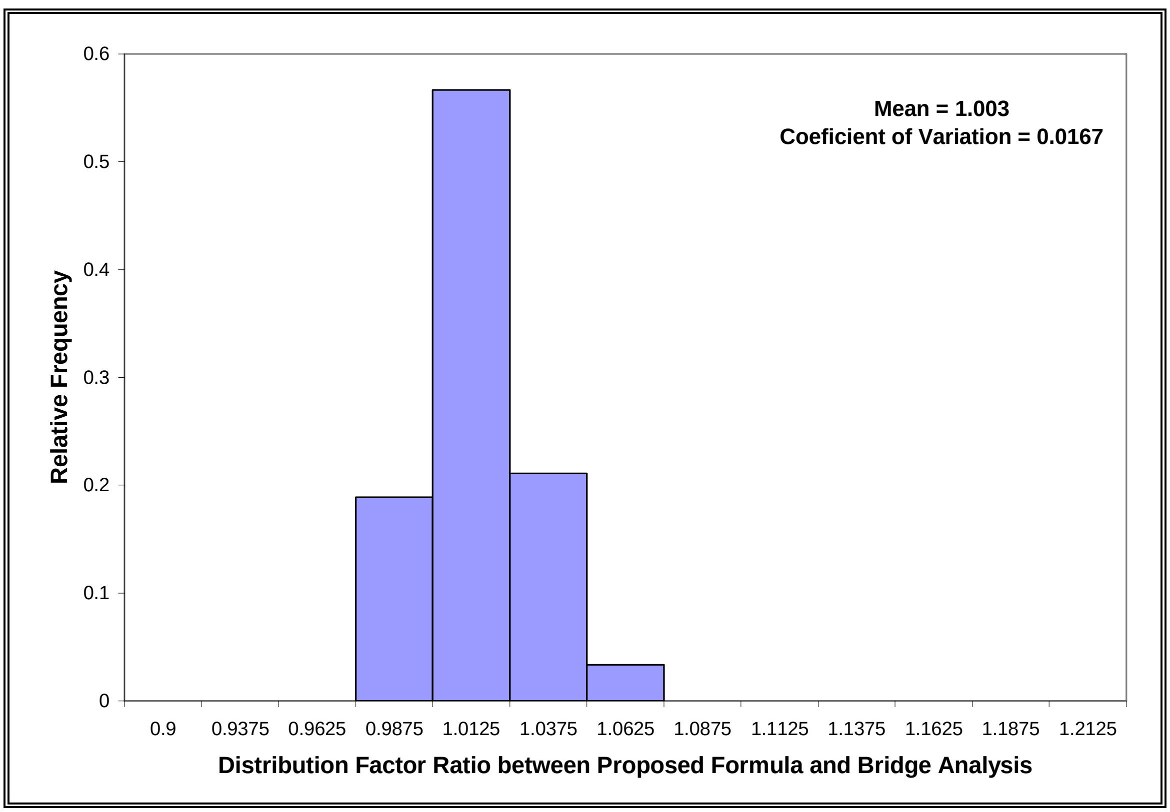
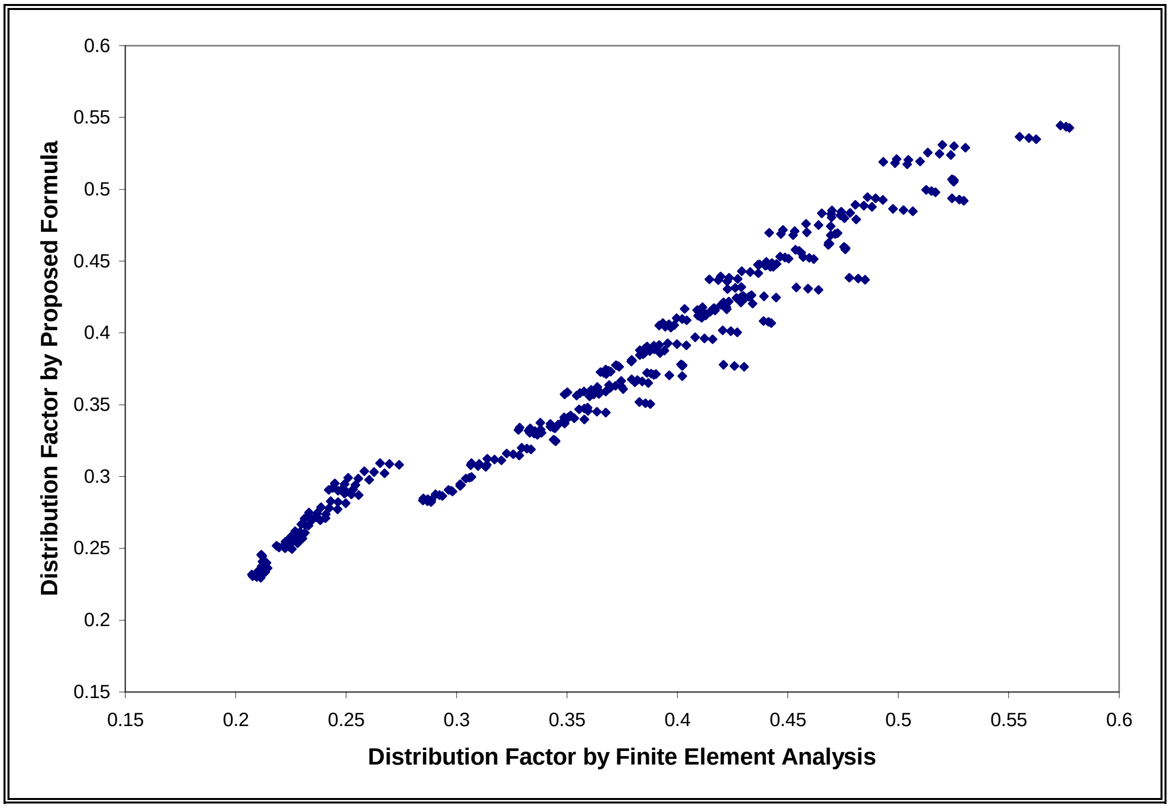


Figure D. 26Comparison of Proposed Formulas and Bridge Analysis for LAVIII, Bending Moment on Interior Beams for Double Lanes



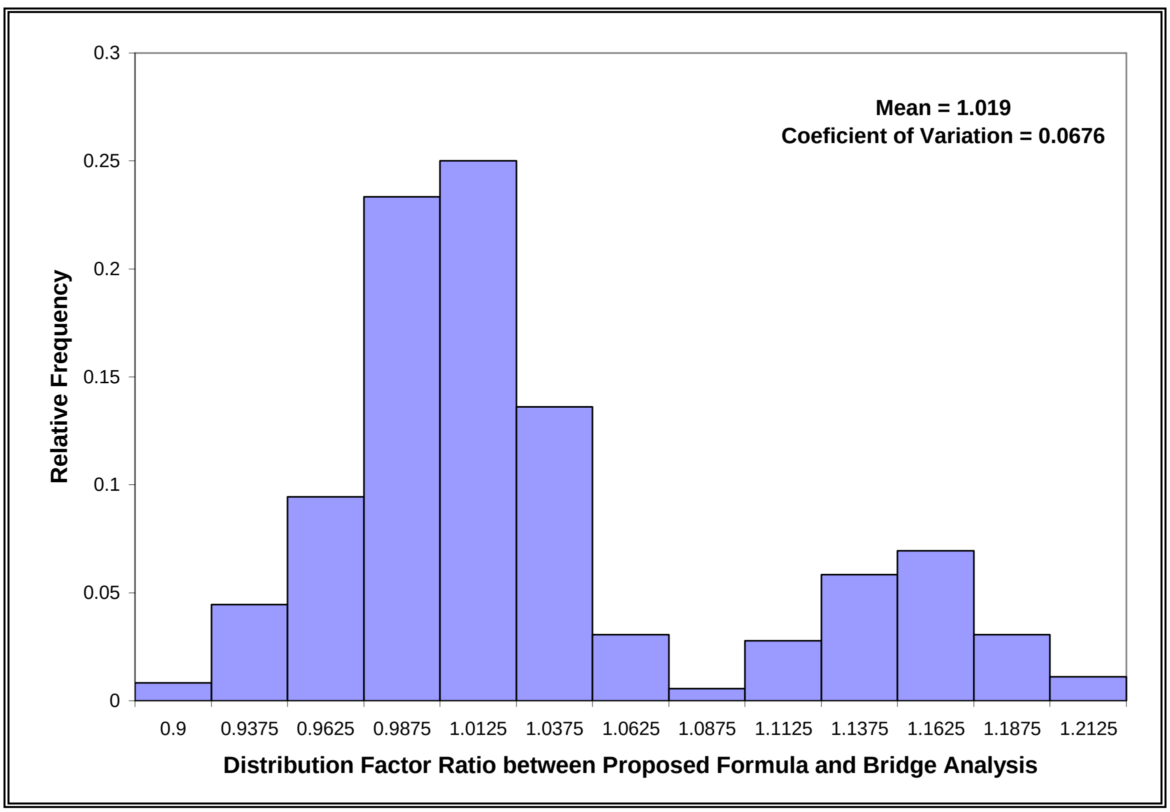
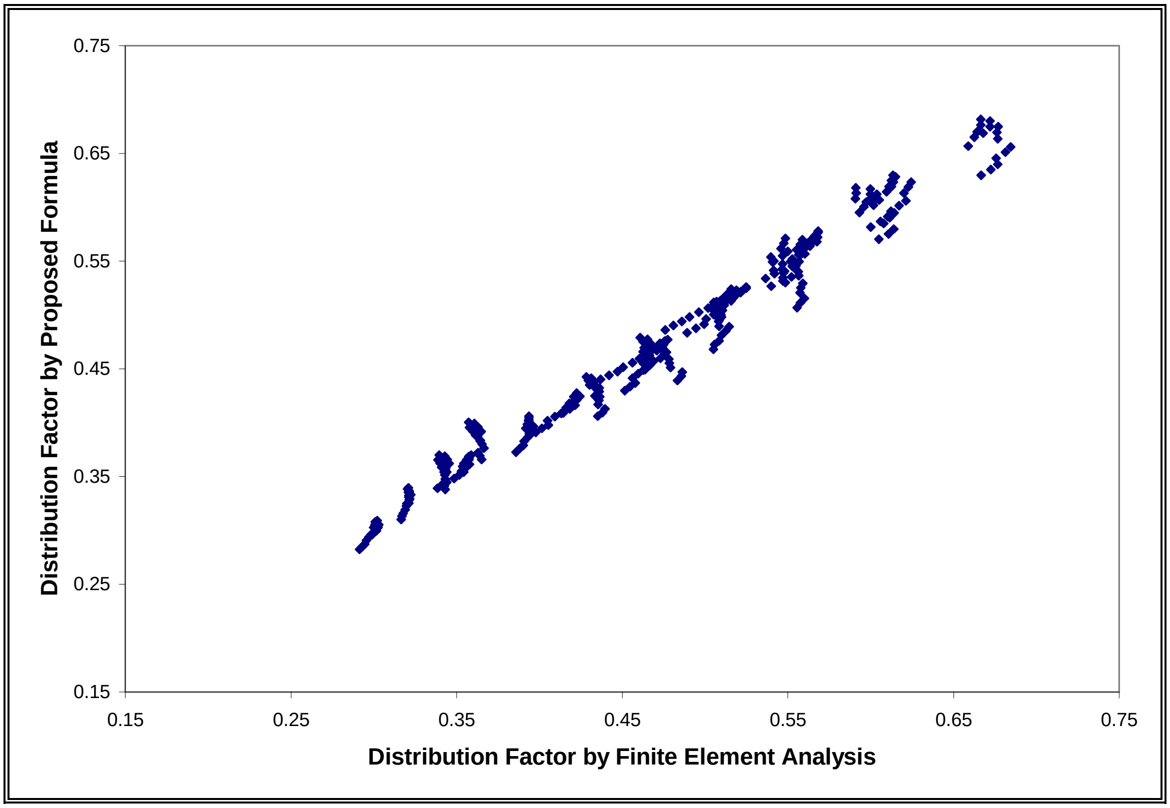


Figure D. 27Comparison of Proposed Formulas and Bridge Analysis for LAVIII, Bending Moment on Exterior Beams for Single Lane



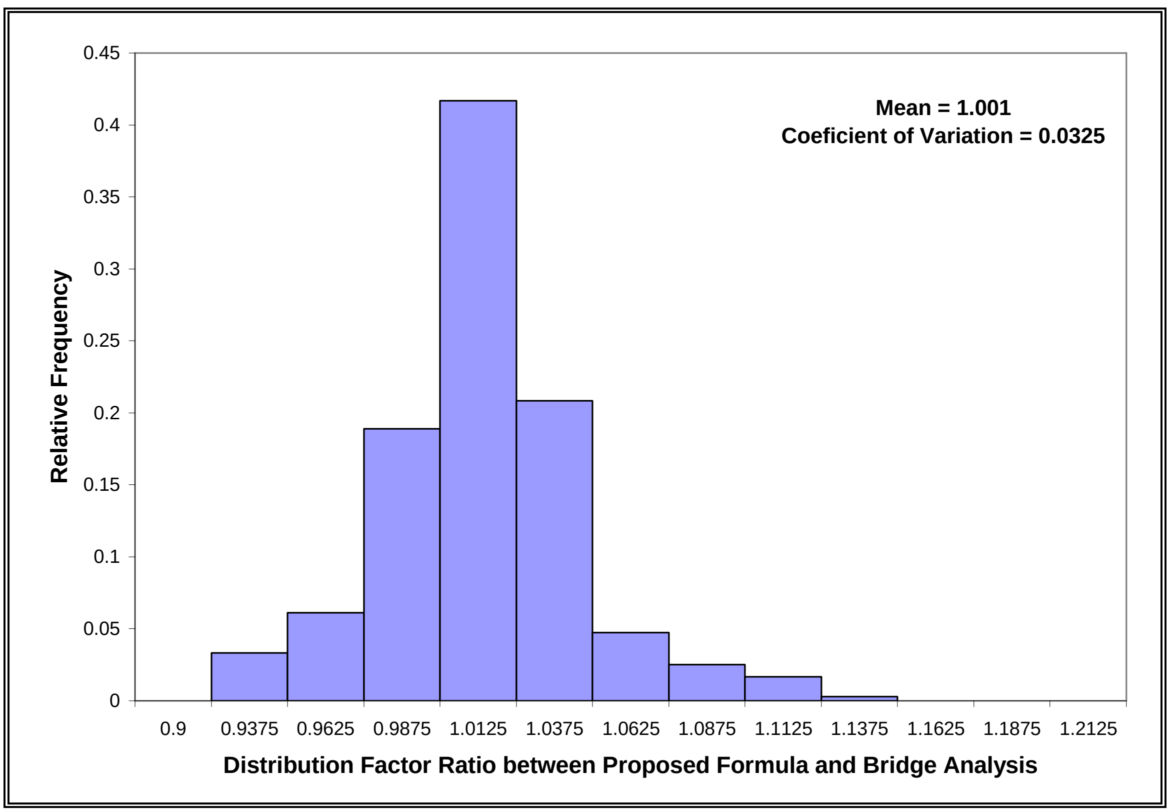
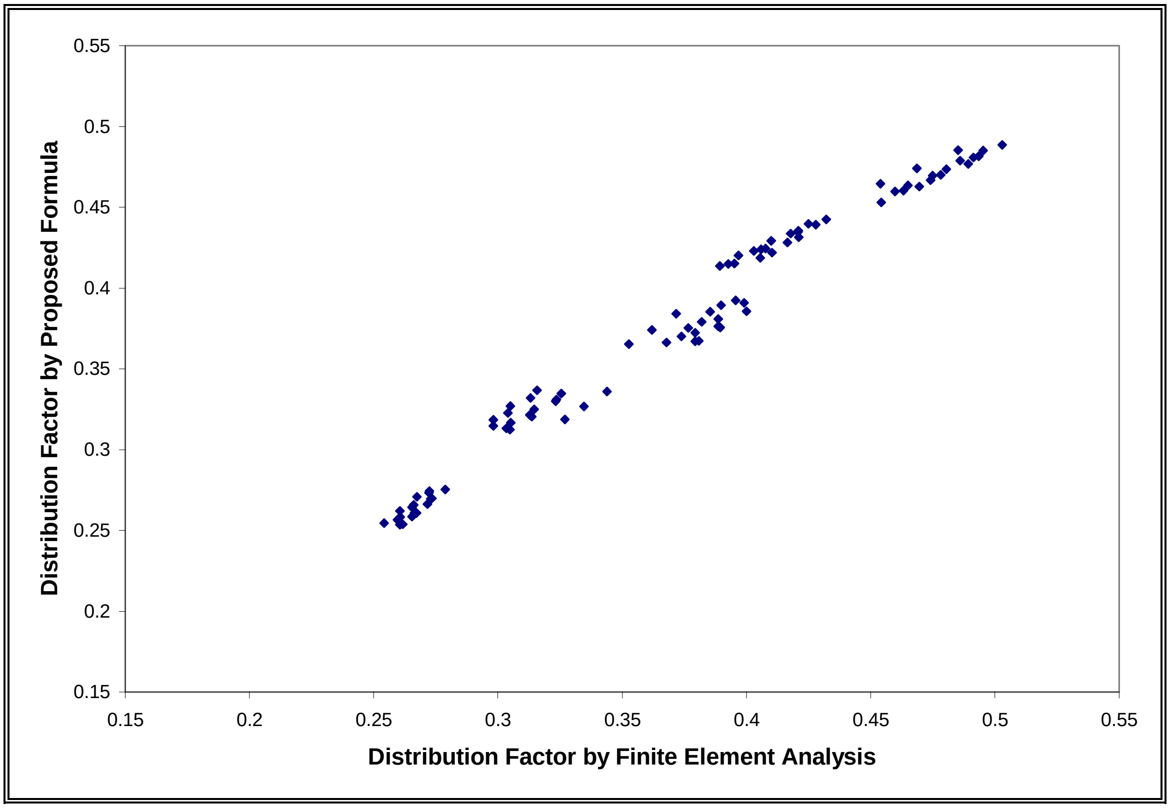


Figure D. 28Comparison of Proposed Formulas and Bridge Analysis for LAVIII, Bending Moment on Exterior Beams for Double Lanes



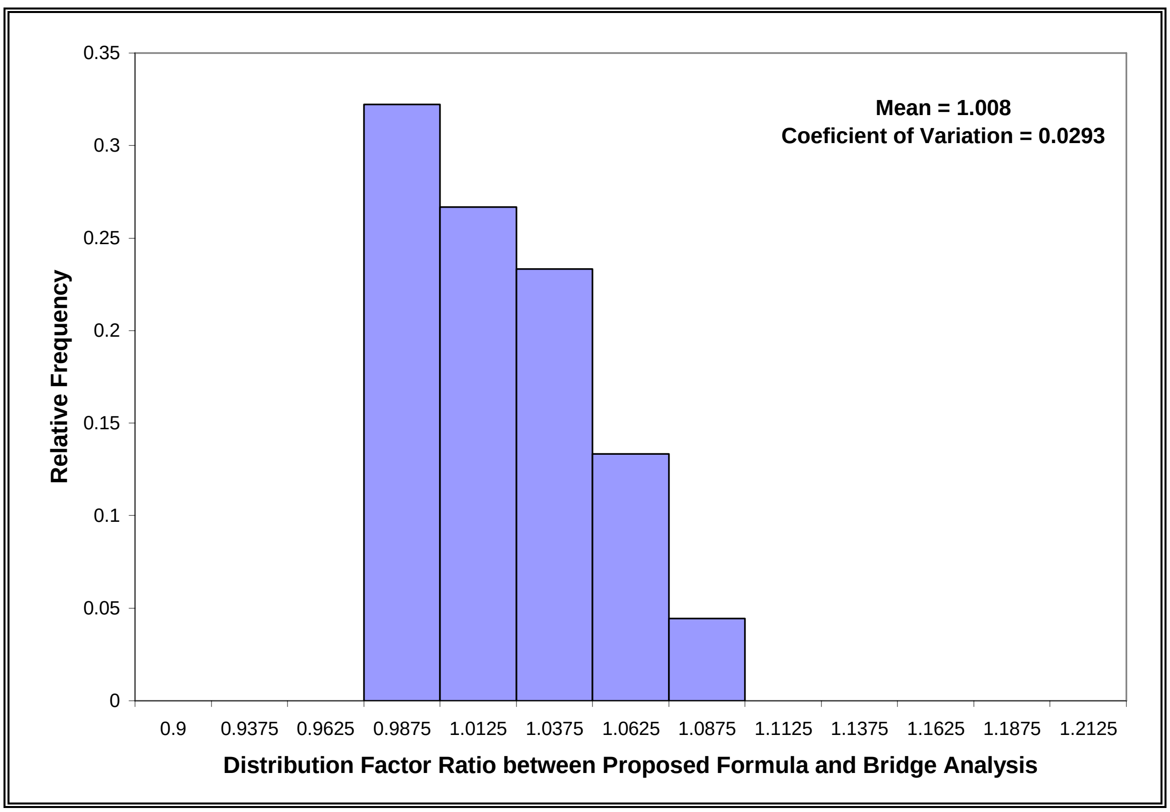
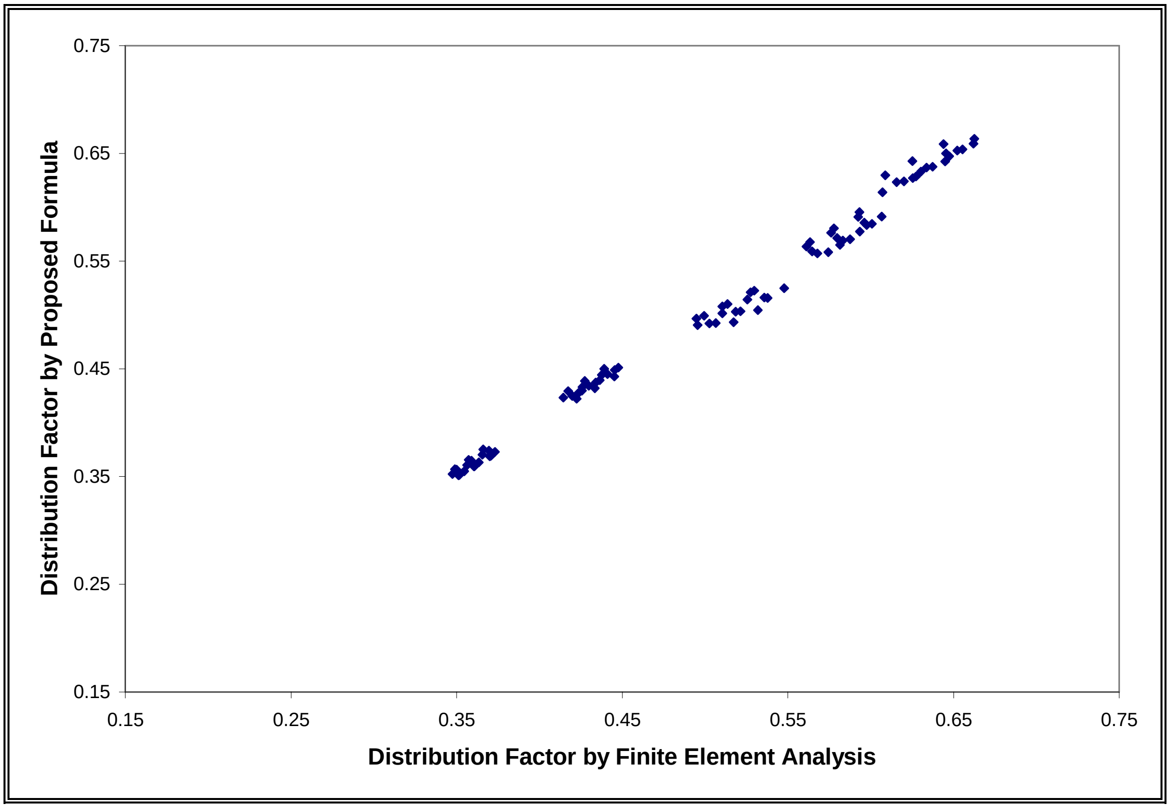


Figure D. 29Comparison of Proposed Formulas and Bridge Analysis for LAVIII, Shear Force on Interior Beams for Single Lane



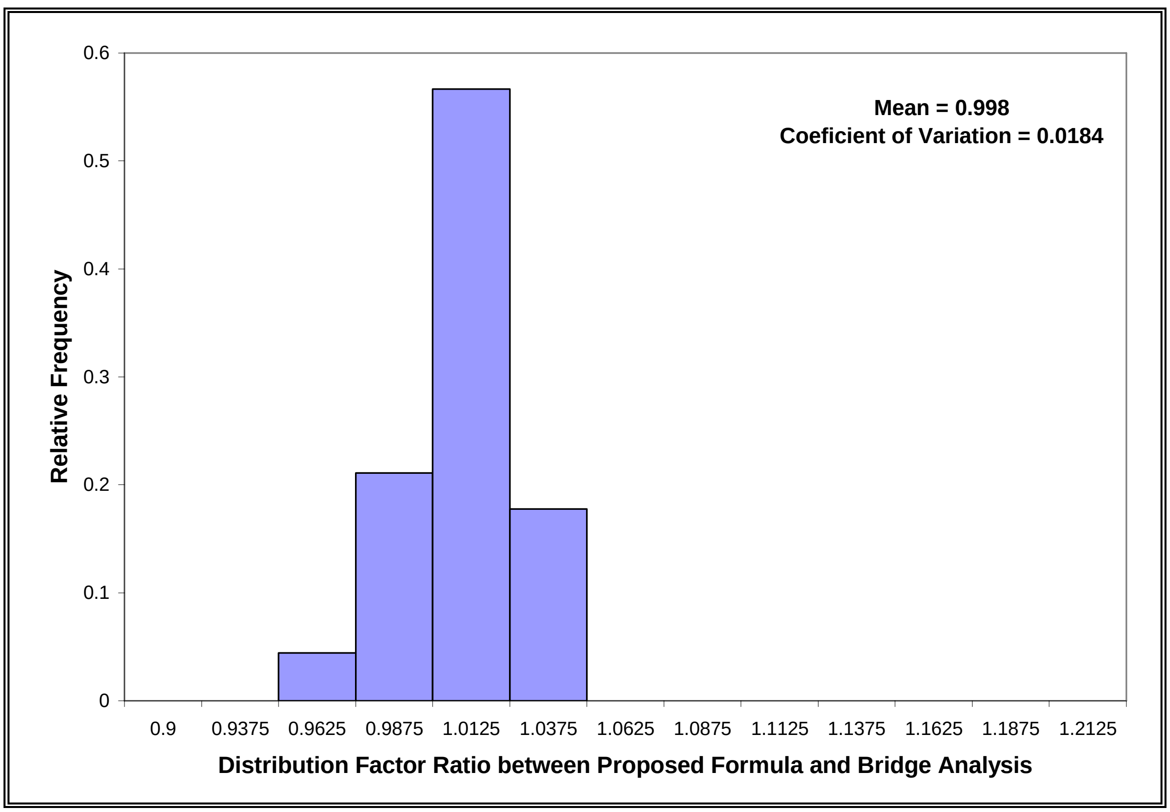
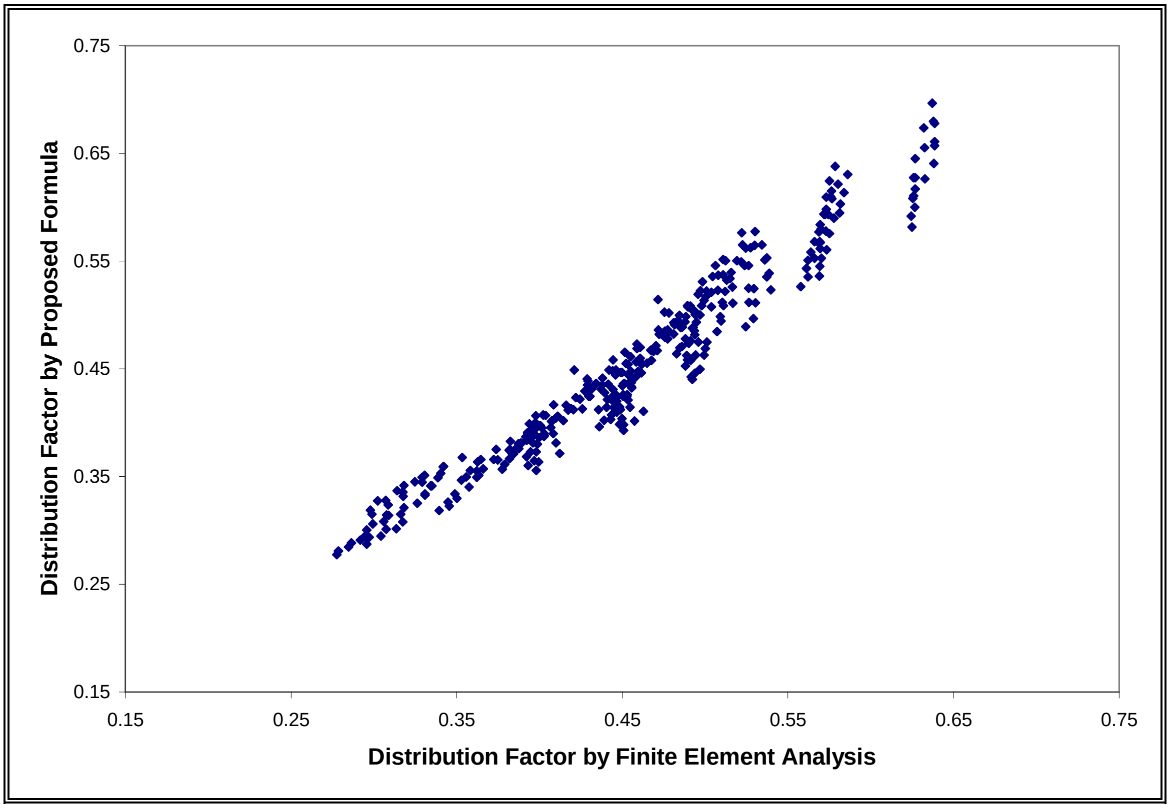


Figure D. 30Comparison of Proposed Formulas and Bridge Analysis for LAVIII, Shear Force on Interior Beams for Double Lanes



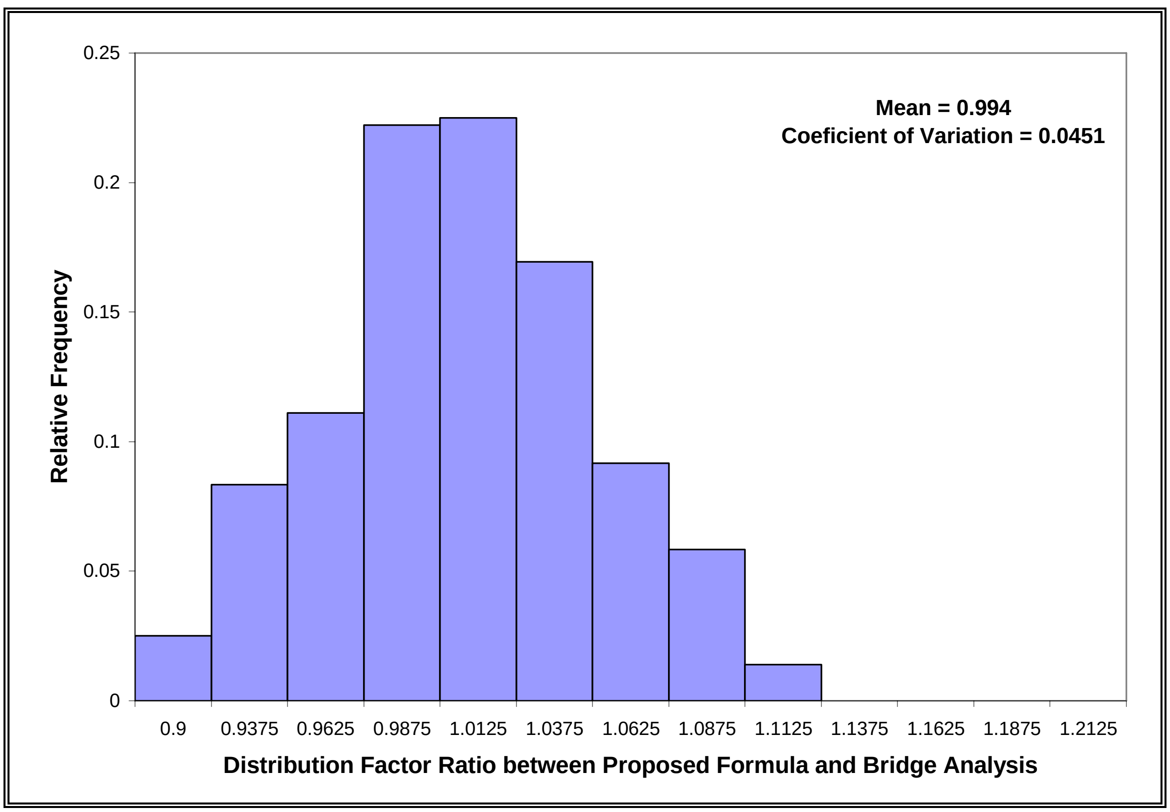
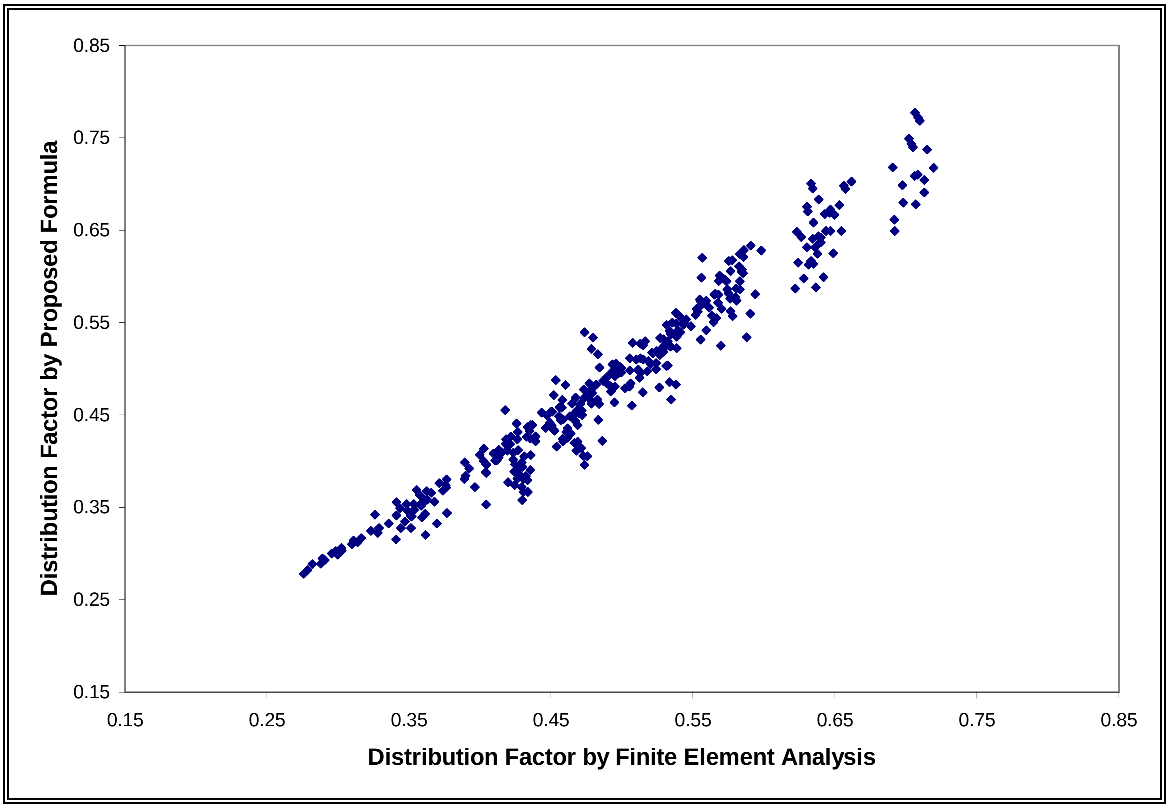


Figure D. 31Comparison of Proposed Formulas and Bridge Analysis for LAVIII, Shear Force on Exterior Beams for Single Lane



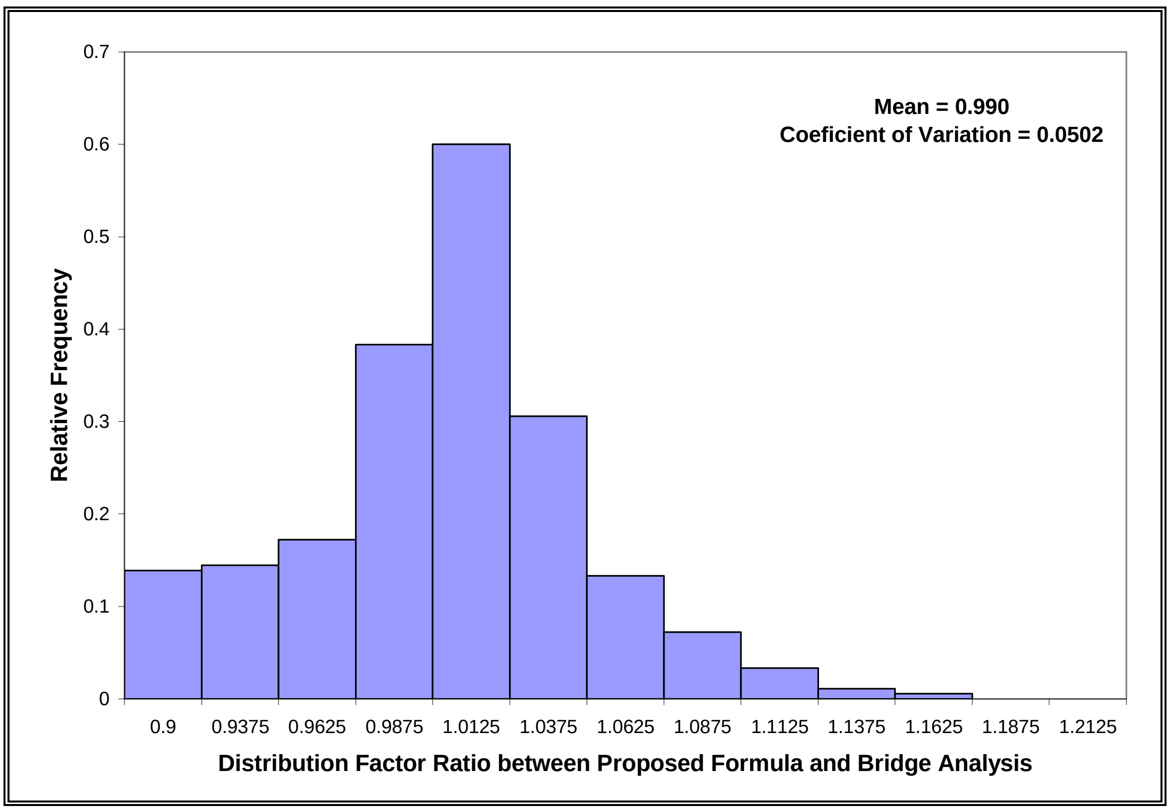
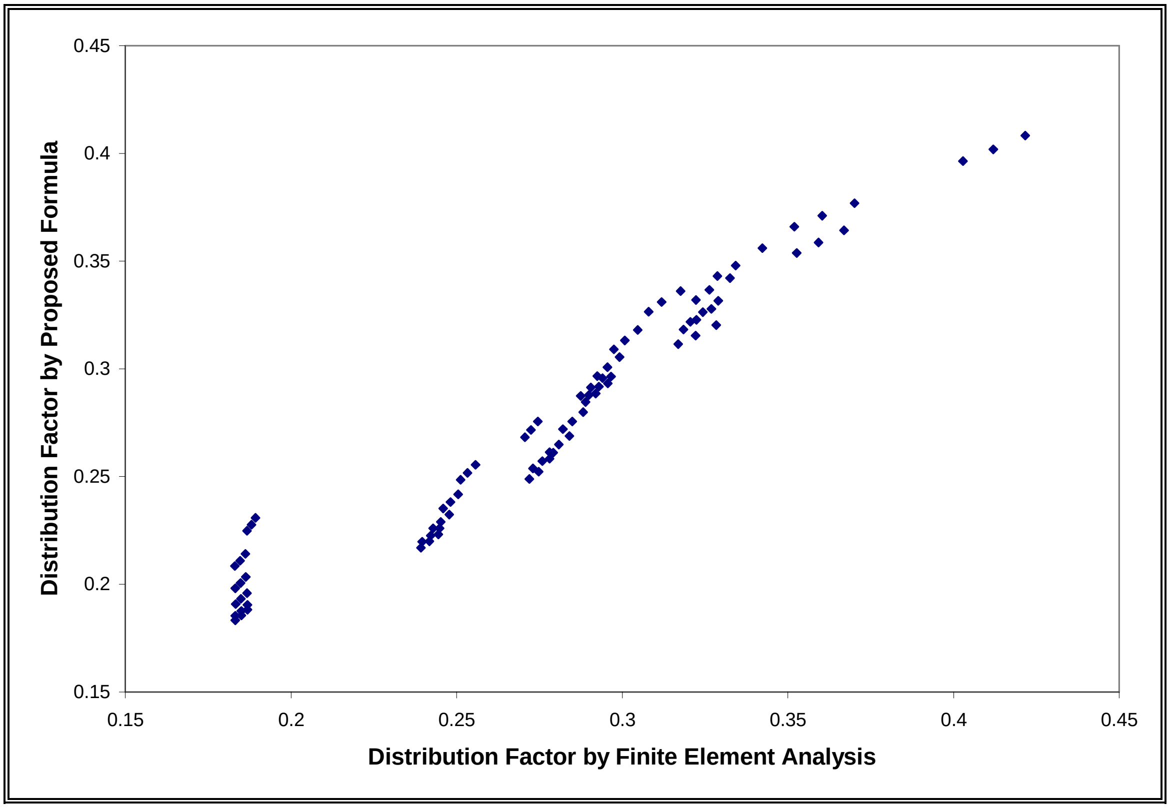


Figure D. 32Comparison of Proposed Formulas and Bridge Analysis for LAVIII, Shear Force on Exterior Beams for Double Lanes



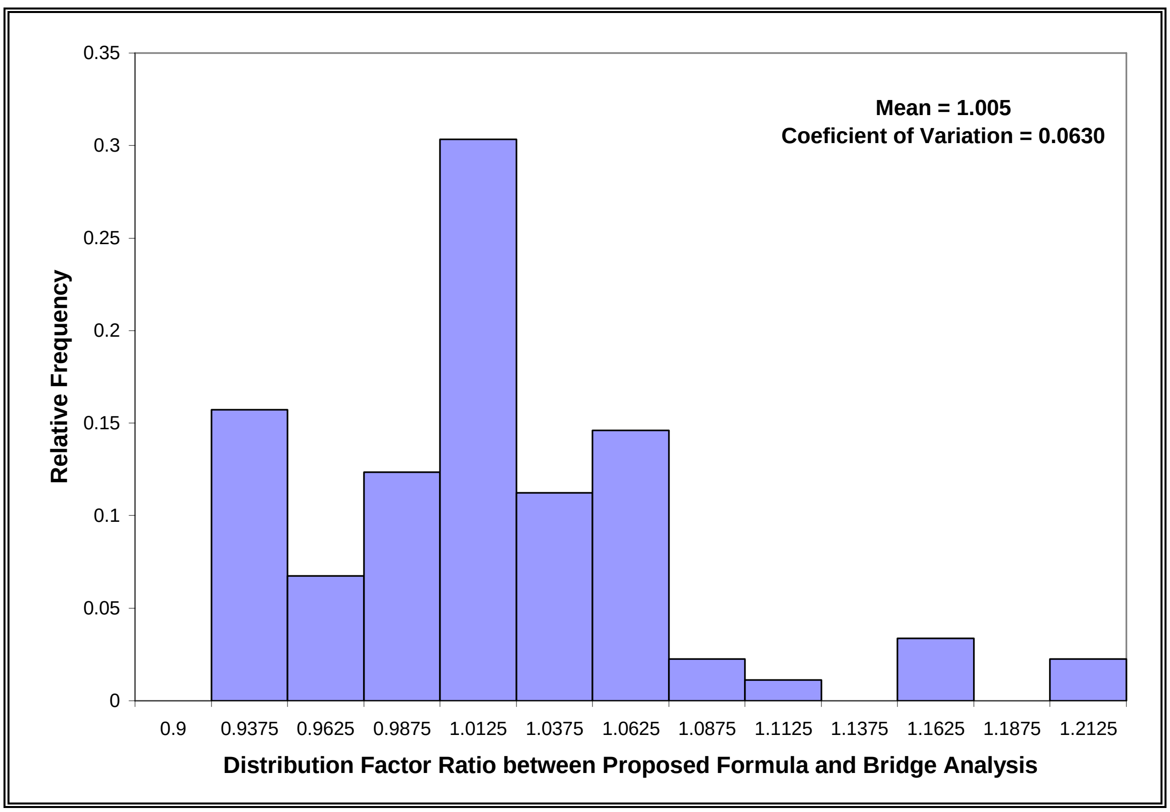
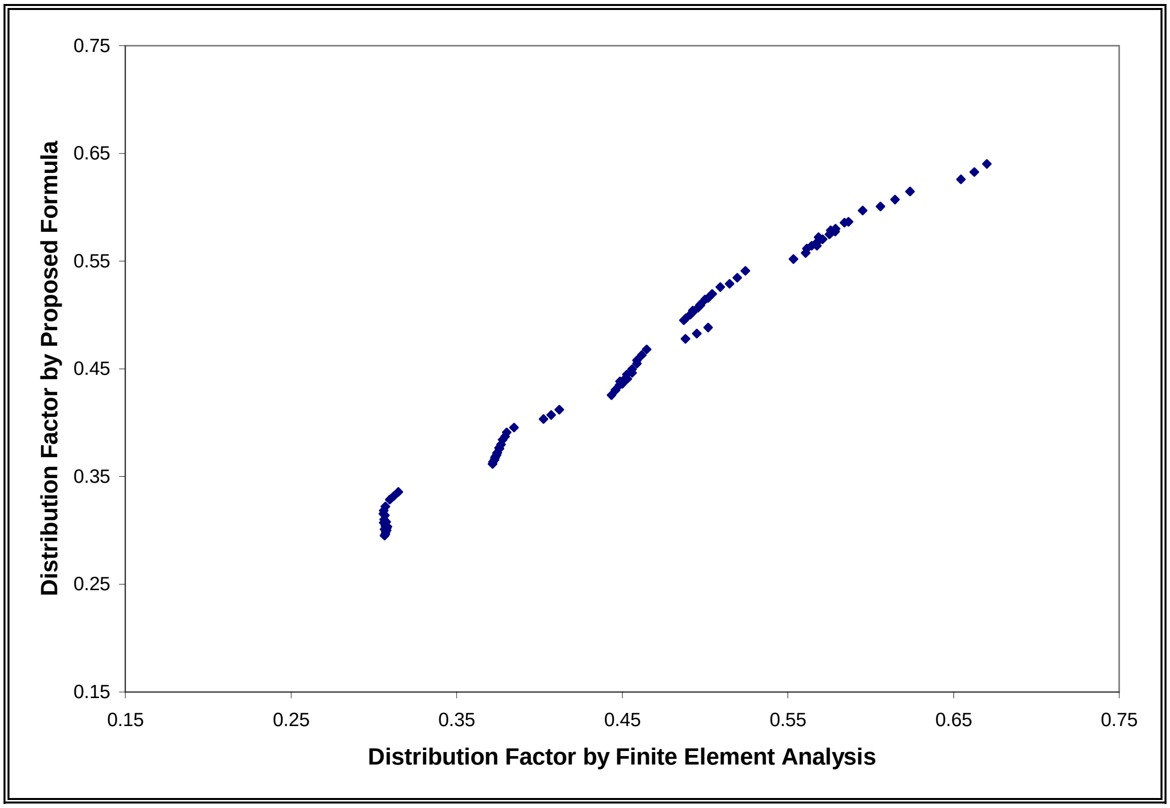


Figure D. 33Comparison of Proposed Formulas and Bridge Analysis for HEMTT, Bending Moment on Interior Beams for Single Lane



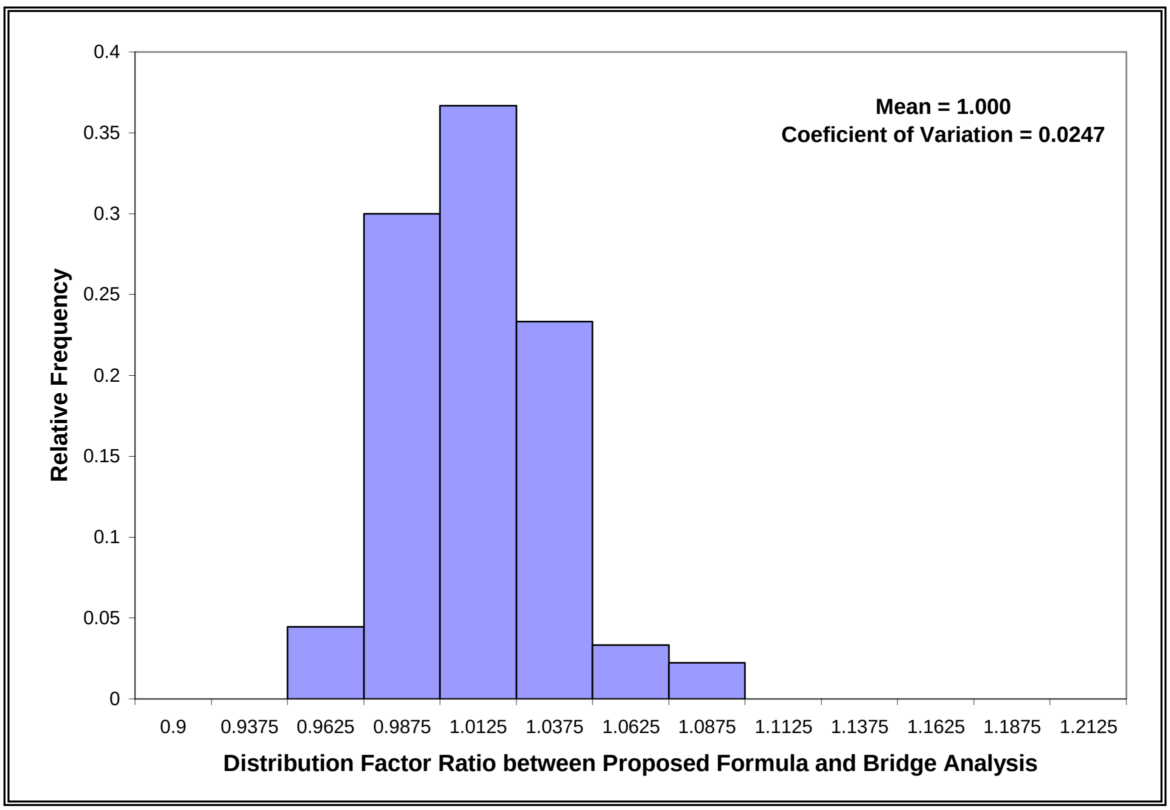
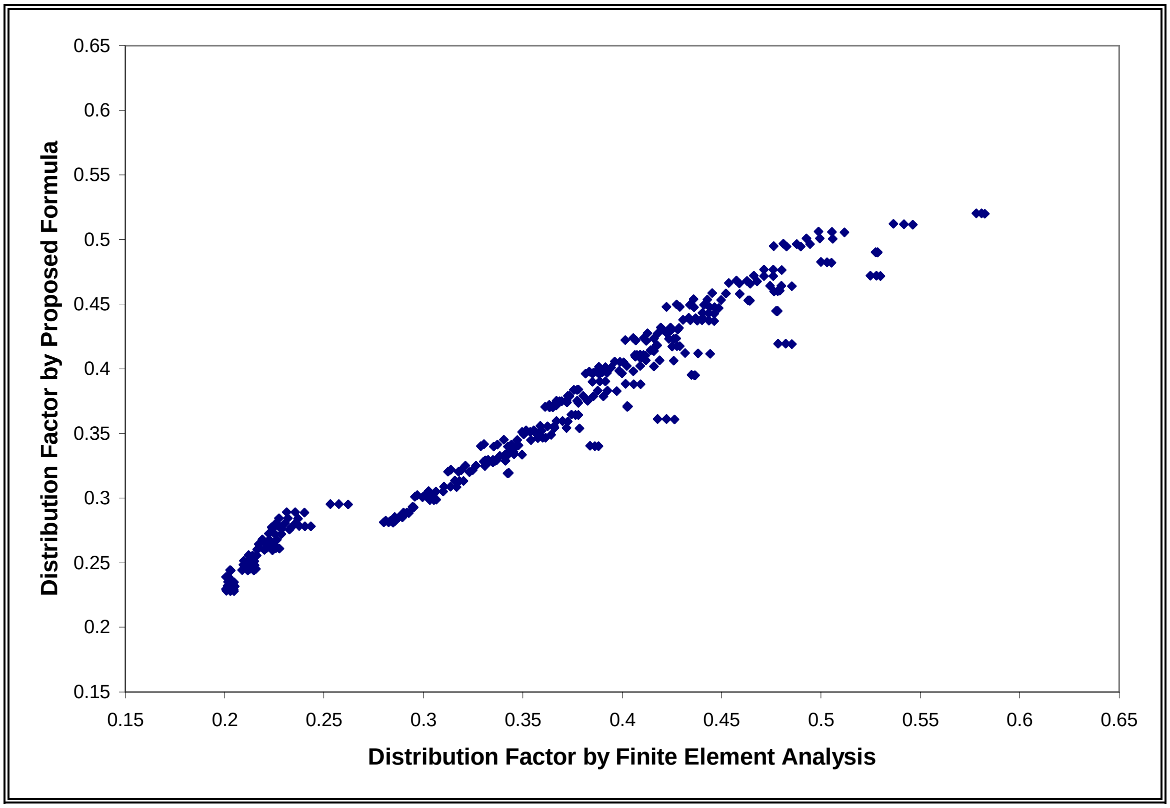


Figure D. 34Comparison of Proposed Formulas and Bridge Analysis for HEMTT, Bending Moment on Interior Beams for Double Lanes



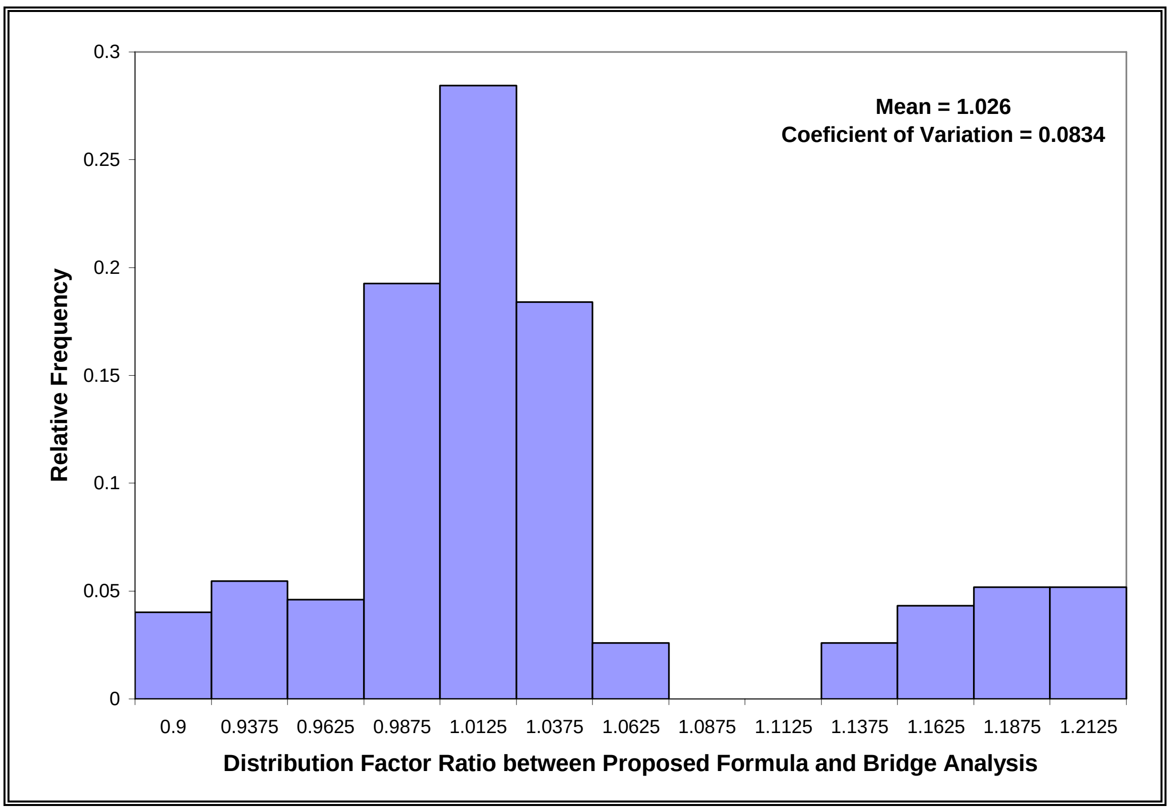
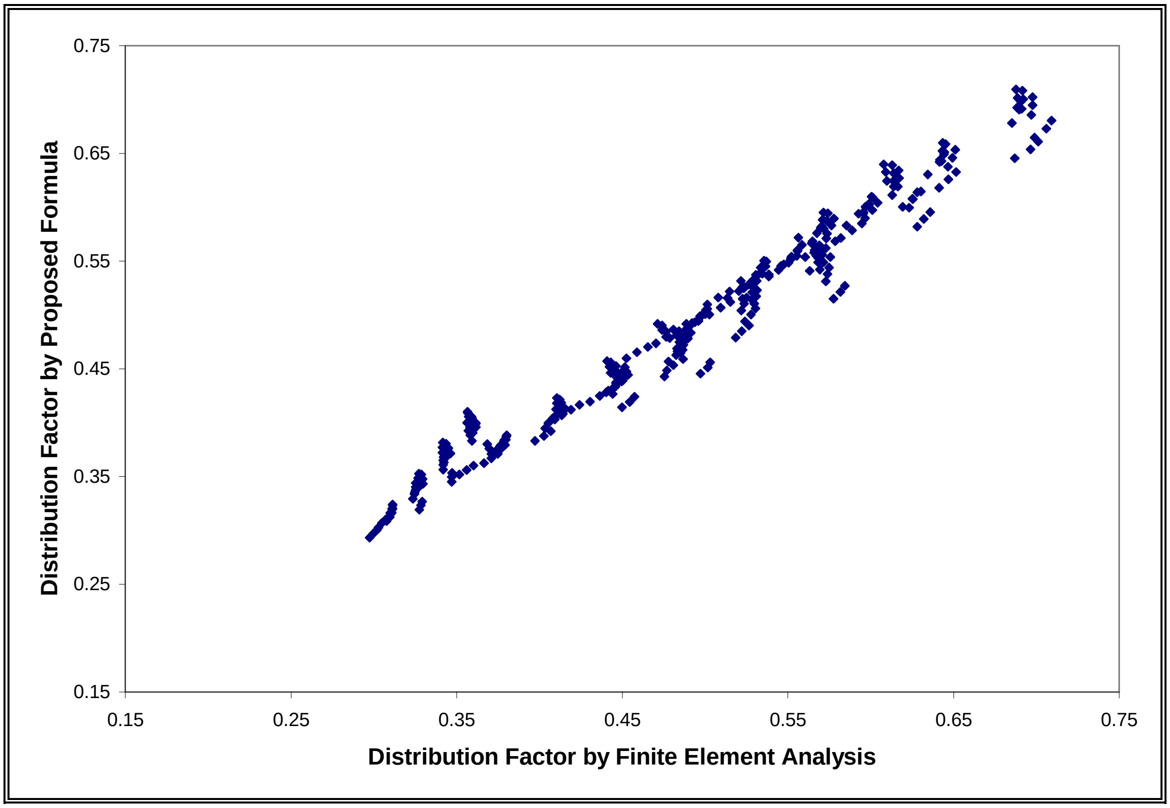


Figure D. 35Comparison of Proposed Formulas and Bridge Analysis for HEMTT, Bending Moment on Exterior Beams for Single Lane



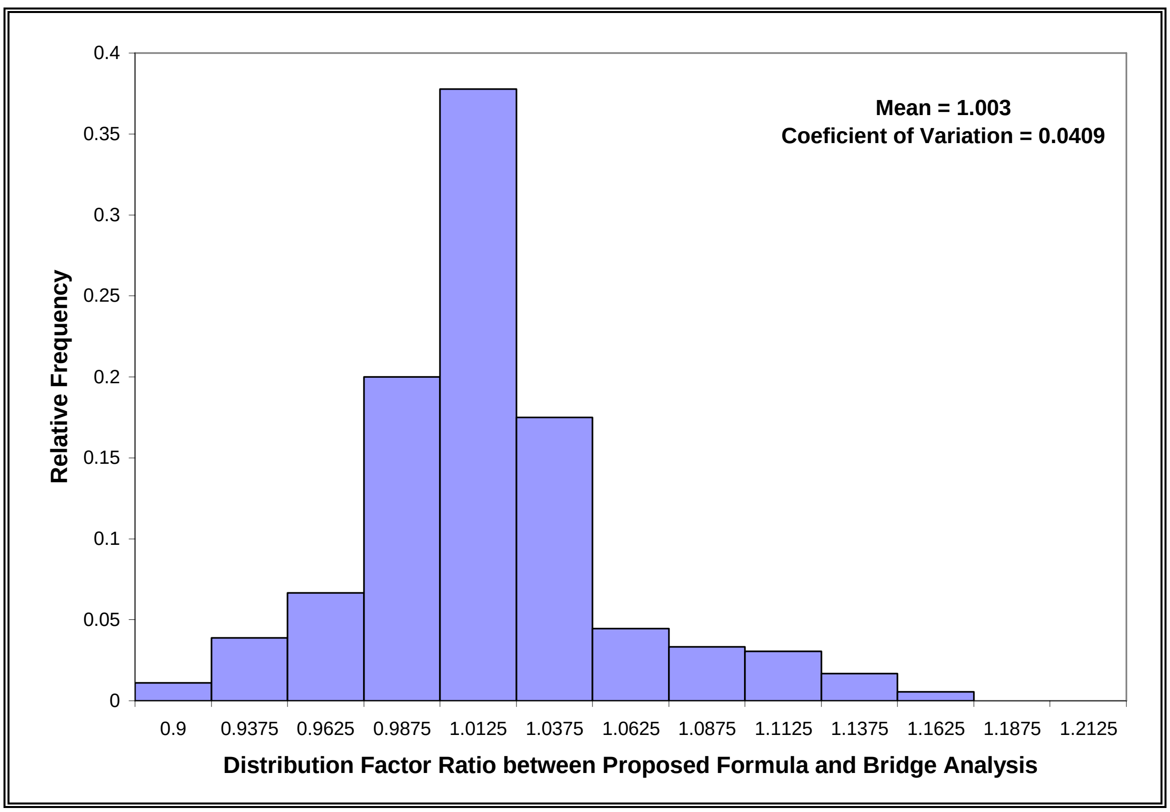
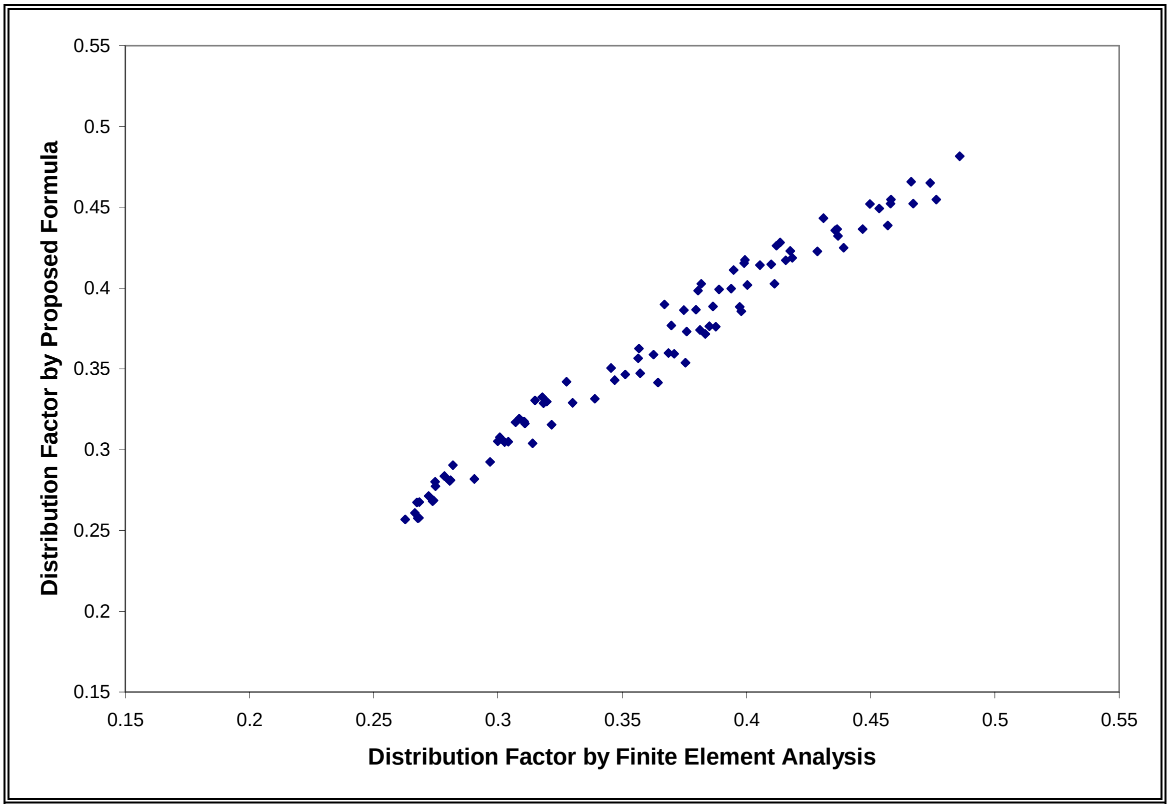


Figure D. 36Comparison of Proposed Formulas and Bridge Analysis for HEMTT, Bending Moment on Exterior Beams for Double Lanes



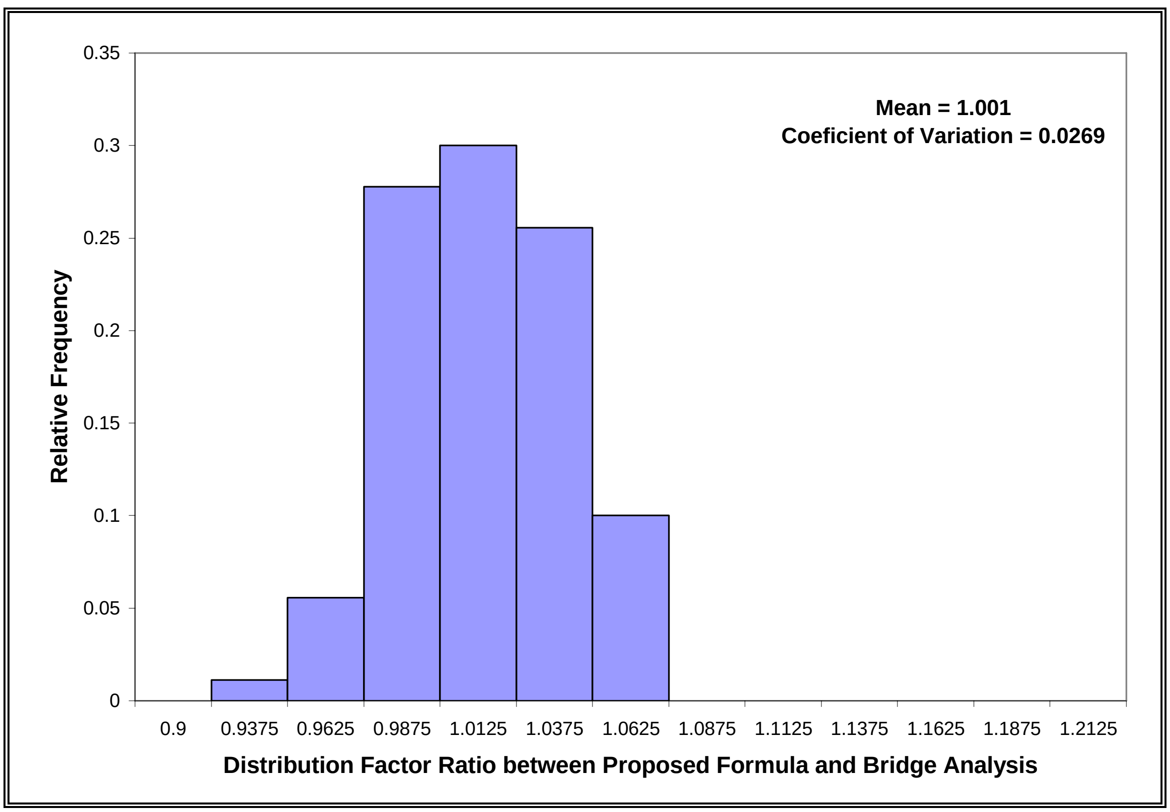


Figure D. 37Comparison of Proposed Formulas and Bridge Analysis for HEMTT, Shear Force on Interior Beams for Single Lane

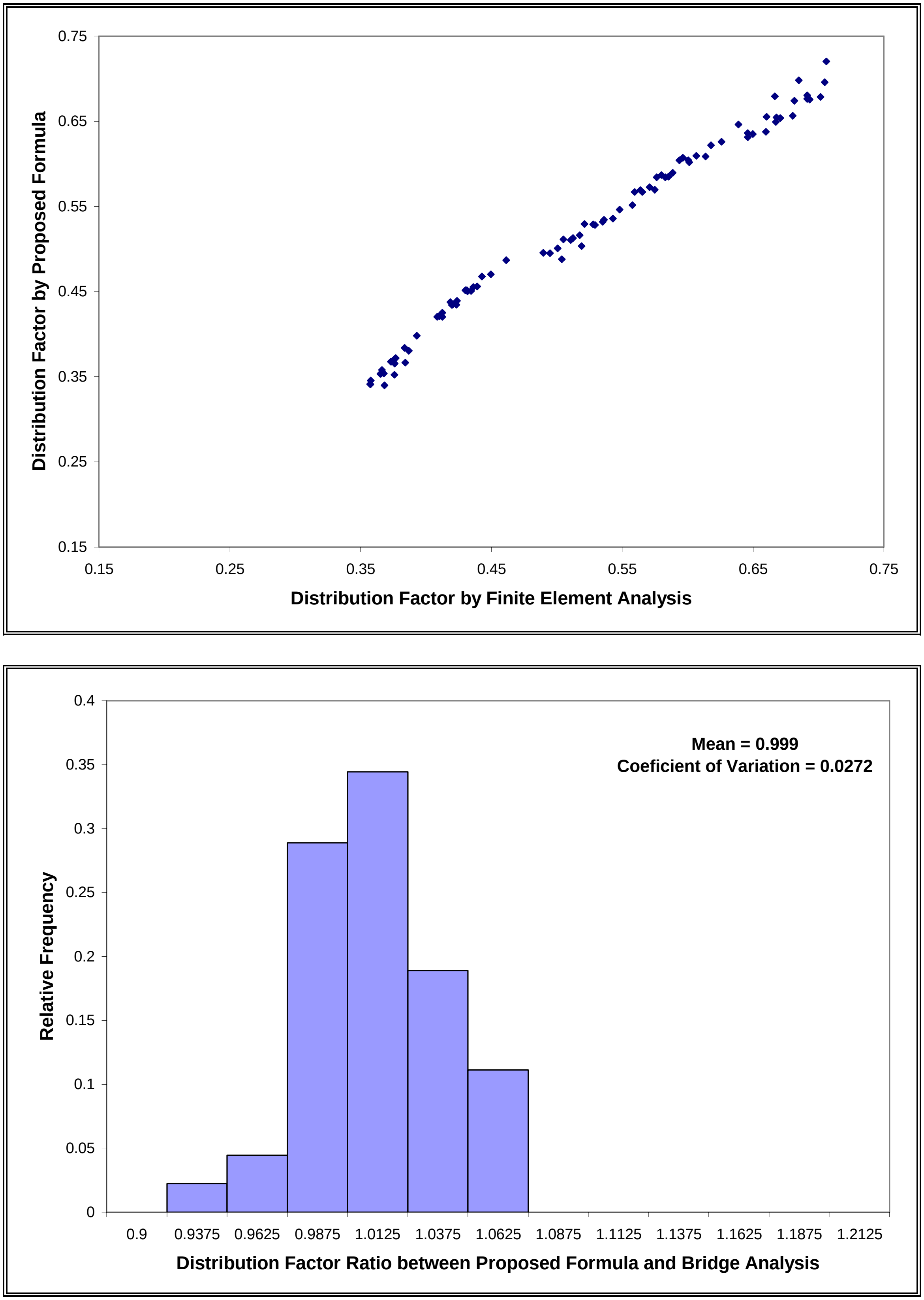
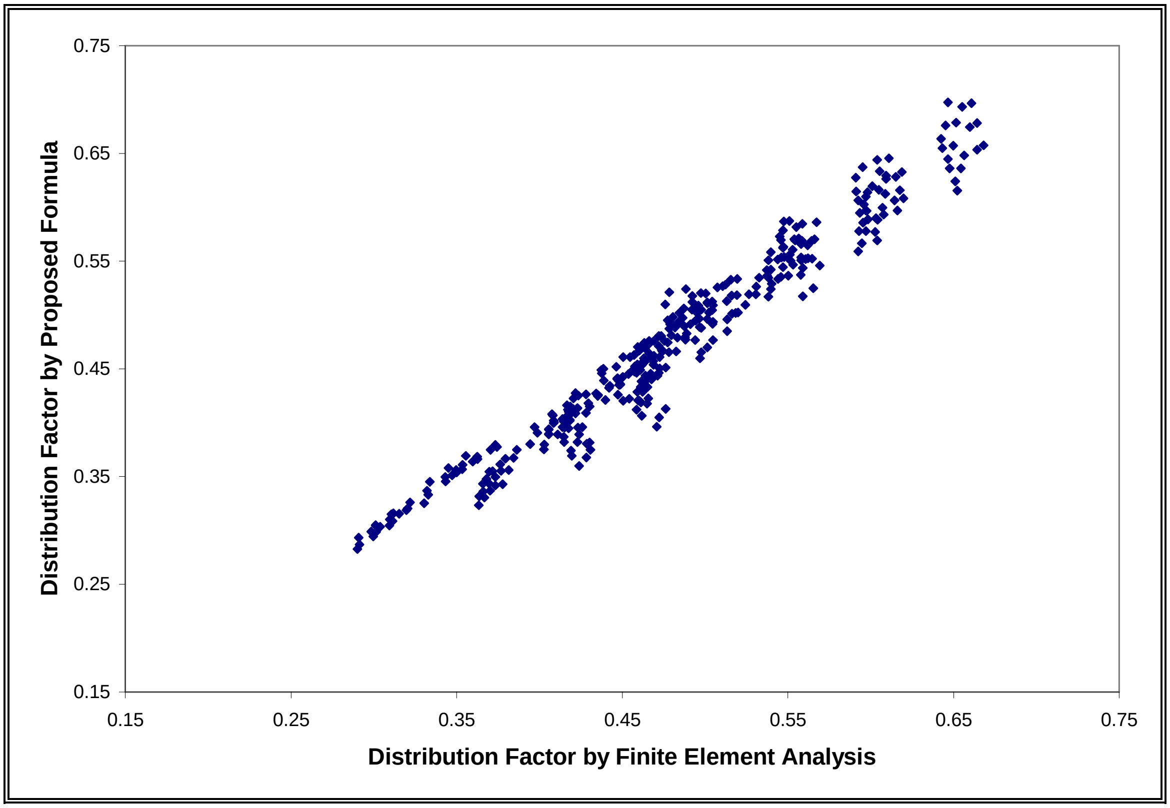


Figure D. 38Comparison of Proposed Formulas and Bridge Analysis for HEMTT, Shear Force on Interior Beams for Double Lanes



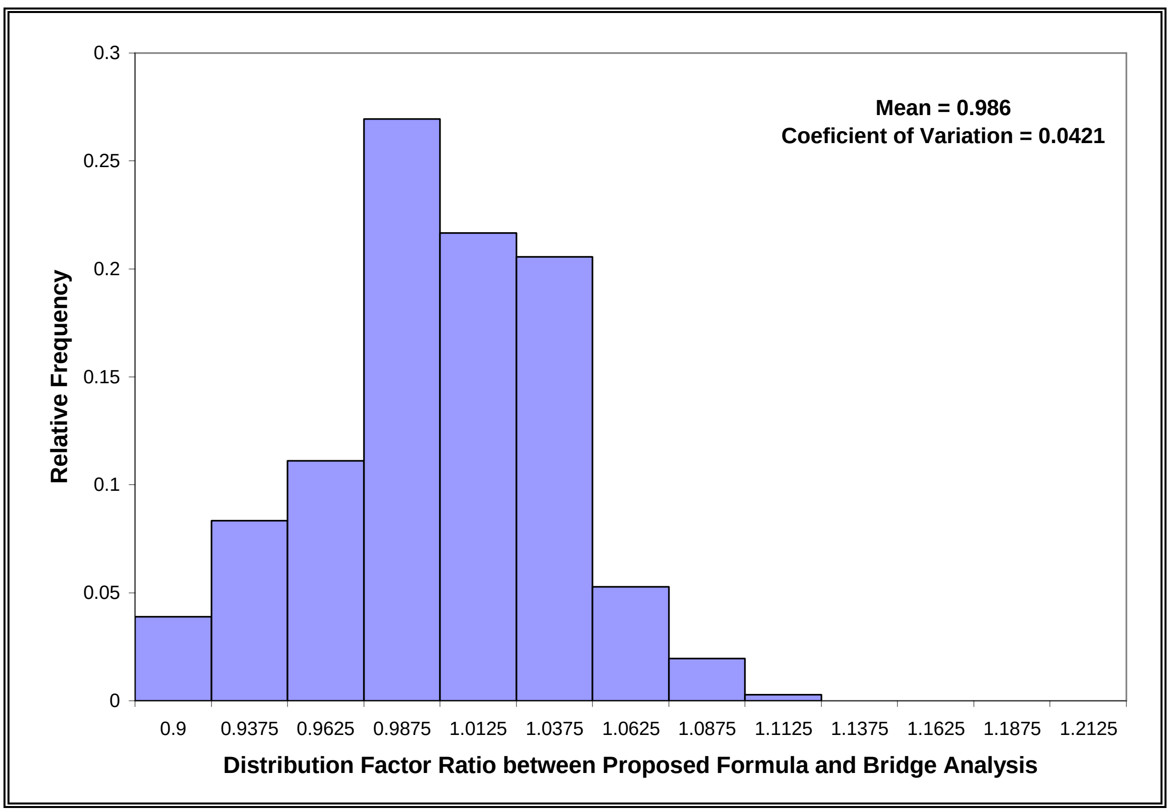
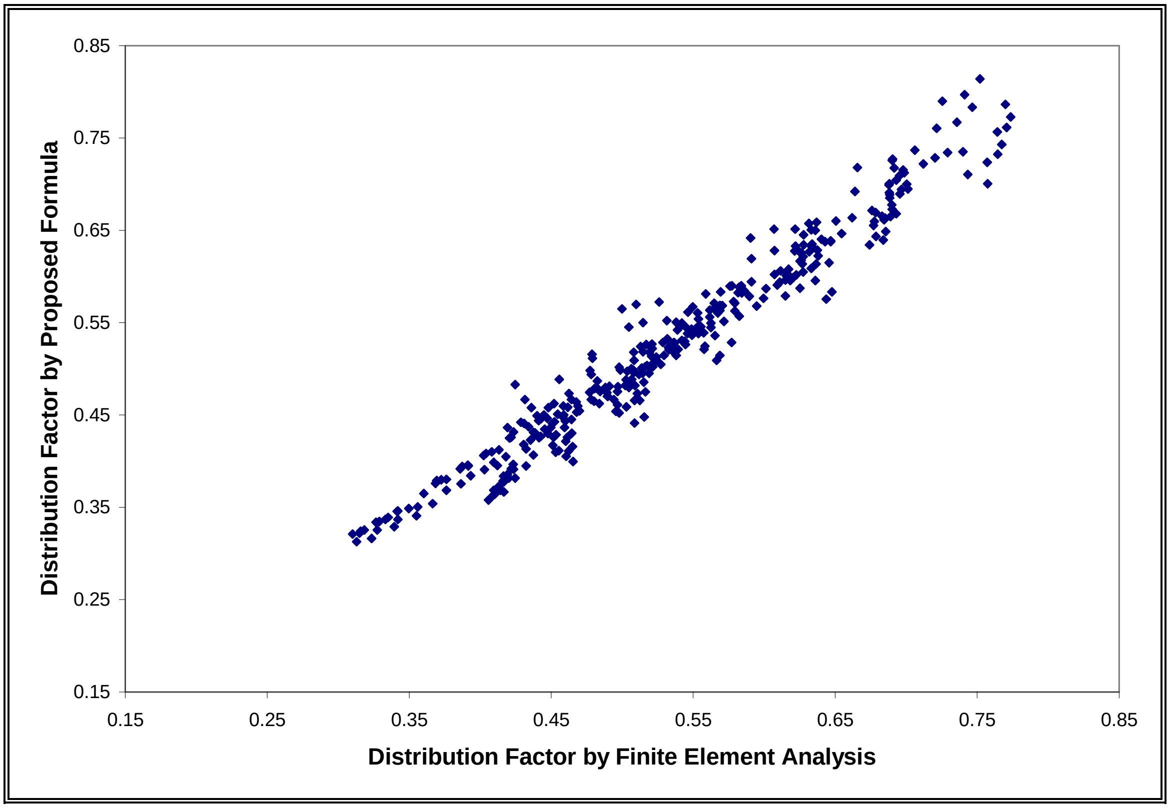


Figure D. 39Comparison of Proposed Formulas and Bridge Analysis for HEMTT, Shear Force on Exterior Beams for Single Lane



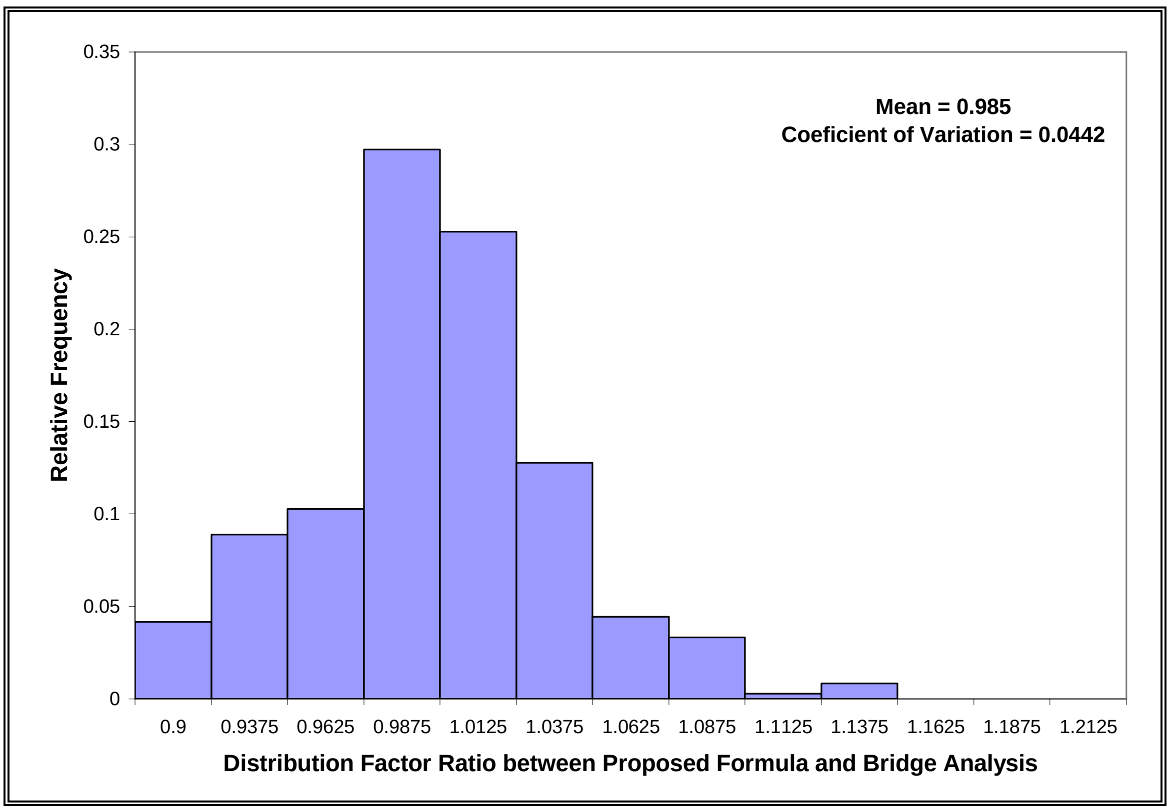
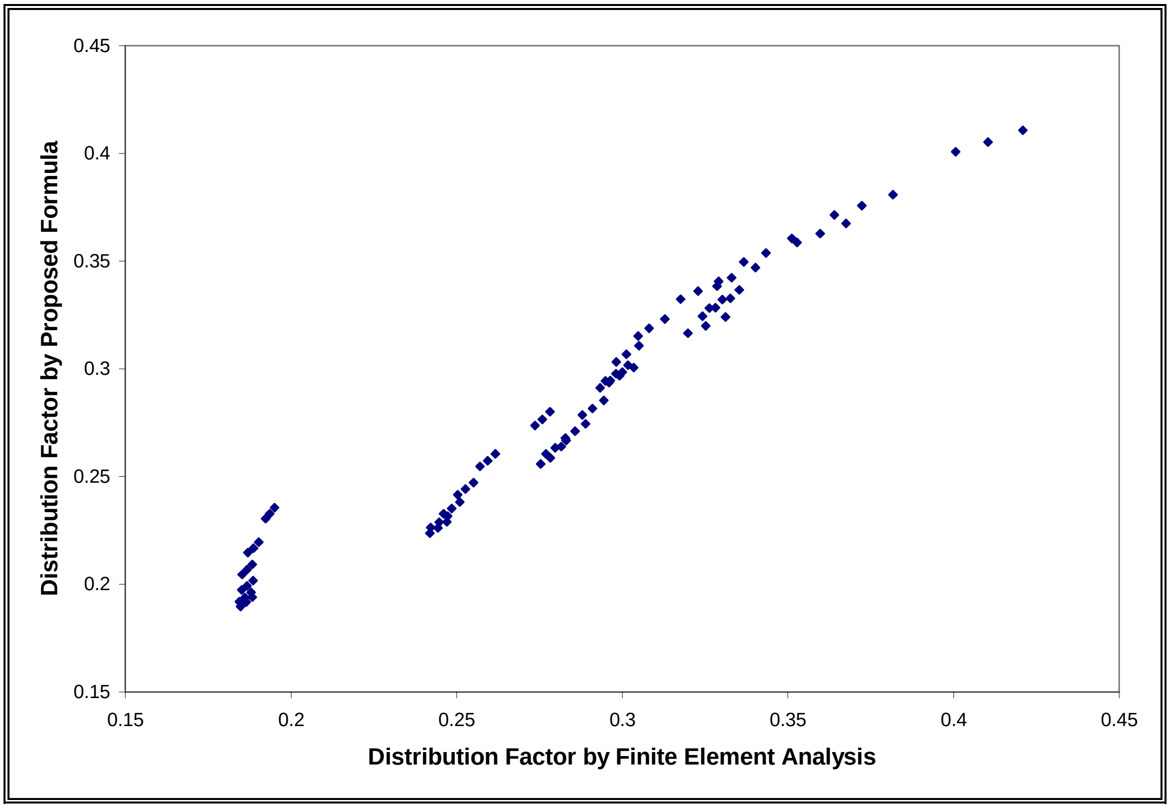


Figure D. 40Comparison of Proposed Formulas and Bridge Analysis for HEMTT, Shear Force on Exterior Beams for Double Lanes



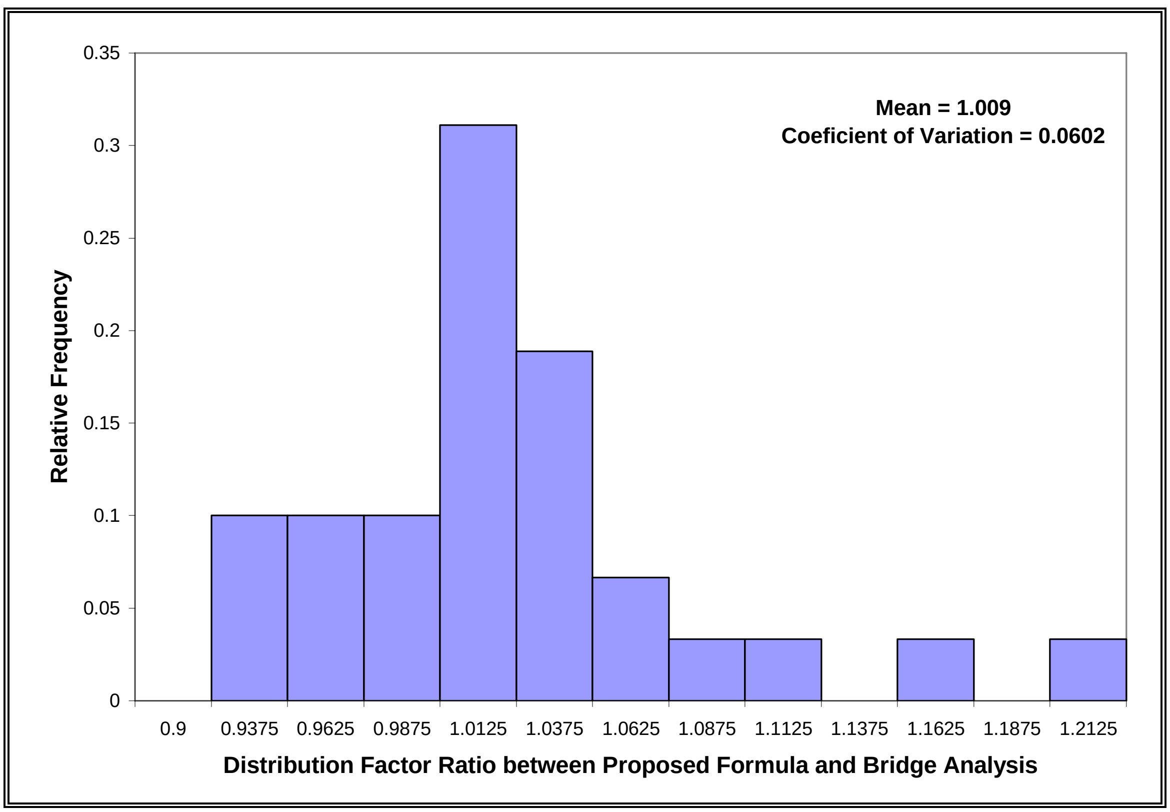
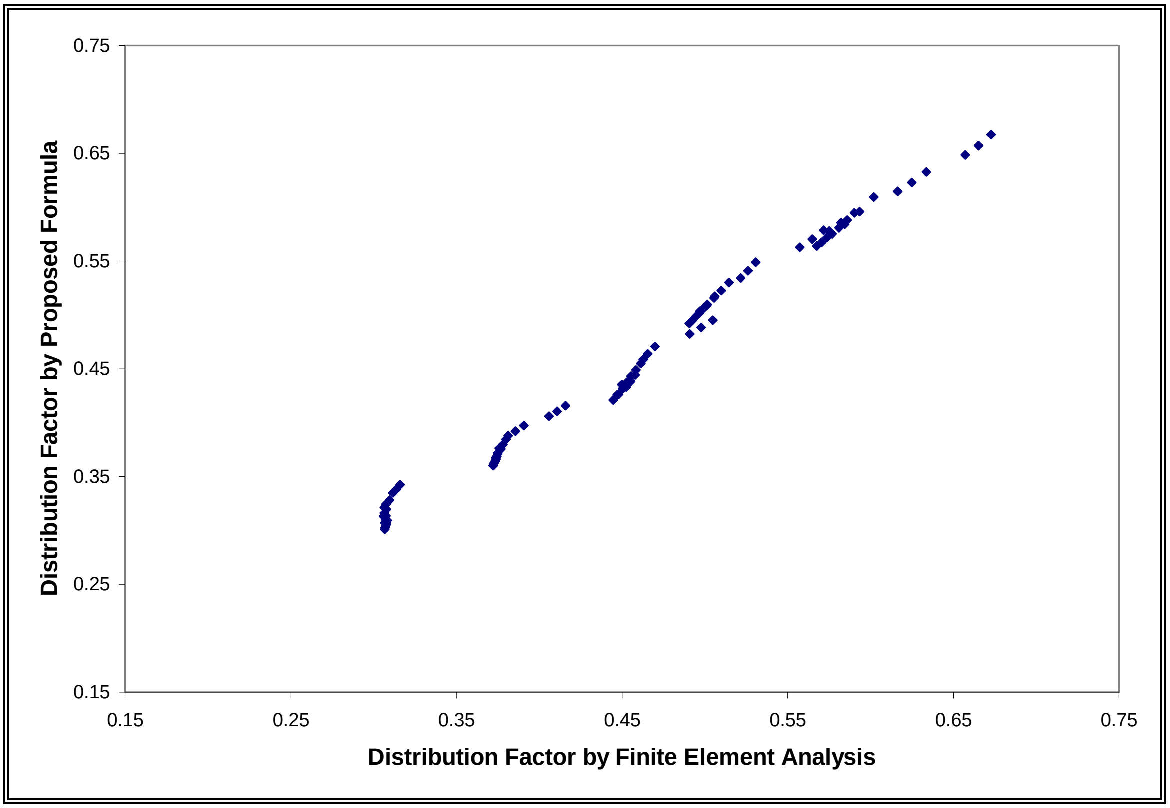


Figure D. 41Comparison of Proposed Formulas and Bridge Analysis for PLS, Bending Moment on Interior Beams for Single Lane



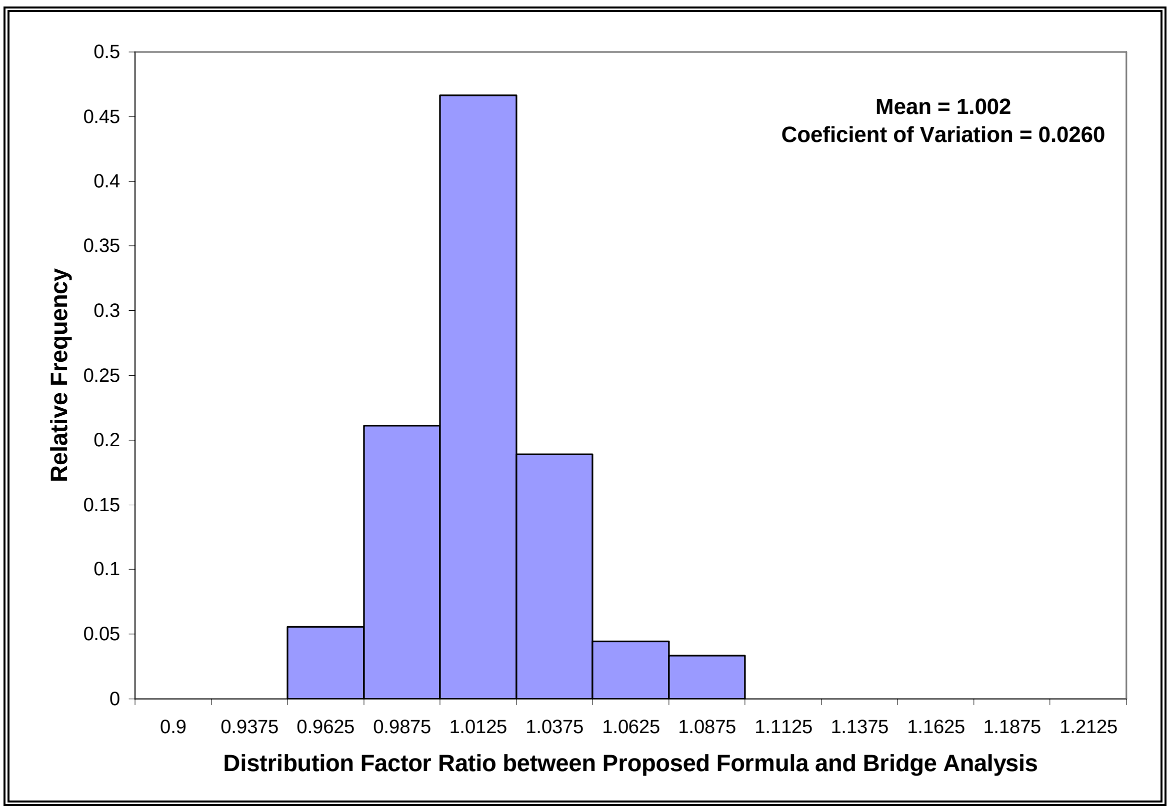
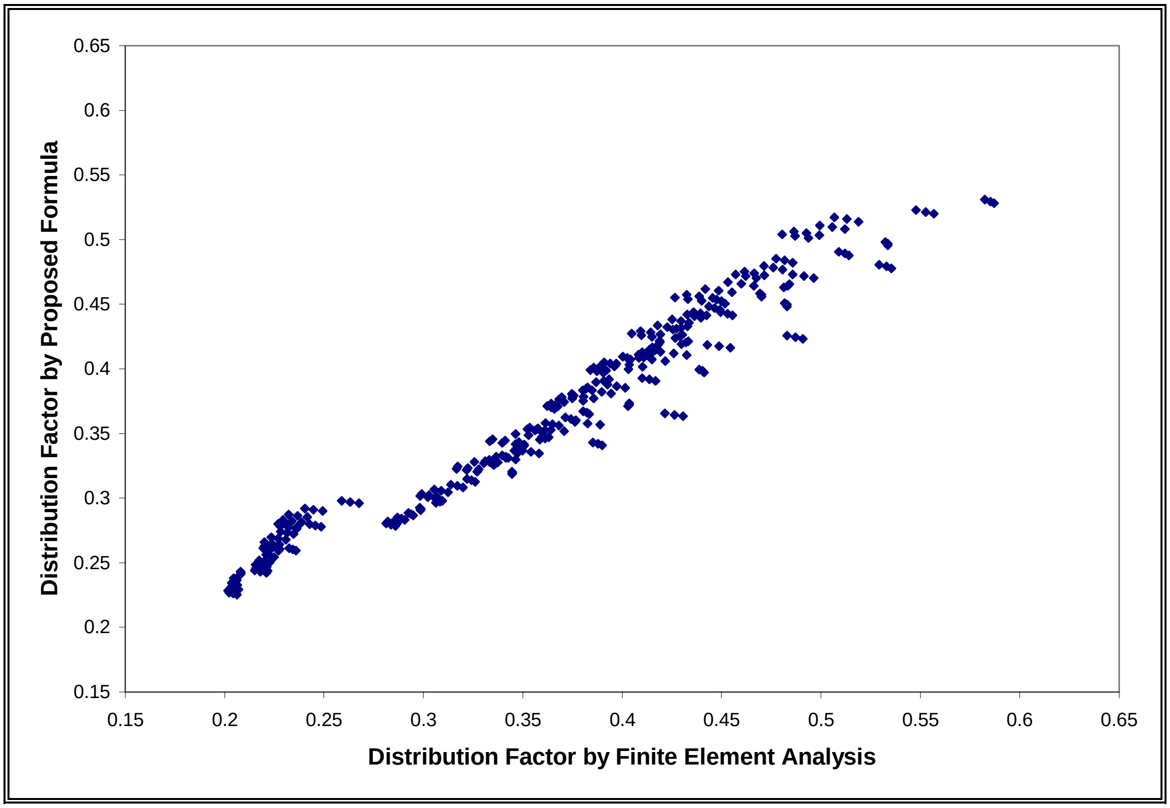


Figure D. 42Comparison of Proposed Formulas and Bridge Analysis for PLS, Bending Moment on Interior Beams for Double Lanes



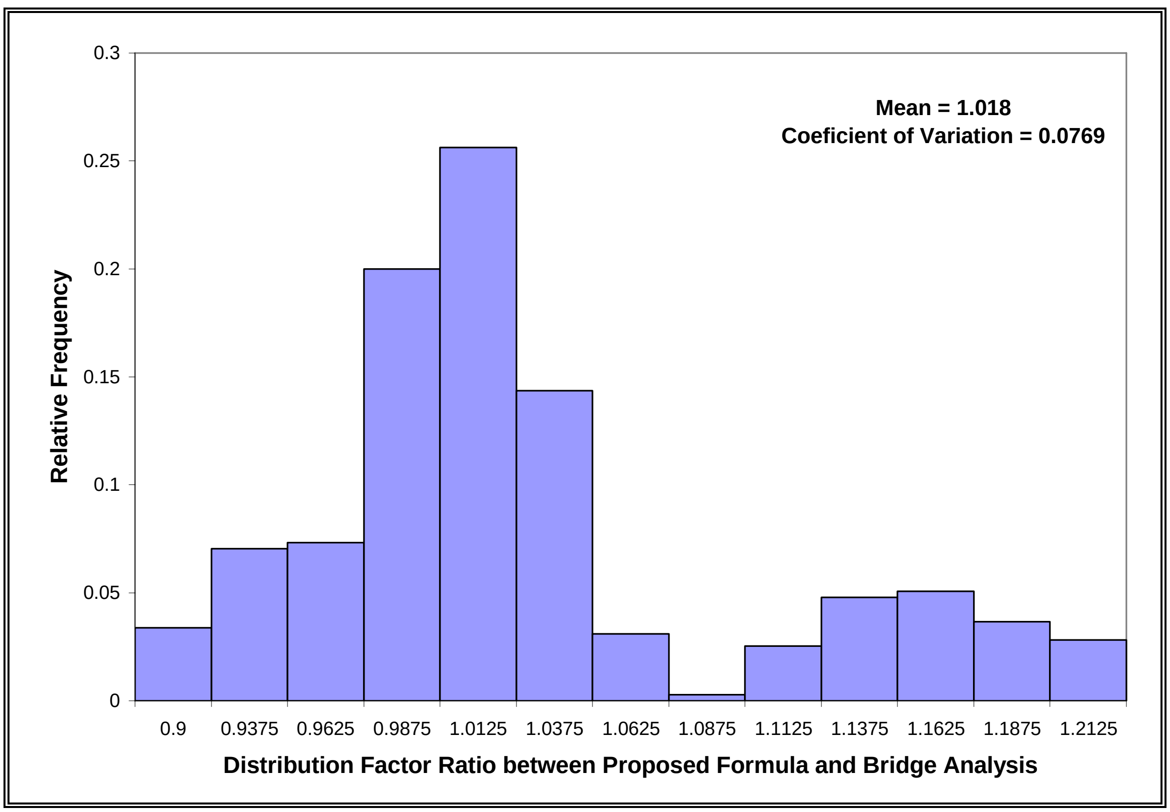
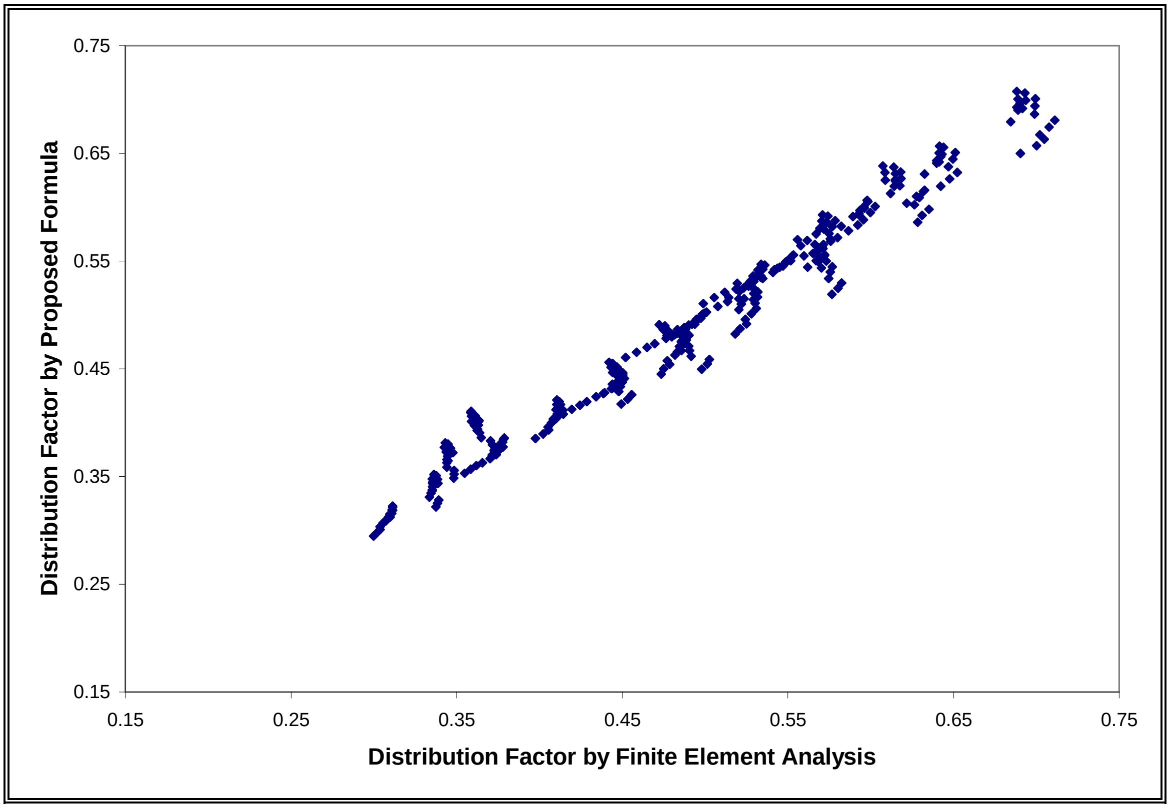


Figure D. 43Comparison of Proposed Formulas and Bridge Analysis for PLS, Bending Moment on Exterior Beams for Single Lane



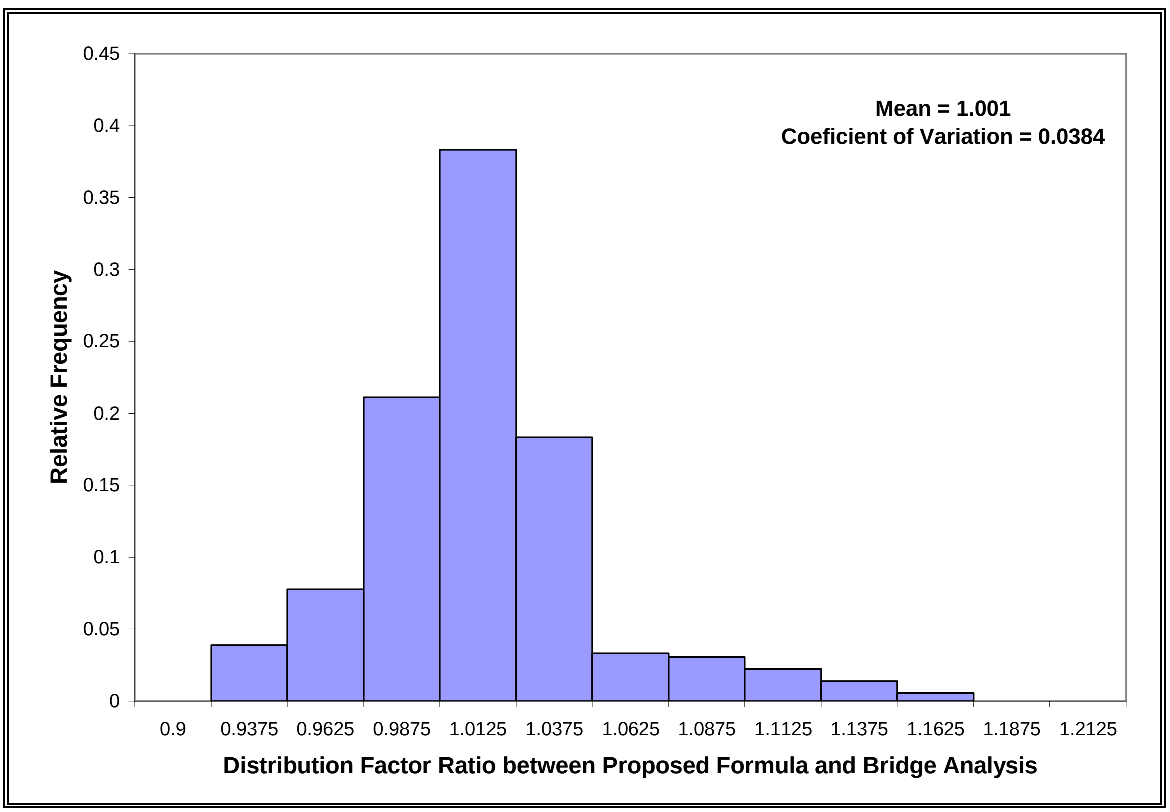
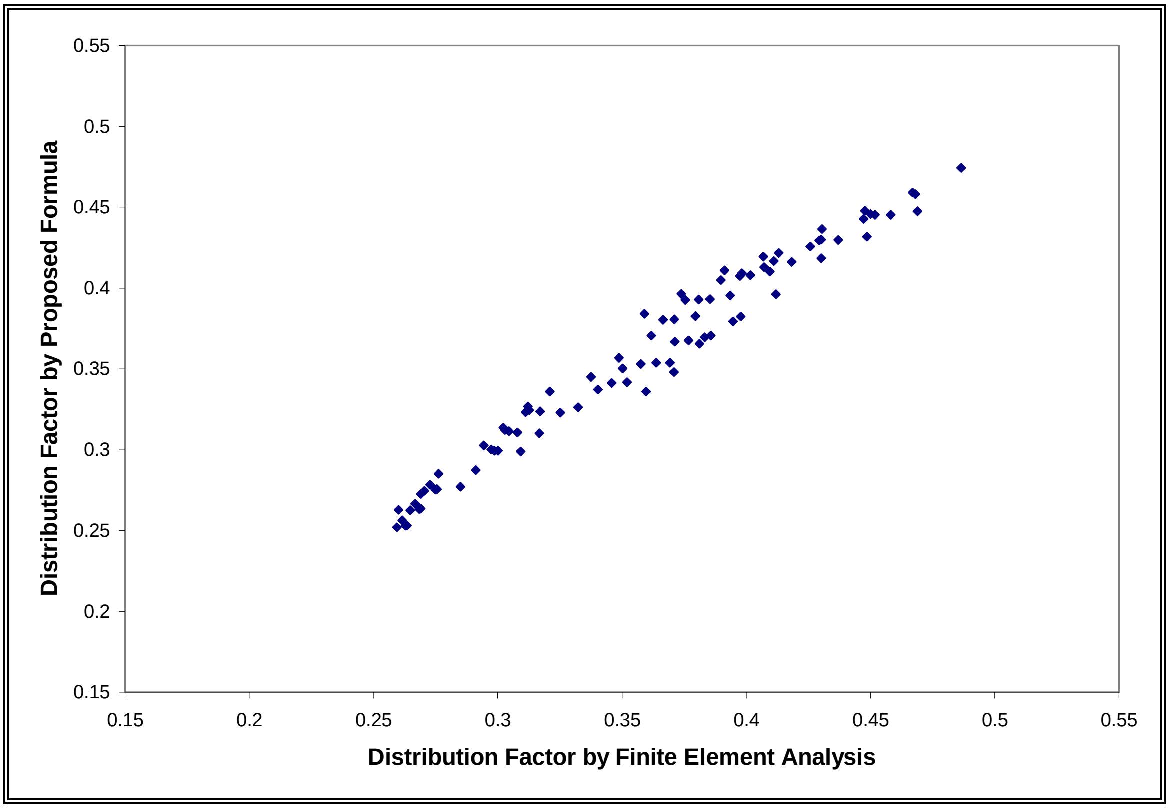


Figure D. 44Comparison of Proposed Formulas and Bridge Analysis for PLS, Bending Moment on Exterior Beams for Double Lanes



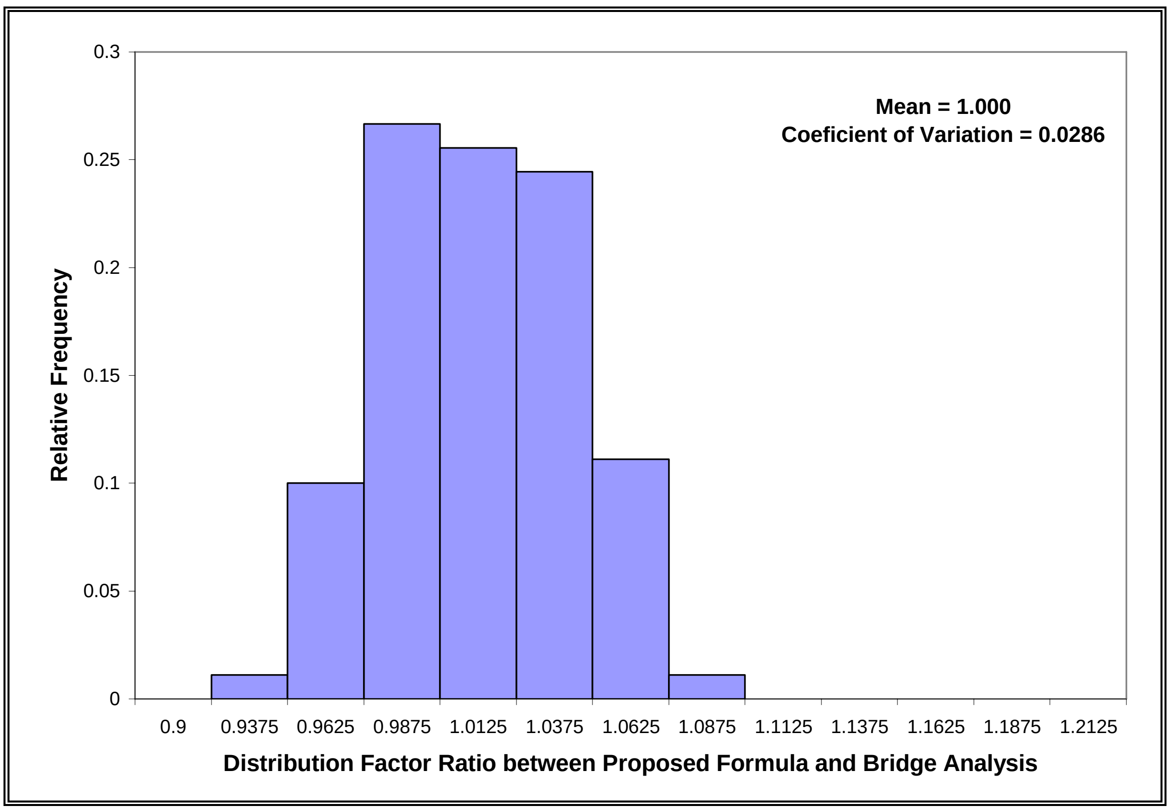
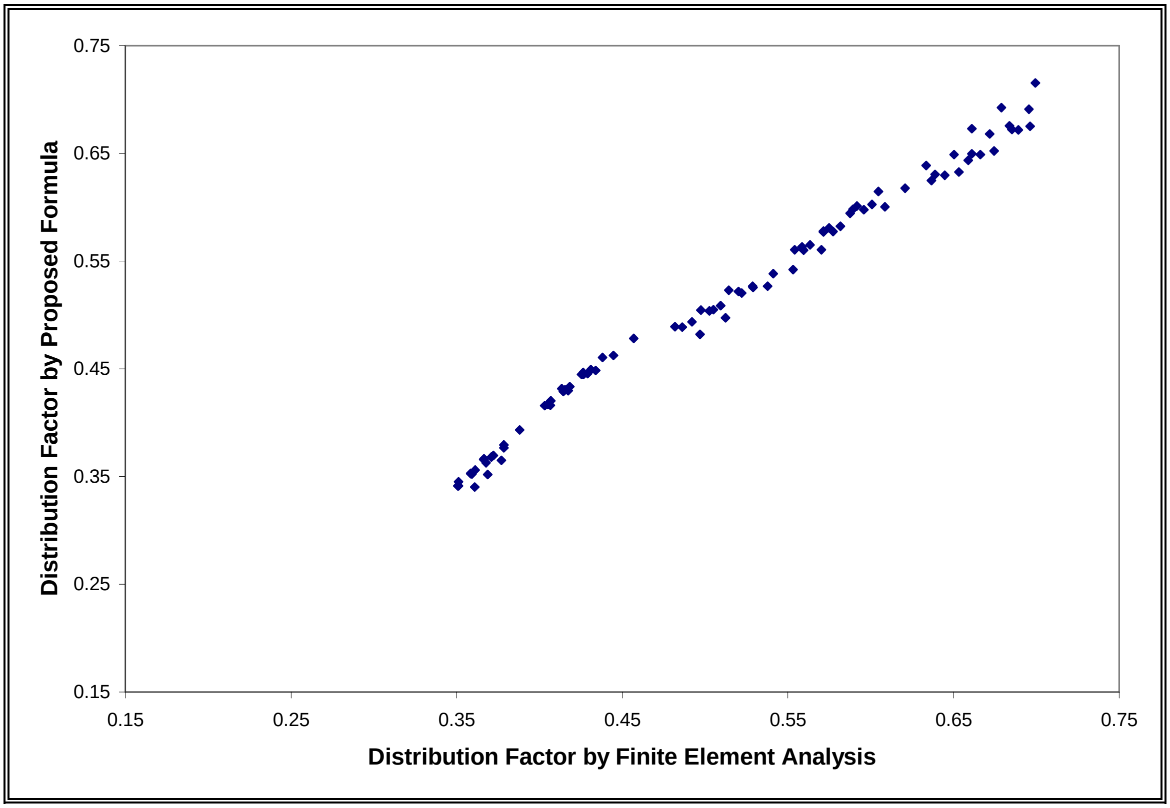


Figure D. 45Comparison of Proposed Formulas and Bridge Analysis for PLS, Shear Force on Interior Beams for Single Lane



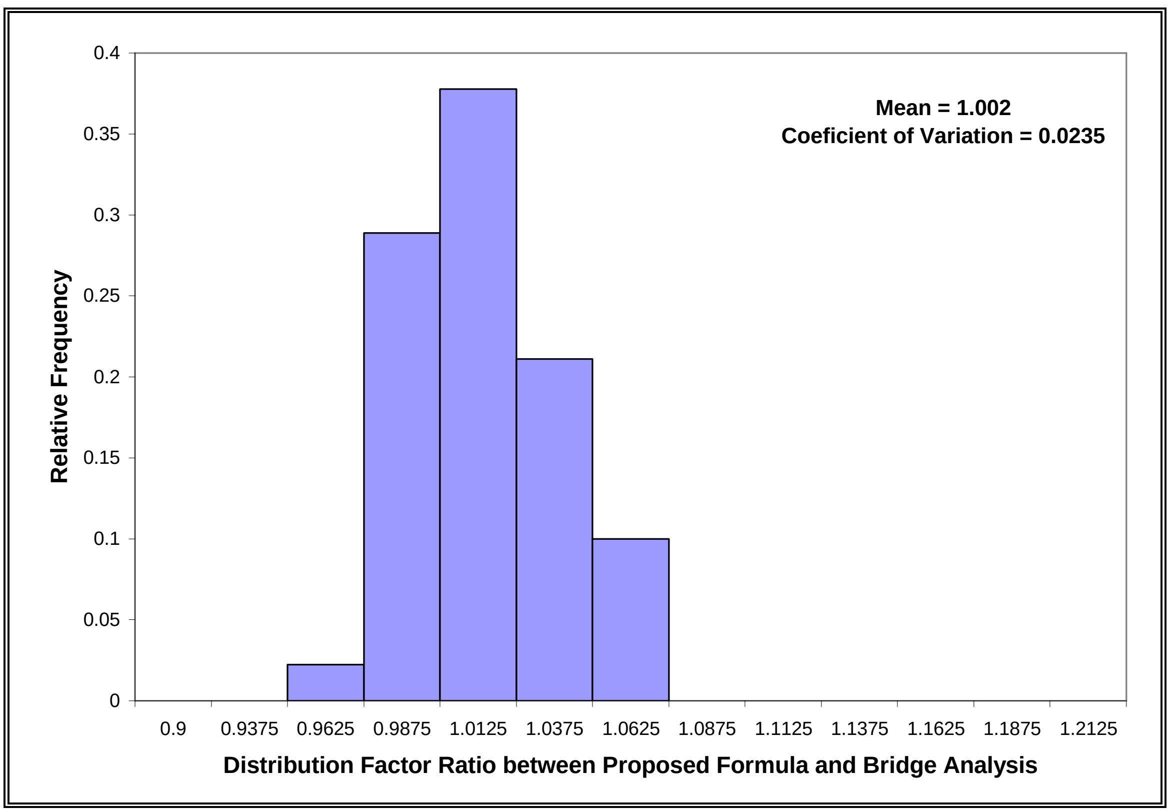
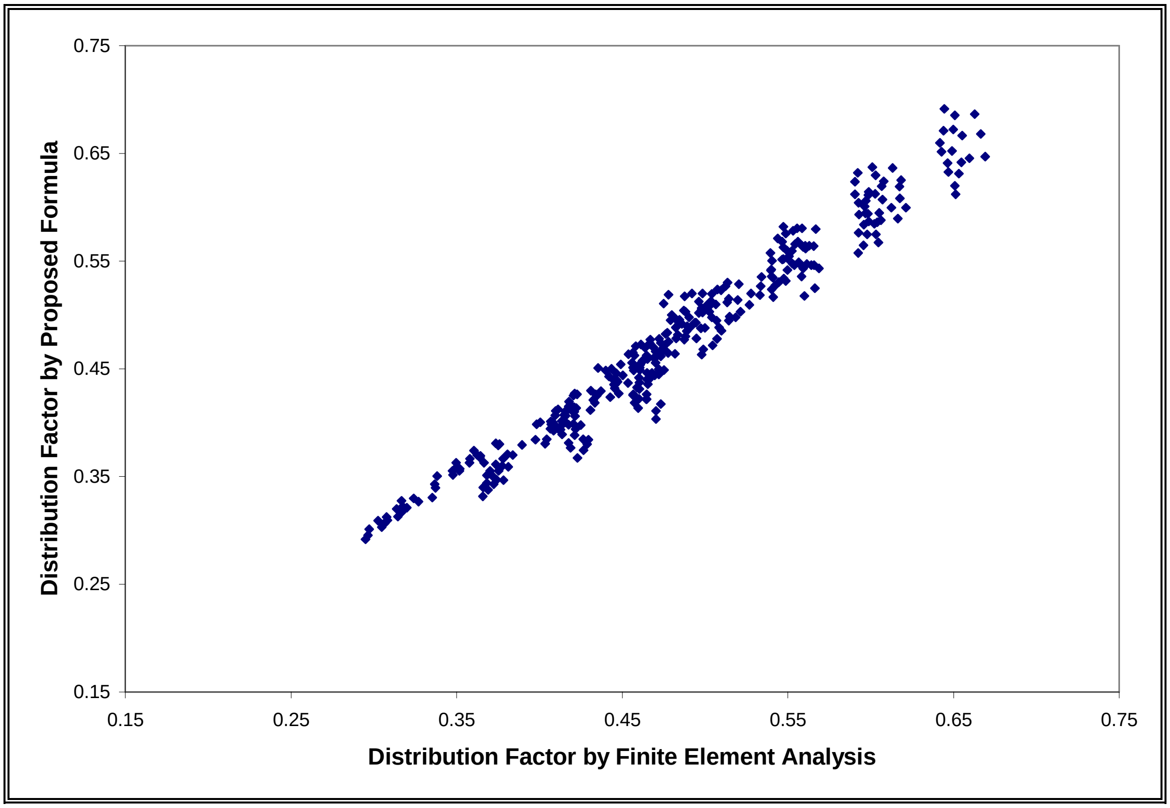


Figure D. 46Comparison of Proposed Formulas and Bridge Analysis for PLS, Shear Force on Interior Beams for Double Lanes



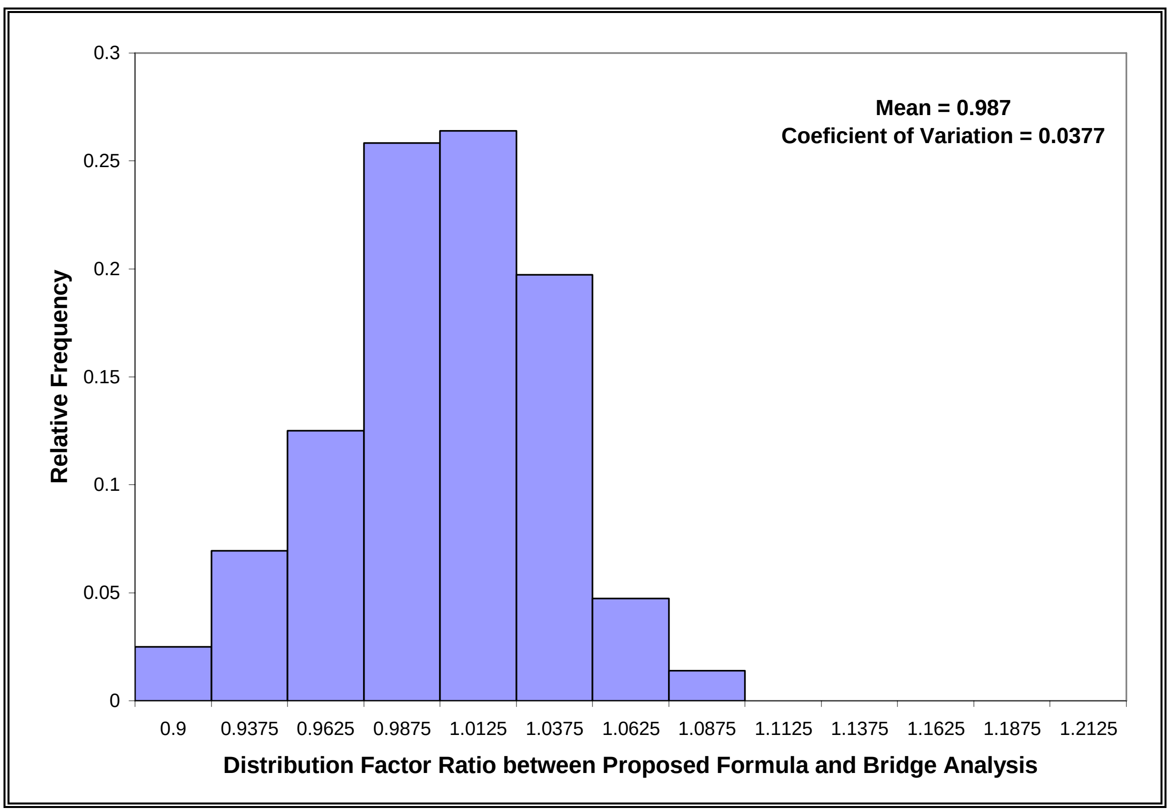
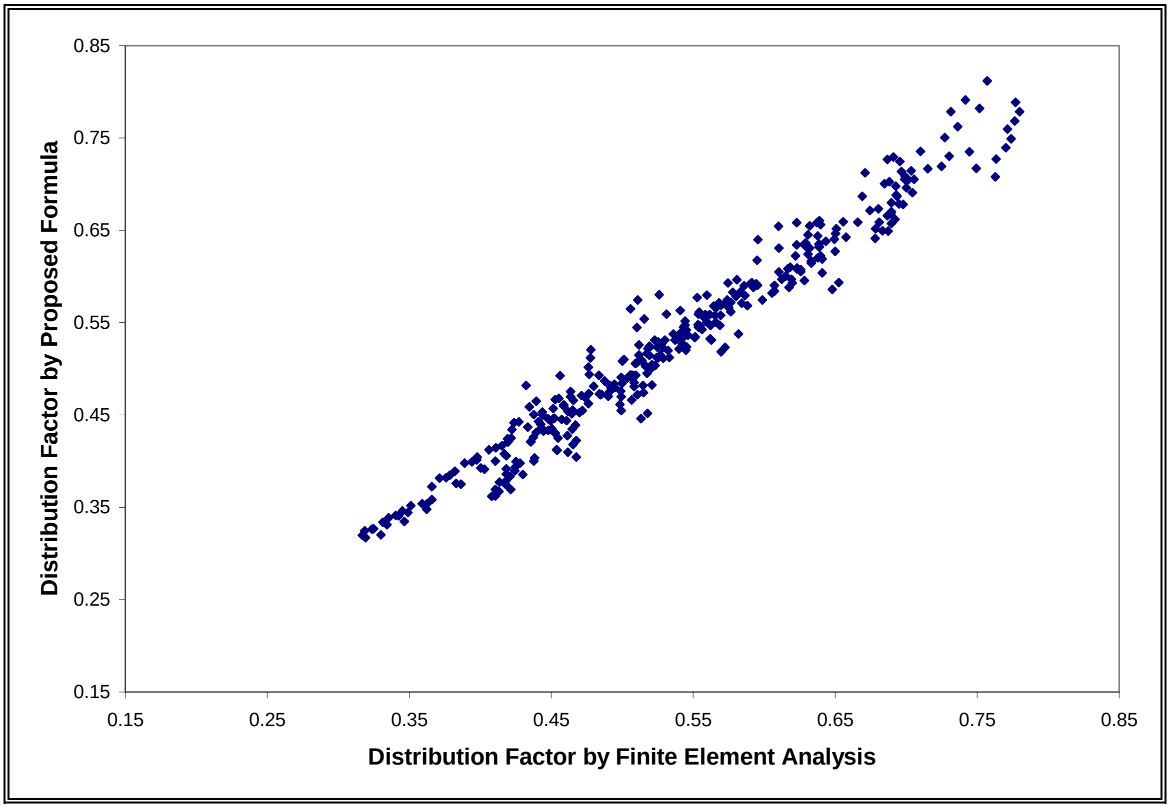


Figure D. 47Comparison of Proposed Formulas and Bridge Analysis for PLS, Shear Force on Exterior Beams for Single Lane



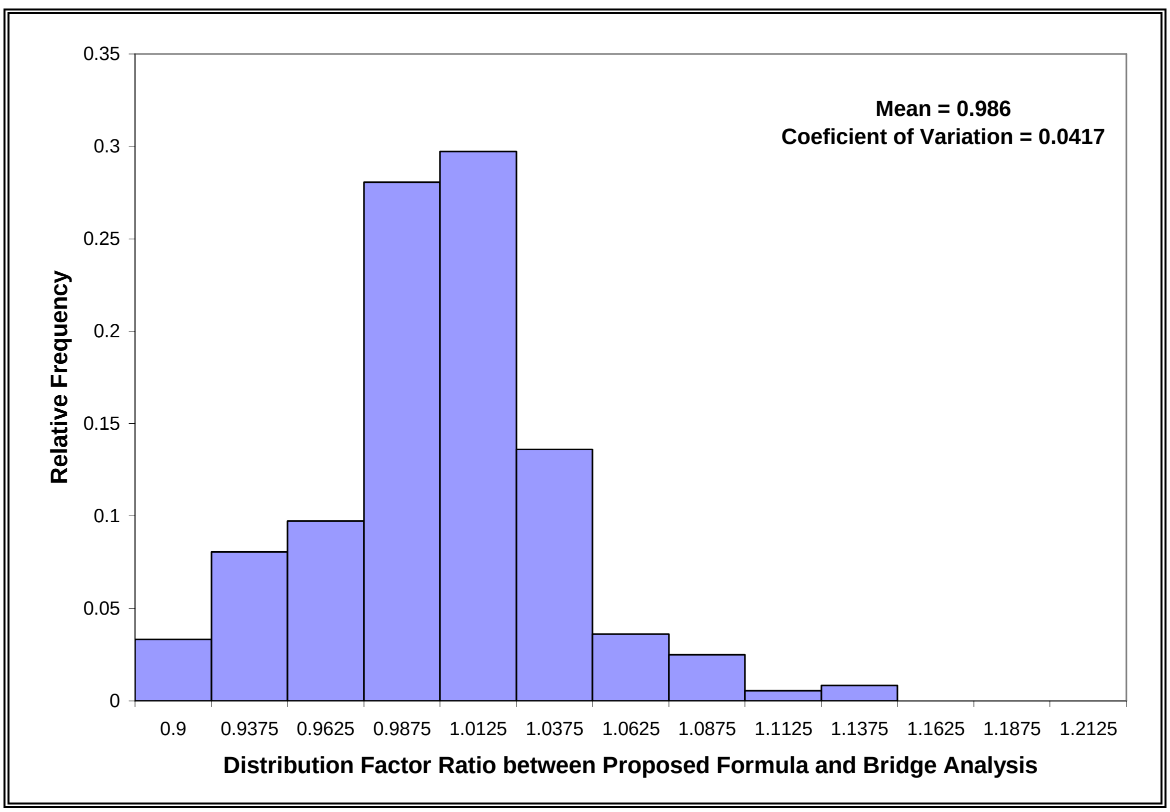
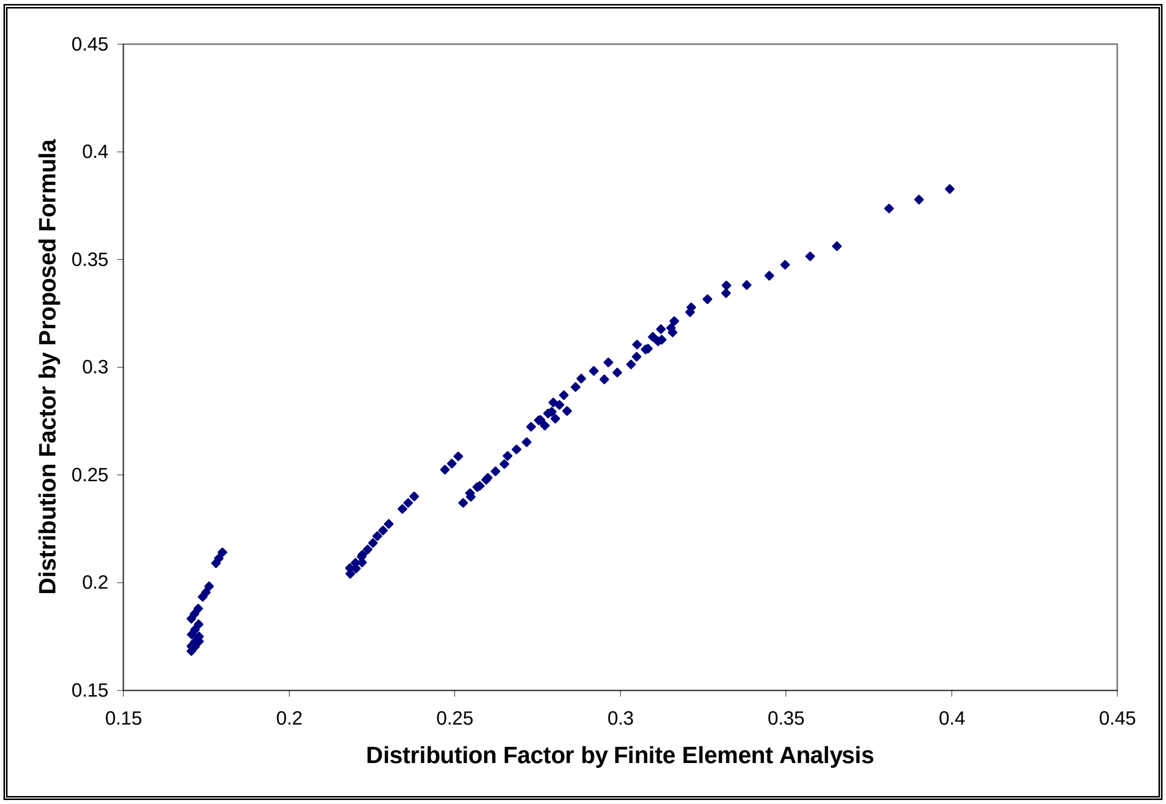


Figure D. 48Comparison of Proposed Formulas and Bridge Analysis for PLS, Shear Force on Exterior Beams for Double Lanes



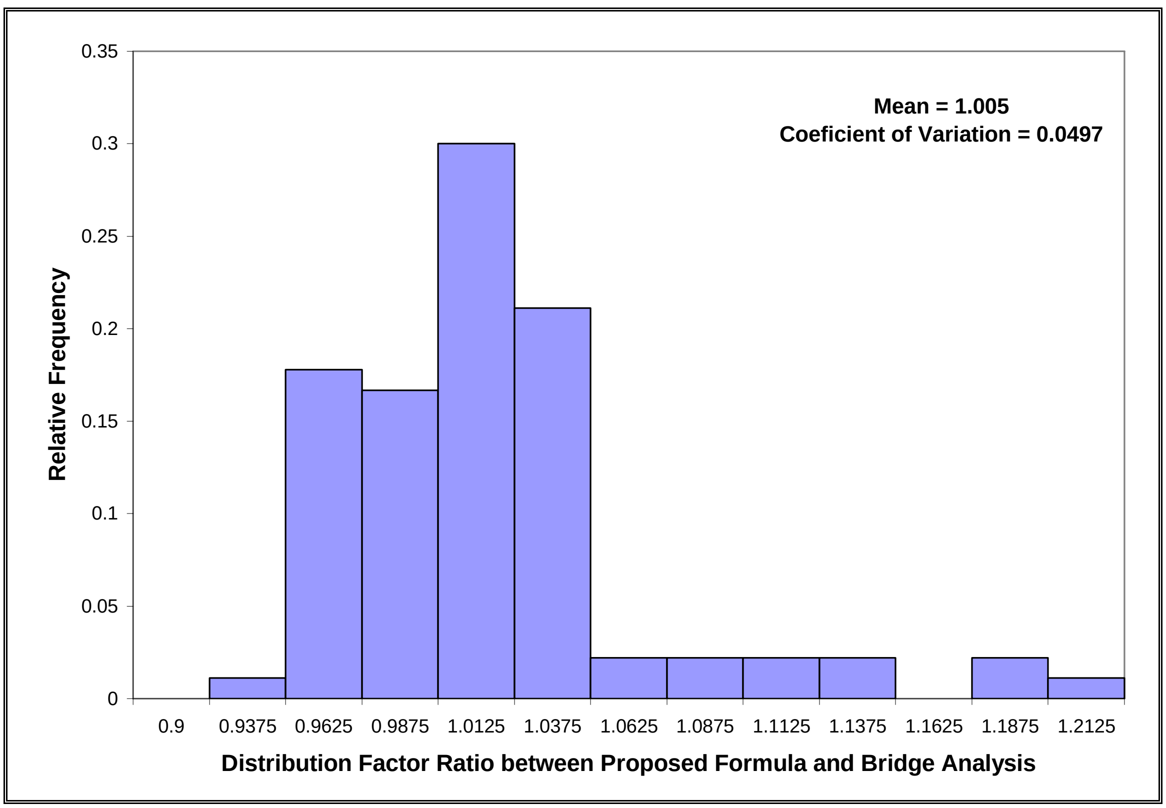
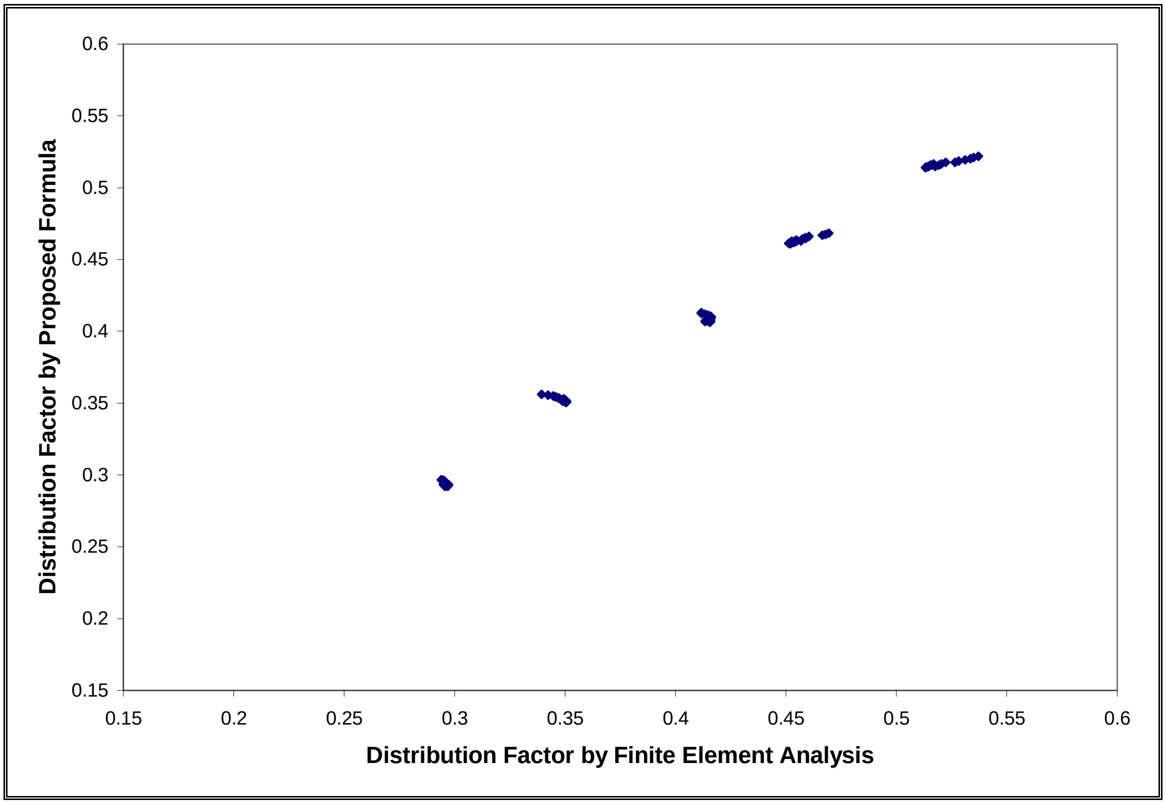


Figure D. 49Comparison of Proposed Formulas and Bridge Analysis for HETS, Bending Moment on Interior Beams for Single Lane



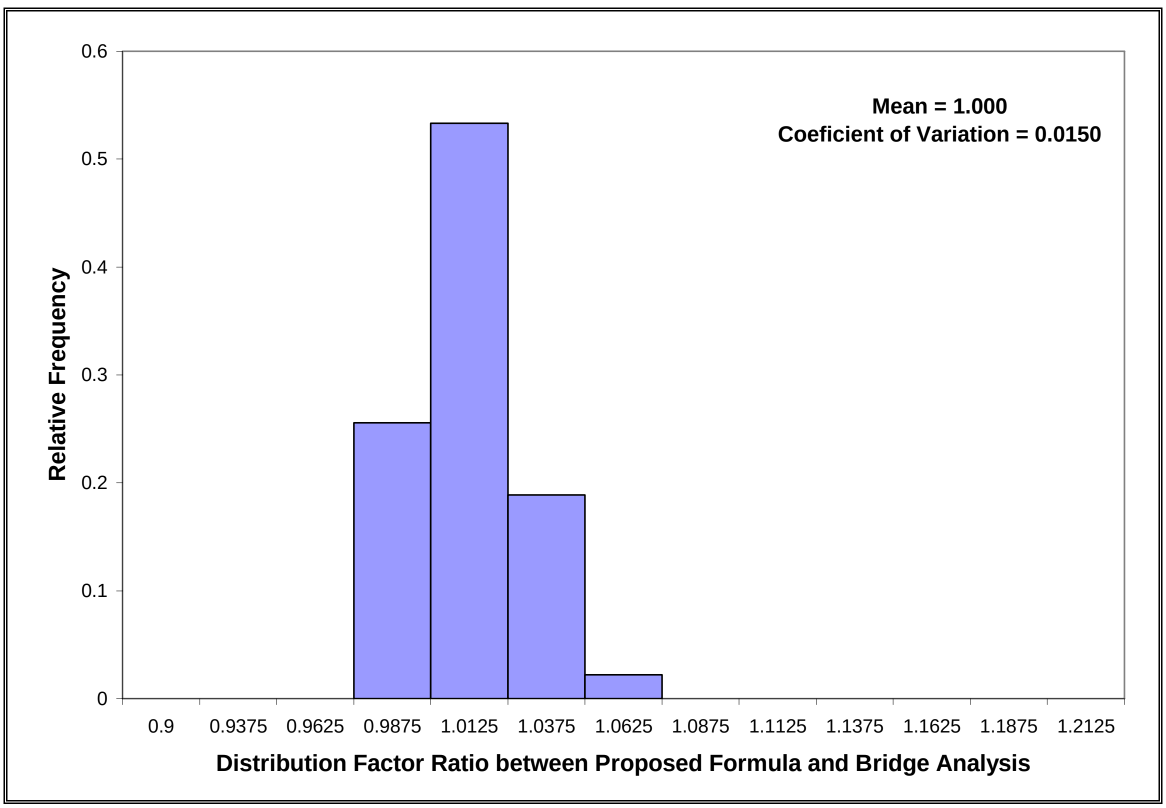
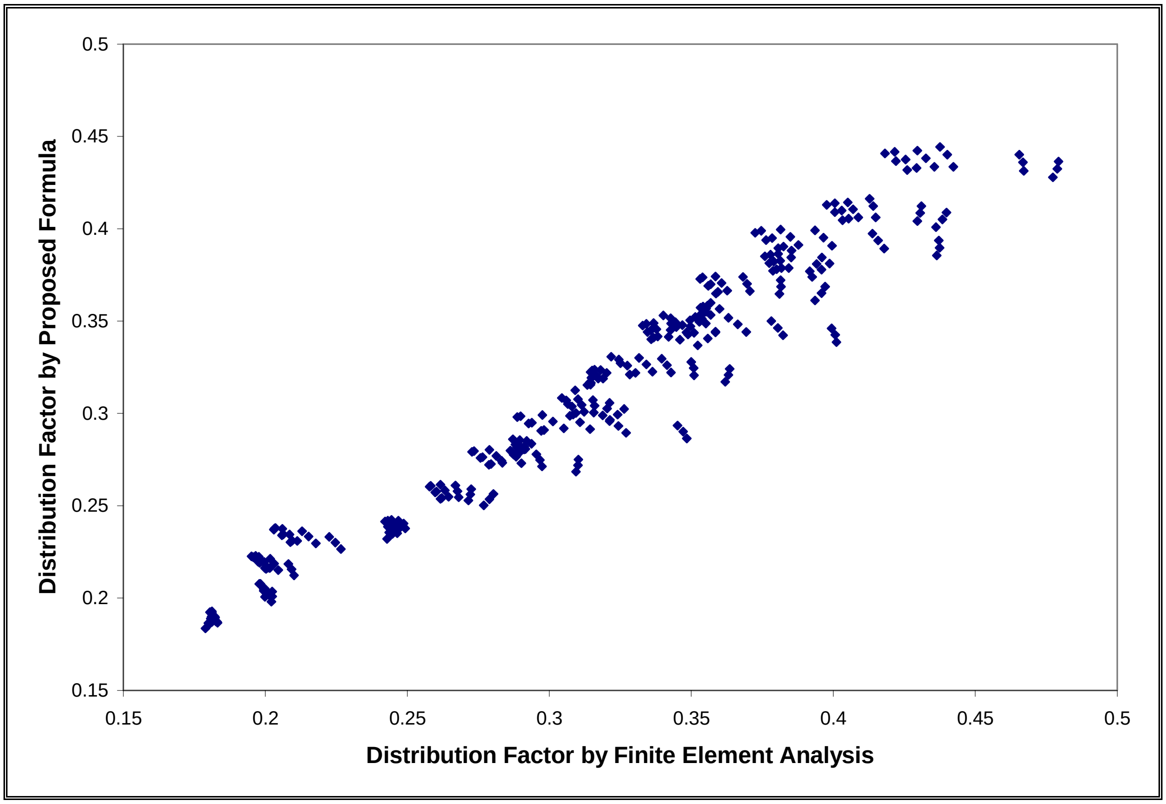


Figure D. 50Comparison of Proposed Formulas and Bridge Analysis for HETS, Bending Moment on Interior Beams for Double Lanes



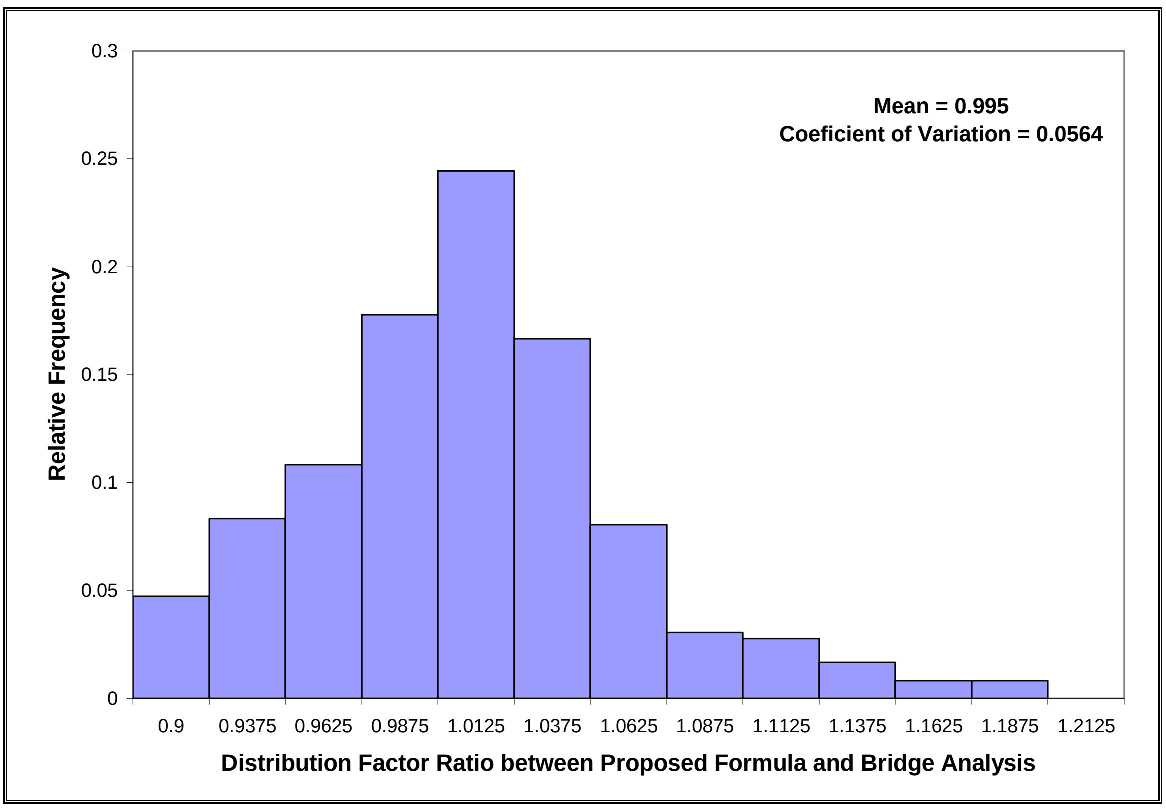
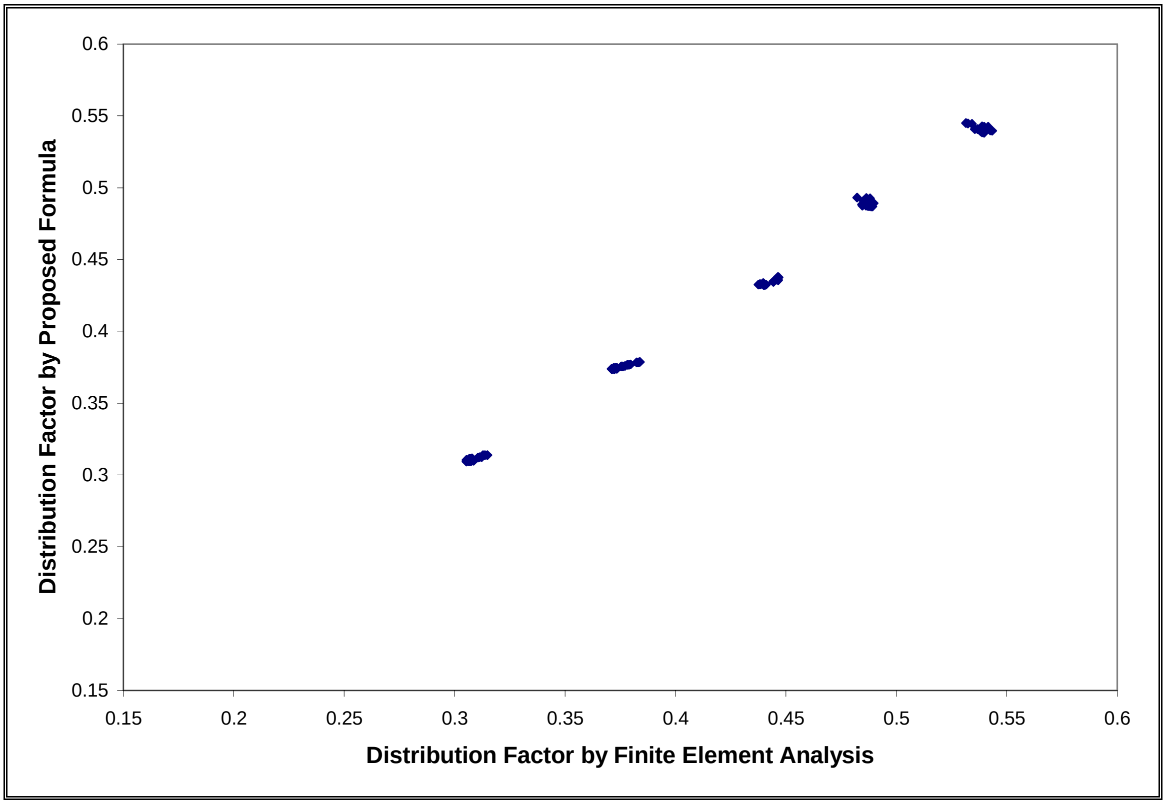


Figure D. 51Comparison of Proposed Formulas and Bridge Analysis for HETS, Bending Moment on Exterior Beams for Single Lane



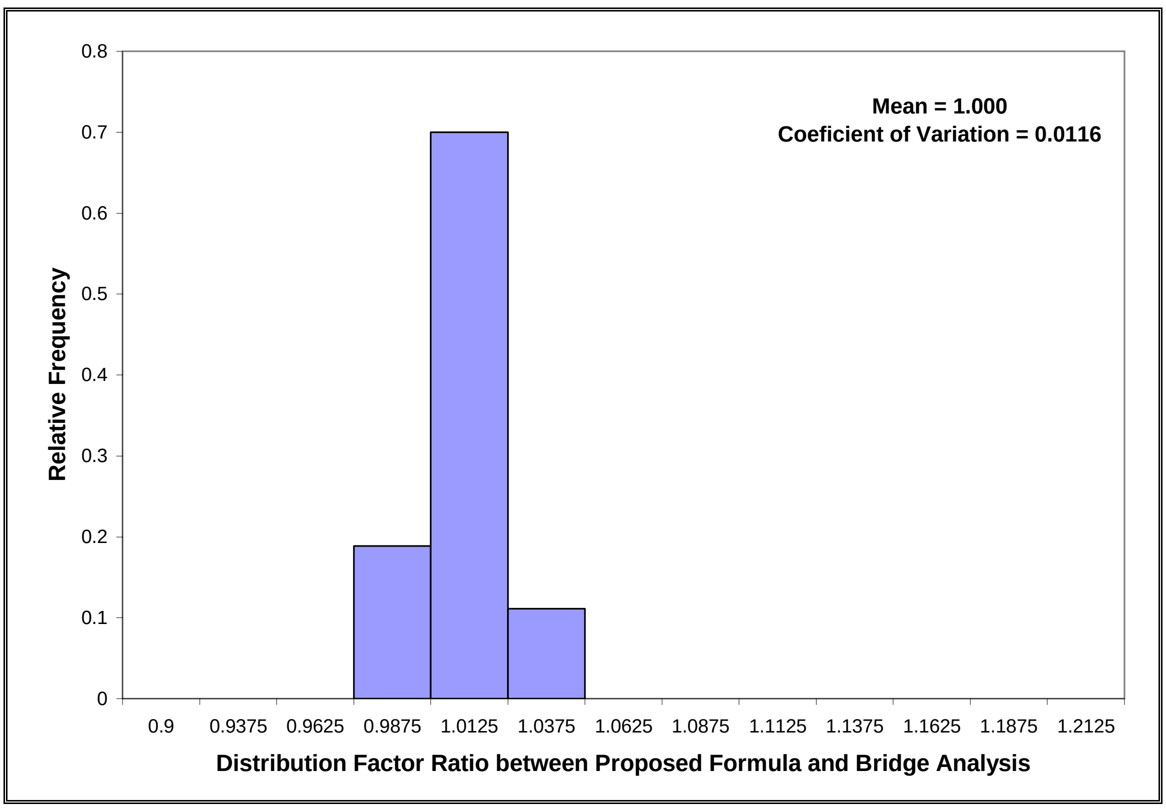
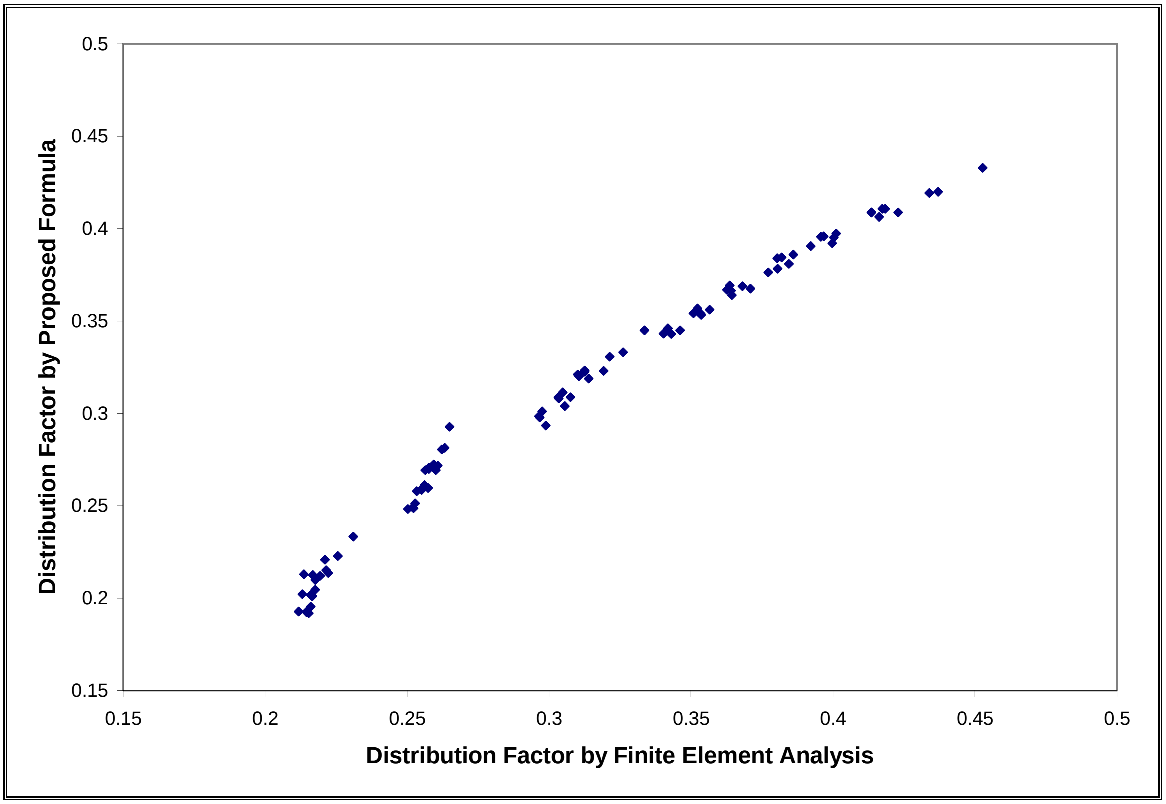


Figure D. 52Comparison of Proposed Formulas and Bridge Analysis for HETS, Bending Moment on Exterior Beams for Double Lanes



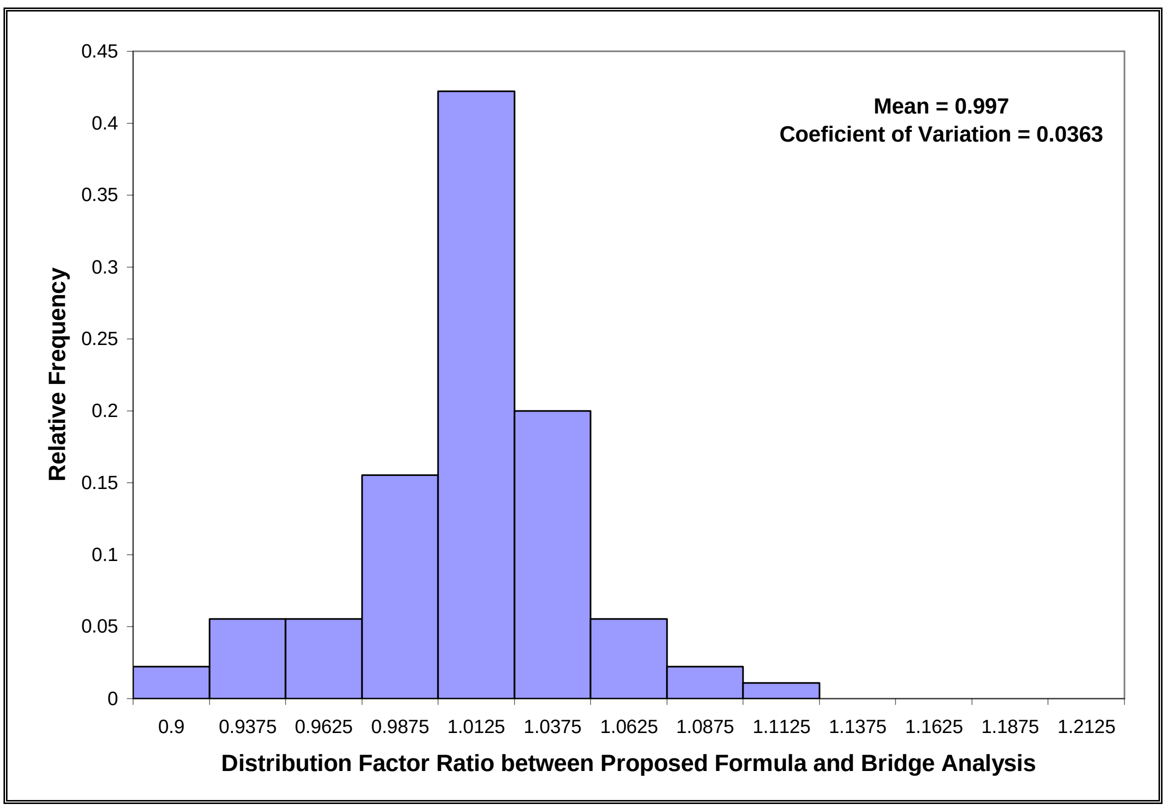
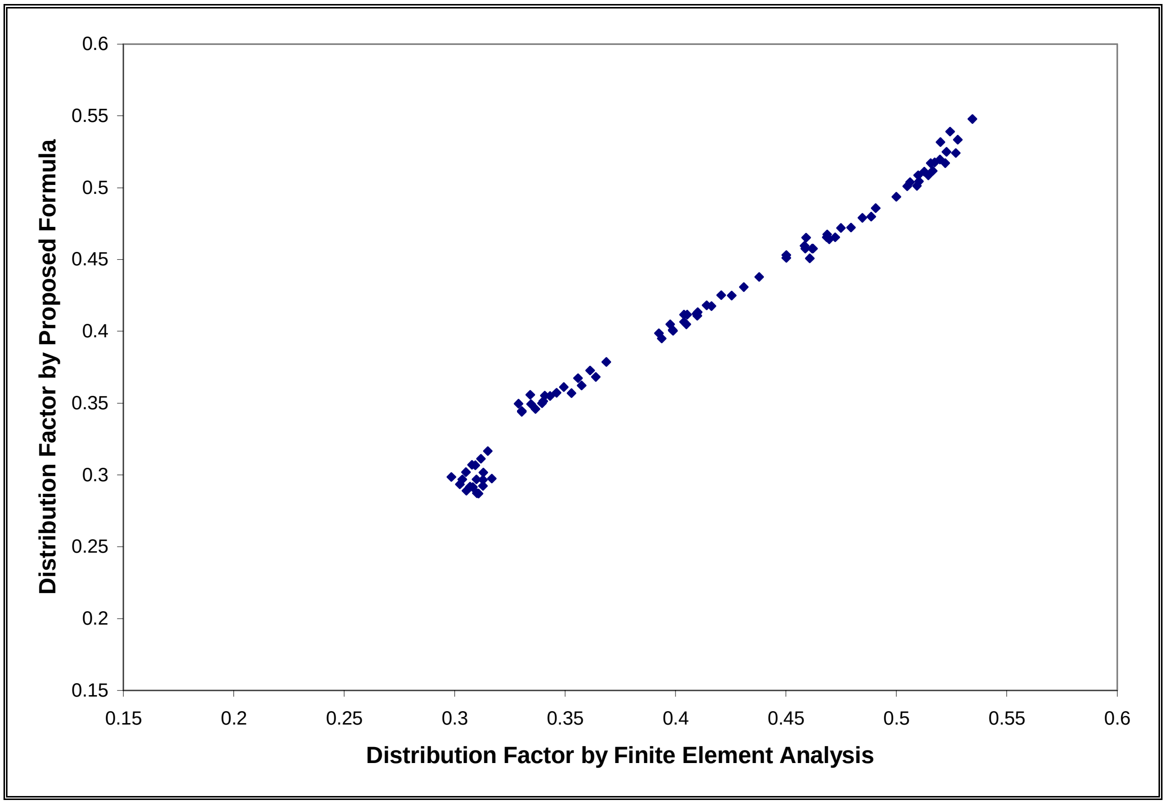


Figure D. 53Comparison of Proposed Formulas and Bridge Analysis for HETS, Shear Force on Interior Beams for Single Lane



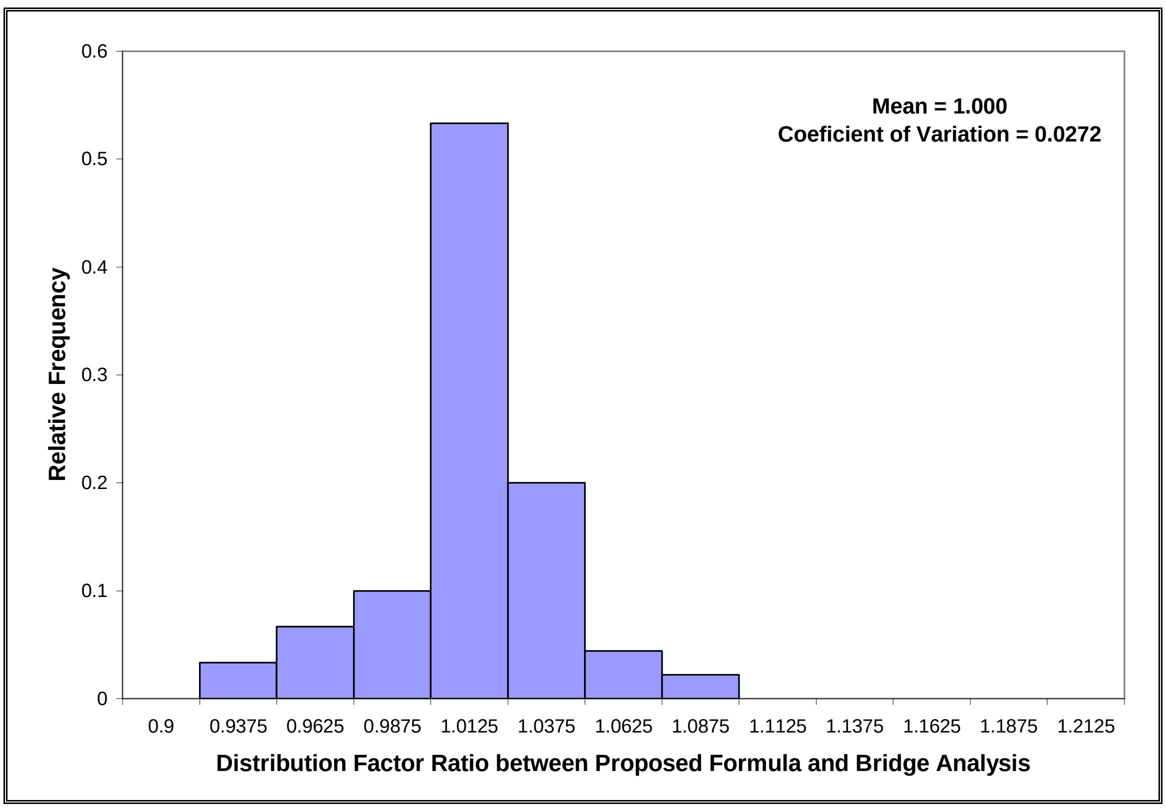
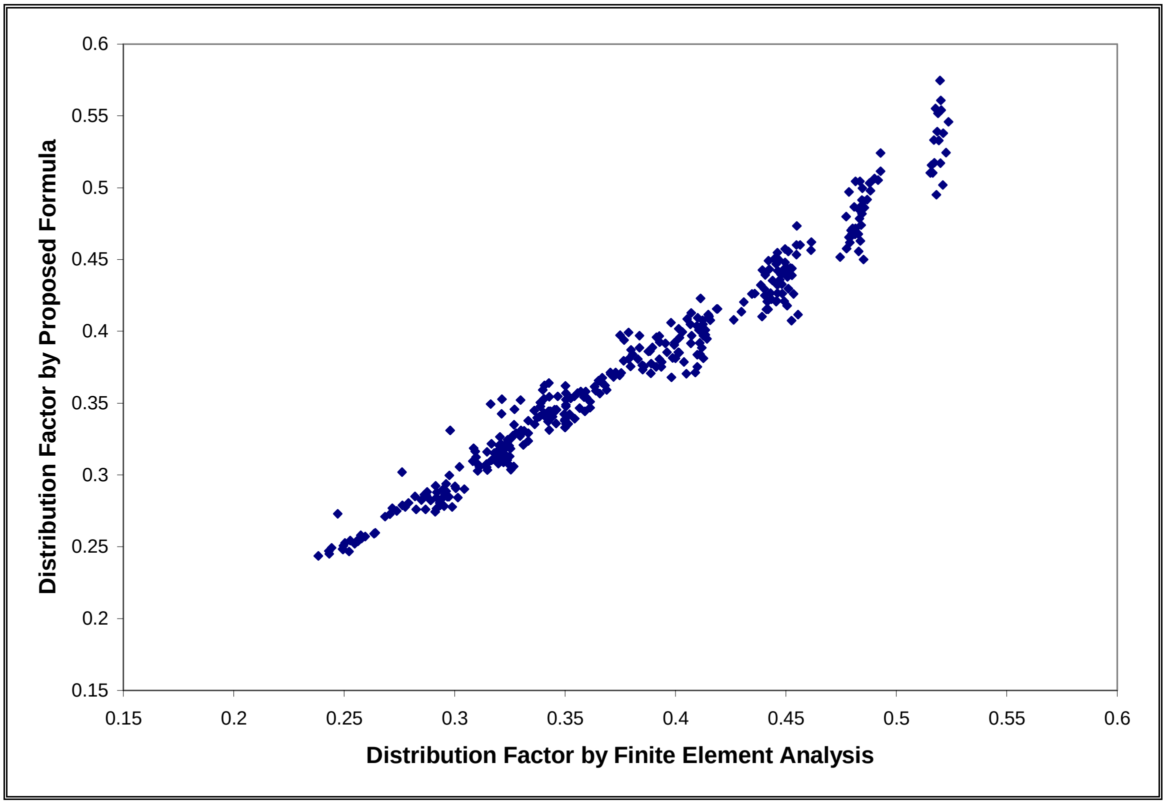


Figure D. 54Comparison of Proposed Formulas and Bridge Analysis for HETS, Shear Force on Interior Beams for Double Lanes



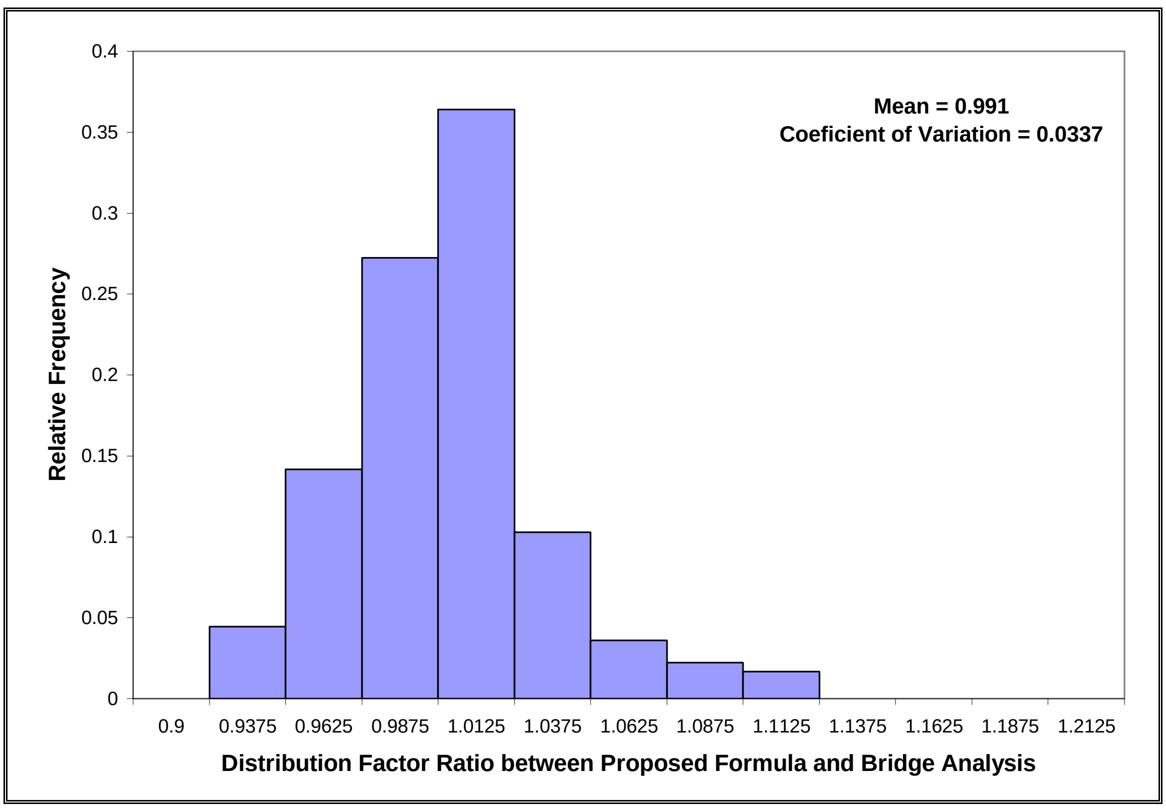
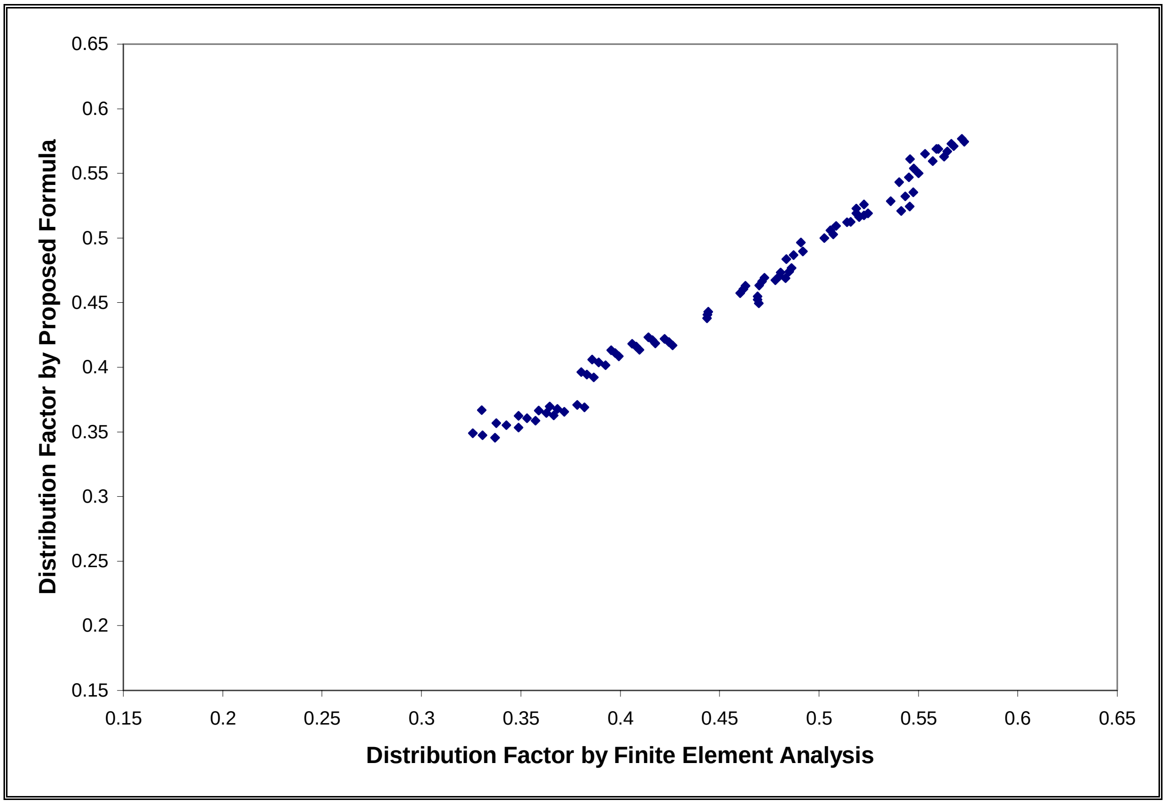


Figure D. 55Comparison of Proposed Formulas and Bridge Analysis for HETS, Shear Force on Exterior Beams for Single Lane



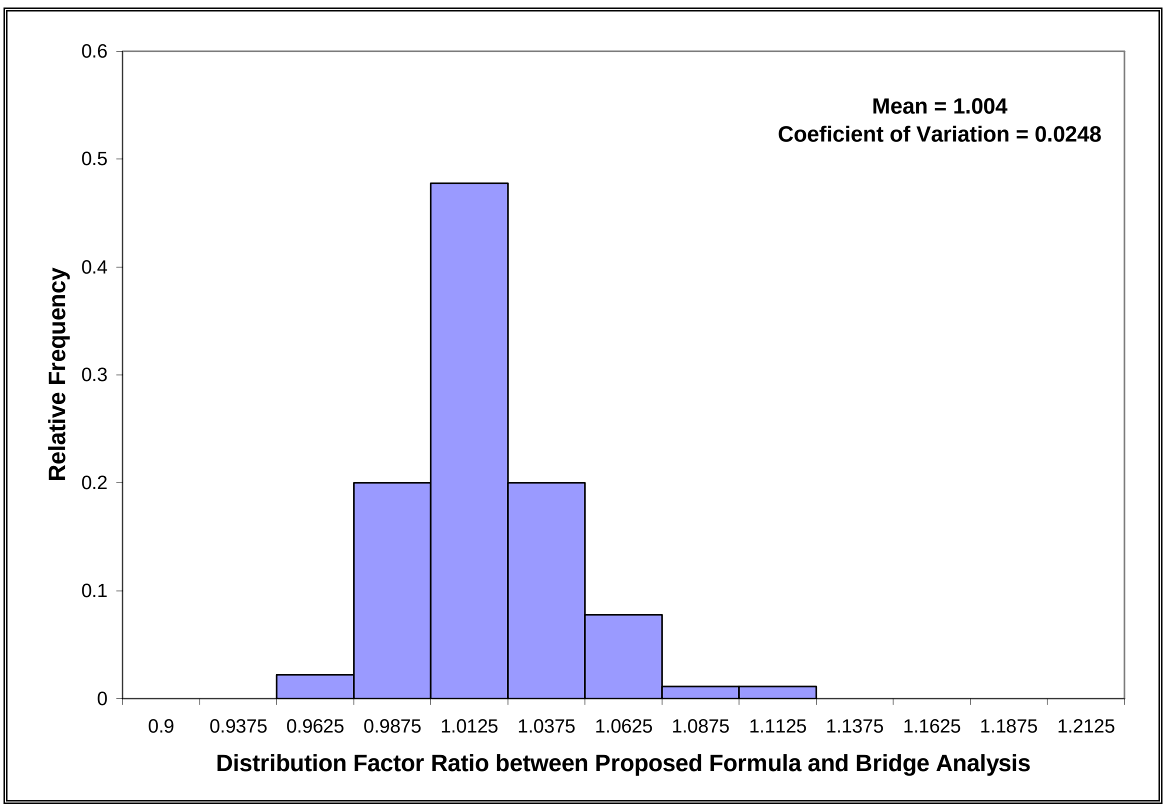


Figure D. 56Comparison of Proposed Formulas and Bridge Analysis for HETS, Shear Force on Exterior Beams for Double Lanes