AMERICAN UNIVERSITY OF BEIRUT

INFLUENCE OF RAILINGS STIFFNESS ON WHEEL LOAD DISTRIBUTION IN CONCRETE SLAB BRIDGES

by
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AN ABSTRACT OF THE THESIS

Mohammad Abou Nouh for Master of Engineering
Major: Civil Engineering

Title: Influence of Railings Stiffness on Wheel Load Distribution in Concrete Slab Bridges

The presence of railings or parapets acting integrally with the bridge deck have the effect of stiffening and attracting load to the slab edge and therefore altering the lateral wheel load distribution on highway bridges. This may also result in increasing the load-carrying capacity of bridges. The current research presents a parametric study to investigate the influence of typical integral railings on wheel load distribution as well as on the load-carrying capacity of skewed concrete slab bridges. Typical one-span, simply supported, multi-lane (one to four lanes), skewed reinforced concrete slab bridges are considered. The finite-element method is used to investigate the effect of span length, slab width, skew angle and to calculate the wheel load distribution on the bridge slab at the critical section. AASHTO design trucks loads are placed transversally and longitudinally to produce maximum moments at the critical section of the slabs. Various configurations of railings on either or both edges of the slab are considered for straight and skewed bridges. Straight bridges with no railings will serve as reference cases. The wheel load distribution on the bridge slab at the critical section for the reference cases and for cases with railing and/or skewness are calculated and compared. The results are also assessed and evaluated with AASHTO procedures, and recommendations are made to assess the influence of railings on skewed bridges. This research will assist structural engineers in better designing new straight and skewed concrete slab bridges, or evaluating more precisely the load-carrying capacity of existing bridges in the presence of railings. In addition, the approach adopted in this research can also be considered as an adequate and practical method for strengthening and rehabilitating skewed concrete slab bridges.

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CHAPTER 1
INTRODUCTION

1.1 Background

Bridges have been used since ancient history for the purpose of providing passage over obstacles, such as a body of water, valley or road. Spans of wooden logs or planks and eventually stones had been the first bridges made by humans. However, these old bridges could not resist heavy loads or withstand strong currents. These causes led bridge engineers to improve and develop the methods of construction bridges. Nowadays, bridges can be designed using different construction techniques, ranging from beam bridges to cable suspension bridges. The bridge deck is the most common component of all types of bridges.

Concrete slab bridges are typically very simple bridges. This allows contractors to develop innovative ways to build them quickly, efficiently, and economically. Society expects buildings and bridges to be designed with a reasonable safety level. In practice, these expectations are achieved by following code requirements specifying design values for minimum strength, maximum allowable deflection, and so on. These code specifications are the AASHTO standard specifications for Highway Bridges (AASHTO 2002) and the AASHTO Load Resistance Factor Design (AASHTO 2010) in which both refer to the American Association of State Highway and Transportation Officials (AASHTO). These code requirements have evolved to include design criteria that take in to account some of the sources of uncertainty in design. These specifications are based on a thorough understanding of the lateral wheel load distribution on the bridge slab.

1.2 Design Procedures

Many sources of uncertainty are inherent in structural design. Despite what it is known, the parameters of the loading and the load-carrying capacities of structural members are not deterministic quantities. They are random variables, and thus absolute safety or zero probability of failure cannot be achieved. Consequently, structures must be designed to serve their function with a finite probability of failure.

To illustrate the distinction between deterministic and random quantities, consider the loads imposed on a bridge by car and truck traffic. The load on the bridge at any time depends on many factors, such as the number of vehicles on the bridge and the weights of the vehicles. As it is known, cars and trucks come in many shapes and sizes. Furthermore, the number of vehicles that pass over a bridge fluctuates, depending on the time of day. Since the specific details about each vehicle that passes over the bridge or the number of vehicles on the bridge at any time are not known, there is some uncertainty about the total load on the bridge. Hence the load is a random variable. So, to achieve safety in construction, the design of bridges must conform to AASHTO Standard Specifications which were developed in 1940s based on the research work of Westergaard (1926, 1930), Newmark (1938), and Jensen (1938, 1939) on moments and stress distribution in reinforced concrete slabs. Federick (1997) presented the results of an experimental and finite-element analysis (FEA) investigation of load distribution in a concrete slab bridge. The FEA was performed using rectangular plate bending element which have assumed the slab to be homogeneous and perfectly elastic material.

NCHR project (Development of a comprehensive Bridge Specifications and Commentary) was initiated in 1988 with the objective of developing a comprehensive new design code that could eventually replace the AASHTO Standard Specifications for

Highway Bridge. AASHTO Standard Specification use allowable stresses and/or load factor design. The new code is based on a probability based approach. Structural performance is measured in terms of the reliability (or probability of failure). The allowable stress method do not provide for a consistent and uniform safety level for various groups of bridges. The new code was developed to provide a uniform safety reserve. The main parts of the AASHTO Specifications were written in 1940s. So, the major tool in the development of new code is the reliability analysis procedure. The code provisions are formulated so that the structure designed using the code have a consistent and uniform safety level.

The work on the new code bridge design code was formulated by first the selection of about 200 structure from various geographical regions of United states. These structures cover materials, types and spans. Second, the work was done by establishing the statistical data base for load and resistance parameters, the development of load and resistance models, and the development of the reliability analysis procedure. Third, the new code was formulated by the selection of the target reliability index and the calibration of load and resistance factors.

1.3 Research Objectives

The presence of railings or parapets acting integrally with the bridge deck have the effect of stiffening and attracting load to the slab edge and therefore altering the lateral wheel load distribution on highway bridges, which would result in increasing the load-carrying capacity of bridges. The current research dwells on a previous study where one typical railing was investigated (*Fawaz et al. 2015*), and studies the influence

of varying the railings size or stiffness on wheel load distribution as well as on the load-carrying capacity of straight concrete slab bridges.

Typical one-span, simply supported, multi-lane (one to four lanes), straight reinforced concrete slab bridges are considered. The finite-element method is used to investigate the effect of span length and slab width, and to calculate the wheel load distribution on the bridge slab at the critical section. AASHTO (HS20) design trucks loads are placed transversally and longitudinally to produce maximum moments at the critical section of the slabs. Various configurations of railings sizes/stiffnesses on either or both edges of the slab are considered for straight bridges, where the cases with no railings will serve as reference cases. The wheel load distribution on the bridge slab at the critical section for the reference cases and for cases with railings are calculated and compared. The results are also assessed with the AASHTO Standard Specifications (2003) and AASHTO LRFD (2010) procedures which do not include railing stiffness as a criterion in design, and recommendations are made for bridge engineers to assess the influence of railings on straight bridges.

1.4 Scope and Methodology of Proposed Research

The current research will present the finite-element results of a parametric study to accurately evaluate the effect of railings stiffness on wheel load distribution in straight concrete slab highway bridges.

In the finite-element method, the bridge is discretized into a convenient number of elements, which are assumed to be interconnected at nodal points; each element has the properties corresponding to the original structure. In the present research, the finite-element modeling consists of shells for concrete slab, frames for railings and simple

supports for the piers. The finite-element program SAP2000 (2012) is selected for the analysis.

The finite-element method is used to investigate the effect of span length and slab width on simply supported, one-span, one- to four-lane concrete slab bridges. Four typical span lengths are investigated: 24, 36, 46, and 54 ft (7.2, 10.8, 13.8, and 16.2 m). Given that the typical lane width is 12 ft (3.6 m) and that the case of one-lane bridges have an additional 1 ft width of slab on each side, the overall slab widths for bridges are: 14ft (4.2 m) for one lane, and 24 ft (7.2 m) for two lanes, 36 ft (10.8 m) for three lanes, and 48 ft (14.4 m) for four lanes. Four different railings sizes/stiffnesses will be analyzed in addition to the reference case without railings.

Design trucks are assumed to be traveling in the same direction. Transversally, Centered and Edge Loading conditions are considered. In the Centered loading condition, the design trucks are placed centered each in its own lane. In the Edge loading, the design trucks are placed side-by-side close to one edge (left) of the slab, such that the center of the left wheel of the leftmost truck is positioned at one foot from the left edge of the slab. The distance between the adjacent trucks is selected to be 4 ft (1.2 m) produce the worst loading condition on the bridge. Various positions of the design trucks are assumed, longitudinally and transversally, in order to produce maximum bending moments. The cases of straight bridges without railings are first analyzed and considered as the reference cases. Railings are then placed integrally at either or both of the slab edges. The wheel load distribution on the bridge slab at the critical section for the reference cases and for bridges with railings with different

stiffnesses is calculated and compared. The results are also assessed with the AASHTO Standard Specifications (2003) and AASHTO LRFD (2010) design procedures

1.5 Thesis Organization

The thesis is divided into five chapters including this introduction. Chapter 2 is a general description of the research work including a description of AASHTO Standard Specifications and LRFD design procedures. Chapter 3 includes a description of the bridge cases considered and the finite element models used in the analyses. Chapter 4 discusses the effect of railings on the different bridge models considered with tables showing the different results and assessment with AASHTO design standards. Conclusions and recommendations are presented in Chapter 5.

CHAPTER 2
BACKGROUND AND AASHTO DESIGN PROCEDURES

2.1 Introduction

In this chapter, a background section is presented, and for later comparison between FEA results and conventional methods of bridge design, a summary of AASHTO Standard Specifications (2002) and AASHTO LRFD (2010) design procedures are provided.

2.2 Background Studies

A concrete slab bridge is designed according to the provisions for main reinforcement parallel to traffic. The AASHTO design procedures was originally developed in the 1940s, based on the research work of Westergaard (1926, 1930) and Jensen (1938, 1939) and is presented in AASHTO Standard Specifications for Highway Bridges (2002) (section 3.24 " Distribution of Loads and Design of Concrete Slabs").

Shekar et al. (1993) performed extensive experimental and analytical investigation to evaluate the load-carrying capacity of existing reinforced concrete slab bridges. The experimental phase of the investigation consisted of field testing of six slab bridges. Test results were used to develop 3D FEA models to be applied by practicing engineers. The test data compared favorably with FEA results and verified that concrete slab bridges have the strength necessary to resist highway loading. Significant differences between maximum bending moments were also obtained for 2D and 3D analyses because of the participation of nonstructural members such as curbs. Therefore, 3D FEA was recommended in analyzing slab bridges.

Frederick (1997) presented the results of an experimental and finite-element analysis investigation of load distribution in a concrete slab bridge. A typical one-span, simply supported slab bridge with a three-lane width was considered. The design live load bending moments were calculated using AASHTO standard specifications (2003) provisions. The FEA was performed using rectangular plate bending element. A one fifteenth size scale concrete model was constructed and tested in the laboratory. The FEA results correlated well with the test data and were less than AASHTO empirical equation. The results for multiple-lane loading indicated that the slab behaved essentially as a wide beam with minor variations in the longitudinal bending moment across the width.

Mabsout et al. (2004) presented the results of an extensive investigation of reinforced concrete slab highway bridges using finite-element analysis. Simply supported one-span bridges were considered with various span lengths, numbers of lanes, and loading conditions (Edge and Centered loading) for cases with and without shoulders. A total of 112 case study bridges were analyzed. The maximum longitudinal bending moments, edge beam moments, and maximum deflections were compared with AASHTO design procedures and conclusions were made regarding the results. The effect of applying the AASHTO reduction factors for the FEA moments with three (10%) and four lanes (25%) was investigated.

Menassa et al. (2007) presented a study to investigate the influence of skew angle on reinforced concrete slab bridges. Typical one-span, simply supported, multi-lane (one to four lanes), and reinforced concrete slab bridges were modeled and analyzed using the finite element method and various angles of skewness were

considered. The case of straight bridges served as reference bridges. A total of 96 case study bridges were analyzed and subjected to AASHTO HS-20 design trucks positioned close to one edge on each bridge to produce maximum bending in the slab. The finite element analysis (FEA) results for skewed bridges were compared to the reference straight bridges as well as the American Association for state Highway and Transportation Officials (AASHTO) standard specifications and LRFD procedures. The ratio between the FEA longitudinal moments for skewed and straight bridges was almost one for bridges with skew angle less than 20º. This ratio decreased to 0.75 for bridges with skew angles between 30º and 40º, and further decreased to 0.5 skew angle of the bridge increased to 50º. AASHTO Standard Specifications gave similar results to the FEA maximum longitudinal bending moment when the skew angle is less than or equal to 20º. As the skew angle increases, AASHTO Standard Specifications procedure overestimated the maximum moment by about 20% for 30º, 50% for 40º and 100% for 50º skew angle. The AASHTO LRFD Design Specifications procedure overestimated the maximum longitudinal bending by up to 40% for skew angles less than 30º and reaching 50% for 50º skew angle. This research supported the AASHTO Standard Specifications as well as the LRFD procedure in recommending that bridges with skew angles less than or equal to 20º to be designed as straight (non-skewed) bridges.

A previous study by *Mabsout et al. (1997)* was conducted to investigate the influence of sidewalks and railings on wheel load distribution in steel girder highway bridges. A typical one-span, two-lane, simply supported, composite steel girder bridges were selected in order to investigate the influence of various parameters such as: span length, girder spacing, sidewalks, and railings. A total of 120 bridges were analyzed using three-dimensional finite-element analysis. AASHTO HS20 design trucks were

positioned in both lanes to produce maximum moments. The finite-element analysis results were used in calculating the maximum wheel-load distribution factors (DF), which were compared with the simple AASHTO standard specifications (2003) formula, DF=S/5.5, and the formula developed as part of NCHRP project 12-26 (1988), included in AASHTO LRFD (2010). The analysis of the steel girder bridges indicated that the AASHTO LRFD wheel load distribution formula correlated conservatively with the finite-element results and were all less than the typical empirical formula (S/5.5). The presence of sidewalks and railings were shown to increase the load-carrying capacity by as much as 30% if they were included in the strength and evaluation of highway bridges.

A recent and extensive study by *Fawaz et al. (2015)* was conducted to investigate the influence of sidewalks and railings on wheel load distribution in one-span concrete slab highway bridges. Typical one-span, simply supported, multi-lane (one to four lanes), reinforced concrete slab bridges were modeled and analyzed using the finite element method and various configurations of sidewalks and/or railings on either or both edges of the slab were considered. The case of one-span bridges with no sidewalks and railings served as reference bridges. AASHTO design trucks (HS20) are assumed, longitudinally and transversally, in order to produce maximum bending moments. The wheel load distribution on the bridge slab at the critical section for the reference and continuous sidewalk/railing cases were calculated and compared. The results were also assessed with the AASHTO Standard Specifications and AASHTO LRFD Design Specifications procedures. The presence of railings was shown to decrease the longitudinal bending moments by about 15 to 25%.

The studies above by *Mabsout et al. (2004 and 1997)* and *Fawaz et al. (2015)* form the basis for the current research which will address the influence of railings stiffness on wheel load distribution in reinforced concrete highway bridges.

2.3 AASHTO Standard Specifications for Highway Bridge

2.3.1 Slab Design

A concrete slab bridge is designed with the provisions for main reinforcement parallel to traffic. AASHTO specifies a distribution width for highway loading or an empirical formula to reduce the two-way bending problem into a beam (one-way) bending problem. Therefore, reinforced concrete slab bridges are typically designed as a series of beam strips. AASHTO Standard Specifications (2002) suggest three approaches to determine the live load bending moment for HS20 loading. One approach, which will be adopted for the assessment in this study, is described below.

Section 3.24.3.2 of AASHTO (2002) provides empirical equations for the longitudinal bending moment M per foot width, for the case of main reinforcement parallel to traffic and is applicable only to simple spans.

- M_{AASHTO} (Kip-ft/ft) =0.9S for S <50 ft (1a)

  or

- M_{AASHTO} (Kip-ft/ft) =(1.30S-20) for 50 ft < S <100 ft (1b)

where S=span length in feet.

The analysis of bridges according to the AASHTO must consider both truck and lane loading, with the design being based on the governing of the two load cases. However for short-span structures, the truck loading governs the design.

Also, AASHTO gives special provisions for transverse reinforcement placed perpendicular to the main steel reinforcement in bridge slabs. The amount of distribution reinforcement is given as a percentage of the main reinforcement equal to $100/(S)^{1/2}$, where S is in feet, and shall not exceed 50%. AASHTO does not include recommendations or specifications to account for the presence of integral railings on the slab edges.

2.3.2 Edge Beam

According to section 3.24.8, a longitudinal AASHTO edge beam moment of a simple span is provided for slabs having main reinforcement parallel to traffic as:

- $Medge\__{AASHTO}$ (Kip-ft/ft) =0.1xPxS (2)

where:

P=16 Kips for the AASHTO HS20 design truck;

S = the span length in feet.

AASHTO standard specification does not specify a width for the edge beam. However, some departments of transportation use an edge beam width of 1.5 ft, which leads to:

- M_{edge_AASHTO} (kip-ft/ft) = $0.1 \times P \times S/1.5$ (3)

2.3.3 Live Load Deflection

AASHTO maximum live load deflection D for simple or continuous spans (section 8.9.3.1) shall not exceed:

- $D\ (in) = \frac{S}{800}$ where S is the span length of the bridge in inches (4)

2.4 AASHTO Load Resistance Factor Design (LRFD)

2.4.1 Slab Design

According to AASHTO LRFD (2010) section 3.6.1.2.1, the vehicular live loading on the roadways of bridges shall consist of a combination of design truck HS20 (section 3.6.1.2.2) or tandem (section 3.6.1.2.3) with design lane load (section 3.6.1.2.4) similar to the AASHTO Standard Specifications lane load (AASHTO Specs fig 3.7.6B) and consists of a uniformly distributed load in the longitudinal direction of 0.64 Kip/ft and occupying 10 ft transversally.

AASHTO LRFD section 4.6.2.3 provides an equivalent strip width to design slab bridges similar to the previous bridge specifications. This simplistic approach is to divide the total statical moment M_0 by the bridge equivalent width E to achieve a moment per unit width for design. The equivalent width E of longitudinal strips per lane for both shear and moment is determined using the following formulas:

The width for one lane (two lines of wheels) loaded is:

- $E=10+5(L_1\times W_1)^{1/2}$ in inches (LRFD Equation 4.6.2.3-1) (5a)

The width for multilane loaded is:

- $E=84+1.44(L_1\times W_1)^{1/2} \le \frac{W}{N_L}$ in inches (LRFD Equation 4.6.2.3-2) (5b)

where:

E=equivalent width in inches;

L_1=span length in feet taken equal to the lesser of the actual span or (60 ft);

W_1=modified edge-to-edge width of bridge taken to be equal to the lesser of the actual width or (60 ft) for multi-lane loading, or (30 ft) for single-lane loading;

W=physical edge-to-edge width of bridge;

N_L= number of design lanes.

The live load longitudinal bending moment M is therefore obtained as:

- $M_{LRFD}\,(\text{Kip-ft/ft}) = \frac{M_0}{E}$

AASHTO LRFD does not include recommendations or specifications to account for the presence of integral railings on the slab edges.

2.4.2 Edge Beam

AASHTO LRFD edge beam moment (article 4.6.2.1.4b) shall be assumed to support one line of wheel load and a tributary portion of the design lane load. Where the effective width is the sum of the distance between the edge of the deck and the inside face of the barrier (assumed equal to 1 ft), plus 1 ft, plus one quarter of the strip width specified above, but shall not exceed either one-half the full strip width or 6 ft.

2.4.3 Live Load Deflection

AASHTO LRFD maximum deflection D for simple or continuous spans (article 2.5.2.6.2) shall not exceed:

- $D\,(\text{in}) = \frac{S}{800}$ where S is the span length of the bridge in inches (6)

CHAPTER 3
BRIDGE CASES DESCRIPTION, MODELING AND ANALYSIS

3.1 Introduction

This chapter presents the parametric study carried out on the analysis of reinforced concrete slab bridges in the presence of integral concrete railings at either or both edges of the slab, including the reference cases with no railings. The various geometric and physical characteristics of the bridges as well as the different railings configurations and loading patterns are presented. The chapter also outlines the three-dimensional (3D) finite element modeling technique adopted and summarizes all the bridge cases considered.

3.2 Bridge Cases Description

3.2.1 Geometry and Dimensions

A total number of three hundred twenty geometrically distinct simply supported one-span reinforced concrete slab bridges cases are considered in the study, whereby the following geometrical properties are varied:

- Span length
- Number of lanes
- Presence of railings
- Railings Stiffness factor

The four span lengths considered, with the corresponding slab thicknesses chosen to control deflection, are as follows:

- Span length of 24 ft with slab thickness of 18 inches
- Span length of 36 ft with slab thickness of 21 inches

- Span length of 46 ft with slab thickness of 24 inches
- Span length of 54 ft with slab thickness of 27 inches

A typical lane is considered to have a fixed width of 12 ft. Cases of one-lane bridges have an additional 1 ft width of slab on each side. For the number of lanes considered, from one to four, the corresponding slab widths are as follows:

- 14 ft for one-lane bridges (1+1×12+1= 14 ft)
- 24 ft for two-lane bridges (2×12 = 24 ft)
- 36 ft for three-lane bridges (3×12 = 36 ft)
- 48 ft for four-lane bridges (4×12 = 48 ft)

The base case for the railings size was adopted from previous work by *Fawaz et al.(2015)* to be in this study 8 in wide and 30 in deep above slab. These railings may be on either or both edges of the bridge. Another parameter of this study is the railings stiffness, which is represented by the moment of inertia of the railing (I) computed at the bottom of the railing section.

$$I_{(bottom)} = I_{(center)} + Ad^2 = bh^3/12 + bh(h/2)^2 = bh^3/3 = 4I_{(center)} \text{ or } 4\ Ic.$$

Five stiffness factors are considered including x0, x1, x2, x3, x4, and x0.5, along with x0 (reference case with no railings).

Where:

x0 No Railings, Reference case =0

x1 Moment of inertia of base case = 4Ic

x2 Twice the base case moment of inertia =8Ic

x3 Triple the base case moment of inertia =12Ic

x4 Four times the base case moment of inertia =16Ic

x0.5 Half the base case moment of inertia =2Ic

Figure 3.1 illustrates typical cross-sections for one-lane, two-lane, three-lane and four-lane bridge cases with/without railings for the base case (x1).

Table 3.1 summarizes the geometrical characteristics and dimensions of all the bridge cases analyzed.

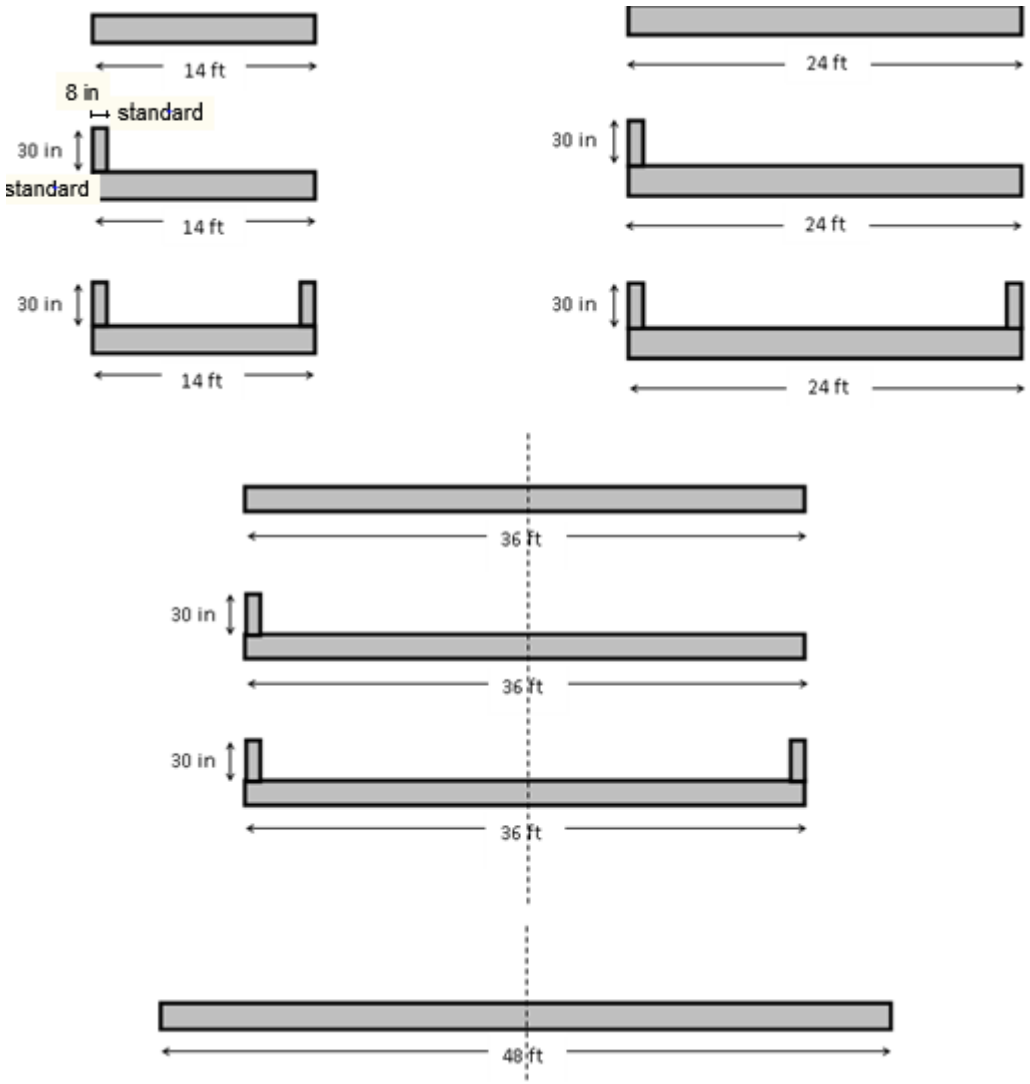


Figure 3.1: *Typical Cross Sections for One-lane, Two-Lane, Three-Lane and Four-Lane Bridge Cases with/without Railings (Base case of railing 8in x 30 in)*

Table 3.1: *Geometrical Characteristics and Dimensions of Modeled Bridges*

No. of Lanes n	Span Length S (ft)	Slab Thickness t (in)	Slab Width B (ft)	Railings Stiffness Factors
1	24	18	14	x0,x1,x2,x3, x4,x0.5
	36	21		
	46	24		
	54	27		
2	24	18	24	x0,x1,x2,x3, x4,x0.5
	36	21		
	46	24		
	54	27		
3	24	18	36	x0,x1,x2,x3, x4,x0.5
	36	21		
	46	24		
	54	27		
4	24	18	48	x0,x1,x2,x3, x4,x0.5
	36	21		
	46	24		
	54	27		

3.2.2 Physical Properties

The material properties of the normal-strength concrete adopted in the study are as follows:

- Compressive Strength: f'_c (28 days) = 4,000 psi
- Modulus of Elasticity: $E_c = 3.60 \times 10^6$ psi
- Poisson's Ratio: $\nu = 0.2$

3.2.3 AASHTO Design Truck

The analysis and design of any highway bridge must consider truck and lane loading. However, truck-loading provisions govern for short-span structures when considering AASHTO Standard Specifications (2002). Therefore, the bridges in this

study are analyzed for HS20-44 Truck load as given in AASHTO (Figure 3.2). The maximum weight of this truck is 72 Kips distributed over two rear axles and one front axle as follows:

- 32 Kips for each of the rear axles
- 8 Kips for the front axle

The three axles are equally spaced at 14 ft.

3.2.4 Longitudinal Loading Position of Design Trucks

For the straight bridges, the maximum moment is determined when the midpoint between the center of gravity of the HS-20 truck and the center load (at the middle axle) coincides with the mid-span of the bridge (Refer to Figure 3.3.a). In the study by Jabakhanji (1998) on straight concrete bridges, it is shown that minor deviations in maximum positive moment occur if the truck is positioned with its center load coinciding with the mid span of the bridge. This simplified position, shown in Figure 3.3b for the 36 ft span, was therefore adopted.

Table 3.2 shows the longitudinal truck position for the various span lengths considered.

3.2.5 Transverse Loading Position of Design Trucks

AASHTO HS20 design trucks are assumed to be traveling in the same direction on the bridge. Transversally, three loading conditions are considered, Center Lane, Center-Center and Edge loading conditions. In the Center-Lane loading condition, the design trucks are placed centered each in its own lane (Refer to Figure 3.4). While in the Center-Center loading condition, the design trucks are placed side-by-side at the middle of the bridge with a distance between adjacent trucks of 4 ft (Refer to Figure 3.5). In the Edge loading condition the design trucks are placed side-by-side close to

one edge (left) of the slab, such that the center of the left wheel of the leftmost truck is positioned at one foot from the left edge of the slab; the distance between the adjacent trucks is selected to be 4 ft and produce worst loading condition on the bridge (Refer to Figure 3.6). *Fawaz et al. (2015)* have shown that the Edge loading condition is always governing and thus only Edge loading conditions are considered for analysis in this study. But because of the One Railing Case, there are two edge loading conditions E1 and E2. E1 where the design truck is placed from the side of the railing in order to get maximum moment in the railing and E2 where the design is placed on the opposite side of the railing to get maximum moment in the slab.

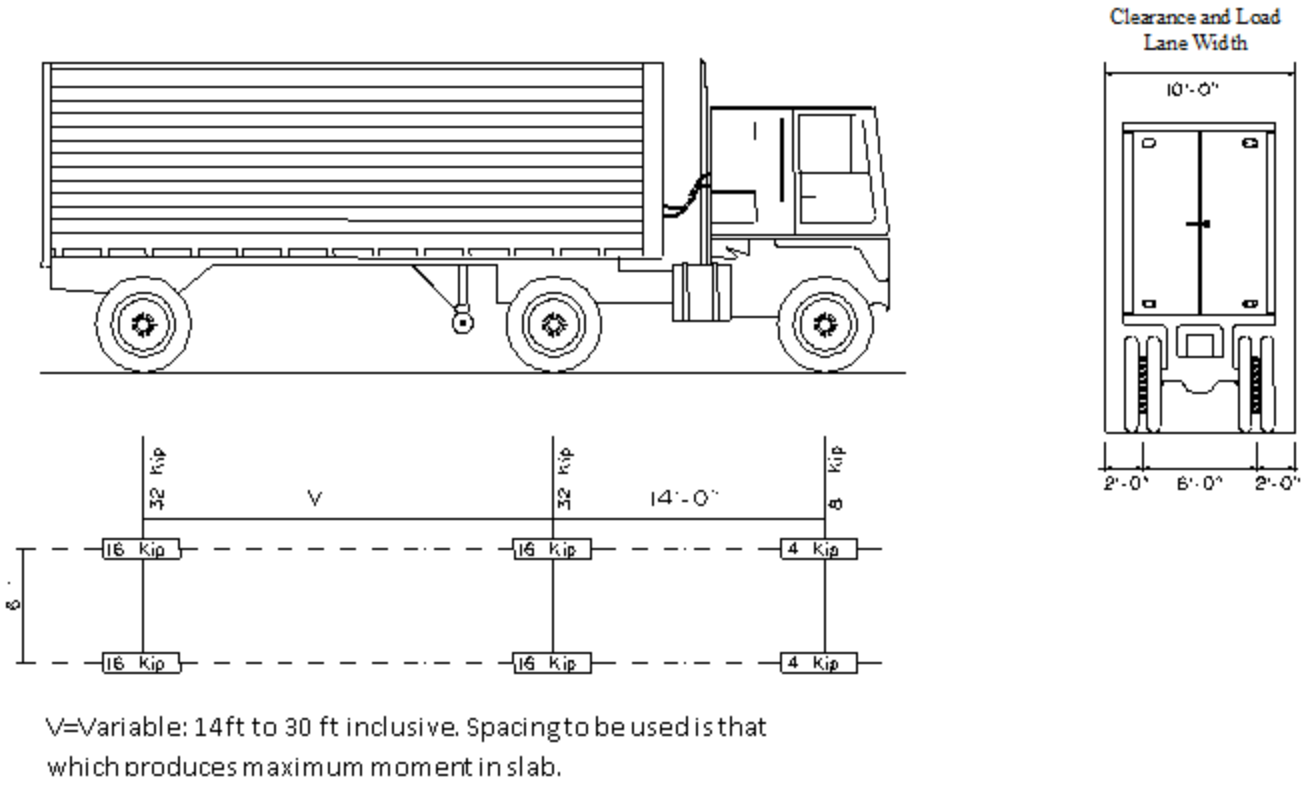


Figure 3.2: *AASHTO HS-20 Design Truck (Source: AASHTO Standard Specifications for Highway Bridges, 2002).*

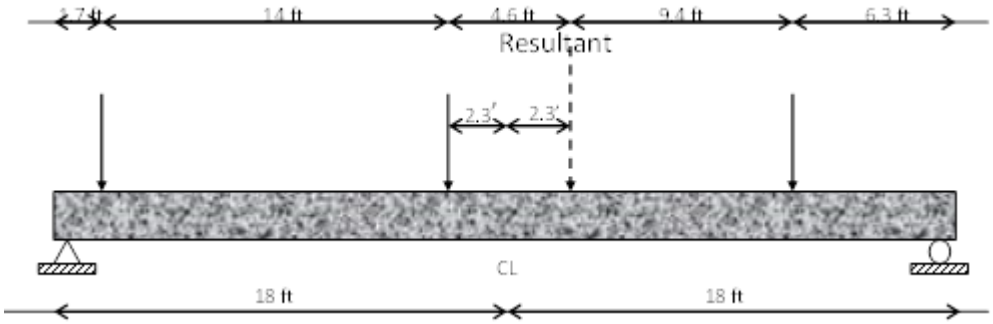


Figure 3.3 (a): *Longitudinal Truck Position in a Typical 36 ft One-Span Bridge for Maximum Positive Bending Moment.*

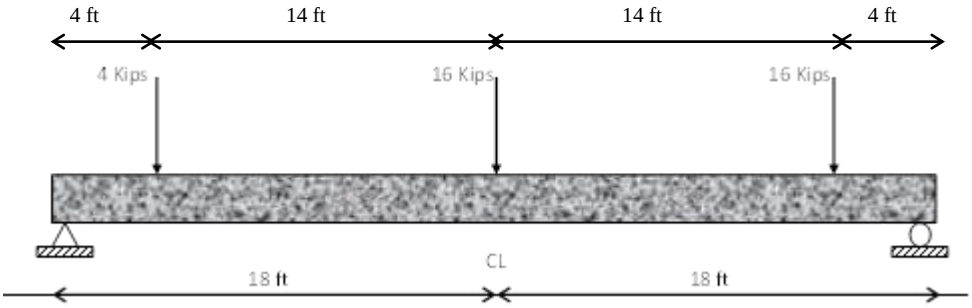
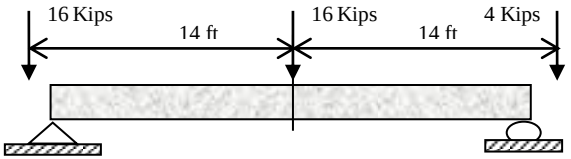
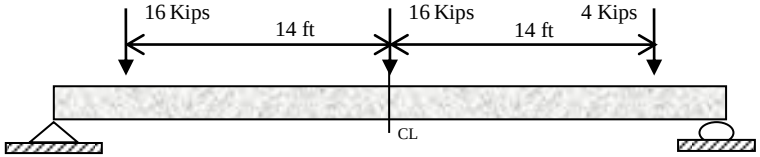
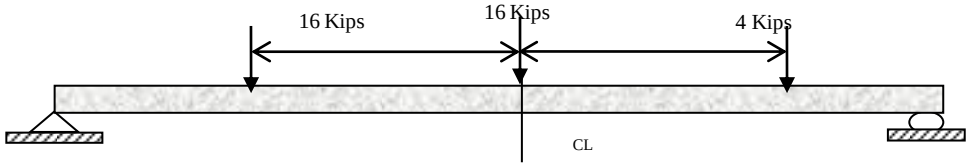
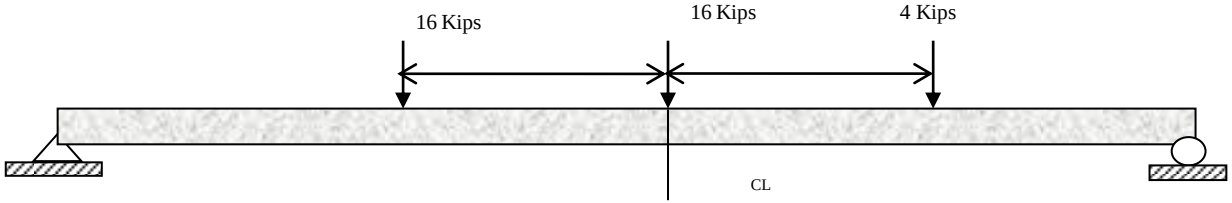


Figure 3.3 (b): *Assumed Longitudinal Truck Position in a Typical 36 ft One-Span Bridge for Maximum Positive Bending Moment in the Current Study.*

Table 3.2: *Longitudinal Truck Position in One-Span Bridges for Maximum Positive Moment at Centerline*

Span S (ft)	Thick t (in)	Truck Loading Position
24	18	
36	21	
46	24	
54	27	

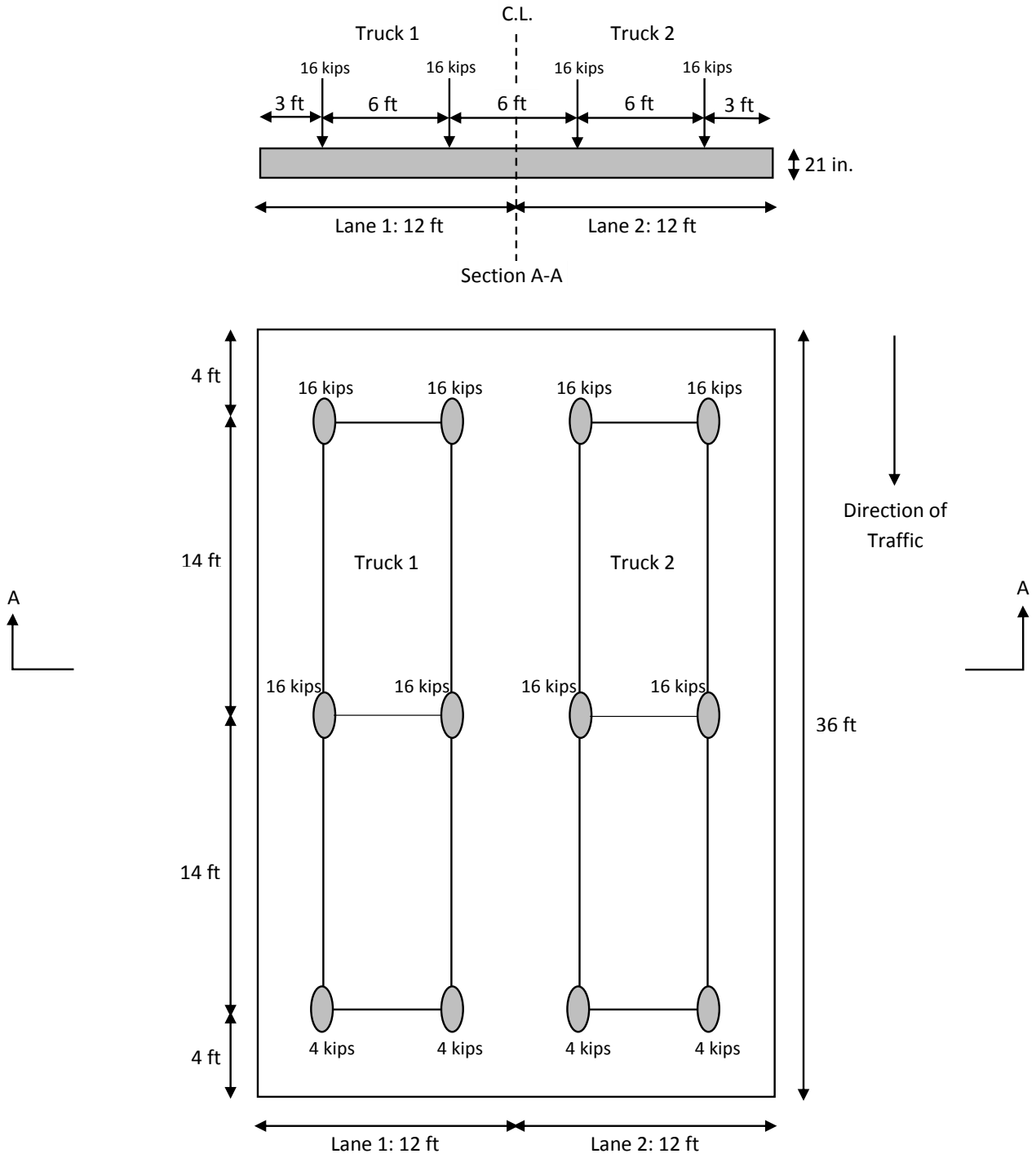


Figure 3.4: *Typical Cross-Section and Plan of Two-Lane 36 ft Span Bridge under Center-Lane Loading Condition.*

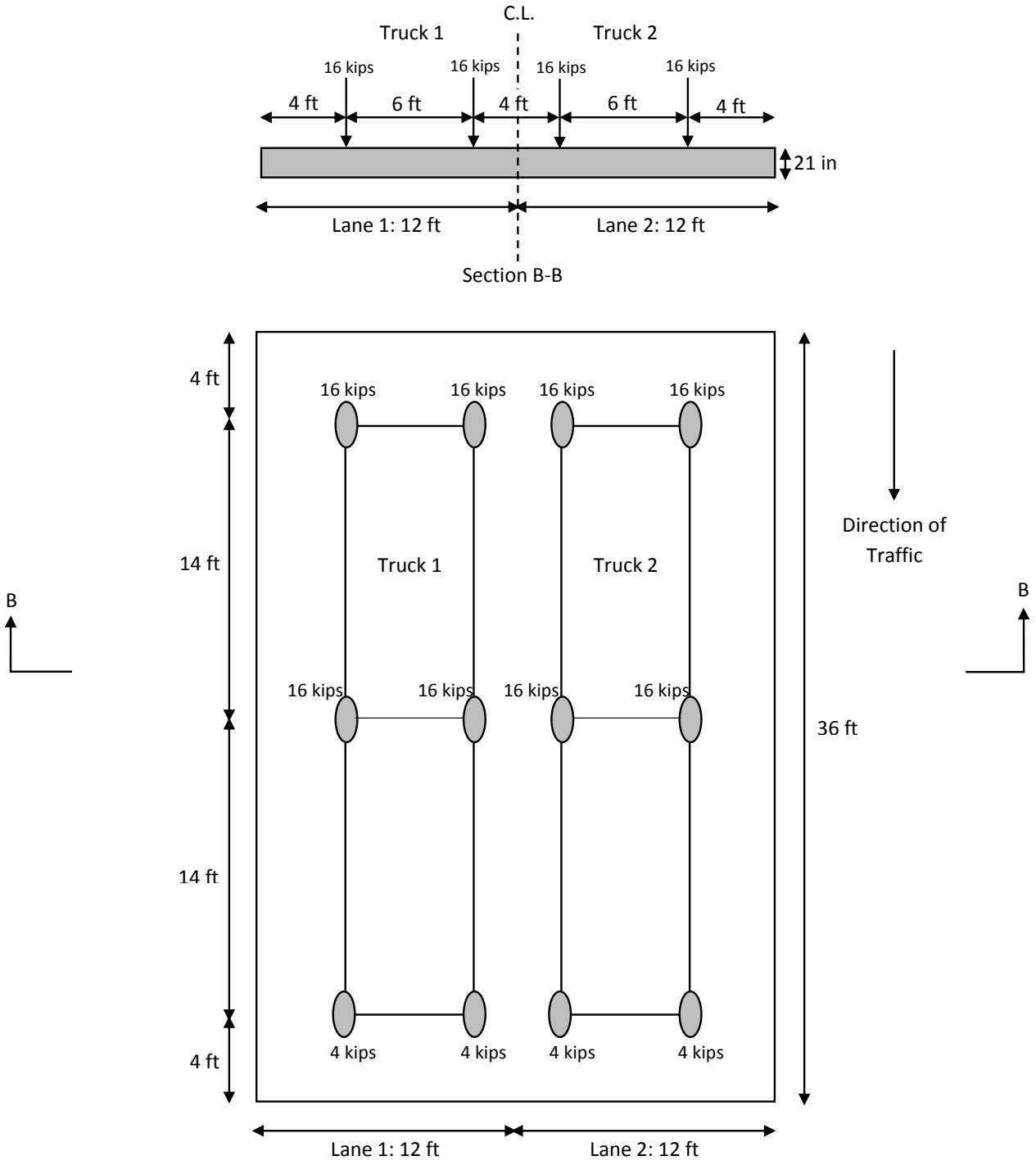


Figure 3.5: *Typical Cross-Section and Plan of Two-Lane 36 ft Span Bridge under Center-Center Loading Condition with no railings*

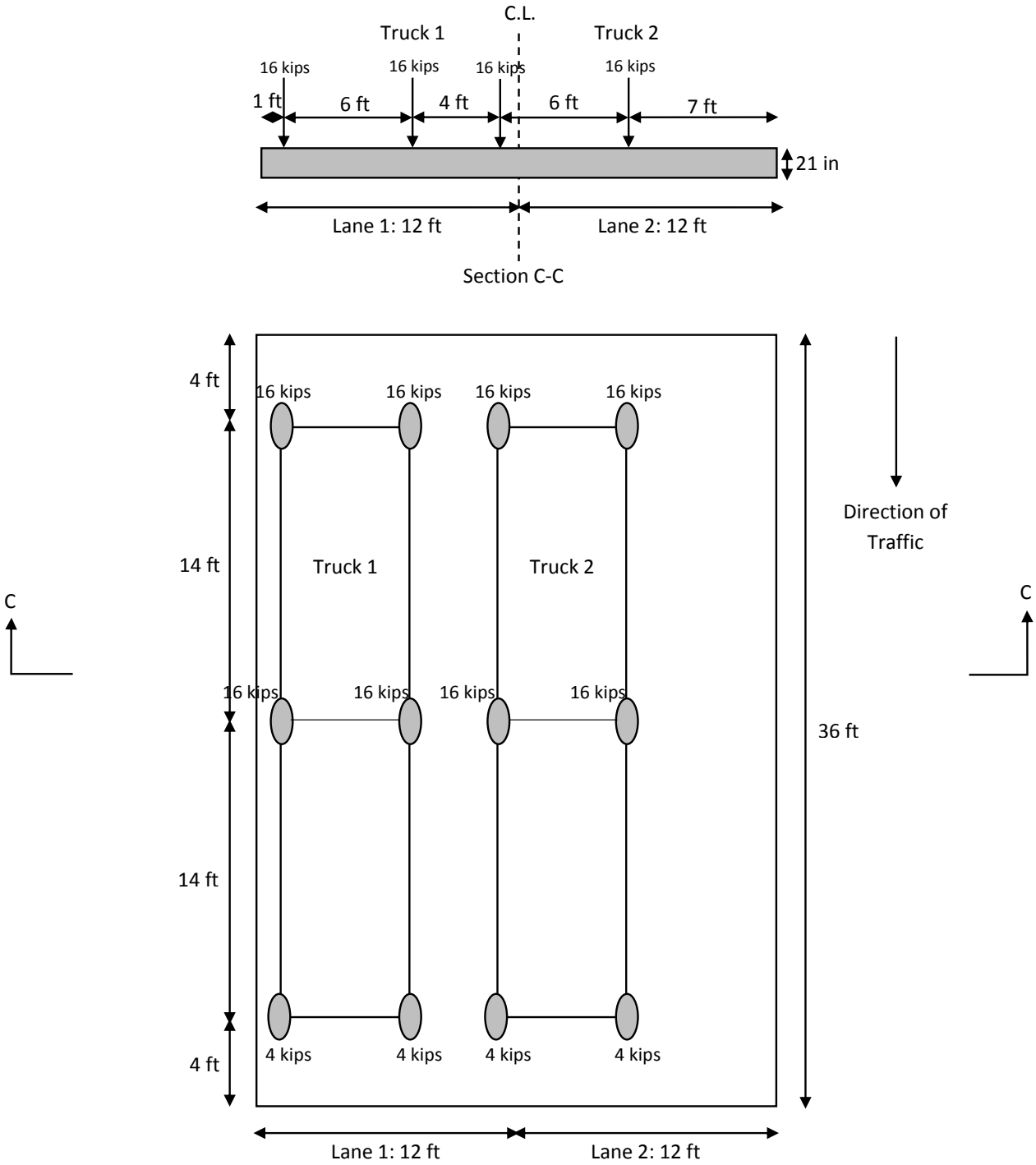


Figure 3.6: *Typical Cross-Section and Plan of Two-Lane 36 ft Span Bridge under Edge Loading Condition with no railings*

3.2.6 Railings Implementation Methodology

Various positions of the design trucks are assumed, longitudinally and transversally, in order to produce maximum bending moments. The cases without railings are first analyzed and considered as the reference cases. Railings are then placed integrally at either or both ends of the slab edges. The wheel load distribution on the bridge slab at the critical section for the reference and railings cases are calculated and compared. The results are also assessed with the AASHTO Standard Specifications (2002) and AASHTO LRFD (2010) procedures. Figures 3.7 to 3.10 show typical cross sections and plans of straight bridges with edge loading and different combinations of transverse loading conditions and railings.

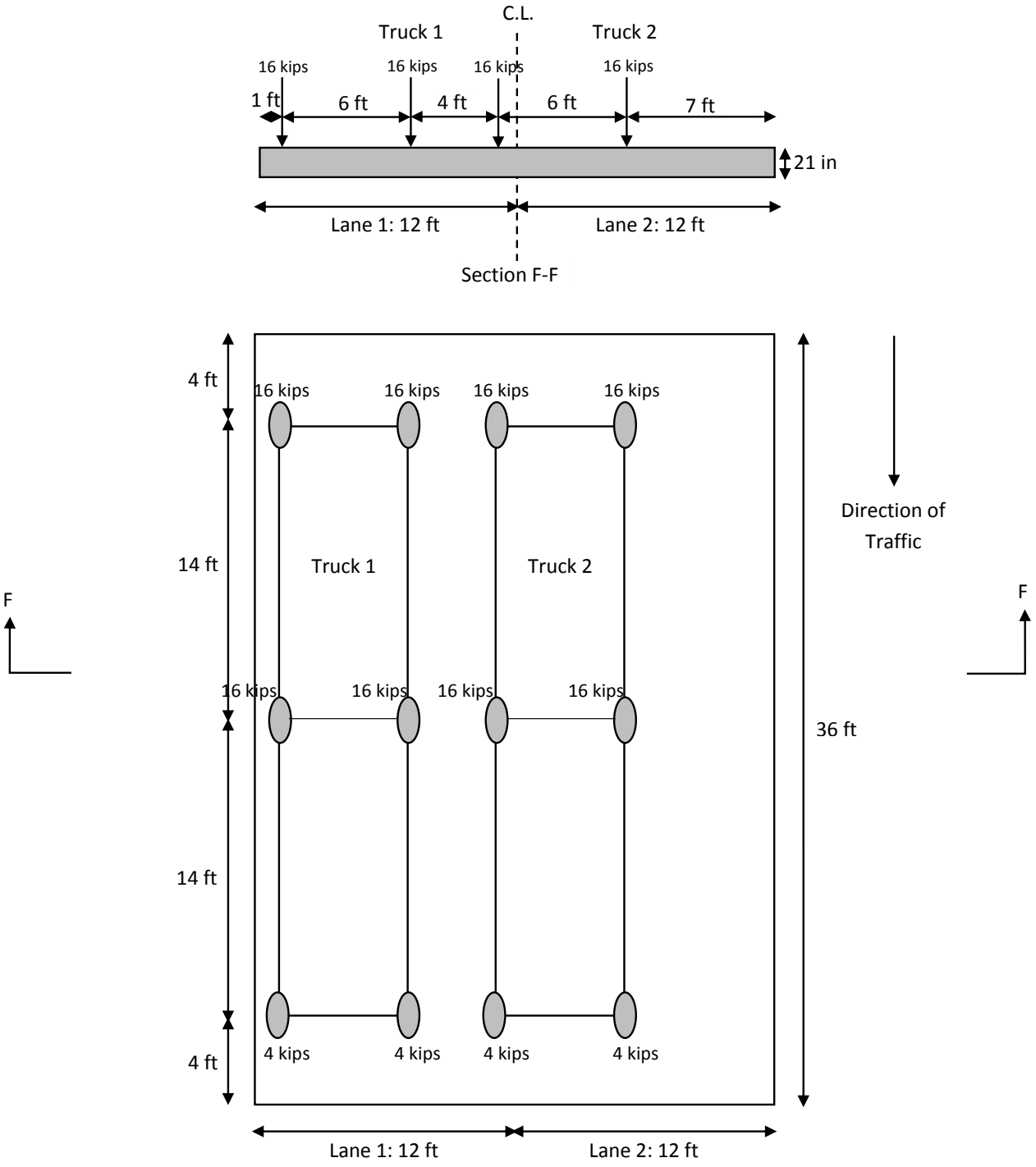


Figure 3.7: *Typical Cross-Section and Plan of a Two-Lane 36 ft Span Straight Bridge with No Railings under Edge Loading E1.*

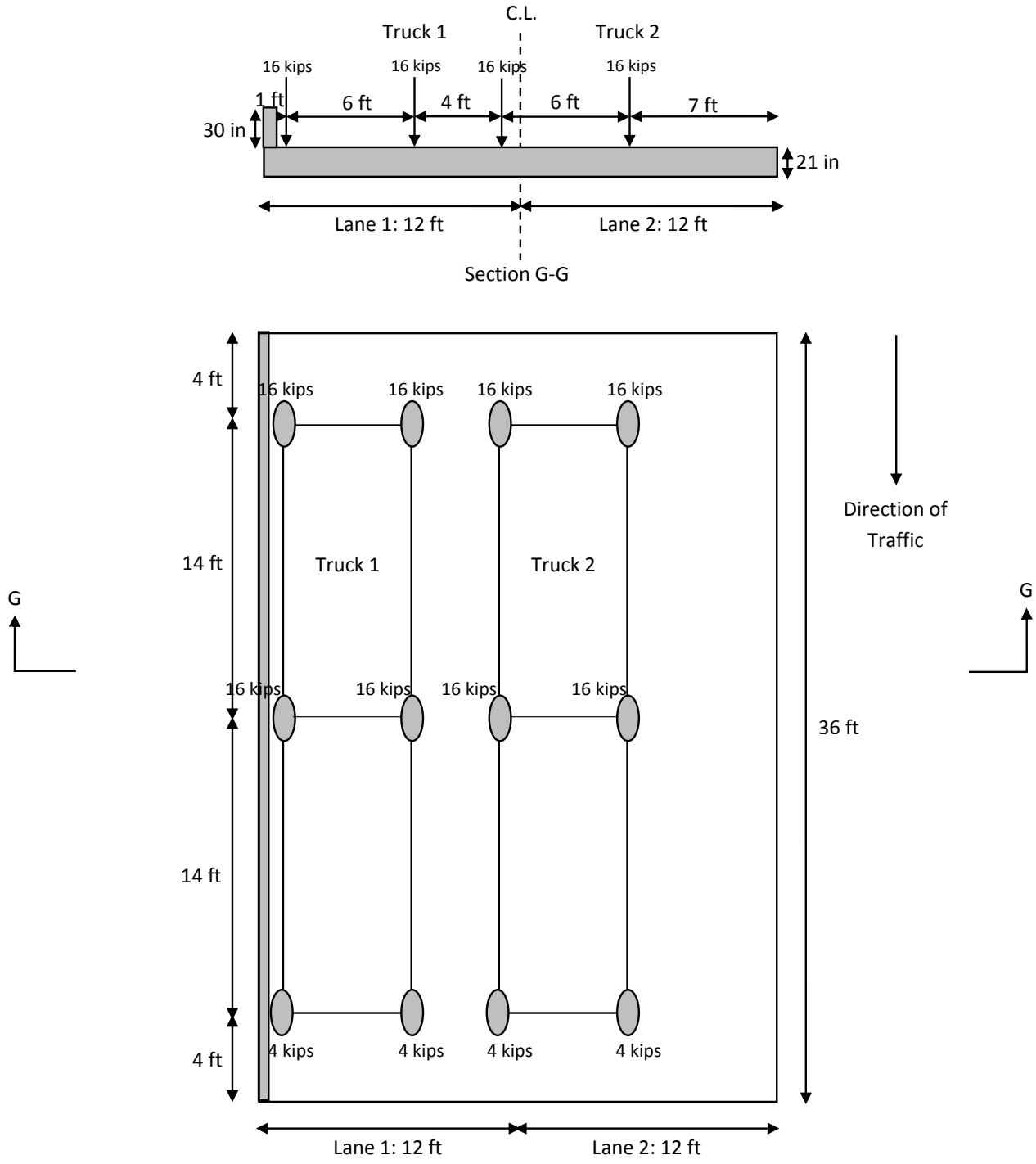


Figure 3.8: *Typical Cross-Section and Plan of a Two-Lane 36 ft straight Bridge with one Railing(Left) under Edge Loading E1.*

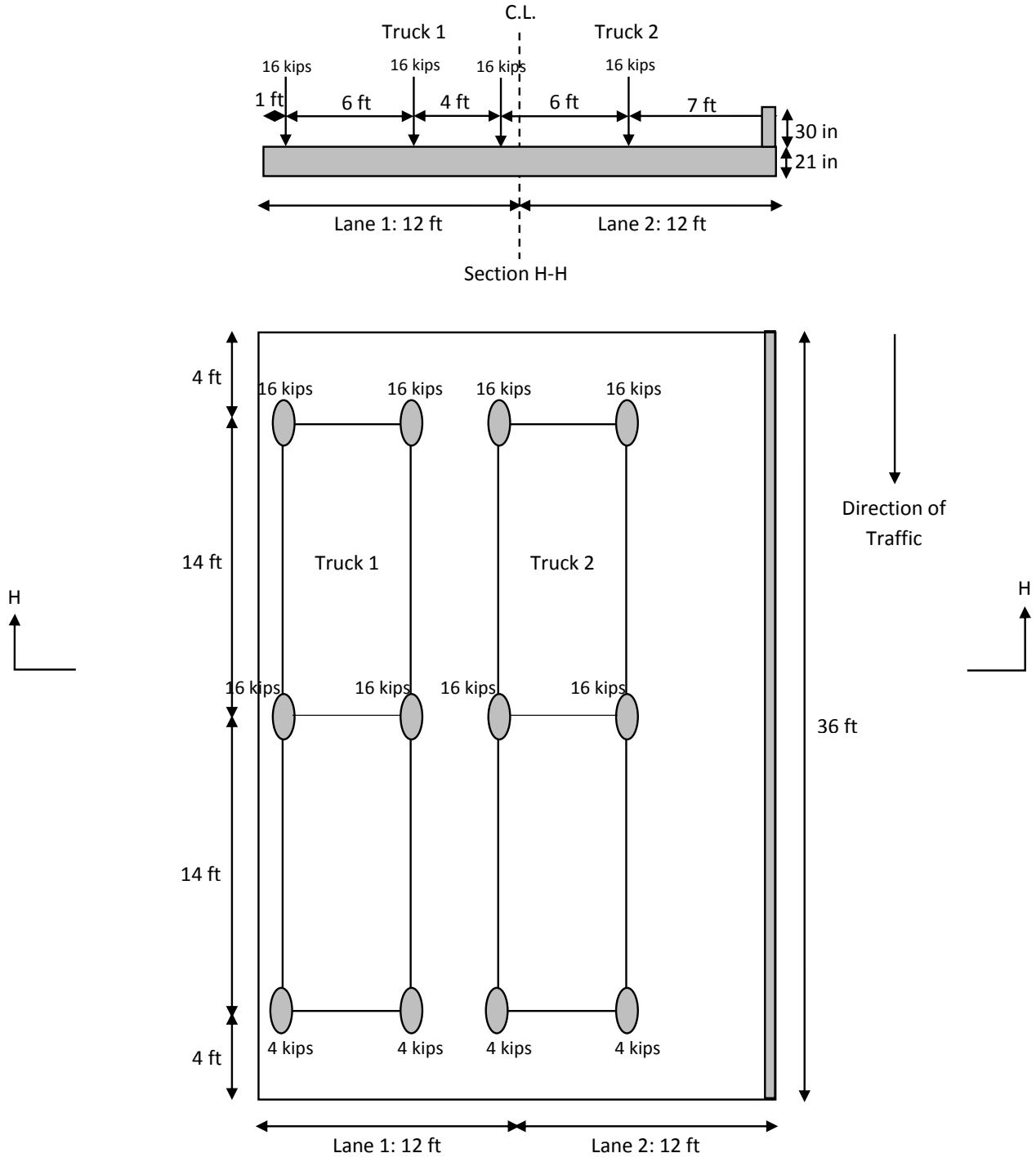


Figure 3.9: *Typical Cross-Section and Plan of a Two-Lane 36 ft Span Straight Bridge with One Railing under Edge Loading E1.*

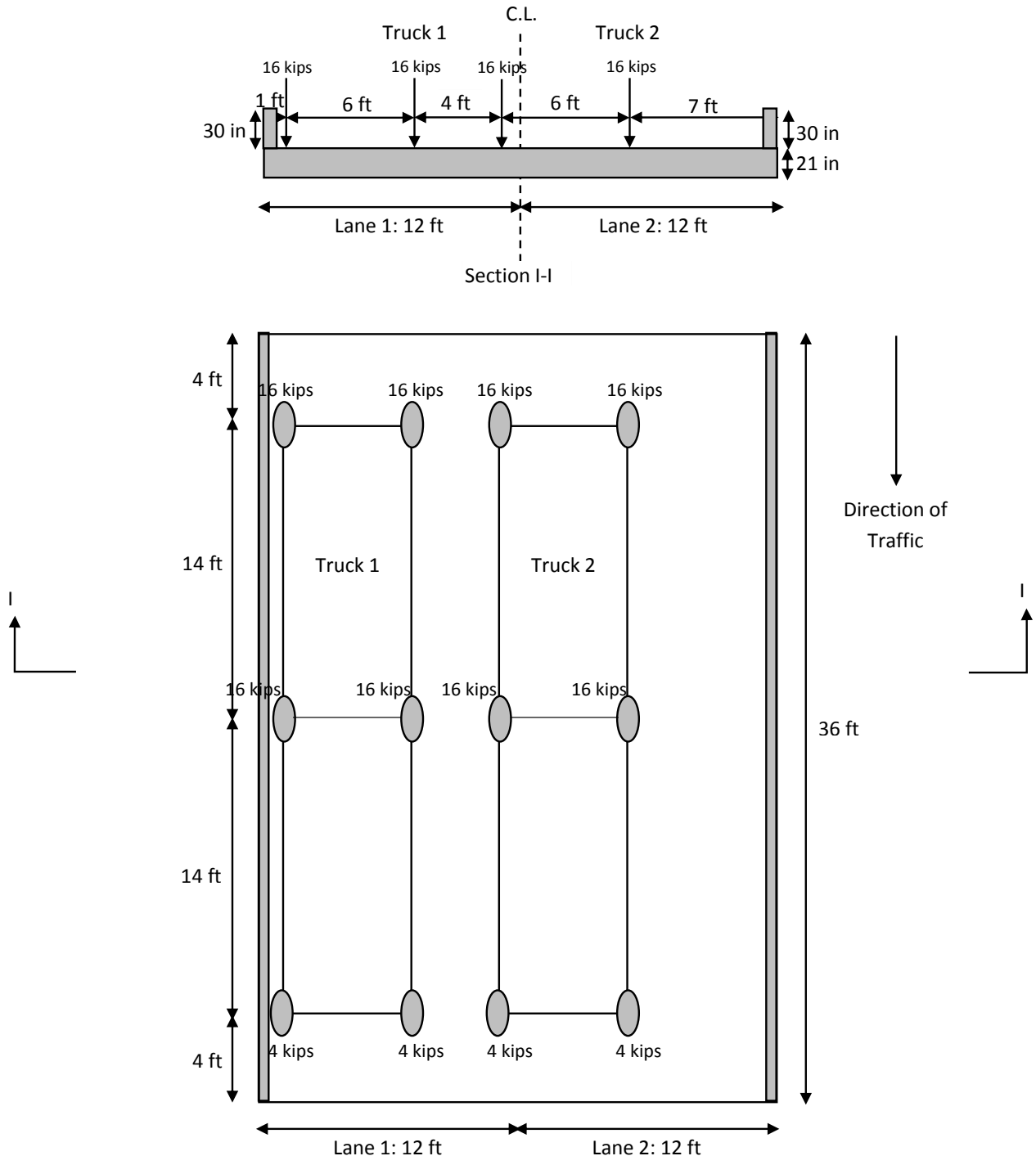


Figure 3.10: *Typical Cross-Section and Plan of a Two-Lane 36 ft Span Straight Bridge with two Railings under Edge Loading E1.*

3.3 Finite Element Modeling and Analysis

The finite element method is used to investigate the effect of span length and slab width on simply supported one to four lanes concrete slab bridges in the presence of railings. Using SAP2000 (2012), the bridge is discretized into a convenient number of square four-node shell elements with six degrees of freedom per node, capable of simulating the membrane and plate-bending behavior. All elements are assumed to be linear elastic and the analysis assumed small deformations and deflections, and shear deformation was neglected. The selection of shell elements dimensions was based on the previous study by *Mabsout et al. (2004)* on simply supported concrete slab bridges which investigated the appropriate mesh discretization. A comparison was made on 0.5×0.5 ft, 1×1 ft and 2×2 ft elements, and the results obtained were nearly identical for the three cases. Thus, the 1×1 ft element size was adopted as sufficient for the bridge cases modeling. This mesh is also convenient for placing truck loads at 1 ft intervals to investigate maximum moments.

Railings modeling assessed using two mesh types:

- As vertical shell elements either on top of the slab or concentric elements.
- As equivalent frame elements either eccentric with moment of inertia equivalent to the top shells ($bh^3/3$) or concentric with moment of inertia equivalent to the concentric shell ($bh^3/12$).

The model adopted in this study is the simpler eccentric frame element which leads to similar results as the realistic case of top shells (*Fawaz et al. 2015*).

The support condition for the simply supported bridges was modeled as follows:

For the one-span bridges, the left pier is assigned as hinge support and the right one as roller. Concentrated wheel loads of the HS-20 truck are applied at nodes to produce the maximum bending moment.

Longitudinal bending moments and deflections are reported and investigated in this study. SAP2000 generates the finite element models and contour plots of bending moments and deflections.

The geometry, loading, deflection diagram and longitudinal moment contours for a typical 36 ft length, two-lane Bridge with two railings are presented in Figures 3.11.a, 3.11.b and 3.11.c below.

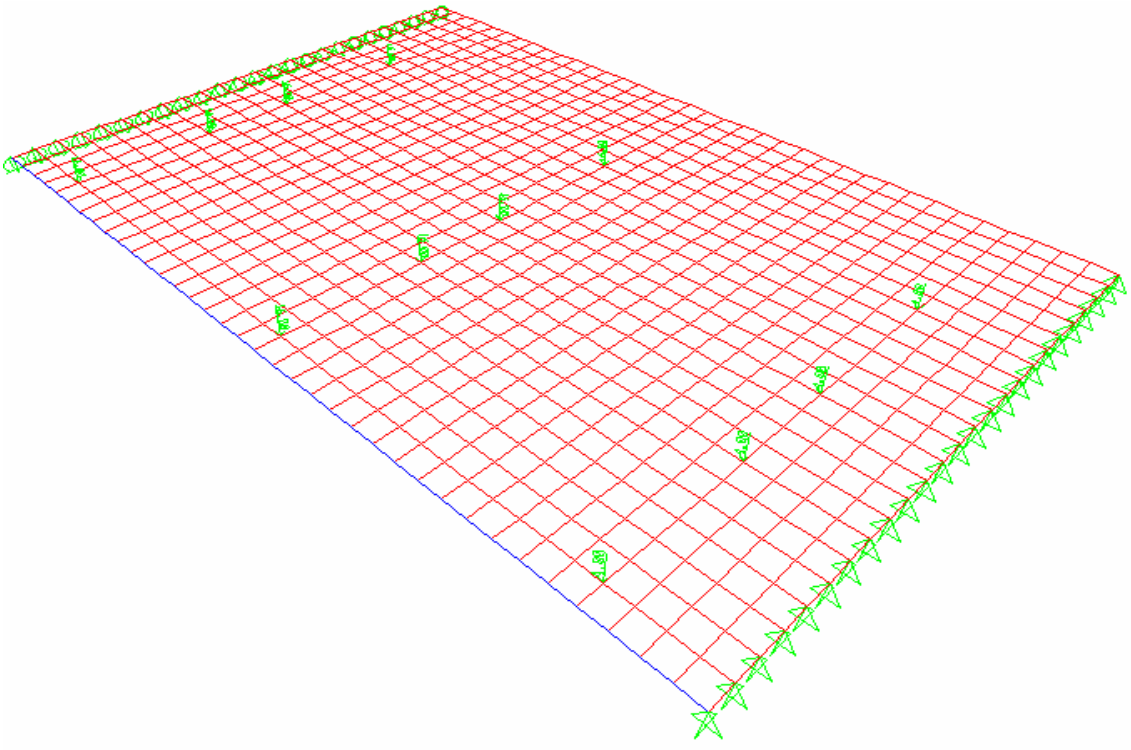


Fig. 3.11. (a) *Finite Element Model of Two-Lane Bridge, Span 36ft, Edge Loading*

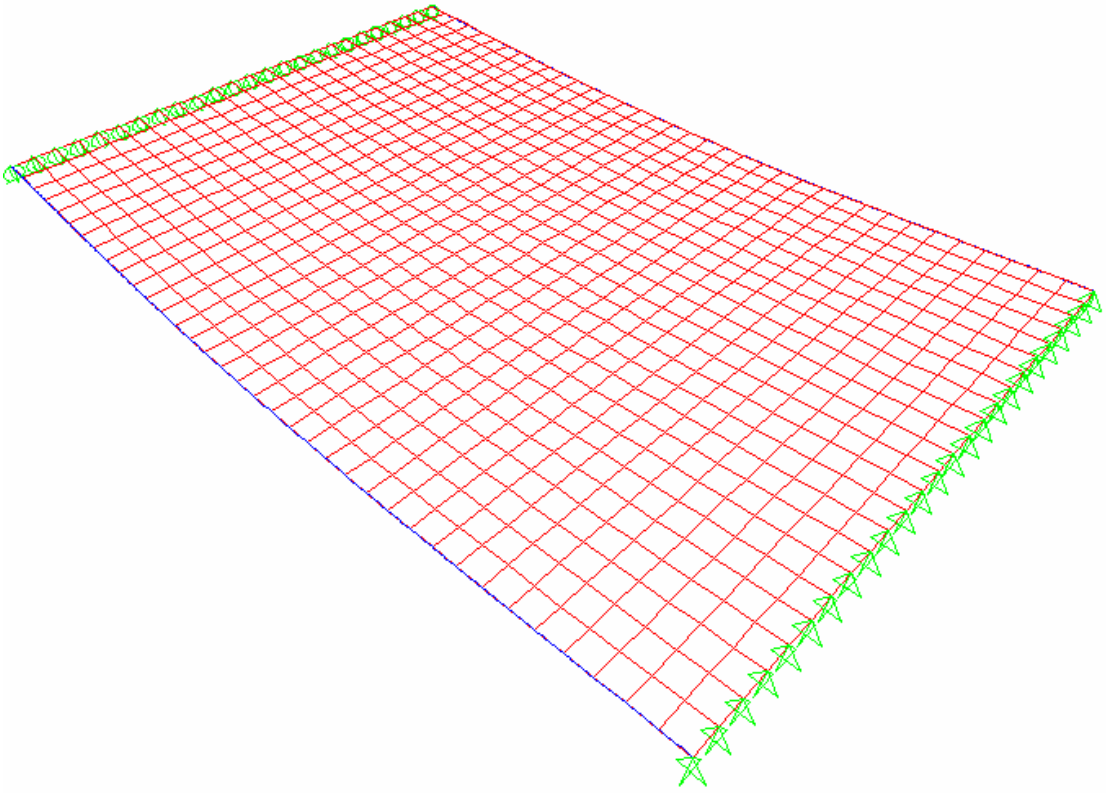


Fig. 3.11. (b) *Slab Deflection of Two-Lane Bridge, Span 36ft, Edge Loading.*

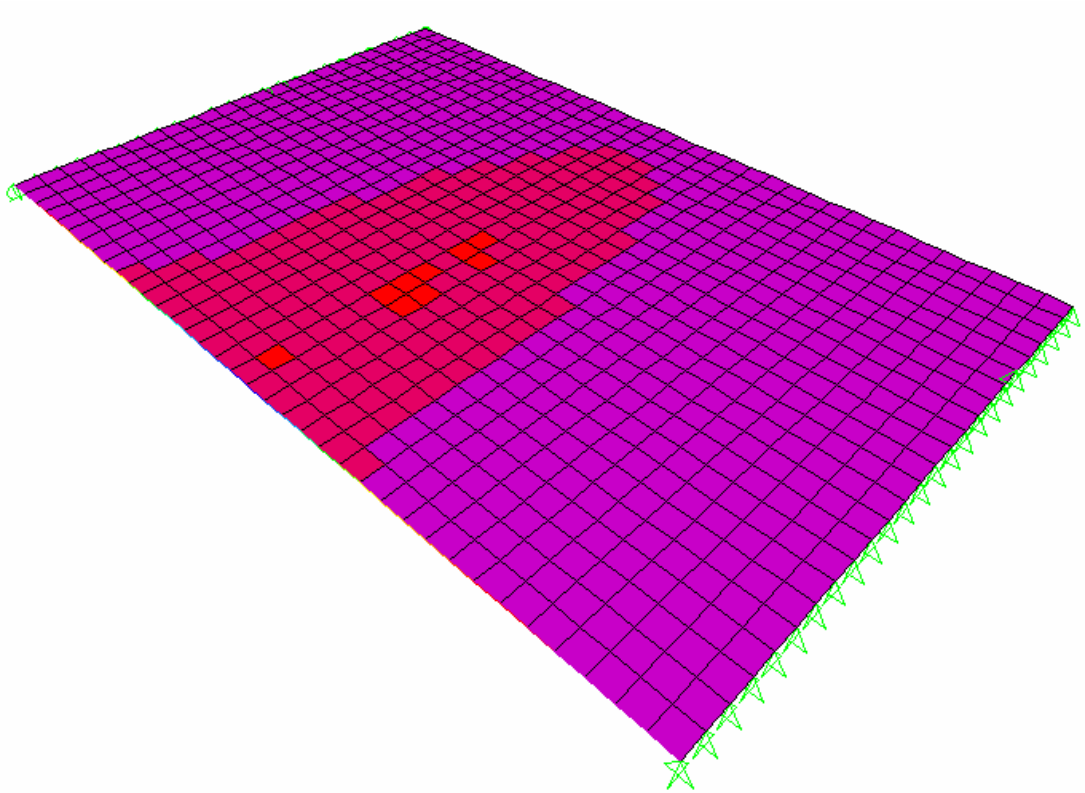


Fig. 3.11. (c) *Longitudinal Bending Moment Distribution in Two-Lane bridge, Span 36ft, Edge Loading.*

3.4 Summary

A total number of 320 bridge cases are analyzed based on the variation of the geometric parameters, loading distribution and railings presence and stiffness.

Four different span sizes were adopted with a total number of four span widths and with five different railings stiffness factors, including the case with no railings.

The case of straight bridges with no railings will serve as reference bridges in order to investigate the influence of railings stiffnesses on concrete slab bridges.

For organizational purposes, the SAP2000 files are conveniently labeled for the various geometric, loading and railings presence configurations. For example, "R0L1S46Hx1E1", where "*R0"* stands for the absence of railings presence, "*L1"* for 1 lane, "*S46"* for the 46 ft span length, "x1" for the railings stiffness factor and "E1" for E1 loading case. Similarly for "R1L1S46Hx1E2", where "R1" stands for the presence of one railing and "E2" for the E2 loading case. The labeling for the 320 bridge cases is tabulated in Tables 3.3, 3.4, 3.5 and 3.6.

Table 3.3: *SAP2000 Files Organization and Labeling for all Bridges with No Railings and with E1 Transverse Loading Condition (SET 1)*

No.of Lanes n	Span Length (ft)	Stiffness Factor					
		x0	x1	x2	x3	x4	x0.5
1	24	R0L1S24Hx0E1	R0L1S24Hx1E1	R0L1S24Hx2E1	R0L1S24Hx3E1	R0L1S24Hx4E1	R0L1S24Hx0.5E1
	36	R0L1S36Hx0E1	R0L1S36Hx1E1	R0L1S36Hx2E1	R0L1S36Hx3E1	R0L1S36Hx4E1	R0L1S36Hx0.5E1
	46	R0L1S46Hx0E1	R0L1S46Hx1E1	R0L1S46Hx2E1	R0L1S46Hx3E1	R0L1S46Hx4E1	R0L1S46Hx0.5E1
	54	R0L1S54Hx0E1	R0L1S54Hx1E1	R0L1S54Hx2E1	R0L1S54Hx3E1	R0L1S54Hx4E1	R0L1S54Hx0.5E1
2	24	R0L2S24Hx0E1	R0L2S24Hx1E1	R0L2S24Hx2E1	R0L2S24Hx3E1	R0L2S24Hx4E1	R0L1S24Hx0.5E1
	36	R0L2S36Hx0E1	R0L2S36Hx1E1	R0L2S36Hx2E1	R0L2S36Hx3E1	R0L2S36Hx4E1	R0L2S36Hx0.5E1
	46	R0L2S46Hx0E1	R0L2S46Hx1E1	R0L2S46Hx2E1	R0L2S46Hx3E1	R0L2S46Hx4E1	R0L2S46Hx0.5E1
	54	R0L2S54Hx0E1	R0L2S54Hx1E1	R0L2S54Hx2E1	R0L2S54Hx3E1	R0L2S54Hx4E1	R0L2S54Hx0.5E1
3	24	R0L3S24Hx0E1	R0L3S24Hx1E1	R0L3S24Hx2E1	R0L3S24Hx3E1	R0L3S24Hx4E1	R0L3S24Hx0.5E1
	36	R0L3S36Hx0E1	R0L3S36Hx1E1	R0L3S36Hx2E1	R0L3S36Hx3E1	R0L3S36Hx4E1	R0L3S36Hx0.5E1
	46	R0L3S46Hx0E1	R0L3S46Hx1E1	R0L3S46Hx2E1	R0L3S46Hx3E1	R0L3S46Hx4E1	R0L3S46Hx0.5E1
	54	R0L3S54Hx0E1	R0L3S54Hx1E1	R0L3S54Hx2E1	R0L3S54Hx3E1	R0L3S54Hx4E1	R0L3S54Hx0.5E1
4	24	R0L4S24Hx0E1	R0L4S24Hx1E1	R0L4S24Hx2E1	R0L4S24Hx3E1	R0L4S24Hx4E1	R0L4S24Hx0.5E1
	36	R0L4S36Hx0E1	R0L4S36Hx1E1	R0L4S36Hx2E1	R0L4S36Hx3E1	R0L4S36Hx4E1	R0L4S36Hx0.5E1
	46	R0L4S46Hx0E1	R0L4S46Hx1E1	R0L4S46Hx2E1	R0L4S46Hx3E1	R0L4S46Hx4E1	R0L4S46Hx0.5E1
	54	R0L4S54Hx0E1	R0L4S54Hx1E1	R0L4S54Hx2E1	R0L4S54Hx3E1	R0L4S54Hx4E1	R0L4S54Hx0.5E1

Table 3.4: *SAP2000 Files Organization and Labeling for all Bridges with One Railing and with E1 Transverse Loading Condition (SET 2)*

No.of Lanes n	Span Length (ft)	Stiffness Factor					
		x0	x1	x2	x3	x4	x0.5
1	24	R0L1S24Hx0E1	R1L1S24Hx1E1	R1L1S24Hx2E1	R1L1S24Hx3E1	R1L1S24Hx4E1	R1L1S24Hx0.5E1
	36	R0L1S36Hx0E1	R1L1S36Hx1E1	R1L1S36Hx2E1	R1L1S36Hx3E1	R1L1S36Hx4E1	R1L1S36Hx0.5E1
	46	R0L1S46Hx0E1	R1L1S46Hx1E1	R1L1S46Hx2E1	R1L1S46Hx3E1	R1L1S46Hx4E1	R1L1S46Hx0.5E1
	54	R0L1S54Hx0E1	R1L1S54Hx1E1	R1L1S54Hx2E1	R1L1S54Hx3E1	R1L1S54Hx4E1	R1L1S54Hx0.5E1
2	24	R0L2S24Hx0E1	R1L2S24Hx1E1	R1L2S24Hx2E1	R1L2S24Hx3E1	R1L2S24Hx4E1	R1L1S24Hx0.5E1
	36	R0L2S36Hx0E1	R1L2S36Hx1E1	R1L2S36Hx2E1	R1L2S36Hx3E1	R1L2S36Hx4E1	R1L2S36Hx0.5E1
	46	R0L2S46Hx0E1	R1L2S46Hx1E1	R1L2S46Hx2E1	R1L2S46Hx3E1	R1L2S46Hx4E1	R1L2S46Hx0.5E1
	54	R0L2S54Hx0E1	R1L2S54Hx1E1	R1L2S54Hx2E1	R1L2S54Hx3E1	R1L2S54Hx4E1	R1L2S54Hx0.5E1
3	24	R0L3S24Hx0E1	R1L3S24Hx1E1	R1L3S24Hx2E1	R1L3S24Hx3E1	R1L3S24Hx4E1	R1L3S24Hx0.5E1
	36	R0L3S36Hx0E1	R1L3S36Hx1E1	R1L3S36Hx2E1	R1L3S36Hx3E1	R1L3S36Hx4E1	R1L3S36Hx0.5E1
	46	R0L3S46Hx0E1	R1L3S46Hx1E1	R1L3S46Hx2E1	R1L3S46Hx3E1	R1L3S46Hx4E1	R1L3S46Hx0.5E1
	54	R0L3S54Hx0E1	R1L3S54Hx1E1	R1L3S54Hx2E1	R1L3S54Hx3E1	R1L3S54Hx4E1	R1L3S54Hx0.5E1
4	24	R0L4S24Hx0E1	R1L4S24Hx1E1	R1L4S24Hx2E1	R1L4S24Hx3E1	R1L4S24Hx4E1	R1L4S24Hx0.5E1
	36	R0L4S36Hx0E1	R1L4S36Hx1E1	R1L4S36Hx2E1	R1L4S36Hx3E1	R1L4S36Hx4E1	R1L4S36Hx0.5E1
	46	R0L4S46Hx0E1	R1L4S46Hx1E1	R1L4S46Hx2E1	R1L4S46Hx3E1	R1L4S46Hx4E1	R1L4S46Hx0.5E1
	54	R0L4S54Hx0E1	R1L4S54Hx1E1	R1L4S54Hx2E1	R1L4S54Hx3E1	R1L4S54Hx4E1	R1L4S54Hx0.5E1

Table 3.5: *SAP2000 Files Organization and Labeling for all Bridges with One Railing and with E2 Transverse Loading Condition (SET 3)*

No.of Lanes n	Span Length (ft)	Stiffness Factor					
		x0	x1	x2	x3	x4	x0.5
1	24	R0L1S24Hx0E1	R1L1S24Hx1E2	R1L1S24Hx2E2	R1L1S24Hx3E2	R1L1S24Hx4E2	R1L1S24Hx0.5E2
	36	R0L1S36Hx0E1	R1L1S36Hx1E2	R1L1S36Hx2E2	R1L1S36Hx3E2	R1L1S36Hx4E2	R1L1S36Hx0.5E2
	46	R0L1S46Hx0E1	R1L1S46Hx1E2	R1L1S46Hx2E2	R1L1S46Hx3E2	R1L1S46Hx4E2	R1L1S46Hx0.5E2
	54	R0L1S54Hx0E1	R1L1S54Hx1E2	R1L1S54Hx2E2	R1L1S54Hx3E2	R1L1S54Hx4E2	R1L1S54Hx0.5E2
2	24	R0L2S24Hx0E1	R1L2S24Hx1E2	R1L2S24Hx2E2	R1L2S24Hx3E2	R1L2S24Hx4E2	R1L1S24Hx0.5E2
	36	R0L2S36Hx0E1	R1L2S36Hx1E2	R1L2S36Hx2E2	R1L2S36Hx3E2	R1L2S36Hx4E2	R1L2S36Hx0.5E2
	46	R0L2S46Hx0E1	R1L2S46Hx1E2	R1L2S46Hx2E2	R1L2S46Hx3E2	R1L2S46Hx4E2	R1L2S46Hx0.5E2
	54	R0L2S54Hx0E1	R1L2S54Hx1E2	R1L2S54Hx2E2	R1L2S54Hx3E2	R1L2S54Hx4E2	R1L2S54Hx0.5E2
3	24	R0L3S24Hx0E1	R1L3S24Hx1E2	R1L3S24Hx2E2	R1L3S24Hx3E2	R1L3S24Hx4E2	R1L3S24Hx0.5E2
	36	R0L3S36Hx0E1	R1L3S36Hx1E2	R1L3S36Hx2E2	R1L3S36Hx3E2	R1L3S36Hx4E2	R1L3S36Hx0.5E2
	46	R0L3S46Hx0E1	R1L3S46Hx1E2	R1L3S46Hx2E2	R1L3S46Hx3E2	R1L3S46Hx4E2	R1L3S46Hx0.5E2
	54	R0L3S54Hx0E1	R1L3S54Hx1E2	R1L3S54Hx2E2	R1L3S54Hx3E2	R1L3S54Hx4E2	R1L3S54Hx0.5E2
4	24	R0L4S24Hx0E1	R1L4S24Hx1E2	R1L4S24Hx2E2	R1L4S24Hx3E2	R1L4S24Hx4E2	R1L4S24Hx0.5E2
	36	R0L4S36Hx0E1	R1L4S36Hx1E2	R1L4S36Hx2E2	R1L4S36Hx3E2	R1L4S36Hx4E2	R1L4S36Hx0.5E2
	46	R0L4S46Hx0E1	R1L4S46Hx1E2	R1L4S46Hx2E2	R1L4S46Hx3E2	R1L4S46Hx4E2	R1L4S46Hx0.5E2
	54	R0L4S54Hx0E1	R1L4S54Hx1E2	R1L4S54Hx2E2	R1L4S54Hx3E2	R1L4S54Hx4E2	R1L4S54Hx0.5E2

Table 3.6: *SAP2000 Files Organization and Labeling for all Bridges with Two Railings and with E1 Transverse Loading Condition (SET 4)*

No.of Lanes n	Span Length (ft)	Stiffness Factor					
		x0	x1	x2	x3	x4	x0.5
1	24	R0L1S24Hx0E1	R2L1S24Hx1E1	R2L1S24Hx2E1	R2L1S24Hx3E1	R2L1S24Hx4E1	R2L1S24Hx0.5E1
	36	R0L1S36Hx0E1	R2L1S36Hx1E1	R2L1S36Hx2E1	R2L1S36Hx3E1	R2L1S36Hx4E1	R2L1S36Hx0.5E1
	46	R0L1S46Hx0E1	R2L1S46Hx1E1	R2L1S46Hx2E1	R2L1S46Hx3E1	R2L1S46Hx4E1	R2L1S46Hx0.5E1
	54	R0L1S54Hx0E1	R2L1S54Hx1E1	R2L1S54Hx2E1	R2L1S54Hx3E1	R2L1S54Hx4E1	R2L1S54Hx0.5E1
2	24	R0L2S24Hx0E1	R2L2S24Hx1E1	R2L2S24Hx2E1	R2L2S24Hx3E1	R2L2S24Hx4E1	R2L1S24Hx0.5E1
	36	R0L2S36Hx0E1	R2L2S36Hx1E1	R2L2S36Hx2E1	R2L2S36Hx3E1	R2L2S36Hx4E1	R2L2S36Hx0.5E1
	46	R0L2S46Hx0E1	R2L2S46Hx1E1	R2L2S46Hx2E1	R2L2S46Hx3E1	R2L2S46Hx4E1	R2L2S46Hx0.5E1
	54	R0L2S54Hx0E1	R2L2S54Hx1E1	R2L2S54Hx2E1	R2L2S54Hx3E1	R2L2S54Hx4E1	R2L2S54Hx0.5E1
3	24	R0L3S24Hx0E1	R2L3S24Hx1E1	R2L3S24Hx2E1	R2L3S24Hx3E1	R2L3S24Hx4E1	R2L3S24Hx0.5E1
	36	R0L3S36Hx0E1	R2L3S36Hx1E1	R2L3S36Hx2E1	R2L3S36Hx3E1	R2L3S36Hx4E1	R2L3S36Hx0.5E1
	46	R0L3S46Hx0E1	R2L3S46Hx1E1	R2L3S46Hx2E1	R2L3S46Hx3E1	R2L3S46Hx4E1	R2L3S46Hx0.5E1
	54	R0L3S54Hx0E1	R2L3S54Hx1E1	R2L3S54Hx2E1	R2L3S54Hx3E1	R2L3S54Hx4E1	R2L3S54Hx0.5E1
4	24	R0L4S24Hx0E1	R2L4S24Hx1E1	R2L4S24Hx2E1	R2L4S24Hx3E1	R2L4S24Hx4E1	R2L4S24Hx0.5E1
	36	R0L4S36Hx0E1	R2L4S36Hx1E1	R2L4S36Hx2E1	R2L4S36Hx3E1	R2L4S36Hx4E1	R2L4S36Hx0.5E1
	46	R0L4S46Hx0E1	R2L4S46Hx1E1	R2L4S46Hx2E1	R2L4S46Hx3E1	R2L4S46Hx4E1	R2L4S46Hx0.5E1
	54	R0L4S54Hx0E1	R2L4S54Hx1E1	R2L4S54Hx2E1	R2L4S54Hx3E1	R2L4S54Hx4E1	R2L4S54Hx0.5E1

CHAPTER 4
ANALYSIS RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results of the parametric study of the bridge cases presented in Chapter 3. The bridge cases are analyzed using the SAP2000 software for various bridge and load configurations and summarized by using contour plots, tables, and graphs. The results are interpreted and compared with the AASHTO design procedures for validation purposes.

4.2 Presentation of Results

The FEA and AASHTO results evaluated and assessed consist of the maximum longitudinal bending moments, edge beam moments, and deflections at critical locations of the bridge slabs.

For every span length (24, 36, 46 and 54 ft), number of lanes from 1 to 4, bridge width (14, 24, 36 and 48 ft), railings stiffnesses/sizes (x0, x1, x2, x3, x4 and x0.5), and loading condition (E1 and E2), with/without the presence of railings (R0, R1 and R2), longitudinal bending moments are extracted from SAP2000 output files. These FEA moments per unit foot along the critical cross-section are tabulated for all bridge cases as shown in Tables 4.1, 4.2, 4.3 and 4.4 for the two-lane bridge with span length of 36 ft with no railings E1 loading condition, one railing E1 loading condition, one railing E2 loading condition and two railings E1 loading condition respectively. For a complete set of moment distribution tables, refer to Appendix-1. These results are also presented in graph plots to facilitate comparison of the longitudinal moment distribution for various bridges. Figures 4.1, 4.2, 4.3and 4.4 are sample plots, which include longitudinal moment distribution values for the same tabulated bridges respectively. For a complete set of these plots, refer to Appendix-1.

A total of 320 bridges were analyzed, and for the purposes of comparison and results tabulation, the bridges were grouped in three categories:

Case 1: “Concrete bridges with no railings”

Case 2: “Concrete bridges with one railing”

Case 3: “Concrete bridges with two railings”

4.2.1 Maximum Longitudinal Bending Moment

The maximum longitudinal bending moment in slab is defined as the first peak value after the left edge peak moment (Figures 4.1 to 4.4). The maximum peak moment at the edge is resisted by an edge beam.

Mi/xj is the maximum FEA moment in the bridge, where “i” represents the presence of railings. It is 0 for no railings, 1 for one railing and 2 for two railings. On the other hand, ‘xj’ represents the railings stiffness which ranges from x0.5 to x4. For example, M0/xj and Mi/x0 represents the moment of concrete bridges with no railings, for any ‘i’ or ‘j’.

4.2.2 Edge Beam Moment

The edge beam moment is defined by the maximum moment at or near the leftmost node along the critical cross-section (Figures 4.1 to 4.4).

Mi/xj is the maximum FEA edge beam moment in the bridge, where “i” and ‘xj’ are defined as above represents the presence of railings.

4.2.3 Maximum Live Load Deflection

Live load deflection obtained from FEA for all the cases are obtained and compared to the AASHTO criterion of S/800. It is worth noting that the FEA is an

elastic analysis, and not the actual cracked section analysis, which would yield higher deflection values.

Δi/xj is the FEA live load deflection in the bridge, where “i” and ‘xj’ ,are defined as above, represents the presence of railings.

Table 4.1: *Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 24 ft, No Railings with Edge Loading E1*

Longitudinal Moment at Critical Section(kip.ft/ft)								
	Stiffness Factor							
Location (ft)	X 0	X 1	X 2	X 3	X4	X 0.5	LRFD Moment (Kip-ft/ft)	AASHTO Moment (Kip-ft/ft)
	FEA	FEA	FEA	FEA	FEA	FEA		
0	37.2	37.2	37.2	37.2	37.2	37.2	45.6	34.2
1	38.5	38.5	38.5	38.5	38.5	38.5	45.6	34.2
2	34.8	34.8	34.8	34.8	34.8	34.8	45.6	34.2
3	33.3	33.3	33.3	33.3	33.3	33.3	45.6	34.2
4	32.6	32.6	32.6	32.6	32.6	32.6	45.6	34.2
5	32.3	32.3	32.3	32.3	32.3	32.3	45.6	34.2
6	32.9	32.9	32.9	32.9	32.9	32.9	45.6	34.2
7	35.3	35.3	35.3	35.3	35.3	35.3	45.6	34.2
8	32.5	32.5	32.5	32.5	32.5	32.5	45.6	34.2
9	31.6	31.6	31.6	31.6	31.6	31.6	45.6	34.2
10	31.8	31.8	31.8	31.8	31.8	31.8	45.6	34.2
11	33.9	33.9	33.9	33.9	33.9	33.9	45.6	34.2
12	30.8	30.8	30.8	30.8	30.8	30.8	45.6	34.2
13	29.4	29.4	29.4	29.4	29.4	29.4	45.6	34.2
14	28.8	28.8	28.8	28.8	28.8	28.8	45.6	34.2
15	28.6	28.6	28.6	28.6	28.6	28.6	45.6	34.2
16	29.1	29.1	29.1	29.1	29.1	29.1	45.6	34.2
17	31.4	31.4	31.4	31.4	31.4	31.4	45.6	34.2
18	28.3	28.3	28.3	28.3	28.3	28.3	45.6	34.2
19	26.9	26.9	26.9	26.9	26.9	26.9	45.6	34.2
20	26.1	26.1	26.1	26.1	26.1	26.1	45.6	34.2
21	25.6	25.6	25.6	25.6	25.6	25.6	45.6	34.2
22	25.3	25.3	25.3	25.3	25.3	25.3	45.6	34.2
23	25.1	25.1	25.1	25.1	25.1	25.1	45.6	34.2
24	25.0	25.0	25.0	25.0	25.0	25.0	45.6	34.2

Table 4.2: *Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge –Deck Span = 36 ft, Deck Width = 24 ft, One Railing with Edge Loading E1*

Longitudinal Moment at Critical Section(kip.ft/ft)								
	Stiffness Factor							
Location (ft)	X 0	X 1	X 2	X 3	X 4	X 0.5	LRFD Moment (Kip-ft/ft)	AASHTO Moment (Kip-ft/ft)
	FEA	FEA	FEA	FEA	FEA	FEA		
0	37.2	24.3	18.9	15.9	13.9	28.8	45.6	34.2
1	38.5	25.2	19.8	16.8	14.8	29.9	45.6	34.2
2	34.8	23.5	18.6	15.7	13.9	27.7	45.6	34.2
3	33.3	22.7	18.1	15.4	13.7	26.7	45.6	34.2
4	32.6	22.8	18.5	15.9	14.3	26.5	45.6	34.2
5	32.3	23.3	19.1	16.7	15.2	26.7	45.6	34.2
6	32.9	24.4	20.5	18.2	16.7	27.7	45.6	34.2
7	35.3	27.3	23.6	21.5	20.1	30.4	45.6	34.2
8	32.5	24.9	21.4	19.4	18.0	27.9	45.6	34.2
9	31.6	24.4	21.1	19.1	17.9	27.2	45.6	34.2
10	31.8	25.0	21.8	20.0	18.8	27.6	45.6	34.2
11	33.9	27.5	24.4	22.7	21.5	30.0	45.6	34.2
12	30.8	24.6	21.7	20.0	18.9	27.0	45.6	34.2
13	29.4	23.6	20.8	19.2	18.1	25.8	45.6	34.2
14	28.8	23.2	20.6	19.0	18.0	25.4	45.6	34.2
15	28.6	23.2	20.7	19.2	18.3	25.3	45.6	34.2
16	29.1	23.9	21.5	20.1	19.2	26.0	45.6	34.2
17	31.4	26.4	24.1	22.7	21.8	28.4	45.6	34.2
18	28.3	23.5	21.2	19.9	19.0	25.3	45.6	34.2
19	26.9	22.3	20.1	18.8	17.9	24.1	45.6	34.2
20	26.1	21.6	19.5	18.2	17.4	23.4	45.6	34.2
21	25.6	21.2	19.1	17.9	17.2	22.9	45.6	34.2
22	25.3	21.0	19.0	17.8	17.0	22.7	45.6	34.2
23	25.1	20.9	18.9	17.7	17.0	22.5	45.6	34.2
24	25	20.9	18.9	17.8	17.1	22.5	45.6	34.2

Table 4.3: *Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge –Deck Span = 36 ft, Deck Width = 24 ft, One Railing with Edge Loading E2*

Longitudinal Moment at Critical Section(kip.ft/ft)								
	Stiffness Factor							
Location (ft)	X 0	X 1	X 2	X 3	x4	X 0.5	LRFD Moment (Kip-ft/ft)	AASHTO Moment (Kip-ft/ft)
	FEA	FEA	FEA	FEA	FEA	FEA		
0	37.2	34.1	32.6	31.7	31.1	35.3	45.6	32.4
1	38.5	35.3	33.8	32.9	32.3	36.5	45.6	32.4
2	34.8	31.5	30.0	29.1	28.5	32.8	45.6	32.4
3	33.3	29.9	28.3	27.4	26.8	31.2	45.6	32.4
4	32.6	29.1	27.4	26.5	25.9	30.4	45.6	32.4
5	32.3	28.8	27.1	26.1	25.4	30.2	45.6	32.4
6	32.9	29.2	27.5	26.4	25.8	30.6	45.6	32.4
7	35.3	31.5	29.7	28.6	28.0	33.0	45.6	32.4
8	32.5	28.5	26.6	25.5	24.8	30.1	45.6	32.4
9	31.6	27.4	25.5	24.3	23.6	29.0	45.6	32.4
10	31.8	27.5	25.4	24.3	23.5	29.2	45.6	32.4
11	33.9	29.4	27.3	26.1	25.3	31.2	45.6	32.4
12	30.8	26.0	23.8	22.5	21.7	27.9	45.6	32.4
13	29.4	24.5	22.2	20.8	19.9	26.4	45.6	32.4
14	28.8	23.6	21.2	19.8	18.8	25.7	45.6	32.4
15	28.6	23.2	20.6	19.1	18.2	25.3	45.6	32.4
16	29.1	23.4	20.7	19.1	18.1	25.6	45.6	32.4
17	31.4	25.4	22.5	20.9	19.8	27.7	45.6	32.4
18	28.3	21.9	18.9	17.2	16.1	24.4	45.6	32.4
19	26.9	20.2	17.0	15.2	14.0	22.8	45.6	32.4
20	26.1	19.0	15.7	13.8	12.5	21.8	45.6	32.4
21	25.6	18.1	14.6	12.6	11.2	21.0	45.6	32.4
22	25.3	17.4	13.7	11.5	10.1	20.4	45.6	32.4
23	25.1	16.5	12.6	10.3	8.8	19.8	45.6	32.4
24	25	16.5	12.6	10.3	8.8	19.8	45.6	32.4

Table 4.4: *Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge –Deck Span = 36 ft, Deck Width = 24 ft, Two Railings with Edge Loading E1*

Longitudinal Moment at Critical Section(kip.ft/ft)								
	Stiffness Factor							
Location (ft)	X 0	X 1	X 2	X 3	x4	X 0.5	LRFD Moment (Kip-ft/ft)	AASHTO Moment (Kip-ft/ft)
	FEA	FEA	FEA	FEA	FEA	FEA		
0	37.2	22.5	17.1	14.2	12.4	27.4	45.6	34.2
1	38.5	23.4	17.9	15.0	13.1	28.5	45.6	34.2
2	34.8	21.5	16.5	13.7	12.0	26.2	45.6	34.2
3	33.3	20.7	15.8	13.2	11.5	25.1	45.6	34.2
4	32.6	20.7	16.0	13.5	11.9	24.9	45.6	34.2
5	32.3	21.0	16.5	14.0	12.5	25.1	45.6	34.2
6	32.9	22.0	17.6	15.3	13.8	25.9	45.6	34.2
7	35.3	24.7	20.5	18.2	16.8	28.6	45.6	34.2
8	32.5	22.2	18.1	15.9	14.5	25.9	45.6	34.2
9	31.6	21.5	17.5	15.3	14.0	25.1	45.6	34.2
10	31.8	21.9	18.0	15.9	14.6	25.5	45.6	34.2
11	33.9	24.2	20.3	18.3	17.0	27.7	45.6	34.2
12	30.8	21.1	17.3	15.3	14.0	24.6	45.6	34.2
13	29.4	19.9	16.1	14.1	12.8	23.3	45.6	34.2
14	28.8	19.3	15.5	13.5	12.3	22.7	45.6	34.2
15	28.6	19.1	15.3	13.3	12.1	22.5	45.6	34.2
16	29.1	19.5	15.8	13.8	12.6	23.0	45.6	34.2
17	31.4	21.7	18.0	16.0	14.7	25.2	45.6	34.2
18	28.3	18.5	14.7	12.7	11.5	22.0	45.6	34.2
19	26.9	16.9	13.1	11.1	9.9	20.5	45.6	34.2
20	26.1	16.0	12.1	10.0	8.8	19.6	45.6	34.2
21	25.6	15.2	11.2	9.2	7.9	18.9	45.6	34.2
22	25.3	14.6	10.6	8.5	7.2	18.4	45.6	34.2
23	25.1	14.0	9.8	7.6	6.3	17.9	45.6	34.2
24	25	14.0	9.9	7.7	6.4	17.9	45.6	34.2

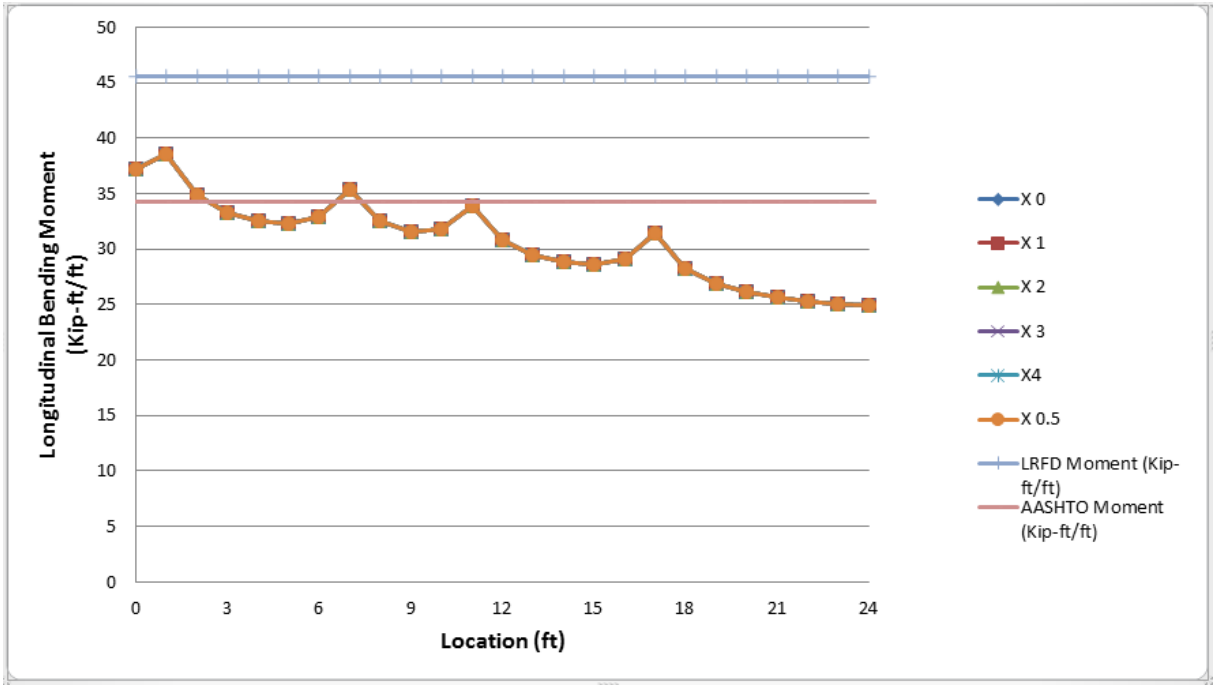


Figure 4.1: *Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge – Deck Span = 36 ft, Deck Width = 24 ft, No Railings with Edge Loading E1.*

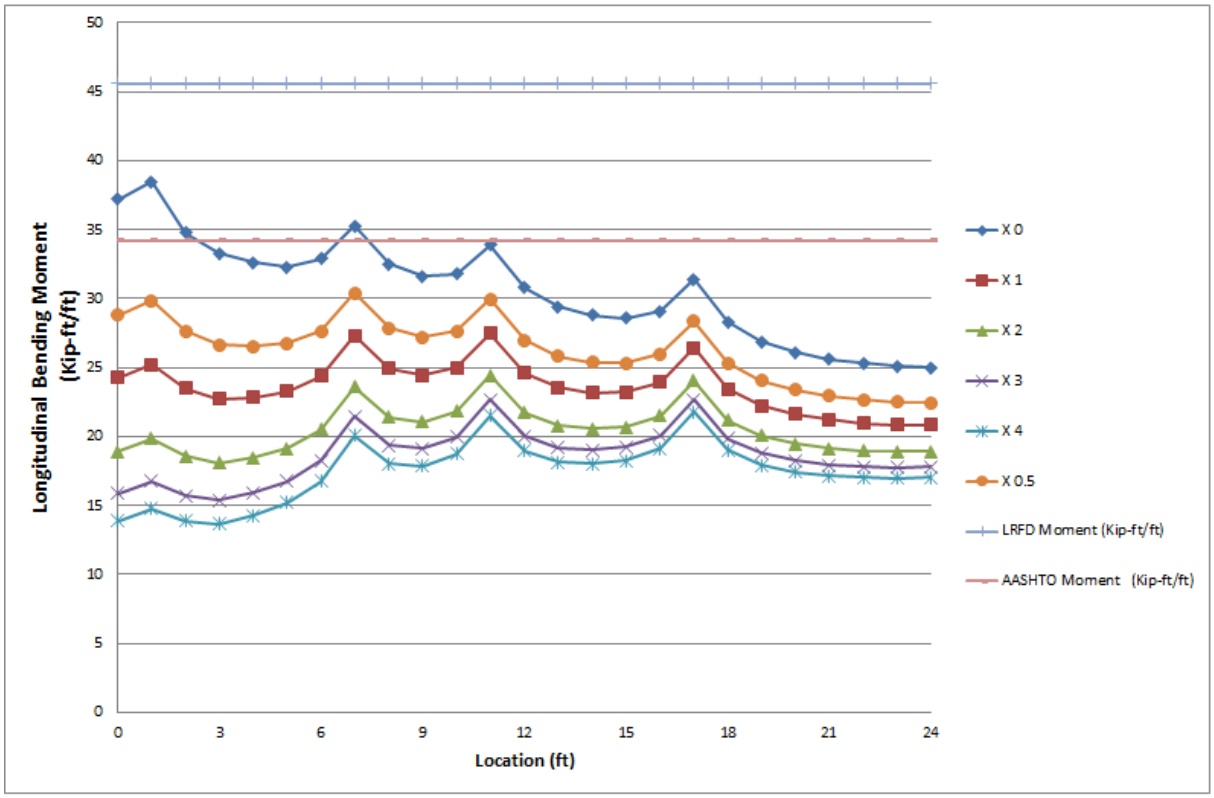


Figure 4.2: *Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge – Deck Span = 36 ft, Deck Width = 24 ft, One Railing with Edge Loading E1*

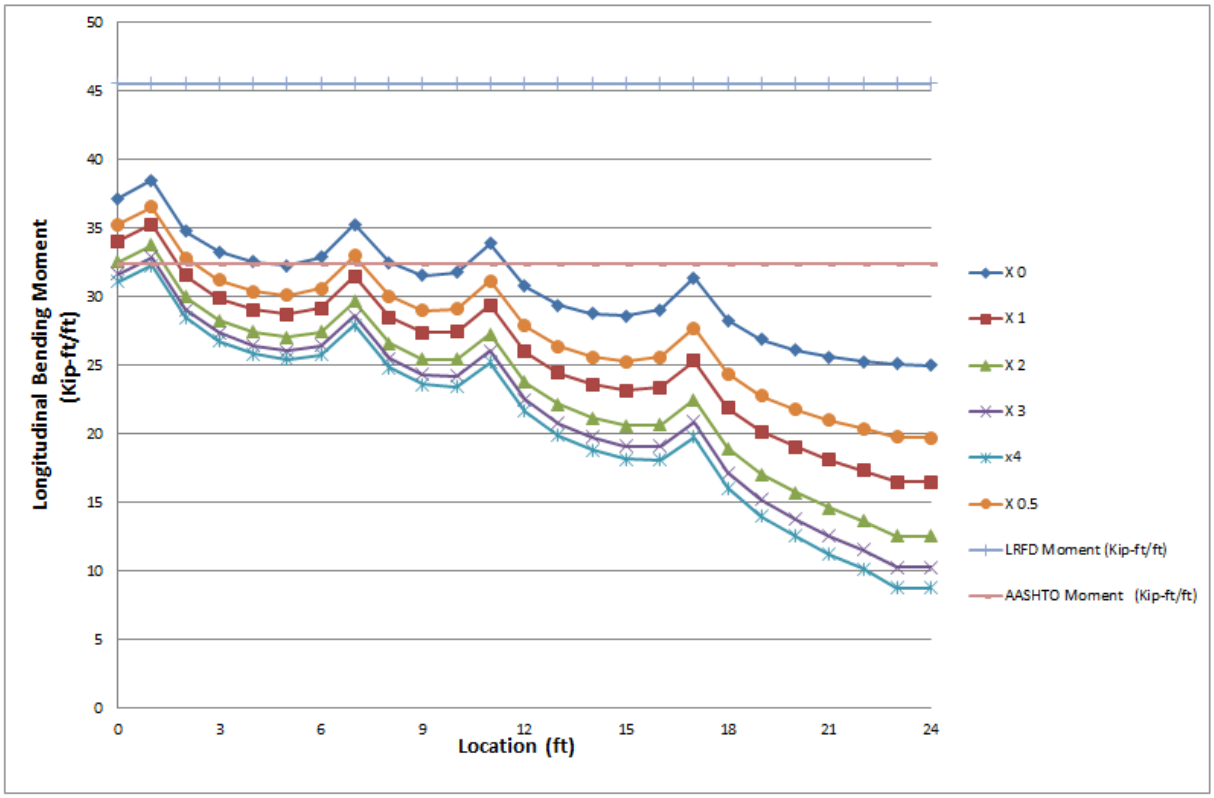


Figure 4.3: *Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge – Deck Span = 36 ft, Deck Width = 24 ft, One Railing with Edge Loading E2*

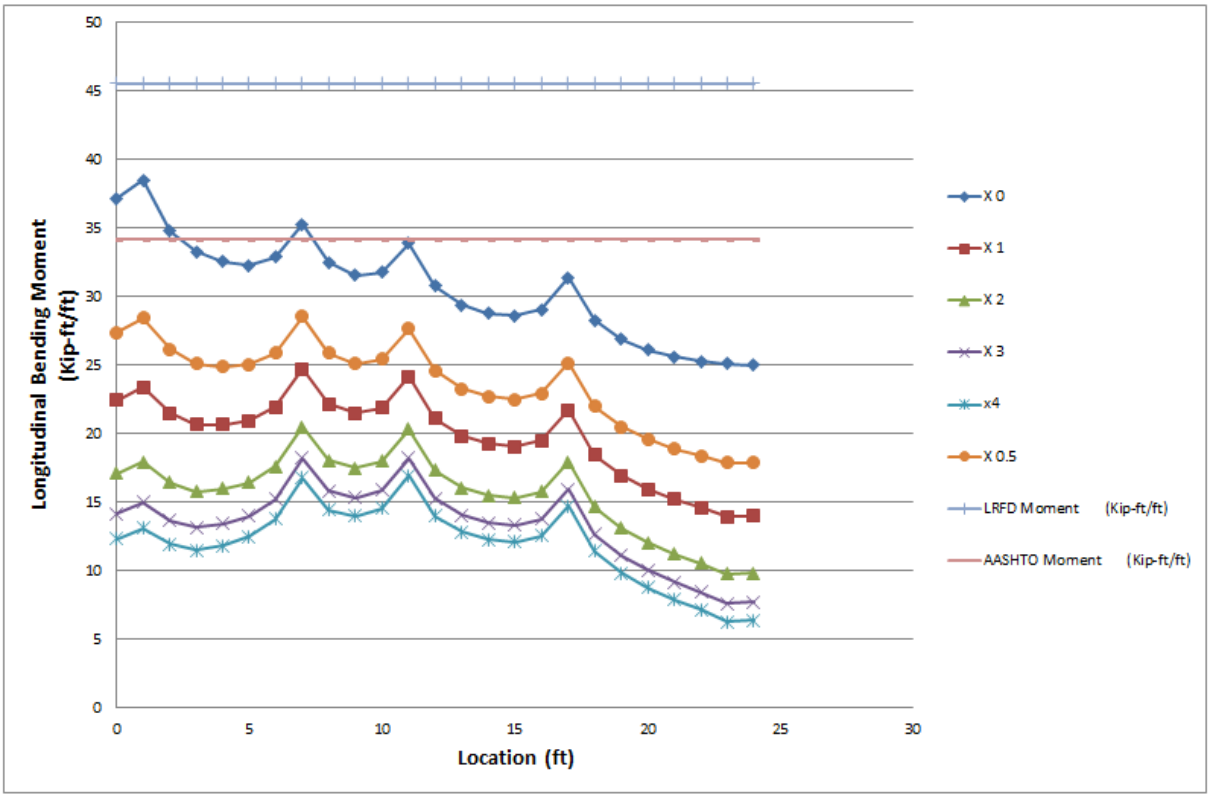


Figure 4.4: *Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge – Deck Span = 36 ft, Deck Width = 24 ft, Two Railings with Edge Loading E1*

4.3 Finite Element Analysis (FEA) Results and Discussion

The FEA results for each bridge category (Case 1, Case2 and Case3) were primarily compared with AASHTO Standard Specifications and AASHTO LRFD procedures. After that, the effects of the increase in the railings stiffnesses/sizes on the maximum longitudinal moment, edge beam moment, and live load deflection for a given bridge span and number of lanes were also evaluated. Thus, the finite-element results for railings stiffnesses/sizes ranging between x0.5 and x4 are compared to their corresponding FEA values for straight bridges without railings for each bridge category. The FEA bending moments are presented in the form of the ratio (Mi/xj / Mi/x0), where Mi/xj is the maximum FEA moment in the bridge for a given railing stiffness xj between x0.5 and x4, and Mi/x0 is the FEA moment for straight bridges without railings. Similarly, the ratio (Δi/xj /Δi/x0) is calculated from the FEA deflection results.

4.3.1 Concrete Bridges with No Railings (X0) "Case 1"

4.3.1.1 FEA Results versus AASHTO

4.3.1.1.1 Maximum Longitudinal Bending Moment

The maximum slab and longitudinal bending moments are summarized in Tables 4.5 and 4.6, for all "Case 1" bridges analyzed along with the corresponding AASHTO bending moments. The AASHTO moments are computed using Eqs. (1) and (2) for the standard specifications, and Eq. (5) for LRFD. For one lane bridges with span lengths less than 36 ft, AASHTO overestimates the maximum longitudinal bending moment by about 25% .AASHTO gives longitudinal bending moment similar to the FEA results for span lengths greater than 36 ft. For two lane bridges, AASHTO gives longitudinal bending moment similar to the FEA results for span lengths less

than 46 ft, and underestimates the maximum moment by about 25% when the span length is greater than 46 ft. For three and four lane bridges, AASHTO recommended moments are similar to FEA maximum longitudinal moment results for bridges with spans less than 36 ft, and underestimates the maximum moments by about 30% for bridges with span lengths greater than 36 ft.

The maximum FEA longitudinal bending moments were also compared to the AASHTO LRFD moments. For one lane bridges with span lengths less than 46 ft, LRFD overestimates the maximum longitudinal bending moment by about 40%, and 30% when the span length is greater than 46 ft. For two lane bridges, LRFD overestimates the maximum longitudinal moment by about 15% for span lengths less than 36 ft, and 25% when the span length is greater than 36 ft. For three and four lane bridges, LRFD recommended moments are similar to FEA maximum longitudinal bending moment results for bridges with span lengths less than 36 ft, and overestimates the maximum moments by about 15% for bridges with span lengths greater than 36 ft.

4.3.1.1.2 Maximum Edge Beam Moment.

The maximum edge beam longitudinal moments are summarized in Tables 4.7 and 4.8. The AASHTO moments are computed using eqs.(1) and (2) for the standard specifications, and eq.(5) for LRFD.

The FEA maximum longitudinal edge beam moments were first compared to the AASHTO standard specifications equations. For one lane bridges with span lengths less than 46 ft, AASHTO overestimates the edge beam moment by about 20%, and gives similar results for spans greater than 46 ft. For two lane bridges, AASHTO gives edge beam moment similar to the FEA results for span length less than 46 ft, and underestimates the edge beam moment by about 15% for spans greater than 46 ft.

For three and four lane bridges, AASHTO recommended moments are similar to FEA edge beam moments for bridges with spans less than 46 ft, and underestimates the edge beam moment by about 20% for bridges with spans greater than 46 ft.

The maximum FEA longitudinal edge beam moments were also compared to the AASHTO LRFD moments. For one lane bridges, LRFD overestimates the maximum edge beam moment by about 15% for spans less than 46 ft, and 25% for spans greater than 46 ft. For two lane bridges, LRFD gives edge beam moment similar to the FEA results for span lengths less than 36 ft., and overestimates the maximum edge beam moment by about 15% for bridges with span lengths greater than 36 ft. For three and four lane bridges, LRFD recommended moments are similar to FEA maximum edge beam moment results for bridges with spans greater than 36 ft, and underestimates the maximum edge beam moment by about 20% for spans less than 36 ft.

4.3.1.1.3 Maximum Live Load Deflection

Table 4.9 summarizes the maximum FEA live load deflection as compared to the AASHTO criterion of (S/800). The FEA results are directly related to the assumed slab thickness, which was a reasonable assumption for deflection control. But one can always assume a different thickness and obtain different deflection results. The slab deflection increases as the span length increases from 24 to 54 ft and the number of lanes from one to four.

AASHTO overestimates the maximum deflection by about 70% for one, two, three, and four lane bridges with spans less than 46 ft, and by about 50% for spans greater than 46 ft. The percent difference with AASHTO is higher for short spans, and decreases as the span length increases to 54 ft. Moreover, the percent difference with AASHTO decreases as the number of lanes increases from one to four for a fixed span length.

Table 4.5: *Comparison of FEA Maximum Longitudinal Bending Moment with AASHTO Moment*

Number of Lanes	Span Length (ft)	FEA Maximum Longitudinal Moment (kip-ft/ft)												AASHTO Moment (kip-ft/ft)
		Stiffnes Factor												
		X0		X1		X2		X3		X4		X0.5		
1	24	16.6	-23%	16.6	-23%	16.6	-23%	16.6	-23%	16.6	-23%	16.6	-23%	21.6
	36	29.1	-10%	29.1	-10%	29.1	-10%	29.1	-10%	29.1	-10%	29.1	-10%	32.4
	46	42.0	1%	42.0	1%	42.0	1%	42.0	1%	42.0	1%	42.0	1%	41.4
	54	52.2	4%	52.2	4%	52.2	4%	52.2	4%	52.2	4%	52.2	4%	50.2
2	24	20.5	-5%	20.5	-5%	20.5	-5%	20.5	-5%	20.5	-5%	20.5	-5%	21.6
	36	35.3	9%	35.3	9%	35.3	9%	35.3	9%	35.3	9%	35.3	9%	32.4
	46	50.4	22%	50.4	22%	50.4	22%	50.4	22%	50.4	22%	50.4	22%	41.4
	54	62.4	24%	62.4	24%	62.4	24%	62.4	24%	62.4	24%	62.4	24%	50.2
3	24	21.7	1%	21.7	1%	21.7	1%	21.7	1%	21.7	1%	21.7	1%	21.6
	36	37.5	16%	37.5	16%	37.5	16%	37.5	16%	37.5	16%	37.5	16%	32.4
	46	52.9	28%	52.9	28%	52.9	28%	52.9	28%	52.9	28%	52.9	28%	41.4
	54	65.0	30%	65.0	30%	65.0	30%	65.0	30%	65.0	30%	65.0	30%	50.2
4	24	22.3	3%	22.3	3%	22.3	3%	22.3	3%	22.3	3%	22.3	3%	21.6
	36	39.1	21%	39.1	21%	39.1	21%	39.1	21%	39.1	21%	39.1	21%	32.4
	46	55.2	33%	55.2	33%	55.2	33%	55.2	33%	55.2	33%	55.2	33%	41.4
	54	67.7	35%	67.7	35%	67.7	35%	67.7	35%	67.7	35%	67.7	35%	50.2

Table 4.6: *Comparison of FEA Maximum Longitudinal Bending Moment with LRFD Moment*

Number of Lanes	Span Length (ft)	FEA Maximum Longitudinal Moment (Kip-ft/ft)												LRFD Moment (kip-ft/ft)
		Stiffnes Factor												
		X0		X1		X2		X3		X4		X0.5		
1	24	16.6	-41%	16.6	-41%	16.6	-41%	16.6	-41%	16.6	-41%	16.6	-41%	28.1
	36	29.1	-38%	29.1	-38%	29.1	-38%	29.1	-38%	29.1	-38%	29.1	-38%	47.2
	46	42.0	-33%	42.0	-33%	42.0	-33%	42.0	-33%	42.0	-33%	42.0	-33%	62.9
	54	52.2	-31%	52.2	-31%	52.2	-31%	52.2	-31%	52.2	-31%	52.2	-31%	75.3
2	24	20.5	-15%	20.5	-15%	20.5	-15%	20.5	-15%	20.5	-15%	20.5	-15%	24.1
	36	35.3	-23%	35.3	-23%	35.3	-23%	35.3	-23%	35.3	-23%	35.3	-23%	45.6
	46	50.4	-23%	50.4	-23%	50.4	-23%	50.4	-23%	50.4	-23%	50.4	-23%	65.3
	54	62.4	-24%	62.4	-24%	62.4	-24%	62.4	-24%	62.4	-24%	62.4	-24%	81.7
3	24	21.7	-4%	21.7	-4%	21.7	-4%	21.7	-4%	21.7	-4%	21.7	-4%	22.6
	36	37.5	-11%	37.5	-11%	37.5	-11%	37.5	-11%	37.5	-11%	37.5	-11%	42.3
	46	52.9	-12%	52.9	-12%	52.9	-12%	52.9	-12%	52.9	-12%	52.9	-12%	60.4
	54	65.0	-16%	65.0	-16%	65.0	-16%	65.0	-16%	65.0	-16%	65.0	-16%	77.1
4	24	22.3	4%	22.3	4%	22.3	4%	22.3	4%	22.3	4%	22.3	4%	21.5
	36	39.1	-2%	39.1	-2%	39.1	-2%	39.1	-2%	39.1	-2%	39.1	-2%	40
	46	55.2	-8%	55.2	-8%	55.2	-8%	55.2	-8%	55.2	-8%	55.2	-8%	59.8
	54	67.7	-12%	67.7	-12%	67.7	-12%	67.7	-12%	67.7	-12%	67.7	-12%	77.1

Table 4.7: *Comparison of FEA Edge Beam Moment with AASHTO Moment*

Number of Lanes	Span Length (ft)	FEA Edge Beam Moment (kip-ft/ft)												AASHTO Moment (kip-ft/ft)
		Stiffnes Factor												
		X0		X1		X2		X3		X4		X0.5		
1	24	20.1	-22%	20.1	-22%	20.1	-22%	20.1	-22%	20.1	-22%	20.1	-22%	25.6
	36	32.7	-15%	32.7	-15%	32.7	-15%	32.7	-15%	32.7	-15%	32.7	-15%	38.4
	46	45.6	-7%	45.6	-7%	45.6	-7%	45.6	-7%	45.6	-7%	45.6	-7%	49.1
	54	55.9	-3%	55.9	-3%	55.9	-3%	55.9	-3%	55.9	-3%	55.9	-3%	57.6
2	24	23.1	-10%	23.1	-10%	23.1	-10%	23.1	-10%	23.1	-10%	23.1	-10%	25.6
	36	38.5	0%	38.5	0%	38.5	0%	38.5	0%	38.5	0%	38.5	0%	38.4
	46	53.7	9%	53.7	9%	53.7	9%	53.7	9%	53.7	9%	53.7	9%	49.1
	54	65.8	14%	65.8	14%	65.8	14%	65.8	14%	65.8	14%	65.8	14%	57.6
3	24	24.1	-6%	24.1	-6%	24.1	-6%	24.1	-6%	24.1	-6%	24.1	-6%	25.6
	36	40.6	6%	40.6	6%	40.6	6%	40.6	6%	40.6	6%	40.6	6%	38.4
	46	56.5	15%	56.5	15%	56.5	15%	56.5	15%	56.5	15%	56.5	15%	49.1
	54	68.8	19%	68.8	19%	68.8	19%	68.8	19%	68.8	19%	68.8	19%	57.6
4	24	24.5	-4%	24.5	-4%	24.5	-4%	24.5	-4%	24.5	-4%	24.5	-4%	25.6
	36	42.1	10%	42.1	10%	42.1	10%	42.1	10%	42.1	10%	42.1	10%	38.4
	46	58.8	20%	58.8	20%	58.8	20%	58.8	20%	58.8	20%	58.8	20%	49.1
	54	71.5	24%	71.5	24%	71.5	24%	71.5	24%	71.5	24%	71.5	24%	57.6

Table 4.8: *Comparison of FEA Edge Beam Moment with LRFD Moment*

Number of Lanes	Span Length (ft)	FEA Edge Beam Moment (kip-ft/ft)												LRFD Moment (kip-ft/ft)
		Stiffnes Factor												
		X0		X1		X2		X3		X4		X0.5		
1	24	20.06	-13%	20.06	-13%	20.06	-13%	20.06	-13%	20.06	-13%	20.06	-13%	23
	36	32.72	-17%	32.72	-17%	32.72	-17%	32.72	-17%	32.72	-17%	32.72	-17%	39.5
	46	45.59	-25%	45.59	-25%	45.59	-25%	45.59	-25%	45.59	-25%	45.59	-25%	60.9
	54	55.87	-27%	55.87	-27%	55.87	-27%	55.87	-27%	55.87	-27%	55.87	-27%	76.1
2	24	23.14	9%	23.14	9%	23.14	9%	23.14	9%	23.14	9%	23.14	9%	21.2
	36	38.52	-7%	38.52	-7%	38.52	-7%	38.52	-7%	38.52	-7%	38.52	-7%	41.4
	46	53.73	-14%	53.73	-14%	53.73	-14%	53.73	-14%	53.73	-14%	53.73	-14%	62.3
	54	65.78	-18%	65.78	-18%	65.78	-18%	65.78	-18%	65.78	-18%	65.78	-18%	79.9
3	24	24.1	18%	24.1	18%	24.10	18%	24.10	18%	24.10	18%	24.10	18%	20.5
	36	40.64	2%	40.64	2%	40.64	2%	40.64	2%	40.64	2%	40.64	2%	39.7
	46	56.49	-5%	56.49	-5%	56.49	-5%	56.49	-5%	56.49	-5%	56.49	-5%	59.5
	54	68.78	-11%	68.78	-11%	68.78	-11%	68.78	-11%	68.78	-11%	68.78	-11%	77.3
4	24	24.5	23%	24.5	23%	24.50	23%	24.50	23%	24.50	23%	24.50	23%	19.9
	36	42.06	10%	42.06	10%	42.06	10%	42.06	10%	42.06	10%	42.06	10%	38.4
	46	58.75	-1%	58.75	-1%	58.75	-1%	58.75	-1%	58.75	-1%	58.75	-1%	59.1
	54	71.50	-8%	71.50	-8%	71.50	-8%	71.50	-8%	71.50	-8%	71.50	-8%	77.3

Table 4.9: *Comparison of FEA Maximum Live Load Deflection with AASHTO Criterion*

Number of Lanes	Span Length (ft)	FEA Maximum Slab Deflection (in)												AASHTO Deflection (in)
		Stiffnes Factor												
		X0		X1		X2		X3		X4		X0.5		
1	24	0.066	-82%	0.066	-82%	0.066	-82%	0.066	-82%	0.066	-82%	0.066	-82%	0.360
	36	0.179	-67%	0.179	-67%	0.179	-67%	0.179	-67%	0.179	-67%	0.179	-67%	0.540
	46	0.291	-58%	0.291	-58%	0.291	-58%	0.291	-58%	0.291	-58%	0.291	-58%	0.690
	54	0.352	-57%	0.352	-57%	0.352	-57%	0.352	-57%	0.352	-57%	0.352	-57%	0.810
2	24	0.080	-78%	0.080	-78%	0.080	-78%	0.080	-78%	0.080	-78%	0.080	-78%	0.360
	36	0.219	-59%	0.219	-59%	0.219	-59%	0.219	-59%	0.219	-59%	0.219	-59%	0.540
	46	0.352	-49%	0.352	-49%	0.352	-49%	0.352	-49%	0.352	-49%	0.352	-49%	0.690
	54	0.422	-48%	0.422	-48%	0.422	-48%	0.422	-48%	0.422	-48%	0.422	-48%	0.810
3	24	0.085	-76%	0.085	-76%	0.085	-76%	0.085	-76%	0.085	-76%	0.085	-76%	0.360
	36	0.233	-57%	0.233	-57%	0.233	-57%	0.233	-57%	0.233	-57%	0.233	-57%	0.540
	46	0.373	-46%	0.373	-46%	0.373	-46%	0.373	-46%	0.373	-46%	0.373	-46%	0.690
	54	0.445	-45%	0.445	-45%	0.445	-45%	0.445	-45%	0.445	-45%	0.445	-45%	0.810
4	24	0.087	-76%	0.087	-76%	0.087	-76%	0.087	-76%	0.087	-76%	0.087	-76%	0.360
	36	0.243	-55%	0.243	-55%	0.243	-55%	0.243	-55%	0.243	-55%	0.243	-55%	0.540
	46	0.390	-43%	0.390	-43%	0.390	-43%	0.390	-43%	0.390	-43%	0.39	-43%	0.690
	54	0.464	-43%	0.464	-43%	0.464	-43%	0.464	-43%	0.464	-43%	0.464	-43%	0.810

4.3.1.2 Summary

The AASHTO Standard Specifications overestimated the maximum longitudinal bending moment by about 25% for one lane bridges. As the span length increases, the overestimation value decreases to zero for span lengths greater than 36 ft. As the number of lanes increases from one to four, AASHTO starts to underestimate the maximum bending moment, and this value increases to 30% for span lengths greater than 36 ft for four lane bridges. However, LRFD design specifications overestimated the maximum longitudinal moment by about 40% for one lane bridges, and as the number of lanes increases , this value decreases to 10% for four lane bridges. AASHTO specifications overestimated the FEA Maximum deflection by about 80% for one lane bridges. As the number of lanes increases with an increase in span length up to 54 ft, this value decreases to about 40 %.

4.3.2 Concrete Bridges with One Railing "Case 2"

4.3.2.1 FEA Results versus AASHTO

4.3.2.1.1 Maximum Longitudinal Bending Moment

The maximum slab longitudinal bending moments are summarized in Tables 4.10 and 4.11, for all "Case 2" bridges analyzed along with the corresponding AASHTO bending moments.

The AASHTO moments are computed using Eqs. (1) and (2) for the standard specifications, and Eq. (5) for LRFD.

The FEA maximum longitudinal bending moments for stiffness factor x0 (Case of no railings-x0) were first compared to the AASHTO standard specifications equations. For one lane bridges with span lengths less than 36 ft, AASHTO overestimates the maximum longitudinal bending moment by about 25% .AASHTO gives longitudinal bending moment similar to the FEA results for span lengths greater than 36 ft. Considering the stiffness factor (x0.5), and for spans lengths less than 36 ft, AASHTO overestimates the maximum longitudinal moment by about 30%. However, by increasing the stiffness factor from x0 to x1, x2, x3 and x4, the overestimation value by AASHTO increases to 40%. For bridges with span lengths less than 46 ft and greater than 24 ft, AASHTO overestimates the maximum moment by about 20% for bridges with railings of stiffness x0.5, 35 % for railings of stiffnesses x1 and x2, 45% for railings of stiffnesses x3 and x4. For two lane bridges, AASHTO gives longitudinal bending moment similar to the FEA results for span lengths less than 46 ft, and underestimates the maximum moment by about 25% when the span length is greater than 46 ft (Case of no railings-x0). Considering the stiffness factors (x0.5, x1, x2, x3 and x4), and for bridges with span lengths greater than 36 ft, AASHTO gives longitudinal moment similar to the FEA results. For three and four lane bridges,

AASHTO recommended moments are similar to FEA maximum longitudinal moment results for bridges with spans less than 36 ft, and underestimates the maximum moments by about 30% for bridges with span lengths greater than 36 ft (Case of no railings-x0). Considering the stiffness factors from x0.5 to x4, and for three lane bridges with span lengths less than 46 ft, AASHTO gives longitudinal bending moment similar to the FEA results. However, AASHTO underestimates the maximum longitudinal bending moment for bridges with span lengths greater than 36 ft by about 20% for three lane bridges and 30% for four lane bridges for all stiffness factors.

The maximum FEA longitudinal bending moments were also compared to AASHTO LRFD moments. For one lane bridges with span lengths less than 46 ft, LRFD overestimates the maximum longitudinal bending moment by about 40%, and 30% when the span length is greater than 46 ft (Case of no railings-x0). For stiffness factors less than x3, LRFD overestimates the maximum longitudinal moment by about 50% for spans less than 46 ft, and 45% for spans greater than 46 ft. Considering the stiffness factors x3 and x4, LRFD overestimates the maximum longitudinal moment by about 55% for bridges with spans less than 36 ft, and 60% for spans greater than 36 ft. For two lane bridges, LRFD overestimates the maximum longitudinal moment by about 15% for span lengths less than 36 ft, and 25% when the span length is greater than 36 ft (Case of no railings-x0). Considering all the stiffness factors (x0.5, x1, x2, x3 and x4), LRFD overestimates the maximum longitudinal moments by about 20% for bridges with span length less than 36 ft, and 35% for spans greater than 36 ft. For three and four lane bridges, LRFD recommended moments are similar to FEA maximum longitudinal bending moment results for bridges with span lengths less than 36 ft, and overestimates the maximum moments by about 15% for bridges with span lengths greater than 36 ft (Case of no railings-x0). Considering the stiffness factors

from x0.5 to x4, LRFD gives longitudinal bending moment similar to FEA results for span lengths less than 46 ft, and underestimates the maximum moment by about 20% for three lanes and 15% for four lane bridges.

4.3.2.1.2 Maximum Edge Beam Moment

The maximum edge beam longitudinal moments are summarized in Tables 4.12 and 4.13. The AASHTO moments are computed using eqs.(1) and (2) for the standard specifications, and eq.(5) for LRFD.

The FEA maximum longitudinal edge beam moments were first compared to the AASHTO standard specifications equations. For one lane bridges with span lengths less than 46 ft, AASHTO overestimates the edge beam moment by about 20%, and gives similar results for spans greater than 46 ft (Case of no railings-x0). Considering the stiffness factors between x0.5 and x3, AASHTO overestimates the edge beam moment by about 30% for span lengths less than 46 ft. However, AASHTO overestimates the edge beam moment by about 40% for the stiffness factors x3 and x4. For bridges with span lengths greater than 46 ft, AASHTO overestimates the edge beam moment by 15%, 20%, 30%, 35% and 40% for the stiffness factors x0.5, x1, x2, x3 and x4 respectively. For two lane bridges, AASHTO gives edge beam moment similar to the FEA results for span lengths less than 46 ft, and underestimates the edge beam moment by about 15% for spans greater than 46 ft (Case of no railings-x0). Considering the stiffness factors from x0.5 to x4, AASHTO gives edge beam moment similar to FEA results for span lengths greater than 46 ft, and overestimates the edge beam moment by about 15% for span lengths less than 46 ft. For three and four lane bridges, AASHTO recommended moments are similar to FEA edge beam moments for bridges with spans less than 46 ft, and underestimates the edge beam moment by about 20% for bridges with spans greater than 46 ft (Case of no railings-x0).

Considering the stiffness factors from x0.5 to x4, AASHTO gives edge beam moment similar to FEA results for all span lengths, and underestimates the edge beam moment by about 20% for four lane bridges with span lengths greater than 54 ft.

The maximum FEA longitudinal edge beam moments were also compared to the AASHTO LRFD moments. For one lane bridges, LRFD overestimates the maximum edge beam moment by about 15% for spans less than 46 ft, and 25% for spans greater than 46 ft (Case of no railings-x0). Considering the stiffness factors between x1 and x4, LRFD overestimates the edge beam moments by about 35% for span lengths less than 46 ft and 50% for span lengths greater than 46 ft. However, for the stiffness factor x0.5, LRFD overestimates the edge beam moment by about 25% for spans less than 46 ft and 35% for spans greater than 46 ft. For two lane bridges, LRFD gives edge beam moment similar to the FEA results for span lengths less than 36 ft., and overestimates the maximum edge beam moment by about 15% for bridges with span lengths greater than 36 ft (Case of no railings-x0). Considering the stiffness factors from x0.5 to x4, LRFD gives edge beam moment similar to the FEA results for span lengths less than 36 ft, and overestimates the edge beam moment by about 15% for spans greater than 36 ft and less than 46 ft. However, LRFD overestimates the edge beam moment by about 30% for spans greater than 46 ft for all Stiffness factors. For three and four lane bridges, LRFD recommended moments are similar to FEA maximum edge beam moment results for bridges with spans greater than 36 ft, and underestimates the maximum edge beam moment by about 20% for spans less than 36 ft (Case of no railings-x0). LRFD underestimates the edge beam moment by about 15% for span lengths less than 36ft for three lane bridges and for all stiffness factors. However, LRFD overestimates the edge beam moment by about 15% for span lengths greater than 46 ft for three lane bridges and for all stiffness factors. For four

lane bridges, LRFD underestimates the edge beam moment by about 25% for span lengths less than 36 ft for all stiffness factors, and gives edge beam moment similar to the FEA results for span lengths greater than 36 ft for all stiffness factors.

4.3.2.1.3 Maximum Live Load Deflection

Table 4.14 summarizes the maximum FEA live load deflection as compared to the AASHTO criterion of (*S*/800). The FEA results are directly related to the assumed slab thickness, which was a reasonable assumption for deflection control. But one can always assume a different thickness and obtain different deflection results.

For one lane bridges, AASHTO overestimates the maximum deflection by about 75% for all span lengths and for all stiffness factors (x0.5, x1, x2, x3, x4). For two lane bridges, AASHTO overestimates the maximum deflection by about 65% for all span length and for all stiffness factors. For three and four lane bridges, AASHTO overestimates the maximum deflection by about 65% for spans less than 46 ft and for all stiffness factors, and by 45% for spans greater than 46 ft.

The overestimation value by AASHTO increases as the stiffness factor increases from x0.5 to x4. However, the percent difference decreases as the number of lanes increases from one to four lanes.

Table 4.10: *Comparison of FEA Maximum Longitudinal Bending Moment with AASHTO Moment*

Number of Lanes	Span Length (ft)	FEA Maximum Longitudinal Moment (kip-ft/ft)												AASHTO Moment (kip-ft/ft)
		Stiffness Factor												
		X0		X1		X2		X3		X4		X0.5		
1	24	16.6	-23%	13.9	-36%	13.2	-39%	12.9	-40%	12.7	-41%	14.6	-32%	21.6
	36	29.1	-10%	22.8	-30%	20.3	-37%	18.9	-42%	18.0	-45%	25.1	-22%	32.4
	46	42.0	1%	33.6	-19%	29.2	-29%	26.5	-36%	24.6	-41%	37.0	-11%	41.4
	54	52.2	4%	43.7	-13%	38.3	-24%	34.6	-31%	32.0	-36%	47.4	-6%	50.2
2	24	20.5	-5%	19.2	-11%	18.9	-13%	18.7	-13%	18.6	-14%	19.6	-9%	21.6
	36	35.3	9%	31.6	-3%	30.0	-7%	29.1	-10%	28.5	-12%	33.0	2%	32.4
	46	50.4	22%	45.1	9%	42.1	2%	40.0	-3%	38.6	-7%	47.2	14%	41.4
	54	62.4	24%	56.8	13%	53.0	6%	50.2	0%	48.0	-4%	59.2	18%	50.2
3	24	21.7	1%	21.5	-1%	21.4	-1%	21.3	-1%	21.3	-1%	21.5	0%	21.6
	36	37.5	16%	36.0	11%	35.3	9%	34.9	8%	34.6	7%	36.6	13%	32.4
	46	52.9	28%	50.5	22%	49.0	18%	48.0	16%	47.3	14%	51.5	24%	41.4
	54	65.0	30%	62.3	24%	60.4	20%	58.8	17%	57.6	15%	63.6	27%	50.2
4	24	22.3	3%	22.2	3%	22.2	3%	22.2	3%	22.2	3%	22.2	3%	21.6
	36	39.1	21%	38.6	19%	38.3	18%	38.1	18%	38.0	17%	38.8	20%	32.4
	46	55.2	33%	54.1	31%	53.3	29%	52.9	28%	52.5	27%	54.6	32%	41.4
	54	67.7	35%	66.4	32%	65.3	30%	64.5	29%	63.9	27%	67.0	33%	50.2

Table 4.11*: Comparison of FEA Maximum Longitudinal Bending Moment with LRFD Moment*

Number of Lanes	Span length (ft)	FEA Maximum Longitudinal Moment (Kip-ft/ft)												LRFD Moment (kip-ft/ft)
		Stiffness Factor												
		X0		X1		X2		X3		X4		X0.5		
1	24	16.6	-41%	13.9	-51%	13.2	-53%	12.9	-54%	12.7	-55%	14.6	-48%	28.1
	36	29.1	-38%	22.8	-52%	20.3	-57%	18.9	-60%	18.0	-62%	25.1	-47%	47.2
	46	42.0	-33%	33.6	-47%	29.2	-54%	26.5	-58%	24.6	-61%	37.0	-41%	62.9
	54	52.2	-31%	43.7	-42%	38.3	-49%	34.6	-54%	32.0	-58%	47.4	-37%	75.3
2	24	20.5	-15%	19.2	-20%	18.9	-22%	18.7	-22%	18.6	-23%	19.6	-19%	24.1
	36	35.3	-23%	31.6	-31%	30.0	-34%	29.1	-36%	28.5	-37%	33.0	-28%	45.6
	46	50.4	-23%	45.1	-31%	42.1	-36%	40.0	-39%	38.6	-41%	47.2	-28%	65.3
	54	62.4	-24%	56.8	-31%	53.0	-35%	50.2	-39%	48.0	-41%	59.2	-28%	81.7
3	24	21.7	-4%	21.5	-5%	21.4	-5%	21.3	-6%	21.3	-6%	21.5	-5%	22.6
	36	37.5	-11%	36.0	-15%	35.3	-16%	34.9	-17%	34.6	-18%	36.6	-13%	42.3
	46	52.9	-12%	50.5	-16%	49.0	-19%	48.0	-20%	47.3	-22%	51.5	-15%	60.4
	54	65.0	-16%	62.3	-19%	60.4	-22%	58.8	-24%	57.6	-25%	63.6	-18%	77.1
4	24	22.3	4%	22.2	3%	22.2	3%	22.2	3%	22.2	3%	22.2	3%	21.5
	36	39.1	-2%	38.6	-4%	38.3	-4%	38.1	-5%	38.0	-5%	38.8	-3%	40
	46	55.2	-8%	54.1	-10%	53.3	-11%	52.9	-12%	52.5	-12%	54.6	-9%	59.8
	54	67.7	-12%	66.4	-14%	65.3	-15%	64.5	-16%	63.9	-17%	67.0	-13%	77.1

Table 4.12: *Comparison of FEA Edge Beam Moment with AASHTO Moment*

Number of Lanes	Span Length (ft)	FEA Edge Beam Moment (kip-ft/ft)												AASHTO Moment (kip-ft/ft)
		Stiffness Factor												
		X0		X1		X2		X3		X4		X0.5		
1	24	20.1	-22%	17.6	-31%	16.9	-34%	16.6	-35%	16.5	-36%	18.3	-28%	25.6
	36	32.7	-15%	26.6	-31%	24.1	-37%	22.7	-41%	21.8	-43%	28.9	-25%	38.4
	46	45.6	-7%	37.4	-24%	33.0	-33%	30.3	-38%	28.4	-42%	40.7	-17%	49.1
	54	55.9	-3%	47.4	-18%	42.1	-27%	38.4	-33%	35.8	-38%	51.1	-11%	57.6
2	24	23.1	-10%	22.3	-13%	22.0	-14%	21.9	-14%	21.8	-15%	22.5	-12%	25.6
	36	38.5	0%	35.3	-8%	33.8	-12%	32.9	-14%	32.3	-16%	36.6	-5%	38.4
	46	53.7	9%	48.8	-1%	45.9	-7%	43.9	-11%	42.4	-14%	51.0	4%	49.1
	54	65.8	14%	60.5	5%	56.8	-1%	54.0	-6%	51.9	-10%	62.9	9%	57.6
3	24	24.1	-6%	23.9	-7%	23.9	-7%	23.8	-7%	23.8	-7%	24.0	-6%	25.6
	36	40.6	6%	39.5	3%	38.9	1%	38.5	0%	38.3	0%	39.9	4%	38.4
	46	56.5	15%	54.3	11%	52.9	8%	51.9	6%	51.2	4%	52.2	6%	49.1
	54	68.8	19%	66.1	15%	64.2	11%	62.7	9%	61.5	7%	67.4	17%	57.6
4	24	24.5	-4%	24.5	-4%	24.5	-4%	24.5	-4%	24.5	-4%	24.5	-4%	25.6
	36	42.1	10%	41.6	8%	41.4	8%	41.3	8%	41.2	7%	41.8	9%	38.4
	46	58.8	20%	57.8	18%	57.1	16%	56.7	15%	56.3	15%	58.2	19%	49.1
	54	71.5	24%	70.2	22%	69.2	20%	68.4	19%	67.6	17%	70.8	23%	57.6

Table 4.13: *Comparison of FEA Edge Beam Moment with LRFD Moment*

Number of Lanes	Span Length (ft)	FEA Edge Beam Moment (kip-ft/ft)												LRFD Moment (kip-ft/ft)
		Stiffness Factor												
		X0		X1		X2		X3		X4		X0.5		
1	24	20.06	-13%	17.6	-24%	16.9	-26%	16.6	-28%	16.5	-28%	18.3	-20%	23
	36	32.72	-17%	26.6	-33%	24.1	-39%	22.7	-43%	21.8	-45%	28.9	-27%	39.5
	46	45.59	-25%	37.4	-39%	33.0	-46%	30.3	-50%	28.4	-53%	40.7	-33%	60.9
	54	55.87	-27%	47.4	-38%	42.1	-45%	38.4	-50%	35.8	-53%	51.1	-33%	76.1
2	24	23.14	9%	22.3	5%	22.0	4%	21.9	3%	21.8	3%	22.5	6%	21.2
	36	38.52	-7%	35.3	-15%	33.8	-18%	32.9	-21%	32.3	-22%	36.6	-12%	41.4
	46	53.73	-14%	48.8	-22%	45.9	-26%	43.9	-30%	42.4	-32%	51.0	-18%	62.3
	54	65.78	-18%	60.5	-24%	56.8	-29%	54.0	-32%	51.9	-35%	62.9	-21%	79.9
3	24	24.1	18%	23.9	17%	23.9	16%	23.8	16%	23.8	16%	24.0	17%	20.5
	36	40.64	2%	39.5	-1%	38.9	-2%	38.5	-3%	38.3	-3%	39.9	1%	39.7
	46	56.49	-5%	54.3	-9%	52.9	-11%	51.9	-13%	51.2	-14%	52.2	-12%	59.5
	54	68.78	-11%	66.1	-14%	64.2	-17%	62.7	-19%	61.5	-20%	67.4	-13%	77.3
4	24	24.5	23%	24.5	23%	24.5	23%	24.5	23%	24.5	23%	24.5	23%	19.9
	36	42.06	10%	41.6	8%	41.4	8%	41.3	8%	41.2	7%	41.8	9%	38.4
	46	58.75	-1%	57.8	-2%	57.1	-3%	56.7	-4%	56.3	-5%	58.2	-2%	59.1
	54	71.50	-8%	70.2	-9%	69.2	-11%	68.4	-12%	67.6	-12%	70.8	-8%	77.3

Table 4.14: *Comparison of FEA Maximum Live Load Deflection with AASHTO Criterion*

Number of Lanes	Span Length (ft)	FEA Maximum Slab Deflection (in)												AASHTO Deflection (in)
		Stiffness Factor												
		X0		X1		X2		X3		X4		X0.5		
1	24	0.066	-82%	0.055	-85%	0.052	-86%	0.050	-86%	0.049	-86%	0.058	-84%	0.360
	36	0.179	-67%	0.138	-74%	0.121	-78%	0.112	-79%	0.106	-80%	0.153	-72%	0.540
	46	0.291	-58%	0.230	-67%	0.198	-71%	0.178	-74%	0.164	-76%	0.255	-63%	0.690
	54	0.352	-57%	0.291	-64%	0.253	-69%	0.227	-72%	0.208	-74%	0.317	-61%	0.810
2	24	0.080	-78%	0.076	-79%	0.075	-79%	0.075	-79%	0.074	-79%	0.078	-78%	0.360
	36	0.219	-59%	0.197	-64%	0.187	-65%	0.181	-66%	0.177	-67%	0.205	-62%	0.540
	46	0.352	-49%	0.316	-54%	0.294	-57%	0.280	-59%	0.269	-61%	0.332	-52%	0.690
	54	0.422	-48%	0.385	-52%	0.359	-56%	0.339	-58%	0.324	-60%	0.402	-50%	0.810
3	24	0.085	-76%	0.084	-77%	0.084	-77%	0.084	-77%	0.084	-77%	0.084	-77%	0.360
	36	0.233	-57%	0.225	-58%	0.221	-59%	0.219	-59%	0.218	-60%	0.228	-58%	0.540
	46	0.373	-46%	0.357	-48%	0.346	-50%	0.339	-51%	0.334	-52%	0.364	-47%	0.690
	54	0.445	-45%	0.426	-47%	0.412	-49%	0.401	-50%	0.393	-51%	0.434	-46%	0.810
4	24	0.087	-76%	0.087	-76%	0.087	-76%	0.087	-76%	0.086	-76%	0.087	-76%	0.360
	36	0.243	-55%	0.240	-56%	0.238	-56%	0.238	-56%	0.237	-56%	0.241	-55%	0.540
	46	0.390	-43%	0.382	-45%	0.378	-45%	0.374	-46%	0.372	-46%	0.386	-44%	0.690
	54	0.464	-43%	0.455	-44%	0.448	-45%	0.442	-45%	0.438	-46%	0.459	-43%	0.810

4.3.2.2 FEA Results of Bridges with different railing sizes versus Bridges with no railings

4.3.2.2.1 Maximum Longitudinal Bending Moment

The ratios M1/xj /M1/x0 for the maximum longitudinal moment are shown in Table 4.15 and Figure 4.5 for each of the four span lengths considered (24, 36, 46, and 54 ft) versus the railing's stiffness factor. Such Table/Figure indicates a decrease in the maximum longitudinal bending moment values with the increase in the stiffness factor, compared to that of bridges with no railings. This decrease appears to be significant when the span length is greater than 36 ft. Also, the ratio M1/xj / M1/x0 increase with the increase in the number of lanes from one to four. For the maximum longitudinal moment, the ratio M1/xj / M1/x0 is almost one for bridges with railings of stiffness factor x0, decreases to about 0.90 for bridges with railings of stiffness factor between x0.5 and x2, and further decreases to about 0.80 as the stiffness factor increases to x4.

4.3.2.2.2 Edge beam moment

The ratios M1/xj/M1/x0 for the edge beam moment are shown in Table 4.16 and Figure 4.6 for each of the four span lengths considered (24, 36, 46, and 54 ft) versus the railing's stiffness factor. Such Table/ Figure indicate a decrease in edge beam moment values with the increase in the stiffness factor, compared to that of bridges with no railings. The ratio M1/xj /M0/x0 increase with the increase in the number of lanes from one to four. For the edge beam moment, the ratio M1/xj /M1/x0 is almost one for bridges with railings of stiffness factor x0, decreases to 0.90 for bridges with railings of stiffness factor between x0.5 and x2, and further decreases to about 0.80 as the stiffness factor increases to x4.

4.3.2.2.3 Maximum Live Load Deflection

The ratio Δ1/xj / Δ1/x0 values obtained are presented in Table 4.17 and Figure 4.7 for each of the four span lengths considered (24, 36, 46, and 54 ft). These values indicate that the maximum live load deflection for bridges with different railings sizes compared to that of bridges without railings decreases with the increase in the railing's stiffness factor for all span lengths and the number of lanes. This decrease is summarized as follows: The ratio is about one for a stiffness factor x0 (Case of no railing) and is approximately equal to 0.90 for a stiffness factor x1. This ratio further decreases to about 0.75 as the railing's stiffness factor increases to x4.

Table 4.15: *FEA Maximum Longitudinal Bending Moment – Ratio M1/xj / M1/x0*

Number of Lanes	Span Length (ft)	FEA Maximum Longitudinal Moment (Kip-ft/ft)												Reference Moment X0
		Stiffness Factor												
		X0		X1		X2		X3		X4		X0.5		
1	24	16.6	1.00	13.9	0.84	13.2	0.80	12.9	0.78	12.7	0.77	14.6	0.88	16.6
	36	29.1	1.00	22.8	0.78	20.3	0.70	18.9	0.65	18.0	0.62	25.1	0.86	29.1
	46	42.0	1.00	33.6	0.80	29.2	0.70	26.5	0.63	24.6	0.59	37.0	0.88	42.0
	54	52.2	1.00	43.7	0.84	38.3	0.73	34.6	0.66	32.0	0.61	47.4	0.91	52.2
2	24	20.5	1.00	19.2	0.94	18.9	0.92	18.7	0.91	18.6	0.91	19.6	0.96	20.5
	36	35.3	1.00	31.6	0.89	30.0	0.85	29.1	0.82	28.5	0.81	33.0	0.93	35.3
	46	50.4	1.00	45.1	0.90	42.1	0.84	40.0	0.79	38.6	0.77	47.2	0.94	50.4
	54	62.4	1.00	56.8	0.91	53.0	0.85	50.2	0.80	48.0	0.77	59.2	0.95	62.4
3	24	21.7	1.00	21.5	0.99	21.4	0.98	21.3	0.98	21.3	0.98	21.5	0.99	21.7
	36	37.5	1.00	36.0	0.96	35.3	0.94	34.9	0.93	34.6	0.92	36.6	0.98	37.5
	46	52.9	1.00	50.5	0.95	49.0	0.93	48.0	0.91	47.3	0.89	51.5	0.97	52.9
	54	65.0	1.00	62.3	0.96	60.4	0.93	58.8	0.90	57.6	0.89	63.6	0.98	65.0
4	24	22.3	1.00	22.2	1.00	22.2	1.00	22.2	1.00	22.2	1.00	22.2	1.00	22.3
	36	39.1	1.00	38.6	0.99	38.3	0.98	38.1	0.98	38.0	0.97	38.8	0.99	39.1
	46	55.2	1.00	54.1	0.98	53.3	0.97	52.9	0.96	52.5	0.95	54.6	0.99	55.2
	54	67.7	1.00	66.4	0.98	65.3	0.96	64.5	0.95	63.9	0.94	67.0	0.99	67.7

Table 4.16: *FEA Edge Beam Moment – Ratio M1/xj / M1/x0*

Number of Lanes	Span Length (ft)	FEA Edge Beam Moment (Kip-ft/ft)												Reference Moment X0
		Stiffness factor												
		X0		X1		X2		X3		X4		X0.5		
1	24	20.1	1.00	17.6	0.88	16.9	0.84	16.6	0.83	16.5	0.82	18.3	0.91	20.1
	36	32.7	1.00	26.6	0.81	24.1	0.74	22.7	0.69	21.8	0.67	28.9	0.88	32.7
	46	45.6	1.00	37.4	0.82	33.0	0.72	30.3	0.66	28.4	0.62	40.7	0.89	45.6
	54	55.9	1.00	47.4	0.85	42.1	0.75	38.4	0.69	35.8	0.64	51.1	0.91	55.9
2	24	23.1	1.00	22.3	0.96	22.0	0.95	21.9	0.95	21.8	0.94	22.5	0.97	23.1
	36	38.5	1.00	35.3	0.92	33.8	0.88	32.9	0.85	32.3	0.84	36.6	0.95	38.5
	46	53.7	1.00	48.8	0.91	45.9	0.85	43.9	0.82	42.4	0.79	51.0	0.95	53.7
	54	65.8	1.00	60.5	0.92	56.8	0.86	54.0	0.82	51.9	0.79	62.9	0.96	65.8
3	24	24.1	1.00	23.9	0.99	23.9	0.99	23.8	0.99	23.8	0.99	24.0	0.99	24.1
	36	40.6	1.00	39.5	0.97	38.9	0.96	38.5	0.95	38.3	0.94	39.9	0.98	40.6
	46	56.5	1.00	54.3	0.96	52.9	0.94	51.9	0.92	51.2	0.91	52.2	0.92	56.5
	54	68.8	1.00	66.1	0.96	64.2	0.93	62.7	0.91	61.5	0.89	67.4	0.98	68.8
4	24	24.5	1.00	24.5	1.00	24.5	1.00	24.5	1.00	24.5	1.00	24.5	1.00	24.5
	36	42.1	1.00	41.6	0.99	41.4	0.99	41.3	0.98	41.2	0.98	41.8	0.99	42.1
	46	58.8	1.00	57.8	0.98	57.1	0.97	56.7	0.96	56.3	0.96	58.2	0.99	58.8
	54	71.5	1.00	70.2	0.98	69.2	0.97	68.4	0.96	67.6	0.95	70.8	0.99	71.5

Table 4.17: *FEA Maximum Live Load Deflection – Ratio Δ1/xj / Δ1/x0*

Number of Lanes	Span Length (ft)	FEA Maximum Slab Deflection (in)												Reference Deflection X0
		Stiffness Factor												
		X0		X1		X2		X3		X4		X0.5		
1	24	0.066	1.00	0.055	0.83	0.052	0.79	0.050	0.76	0.049	0.74	0.058	0.88	0.066
	36	0.179	1.00	0.138	0.77	0.121	0.68	0.112	0.63	0.106	0.59	0.153	0.85	0.179
	46	0.291	1.00	0.230	0.79	0.198	0.68	0.178	0.61	0.164	0.56	0.255	0.88	0.291
	54	0.352	1.00	0.291	0.83	0.253	0.72	0.227	0.64	0.208	0.59	0.317	0.90	0.352
2	24	0.080	1.00	0.076	0.95	0.075	0.94	0.075	0.94	0.074	0.93	0.078	0.98	0.080
	36	0.219	1.00	0.197	0.90	0.187	0.85	0.181	0.83	0.177	0.81	0.205	0.94	0.219
	46	0.352	1.00	0.316	0.90	0.294	0.84	0.280	0.80	0.269	0.76	0.332	0.94	0.352
	54	0.422	1.00	0.385	0.91	0.359	0.85	0.339	0.80	0.324	0.77	0.402	0.95	0.422
3	24	0.085	1.00	0.084	0.99	0.084	0.99	0.084	0.99	0.084	0.99	0.084	0.99	0.085
	36	0.233	1.00	0.225	0.97	0.221	0.95	0.219	0.94	0.218	0.94	0.228	0.98	0.233
	46	0.373	1.00	0.357	0.96	0.346	0.93	0.339	0.91	0.334	0.90	0.364	0.98	0.373
	54	0.445	1.00	0.426	0.96	0.412	0.93	0.401	0.90	0.393	0.88	0.434	0.98	0.445
4	24	0.087	1.00	0.087	1.00	0.087	1.00	0.087	1.00	0.086	0.99	0.087	1.00	0.087
	36	0.243	1.00	0.240	0.99	0.238	0.98	0.238	0.98	0.237	0.98	0.241	0.99	0.243
	46	0.390	1.00	0.382	0.98	0.378	0.97	0.374	0.96	0.372	0.95	0.386	0.99	0.390
	54	0.464	1.00	0.455	0.98	0.448	0.97	0.442	0.95	0.438	0.94	0.459	0.99	0.464

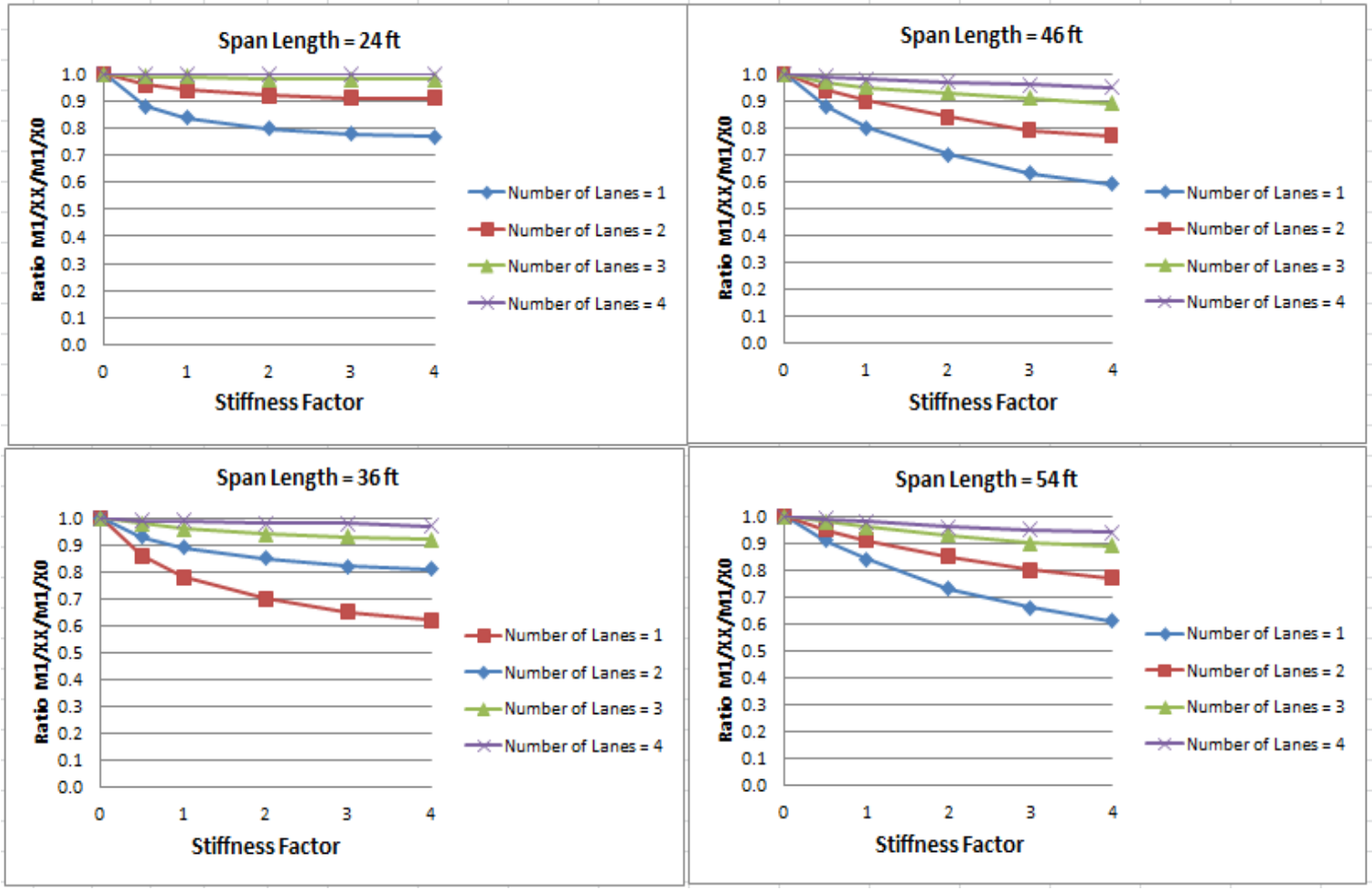


Figure 4.5: *FEA Maximum Longitudinal Bending Moment – Ratio M1/xj / M1/x0*

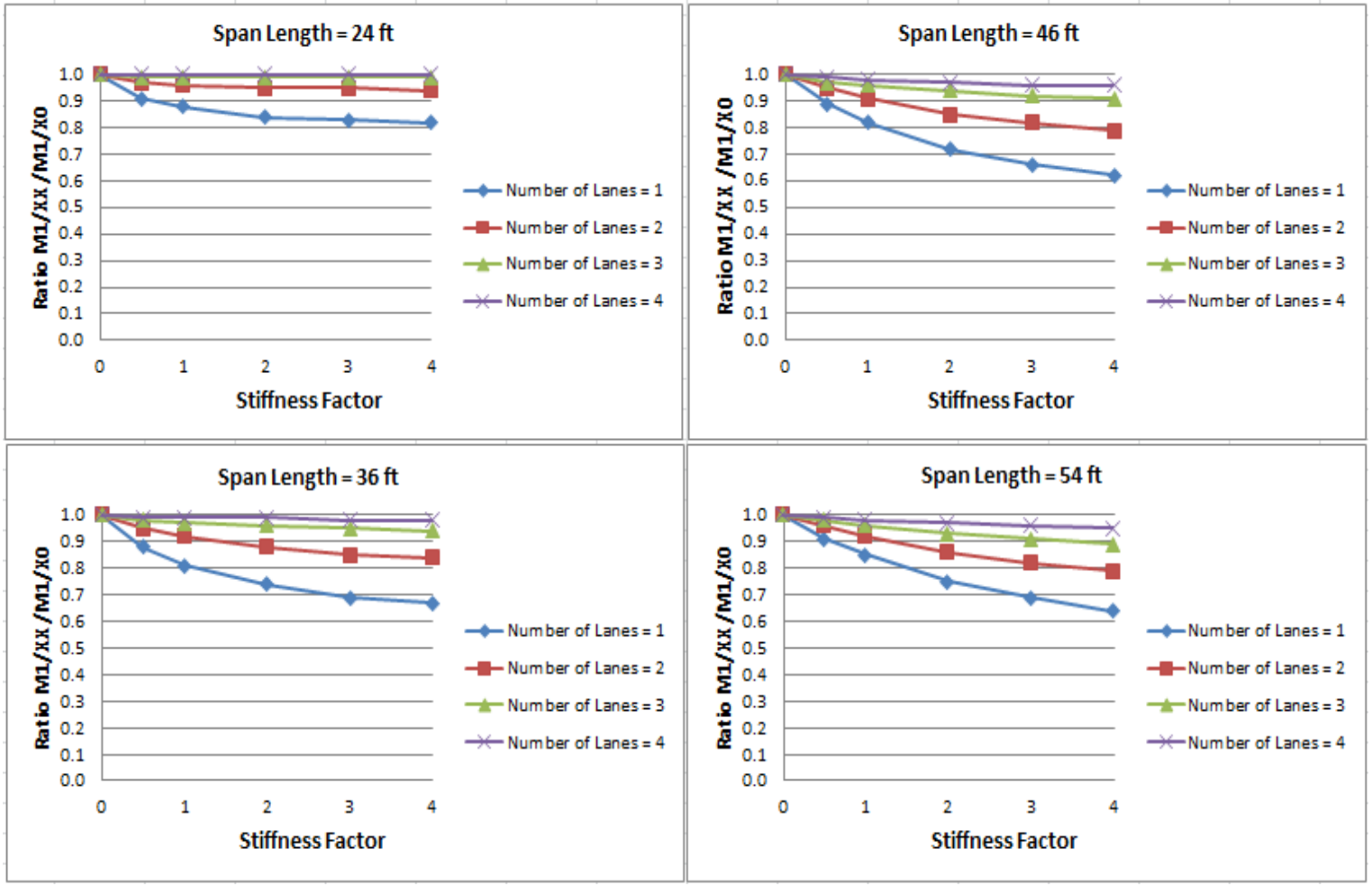


Figure 4.6: *FEA Edge Beam Moment – Ratio M1/xj / M1/x0*

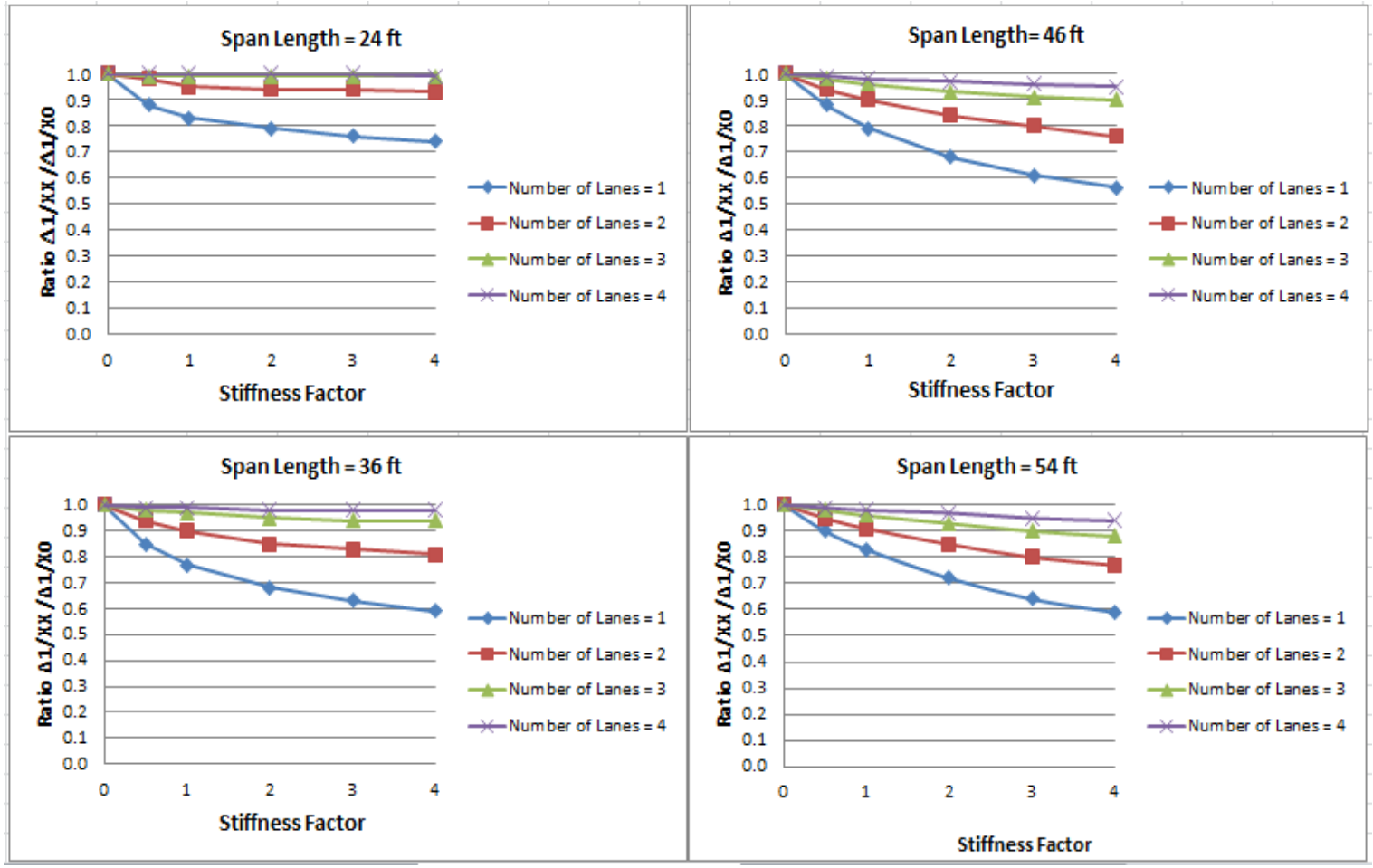


Figure 4.7: *FEA Maximum Live Load Deflection – Ratio Δ1/xj/ Δ1/x0*

4.3.2.3 Summary

The AASHTO Standard Specifications overestimated the maximum longitudinal moment for bridges with spans less than 46 ft by about 40% for one lane bridges with railing's stiffness factor less than x3, and gave similar results to the FEA maximum longitudinal bending moment for two, three and four lane bridges. As the railing's stiffness factor increases to x4, AASHTO overestimated the maximum moment by about 45% for one lane bridges. However, for span lengths greater than 46 ft, AASHTO overestimated the maximum moment by about 30% for one lane bridges, gave similar results to the FEA maximum longitudinal bending moment, and underestimated the maximum moment by about 20% and 30% for three and four lanes respectively. AASHTO LRFD Design Specifications overestimated the maximum longitudinal moment for bridges with railings of stiffness factor less than x2 by about 50%, 30%, 20% for one, two and three lanes respectively, and gave similar results to the FEA maximum moment for four lane bridges. However, as the railing's stiffness factor increases to x4, the overestimation value increased to 60%, 35%, 25% for one, two and three lane bridges. The ratio between bridges with different railing sizes and bridges with no railings increased with the increase in the number of lanes from one to four. This ratio was 1.00 for bridges with no railings. This ratio decreased to about 0.90 as the railing's stiffness factor increased to x2, and further decreased to about 0.80 as the railing's stiffness factor increased to x4. The ratio between the FEA maximum live load deflection for bridges with different railing's sizes and bridges with no railings decreased in a pattern consistent with that of the longitudinal moment. This ratio decreased from 1.00 for x0 to 0.90 for x1, and further decreased to 0.75 as the railing's stiffness factor increased to x4.

4.3.3 Concrete Bridges with Two Railings "Case 3"

4.3.3.1 FEA Results versus AASHTO

4.3.3.1.1 Maximum Longitudinal Bending Moment

The maximum slab longitudinal bending moments are summarized in Tables 4.18 and 4.19, for all "Case 3" bridges analyzed along with the corresponding AASHTO bending moments.

The AASHTO moments are computed using Eq. (1) for the standard specifications and Eq. (5) for LRFD.

The FEA maximum longitudinal bending moments were first compared to the AASHTO standard specifications equations. For one lane bridges with span lengths less than 36 ft, AASHTO overestimates the maximum longitudinal bending moment by about 25% .AASHTO gives longitudinal bending moment similar to the FEA results for span lengths greater than 36 ft (Case of no railings-x0). For span lengths less than 46 ft, the AASHTO procedure overestimates the maximum moment by about 40% for railings with stiffness factor x0.5, and by about 60% for railings with stiffness factor between x1 and x4. For span lengths greater than 46 ft, AASHTO overestimates the maximum moment by about 20%, 35%, 45%, 55% and 60% for the stiffness factors x0.5, x1, x2, x3 and x4 respectively. For two lane bridges, AASHTO gives longitudinal bending moment similar to the FEA results for span lengths less than 46 ft, and underestimates the maximum moment by about 25% when the span length is greater than 46 ft (Case of no railings-x0). For railings with stiffness factor x0.5, and with spans less than 46 ft, AASHTO overestimates the maximum moment by about 20%. However, for stiffness factors x1, x2 and x3, x4, AASHTO overestimates the maximum moment by about 35% and 45% respectively. For bridges with span lengths greater than 46 ft, AASHTO gives longitudinal bending moment

similar to the FEA results for stiffness factors x0.5 and x1, and overestimates the maximum moment by about 30% for stiffness factors x2, x3 and x4. For three and four lane bridges, AASHTO recommended moments are similar to FEA maximum longitudinal moment results for bridges with spans less than 36 ft, and underestimates the maximum moments by about 30% for bridges with span lengths greater than 36 ft (Case of no railings-x0). Considering the stiffness factors between x0.5 and x4, and for span lengths less than 46 ft, AASHTO gives longitudinal bending moment similar to the FEA results. However, for spans greater than 46 ft, AASHTO underestimates the maximum moment by about 20% for stiffness factors x0.5 and x1, and gives longitudinal moment similar to FEA results for stiffness factors x2, x3 and x4.

The maximum FEA longitudinal bending moments were also compared to AASHTO LRFD moments. For one lane bridges with span lengths less than 46 ft, LRFD overestimates the maximum longitudinal bending moment by about 40%, and 30% when the span length is greater than 46 ft (Case of no railings-X0). Considering the stiffness factors between x0.5 and x4, and for span lengths less than 46 ft, LRFD overestimates the maximum moment by about 70%. However, for span lengths greater than 46 ft, LRFD overestimates the maximum moment by about 50% for stiffness factors x0.5 and x1, and by about 70% for stiffness factors x2, x3 and x4. For two lane bridges, LRFD overestimates the maximum longitudinal moment by about 15% for span lengths less than 36 ft, and 25% when the span length is greater than 36 ft (Case of no railings-X0). For bridges with span lengths less than 36 ft, LRFD overestimates the maximum moment by about 30% for railings with stiffness factor x0.5, and by about 45% for railings with stiffness factors x1, x2, x3 and x4. However, for bridges with span lengths greater than 36 ft, LRFD overestimates the maximum longitudinal moment by about 35% for railings with stiffness factor x0.5 and 55% for

railings with stiffness factors x1, x2, x3 and x4. For three and four lane bridges, LRFD recommended moments are similar to FEA maximum longitudinal bending moment results for bridges with span lengths less than 36 ft, and overestimates the maximum moments by about 15% for bridges with span lengths greater than 36 ft (Case of no railings-x0). Considering the stiffness factor between x1 and x4, and for span lengths less than 36 ft, LRFD overestimates the maximum moment by about 30% and 15% for three and four lane bridges respectively. However, for bridges with span lengths greater than 36 ft, LRFD overestimates the maximum longitudinal moment by about 45% and 35% for three and four lane bridges respectively.

4.3.3.1.2 Edge Beam Moment

The maximum edge beam longitudinal moments are summarized in Tables 4.20 and 4.21. The AASHTO moments are computed using eqs.(1) and (2) for the standard specifications, and eq.(5) for LRFD.

The FEA maximum longitudinal edge beam moments were first compared to the AASHTO standard specifications equations. For one lane bridges with span lengths less than 46 ft, AASHTO overestimates the edge beam moment by about 20%, and gives similar results for spans greater than 46 ft (Case of no railings-x0). Considering the stiffness factors between x1 and x4, and for span lengths less than 46 ft, AASHTO overestimates the edge beam moment by about 70%. However, AASHTO overestimates the edge beam moment by about 55% for span lengths greater than 46 ft. For two lane bridges, AASHTO gives edge beam moment similar to the FEA results for span lengths less than 46 ft, and underestimates the edge beam moment by about 15% for spans greater than 46 ft (Case of no railings-x0). Considering the stiffness factor between x1 and x4, and for span length less than 46 ft, AASHTO overestimates the edge beam moment by about 60%. However, for bridges

with span lengths greater than 46 ft, AASHTO overestimates the edge beam moment by about 20%, 35%, 45% and 50% for the stiffness factors x1, x2, x3 and x4 respectively. For three and four lane bridges, AASHTO recommended moments are similar to FEA edge beam moments for bridges with spans less than 46 ft, and underestimates the edge beam moment by about 20% for bridges with spans greater than 46 ft (Case of no railings-x0). Considering the railings with stiffness factor between x1 and x4, and for span lengths less than 46 ft, AASHTO overestimates the edge moment by about 60%. However, for bridges with span lengths greater than 46 ft, AASHTO gives edge beam moment similar to FEA results for railings with stiffness factors x0.5 and x1, and overestimates the edge beam moment by about 35% for railings with stiffness factors x2, x3 and x4.

The maximum FEA longitudinal edge beam moments were also compared to the AASHTO LRFD moments. For one lane bridges, LRFD overestimates the maximum edge beam moment by about 15% for spans less than 46 ft, and 25% for spans greater than 46 ft (Case of no railings-x0). LRFD overestimates the edge beam moment for all span lengths by about 45%, 55%, 65%, 70% and 75% for railings with stiffness factors x0.5, x1, x2, x3 and x4 respectively. For two lane bridges, LRFD gives edge beam moment similar to the FEA results for span lengths less than 36 ft., and overestimates the maximum edge beam moment by about 15% for bridges with span lengths greater than 36 ft (Case of no railings-x0). LRFD overestimates the edge beam moment for all span lengths by about 30%, 40%, 55% and 60% for railings with stiffness factors x0.5, x1, x2, x3 and x4. For three and four lane bridges, LRFD recommended moments are similar to FEA maximum edge beam moment results for bridges with spans greater than 36 ft, and underestimates the maximum edge beam moment by about 20% for spans less than 36 ft (Case of no railings-x0). For all span

lengths, LRFD overestimates the edge beam moment by about 20%, 30%, 45%, 55% and 60% for railings with stiffness factors x0.5, x1, x2, x3 and x4.

4.3.3.1.3 Maximum Live Load Deflection

Table 4.22 summarizes the maximum FEA live load deflection as compared to the AASHTO criterion of (*S*/800). The FEA results are directly related to the assumed slab thickness, which was a reasonable assumption for deflection control. But one can always assume a different thickness and obtain different deflection results.

For one lane bridges, AASHTO overestimates the maximum deflection by about 95% for all span lengths and for all stiffness factors (x0.5, x1, x2, x3and x4). For two lane bridges, AASHTO overestimates the maximum deflection by about 85% for bridges with span lengths less than 46 ft. However, for bridges with span lengths greater than 46 ft, AASHTO overestimates the maximum deflection by about 70% for all stiffness factors. For three and four lane bridges, AASHTO overestimates the maximum deflection by about 85% for spans less than 46 ft and for all stiffness factors, and by 65% for spans greater than 46 ft.

The overestimation value by AASHTO increases as the stiffness factor increases from X0.5 to X4. However, the percent difference decreases as the number of lanes increases from one to four lanes.

Table 4.18: *Comparison of FEA Maximum Longitudinal Bending Moment with AASHTO Moment*

Number of Lanes	Span Length (ft)	FEA Maximum Longitudinal Moment (Kip-ft/ft)												AASHTO Moment (kip-ft/ft)
		Stiffness Factor												
		X0		X1		X2		X3		X4		X0.5		
1	24	16.6	-23%	10.0	-54%	8.7	-60%	8.1	-62%	7.8	-64%	11.6	-46%	21.6
	36	29.1	-10%	16.9	-48%	13.3	-59%	11.5	-64%	10.5	-68%	20.7	-36%	32.4
	46	42.0	1%	26.5	-36%	20.4	-51%	17.2	-59%	15.2	-63%	32.0	-23%	41.4
	54	52.2	4%	36.2	-28%	28.5	-43%	24.0	-52%	21.0	-58%	42.5	-15%	50.2
2	24	20.5	-5%	14.7	-32%	13.4	-38%	12.9	-40%	12.6	-42%	16.3	-25%	21.6
	36	35.3	9%	24.7	-24%	20.5	-37%	18.3	-44%	17.0	-48%	28.6	-12%	32.4
	46	50.4	22%	37.5	-9%	31.0	-25%	27.0	-35%	24.3	-41%	42.7	3%	41.4
	54	62.4	24%	49.5	-1%	41.9	-17%	36.7	-27%	33.0	-34%	55.0	10%	50.2
3	24	21.7	1%	17.4	-20%	16.7	-23%	16.3	-24%	16.2	-25%	18.8	-13%	21.6
	36	37.5	16%	28.8	-11%	25.4	-22%	23.6	-27%	22.5	-30%	32.0	-1%	32.4
	46	52.9	28%	42.7	3%	36.9	-11%	33.4	-19%	30.9	-25%	47.0	14%	41.4
	54	65.0	30%	55.3	10%	48.7	-3%	43.9	-13%	40.5	-19%	59.6	19%	50.2
4	24	22.3	3%	19.2	-11%	18.8	-13%	18.6	-14%	18.5	-15%	19.7	-9%	21.6
	36	39.1	21%	31.6	-3%	29.2	-10%	28.0	-14%	27.2	-16%	33.9	5%	32.4
	46	55.2	33%	46.1	11%	41.3	0%	38.5	-7%	36.5	-12%	50.0	21%	41.4
	54	67.7	35%	59.2	18%	53.2	6%	49.2	-2%	46.3	-8%	63.1	26%	50.2

Table 4.19: *Comparison of FEA Maximum Longitudinal Bending Moment with LRFD Moment*

Number of Lanes	Span Length (ft)	FEA Maximum Longitudinal Moment (Kip-ft/ft)												LRFD Moment (kip-ft/ft)
		Stiffness Factor												
		X0		X1		X2		X3		X4		X0.5		
1	24	16.6	-41%	10.0	-65%	8.7	-69%	8.1	-71%	7.8	-72%	11.6	-59%	28.1
	36	29.1	-38%	16.9	-64%	13.3	-72%	11.5	-76%	10.5	-78%	20.7	-56%	47.2
	46	42.0	-33%	26.5	-58%	20.4	-68%	17.2	-73%	15.2	-76%	32.0	-49%	62.9
	54	52.2	-31%	36.2	-52%	28.5	-62%	24.0	-68%	21.0	-72%	42.5	-44%	75.3
2	24	20.5	-15%	14.7	-39%	13.4	-44%	12.9	-47%	12.6	-48%	16.3	-32%	24.1
	36	35.3	-23%	24.7	-46%	20.5	-55%	18.3	-60%	17.0	-63%	28.6	-37%	45.6
	46	50.4	-23%	37.5	-43%	31.0	-53%	27.0	-59%	24.3	-63%	42.7	-35%	65.3
	54	62.4	-24%	49.5	-39%	41.9	-49%	36.7	-55%	33.0	-60%	55.0	-33%	81.7
3	24	21.7	-4%	17.4	-23%	16.7	-26%	16.3	-28%	16.2	-29%	18.8	-17%	22.6
	36	37.5	-11%	28.8	-32%	25.4	-40%	23.6	-44%	22.5	-47%	32.0	-24%	42.3
	46	52.9	-12%	42.7	-29%	36.9	-39%	33.4	-45%	30.9	-49%	47.0	-22%	60.4
	54	65.0	-16%	55.3	-28%	48.7	-37%	43.9	-43%	40.5	-47%	59.6	-23%	77.1
4	24	22.3	4%	19.2	-11%	18.8	-13%	18.6	-14%	18.5	-14%	19.7	-8%	21.5
	36	39.1	-2%	31.6	-21%	29.2	-27%	28.0	-30%	27.2	-32%	33.9	-15%	40
	46	55.2	-8%	46.1	-23%	41.3	-31%	38.5	-36%	36.5	-39%	50.0	-16%	59.8
	54	67.7	-12%	59.2	-23%	53.2	-31%	49.2	-36%	46.3	-40%	63.1	-18%	77.1

Table 4.20: *Comparison of FEA Edge Beam Moment with AASHTO Moment*

Number of Lanes	Span Length (ft)	FEA Edge Beam Moment (kip-ft/ft)												AASHTO Moment (kip-ft/ft)
		Stiffness Factor												
		X0		X1		X2		X3		X4		X0.5		
1	24	20.1	-22%	9.4	-63%	7.4	-71%	6.5	-75%	6.0	-76%	11.8	-54%	25.6
	36	32.7	-15%	17.2	-55%	12.9	-66%	10.8	-72%	9.5	-75%	21.8	-43%	38.4
	46	45.6	-7%	27.3	-44%	20.6	-58%	17.0	-65%	14.7	-70%	35.6	-28%	49.1
	54	55.9	-3%	37.4	-35%	29.0	-50%	24.1	-58%	20.9	-64%	44.4	-23%	57.6
2	24	23.1	-10%	11.7	-54%	9.1	-64%	7.9	-69%	7.3	-72%	14.6	-43%	25.6
	36	38.5	0%	23.4	-39%	17.9	-53%	15.0	-61%	13.1	-66%	28.5	-26%	38.4
	46	53.7	9%	37.3	-24%	29.5	-40%	24.9	-49%	21.7	-56%	43.5	-11%	49.1
	54	65.8	14%	49.9	-13%	41.2	-29%	35.3	-39%	31.2	-46%	56.4	-2%	57.6
3	24	24.1	-6%	12.5	-51%	9.8	-62%	8.5	-67%	7.8	-70%	15.6	-39%	25.6
	36	40.6	6%	26.4	-31%	20.7	-46%	17.4	-55%	15.3	-60%	31.4	-18%	38.4
	46	56.5	15%	42.1	-14%	34.5	-30%	29.6	-40%	26.1	-47%	47.7	-3%	49.1
	54	68.8	19%	55.6	-4%	47.6	-17%	41.8	-27%	37.5	-35%	61.1	6%	57.6
4	24	24.5	-4%	12.8	-50%	10.0	-61%	8.7	-66%	7.9	-69%	15.9	-38%	25.6
	36	42.1	10%	27.9	-27%	22.0	-43%	18.6	-52%	16.4	-57%	32.9	-14%	38.4
	46	58.8	20%	45.0	-8%	37.5	-24%	32.4	-34%	28.8	-41%	50.5	3%	49.1
	54	71.5	24%	59.3	3%	51.7	-10%	46.0	-20%	41.6	-28%	64.5	12%	57.6

Table 4.21: *Comparison of FEA Edge Beam Moment with LRFD Moment*

Number of Lanes	Span Length (ft)	FEA Edge Beam Moment (kip-ft/ft)												LRFD Moment (kip-ft/ft)
		Stiffness Factor												
		X0		X1		X2		X3		X4		X0.5		
1	24	20.06	-13%	9.4	-59%	7.4	-68%	6.5	-72%	6.0	-74%	11.8	-49%	23
	36	32.72	-17%	17.2	-56%	12.9	-67%	10.8	-73%	9.5	-76%	21.8	-45%	39.5
	46	45.59	-25%	27.3	-55%	20.6	-66%	17.0	-72%	14.7	-76%	35.6	-42%	60.9
	54	55.87	-27%	37.4	-51%	29.0	-62%	24.1	-68%	20.9	-73%	44.4	-42%	76.1
2	24	23.14	9%	11.7	-45%	9.1	-57%	7.9	-63%	7.3	-66%	14.6	-31%	21.2
	36	38.52	-7%	23.4	-43%	17.9	-57%	15.0	-64%	13.1	-68%	28.5	-31%	41.4
	46	53.73	-14%	37.3	-40%	29.5	-53%	24.9	-60%	21.7	-65%	43.5	-30%	62.3
	54	65.78	-18%	49.9	-37%	41.2	-48%	35.3	-56%	31.2	-61%	56.4	-29%	79.9
3	24	24.1	18%	12.5	-39%	9.8	-52%	8.5	-58%	7.8	-62%	15.6	-24%	20.5
	36	40.64	2%	26.4	-34%	20.7	-48%	17.4	-56%	15.3	-62%	31.4	-21%	39.7
	46	56.49	-5%	42.1	-29%	34.5	-42%	29.6	-50%	26.1	-56%	47.7	-20%	59.5
	54	68.78	-11%	55.6	-28%	47.6	-38%	41.8	-46%	37.5	-51%	61.1	-21%	77.3
4	24	24.5	23%	12.8	-36%	10.0	-50%	8.7	-56%	7.9	-60%	15.9	-20%	19.9
	36	42.06	10%	27.9	-27%	22.0	-43%	18.6	-52%	16.4	-57%	32.9	-14%	38.4
	46	58.75	-1%	45.0	-24%	37.5	-37%	32.4	-45%	28.8	-51%	50.5	-15%	59.1
	54	71.50	-8%	59.3	-23%	51.7	-33%	46.0	-41%	41.6	-46%	64.5	-17%	77.3

Table 4.22: *Comparison of FEA Maximum Live Load Deflection with AASHTO Criterion*

Number of Lanes	Span Length (ft)	FEA Maximum Slab Deflection (in)												AASHTO Deflection (in)
		Stiffness Factor												
		X0		X1		X2		X3		X4		X0.5		
1	24	0.066	-82%	0.025	-93%	0.016	-96%	0.013	-96%	0.011	-97%	0.035	-90%	0.360
	36	0.179	-67%	0.088	-84%	0.060	-89%	0.046	-91%	0.038	-93%	0.117	-78%	0.540
	46	0.291	-58%	0.170	-75%	0.122	-82%	0.096	-86%	0.080	-88%	0.214	-69%	0.690
	54	0.352	-57%	0.233	-71%	0.176	-78%	0.142	-82%	0.120	-85%	0.280	-65%	0.810
2	24	0.080	-78%	0.039	-89%	0.033	-91%	0.030	-92%	0.028	-92%	0.048	-87%	0.360
	36	0.219	-59%	0.129	-76%	0.093	-83%	0.076	-86%	0.067	-88%	0.162	-70%	0.540
	46	0.352	-49%	0.244	-65%	0.188	-73%	0.154	-78%	0.130	-81%	0.287	-58%	0.690
	54	0.422	-48%	0.323	-60%	0.263	-68%	0.222	-73%	0.193	-76%	0.366	-55%	0.810
3	24	0.085	-76%	0.051	-86%	0.047	-87%	0.046	-87%	0.045	-88%	0.056	-84%	0.360
	36	0.233	-57%	0.149	-72%	0.122	-77%	0.109	-80%	0.101	-81%	0.181	-66%	0.540
	46	0.373	-46%	0.280	-59%	0.225	-67%	0.189	-73%	0.170	-75%	0.319	-54%	0.690
	54	0.445	-45%	0.364	-55%	0.309	-62%	0.268	-67%	0.238	-71%	0.400	-51%	0.810
4	24	0.087	-76%	0.060	-83%	0.058	-84%	0.057	-84%	0.056	-84%	0.063	-83%	0.360
	36	0.243	-55%	0.164	-70%	0.147	-73%	0.137	-75%	0.132	-76%	0.192	-64%	0.540
	46	0.390	-43%	0.301	-56%	0.247	-64%	0.224	-68%	0.208	-70%	0.339	-51%	0.690
	54	0.464	-43%	0.391	-52%	0.338	-58%	0.298	-63%	0.268	-67%	0.424	-48%	0.810

4.3.3.2 FEA Results of Bridges with different railing sizes versus Bridges with no railings

4.3.3.2.1 Maximum Longitudinal Bending Moment

The ratios M2/xj / M2/x0 for the maximum longitudinal moment are shown in Table 4.23 and Figure 4.8, for each of the four span lengths considered (24, 36, 46, and 54 ft) versus the stiffness factor. Such Tables/Figures indicate a decrease in the maximum longitudinal moment values with the increase in the railing's stiffness factor, compared to that of bridges without railings. This decrease appears to be significant when the span length is greater than 36 ft. Also, the ratio M2/xj / M2/x0 increase with the increase in the number of lanes from one to four. For the maximum longitudinal moment, the ratio M2/xj / M2/x0 is almost one for bridges with railing's stiffness factor x0 (Case of no railings), decreases to about 0.65 for bridges with railing's stiffness factor between x0.5 and x2, and further decreases to about 0.5 as the stiffness factor increases to x4.

4.3.3.2.2 Edge Beam Moment

The ratios M2/xj /M2/x0 for the edge beam moment are shown in Table 4.24 and Figure 4.9, for each of the four span lengths considered (24, 36, 46, and 54 ft) versus the railing's stiffness factor. Such Table/Figure indicates a decrease in the edge beam moment values with the increase in the railing's stiffness factor. This decrease appears to be significant when the span length is greater than 36 ft. The ratio M2/xj /M2/x0 increases with the increase in the number of lanes from one to four. For the edge beam moment, the ratio M2/xj /M2/x0 is almost one for bridges with railings of stiffness factor x0 (Case of no railings), decreases to about 0.65 for bridges with railings of stiffness factor between x0.5 and x2, and further decreases to about 0.45 as the railing's stiffness factor increase to x4.

4.3.3.2.3 Maximum Live Load Deflection

The ratio Δ2/xj /Δ2/x0 values obtained are presented in Table 4.25 and Figure 4.10 for each of the four span lengths considered (24, 36, 46, and 54 ft). The maximum live load deflection pattern is consistent and expected to be similar to the maximum longitudinal bending moment. These values indicate that the maximum live load deflection for bridges with railings of different sizes compared to that of bridges with no railings decrease with the increase of the railing's stiffness factor for all span lengths and the number of lanes. This decrease is summarized as follows: The ratio is about one for bridges with stiffness factor x0 (Case of no railings) and is approximately equal to 0.60 for railings of stiffness factor between x0.5 and x2; this ratio further decreases to about 0.40 for bridges with the increase of the stiffness factor.

Table 4.23: *FEA Maximum Longitudinal Bending Moment – Ratio M2/xj /M2/x0*

Number of Lanes	Span Length (ft)	FEA Maximum Longitudinal Moment (Kip-ft/ft)												Reference Moment X0
		Stiffness Factor												
		X0		X1		X2		X3		X4		X0.5		
1	24	16.6	1.00	10.0	0.60	8.7	0.52	8.1	0.49	7.8	0.47	11.6	0.70	16.6
	36	29.1	1.00	16.9	0.58	13.3	0.46	11.5	0.40	10.5	0.36	20.7	0.71	29.1
	46	42.0	1.00	26.5	0.63	20.4	0.49	17.2	0.41	15.2	0.36	32.0	0.76	42.0
	54	52.2	1.00	36.2	0.69	28.5	0.54	24.0	0.46	21.0	0.40	42.5	0.81	52.2
2	24	20.5	1.00	14.7	0.71	13.4	0.66	12.9	0.63	12.6	0.61	16.3	0.80	20.5
	36	35.3	1.00	24.7	0.70	20.5	0.58	18.3	0.52	17.0	0.48	28.6	0.81	35.3
	46	50.4	1.00	37.5	0.74	31.0	0.62	27.0	0.54	24.3	0.48	42.7	0.85	50.4
	54	62.4	1.00	49.5	0.79	41.9	0.67	36.7	0.59	33.0	0.53	55.0	0.88	62.4
3	24	21.7	1.00	17.4	0.80	16.7	0.77	16.3	0.75	16.2	0.74	18.8	0.87	21.7
	36	37.5	1.00	28.8	0.77	25.4	0.68	23.6	0.63	22.5	0.60	32.0	0.85	37.5
	46	52.9	1.00	42.7	0.81	36.9	0.70	33.4	0.63	30.9	0.58	47.0	0.89	52.9
	54	65.0	1.00	55.3	0.85	48.7	0.75	43.9	0.68	40.5	0.62	59.6	0.92	65.0
4	24	22.3	1.00	19.2	0.86	18.8	0.84	18.6	0.83	18.5	0.83	19.7	0.89	22.3
	36	39.1	1.00	31.6	0.81	29.2	0.75	28.0	0.72	27.2	0.70	33.9	0.87	39.1
	46	55.2	1.00	46.1	0.83	41.3	0.75	38.5	0.70	36.5	0.66	50.0	0.91	55.2
	54	67.7	1.00	59.2	0.87	53.2	0.79	49.2	0.73	46.3	0.68	63.1	0.93	67.7

Table 4.24: *FEA Edge Beam Moment – Ratio M2/xj /M2/x0*

Number of Lanes	Span Length (ft)	FEA Edge Beam Moment (Kip-ft/ft)												Reference Moment X0
		Stiffness factor												
		X0		X1		X2		X3		X4		X0.5		
1	24	20.1	1.00	9.4	0.47	7.4	0.37	6.5	0.33	6.0	0.30	11.8	0.59	20.1
	36	32.7	1.00	17.2	0.53	12.9	0.39	10.8	0.33	9.5	0.29	21.8	0.67	32.7
	46	45.6	1.00	27.3	0.60	20.6	0.45	17.0	0.37	14.7	0.32	35.6	0.78	45.6
	54	55.9	1.00	37.4	0.67	29.0	0.52	24.1	0.43	20.9	0.37	44.4	0.79	55.9
2	24	23.1	1.00	11.7	0.50	9.1	0.39	7.9	0.34	7.3	0.31	14.6	0.63	23.1
	36	38.5	1.00	23.4	0.61	17.9	0.47	15.0	0.39	13.1	0.34	28.5	0.74	38.5
	46	53.7	1.00	37.3	0.69	29.5	0.55	24.9	0.46	21.7	0.40	43.5	0.81	53.7
	54	65.8	1.00	49.9	0.76	41.2	0.63	35.3	0.54	31.2	0.47	56.4	0.86	65.8
3	24	24.1	1.00	12.5	0.52	9.8	0.41	8.5	0.35	7.8	0.32	15.6	0.65	24.1
	36	40.6	1.00	26.4	0.65	20.7	0.51	17.4	0.43	15.3	0.38	31.4	0.77	40.6
	46	56.5	1.00	42.1	0.74	34.5	0.61	29.6	0.52	26.1	0.46	47.7	0.84	56.5
	54	68.8	1.00	55.6	0.81	47.6	0.69	41.8	0.61	37.5	0.55	61.1	0.89	68.8
4	24	24.5	1.00	12.8	0.52	10.0	0.41	8.7	0.36	7.9	0.32	15.9	0.65	24.5
	36	42.1	1.00	27.9	0.66	22.0	0.52	18.6	0.44	16.4	0.39	32.9	0.78	42.1
	46	58.8	1.00	45.0	0.77	37.5	0.64	32.4	0.55	28.8	0.49	50.5	0.86	58.8
	54	71.5	1.00	59.3	0.83	51.7	0.72	46.0	0.64	41.6	0.58	64.5	0.90	71.5

Table 4.25: *FEA Maximum Live Load Deflection – Ratio Δ2/xj /Δ2/x0*

Number of Lanes	Span Length (ft)	FEA Maximum Slab Deflection (in)												Reference Deflection X0
		Stiffness Factor												
		X0		X1		X2		X3		X4		X0.5		
1	24	0.066	1.00	0.025	0.38	0.016	0.24	0.013	0.20	0.011	0.17	0.035	0.53	0.066
	36	0.179	1.00	0.088	0.49	0.060	0.34	0.046	0.26	0.038	0.21	0.117	0.65	0.179
	46	0.291	1.00	0.170	0.58	0.122	0.42	0.096	0.33	0.080	0.27	0.214	0.74	0.291
	54	0.352	1.00	0.233	0.66	0.176	0.50	0.142	0.40	0.120	0.34	0.280	0.80	0.352
2	24	0.080	1.00	0.039	0.49	0.033	0.41	0.030	0.38	0.028	0.35	0.048	0.60	0.080
	36	0.219	1.00	0.129	0.59	0.093	0.42	0.076	0.35	0.067	0.31	0.162	0.74	0.219
	46	0.352	1.00	0.244	0.69	0.188	0.53	0.154	0.44	0.130	0.37	0.287	0.82	0.352
	54	0.422	1.00	0.323	0.77	0.263	0.62	0.222	0.53	0.193	0.46	0.366	0.87	0.422
3	24	0.085	1.00	0.051	0.60	0.047	0.55	0.046	0.54	0.045	0.53	0.056	0.66	0.085
	36	0.233	1.00	0.149	0.64	0.122	0.52	0.109	0.47	0.101	0.43	0.181	0.78	0.233
	46	0.373	1.00	0.280	0.75	0.225	0.60	0.189	0.51	0.170	0.46	0.319	0.86	0.373
	54	0.445	1.00	0.364	0.82	0.309	0.69	0.268	0.60	0.238	0.53	0.400	0.90	0.445
4	24	0.087	1.00	0.060	0.69	0.058	0.67	0.057	0.66	0.056	0.64	0.063	0.72	0.087
	36	0.243	1.00	0.164	0.67	0.147	0.60	0.137	0.56	0.132	0.54	0.192	0.79	0.243
	46	0.390	1.00	0.301	0.77	0.247	0.63	0.224	0.57	0.208	0.53	0.339	0.87	0.390
	54	0.464	1.00	0.391	0.84	0.338	0.73	0.298	0.64	0.268	0.58	0.424	0.91	0.464

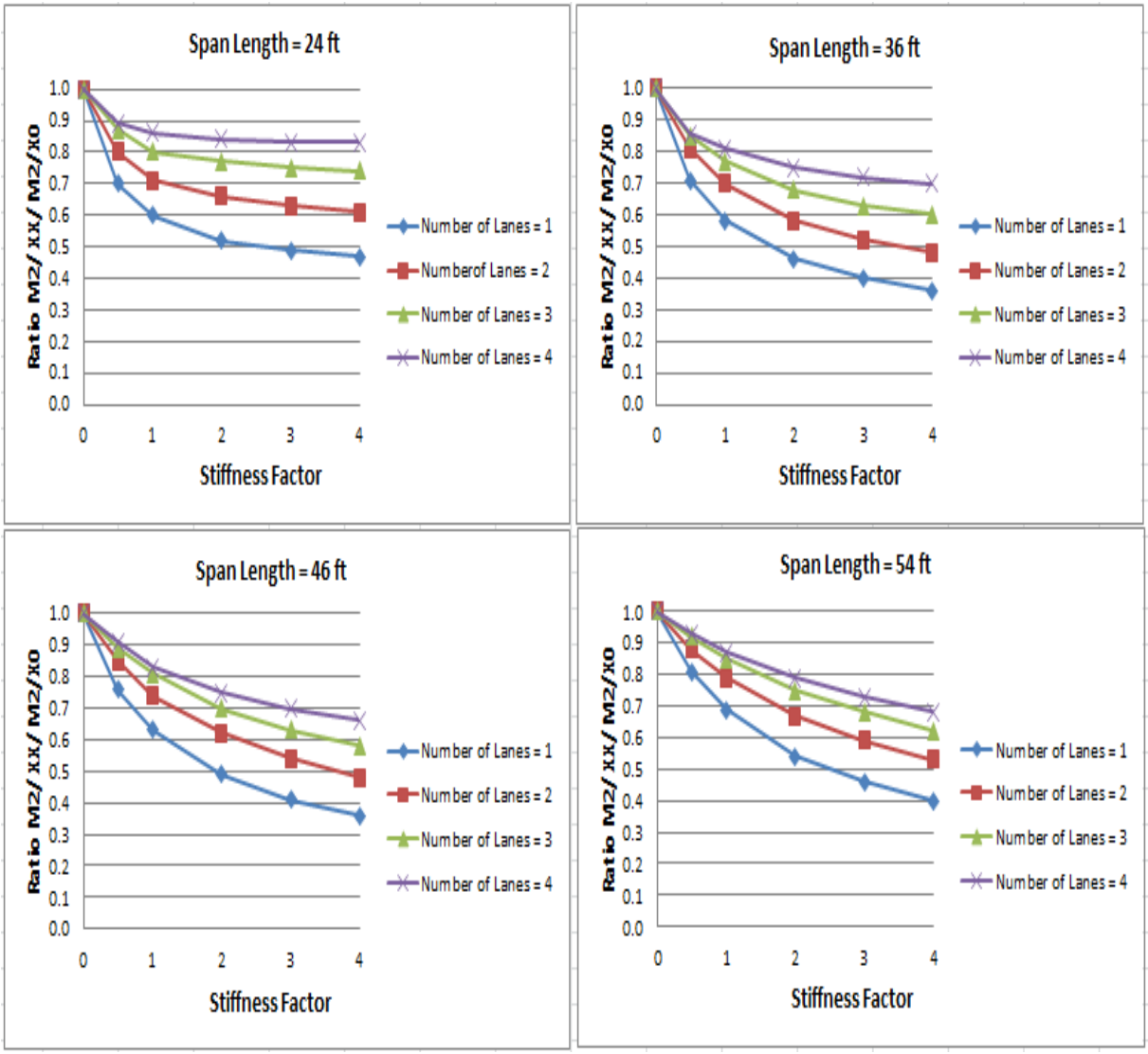


Figure 4.8: *FEA Maximum Longitudinal Bending Moment – Ratio M2/xj / M2/x0*

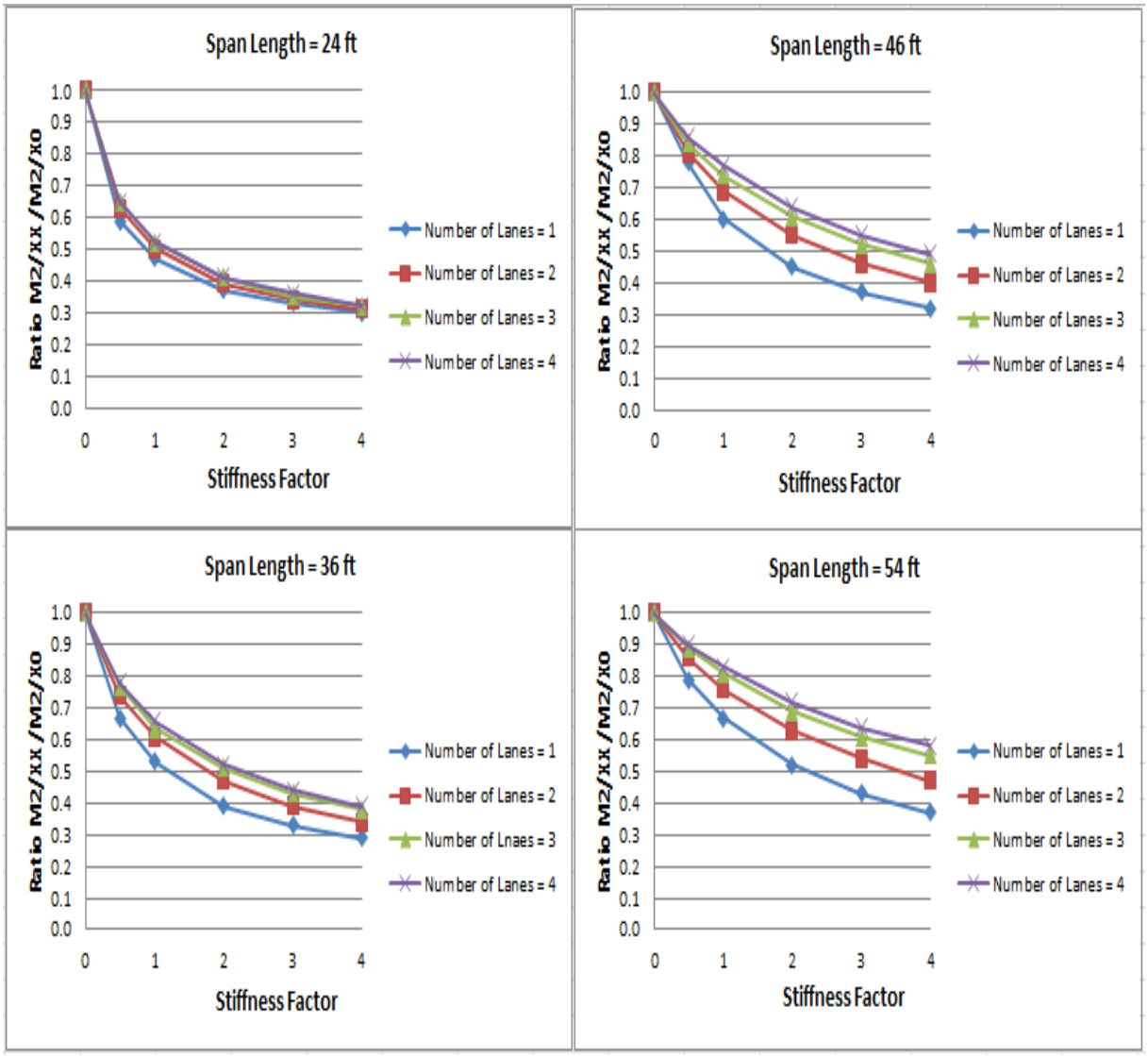


Figure 4.9: *FEA Edge Beam Moment – Ratio M2/xj / M2/x0*

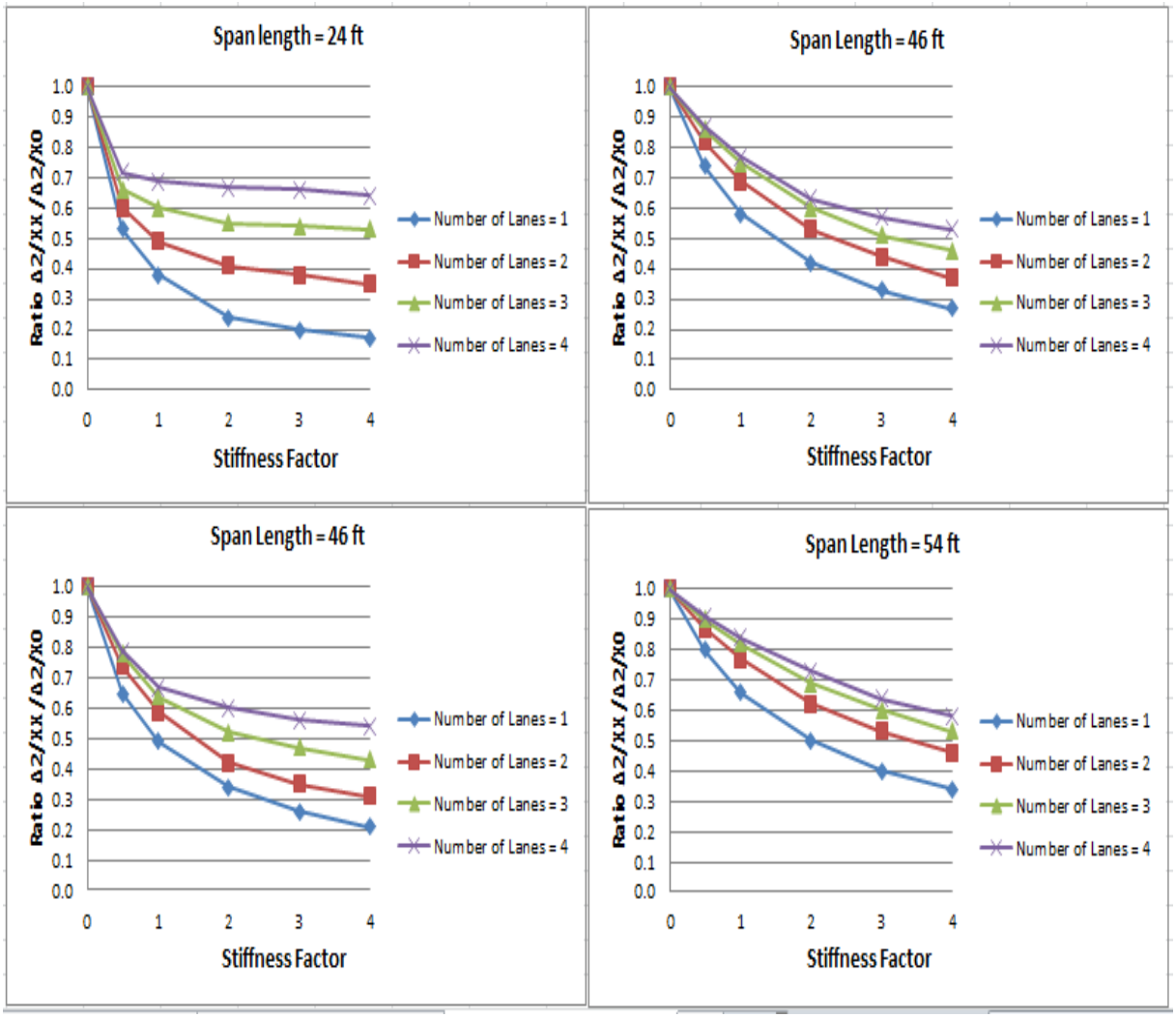


Figure 4.10: *FEA Maximum Live Load Deflection – Ratio Δ2/xj / Δ2/x0*

4.3.3.3 Summary

The AASHTO Standard Specifications overestimated the maximum longitudinal bending moment for span lengths less than 46 ft with railing's stiffness factor less than x2 by about 60%, 35% and 20% for one, two and three lanes respectively, and gave similar results to the FEA maximum longitudinal moment for four lane bridges. As the railing's stiffness factor increased to x4, the overestimation value increased to 65%, 45% and 30% for one, two and three lane bridges. AASHTO LRFD Design Specifications overestimated the maximum longitudinal moment by about 70%, 45%, 35% and 25% for one, two, three and four lane bridges respectively. This overestimation value decreased as the number of lanes increased from one to four. The ratio between the FEA longitudinal moments for bridges with different railing's sizes and bridges without railings was almost one for bridges with no railings. This ratio decreased to 0.65 for bridges with railings of stiffness factor between x0.5 and x2, and further decreased to about 0.5 as the stiffness factor increased to x4. So, as the number of lanes increased from one to four, this ratio increased. The ratio between the FEA maximum live load deflection for bridges with different stiffness factors and bridges without railings decreased in the same pattern consistent with that of the longitudinal moment. This ratio decreased from one for stiffness factor x0 to about 0.6 for stiffness factors between x0.5 and x2, and further decreased to about 0.40 as the stiffness factor increased to x4.

CHAPTER 5
SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Summary

The current research studies the influence of varying the railing size or stiffness on wheel load distribution as well as on the wheel load-carrying capacity of straight concrete slab bridges. In this research, the finite-element method is used to investigate the effect of span length and slab width, and to calculate the wheel load distribution on the bridge slab at the critical section. AASHTO (HS20) design trucks loads are placed transversally and longitudinally to produce maximum moments at the critical section of the slabs. Various configurations of railings sizes/stiffnesses on either or both edges of the slab are considered for straight bridges, where the cases with no railings will serve as reference cases. The wheel load distribution on the bridge slab at the critical section for the reference cases and for cases with railings are calculated and compared. The results are also assessed with the AASHTO Standard Specifications (2003) and AASHTO LRFD (2010) procedures which do not include railing stiffness as a criterion in design.

The FEA method was used to analyze the slab bridges; where by, the slabs were modeled and analyzed using SAP2000 computer program. In the present research, the finite-element modeling consists of shells for concrete slab, frames for railings and simple supports for the piers.

For the purpose of this study, a total number of 320 bridges were modeled divided into four categories: one lane, two lane, three lane, and four lane bridges with lane width of 12 ft. Each category was subdivided further into four other categories according to span length: 24 ft, 36 ft, 46 ft, and 54 ft, with the slab thickness being 18in, 21in, 24in and 27in, respectively, and after that, each category is subdivided in

to six other categories representing six distinct stiffness factors, which are x0, x0.5, x1, x2, x3 and x4. Bridges were then split into three major categories:

Case 1: “Concrete Bridges with no railings”

Case 2: “Concrete Bridges with one railing”

Case 3: “Concrete Bridges with two railings”

AASHTO HS20 design trucks were positioned longitudinally on the bridges to produce maximum moments where two different configurations were considered: E1 and E2 edge loading conditions. These loading conditions give maximum longitudinal and edge beam moments.

Based on FEA tabulated results a comparison between the reference case bridges and bridges with railings of different stiffness factors was conducted to assess the influence of railing’s stiffness on the capacity of the bridges. Bending moments, edge beam moments and deflections were considered. In addition, a comparison with AASHTO design moments and deflection values was also conducted. Results were presented in plots, graphs, and tables, and summarized in comparative tables which show the relative percentage differences and ratios.

5.2 Conclusions

The results of this research evaluated the influence of railing’s stiffness on the maximum bending moments, edge beam moments, and maximum live load deflections for single span bridges. The following conclusions are drawn based on the results of this investigation.

5.2.1 Longitudinal Bending Moments

For bridges with no railings, the AASHTO Standard Specifications overestimated the maximum moment by about 25% for one lane bridges, and underestimated the maximum moment by about 30% for two, three and four lane bridges. For bridges with one railing, as the railing's stiffness factor increases to x2, AASHTO overestimated the maximum moment by about 35% for one lane bridges, and kept the underestimation value constant (30%) for three and four lane bridges. However, for bridges with two railings, as the railing's stiffness factor increases to x2, AASHTO overestimated the maximum moment by about 55% for one and two lane bridges, and gave similar results to the FEA maximum moment for three and four lane bridges. For bridges with one railing, as the stiffness factor increase to x4, AASHTO overestimated the maximum moment by about45% for one lane bridges, gave similar results to the FEA maximum moment for two and three lane bridges, and kept the underestimation value constant (30%) for four lane bridges. However, for bridges with two railings, as the stiffness factor increases to x4, AASHTO overestimated the maximum moment by about 65%, 45% and 30% for one, two and three lane bridges respectively, and gave similar results to the FEA maximum moment for four lane bridges.

For bridges with no railings, AASHTO LRFD Design Specifications overestimated the maximum moment by about 40% and 25% for one and two lane bridges respectively, and gave similar results to the FEA maximum moment. For bridges with one railing, as the stiffness factor increases to x2, LRFD overestimated the maximum moment by about 50%, 30% and 20% for one, two and three lane bridges respectively, and gave similar results to the FEA maximum moment for four lane bridges. However, for bridges with two railings, as the stiffness factor increases

to x2, LRFD overestimated the maximum moment by about 65%, 50% and 30% for one, two and three and four lane bridges respectively. On the other hand, for bridges with one railing, and as the stiffness factor increases to x4, LRFD overestimated the maximum moment by about 60%, 35% and 25% for one, two and three lane bridges, and gave similar results to the FEA maximum moment for four lane bridges. However, for bridges with two railings, as the stiffness factor increases to x4, LRFD overestimated the maximum moment by about 75%, 60% and 40% for one, two and three and four lane bridges respectively.

Based on the comparison of the longitudinal moment of all bridges with the reference case bridges, the following conclusions can be made:

For stiffness factor x0.5, and for bridges with one railing, the reduction in the maximum longitudinal moment reaches 10% for one lane bridges and about none for two, three and four lane bridges. However, for bridges with two railings, the reductions in the maximum longitudinal moment reaches 30%, 20% and 10% for one, two and three and four lane bridges respectively.

For stiffness factor x1, and for bridges with one railing, the reduction in the maximum moment reaches 20% and 10% for one and two lane bridges, and about none for three and for lane bridges. However, for bridges with two railings, the reduction in the maximum moment reaches 35%, 30% and 20% for one, two and three and four lane bridges respectively.

For stiffness factor x2, and for bridges with one railing, the reduction in the maximum moment reaches 30% and 15% for one and two lane bridges, and about none for three and four lane bridges. However, for bridges with two railings, the

reduction in the maximum moment reaches 50%, 35% and 25% for one, two and three and four lane bridges respectively.

For stiffness factor x3, and for bridges with one railing, the reduction in the maximum moment reaches 35%, 20% and 10% for one, two and three lane bridges, and about none for four lane bridges. However, for bridges with two railings, the reduction in the maximum moment reaches 60%, 45%, 35% and 30% for one, two, three and four lane bridges respectively.

For stiffness factor x4, and for bridges with one railing, the reduction in the maximum moment reaches 40%, 25% and 10% for one, two and three and four lane bridges. However, for bridges with two railings, the reduction in the maximum moment reaches 65%, 50%, 40% and 30% for one, two, three and four lane bridges respectively.

The reduction in the maximum longitudinal moment is not affected by the span length. The reduction in the longitudinal moment is more when the number of lanes decreases. So, the reduction in the maximum moment increases with the increase in the stiffness factor, and decreases with the increase in the number of lanes.

5.2.2 Edge Beam Moments

For bridges with no railings, the AASHTO Standard Specifications overestimated the edge beam moment by about 20% for one lane bridge, gave similar results to the FEA edge beam moment, and underestimated the edge beam moment by about 20% for three and four lane bridges. For bridges with one railing, as the stiffness increases to x2, AASHTO overestimated the edge beam moment by about 30% for one lane bridges, gave similar results to the FEA edge beam moment for two lane bridges, and underestimated the edge beam moment by about 15% for three and

four lane bridges. However, for bridges with two railings, as the stiffness factor increases to x2, AASHTO overestimated the edge beam moment by about 60%, 50%, 35% and 30% for one, two, three and four lane bridges respectively. For bridges with one railing, as the stiffness factor increases to x4, AASHTO overestimated the edge beam moment by about 40% for one lane bridges, gave similar results to the FEA edge beam moment for two and three lane bridges, and underestimated the edge beam moment by about 15% for four lane bridges. However, for bridges with two railings, as the stiffness increases to x4, AASHTO overestimated the edge beam moment by about 70%, 60%, 50% and 45% for one, two, three and four lane bridges respectively.

For bridges with no railings, AASHTO LRFD Design Specifications overestimated the edge beam moment by about 20% and 15% for one and two lane bridges, and underestimated the edge beam moment by about 20% for three and four lane bridges. For bridges with one railing, as the stiffness factor increases to x2, LRFD overestimated the edge beam moment by about 40%, 20% and 15% for one, two and three lane bridges respectively, and underestimated the edge beam moment by about 15% for four lane bridges. However, for bridges with two railings, as the stiffness increases to x2, .LRFD overestimated the edge beam moment by about 60%, 50%, 40% and 35% for one, two, three and four lane bridges respectively. On the other hand, for bridges with one railing, as the stiffness increases to x4, LRFD overestimated the edge beam moment by about 50%, 30% and 15% for one, two and three lane bridges respectively, and underestimated the edge beam moment by about 15% for four lane bridges. However, for bridges with two railing, as the stiffness increases to x4, LRFD overestimated the edge beam moment by about 75%, 65%, 55% and 55% for one, two, three and four lane bridges respectively.

5.2.3 Maximum Deflections

The FEA results are directly related to the assumed slab thickness, which was a reasonable assumption for deflection control. But one can always assume a different thickness and obtain different deflection results.

For any given span length and its corresponding slab thickness, the maximum live load deflection results decrease as the railing's stiffness factor increases from x0.5 to x4. The percent difference with the AASHTO limiting criteria increases with the increase in the stiffness factor. The percent difference is higher for short spans, and decreases as the span length increases to 54 ft for a given stiffness factor. Moreover, the basic assumption of the FEA model is the elastic section behavior, an actual cracked section analysis would yield higher deflections in the slabs.

5.3 Recommendations

AASHTO Standard specifications and AASHTO LRFD empirical equations did not account neither for the presence of railings as integral parts of the bridges nor for the influence of railing's stiffness on the wheel load were distribution in concrete bridges, and these elements were neglected during the design stage. Based on the finite element analysis, it is clearly shown that these elements increase the capacity of the bridges if the same are modeled as integral parts of the bridge. In addition, railings can be used as a reinforcement method to upgrade already existing bridges that require rehabilitation or upgrading. Experimental work is recommended to assess the accuracy of the finite element analysis results obtained in this investigation. Moreover, continuous slab bridges, two spans and three span slab bridges should be investigated for the same variation of railings.

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Table 1.1: Longitudinal Moment Distribution at Critical Section for One-Lane Single Span Bridge Deck Span = 24 ft, Deck Width = 14 ft, No Railings with Edge Loading E1

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	18.7	28.1	18.7	28.1	18.7	28.1	18.7	28.1	18.7	28.1	21.6
1	20.1	28.1	20.1	28.1	20.1	28.1	20.1	28.1	20.1	28.1	21.6
2	16.4	28.1	16.4	28.1	16.4	28.1	16.4	28.1	16.4	28.1	21.6
3	14.9	28.1	14.9	28.1	14.9	28.1	14.9	28.1	14.9	28.1	21.6
4	14.1	28.1	14.1	28.1	14.1	28.1	14.1	28.1	14.1	28.1	21.6
5	13.9	28.1	13.9	28.1	13.9	28.1	13.9	28.1	13.9	28.1	21.6
6	14.3	28.1	14.3	28.1	14.3	28.1	14.3	28.1	14.3	28.1	21.6
7	16.6	28.1	16.6	28.1	16.6	28.1	16.6	28.1	16.6	28.1	21.6
8	13.4	28.1	13.4	28.1	13.4	28.1	13.4	28.1	13.4	28.1	21.6
9	12.0	28.1	12.0	28.1	12.0	28.1	12.0	28.1	12.0	28.1	21.6
10	11.2	28.1	11.2	28.1	11.2	28.1	11.2	28.1	11.2	28.1	21.6
11	10.6	28.1	10.6	28.1	10.6	28.1	10.6	28.1	10.6	28.1	21.6
12	10.2	28.1	10.2	28.1	10.2	28.1	10.2	28.1	10.2	28.1	21.6
13	10.0	28.1	10.0	28.1	10.0	28.1	10.0	28.1	10.0	28.1	21.6
14	9.8	28.1	9.8	28.1	9.8	28.1	9.8	28.1	9.8	28.1	21.6

Figure 1.1: Longitudinal Moment Distribution at Critical Section for One-Lane Single Span Bridge – Deck Span = 24 ft, Deck Width = 14 ft, No Railings with Edge Loading E1

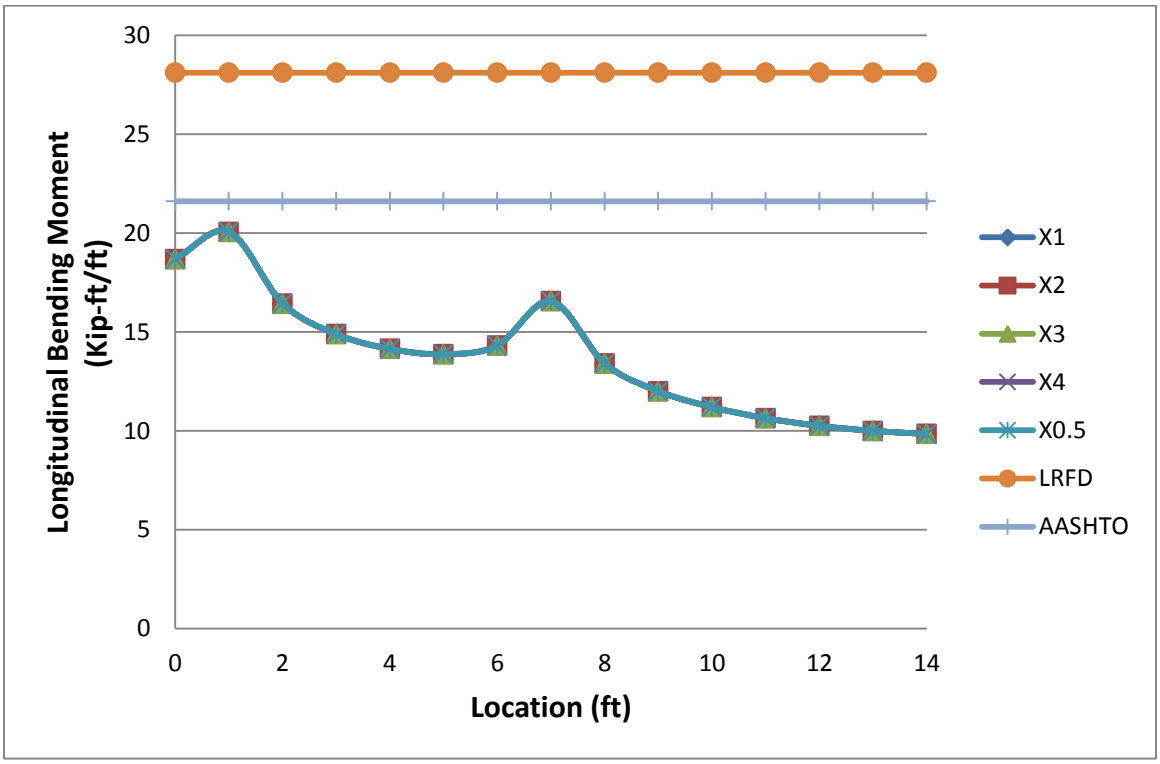

Table 1.2: Longitudinal Moment Distribution at Critical Section for One-Lane Single Span Bridge Deck Span = 24 ft, Deck Width = 14 ft, One Railing with Edge Loading E1 (LEFT)

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	8.8	28.1	6.7	28.1	5.8	28.1	5.2	28.1	11.3	28.1	21.6
1	10.1	28.1	8.0	28.1	7.1	28.1	6.5	28.1	12.6	28.1	21.6
2	8.4	28.1	6.6	28.1	5.7	28.1	5.2	28.1	10.6	28.1	21.6
3	7.7	28.1	6.0	28.1	5.2	28.1	4.8	28.1	9.7	28.1	21.6
4	7.8	28.1	6.2	28.1	5.5	28.1	5.1	28.1	9.5	28.1	21.6
5	8.1	28.1	6.6	28.1	6.0	28.1	5.6	28.1	9.7	28.1	21.6
6	9.0	28.1	7.7	28.1	7.0	28.1	6.7	28.1	10.5	28.1	21.6
7	11.7	28.1	10.4	28.1	9.8	28.1	9.5	28.1	13.1	28.1	21.6
8	8.9	28.1	7.7	28.1	7.1	28.1	6.8	28.1	10.2	28.1	21.6
9	7.7	28.1	6.6	28.1	6.1	28.1	5.8	28.1	9.0	28.1	21.6
10	7.2	28.1	6.1	28.1	5.6	28.1	5.4	28.1	8.3	28.1	21.6
11	6.8	28.1	5.8	28.1	5.3	28.1	5.1	28.1	7.9	28.1	21.6
12	6.6	28.1	5.6	28.1	5.2	28.1	4.9	28.1	7.7	28.1	21.6
13	6.5	28.1	5.5	28.1	5.1	28.1	4.9	28.1	7.5	28.1	21.6
14	6.4	28.1	5.5	28.1	5.1	28.1	4.9	28.1	7.4	28.1	21.6

Figure 1.2: Longitudinal Moment Distribution at Critical Section for One-Lane Single Span Bridge – Deck Span = 24 ft, Deck Width = 14 ft, One Railing with Edge Loading E1 (LEFT)

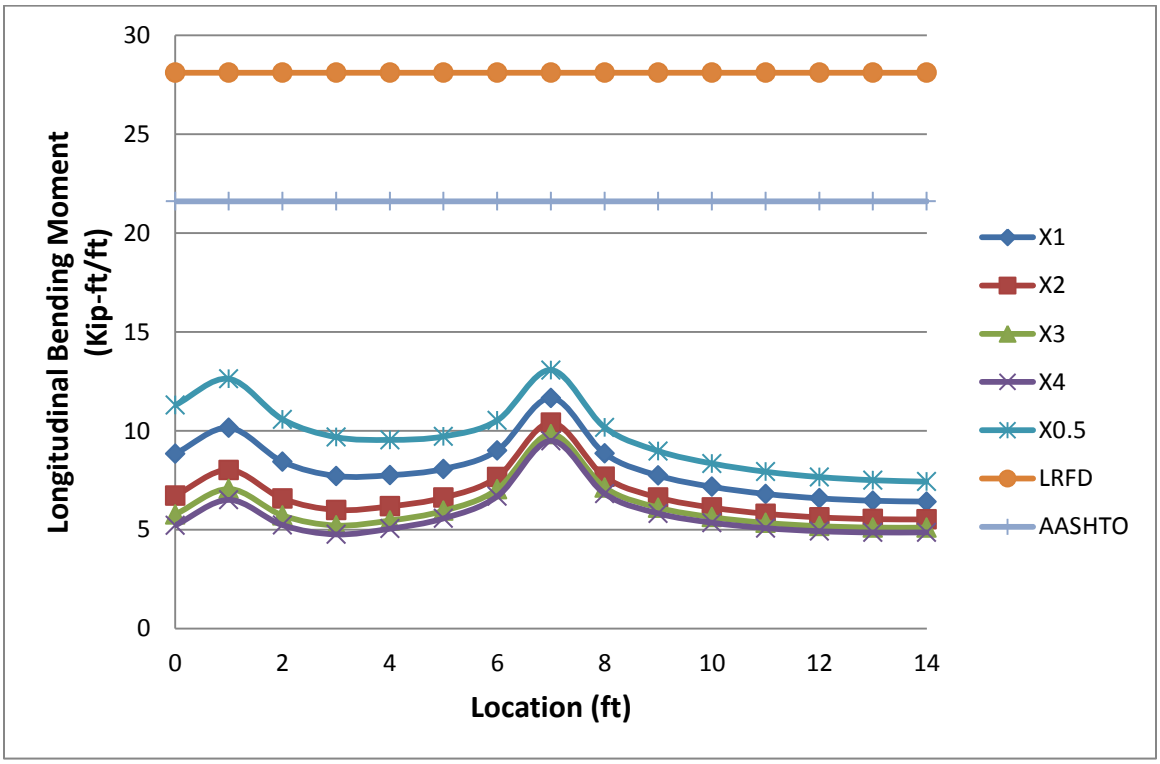

Table 1.3: Longitudinal Moment Distribution at Critical Section for One-Lane Single Span Bridge Deck Span = 24 ft, Deck Width = 14 ft, One Railing with Edge Loading E1 (RIGHT)

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	16.3	28.1	15.7	28.1	15.4	28.1	15.2	28.1	17.0	28.1	21.6
1	17.6	28.1	16.9	28.1	16.6	28.1	16.5	28.1	18.3	28.1	21.6
2	13.9	28.1	13.2	28.1	12.9	28.1	12.7	28.1	14.6	28.1	21.6
3	12.2	28.1	11.5	28.1	11.2	28.1	11.0	28.1	13.0	28.1	21.6
4	11.4	28.1	10.6	28.1	10.3	28.1	10.1	28.1	12.2	28.1	21.6
5	10.9	28.1	10.2	28.1	9.8	28.1	9.6	28.1	11.8	28.1	21.6
6	11.2	28.1	10.4	28.1	10.0	28.1	9.8	28.1	12.1	28.1	21.6
7	13.2	28.1	12.4	28.1	12.0	28.1	11.8	28.1	14.2	28.1	21.6
8	9.9	28.1	8.9	28.1	8.5	28.1	8.3	28.1	10.9	28.1	21.6
9	8.2	28.1	7.2	28.1	6.8	28.1	6.5	28.1	9.3	28.1	21.6
10	7.1	28.1	6.0	28.1	5.6	28.1	5.3	28.1	8.3	28.1	21.6
11	6.2	28.1	5.1	28.1	4.5	28.1	4.2	28.1	7.5	28.1	21.6
12	5.5	28.1	4.2	28.1	3.7	28.1	3.4	28.1	6.9	28.1	21.6
13	4.7	28.1	3.3	28.1	2.7	28.1	2.3	28.1	6.2	28.1	21.6
14	4.5	28.1	3.2	28.1	2.5	28.1	2.2	28.1	6.1	28.1	21.6

Figure 1.3: Longitudinal Moment Distribution at Critical Section for One-Lane Single Span Bridge – Deck Span = 24 ft, Deck Width = 14 ft, One Railing with Edge Loading E1 (RIGHT)

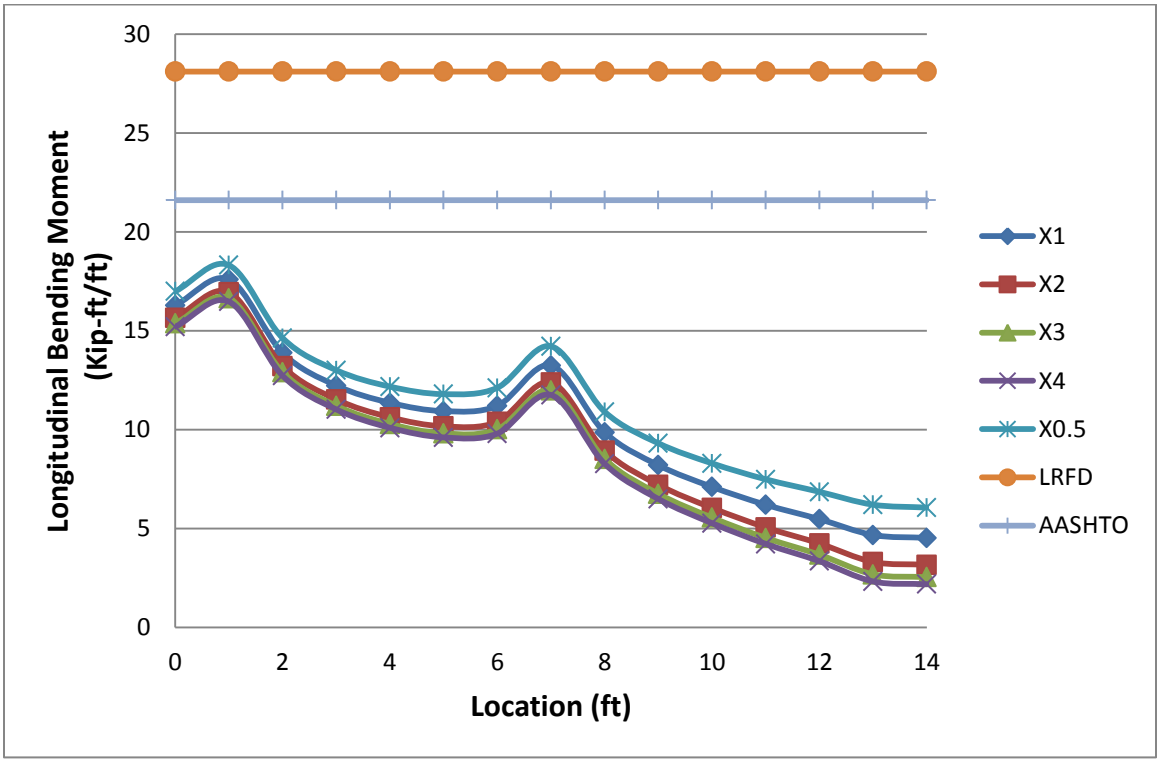

Table 1.4: Longitudinal Moment Distribution at Critical Section for One-Lane Single Span Bridge Deck Span = 24 ft, Deck Width = 14 ft. Two Railings with Edge Loading E1

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	8.1	28.1	6.1	28.1	5.3	28.1	4.8	28.1	10.5	28.1	21.6
1	9.3	28.1	7.4	28.1	6.5	28.1	6.0	28.1	11.8	28.1	21.6
2	7.5	28.1	5.8	28.1	5.0	28.1	4.6	28.1	9.6	28.1	21.6
3	6.6	28.1	5.0	28.1	4.3	28.1	3.9	28.1	8.7	28.1	21.6
4	6.5	28.1	5.0	28.1	4.4	28.1	4.0	28.1	8.4	28.1	21.6
5	6.7	28.1	5.3	28.1	4.7	28.1	4.3	28.1	8.5	28.1	21.6
6	7.5	28.1	6.1	28.1	5.6	28.1	5.2	28.1	9.2	28.1	21.6
7	10.0	28.1	8.7	28.1	8.1	28.1	7.8	28.1	11.6	28.1	21.6
8	7.0	28.1	5.7	28.1	5.2	28.1	4.9	28.1	8.5	28.1	21.6
9	5.6	28.1	4.4	28.1	3.9	28.1	3.6	28.1	7.2	28.1	21.6
10	4.8	28.1	3.6	28.1	3.2	28.1	2.9	28.1	6.4	28.1	21.6
11	4.2	28.1	3.0	28.1	2.5	28.1	2.3	28.1	5.7	28.1	21.6
12	3.7	28.1	2.6	28.1	2.1	28.1	1.8	28.1	5.3	28.1	21.6
13	3.2	28.1	2.0	28.1	1.5	28.1	1.3	28.1	4.8	28.1	21.6
14	3.1	28.1	2.0	28.1	1.5	28.1	1.3	28.1	4.7	28.1	21.6

Figure 1.4: Longitudinal Moment Distribution at Critical Section for One-Lane Single Span Bridge – Deck Span = 24 ft, Deck Width = 14 ft. Two Railings with Edge Loading E1

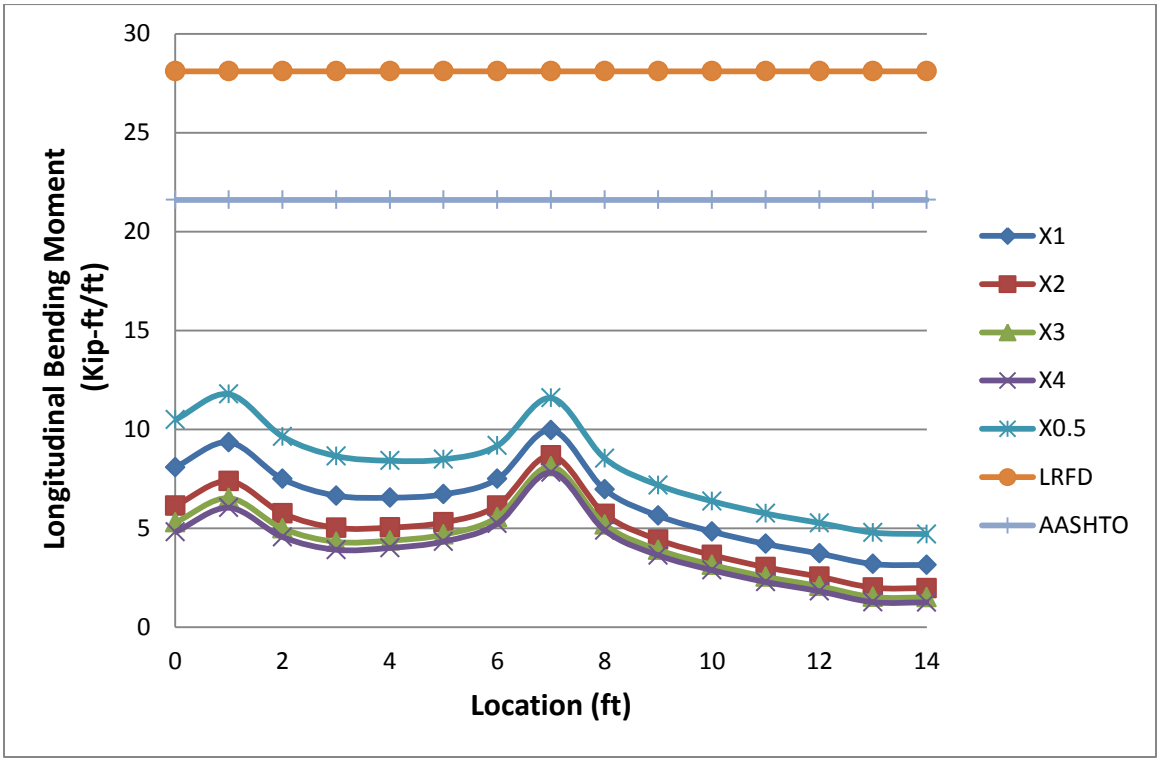

Table 2.1: Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge Deck Span = 24 ft, Deck Width = 24 ft. No Railings with Edge Loading E1

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	21.7	24.1	21.7	24.1	21.7	24.1	21.7	24.1	21.7	24.1	21.6
1	23.1	24.1	23.1	24.1	23.1	24.1	23.1	24.1	23.1	24.1	21.6
2	19.6	24.1	19.6	24.1	19.6	24.1	19.6	24.1	19.6	24.1	21.6
3	18.1	24.1	18.1	24.1	18.1	24.1	18.1	24.1	18.1	24.1	21.6
4	17.4	24.1	17.4	24.1	17.4	24.1	17.4	24.1	17.4	24.1	21.6
5	17.3	24.1	17.3	24.1	17.3	24.1	17.3	24.1	17.3	24.1	21.6
6	18.0	24.1	18.0	24.1	18.0	24.1	18.0	24.1	18.0	24.1	21.6
7	20.5	24.1	20.5	24.1	20.5	24.1	20.5	24.1	20.5	24.1	21.6
8	17.7	24.1	17.7	24.1	17.7	24.1	17.7	24.1	17.7	24.1	21.6
9	16.9	24.1	16.9	24.1	16.9	24.1	16.9	24.1	16.9	24.1	21.6
10	17.2	24.1	17.2	24.1	17.2	24.1	17.2	24.1	17.2	24.1	21.6
11	19.4	24.1	19.4	24.1	19.4	24.1	19.4	24.1	19.4	24.1	21.6
12	16.3	24.1	16.3	24.1	16.3	24.1	16.3	24.1	16.3	24.1	21.6
13	15.0	24.1	15.0	24.1	15.0	24.1	15.0	24.1	15.0	24.1	21.6
14	14.4	24.1	14.4	24.1	14.4	24.1	14.4	24.1	14.4	24.1	21.6
15	14.2	24.1	14.2	24.1	14.2	24.1	14.2	24.1	14.2	24.1	21.6
16	14.8	24.1	14.8	24.1	14.8	24.1	14.8	24.1	14.8	24.1	21.6
17	17.0	24.1	17.0	24.1	17.0	24.1	17.0	24.1	17.0	24.1	21.6
18	13.9	24.1	13.9	24.1	13.9	24.1	13.9	24.1	13.9	24.1	21.6
19	12.6	24.1	12.6	24.1	12.6	24.1	12.6	24.1	12.6	24.1	21.6
20	11.8	24.1	11.8	24.1	11.8	24.1	11.8	24.1	11.8	24.1	21.6
21	11.2	24.1	11.2	24.1	11.2	24.1	11.2	24.1	11.2	24.1	21.6
22	10.9	24.1	10.9	24.1	10.9	24.1	10.9	24.1	10.9	24.1	21.6
23	10.6	24.1	10.6	24.1	10.6	24.1	10.6	24.1	10.6	24.1	21.6
24	10.5	24.1	10.5	24.1	10.5	24.1	10.5	24.1	10.5	24.1	21.6

Figure 2.1: Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge Deck Span = 24 ft, Deck Width = 24 ft. No Railings with Edge Loading E1

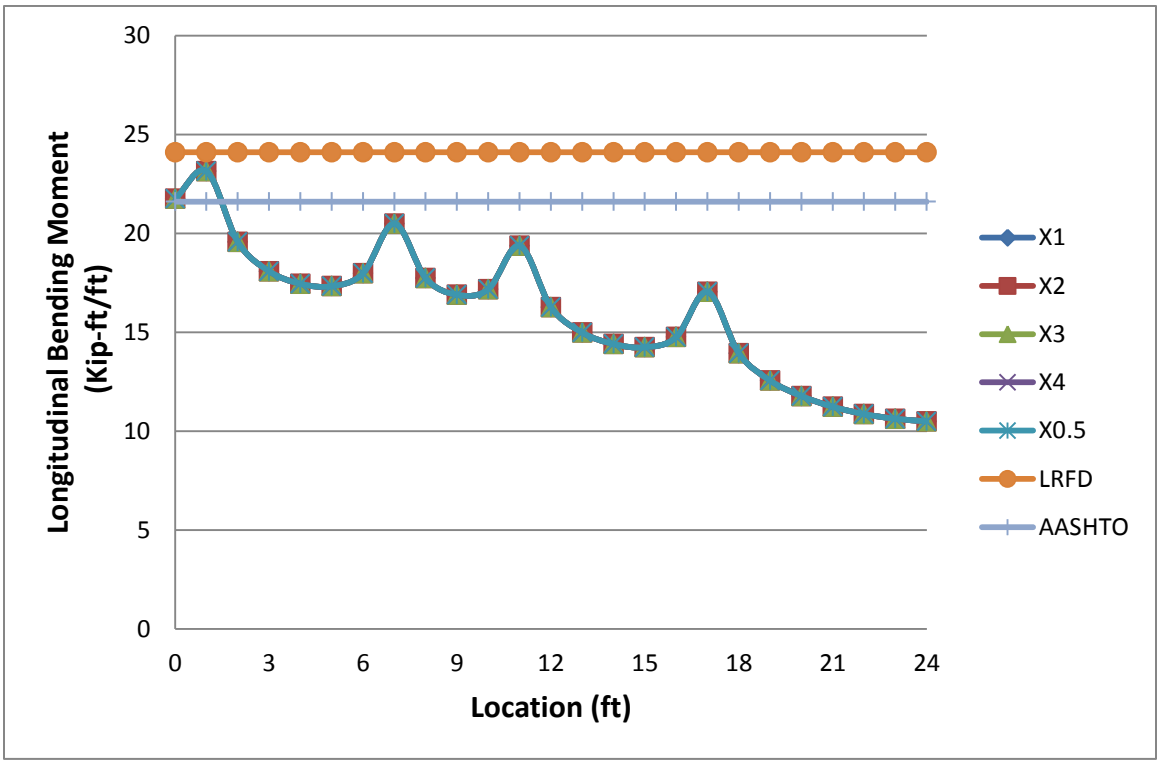

Table 2.2: Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge Deck Span = 24 ft, Deck Width = 24 ft. One Railing with Edge Loading E1 (LEFT)

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	10.7	24.1	8.1	24.1	6.9	24.1	6.2	24.1	13.6	24.1	21.6
1	12.1	24.1	9.5	24.1	8.2	24.1	7.5	24.1	15.0	24.1	21.6
2	10.6	24.1	8.4	24.1	7.3	24.1	6.7	24.1	13.1	24.1	21.6
3	10.1	24.1	8.1	24.1	7.1	24.1	6.6	24.1	12.4	24.1	21.6
4	10.5	24.1	8.6	24.1	7.7	24.1	7.2	24.1	12.5	24.1	21.6
5	11.1	24.1	9.4	24.1	8.6	24.1	8.2	24.1	12.9	24.1	21.6
6	12.4	24.1	10.9	24.1	10.2	24.1	9.7	24.1	14.1	24.1	21.6
7	15.5	24.1	14.1	24.1	13.4	24.1	13.1	24.1	17.0	24.1	21.6
8	13.2	24.1	11.9	24.1	11.3	24.1	11.0	24.1	14.6	24.1	21.6
9	12.8	24.1	11.6	24.1	11.1	24.1	10.8	24.1	14.0	24.1	21.6
10	13.5	24.1	12.4	24.1	11.9	24.1	11.6	24.1	14.6	24.1	21.6
11	16.0	24.1	15.0	24.1	14.6	24.1	14.3	24.1	17.0	24.1	21.6
12	13.2	24.1	12.3	24.1	11.9	24.1	11.7	24.1	14.1	24.1	21.6
13	12.2	24.1	11.4	24.1	11.0	24.1	10.8	24.1	13.0	24.1	21.6
14	11.8	24.1	11.1	24.1	10.7	24.1	10.5	24.1	12.6	24.1	21.6
15	11.9	24.1	11.2	24.1	10.9	24.1	10.7	24.1	12.6	24.1	21.6
16	12.6	24.1	11.9	24.1	11.6	24.1	11.5	24.1	13.2	24.1	21.6
17	15.0	24.1	14.4	24.1	14.2	24.1	14.0	24.1	15.6	24.1	21.6
18	12.0	24.1	11.5	24.1	11.2	24.1	11.1	24.1	12.6	24.1	21.6
19	10.8	24.1	10.3	24.1	10.0	24.1	9.9	24.1	11.3	24.1	21.6
20	10.1	24.1	9.6	24.1	9.4	24.1	9.3	24.1	10.6	24.1	21.6
21	9.7	24.1	9.2	24.1	9.0	24.1	8.9	24.1	10.1	24.1	21.6
22	9.4	24.1	8.9	24.1	8.7	24.1	8.6	24.1	9.8	24.1	21.6
23	9.2	24.1	8.8	24.1	8.6	24.1	8.5	24.1	9.6	24.1	21.6
24	9.1	24.1	8.7	24.1	8.5	24.1	8.4	24.1	9.5	24.1	21.6

Figure 2.2: Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge Deck Span = 24 ft, Deck Width = 24 ft. One Railing with Edge Loading E1 (LEFT)

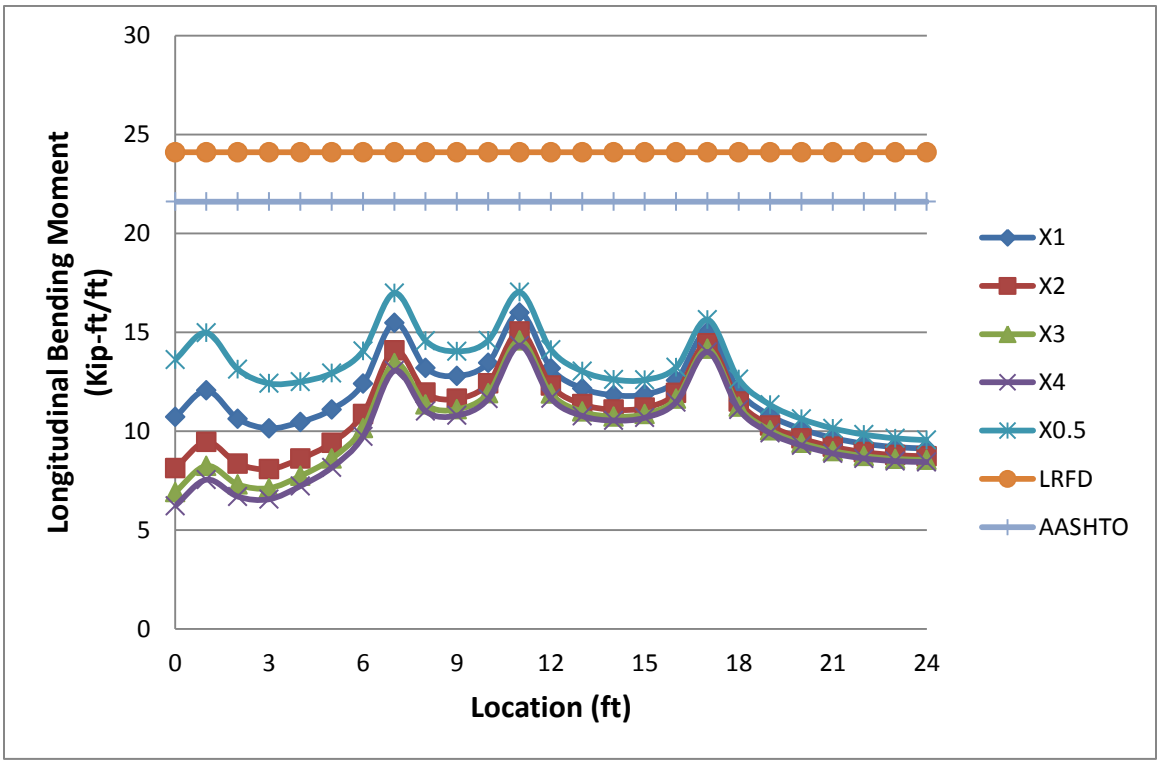

Table 2.3: Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge Deck Span = 24 ft, Deck Width = 24 ft, One Railing with Edge Loading E1 (RIGHT)

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	20.9	24.1	20.7	24.1	20.5	24.1	20.5	24.1	21.2	24.1	21.6
1	22.3	24.1	22.0	24.1	21.9	24.1	21.8	24.1	22.5	24.1	21.6
2	18.6	24.1	18.4	24.1	18.3	24.1	18.2	24.1	18.9	24.1	21.6
3	17.1	24.1	16.8	24.1	16.7	24.1	16.6	24.1	17.4	24.1	21.6
4	16.4	24.1	16.1	24.1	16.0	24.1	15.9	24.1	16.7	24.1	21.6
5	16.2	24.1	15.9	24.1	15.8	24.1	15.7	24.1	16.6	24.1	21.6
6	16.8	24.1	16.5	24.1	16.3	24.1	16.2	24.1	17.2	24.1	21.6
7	19.2	24.1	18.9	24.1	18.7	24.1	18.6	24.1	19.6	24.1	21.6
8	16.4	24.1	16.0	24.1	15.8	24.1	15.7	24.1	16.8	24.1	21.6
9	15.4	24.1	15.0	24.1	14.8	24.1	14.7	24.1	15.9	24.1	21.6
10	15.6	24.1	15.1	24.1	14.9	24.1	14.8	24.1	16.1	24.1	21.6
11	17.7	24.1	17.2	24.1	16.9	24.1	16.8	24.1	18.2	24.1	21.6
12	14.4	24.1	13.9	24.1	13.6	24.1	13.5	24.1	15.0	24.1	21.6
13	12.9	24.1	12.3	24.1	12.1	24.1	11.9	24.1	13.6	24.1	21.6
14	12.2	24.1	11.5	24.1	11.2	24.1	11.0	24.1	12.8	24.1	21.6
15	11.8	24.1	11.1	24.1	10.7	24.1	10.6	24.1	12.5	24.1	21.6
16	12.0	24.1	11.3	24.1	10.9	24.1	10.7	24.1	12.9	24.1	21.6
17	14.1	24.1	13.2	24.1	12.8	24.1	12.6	24.1	15.0	24.1	21.6
18	10.7	24.1	9.7	24.1	9.3	24.1	9.1	24.1	11.7	24.1	21.6
19	9.0	24.1	8.0	24.1	7.5	24.1	7.2	24.1	10.1	24.1	21.6
20	7.8	24.1	6.7	24.1	6.2	24.1	5.9	24.1	9.0	24.1	21.6
21	6.9	24.1	5.7	24.1	5.1	24.1	4.8	24.1	8.2	24.1	21.6
22	6.1	24.1	4.8	24.1	4.2	24.1	3.8	24.1	7.5	24.1	21.6
23	5.2	24.1	3.8	24.1	3.1	24.1	2.7	24.1	6.9	24.1	21.6
24	5.1	24.1	3.6	24.1	2.9	24.1	2.5	24.1	6.7	24.1	21.6

Figure 2.3: Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge Deck Span = 24 ft, Deck Width = 24 ft, One Railing with Edge Loading E1 (RIGHT)

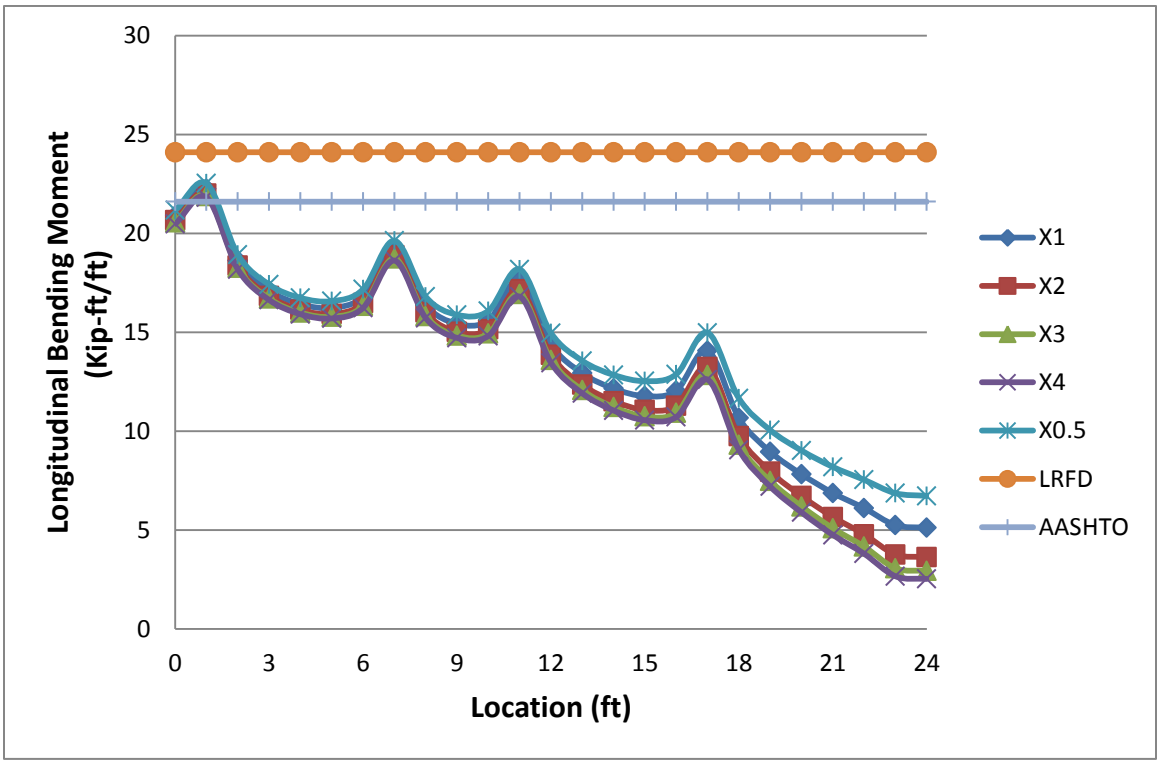

Table 2.4: Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge Deck Span = 24 ft, Deck Width = 24 ft. Two Railings with Edge Loading E1

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	10.4	24.1	7.8	24.1	6.7	24.1	6.0	24.1	13.3	24.1	21.6
1	11.7	24.1	9.1	24.1	7.9	24.1	7.3	24.1	14.6	24.1	21.6
2	10.2	24.1	7.9	24.1	6.9	24.1	6.3	24.1	12.7	24.1	21.6
3	9.6	24.1	7.5	24.1	6.6	24.1	6.0	24.1	12.0	24.1	21.6
4	9.9	24.1	8.0	24.1	7.1	24.1	6.6	24.1	12.0	24.1	21.6
5	10.4	24.1	8.7	24.1	7.8	24.1	7.4	24.1	12.4	24.1	21.6
6	11.6	24.1	10.0	24.1	9.2	24.1	8.8	24.1	13.4	24.1	21.6
7	14.6	24.1	13.1	24.1	12.4	24.1	12.0	24.1	16.3	24.1	21.6
8	12.2	24.1	10.8	24.1	10.2	24.1	9.8	24.1	13.8	24.1	21.6
9	11.7	24.1	10.4	24.1	9.8	24.1	9.4	24.1	13.2	24.1	21.6
10	12.2	24.1	11.0	24.1	10.4	24.1	10.1	24.1	13.7	24.1	21.6
11	14.6	24.1	13.4	24.1	12.9	24.1	12.6	24.1	16.0	24.1	21.6
12	11.7	24.1	10.5	24.1	10.0	24.1	9.7	24.1	13.0	24.1	21.6
13	10.5	24.1	9.4	24.1	8.8	24.1	8.6	24.1	11.8	24.1	21.6
14	10.0	24.1	8.9	24.1	8.4	24.1	8.1	24.1	11.3	24.1	21.6
15	9.8	24.1	8.7	24.1	8.2	24.1	7.9	24.1	11.1	24.1	21.6
16	10.3	24.1	9.2	24.1	8.7	24.1	8.4	24.1	11.6	24.1	21.6
17	12.5	24.1	11.4	24.1	10.9	24.1	10.6	24.1	13.8	24.1	21.6
18	9.3	24.1	8.1	24.1	7.6	24.1	7.3	24.1	10.6	24.1	21.6
19	7.7	24.1	6.6	24.1	6.0	24.1	5.7	24.1	9.1	24.1	21.6
20	6.7	24.1	5.5	24.1	5.0	24.1	4.7	24.1	8.1	24.1	21.6
21	5.9	24.1	4.7	24.1	4.1	24.1	3.8	24.1	7.4	24.1	21.6
22	5.3	24.1	3.9	24.1	3.4	24.1	3.0	24.1	6.8	24.1	21.6
23	4.6	24.1	3.1	24.1	2.5	24.1	2.1	24.1	6.2	24.1	21.6
24	4.5	24.1	3.1	24.1	2.4	24.1	2.1	24.1	6.1	24.1	21.6

Figure 2.4: Longitudinal Moment Distribution at Critical Section for one-Lane Single Span Bridge Deck Span = 24 ft, Deck Width = 24 ft. Two Railings with Edge Loading E1

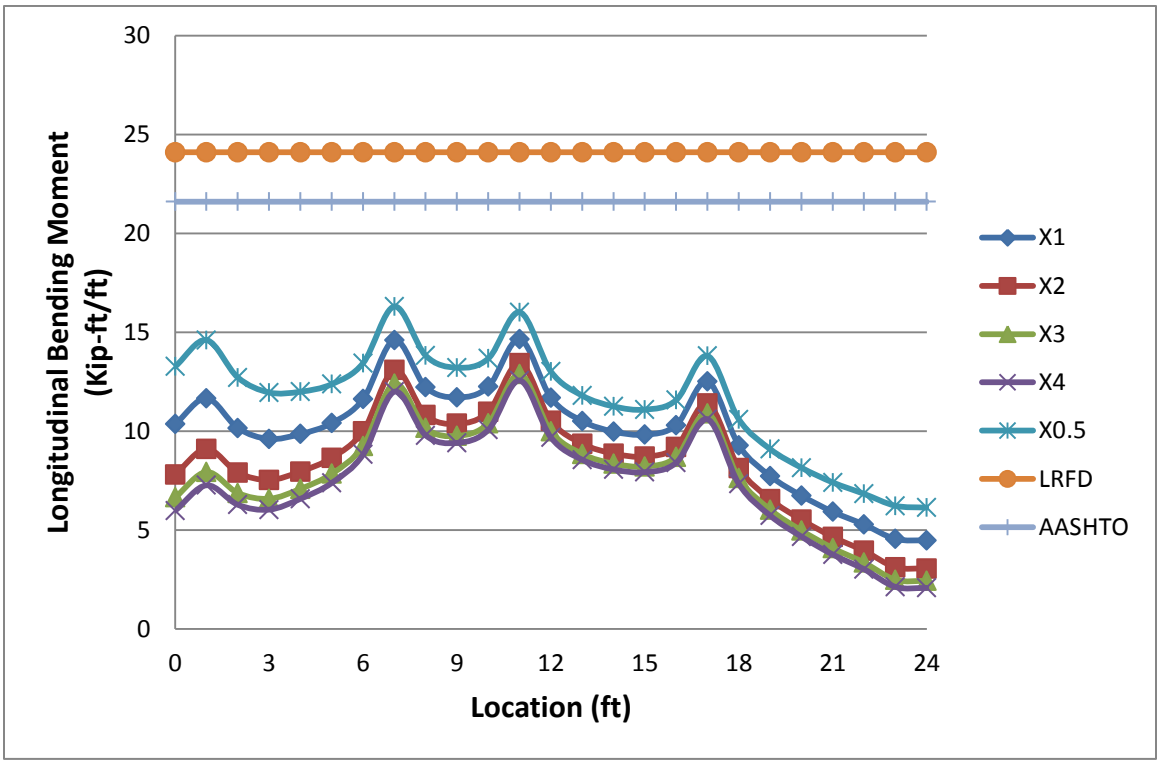

Table 3.1: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 24 ft, Deck Width = 36 ft. No Railings with Edge Loading E1

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	22.7	22.6	22.7	22.6	22.7	22.6	22.7	22.6	22.7	22.6	21.6
1	24.1	22.6	24.1	22.6	24.1	22.6	24.1	22.6	24.1	22.6	21.6
2	20.6	22.6	20.6	22.6	20.6	22.6	20.6	22.6	20.6	22.6	21.6
3	19.1	22.6	19.1	22.6	19.1	22.6	19.1	22.6	19.1	22.6	21.6
4	18.5	22.6	18.5	22.6	18.5	22.6	18.5	22.6	18.5	22.6	21.6
5	18.4	22.6	18.4	22.6	18.4	22.6	18.4	22.6	18.4	22.6	21.6
6	19.1	22.6	19.1	22.6	19.1	22.6	19.1	22.6	19.1	22.6	21.6
7	21.7	22.6	21.7	22.6	21.7	22.6	21.7	22.6	21.7	22.6	21.6
8	19.0	22.6	19.0	22.6	19.0	22.6	19.0	22.6	19.0	22.6	21.6
9	18.3	22.6	18.3	22.6	18.3	22.6	18.3	22.6	18.3	22.6	21.6
10	18.7	22.6	18.7	22.6	18.7	22.6	18.7	22.6	18.7	22.6	21.6
11	21.0	22.6	21.0	22.6	21.0	22.6	21.0	22.6	21.0	22.6	21.6
12	18.0	22.6	18.0	22.6	18.0	22.6	18.0	22.6	18.0	22.6	21.6
13	16.8	22.6	16.8	22.6	16.8	22.6	16.8	22.6	16.8	22.6	21.6
14	16.4	22.6	16.4	22.6	16.4	22.6	16.4	22.6	16.4	22.6	21.6
15	16.5	22.6	16.5	22.6	16.5	22.6	16.5	22.6	16.5	22.6	21.6
16	17.2	22.6	17.2	22.6	17.2	22.6	17.2	22.6	17.2	22.6	21.6
17	19.8	22.6	19.8	22.6	19.8	22.6	19.8	22.6	19.8	22.6	21.6
18	17.1	22.6	17.1	22.6	17.1	22.6	17.1	22.6	17.1	22.6	21.6
19	16.3	22.6	16.3	22.6	16.3	22.6	16.3	22.6	16.3	22.6	21.6
20	16.6	22.6	16.6	22.6	16.6	22.6	16.6	22.6	16.6	22.6	21.6
21	18.8	22.6	18.8	22.6	18.8	22.6	18.8	22.6	18.8	22.6	21.6
22	15.6	22.6	15.6	22.6	15.6	22.6	15.6	22.6	15.6	22.6	21.6
23	14.3	22.6	14.3	22.6	14.3	22.6	14.3	22.6	14.3	22.6	21.6
24	13.7	22.6	13.7	22.6	13.7	22.6	13.7	22.6	13.7	22.6	21.6
25	13.5	22.6	13.5	22.6	13.5	22.6	13.5	22.6	13.5	22.6	21.6
26	14.0	22.6	14.0	22.6	14.0	22.6	14.0	22.6	14.0	22.6	21.6
27	16.2	22.6	16.2	22.6	16.2	22.6	16.2	22.6	16.2	22.6	21.6
28	13.0	22.6	13.0	22.6	13.0	22.6	13.0	22.6	13.0	22.6	21.6
29	11.5	22.6	11.5	22.6	11.5	22.6	11.5	22.6	11.5	22.6	21.6
30	10.6	22.6	10.6	22.6	10.6	22.6	10.6	22.6	10.6	22.6	21.6
31	10.0	22.6	10.0	22.6	10.0	22.6	10.0	22.6	10.0	22.6	21.6
32	9.5	22.6	9.5	22.6	9.5	22.6	9.5	22.6	9.5	22.6	21.6
33	9.1	22.6	9.1	22.6	9.1	22.6	9.1	22.6	9.1	22.6	21.6
34	8.8	22.6	8.8	22.6	8.8	22.6	8.8	22.6	8.8	22.6	21.6
35	8.6	22.6	8.6	22.6	8.6	22.6	8.6	22.6	8.6	22.6	21.6
36	8.5	22.6	8.5	22.6	8.5	22.6	8.5	22.6	8.5	22.6	21.6

Figure 3.1: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 24 ft, Deck Width = 36 ft. No Railings with Edge Loading E1

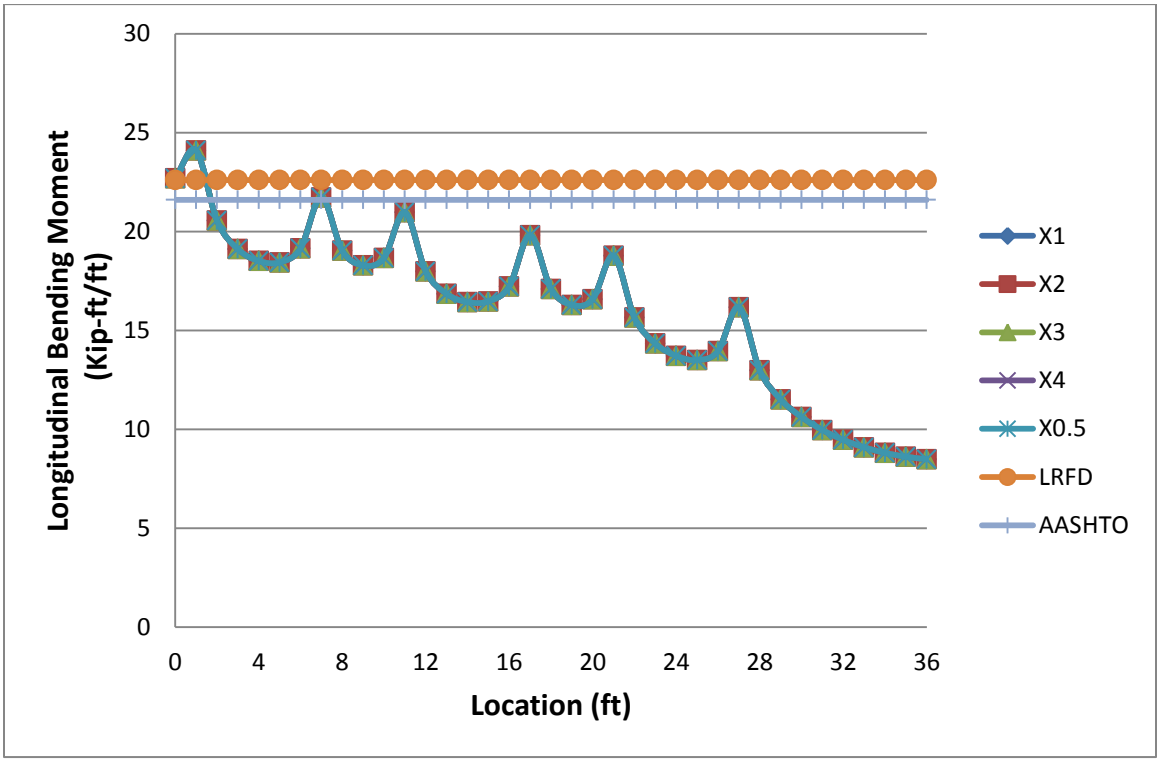

Table 3.2: Longitudinal Moment Distribution at Critical Section for Three -Lane Single Span Bridge Deck Span = 24 ft, Deck Width = 36 ft, One Railing with Edge Loading E1 (LEFT)

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	11.2	22.6	8.5	22.6	7.2	22.6	6.5	22.6	14.3	22.6	21.6
1	12.6	22.6	9.9	22.6	8.6	22.6	7.8	22.6	15.7	22.6	21.6
2	11.3	22.6	8.9	22.6	7.8	22.6	7.1	22.6	13.9	22.6	21.6
3	10.9	22.6	8.7	22.6	7.7	22.6	7.1	22.6	13.2	22.6	21.6
4	11.3	22.6	9.3	22.6	8.4	22.6	7.9	22.6	13.4	22.6	21.6
5	12.0	22.6	10.2	22.6	9.4	22.6	8.9	22.6	13.9	22.6	21.6
6	13.4	22.6	11.8	22.6	11.0	22.6	10.6	22.6	15.1	22.6	21.6
7	16.6	22.6	15.1	22.6	14.4	22.6	14.0	22.6	18.1	22.6	21.6
8	14.4	22.6	13.1	22.6	12.5	22.6	12.1	22.6	15.8	22.6	21.6
9	14.1	22.6	12.9	22.6	12.4	22.6	12.1	22.6	15.4	22.6	21.6
10	14.9	22.6	13.9	22.6	13.4	22.6	13.1	22.6	16.1	22.6	21.6
11	17.6	22.6	16.6	22.6	16.2	22.6	15.9	22.6	18.6	22.6	21.6
12	14.9	22.6	14.1	22.6	13.7	22.6	13.4	22.6	15.9	22.6	21.6
13	14.1	22.6	13.3	22.6	13.0	22.6	12.7	22.6	14.9	22.6	21.6
14	14.0	22.6	13.3	22.6	12.9	22.6	12.7	22.6	14.7	22.6	21.6
15	14.2	22.6	13.6	22.6	13.3	22.6	13.1	22.6	14.9	22.6	21.6
16	15.2	22.6	14.6	22.6	14.4	22.6	14.2	22.6	15.8	22.6	21.6
17	18.0	22.6	17.5	22.6	17.2	22.6	17.1	22.6	18.6	22.6	21.6
18	15.5	22.6	15.0	22.6	14.8	22.6	14.6	22.6	16.0	22.6	21.6
19	14.8	22.6	14.4	22.6	14.2	22.6	14.1	22.6	15.3	22.6	21.6
20	15.3	22.6	14.9	22.6	14.7	22.6	14.6	22.6	15.7	22.6	21.6
21	17.6	22.6	17.2	22.6	17.1	22.6	17.0	22.6	17.9	22.6	21.6
22	14.6	22.6	14.2	22.6	14.1	22.6	14.0	22.6	14.9	22.6	21.6
23	13.3	22.6	13.1	22.6	12.9	22.6	12.9	22.6	13.7	22.6	21.6
24	12.8	22.6	12.6	22.6	12.4	22.6	12.4	22.6	13.1	22.6	21.6
25	12.7	22.6	12.5	22.6	12.3	22.6	12.3	22.6	12.9	22.6	21.6
26	13.2	22.6	13.0	22.6	12.9	22.6	12.8	22.6	13.4	22.6	21.6
27	15.5	22.6	15.3	22.6	15.2	22.6	15.2	22.6	15.7	22.6	21.6
28	12.4	22.6	12.2	22.6	12.1	22.6	12.0	22.6	12.5	22.6	21.6
29	10.9	22.6	10.8	22.6	10.7	22.6	10.6	22.6	11.1	22.6	21.6
30	10.1	22.6	9.9	22.6	9.9	22.6	9.8	22.6	10.3	22.6	21.6
31	9.5	22.6	9.3	22.6	9.3	22.6	9.2	22.6	9.6	22.6	21.6
32	9.0	22.6	8.9	22.6	8.8	22.6	8.8	22.6	9.1	22.6	21.6
33	8.7	22.6	8.5	22.6	8.5	22.6	8.4	22.6	8.8	22.6	21.6
34	8.4	22.6	8.3	22.6	8.2	22.6	8.2	22.6	8.5	22.6	21.6
35	8.2	22.6	8.1	22.6	8.1	22.6	8.0	22.6	8.3	22.6	21.6
36	8.1	22.6	8.0	22.6	8.0	22.6	7.9	22.6	8.2	22.6	21.6

Figure 3.2: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 24 ft, Deck Width = 36 ft, One Railing with Edge Loading E1 (LEFT)

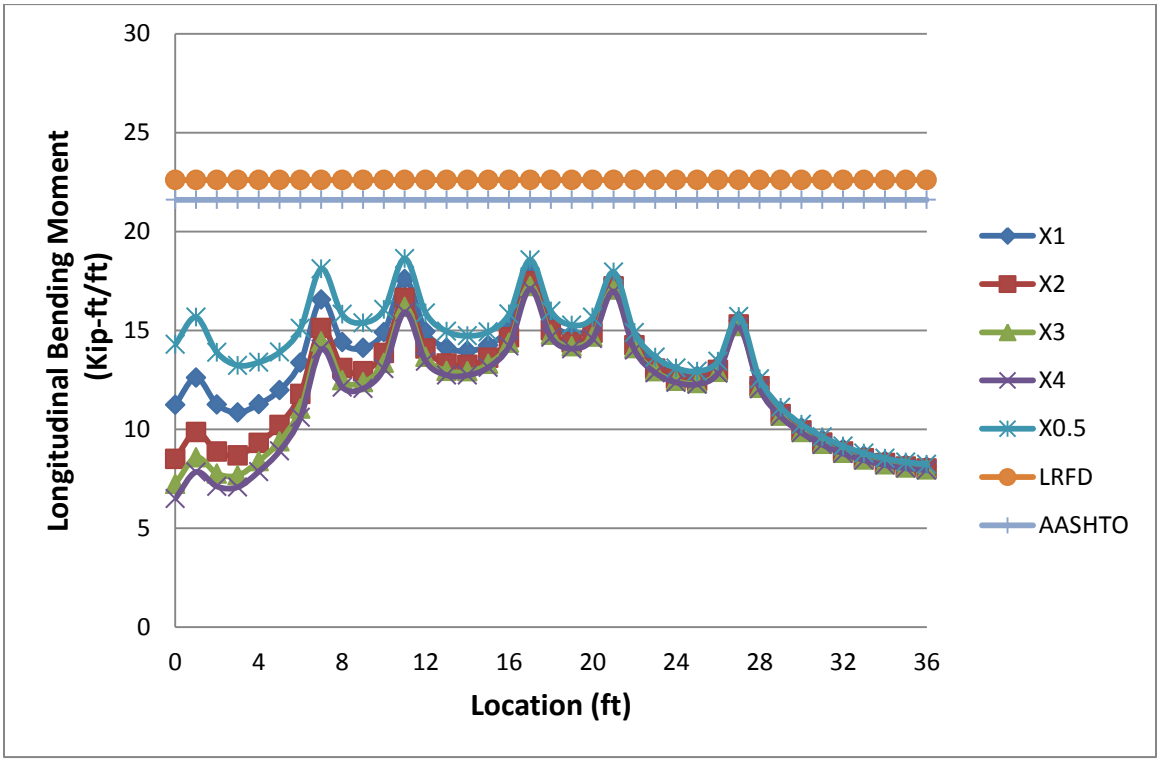

Table 3.3: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 24 ft, Deck Width = 36 ft, One Railing with Edge Loading E1 (RIGHT)

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	22.5	22.6	22.5	22.6	22.4	22.6	22.4	22.6	22.6	22.6	21.6
1	23.9	22.6	23.9	22.6	23.8	22.6	23.8	22.6	24.0	22.6	21.6
2	20.4	22.6	20.3	22.6	20.3	22.6	20.3	22.6	20.4	22.6	21.6
3	18.9	22.6	18.8	22.6	18.8	22.6	18.8	22.6	19.0	22.6	21.6
4	18.3	22.6	18.2	22.6	18.2	22.6	18.2	22.6	18.4	22.6	21.6
5	18.2	22.6	18.1	22.6	18.1	22.6	18.1	22.6	18.3	22.6	21.6
6	18.9	22.6	18.8	22.6	18.8	22.6	18.8	22.6	19.0	22.6	21.6
7	21.4	22.6	21.4	22.6	21.3	22.6	21.3	22.6	21.5	22.6	21.6
8	18.7	22.6	18.7	22.6	18.6	22.6	18.6	22.6	18.8	22.6	21.6
9	18.0	22.6	17.9	22.6	17.8	22.6	17.8	22.6	18.1	22.6	21.6
10	18.3	22.6	18.2	22.6	18.2	22.6	18.1	22.6	18.4	22.6	21.6
11	20.6	22.6	20.5	22.6	20.4	22.6	20.4	22.6	20.7	22.6	21.6
12	17.6	22.6	17.4	22.6	17.4	22.6	17.3	22.6	17.7	22.6	21.6
13	16.4	22.6	16.2	22.6	16.2	22.6	16.1	22.6	16.5	22.6	21.6
14	15.9	22.6	15.8	22.6	15.7	22.6	15.7	22.6	16.1	22.6	21.6
15	15.9	22.6	15.7	22.6	15.6	22.6	15.6	22.6	16.1	22.6	21.6
16	16.6	22.6	16.4	22.6	16.3	22.6	16.3	22.6	16.8	22.6	21.6
17	19.1	22.6	18.9	22.6	18.8	22.6	18.8	22.6	19.3	22.6	21.6
18	16.3	22.6	16.1	22.6	16.0	22.6	15.9	22.6	16.6	22.6	21.6
19	15.4	22.6	15.2	22.6	15.1	22.6	15.0	22.6	15.7	22.6	21.6
20	15.6	22.6	15.3	22.6	15.2	22.6	15.1	22.6	15.9	22.6	21.6
21	17.7	22.6	17.4	22.6	17.3	22.6	17.2	22.6	18.0	22.6	21.6
22	14.5	22.6	14.1	22.6	14.0	22.6	13.9	22.6	14.8	22.6	21.6
23	13.0	22.6	12.7	22.6	12.5	22.6	12.4	22.6	13.4	22.6	21.6
24	12.3	22.6	11.9	22.6	11.7	22.6	11.6	22.6	12.7	22.6	21.6
25	11.9	22.6	11.5	22.6	11.2	22.6	11.1	22.6	12.4	22.6	21.6
26	12.2	22.6	11.7	22.6	11.5	22.6	11.3	22.6	12.7	22.6	21.6
27	14.2	22.6	13.7	22.6	13.4	22.6	13.3	22.6	14.8	22.6	21.6
28	10.8	22.6	10.2	22.6	9.9	22.6	9.8	22.6	11.5	22.6	21.6
29	9.1	22.6	8.5	22.6	8.1	22.6	8.0	22.6	9.9	22.6	21.6
30	8.0	22.6	7.3	22.6	6.9	22.6	6.7	22.6	8.8	22.6	21.6
31	7.1	22.6	6.3	22.6	5.9	22.6	5.6	22.6	8.0	22.6	21.6
32	6.3	22.6	5.4	22.6	5.0	22.6	4.7	22.6	7.3	22.6	21.6
33	5.6	22.6	4.6	22.6	4.1	22.6	3.9	22.6	6.7	22.6	21.6
34	5.0	22.6	3.9	22.6	3.4	22.6	3.1	22.6	6.2	22.6	21.6
35	4.3	22.6	3.1	22.6	2.5	22.6	2.2	22.6	5.6	22.6	21.6
36	4.2	22.6	3.0	22.6	2.4	22.6	2.1	22.6	5.5	22.6	21.6

Figure 3.3: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 24 ft, Deck Width = 36 ft, One Railing with Edge Loading E1 (RIGHT)

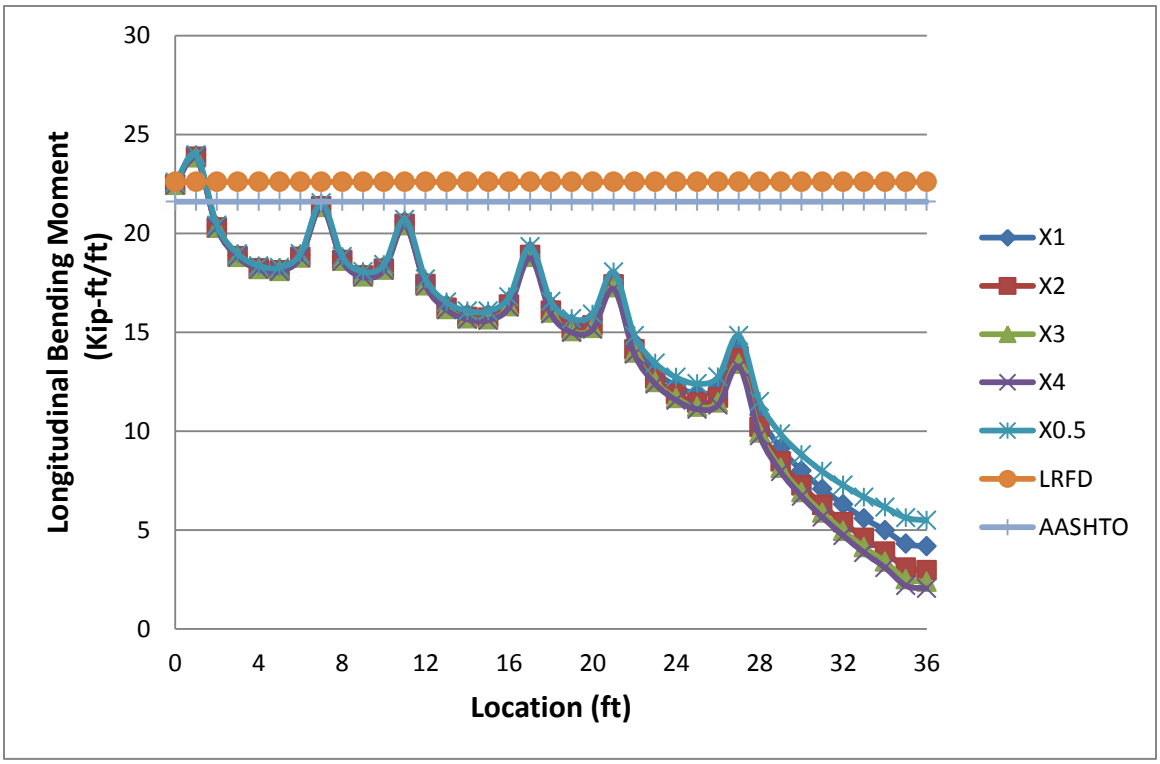

Table 3.4: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 24 ft, Deck Width = 36ft. Two Railings with Edge Loading E1

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	11.2	22.6	8.4	22.6	7.2	22.6	6.4	22.6	14.2	22.6	21.6
1	12.5	22.6	9.8	22.6	8.5	22.6	7.8	22.6	15.6	22.6	21.6
2	11.1	22.6	8.8	22.6	7.6	22.6	7.0	22.6	13.8	22.6	21.6
3	10.7	22.6	8.5	22.6	7.5	22.6	6.9	22.6	13.1	22.6	21.6
4	11.1	22.6	9.1	22.6	8.2	22.6	7.7	22.6	13.3	22.6	21.6
5	11.8	22.6	10.0	22.6	9.2	22.6	8.7	22.6	13.8	22.6	21.6
6	13.2	22.6	11.6	22.6	10.8	22.6	10.4	22.6	15.0	22.6	21.6
7	16.3	22.6	14.9	22.6	14.2	22.6	13.8	22.6	18.0	22.6	21.6
8	14.2	22.6	12.8	22.6	12.2	22.6	11.8	22.6	15.6	22.6	21.6
9	13.8	22.6	12.6	22.6	12.0	22.6	11.7	22.6	15.2	22.6	21.6
10	14.6	22.6	13.5	22.6	12.9	22.6	12.6	22.6	15.8	22.6	21.6
11	17.3	22.6	16.2	22.6	15.7	22.6	15.4	22.6	18.4	22.6	21.6
12	14.6	22.6	13.6	22.6	13.2	22.6	12.9	22.6	15.6	22.6	21.6
13	13.7	22.6	12.8	22.6	12.4	22.6	12.1	22.6	14.6	22.6	21.6
14	13.5	22.6	12.7	22.6	12.3	22.6	12.1	22.6	14.4	22.6	21.6
15	13.7	22.6	12.9	22.6	12.6	22.6	12.4	22.6	14.6	22.6	21.6
16	14.6	22.6	13.9	22.6	13.6	22.6	13.4	22.6	15.4	22.6	21.6
17	17.4	22.6	16.7	22.6	16.3	22.6	16.1	22.6	18.1	22.6	21.6
18	14.7	22.6	14.1	22.6	13.8	22.6	13.6	22.6	15.5	22.6	21.6
19	14.0	22.6	13.4	22.6	13.1	22.6	12.9	22.6	14.7	22.6	21.6
20	14.3	22.6	13.7	22.6	13.4	22.6	13.3	22.6	15.0	22.6	21.6
21	16.6	22.6	16.0	22.6	15.7	22.6	15.5	22.6	17.2	22.6	21.6
22	13.4	22.6	12.8	22.6	12.6	22.6	12.4	22.6	14.1	22.6	21.6
23	12.1	22.6	11.5	22.6	11.2	22.6	11.1	22.6	12.8	22.6	21.6
24	11.5	22.6	10.8	22.6	10.5	22.6	10.4	22.6	12.1	22.6	21.6
25	11.2	22.6	10.5	22.6	10.2	22.6	10.1	22.6	11.9	22.6	21.6
26	11.5	22.6	10.9	22.6	10.6	22.6	10.4	22.6	12.3	22.6	21.6
27	13.6	22.6	13.0	22.6	12.6	22.6	12.4	22.6	14.4	22.6	21.6
28	10.3	22.6	9.6	22.6	9.2	22.6	9.0	22.6	11.1	22.6	21.6
29	8.7	22.6	7.9	22.6	7.5	22.6	7.3	22.6	9.5	22.6	21.6
30	7.6	22.6	6.8	22.6	6.4	22.6	6.2	22.6	8.5	22.6	21.6
31	6.7	22.6	5.8	22.6	5.4	22.6	5.2	22.6	7.7	22.6	21.6
32	6.0	22.6	5.0	22.6	4.6	22.6	4.3	22.6	7.0	22.6	21.6
33	5.3	22.6	4.3	22.6	3.8	22.6	3.6	22.6	6.4	22.6	21.6
34	4.8	22.6	3.7	22.6	3.2	22.6	2.9	22.6	6.0	22.6	21.6
35	4.1	22.6	2.9	22.6	2.4	22.6	2.0	22.6	5.4	22.6	21.6
36	4.0	22.6	2.8	22.6	2.2	22.6	1.9	22.6	5.3	22.6	21.6

Figure 3.4: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 24 ft, Deck Width = 36ft. Two Railings with Edge Loading E1

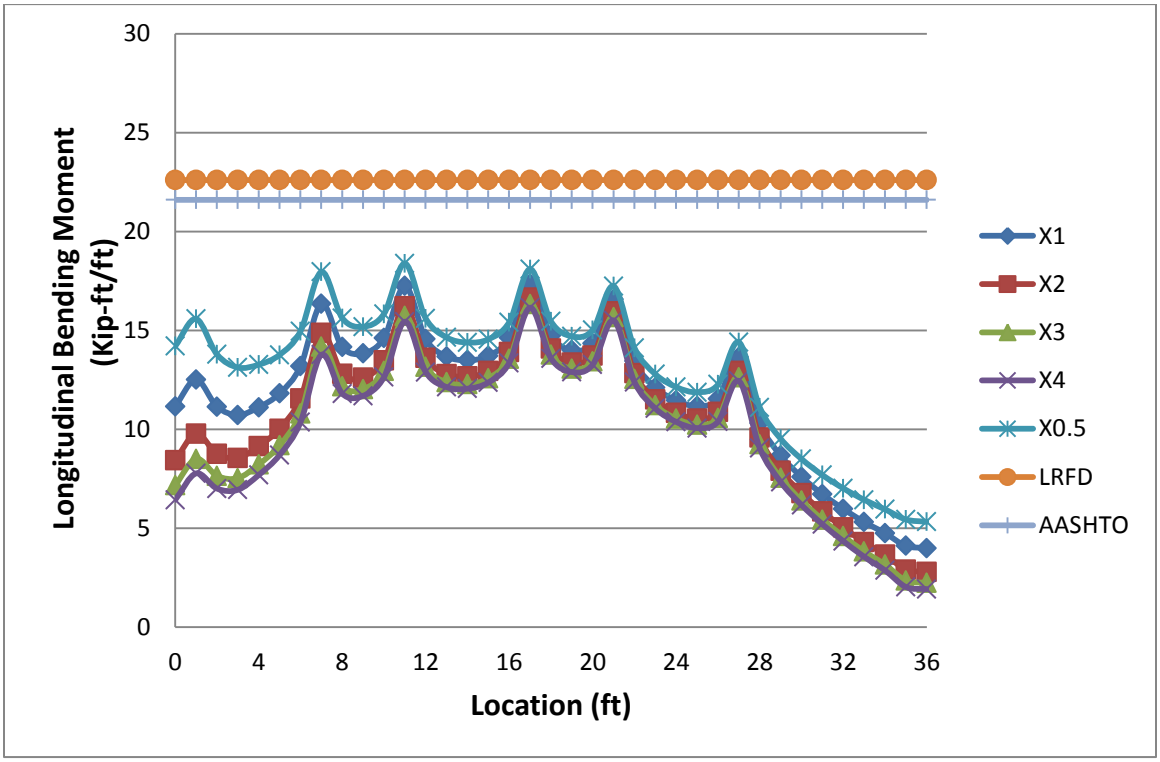

Table 4.1: Longitudinal Moment Distribution at Critical Section for Four-Lane Single Span Bridge Deck Span = 24 ft, Deck Width = 48 ft, No Railings with Edge Loading E1

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	23.1	21.5	23.1	21.5	23.1	21.5	23.1	21.5	23.1	21.5	21.6
1	24.5	21.5	24.5	21.5	24.5	21.5	24.5	21.5	24.5	21.5	21.6
2	21.0	21.5	21.0	21.5	21.0	21.5	21.0	21.5	21.0	21.5	21.6
3	19.5	21.5	19.5	21.5	19.5	21.5	19.5	21.5	19.5	21.5	21.6
4	19.0	21.5	19.0	21.5	19.0	21.5	19.0	21.5	19.0	21.5	21.6
5	18.9	21.5	18.9	21.5	18.9	21.5	18.9	21.5	18.9	21.5	21.6
6	19.7	21.5	19.7	21.5	19.7	21.5	19.7	21.5	19.7	21.5	21.6
7	22.3	21.5	22.3	21.5	22.3	21.5	22.3	21.5	22.3	21.5	21.6
8	19.6	21.5	19.6	21.5	19.6	21.5	19.6	21.5	19.6	21.5	21.6
9	18.9	21.5	18.9	21.5	18.9	21.5	18.9	21.5	18.9	21.5	21.6
10	19.4	21.5	19.4	21.5	19.4	21.5	19.4	21.5	19.4	21.5	21.6
11	21.7	21.5	21.7	21.5	21.7	21.5	21.7	21.5	21.7	21.5	21.6
12	18.8	21.5	18.8	21.5	18.8	21.5	18.8	21.5	18.8	21.5	21.6
13	17.7	21.5	17.7	21.5	17.7	21.5	17.7	21.5	17.7	21.5	21.6
14	17.4	21.5	17.4	21.5	17.4	21.5	17.4	21.5	17.4	21.5	21.6
15	17.5	21.5	17.5	21.5	17.5	21.5	17.5	21.5	17.5	21.5	21.6
16	18.4	21.5	18.4	21.5	18.4	21.5	18.4	21.5	18.4	21.5	21.6
17	21.1	21.5	21.1	21.5	21.1	21.5	21.1	21.5	21.1	21.5	21.6
18	18.5	21.5	18.5	21.5	18.5	21.5	18.5	21.5	18.5	21.5	21.6
19	17.8	21.5	17.8	21.5	17.8	21.5	17.8	21.5	17.8	21.5	21.6
20	18.2	21.5	18.2	21.5	18.2	21.5	18.2	21.5	18.2	21.5	21.6
21	20.6	21.5	20.6	21.5	20.6	21.5	20.6	21.5	20.6	21.5	21.6
22	17.6	21.5	17.6	21.5	17.6	21.5	17.6	21.5	17.6	21.5	21.6
23	16.5	21.5	16.5	21.5	16.5	21.5	16.5	21.5	16.5	21.5	21.6
24	16.1	21.5	16.1	21.5	16.1	21.5	16.1	21.5	16.1	21.5	21.6
25	16.2	21.5	16.2	21.5	16.2	21.5	16.2	21.5	16.2	21.5	21.6
26	16.9	21.5	16.9	21.5	16.9	21.5	16.9	21.5	16.9	21.5	21.6
27	19.5	21.5	19.5	21.5	19.5	21.5	19.5	21.5	19.5	21.5	21.6
28	16.8	21.5	16.8	21.5	16.8	21.5	16.8	21.5	16.8	21.5	21.6
29	16.0	21.5	16.0	21.5	16.0	21.5	16.0	21.5	16.0	21.5	21.6
30	16.2	21.5	16.2	21.5	16.2	21.5	16.2	21.5	16.2	21.5	21.6
31	18.4	21.5	18.4	21.5	18.4	21.5	18.4	21.5	18.4	21.5	21.6
32	15.3	21.5	15.3	21.5	15.3	21.5	15.3	21.5	15.3	21.5	21.6
33	13.9	21.5	13.9	21.5	13.9	21.5	13.9	21.5	13.9	21.5	21.6
34	13.3	21.5	13.3	21.5	13.3	21.5	13.3	21.5	13.3	21.5	21.6
35	13.0	21.5	13.0	21.5	13.0	21.5	13.0	21.5	13.0	21.5	21.6
36	13.4	21.5	13.4	21.5	13.4	21.5	13.4	21.5	13.4	21.5	21.6
37	15.6	21.5	15.6	21.5	15.6	21.5	15.6	21.5	15.6	21.5	21.6
38	12.3	21.5	12.3	21.5	12.3	21.5	12.3	21.5	12.3	21.5	21.6

39	10.8	21.5	10.8	21.5	10.8	21.5	10.8	21.5	10.8	21.5	21.6
40	9.8	21.5	9.8	21.5	9.8	21.5	9.8	21.5	9.8	21.5	21.6
41	9.1	21.5	9.1	21.5	9.1	21.5	9.1	21.5	9.1	21.5	21.6
42	8.5	21.5	8.5	21.5	8.5	21.5	8.5	21.5	8.5	21.5	21.6
43	8.1	21.5	8.1	21.5	8.1	21.5	8.1	21.5	8.1	21.5	21.6
44	7.7	21.5	7.7	21.5	7.7	21.5	7.7	21.5	7.7	21.5	21.6
45	7.4	21.5	7.4	21.5	7.4	21.5	7.4	21.5	7.4	21.5	21.6
46	7.1	21.5	7.1	21.5	7.1	21.5	7.1	21.5	7.1	21.5	21.6
47	7.0	21.5	7.0	21.5	7.0	21.5	7.0	21.5	7.0	21.5	21.6
48	6.9	21.5	6.9	21.5	6.9	21.5	6.9	21.5	6.9	21.5	21.6

Figure 4.1: Longitudinal Moment Distribution at Critical Section for four-Lane Single Span Bridge Deck Span = 24 ft, Deck Width = 48 ft, No Railings with Edge Loading E1

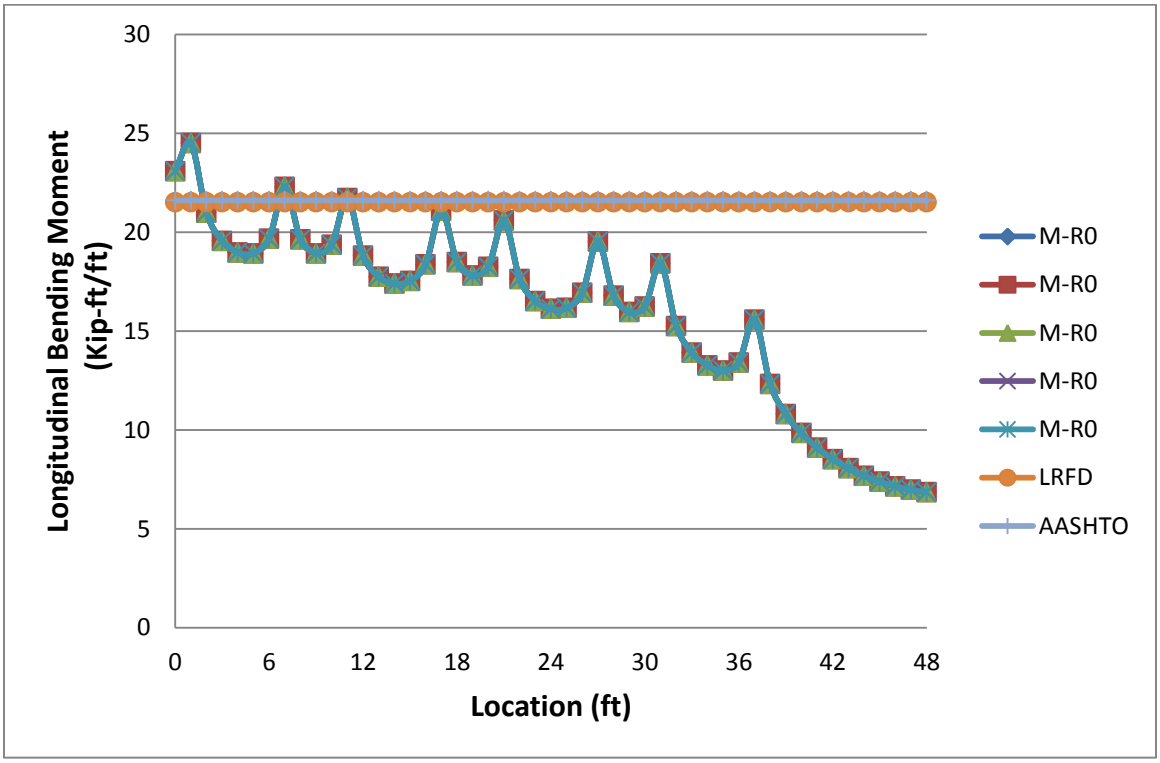

Table 4.2: Longitudinal Moment Distribution at Critical Section for Four-Lane Single Span Bridge Deck Span = 24 ft, Deck Width = 48 ft, One Railing with Edge Loading E1 (LEFT)

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	11.4	21.5	8.6	21.5	7.3	21.5	6.6	21.5	14.5	21.5	21.6
1	12.8	21.5	10.0	21.5	8.7	21.5	8.0	21.5	15.9	21.5	21.6
2	11.5	21.5	9.1	21.5	7.9	21.5	7.3	21.5	14.2	21.5	21.6
3	11.1	21.5	8.9	21.5	7.9	21.5	7.3	21.5	13.6	21.5	21.6
4	11.6	21.5	9.6	21.5	8.7	21.5	8.1	21.5	13.8	21.5	21.6
5	12.3	21.5	10.5	21.5	9.7	21.5	9.2	21.5	14.3	21.5	21.6
6	13.8	21.5	12.2	21.5	11.4	21.5	10.9	21.5	15.5	21.5	21.6
7	17.0	21.5	15.5	21.5	14.9	21.5	14.5	21.5	18.6	21.5	21.6
8	14.9	21.5	13.6	21.5	13.0	21.5	12.6	21.5	16.3	21.5	21.6
9	14.7	21.5	13.5	21.5	12.9	21.5	12.6	21.5	16.0	21.5	21.6
10	15.5	21.5	14.5	21.5	13.9	21.5	13.6	21.5	16.7	21.5	21.6
11	18.3	21.5	17.3	21.5	16.9	21.5	16.6	21.5	19.3	21.5	21.6
12	15.7	21.5	14.8	21.5	14.4	21.5	14.2	21.5	16.7	21.5	21.6
13	15.0	21.5	14.2	21.5	13.8	21.5	13.6	21.5	15.8	21.5	21.6
14	14.9	21.5	14.2	21.5	13.8	21.5	13.7	21.5	15.7	21.5	21.6
15	15.3	21.5	14.6	21.5	14.3	21.5	14.1	21.5	16.0	21.5	21.6
16	16.4	21.5	15.8	21.5	15.5	21.5	15.3	21.5	17.0	21.5	21.6
17	19.3	21.5	18.7	21.5	18.5	21.5	18.3	21.5	19.8	21.5	21.6
18	16.8	21.5	16.4	21.5	16.2	21.5	16.0	21.5	17.3	21.5	21.6
19	16.3	21.5	15.9	21.5	15.7	21.5	15.6	21.5	16.8	21.5	21.6
20	16.9	21.5	16.5	21.5	16.4	21.5	16.2	21.5	17.3	21.5	21.6
21	19.4	21.5	19.1	21.5	18.9	21.5	18.8	21.5	19.8	21.5	21.6
22	16.6	21.5	16.3	21.5	16.1	21.5	16.0	21.5	16.9	21.5	21.6
23	15.6	21.5	15.3	21.5	15.2	21.5	15.1	21.5	15.9	21.5	21.6
24	15.3	21.5	15.0	21.5	14.9	21.5	14.8	21.5	15.5	21.5	21.6
25	15.4	21.5	15.2	21.5	15.1	21.5	15.0	21.5	15.6	21.5	21.6
26	16.2	21.5	16.0	21.5	15.9	21.5	15.9	21.5	16.4	21.5	21.6
27	18.9	21.5	18.7	21.5	18.6	21.5	18.6	21.5	19.1	21.5	21.6
28	16.2	21.5	16.1	21.5	16.0	21.5	16.0	21.5	16.4	21.5	21.6
29	15.5	21.5	15.3	21.5	15.3	21.5	15.2	21.5	15.6	21.5	21.6
30	15.8	21.5	15.7	21.5	15.6	21.5	15.6	21.5	15.9	21.5	21.6
31	18.0	21.5	17.9	21.5	17.8	21.5	17.8	21.5	18.1	21.5	21.6
32	14.9	21.5	14.8	21.5	14.7	21.5	14.7	21.5	15.0	21.5	21.6
33	13.6	21.5	13.5	21.5	13.5	21.5	13.4	21.5	13.7	21.5	21.6
34	13.0	21.5	12.9	21.5	12.8	21.5	12.8	21.5	13.1	21.5	21.6
35	12.7	21.5	12.7	21.5	12.6	21.5	12.6	21.5	12.8	21.5	21.6
36	13.2	21.5	13.1	21.5	13.1	21.5	13.1	21.5	13.2	21.5	21.6
37	15.4	21.5	15.3	21.5	15.3	21.5	15.3	21.5	15.4	21.5	21.6
38	12.1	21.5	12.1	21.5	12.0	21.5	12.0	21.5	12.2	21.5	21.6

39	10.6	21.5	10.6	21.5	10.5	21.5	10.5	21.5	10.7	21.5	21.6
40	9.7	21.5	9.6	21.5	9.6	21.5	9.6	21.5	9.7	21.5	21.6
41	9.0	21.5	8.9	21.5	8.9	21.5	8.9	21.5	9.0	21.5	21.6
42	8.4	21.5	8.3	21.5	8.3	21.5	8.3	21.5	8.4	21.5	21.6
43	7.9	21.5	7.9	21.5	7.9	21.5	7.9	21.5	8.0	21.5	21.6
44	7.6	21.5	7.5	21.5	7.5	21.5	7.5	21.5	7.6	21.5	21.6
45	7.3	21.5	7.2	21.5	7.2	21.5	7.2	21.5	7.3	21.5	21.6
46	7.0	21.5	7.0	21.5	7.0	21.5	7.0	21.5	7.1	21.5	21.6
47	6.9	21.5	6.8	21.5	6.8	21.5	6.8	21.5	6.9	21.5	21.6
48	6.8	21.5	6.7	21.5	6.7	21.5	6.7	21.5	6.8	21.5	21.6

Figure 4.2: Longitudinal Moment Distribution at Critical Section for Four-Lane Single Span Bridge Deck Span = 24 ft, Deck Width = 48 ft, One Railing with Edge Loading E1 (LEFT)

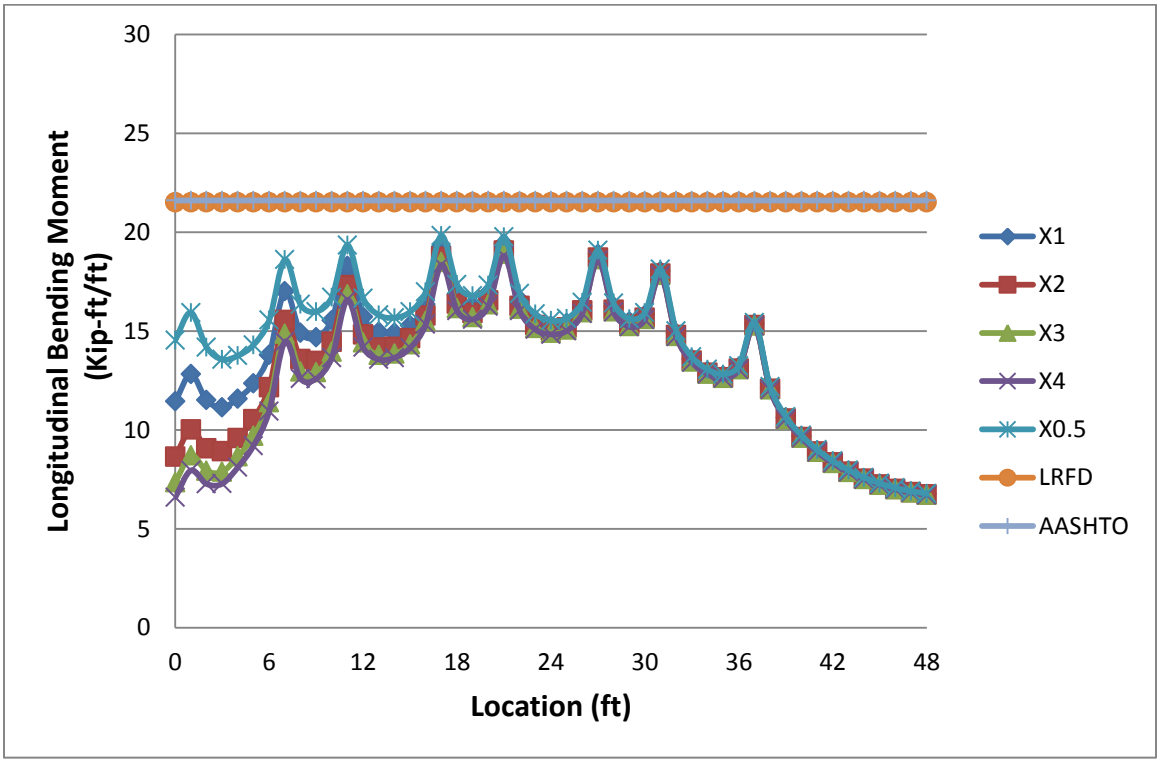

Table 4.3: Longitudinal Moment Distribution at Critical Section for Four-Lane Single Span Bridge Deck Span = 24 ft, Deck Width = 48 ft, One Railing with Edge Loading E1 (RIGHT)

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	23.0	21.5	23.0	21.5	23.0	21.5	23.0	21.5	23.1	21.5	21.6
1	24.5	21.5	24.5	21.5	24.5	21.5	24.4	21.5	24.5	21.5	21.6
2	20.9	21.5	20.9	21.5	20.9	21.5	20.9	21.5	20.9	21.5	21.6
3	19.5	21.5	19.5	21.5	19.5	21.5	19.5	21.5	19.5	21.5	21.6
4	18.9	21.5	18.9	21.5	18.9	21.5	18.9	21.5	18.9	21.5	21.6
5	18.9	21.5	18.9	21.5	18.9	21.5	18.9	21.5	18.9	21.5	21.6
6	19.6	21.5	19.6	21.5	19.6	21.5	19.6	21.5	19.6	21.5	21.6
7	22.2	21.5	22.2	21.5	22.2	21.5	22.2	21.5	22.2	21.5	21.6
8	19.6	21.5	19.6	21.5	19.5	21.5	19.5	21.5	19.6	21.5	21.6
9	18.9	21.5	18.8	21.5	18.8	21.5	18.8	21.5	18.9	21.5	21.6
10	19.3	21.5	19.3	21.5	19.3	21.5	19.2	21.5	19.3	21.5	21.6
11	21.6	21.5	21.6	21.5	21.6	21.5	21.6	21.5	21.7	21.5	21.6
12	18.7	21.5	18.7	21.5	18.7	21.5	18.7	21.5	18.7	21.5	21.6
13	17.6	21.5	17.6	21.5	17.6	21.5	17.6	21.5	17.7	21.5	21.6
14	17.3	21.5	17.3	21.5	17.2	21.5	17.2	21.5	17.3	21.5	21.6
15	17.4	21.5	17.4	21.5	17.3	21.5	17.3	21.5	17.4	21.5	21.6
16	18.2	21.5	18.2	21.5	18.2	21.5	18.2	21.5	18.3	21.5	21.6
17	20.9	21.5	20.9	21.5	20.9	21.5	20.8	21.5	21.0	21.5	21.6
18	18.3	21.5	18.3	21.5	18.2	21.5	18.2	21.5	18.4	21.5	21.6
19	17.6	21.5	17.6	21.5	17.5	21.5	17.5	21.5	17.7	21.5	21.6
20	18.0	21.5	18.0	21.5	17.9	21.5	17.9	21.5	18.1	21.5	21.6
21	20.3	21.5	20.3	21.5	20.2	21.5	20.2	21.5	20.4	21.5	21.6
22	17.4	21.5	17.3	21.5	17.3	21.5	17.2	21.5	17.4	21.5	21.6
23	16.2	21.5	16.1	21.5	16.1	21.5	16.1	21.5	16.3	21.5	21.6
24	15.8	21.5	15.7	21.5	15.7	21.5	15.6	21.5	15.9	21.5	21.6
25	15.8	21.5	15.7	21.5	15.6	21.5	15.6	21.5	15.9	21.5	21.6
26	16.5	21.5	16.4	21.5	16.3	21.5	16.3	21.5	16.6	21.5	21.6
27	19.1	21.5	18.9	21.5	18.9	21.5	18.8	21.5	19.2	21.5	21.6
28	16.3	21.5	16.1	21.5	16.1	21.5	16.0	21.5	16.4	21.5	21.6
29	15.4	21.5	15.2	21.5	15.2	21.5	15.1	21.5	15.6	21.5	21.6
30	15.6	21.5	15.4	21.5	15.4	21.5	15.3	21.5	15.8	21.5	21.6
31	17.7	21.5	17.5	21.5	17.4	21.5	17.4	21.5	17.9	21.5	21.6
32	14.5	21.5	14.3	21.5	14.2	21.5	14.1	21.5	14.7	21.5	21.6
33	13.1	21.5	12.8	21.5	12.7	21.5	12.6	21.5	13.3	21.5	21.6
34	12.3	21.5	12.0	21.5	11.9	21.5	11.8	21.5	12.6	21.5	21.6
35	11.9	21.5	11.6	21.5	11.5	21.5	11.4	21.5	12.3	21.5	21.6
36	12.2	21.5	11.9	21.5	11.7	21.5	11.7	21.5	12.6	21.5	21.6
37	14.3	21.5	13.9	21.5	13.7	21.5	13.6	21.5	14.7	21.5	21.6
38	10.9	21.5	10.5	21.5	10.3	21.5	10.2	21.5	11.3	21.5	21.6

39	9.2	21.5	8.8	21.5	8.5	21.5	8.4	21.5	9.7	21.5	21.6
40	8.1	21.5	7.6	21.5	7.4	21.5	7.2	21.5	8.6	21.5	21.6
41	7.2	21.5	6.6	21.5	6.4	21.5	6.2	21.5	7.8	21.5	21.6
42	6.4	21.5	5.8	21.5	5.5	21.5	5.3	21.5	7.1	21.5	21.6
43	5.7	21.5	5.1	21.5	4.7	21.5	4.6	21.5	6.4	21.5	21.6
44	5.1	21.5	4.4	21.5	4.0	21.5	3.8	21.5	5.9	21.5	21.6
45	4.6	21.5	3.7	21.5	3.4	21.5	3.1	21.5	5.4	21.5	21.6
46	4.1	21.5	3.2	21.5	2.8	21.5	2.5	21.5	5.0	21.5	21.6
47	3.5	21.5	2.5	21.5	2.1	21.5	1.8	21.5	4.6	21.5	21.6
48	3.4	21.5	2.4	21.5	1.9	21.5	1.7	21.5	4.4	21.5	21.6

Figure 4.3: Longitudinal Moment Distribution at Critical Section for Four-Lane Single Span Bridge Deck Span = 24 ft, Deck Width = 48 ft, One Railing with Edge Loading E1 (RIGHT)

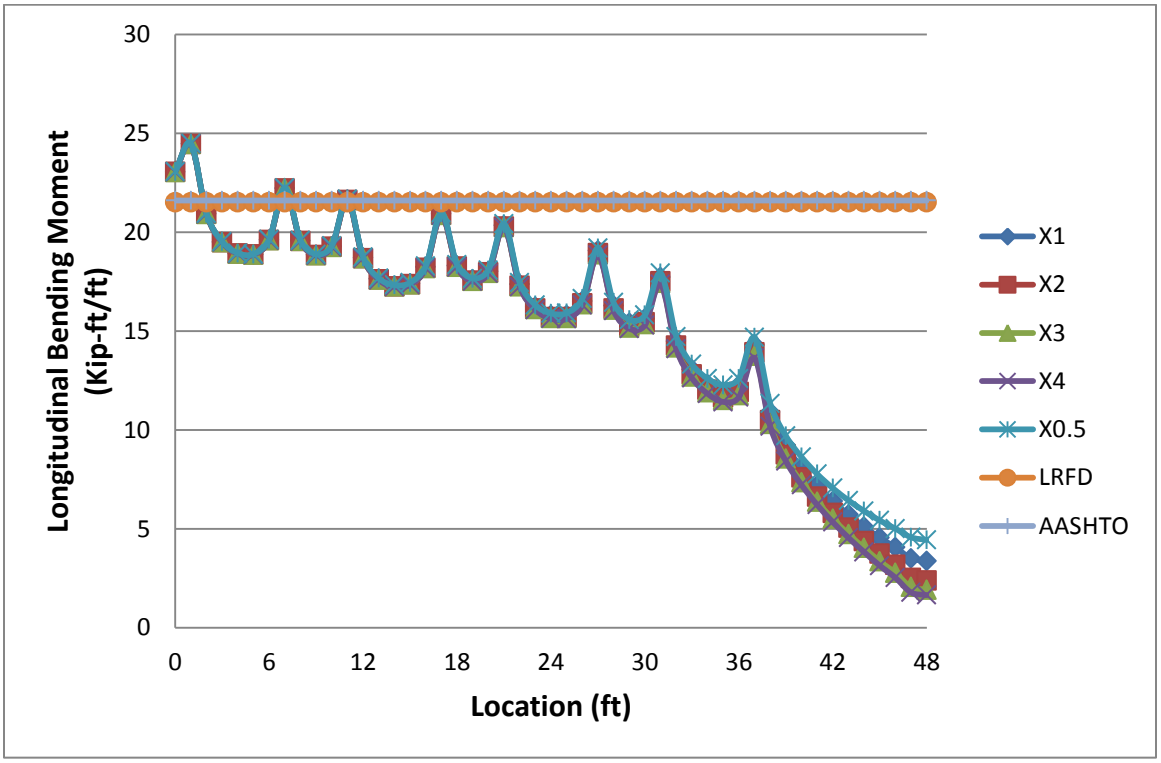

Table 4.4: Longitudinal Moment Distribution at Critical Section for Four-Lane Single Span Bridge Deck Span = 24 ft, Deck Width = 48ft. Two Railings with Edge Loading E1

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	11.4	21.5	8.6	21.5	7.3	21.5	6.6	21.5	14.5	21.5	21.6
1	12.8	21.5	10.0	21.5	8.7	21.5	7.9	21.5	15.9	21.5	21.6
2	11.5	21.5	9.0	21.5	7.9	21.5	7.2	21.5	14.2	21.5	21.6
3	11.1	21.5	8.9	21.5	7.9	21.5	7.3	21.5	13.5	21.5	21.6
4	11.6	21.5	9.6	21.5	8.6	21.5	8.1	21.5	13.7	21.5	21.6
5	12.3	21.5	10.5	21.5	9.7	21.5	9.2	21.5	14.3	21.5	21.6
6	13.7	21.5	12.1	21.5	11.3	21.5	10.9	21.5	15.5	21.5	21.6
7	17.0	21.5	15.5	21.5	14.8	21.5	14.4	21.5	18.6	21.5	21.6
8	14.9	21.5	13.5	21.5	12.9	21.5	12.5	21.5	16.3	21.5	21.6
9	14.6	21.5	13.4	21.5	12.8	21.5	12.5	21.5	15.9	21.5	21.6
10	15.5	21.5	14.4	21.5	13.9	21.5	13.6	21.5	16.7	21.5	21.6
11	18.2	21.5	17.2	21.5	16.8	21.5	16.5	21.5	19.3	21.5	21.6
12	15.6	21.5	14.7	21.5	14.3	21.5	14.1	21.5	16.6	21.5	21.6
13	14.9	21.5	14.0	21.5	13.7	21.5	13.4	21.5	15.7	21.5	21.6
14	14.8	21.5	14.1	21.5	13.7	21.5	13.5	21.5	15.6	21.5	21.6
15	15.2	21.5	14.5	21.5	14.2	21.5	14.0	21.5	15.9	21.5	21.6
16	16.2	21.5	15.6	21.5	15.3	21.5	15.1	21.5	16.9	21.5	21.6
17	19.1	21.5	18.5	21.5	18.3	21.5	18.1	21.5	19.7	21.5	21.6
18	16.7	21.5	16.2	21.5	15.9	21.5	15.8	21.5	17.2	21.5	21.6
19	16.1	21.5	15.7	21.5	15.4	21.5	15.3	21.5	16.7	21.5	21.6
20	16.7	21.5	16.3	21.5	16.1	21.5	15.9	21.5	17.2	21.5	21.6
21	19.2	21.5	18.8	21.5	18.6	21.5	18.5	21.5	19.6	21.5	21.6
22	16.3	21.5	15.9	21.5	15.8	21.5	15.6	21.5	16.7	21.5	21.6
23	15.3	21.5	14.9	21.5	14.8	21.5	14.7	21.5	15.7	21.5	21.6
24	14.9	21.5	14.6	21.5	14.4	21.5	14.4	21.5	15.3	21.5	21.6
25	15.0	21.5	14.7	21.5	14.6	21.5	14.5	21.5	15.4	21.5	21.6
26	15.8	21.5	15.5	21.5	15.4	21.5	15.3	21.5	16.2	21.5	21.6
27	18.4	21.5	18.1	21.5	18.0	21.5	17.9	21.5	18.8	21.5	21.6
28	15.7	21.5	15.4	21.5	15.3	21.5	15.2	21.5	16.1	21.5	21.6
29	14.9	21.5	14.6	21.5	14.5	21.5	14.4	21.5	15.2	21.5	21.6
30	15.2	21.5	14.9	21.5	14.7	21.5	14.7	21.5	15.5	21.5	21.6
31	17.3	21.5	17.0	21.5	16.9	21.5	16.8	21.5	17.7	21.5	21.6
32	14.1	21.5	13.8	21.5	13.7	21.5	13.6	21.5	14.5	21.5	21.6
33	12.7	21.5	12.4	21.5	12.3	21.5	12.2	21.5	13.1	21.5	21.6
34	12.0	21.5	11.7	21.5	11.5	21.5	11.4	21.5	12.4	21.5	21.6
35	11.7	21.5	11.3	21.5	11.2	21.5	11.1	21.5	12.1	21.5	21.6
36	12.0	21.5	11.6	21.5	11.4	21.5	11.3	21.5	12.4	21.5	21.6
37	14.1	21.5	13.7	21.5	13.5	21.5	13.4	21.5	14.5	21.5	21.6
38	10.7	21.5	10.3	21.5	10.1	21.5	9.9	21.5	11.2	21.5	21.6

39	9.1	21.5	8.6	21.5	8.3	21.5	8.2	21.5	9.6	21.5	21.6
40	8.0	21.5	7.4	21.5	7.2	21.5	7.0	21.5	8.5	21.5	21.6
41	7.1	21.5	6.5	21.5	6.2	21.5	6.1	21.5	7.7	21.5	21.6
42	6.3	21.5	5.7	21.5	5.4	21.5	5.2	21.5	7.0	21.5	21.6
43	5.6	21.5	4.9	21.5	4.6	21.5	4.4	21.5	6.4	21.5	21.6
44	5.0	21.5	4.3	21.5	3.9	21.5	3.7	21.5	5.8	21.5	21.6
45	4.5	21.5	3.7	21.5	3.3	21.5	3.1	21.5	5.4	21.5	21.6
46	4.0	21.5	3.1	21.5	2.7	21.5	2.5	21.5	5.0	21.5	21.6
47	3.5	21.5	2.5	21.5	2.0	21.5	1.7	21.5	4.5	21.5	21.6
48	3.3	21.5	2.4	21.5	1.9	21.5	1.6	21.5	4.4	21.5	21.6

Figure 4.4: Longitudinal Moment Distribution at Critical Section for Four-Lane Single Span Bridge Deck Span = 24 ft, Deck Width = 48ft. Two Railings with Edge Loading E1

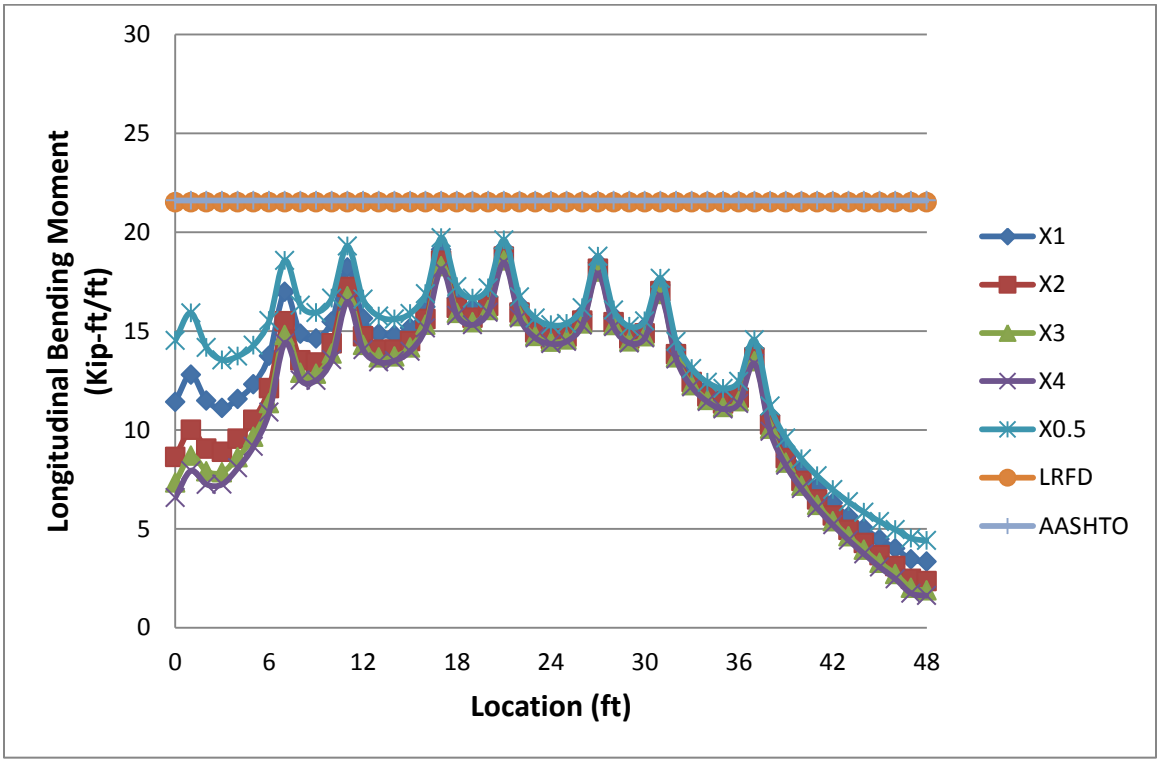

Table 5.1: Longitudinal Moment Distribution at Critical Section for One-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 14 ft, No Railings with Edge Loading E1

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	31.4	47.2	31.4	47.2	31.4	47.2	31.4	47.2	31.4	47.2	32.4
1	32.7	47.2	32.7	47.2	32.7	47.2	32.7	47.2	32.7	47.2	32.4
2	29.1	47.2	29.1	47.2	29.1	47.2	29.1	47.2	29.1	47.2	32.4
3	27.5	47.2	27.5	47.2	27.5	47.2	27.5	47.2	27.5	47.2	32.4
4	26.7	47.2	26.7	47.2	26.7	47.2	26.7	47.2	26.7	47.2	32.4
5	26.4	47.2	26.4	47.2	26.4	47.2	26.4	47.2	26.4	47.2	32.4
6	26.9	47.2	26.9	47.2	26.9	47.2	26.9	47.2	26.9	47.2	32.4
7	29.1	47.2	29.1	47.2	29.1	47.2	29.1	47.2	29.1	47.2	32.4
8	25.9	47.2	25.9	47.2	25.9	47.2	25.9	47.2	25.9	47.2	32.4
9	24.5	47.2	24.5	47.2	24.5	47.2	24.5	47.2	24.5	47.2	32.4
10	23.7	47.2	23.7	47.2	23.7	47.2	23.7	47.2	23.7	47.2	32.4
11	23.2	47.2	23.2	47.2	23.2	47.2	23.2	47.2	23.2	47.2	32.4
12	22.8	47.2	22.8	47.2	22.8	47.2	22.8	47.2	22.8	47.2	32.4
13	22.5	47.2	22.5	47.2	22.5	47.2	22.5	47.2	22.5	47.2	32.4
14	22.4	47.2	22.4	47.2	22.4	47.2	22.4	47.2	22.4	47.2	32.4

Figure 5.1: Longitudinal Moment Distribution at Critical Section for One-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 14 ft, No Railings with Edge Loading E1

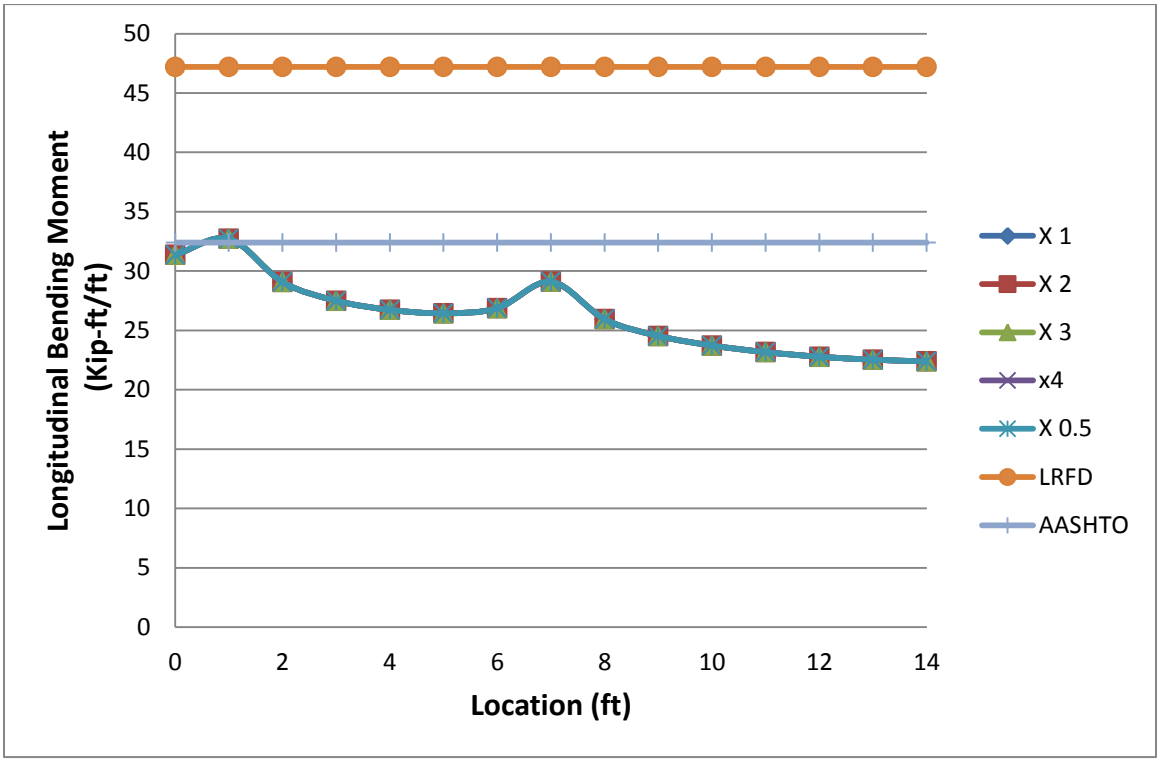

Table 5.2: Longitudinal Moment Distribution at Critical Section for One-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 14 ft, One Railing with Edge Loading E1 (LEFT)

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	18.9	47.2	14.4	47.2	11.9	47.2	10.4	47.2	23.1	47.2	32.4
1	19.9	47.2	15.3	47.2	12.9	47.2	11.3	47.2	24.2	47.2	32.4
2	18.0	47.2	13.7	47.2	11.4	47.2	10.0	47.2	21.8	47.2	32.4
3	17.1	47.2	13.0	47.2	10.8	47.2	9.4	47.2	20.8	47.2	32.4
4	17.0	47.2	13.1	47.2	11.0	47.2	9.7	47.2	20.5	47.2	32.4
5	17.2	47.2	13.5	47.2	11.4	47.2	10.2	47.2	20.5	47.2	32.4
6	18.0	47.2	14.4	47.2	12.5	47.2	11.2	47.2	21.2	47.2	32.4
7	20.6	47.2	17.1	47.2	15.2	47.2	14.0	47.2	23.7	47.2	32.4
8	17.7	47.2	14.4	47.2	12.5	47.2	11.4	47.2	20.7	47.2	32.4
9	16.6	47.2	13.3	47.2	11.5	47.2	10.4	47.2	19.5	47.2	32.4
10	16.0	47.2	12.8	47.2	11.0	47.2	9.9	47.2	18.8	47.2	32.4
11	15.6	47.2	12.5	47.2	10.8	47.2	9.7	47.2	18.4	47.2	32.4
12	15.4	47.2	12.3	47.2	10.6	47.2	9.6	47.2	18.1	47.2	32.4
13	15.2	47.2	12.2	47.2	10.6	47.2	9.5	47.2	17.9	47.2	32.4
14	15.2	47.2	12.2	47.2	10.6	47.2	9.6	47.2	17.9	47.2	32.4

Figure 5.2: Longitudinal Moment Distribution at Critical Section for One-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 14 ft, One Railing with Edge Loading E1 (LEFT)

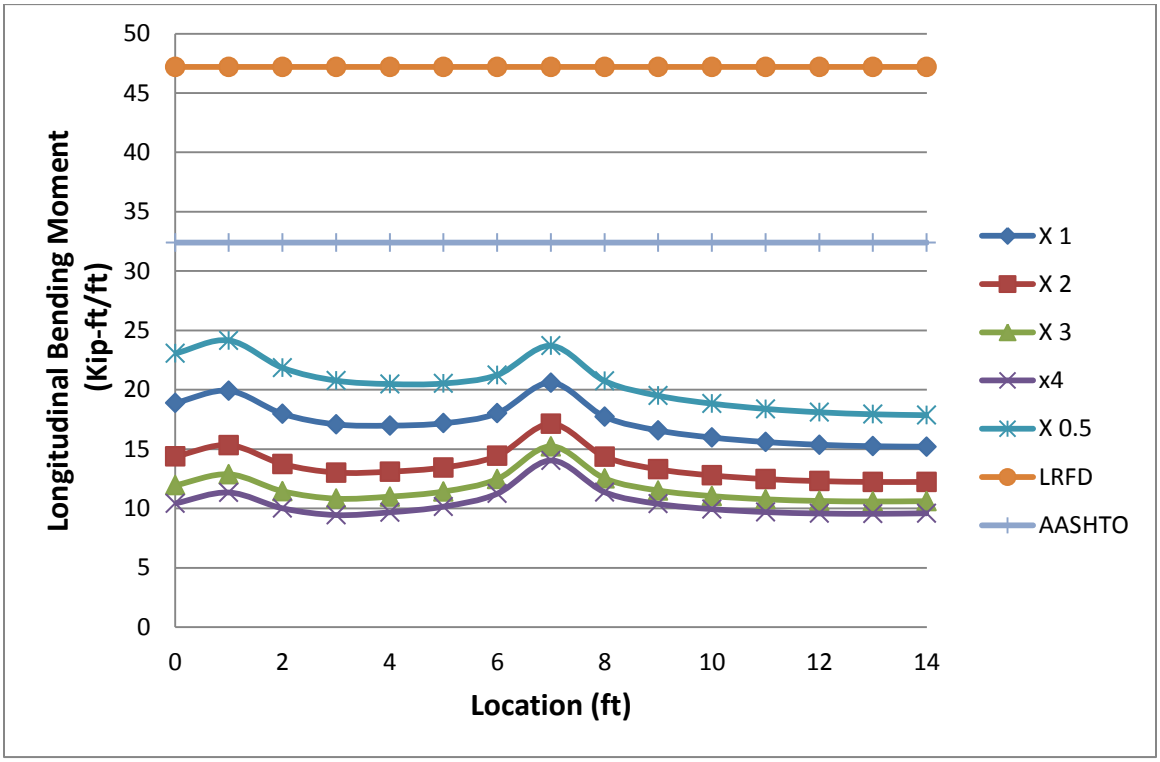

Table 5.3: Longitudinal Moment Distribution at Critical Section for One-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 14 ft, One Railing with Edge Loading E1 (RIGHT)

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	25.3	47.2	22.8	47.2	21.5	47.2	20.6	47.2	27.6	47.2	32.4
1	26.6	47.2	24.1	47.2	22.7	47.2	21.8	47.2	28.8	47.2	32.4
2	22.8	47.2	20.3	47.2	18.9	47.2	18.0	47.2	25.1	47.2	32.4
3	21.2	47.2	18.5	47.2	17.1	47.2	16.2	47.2	23.5	47.2	32.4
4	20.2	47.2	17.6	47.2	16.1	47.2	15.2	47.2	22.6	47.2	32.4
5	19.8	47.2	17.1	47.2	15.6	47.2	14.6	47.2	22.2	47.2	32.4
6	20.0	47.2	17.2	47.2	15.7	47.2	14.7	47.2	22.6	47.2	32.4
7	22.1	47.2	19.2	47.2	17.6	47.2	16.6	47.2	24.7	47.2	32.4
8	18.7	47.2	15.7	47.2	14.1	47.2	13.0	47.2	21.4	47.2	32.4
9	17.0	47.2	13.9	47.2	12.2	47.2	11.2	47.2	19.8	47.2	32.4
10	15.9	47.2	12.7	47.2	11.0	47.2	9.9	47.2	18.8	47.2	32.4
11	15.1	47.2	11.7	47.2	9.9	47.2	8.8	47.2	18.0	47.2	32.4
12	14.4	47.2	10.9	47.2	9.0	47.2	7.9	47.2	17.4	47.2	32.4
13	13.6	47.2	10.0	47.2	8.0	47.2	6.7	47.2	16.9	47.2	32.4
14	13.5	47.2	9.9	47.2	7.9	47.2	6.7	47.2	16.8	47.2	32.4

Figure 5.3: Longitudinal Moment Distribution at Critical Section for One-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 14 ft, One Railing with Edge Loading E1 (RIGHT)

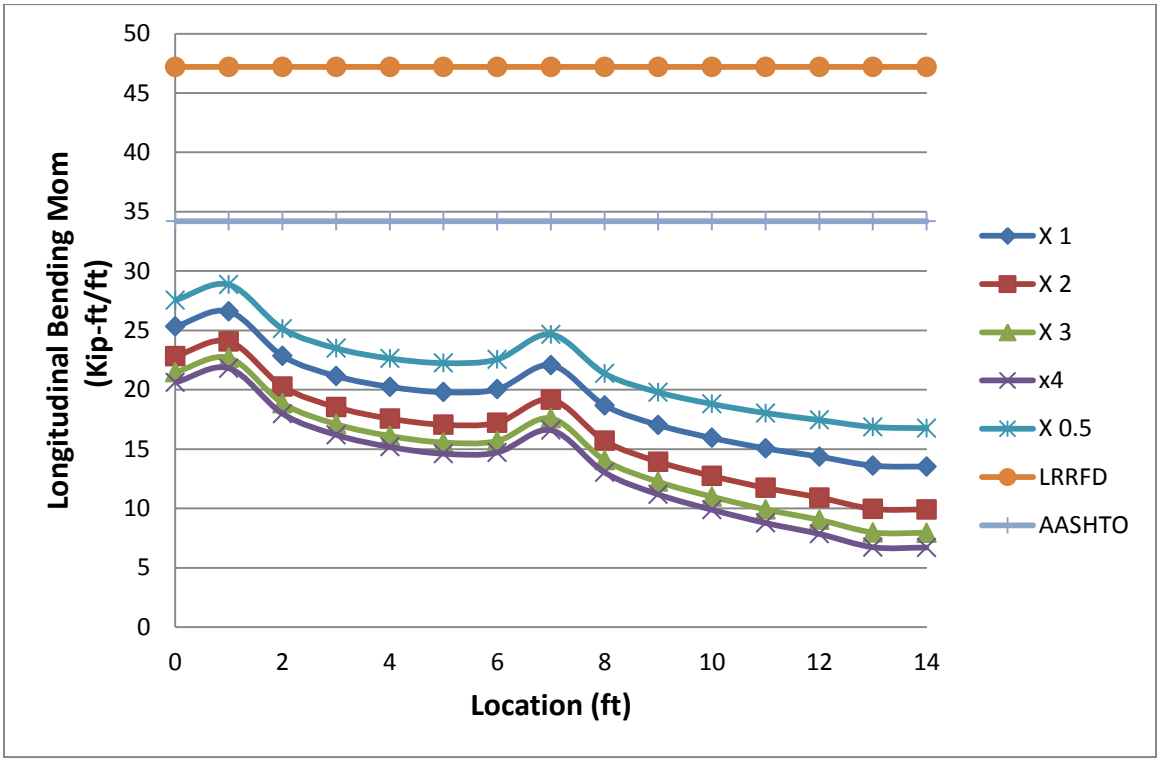

Table 5.4: Longitudinal Moment Distribution at Critical Section for One-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 14ft. Two Railings with Edge Loading E1

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	16.2	47.2	12.0	47.2	9.9	47.2	8.7	47.2	20.7	47.2	32.4
1	17.2	47.2	12.9	47.2	10.8	47.2	9.5	47.2	21.8	47.2	32.4
2	15.1	47.2	11.0	47.2	9.1	47.2	7.9	47.2	19.4	47.2	32.4
3	14.1	47.2	10.1	47.2	8.2	47.2	7.1	47.2	18.2	47.2	32.4
4	13.8	47.2	10.0	47.2	8.1	47.2	7.0	47.2	17.8	47.2	32.4
5	13.8	47.2	10.1	47.2	8.3	47.2	7.2	47.2	17.8	47.2	32.4
6	14.5	47.2	10.8	47.2	9.1	47.2	8.0	47.2	18.4	47.2	32.4
7	16.9	47.2	13.3	47.2	11.5	47.2	10.5	47.2	20.7	47.2	32.4
8	13.8	47.2	10.2	47.2	8.5	47.2	7.5	47.2	17.6	47.2	32.4
9	12.4	47.2	8.9	47.2	7.2	47.2	6.2	47.2	16.2	47.2	32.4
10	11.6	47.2	8.0	47.2	6.4	47.2	5.4	47.2	15.4	47.2	32.4
11	10.9	47.2	7.4	47.2	5.7	47.2	4.8	47.2	14.7	47.2	32.4
12	10.4	47.2	6.9	47.2	5.2	47.2	4.3	47.2	14.3	47.2	32.4
13	9.9	47.2	6.3	47.2	4.6	47.2	3.7	47.2	13.8	47.2	32.4
14	9.9	47.2	6.3	47.2	4.7	47.2	3.8	47.2	13.8	47.2	32.4

Figure 5.4: Longitudinal Moment Distribution at Critical Section for One-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 14ft. Two Railings with Edge Loading E1

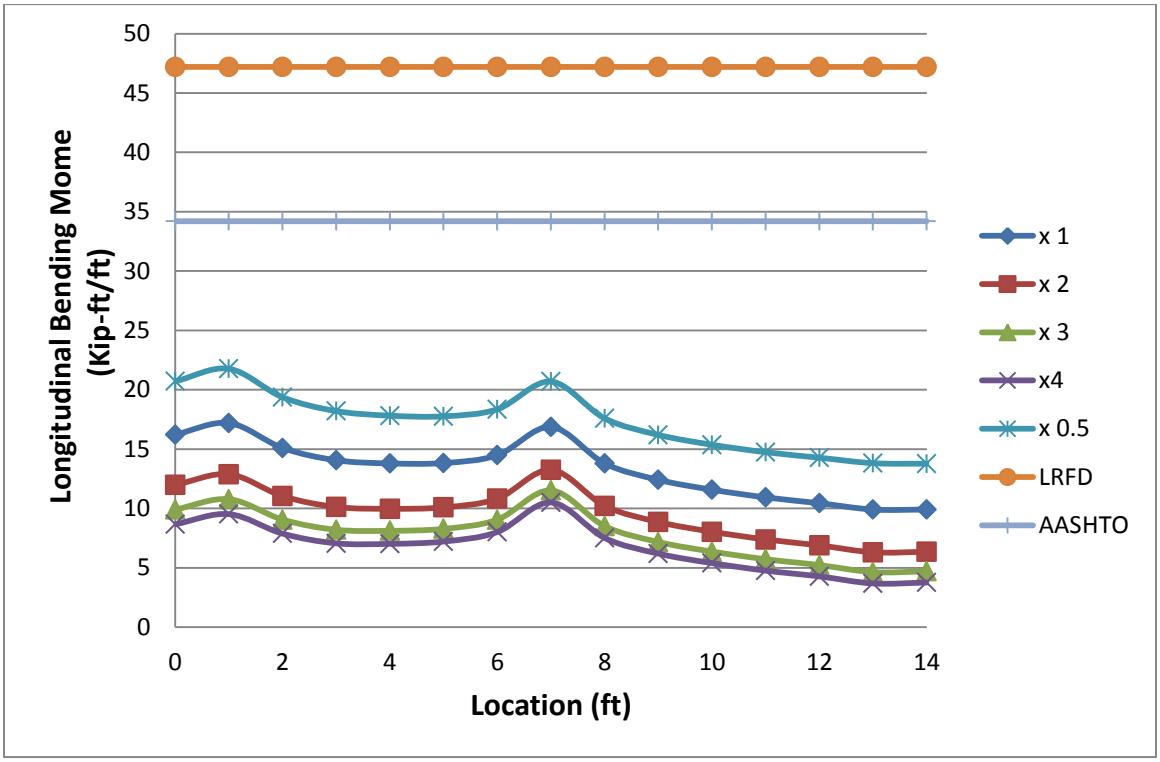

Table 6.1: Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 24 ft. No Railings with Edge Loading E1

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	37.2	45.6	37.2	45.6	37.2	45.6	37.2	45.6	37.2	45.6	34.2
1	38.5	45.6	38.5	45.6	38.5	45.6	38.5	45.6	38.5	45.6	34.2
2	34.8	45.6	34.8	45.6	34.8	45.6	34.8	45.6	34.8	45.6	34.2
3	33.3	45.6	33.3	45.6	33.3	45.6	33.3	45.6	33.3	45.6	34.2
4	32.6	45.6	32.6	45.6	32.6	45.6	32.6	45.6	32.6	45.6	34.2
5	32.3	45.6	32.3	45.6	32.3	45.6	32.3	45.6	32.3	45.6	34.2
6	32.9	45.6	32.9	45.6	32.9	45.6	32.9	45.6	32.9	45.6	34.2
7	35.3	45.6	35.3	45.6	35.3	45.6	35.3	45.6	35.3	45.6	34.2
8	32.5	45.6	32.5	45.6	32.5	45.6	32.5	45.6	32.5	45.6	34.2
9	31.6	45.6	31.6	45.6	31.6	45.6	31.6	45.6	31.6	45.6	34.2
10	31.8	45.6	31.8	45.6	31.8	45.6	31.8	45.6	31.8	45.6	34.2
11	33.9	45.6	33.9	45.6	33.9	45.6	33.9	45.6	33.9	45.6	34.2
12	30.8	45.6	30.8	45.6	30.8	45.6	30.8	45.6	30.8	45.6	34.2
13	29.4	45.6	29.4	45.6	29.4	45.6	29.4	45.6	29.4	45.6	34.2
14	28.8	45.6	28.8	45.6	28.8	45.6	28.8	45.6	28.8	45.6	34.2
15	28.6	45.6	28.6	45.6	28.6	45.6	28.6	45.6	28.6	45.6	34.2
16	29.1	45.6	29.1	45.6	29.1	45.6	29.1	45.6	29.1	45.6	34.2
17	31.4	45.6	31.4	45.6	31.4	45.6	31.4	45.6	31.4	45.6	34.2
18	28.3	45.6	28.3	45.6	28.3	45.6	28.3	45.6	28.3	45.6	34.2
19	26.9	45.6	26.9	45.6	26.9	45.6	26.9	45.6	26.9	45.6	34.2
20	26.1	45.6	26.1	45.6	26.1	45.6	26.1	45.6	26.1	45.6	34.2
21	25.6	45.6	25.6	45.6	25.6	45.6	25.6	45.6	25.6	45.6	34.2
22	25.3	45.6	25.3	45.6	25.3	45.6	25.3	45.6	25.3	45.6	34.2
23	25.1	45.6	25.1	45.6	25.1	45.6	25.1	45.6	25.1	45.6	34.2
24	25.0	45.6	25.0	45.6	25.0	45.6	25.0	45.6	25.0	45.6	34.2

Figure 6.1: Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 24 ft. No Railings with Edge Loading E1

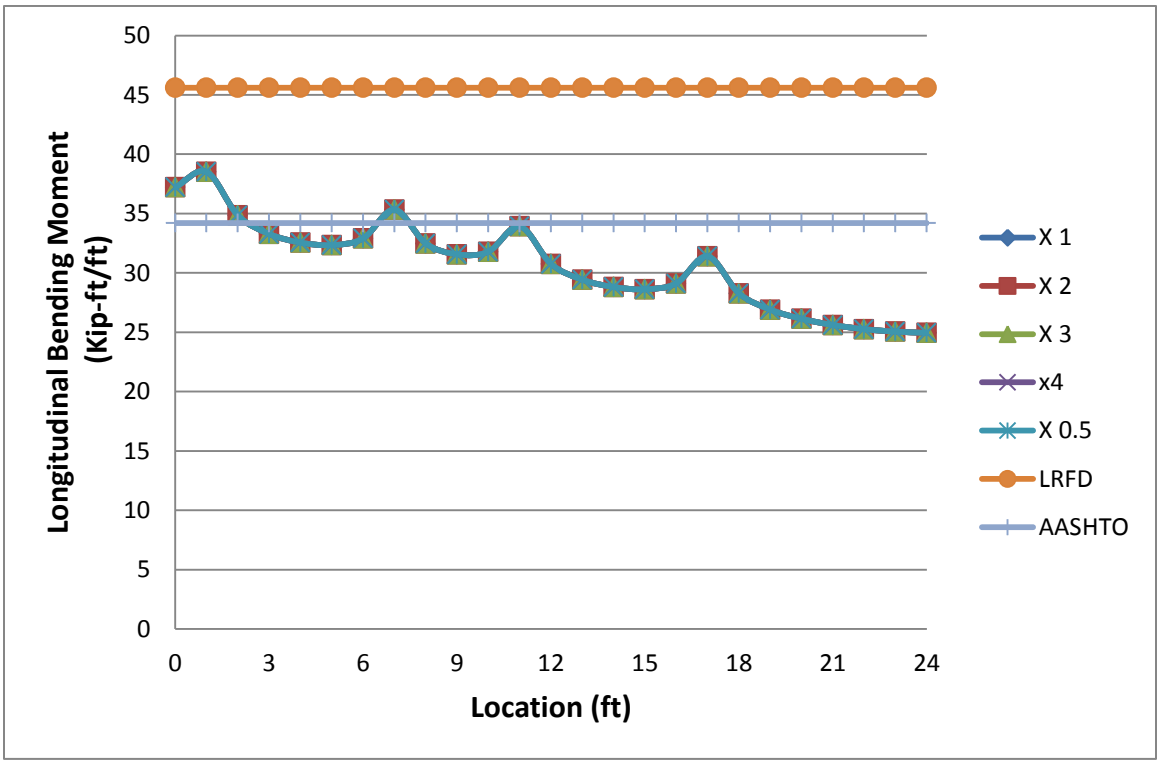

Table 6.2: Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 24 ft, One Railing with Edge Loading E1 (LEFT)

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	24.3	45.6	18.9	45.6	15.9	45.6	13.9	45.6	28.8	45.6	34.2
1	25.2	45.6	19.8	45.6	16.8	45.6	14.8	45.6	29.9	45.6	34.2
2	23.5	45.6	18.6	45.6	15.7	45.6	13.9	45.6	27.7	45.6	34.2
3	22.7	45.6	18.1	45.6	15.4	45.6	13.7	45.6	26.7	45.6	34.2
4	22.8	45.6	18.5	45.6	15.9	45.6	14.3	45.6	26.5	45.6	34.2
5	23.3	45.6	19.1	45.6	16.7	45.6	15.2	45.6	26.7	45.6	34.2
6	24.4	45.6	20.5	45.6	18.2	45.6	16.7	45.6	27.7	45.6	34.2
7	27.3	45.6	23.6	45.6	21.5	45.6	20.1	45.6	30.4	45.6	34.2
8	24.9	45.6	21.4	45.6	19.4	45.6	18.0	45.6	27.9	45.6	34.2
9	24.4	45.6	21.1	45.6	19.1	45.6	17.9	45.6	27.2	45.6	34.2
10	25.0	45.6	21.8	45.6	20.0	45.6	18.8	45.6	27.6	45.6	34.2
11	27.5	45.6	24.4	45.6	22.7	45.6	21.5	45.6	30.0	45.6	34.2
12	24.6	45.6	21.7	45.6	20.0	45.6	18.9	45.6	27.0	45.6	34.2
13	23.6	45.6	20.8	45.6	19.2	45.6	18.1	45.6	25.8	45.6	34.2
14	23.2	45.6	20.6	45.6	19.0	45.6	18.0	45.6	25.4	45.6	34.2
15	23.2	45.6	20.7	45.6	19.2	45.6	18.3	45.6	25.3	45.6	34.2
16	23.9	45.6	21.5	45.6	20.1	45.6	19.2	45.6	26.0	45.6	34.2
17	26.4	45.6	24.1	45.6	22.7	45.6	21.8	45.6	28.4	45.6	34.2
18	23.5	45.6	21.2	45.6	19.9	45.6	19.0	45.6	25.3	45.6	34.2
19	22.3	45.6	20.1	45.6	18.8	45.6	17.9	45.6	24.1	45.6	34.2
20	21.6	45.6	19.5	45.6	18.2	45.6	17.4	45.6	23.4	45.6	34.2
21	21.2	45.6	19.1	45.6	17.9	45.6	17.2	45.6	22.9	45.6	34.2
22	21.0	45.6	19.0	45.6	17.8	45.6	17.0	45.6	22.7	45.6	34.2
23	20.9	45.6	18.9	45.6	17.7	45.6	17.0	45.6	22.5	45.6	34.2
24	20.9	45.6	18.9	45.6	17.8	45.6	17.1	45.6	22.5	45.6	34.2

Figure 6.2: Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 24 ft, One Railing with Edge Loading E1 (LEFT)

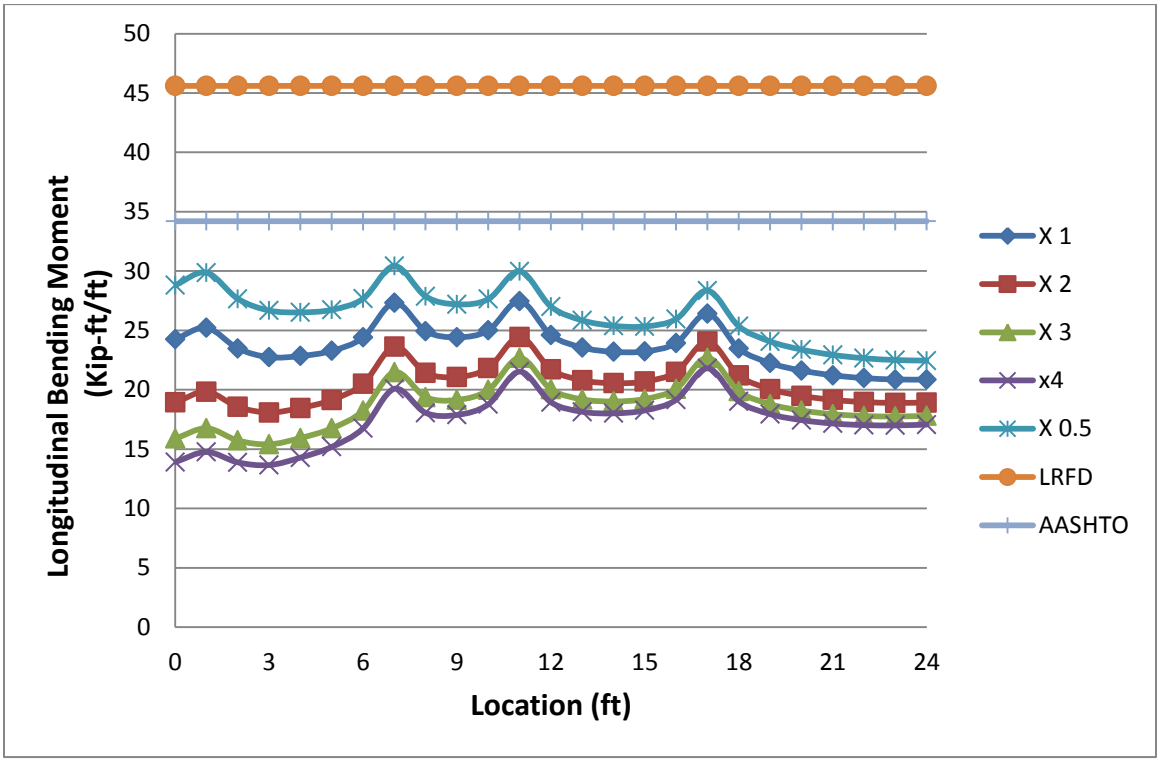

Table 6.3: Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 24 ft, One Railing with Edge Loading E1 (RIGHT)

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	34.1	45.6	32.6	45.6	31.7	45.6	31.1	45.6	35.3	45.6	34.2
1	35.3	45.6	33.8	45.6	32.9	45.6	32.3	45.6	36.5	45.6	34.2
2	31.5	45.6	30.0	45.6	29.1	45.6	28.5	45.6	32.8	45.6	34.2
3	29.9	45.6	28.3	45.6	27.4	45.6	26.8	45.6	31.2	45.6	34.2
4	29.1	45.6	27.4	45.6	26.5	45.6	25.9	45.6	30.4	45.6	34.2
5	28.8	45.6	27.1	45.6	26.1	45.6	25.4	45.6	30.2	45.6	34.2
6	29.2	45.6	27.5	45.6	26.4	45.6	25.8	45.6	30.6	45.6	34.2
7	31.5	45.6	29.7	45.6	28.6	45.6	28.0	45.6	33.0	45.6	34.2
8	28.5	45.6	26.6	45.6	25.5	45.6	24.8	45.6	30.1	45.6	34.2
9	27.4	45.6	25.5	45.6	24.3	45.6	23.6	45.6	29.0	45.6	34.2
10	27.5	45.6	25.4	45.6	24.3	45.6	23.5	45.6	29.2	45.6	34.2
11	29.4	45.6	27.3	45.6	26.1	45.6	25.3	45.6	31.2	45.6	34.2
12	26.0	45.6	23.8	45.6	22.5	45.6	21.7	45.6	27.9	45.6	34.2
13	24.5	45.6	22.2	45.6	20.8	45.6	19.9	45.6	26.4	45.6	34.2
14	23.6	45.6	21.2	45.6	19.8	45.6	18.8	45.6	25.7	45.6	34.2
15	23.2	45.6	20.6	45.6	19.1	45.6	18.2	45.6	25.3	45.6	34.2
16	23.4	45.6	20.7	45.6	19.1	45.6	18.1	45.6	25.6	45.6	34.2
17	25.4	45.6	22.5	45.6	20.9	45.6	19.8	45.6	27.7	45.6	34.2
18	21.9	45.6	18.9	45.6	17.2	45.6	16.1	45.6	24.4	45.6	34.2
19	20.2	45.6	17.0	45.6	15.2	45.6	14.0	45.6	22.8	45.6	34.2
20	19.0	45.6	15.7	45.6	13.8	45.6	12.5	45.6	21.8	45.6	34.2
21	18.1	45.6	14.6	45.6	12.6	45.6	11.2	45.6	21.0	45.6	34.2
22	17.4	45.6	13.7	45.6	11.5	45.6	10.1	45.6	20.4	45.6	34.2
23	16.5	45.6	12.6	45.6	10.3	45.6	8.8	45.6	19.8	45.6	34.2
24	16.5	45.6	12.6	45.6	10.3	45.6	8.8	45.6	19.8	45.6	34.2

Figure 6.3: Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 24 ft, One Railing with Edge Loading E1 (RIGHT)

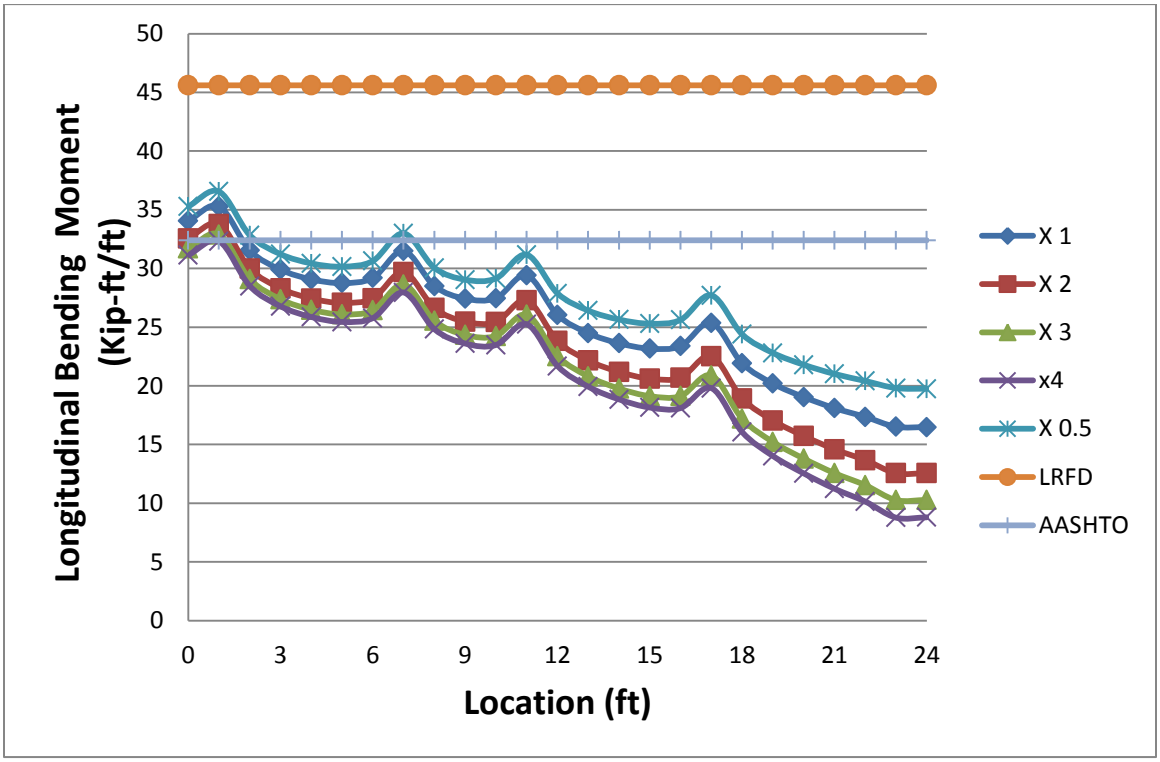

Table 6.4: Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 24ft. Two Railings with Edge Loading E1

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	22.5	45.6	17.1	45.6	14.2	45.6	12.4	45.6	27.4	45.6	34.2
1	23.4	45.6	17.9	45.6	15.0	45.6	13.1	45.6	28.5	45.6	34.2
2	21.5	45.6	16.5	45.6	13.7	45.6	12.0	45.6	26.2	45.6	34.2
3	20.7	45.6	15.8	45.6	13.2	45.6	11.5	45.6	25.1	45.6	34.2
4	20.7	45.6	16.0	45.6	13.5	45.6	11.9	45.6	24.9	45.6	34.2
5	21.0	45.6	16.5	45.6	14.0	45.6	12.5	45.6	25.1	45.6	34.2
6	22.0	45.6	17.6	45.6	15.3	45.6	13.8	45.6	25.9	45.6	34.2
7	24.7	45.6	20.5	45.6	18.2	45.6	16.8	45.6	28.6	45.6	34.2
8	22.2	45.6	18.1	45.6	15.9	45.6	14.5	45.6	25.9	45.6	34.2
9	21.5	45.6	17.5	45.6	15.3	45.6	14.0	45.6	25.1	45.6	34.2
10	21.9	45.6	18.0	45.6	15.9	45.6	14.6	45.6	25.5	45.6	34.2
11	24.2	45.6	20.3	45.6	18.3	45.6	17.0	45.6	27.7	45.6	34.2
12	21.1	45.6	17.3	45.6	15.3	45.6	14.0	45.6	24.6	45.6	34.2
13	19.9	45.6	16.1	45.6	14.1	45.6	12.8	45.6	23.3	45.6	34.2
14	19.3	45.6	15.5	45.6	13.5	45.6	12.3	45.6	22.7	45.6	34.2
15	19.1	45.6	15.3	45.6	13.3	45.6	12.1	45.6	22.5	45.6	34.2
16	19.5	45.6	15.8	45.6	13.8	45.6	12.6	45.6	23.0	45.6	34.2
17	21.7	45.6	18.0	45.6	16.0	45.6	14.7	45.6	25.2	45.6	34.2
18	18.5	45.6	14.7	45.6	12.7	45.6	11.5	45.6	22.0	45.6	34.2
19	16.9	45.6	13.1	45.6	11.1	45.6	9.9	45.6	20.5	45.6	34.2
20	16.0	45.6	12.1	45.6	10.0	45.6	8.8	45.6	19.6	45.6	34.2
21	15.2	45.6	11.2	45.6	9.2	45.6	7.9	45.6	18.9	45.6	34.2
22	14.6	45.6	10.6	45.6	8.5	45.6	7.2	45.6	18.4	45.6	34.2
23	14.0	45.6	9.8	45.6	7.6	45.6	6.3	45.6	17.9	45.6	34.2
24	14.0	45.6	9.9	45.6	7.7	45.6	6.4	45.6	17.9	45.6	34.2

Figure 6.4: Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 24ft. Two Railings with Edge Loading E1

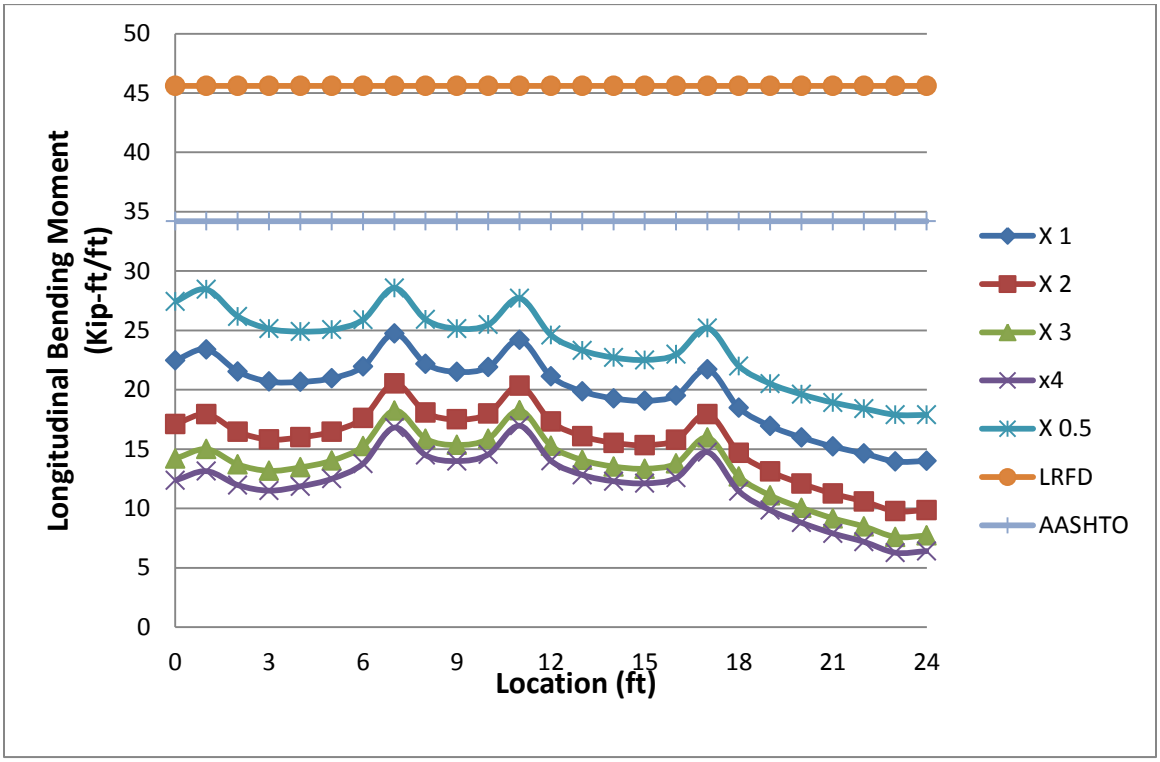

Table 7.1: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 36 ft. No Railings with Edge Loading E1

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	39.3	42.3	39.3	42.3	39.3	42.3	39.3	42.3	39.3	42.3	32.4
1	40.6	42.3	40.6	42.3	40.6	42.3	40.6	42.3	40.6	42.3	32.4
2	37.0	42.3	37.0	42.3	37.0	42.3	37.0	42.3	37.0	42.3	32.4
3	35.4	42.3	35.4	42.3	35.4	42.3	35.4	42.3	35.4	42.3	32.4
4	34.7	42.3	34.7	42.3	34.7	42.3	34.7	42.3	34.7	42.3	32.4
5	34.5	42.3	34.5	42.3	34.5	42.3	34.5	42.3	34.5	42.3	32.4
6	35.0	42.3	35.0	42.3	35.0	42.3	35.0	42.3	35.0	42.3	32.4
7	37.5	42.3	37.5	42.3	37.5	42.3	37.5	42.3	37.5	42.3	32.4
8	34.7	42.3	34.7	42.3	34.7	42.3	34.7	42.3	34.7	42.3	32.4
9	33.8	42.3	33.8	42.3	33.8	42.3	33.8	42.3	33.8	42.3	32.4
10	34.0	42.3	34.0	42.3	34.0	42.3	34.0	42.3	34.0	42.3	32.4
11	36.2	42.3	36.2	42.3	36.2	42.3	36.2	42.3	36.2	42.3	32.4
12	33.1	42.3	33.1	42.3	33.1	42.3	33.1	42.3	33.1	42.3	32.4
13	31.8	42.3	31.8	42.3	31.8	42.3	31.8	42.3	31.8	42.3	32.4
14	31.3	42.3	31.3	42.3	31.3	42.3	31.3	42.3	31.3	42.3	32.4
15	31.2	42.3	31.2	42.3	31.2	42.3	31.2	42.3	31.2	42.3	32.4
16	31.8	42.3	31.8	42.3	31.8	42.3	31.8	42.3	31.8	42.3	32.4
17	34.3	42.3	34.3	42.3	34.3	42.3	34.3	42.3	34.3	42.3	32.4
18	31.5	42.3	31.5	42.3	31.5	42.3	31.5	42.3	31.5	42.3	32.4
19	30.6	42.3	30.6	42.3	30.6	42.3	30.6	42.3	30.6	42.3	32.4
20	30.7	42.3	30.7	42.3	30.7	42.3	30.7	42.3	30.7	42.3	32.4
21	32.9	42.3	32.9	42.3	32.9	42.3	32.9	42.3	32.9	42.3	32.4
22	29.6	42.3	29.6	42.3	29.6	42.3	29.6	42.3	29.6	42.3	32.4
23	28.3	42.3	28.3	42.3	28.3	42.3	28.3	42.3	28.3	42.3	32.4
24	27.6	42.3	27.6	42.3	27.6	42.3	27.6	42.3	27.6	42.3	32.4
25	27.3	42.3	27.3	42.3	27.3	42.3	27.3	42.3	27.3	42.3	32.4
26	27.7	42.3	27.7	42.3	27.7	42.3	27.7	42.3	27.7	42.3	32.4
27	29.9	42.3	29.9	42.3	29.9	42.3	29.9	42.3	29.9	42.3	32.4
28	26.7	42.3	26.7	42.3	26.7	42.3	26.7	42.3	26.7	42.3	32.4
29	25.2	42.3	25.2	42.3	25.2	42.3	25.2	42.3	25.2	42.3	32.4
30	24.3	42.3	24.3	42.3	24.3	42.3	24.3	42.3	24.3	42.3	32.4
31	23.6	42.3	23.6	42.3	23.6	42.3	23.6	42.3	23.6	42.3	32.4
32	23.1	42.3	23.1	42.3	23.1	42.3	23.1	42.3	23.1	42.3	32.4
33	22.8	42.3	22.8	42.3	22.8	42.3	22.8	42.3	22.8	42.3	32.4
34	22.5	42.3	22.5	42.3	22.5	42.3	22.5	42.3	22.5	42.3	32.4
35	22.3	42.3	22.3	42.3	22.3	42.3	22.3	42.3	22.3	42.3	32.4
36	22.2	42.3	22.2	42.3	22.2	42.3	22.2	42.3	22.2	42.3	32.4

Figure 7.1: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 36 ft. No Railings with Edge Loading E1

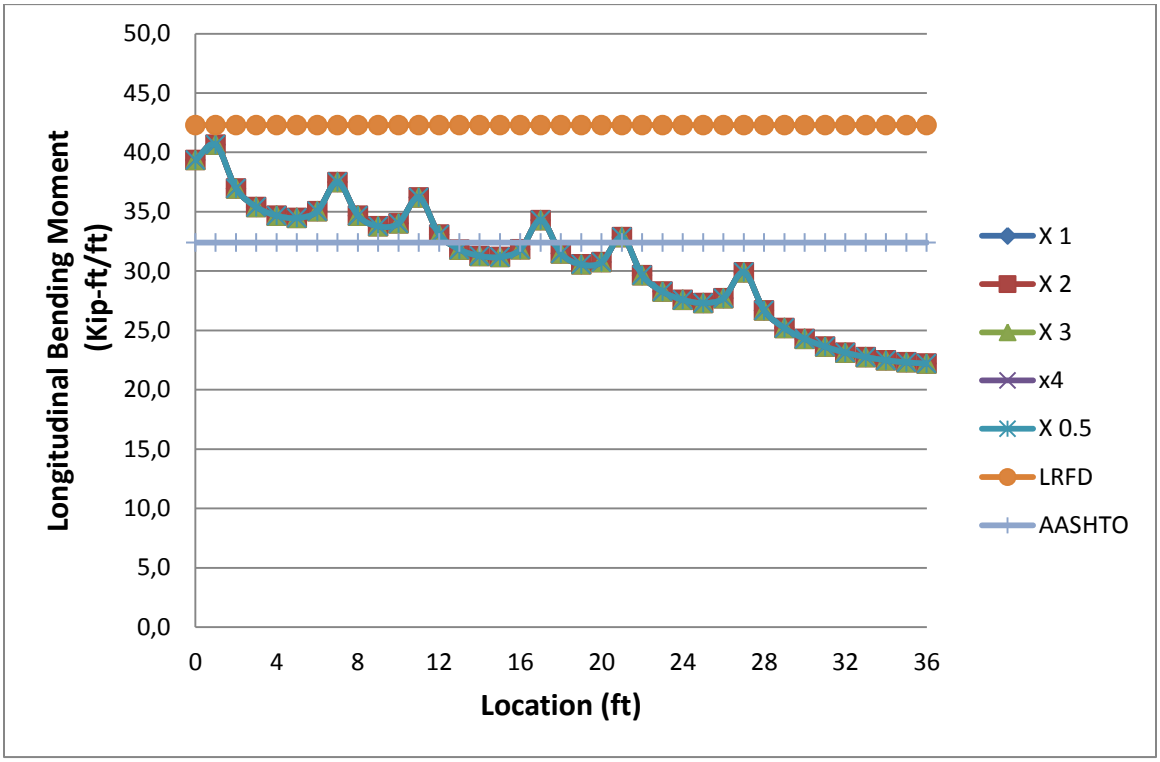

Table 7.2: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 36 ft. One Railing with Edge Loading E1 (LEFT)

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	26.2	42.3	20.6	42.3	17.3	42.3	15.2	42.3	30.9	42.3	32.4
1	27.1	42.3	21.5	42.3	18.2	42.3	16.0	42.3	31.9	42.3	32.4
2	25.5	42.3	20.3	42.3	17.3	42.3	15.3	42.3	29.8	42.3	32.4
3	24.8	42.3	19.9	42.3	17.1	42.3	15.2	42.3	28.8	42.3	32.4
4	25.0	42.3	20.4	42.3	17.8	42.3	16.0	42.3	28.7	42.3	32.4
5	25.5	42.3	21.2	42.3	18.7	42.3	17.1	42.3	28.9	42.3	32.4
6	26.7	42.3	22.7	42.3	20.3	42.3	18.8	42.3	29.9	42.3	32.4
7	29.7	42.3	25.9	42.3	23.7	42.3	22.3	42.3	32.7	42.3	32.4
8	27.4	42.3	23.8	42.3	21.8	42.3	20.4	42.3	30.2	42.3	32.4
9	26.9	42.3	23.6	42.3	21.7	42.3	20.4	42.3	29.6	42.3	32.4
10	27.6	42.3	24.5	42.3	22.7	42.3	21.4	42.3	30.1	42.3	32.4
11	30.2	42.3	27.2	42.3	25.5	42.3	24.4	42.3	32.5	42.3	32.4
12	27.4	42.3	24.7	42.3	23.0	42.3	22.0	42.3	29.7	42.3	32.4
13	26.5	42.3	23.9	42.3	22.4	42.3	21.4	42.3	28.6	42.3	32.4
14	26.3	42.3	23.8	42.3	22.4	42.3	21.4	42.3	28.2	42.3	32.4
15	26.5	42.3	24.2	42.3	22.8	42.3	21.9	42.3	28.3	42.3	32.4
16	27.4	42.3	25.2	42.3	24.0	42.3	23.1	42.3	29.1	42.3	32.4
17	30.1	42.3	28.1	42.3	26.9	42.3	26.1	42.3	31.8	42.3	32.4
18	27.5	42.3	25.6	42.3	24.5	42.3	23.7	42.3	29.1	42.3	32.4
19	26.8	42.3	25.0	42.3	24.0	42.3	23.3	42.3	28.3	42.3	32.4
20	27.2	42.3	25.5	42.3	24.5	42.3	23.9	42.3	28.6	42.3	32.4
21	29.5	42.3	27.9	42.3	27.0	42.3	26.3	42.3	30.8	42.3	32.4
22	26.5	42.3	25.0	42.3	24.1	42.3	23.5	42.3	27.7	42.3	32.4
23	25.3	42.3	23.8	42.3	23.0	42.3	22.4	42.3	26.5	42.3	32.4
24	24.7	42.3	23.4	42.3	22.6	42.3	22.0	42.3	25.9	42.3	32.4
25	24.6	42.3	23.3	42.3	22.5	42.3	22.0	42.3	25.7	42.3	32.4
26	25.2	42.3	23.9	42.3	23.2	42.3	22.7	42.3	26.2	42.3	32.4
27	27.5	42.3	26.3	42.3	25.6	42.3	25.1	42.3	28.4	42.3	32.4
28	24.3	42.3	23.2	42.3	22.5	42.3	22.1	42.3	25.3	42.3	32.4
29	22.9	42.3	21.9	42.3	21.2	42.3	20.8	42.3	23.8	42.3	32.4
30	22.1	42.3	21.1	42.3	20.5	42.3	20.1	42.3	23.0	42.3	32.4
31	21.6	42.3	20.5	42.3	19.9	42.3	19.5	42.3	22.4	42.3	32.4
32	21.1	42.3	20.2	42.3	19.6	42.3	19.2	42.3	21.9	42.3	32.4
33	20.8	42.3	19.9	42.3	19.3	42.3	19.0	42.3	21.6	42.3	32.4
34	20.6	42.3	19.7	42.3	19.2	42.3	18.8	42.3	21.4	42.3	32.4
35	20.5	42.3	19.6	42.3	19.1	42.3	18.7	42.3	21.2	42.3	32.4
36	20.4	42.3	19.6	42.3	19.1	42.3	18.7	42.3	21.1	42.3	32.4

Figure 7.2: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 36 ft. One Railing with Edge Loading E1 (LEFT)

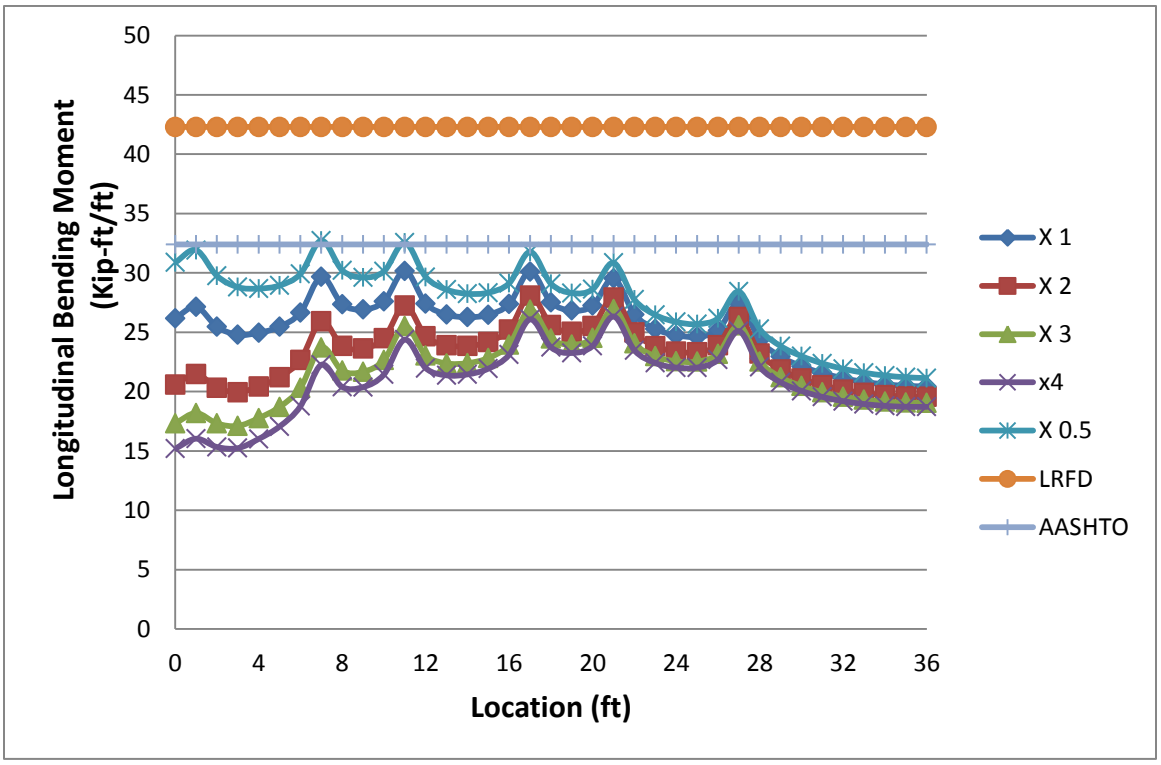

Table 7.3: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 36 ft, One Railing with Edge Loading E1 (RIGHT)

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	38.2	42.3	37.6	42.3	37.3	42.3	37.1	42.3	38.6	42.3	32.4
1	39.5	42.3	38.9	42.3	38.5	42.3	38.3	42.3	39.9	42.3	32.4
2	35.7	42.3	35.2	42.3	34.8	42.3	34.6	42.3	36.2	42.3	32.4
3	34.1	42.3	33.5	42.3	33.2	42.3	32.9	42.3	34.6	42.3	32.4
4	33.4	42.3	32.7	42.3	32.4	42.3	32.1	42.3	33.9	42.3	32.4
5	33.1	42.3	32.5	42.3	32.1	42.3	31.8	42.3	33.7	42.3	32.4
6	33.6	42.3	33.0	42.3	32.6	42.3	32.3	42.3	34.2	42.3	32.4
7	36.0	42.3	35.3	42.3	34.9	42.3	34.6	42.3	36.6	42.3	32.4
8	33.1	42.3	32.4	42.3	32.0	42.3	31.7	42.3	33.7	42.3	32.4
9	32.2	42.3	31.4	42.3	31.0	42.3	30.7	42.3	32.8	42.3	32.4
10	32.4	42.3	31.6	42.3	31.1	42.3	30.8	42.3	33.0	42.3	32.4
11	34.5	42.3	33.6	42.3	33.1	42.3	32.8	42.3	35.1	42.3	32.4
12	31.2	42.3	30.4	42.3	29.8	42.3	29.5	42.3	32.0	42.3	32.4
13	29.9	42.3	28.9	42.3	28.4	42.3	28.0	42.3	30.6	42.3	32.4
14	29.2	42.3	28.3	42.3	27.7	42.3	27.3	42.3	30.0	42.3	32.4
15	29.0	42.3	28.0	42.3	27.4	42.3	27.0	42.3	29.9	42.3	32.4
16	29.5	42.3	28.4	42.3	27.8	42.3	27.4	42.3	30.4	42.3	32.4
17	31.9	42.3	30.7	42.3	30.0	42.3	29.6	42.3	32.8	42.3	32.4
18	28.9	42.3	27.7	42.3	26.9	42.3	26.5	42.3	29.9	42.3	32.4
19	27.8	42.3	26.5	42.3	25.8	42.3	25.2	42.3	28.9	42.3	32.4
20	27.9	42.3	26.5	42.3	25.7	42.3	25.1	42.3	29.0	42.3	32.4
21	29.8	42.3	28.3	42.3	27.5	42.3	26.9	42.3	31.0	42.3	32.4
22	26.4	42.3	24.8	42.3	23.9	42.3	23.3	42.3	27.7	42.3	32.4
23	24.8	42.3	23.2	42.3	22.2	42.3	21.5	42.3	26.2	42.3	32.4
24	23.9	42.3	22.2	42.3	21.1	42.3	20.4	42.3	25.4	42.3	32.4
25	23.4	42.3	21.5	42.3	20.4	42.3	19.7	42.3	25.0	42.3	32.4
26	23.6	42.3	21.6	42.3	20.4	42.3	19.6	42.3	25.2	42.3	32.4
27	25.5	42.3	23.4	42.3	22.1	42.3	21.3	42.3	27.2	42.3	32.4
28	22.0	42.3	19.8	42.3	18.4	42.3	17.5	42.3	23.9	42.3	32.4
29	20.2	42.3	17.8	42.3	16.4	42.3	15.5	42.3	22.2	42.3	32.4
30	19.0	42.3	16.5	42.3	15.0	42.3	14.0	42.3	21.1	42.3	32.4
31	18.0	42.3	15.3	42.3	13.7	42.3	12.7	42.3	20.2	42.3	32.4
32	17.2	42.3	14.3	42.3	12.6	42.3	11.5	42.3	19.5	42.3	32.4
33	16.4	42.3	13.4	42.3	11.6	42.3	10.4	42.3	18.9	42.3	32.4
34	15.8	42.3	12.6	42.3	10.7	42.3	9.4	42.3	18.4	42.3	32.4
35	15.1	42.3	11.6	42.3	9.5	42.3	8.2	42.3	17.9	42.3	32.4
36	15.0	42.3	11.6	42.3	9.5	42.3	8.2	42.3	17.9	42.3	32.4

Figure 7.3: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 36 ft, One Railing with Edge Loading E1 (RIGHT)

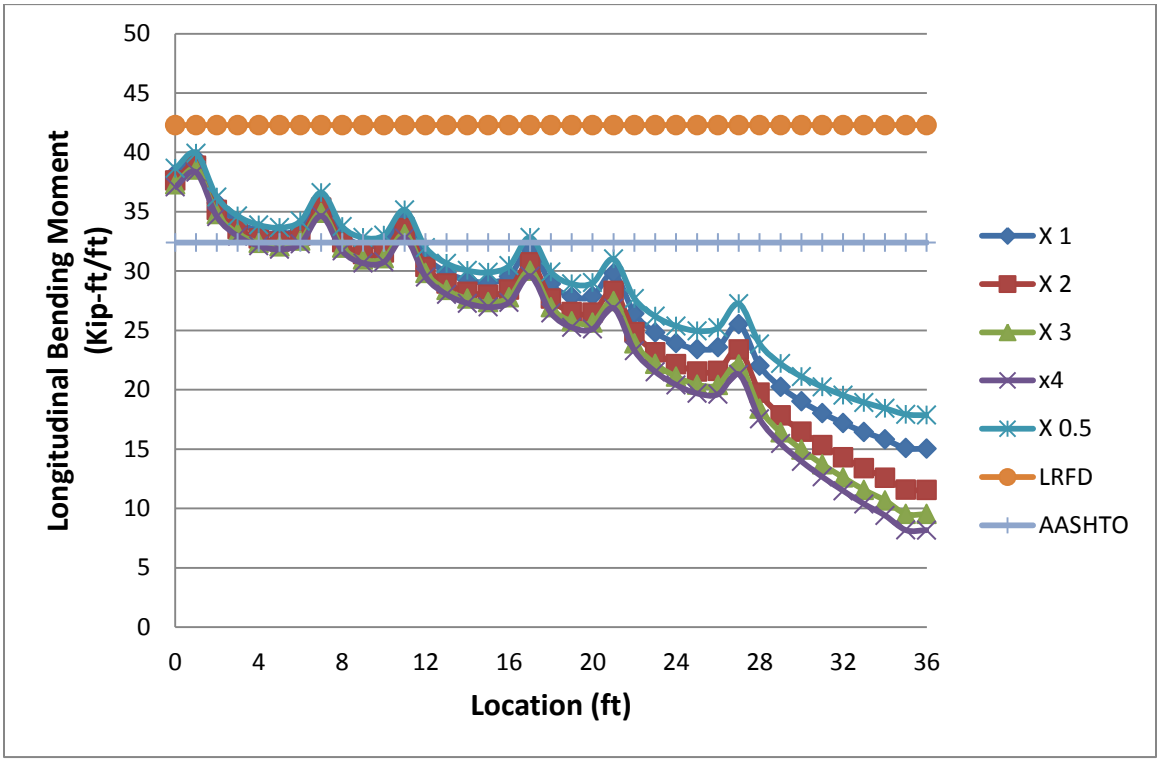

Table 7.4: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 36ft. Two Railings with Edge Loading E1

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	25.5	42.3	19.8	42.3	16.6	42.3	14.5	42.3	30.3	42.3	32.4
1	26.4	42.3	20.7	42.3	17.4	42.3	15.3	42.3	31.4	42.3	32.4
2	24.7	42.3	19.4	42.3	16.4	42.3	14.4	42.3	29.2	42.3	32.4
3	23.9	42.3	18.9	42.3	16.1	42.3	14.2	42.3	28.2	42.3	32.4
4	24.0	42.3	19.3	42.3	16.6	42.3	14.9	42.3	28.0	42.3	32.4
5	24.5	42.3	20.0	42.3	17.4	42.3	15.8	42.3	28.3	42.3	32.4
6	25.6	42.3	21.4	42.3	18.9	42.3	17.3	42.3	29.2	42.3	32.4
7	28.6	42.3	24.5	42.3	22.2	42.3	20.7	42.3	32.0	42.3	32.4
8	26.2	42.3	22.3	42.3	20.1	42.3	18.7	42.3	29.4	42.3	32.4
9	25.7	42.3	22.0	42.3	19.9	42.3	18.5	42.3	28.8	42.3	32.4
10	26.3	42.3	22.7	42.3	20.7	42.3	19.4	42.3	29.3	42.3	32.4
11	28.8	42.3	25.4	42.3	23.4	42.3	22.1	42.3	31.6	42.3	32.4
12	25.9	42.3	22.6	42.3	20.8	42.3	19.5	42.3	28.7	42.3	32.4
13	24.9	42.3	21.7	42.3	19.9	42.3	18.7	42.3	27.5	42.3	32.4
14	24.6	42.3	21.5	42.3	19.7	42.3	18.6	42.3	27.1	42.3	32.4
15	24.6	42.3	21.7	42.3	20.0	42.3	18.9	42.3	27.2	42.3	32.4
16	25.4	42.3	22.5	42.3	20.9	42.3	19.8	42.3	27.9	42.3	32.4
17	28.0	42.3	25.2	42.3	23.6	42.3	22.5	42.3	30.4	42.3	32.4
18	25.3	42.3	22.5	42.3	20.9	42.3	19.9	42.3	27.7	42.3	32.4
19	24.5	42.3	21.7	42.3	20.2	42.3	19.2	42.3	26.8	42.3	32.4
20	24.7	42.3	22.0	42.3	20.4	42.3	19.5	42.3	27.0	42.3	32.4
21	26.8	42.3	24.1	42.3	22.6	42.3	21.6	42.3	29.1	42.3	32.4
22	23.6	42.3	20.9	42.3	19.4	42.3	18.4	42.3	25.9	42.3	32.4
23	22.2	42.3	19.5	42.3	18.0	42.3	17.0	42.3	24.5	42.3	32.4
24	21.5	42.3	18.8	42.3	17.2	42.3	16.2	42.3	23.8	42.3	32.4
25	21.1	42.3	18.4	42.3	16.8	42.3	15.8	42.3	23.5	42.3	32.4
26	21.4	42.3	18.7	42.3	17.1	42.3	16.1	42.3	23.8	42.3	32.4
27	23.5	42.3	20.7	42.3	19.1	42.3	18.1	42.3	25.9	42.3	32.4
28	20.1	42.3	17.2	42.3	15.6	42.3	14.6	42.3	22.6	42.3	32.4
29	18.5	42.3	15.5	42.3	13.8	42.3	12.8	42.3	21.0	42.3	32.4
30	17.4	42.3	14.3	42.3	12.6	42.3	11.5	42.3	20.0	42.3	32.4
31	16.5	42.3	13.3	42.3	11.6	42.3	10.4	42.3	19.2	42.3	32.4
32	15.7	42.3	12.5	42.3	10.7	42.3	9.5	42.3	18.5	42.3	32.4
33	15.1	42.3	11.7	42.3	9.8	42.3	8.6	42.3	18.0	42.3	32.4
34	14.5	42.3	11.0	42.3	9.1	42.3	7.9	42.3	17.5	42.3	32.4
35	13.9	42.3	10.2	42.3	8.2	42.3	6.9	42.3	17.1	42.3	32.4
36	13.9	42.3	10.3	42.3	8.2	42.3	7.0	42.3	17.0	42.3	32.4

Figure 7.4: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 36ft. Two Railings with Edge Loading E1

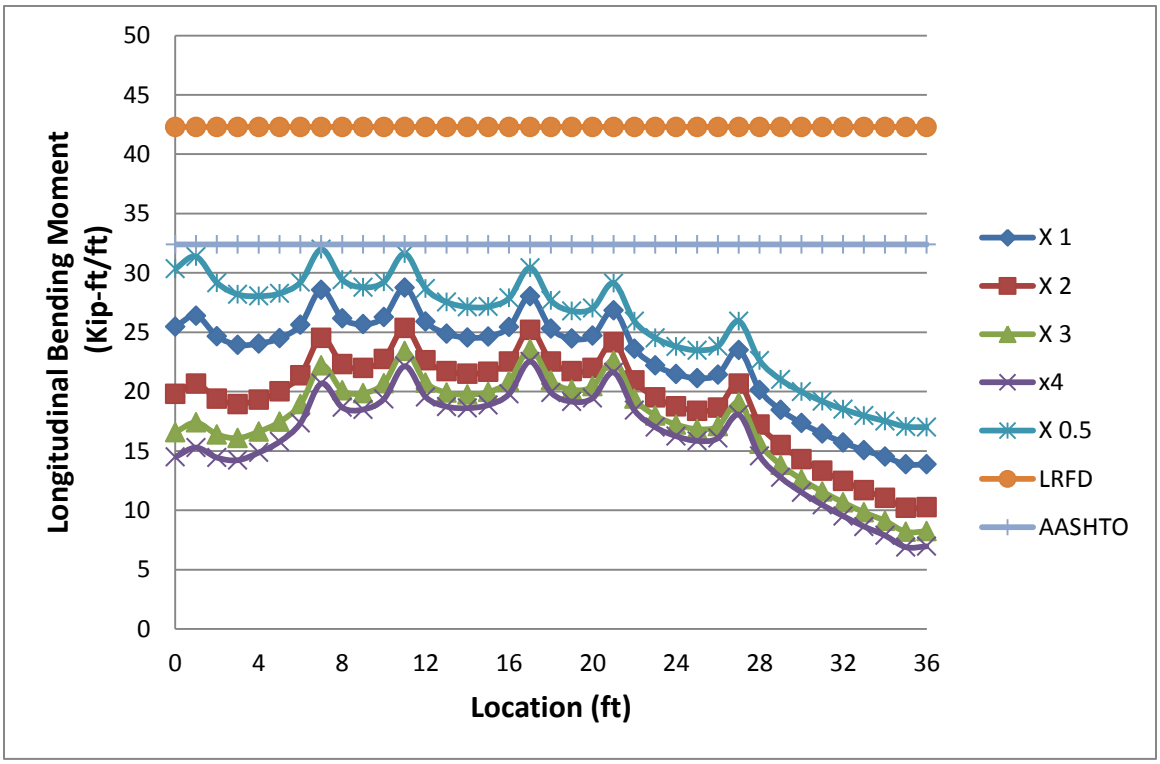

Table 8.1: Longitudinal Moment Distribution at Critical Section for Four-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 48 ft, No Railings with Edge Loading E1

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	40.7	40.0	40.7	40.0	40.7	40.0	40.7	40.0	40.7	40.0	32.4
1	42.1	40.0	42.1	40.0	42.1	40.0	42.1	40.0	42.1	40.0	32.4
2	38.4	40.0	38.4	40.0	38.4	40.0	38.4	40.0	38.4	40.0	32.4
3	36.9	40.0	36.9	40.0	36.9	40.0	36.9	40.0	36.9	40.0	32.4
4	36.2	40.0	36.2	40.0	36.2	40.0	36.2	40.0	36.2	40.0	32.4
5	36.0	40.0	36.0	40.0	36.0	40.0	36.0	40.0	36.0	40.0	32.4
6	36.6	40.0	36.6	40.0	36.6	40.0	36.6	40.0	36.6	40.0	32.4
7	39.1	40.0	39.1	40.0	39.1	40.0	39.1	40.0	39.1	40.0	32.4
8	36.3	40.0	36.3	40.0	36.3	40.0	36.3	40.0	36.3	40.0	32.4
9	35.5	40.0	35.5	40.0	35.5	40.0	35.5	40.0	35.5	40.0	32.4
10	35.8	40.0	35.8	40.0	35.8	40.0	35.8	40.0	35.8	40.0	32.4
11	38.0	40.0	38.0	40.0	38.0	40.0	38.0	40.0	38.0	40.0	32.4
12	34.9	40.0	34.9	40.0	34.9	40.0	34.9	40.0	34.9	40.0	32.4
13	33.7	40.0	33.7	40.0	33.7	40.0	33.7	40.0	33.7	40.0	32.4
14	33.3	40.0	33.3	40.0	33.3	40.0	33.3	40.0	33.3	40.0	32.4
15	33.2	40.0	33.2	40.0	33.2	40.0	33.2	40.0	33.2	40.0	32.4
16	34.0	40.0	34.0	40.0	34.0	40.0	34.0	40.0	34.0	40.0	32.4
17	36.5	40.0	36.5	40.0	36.5	40.0	36.5	40.0	36.5	40.0	32.4
18	33.8	40.0	33.8	40.0	33.8	40.0	33.8	40.0	33.8	40.0	32.4
19	32.9	40.0	32.9	40.0	32.9	40.0	32.9	40.0	32.9	40.0	32.4
20	33.2	40.0	33.2	40.0	33.2	40.0	33.2	40.0	33.2	40.0	32.4
21	35.4	40.0	35.4	40.0	35.4	40.0	35.4	40.0	35.4	40.0	32.4
22	32.4	40.0	32.4	40.0	32.4	40.0	32.4	40.0	32.4	40.0	32.4
23	31.1	40.0	31.1	40.0	31.1	40.0	31.1	40.0	31.1	40.0	32.4
24	30.6	40.0	30.6	40.0	30.6	40.0	30.6	40.0	30.6	40.0	32.4
25	30.5	40.0	30.5	40.0	30.5	40.0	30.5	40.0	30.5	40.0	32.4
26	31.1	40.0	31.1	40.0	31.1	40.0	31.1	40.0	31.1	40.0	32.4
27	33.5	40.0	33.5	40.0	33.5	40.0	33.5	40.0	33.5	40.0	32.4
28	30.7	40.0	30.7	40.0	30.7	40.0	30.7	40.0	30.7	40.0	32.4
29	29.7	40.0	29.7	40.0	29.7	40.0	29.7	40.0	29.7	40.0	32.4
30	29.9	40.0	29.9	40.0	29.9	40.0	29.9	40.0	29.9	40.0	32.4
31	31.9	40.0	31.9	40.0	31.9	40.0	31.9	40.0	31.9	40.0	32.4
32	28.7	40.0	28.7	40.0	28.7	40.0	28.7	40.0	28.7	40.0	32.4
33	27.2	40.0	27.2	40.0	27.2	40.0	27.2	40.0	27.2	40.0	32.4
34	26.5	40.0	26.5	40.0	26.5	40.0	26.5	40.0	26.5	40.0	32.4
35	26.1	40.0	26.1	40.0	26.1	40.0	26.1	40.0	26.1	40.0	32.4
36	26.5	40.0	26.5	40.0	26.5	40.0	26.5	40.0	26.5	40.0	32.4
37	28.6	40.0	28.6	40.0	28.6	40.0	28.6	40.0	28.6	40.0	32.4
38	25.2	40.0	25.2	40.0	25.2	40.0	25.2	40.0	25.2	40.0	32.4

39	23.7	40.0	23.7	40.0	23.7	40.0	23.7	40.0	23.7	40.0	32.4
40	22.7	40.0	22.7	40.0	22.7	40.0	22.7	40.0	22.7	40.0	32.4
41	21.9	40.0	21.9	40.0	21.9	40.0	21.9	40.0	21.9	40.0	32.4
42	21.3	40.0	21.3	40.0	21.3	40.0	21.3	40.0	21.3	40.0	32.4
43	20.8	40.0	20.8	40.0	20.8	40.0	20.8	40.0	20.8	40.0	32.4
44	20.4	40.0	20.4	40.0	20.4	40.0	20.4	40.0	20.4	40.0	32.4
45	20.1	40.0	20.1	40.0	20.1	40.0	20.1	40.0	20.1	40.0	32.4
46	19.8	40.0	19.8	40.0	19.8	40.0	19.8	40.0	19.8	40.0	32.4
47	19.6	40.0	19.6	40.0	19.6	40.0	19.6	40.0	19.6	40.0	32.4
48	19.5	40.0	19.5	40.0	19.5	40.0	19.5	40.0	19.5	40.0	32.4

Figure 8.1: Longitudinal Moment Distribution at Critical Section for Four-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 48ft, No Railings with Edge Loading E1

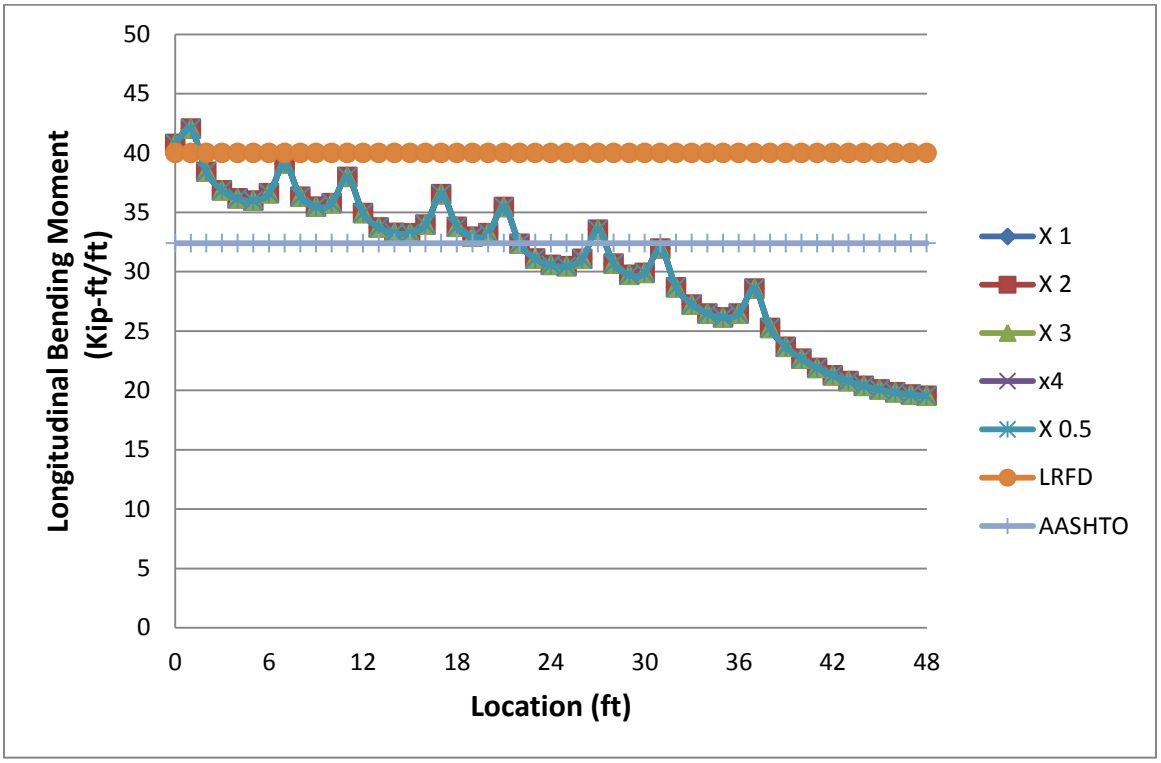

Table 8.2: Longitudinal Moment Distribution at Critical Section for Four-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 48 ft. One Railing with Edge Loading E1 (LEFT)

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	27.2	40.0	21.4	40.0	18.0	40.0	15.8	40.0	32.1	40.0	32.4
1	28.2	40.0	22.3	40.0	18.9	40.0	16.7	40.0	33.1	40.0	32.4
2	26.6	40.0	21.3	40.0	18.1	40.0	16.1	40.0	31.0	40.0	32.4
3	26.0	40.0	20.9	40.0	18.0	40.0	16.1	40.0	30.1	40.0	32.4
4	26.2	40.0	21.5	40.0	18.7	40.0	16.9	40.0	30.0	40.0	32.4
5	26.7	40.0	22.4	40.0	19.8	40.0	18.1	40.0	30.3	40.0	32.4
6	28.0	40.0	23.9	40.0	21.5	40.0	19.9	40.0	31.4	40.0	32.4
7	31.1	40.0	27.2	40.0	25.0	40.0	23.4	40.0	34.2	40.0	32.4
8	28.8	40.0	25.2	40.0	23.1	40.0	21.7	40.0	31.8	40.0	32.4
9	28.5	40.0	25.1	40.0	23.1	40.0	21.8	40.0	31.2	40.0	32.4
10	29.2	40.0	26.1	40.0	24.2	40.0	22.9	40.0	31.8	40.0	32.4
11	31.9	40.0	28.9	40.0	27.1	40.0	26.0	40.0	34.3	40.0	32.4
12	29.2	40.0	26.4	40.0	24.8	40.0	23.7	40.0	31.5	40.0	32.4
13	28.4	40.0	25.8	40.0	24.2	40.0	23.2	40.0	30.5	40.0	32.4
14	28.3	40.0	25.8	40.0	24.4	40.0	23.4	40.0	30.2	40.0	32.4
15	28.6	40.0	26.3	40.0	24.9	40.0	24.0	40.0	30.4	40.0	32.4
16	29.6	40.0	27.4	40.0	26.1	40.0	25.3	40.0	31.3	40.0	32.4
17	32.4	40.0	30.4	40.0	29.2	40.0	28.4	40.0	34.0	40.0	32.4
18	29.9	40.0	28.0	40.0	26.9	40.0	26.2	40.0	31.5	40.0	32.4
19	29.4	40.0	27.6	40.0	26.5	40.0	25.9	40.0	30.8	40.0	32.4
20	29.9	40.0	28.2	40.0	27.2	40.0	26.6	40.0	31.2	40.0	32.4
21	32.3	40.0	30.8	40.0	29.8	40.0	29.2	40.0	33.5	40.0	32.4
22	29.4	40.0	28.0	40.0	27.1	40.0	26.5	40.0	30.6	40.0	32.4
23	28.3	40.0	27.0	40.0	26.2	40.0	25.7	40.0	29.4	40.0	32.4
24	28.0	40.0	26.7	40.0	26.0	40.0	25.5	40.0	29.0	40.0	32.4
25	28.0	40.0	26.9	40.0	26.2	40.0	25.7	40.0	29.0	40.0	32.4
26	28.8	40.0	27.7	40.0	27.0	40.0	26.6	40.0	29.7	40.0	32.4
27	31.4	40.0	30.4	40.0	29.7	40.0	29.3	40.0	32.3	40.0	32.4
28	28.7	40.0	27.7	40.0	27.1	40.0	26.7	40.0	29.5	40.0	32.4
29	27.9	40.0	26.9	40.0	26.4	40.0	26.0	40.0	28.6	40.0	32.4
30	28.1	40.0	27.3	40.0	26.7	40.0	26.4	40.0	28.8	40.0	32.4
31	30.3	40.0	29.5	40.0	29.0	40.0	28.7	40.0	30.9	40.0	32.4
32	27.1	40.0	26.4	40.0	25.9	40.0	25.6	40.0	27.7	40.0	32.4
33	25.8	40.0	25.0	40.0	24.6	40.0	24.3	40.0	26.3	40.0	32.4
34	25.1	40.0	24.4	40.0	24.0	40.0	23.7	40.0	25.6	40.0	32.4
35	24.8	40.0	24.2	40.0	23.8	40.0	23.6	40.0	25.3	40.0	32.4
36	25.2	40.0	24.6	40.0	24.3	40.0	24.0	40.0	25.7	40.0	32.4
37	27.4	40.0	26.8	40.0	26.5	40.0	26.3	40.0	27.9	40.0	32.4
38	24.1	40.0	23.6	40.0	23.3	40.0	23.1	40.0	24.6	40.0	32.4

39	22.6	40.0	22.1	40.0	21.8	40.0	21.6	40.0	23.0	40.0	32.4
40	21.7	40.0	21.2	40.0	20.9	40.0	20.7	40.0	22.1	40.0	32.4
41	20.9	40.0	20.5	40.0	20.2	40.0	20.0	40.0	21.3	40.0	32.4
42	20.4	40.0	19.9	40.0	19.6	40.0	19.5	40.0	20.7	40.0	32.4
43	19.9	40.0	19.5	40.0	19.2	40.0	19.0	40.0	20.2	40.0	32.4
44	19.5	40.0	19.1	40.0	18.9	40.0	18.7	40.0	19.9	40.0	32.4
45	19.2	40.0	18.8	40.0	18.6	40.0	18.4	40.0	19.6	40.0	32.4
46	19.0	40.0	18.6	40.0	18.4	40.0	18.3	40.0	19.3	40.0	32.4
47	18.9	40.0	18.5	40.0	18.3	40.0	18.1	40.0	19.2	40.0	32.4
48	18.8	40.0	18.4	40.0	18.2	40.0	18.1	40.0	19.1	40.0	32.4

Figure 8.2: Longitudinal Moment Distribution at Critical Section for Four-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 48 ft. One Railing with Edge Loading E1 (LEFT)

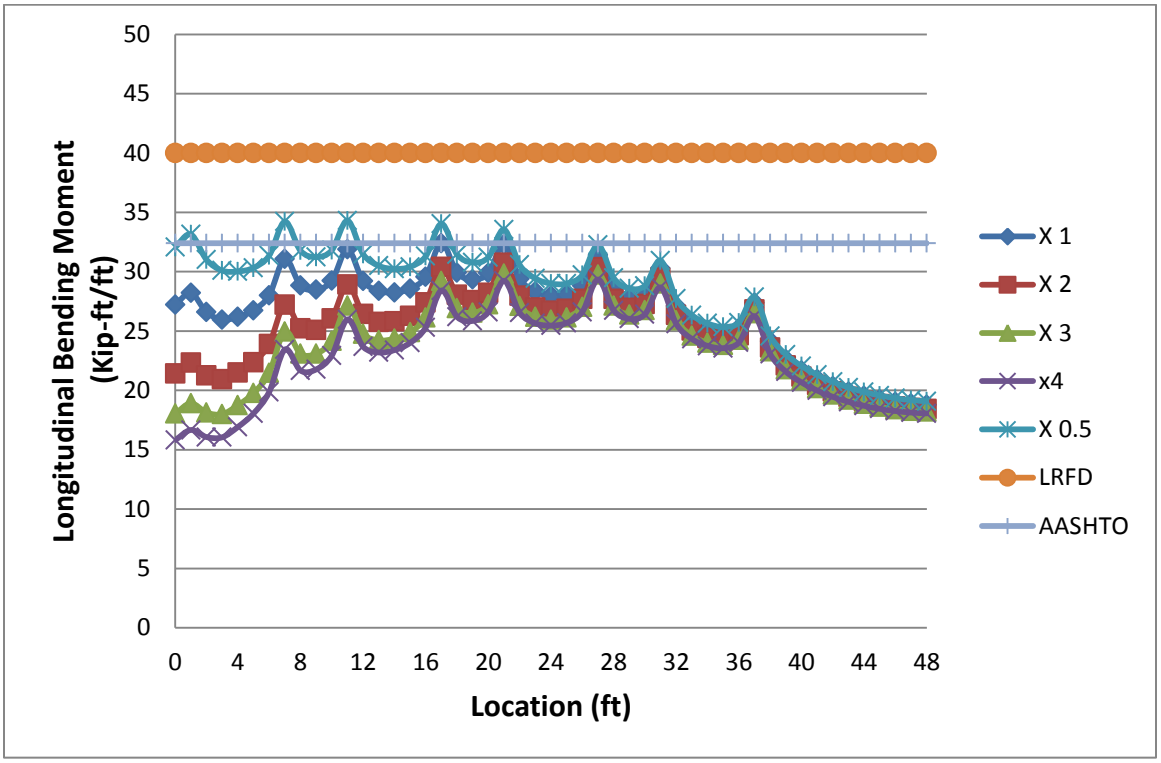

Table 8.3: Longitudinal Moment Distribution at Critical Section for Four-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 48ft, One Railing with Edge Loading E1 (RIGHT)

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	40.3	40.0	40.1	40.0	40.0	40.0	39.9	40.0	40.5	40.0	32.4
1	41.6	40.0	41.4	40.0	41.3	40.0	41.2	40.0	41.8	40.0	32.4
2	38.0	40.0	37.8	40.0	37.6	40.0	37.5	40.0	38.1	40.0	32.4
3	36.4	40.0	36.2	40.0	36.1	40.0	36.0	40.0	36.6	40.0	32.4
4	35.7	40.0	35.5	40.0	35.3	40.0	35.2	40.0	35.9	40.0	32.4
5	35.5	40.0	35.3	40.0	35.1	40.0	35.0	40.0	35.7	40.0	32.4
6	36.1	40.0	35.8	40.0	35.7	40.0	35.6	40.0	36.3	40.0	32.4
7	38.5	40.0	38.3	40.0	38.1	40.0	38.0	40.0	38.8	40.0	32.4
8	35.7	40.0	35.5	40.0	35.3	40.0	35.2	40.0	36.0	40.0	32.4
9	34.9	40.0	34.6	40.0	34.4	40.0	34.3	40.0	35.1	40.0	32.4
10	35.1	40.0	34.8	40.0	34.7	40.0	34.6	40.0	35.4	40.0	32.4
11	37.3	40.0	37.0	40.0	36.8	40.0	36.7	40.0	37.6	40.0	32.4
12	34.3	40.0	33.9	40.0	33.7	40.0	33.6	40.0	34.5	40.0	32.4
13	33.0	40.0	32.7	40.0	32.5	40.0	32.3	40.0	33.3	40.0	32.4
14	32.5	40.0	32.1	40.0	31.9	40.0	31.8	40.0	32.8	40.0	32.4
15	32.4	40.0	32.0	40.0	31.8	40.0	31.7	40.0	32.8	40.0	32.4
16	33.1	40.0	32.7	40.0	32.4	40.0	32.3	40.0	33.4	40.0	32.4
17	35.6	40.0	35.2	40.0	34.9	40.0	34.7	40.0	36.0	40.0	32.4
18	32.8	40.0	32.3	40.0	32.1	40.0	31.9	40.0	33.2	40.0	32.4
19	31.9	40.0	31.4	40.0	31.1	40.0	30.9	40.0	32.3	40.0	32.4
20	32.1	40.0	31.6	40.0	31.3	40.0	31.1	40.0	32.6	40.0	32.4
21	34.3	40.0	33.7	40.0	33.4	40.0	33.1	40.0	34.7	40.0	32.4
22	31.1	40.0	30.5	40.0	30.1	40.0	29.9	40.0	31.6	40.0	32.4
23	29.8	40.0	29.1	40.0	28.7	40.0	28.5	40.0	30.3	40.0	32.4
24	29.1	40.0	28.4	40.0	28.0	40.0	27.8	40.0	29.7	40.0	32.4
25	28.9	40.0	28.2	40.0	27.8	40.0	27.5	40.0	29.5	40.0	32.4
26	29.5	40.0	28.7	40.0	28.2	40.0	27.9	40.0	30.1	40.0	32.4
27	31.8	40.0	31.0	40.0	30.5	40.0	30.1	40.0	32.5	40.0	32.4
28	28.8	40.0	27.9	40.0	27.4	40.0	27.0	40.0	29.6	40.0	32.4
29	27.8	40.0	26.8	40.0	26.2	40.0	25.8	40.0	28.5	40.0	32.4
30	27.8	40.0	26.7	40.0	26.1	40.0	25.7	40.0	28.6	40.0	32.4
31	29.7	40.0	28.6	40.0	27.9	40.0	27.5	40.0	30.6	40.0	32.4
32	26.3	40.0	25.1	40.0	24.4	40.0	23.9	40.0	27.2	40.0	32.4
33	24.7	40.0	23.4	40.0	22.7	40.0	22.2	40.0	25.7	40.0	32.4
34	23.7	40.0	22.4	40.0	21.6	40.0	21.1	40.0	24.8	40.0	32.4
35	23.2	40.0	21.8	40.0	20.9	40.0	20.4	40.0	24.4	40.0	32.4
36	23.3	40.0	21.8	40.0	20.9	40.0	20.3	40.0	24.6	40.0	32.4
37	25.2	40.0	23.6	40.0	22.6	40.0	22.0	40.0	26.6	40.0	32.4
38	21.7	40.0	20.0	40.0	18.9	40.0	18.3	40.0	23.1	40.0	32.4

39	19.9	40.0	18.0	40.0	16.9	40.0	16.2	40.0	21.4	40.0	32.4
40	18.6	40.0	16.7	40.0	15.5	40.0	14.7	40.0	20.2	40.0	32.4
41	17.6	40.0	15.5	40.0	14.3	40.0	13.4	40.0	19.3	40.0	32.4
42	16.7	40.0	14.5	40.0	13.1	40.0	12.3	40.0	18.5	40.0	32.4
43	15.9	40.0	13.5	40.0	12.1	40.0	11.2	40.0	17.8	40.0	32.4
44	15.2	40.0	12.7	40.0	11.2	40.0	10.2	40.0	17.3	40.0	32.4
45	14.6	40.0	11.9	40.0	10.3	40.0	9.2	40.0	16.8	40.0	32.4
46	14.0	40.0	11.2	40.0	9.5	40.0	8.4	40.0	16.3	40.0	32.4
47	13.4	40.0	10.3	40.0	8.5	40.0	7.3	40.0	16.0	40.0	32.4
48	13.3	40.0	10.2	40.0	8.4	40.0	7.2	40.0	15.3	40.0	32.4

Figure 8.3: Longitudinal Moment Distribution at Critical Section for Four-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 48ft, One Railing with Edge Loading E1 (RIGHT)

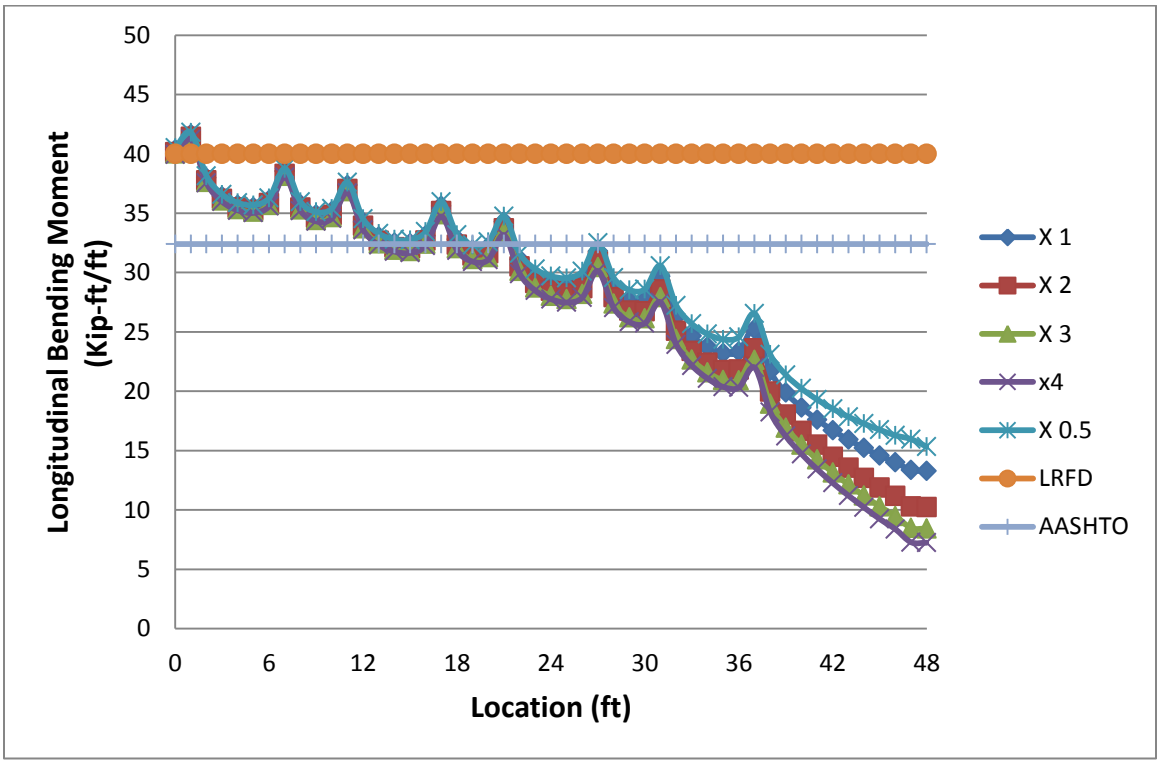

Table 8.4: Longitudinal Moment Distribution at Critical Section for Four-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 48ft. Two Railings with Edge Loading E1

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	27.0	40.0	21.1	40.0	17.7	40.0	15.5	40.0	31.9	40.0	32.4
1	27.9	40.0	22.0	40.0	18.6	40.0	16.4	40.0	32.9	40.0	32.4
2	26.3	40.0	20.9	40.0	17.8	40.0	15.7	40.0	30.8	40.0	32.4
3	25.6	40.0	20.6	40.0	17.6	40.0	15.6	40.0	29.9	40.0	32.4
4	25.8	40.0	21.1	40.0	18.3	40.0	16.5	40.0	29.8	40.0	32.4
5	26.4	40.0	21.9	40.0	19.3	40.0	17.5	40.0	30.1	40.0	32.4
6	27.6	40.0	23.4	40.0	20.9	40.0	19.3	40.0	31.1	40.0	32.4
7	30.7	40.0	26.7	40.0	24.3	40.0	22.8	40.0	33.9	40.0	32.4
8	28.4	40.0	24.6	40.0	22.4	40.0	21.0	40.0	31.5	40.0	32.4
9	28.0	40.0	24.4	40.0	22.4	40.0	21.0	40.0	30.9	40.0	32.4
10	28.7	40.0	25.4	40.0	23.4	40.0	22.1	40.0	31.5	40.0	32.4
11	31.3	40.0	28.2	40.0	26.3	40.0	25.1	40.0	33.9	40.0	32.4
12	28.6	40.0	25.6	40.0	23.8	40.0	22.7	40.0	31.1	40.0	32.4
13	27.8	40.0	24.9	40.0	23.2	40.0	22.1	40.0	30.1	40.0	32.4
14	27.6	40.0	24.9	40.0	23.3	40.0	22.2	40.0	29.8	40.0	32.4
15	27.8	40.0	25.2	40.0	23.7	40.0	22.7	40.0	30.0	40.0	32.4
16	28.8	40.0	26.3	40.0	24.9	40.0	23.9	40.0	30.8	40.0	32.4
17	31.6	40.0	29.2	40.0	27.8	40.0	26.9	40.0	33.5	40.0	32.4
18	29.0	40.0	26.8	40.0	25.5	40.0	24.6	40.0	30.9	40.0	32.4
19	28.4	40.0	26.2	40.0	25.0	40.0	24.1	40.0	30.2	40.0	32.4
20	28.9	40.0	26.8	40.0	25.5	40.0	24.7	40.0	30.6	40.0	32.4
21	31.2	40.0	29.2	40.0	28.0	40.0	27.2	40.0	32.9	40.0	32.4
22	28.2	40.0	26.3	40.0	25.1	40.0	24.4	40.0	29.9	40.0	32.4
23	27.1	40.0	25.2	40.0	24.1	40.0	23.3	40.0	28.7	40.0	32.4
24	26.6	40.0	24.8	40.0	23.7	40.0	23.0	40.0	28.2	40.0	32.4
25	26.6	40.0	24.8	40.0	23.7	40.0	23.0	40.0	28.1	40.0	32.4
26	27.3	40.0	25.5	40.0	24.4	40.0	23.7	40.0	28.8	40.0	32.4
27	29.8	40.0	28.0	40.0	27.0	40.0	26.3	40.0	31.2	40.0	32.4
28	26.9	40.0	25.2	40.0	24.1	40.0	23.5	40.0	28.4	40.0	32.4
29	26.0	40.0	24.2	40.0	23.2	40.0	22.5	40.0	27.4	40.0	32.4
30	26.1	40.0	24.3	40.0	23.3	40.0	22.6	40.0	27.6	40.0	32.4
31	28.1	40.0	26.3	40.0	25.3	40.0	24.6	40.0	29.6	40.0	32.4
32	24.8	40.0	23.0	40.0	22.0	40.0	21.3	40.0	26.3	40.0	32.4
33	23.3	40.0	21.5	40.0	20.4	40.0	19.7	40.0	24.8	40.0	32.4
34	22.5	40.0	20.6	40.0	19.5	40.0	18.8	40.0	24.0	40.0	32.4
35	22.0	40.0	20.1	40.0	19.0	40.0	18.3	40.0	23.6	40.0	32.4
36	22.2	40.0	20.3	40.0	19.1	40.0	18.4	40.0	23.9	40.0	32.4
37	24.2	40.0	22.2	40.0	21.0	40.0	20.2	40.0	25.9	40.0	32.4
38	20.7	40.0	18.6	40.0	17.4	40.0	16.6	40.0	22.5	40.0	32.4

39	19.0	40.0	16.8	40.0	15.5	40.0	14.7	40.0	20.8	40.0	32.4
40	17.8	40.0	15.5	40.0	14.2	40.0	13.4	40.0	19.7	40.0	32.4
41	16.8	40.0	14.4	40.0	13.1	40.0	12.2	40.0	18.8	40.0	32.4
42	16.0	40.0	13.5	40.0	12.1	40.0	11.2	40.0	18.0	40.0	32.4
43	15.2	40.0	12.7	40.0	11.2	40.0	10.2	40.0	17.4	40.0	32.4
44	14.6	40.0	11.9	40.0	10.3	40.0	9.3	40.0	16.8	40.0	32.4
45	14.0	40.0	11.1	40.0	9.5	40.0	8.5	40.0	16.3	40.0	32.4
46	13.4	40.0	10.5	40.0	8.8	40.0	7.7	40.0	15.9	40.0	32.4
47	12.8	40.0	9.7	40.0	7.9	40.0	6.7	40.0	15.5	40.0	32.4
48	12.8	40.0	9.7	40.0	7.9	40.0	6.7	40.0	15.4	40.0	32.4

Figure 8.4: Longitudinal Moment Distribution at Critical Section for Four-Lane Single Span Bridge Deck Span = 36 ft, Deck Width = 48ft. Two Railings with Edge Loading E1

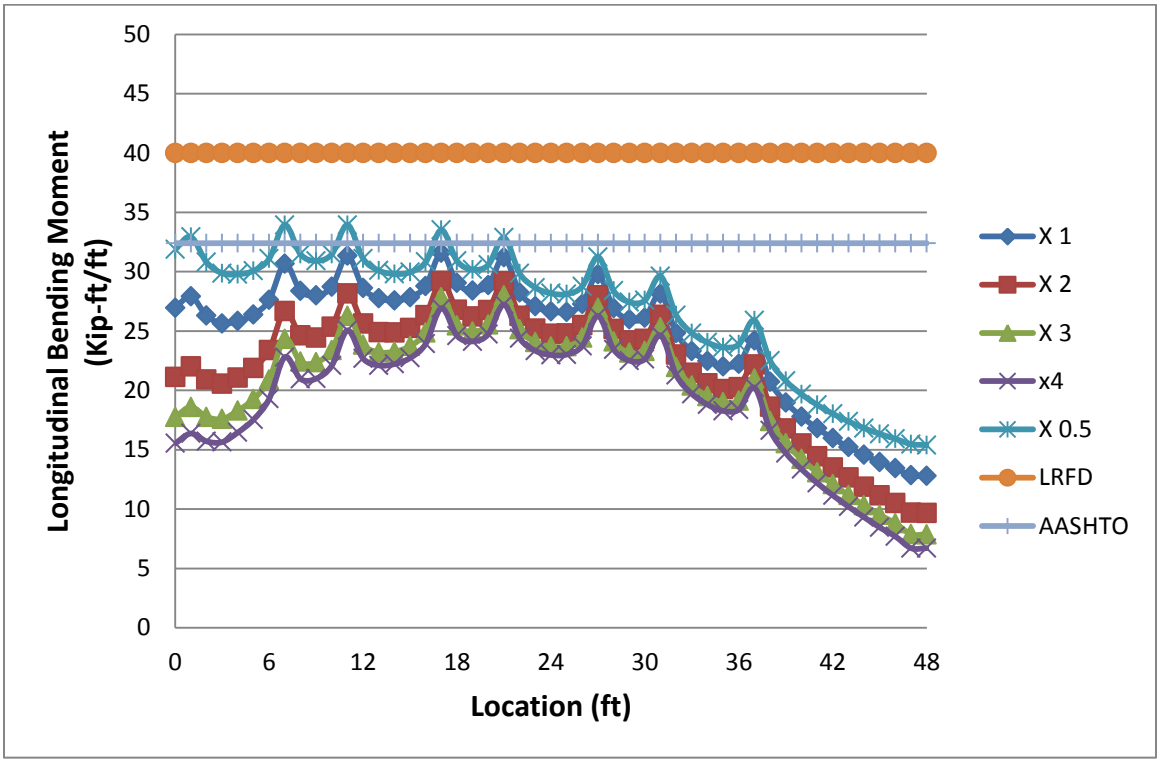

Table 9.1: Longitudinal Moment Distribution at Critical Section for One-Lane Single Span Bridge Deck Span = 46 ft, Deck Width = 14 ft, No Railings with Edge Loading E1

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	44.2	62.9	44.2	62.9	44.2	62.9	44.2	62.9	44.2	62.9	41.4
1	45.6	62.9	45.6	62.9	45.6	62.9	45.6	62.9	45.6	62.9	41.4
2	41.9	62.9	41.9	62.9	41.9	62.9	41.9	62.9	41.9	62.9	41.4
3	40.4	62.9	40.4	62.9	40.4	62.9	40.4	62.9	40.4	62.9	41.4
4	39.6	62.9	39.6	62.9	39.6	62.9	39.6	62.9	39.6	62.9	41.4
5	39.3	62.9	39.3	62.9	39.3	62.9	39.3	62.9	39.3	62.9	41.4
6	39.7	62.9	39.7	62.9	39.7	62.9	39.7	62.9	39.7	62.9	41.4
7	42.0	62.9	42.0	62.9	42.0	62.9	42.0	62.9	42.0	62.9	41.4
8	38.8	62.9	38.8	62.9	38.8	62.9	38.8	62.9	38.8	62.9	41.4
9	37.4	62.9	37.4	62.9	37.4	62.9	37.4	62.9	37.4	62.9	41.4
10	36.6	62.9	36.6	62.9	36.6	62.9	36.6	62.9	36.6	62.9	41.4
11	36.0	62.9	36.0	62.9	36.0	62.9	36.0	62.9	36.0	62.9	41.4
12	35.6	62.9	35.6	62.9	35.6	62.9	35.6	62.9	35.6	62.9	41.4
13	35.4	62.9	35.4	62.9	35.4	62.9	35.4	62.9	35.4	62.9	41.4
14	35.2	62.9	35.2	62.9	35.2	62.9	35.2	62.9	35.2	62.9	41.4

Figure 9.1: Longitudinal Moment Distribution at Critical Section for One-Lane Single Span Bridge Deck Span = 46 ft, Deck Width = 14 ft, No Railings with Edge Loading E1

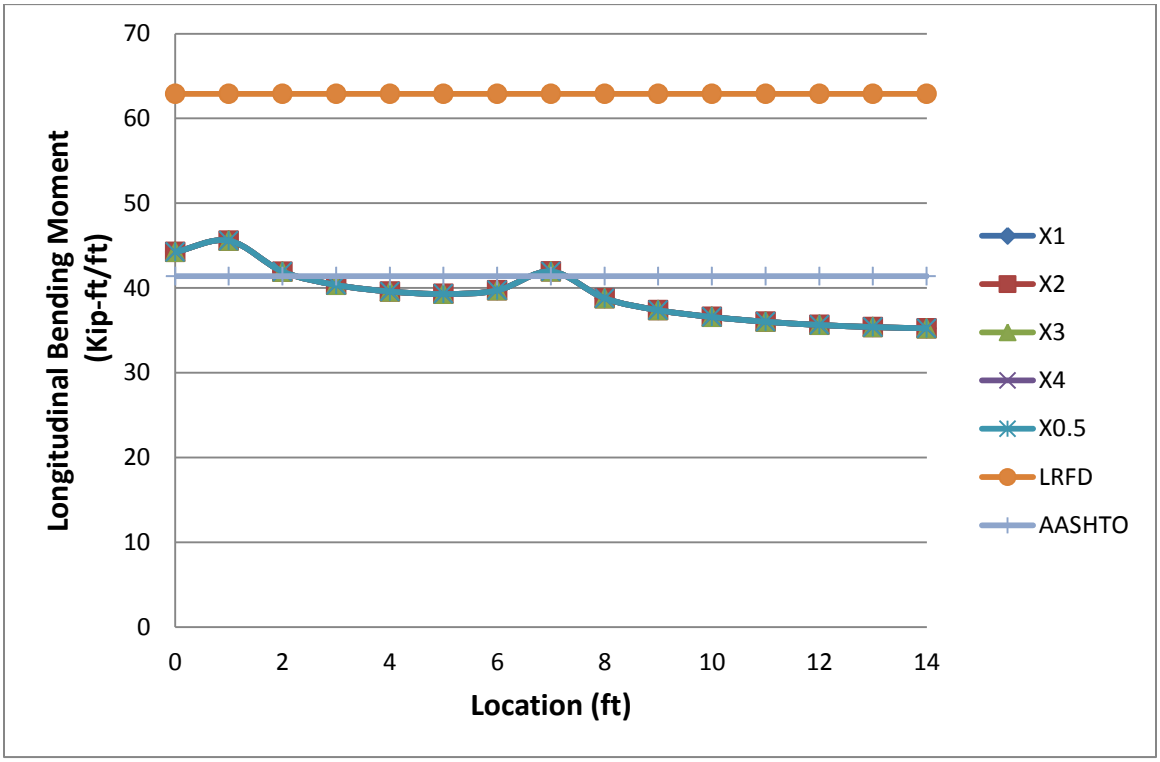

Table 9.2: Longitudinal Moment Distribution at Critical Section for One-Lane Single Span Bridge Deck Span = 46 ft, Deck Width = 14 ft, One Railing with Edge Loading E1 (LEFT)

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	30.9	62.9	24.6	62.9	20.6	62.9	18.0	62.9	36.0	62.9	41.4
1	31.8	62.9	25.3	62.9	21.4	62.9	18.7	62.9	37.0	62.9	41.4
2	29.7	62.9	23.6	62.9	19.8	62.9	17.3	62.9	34.5	62.9	41.4
3	28.7	62.9	22.7	62.9	19.1	62.9	16.6	62.9	33.3	62.9	41.4
4	28.5	62.9	22.7	62.9	19.1	62.9	16.7	62.9	32.9	62.9	41.4
5	28.6	62.9	23.0	62.9	19.5	62.9	17.1	62.9	32.9	62.9	41.4
6	29.3	62.9	23.9	62.9	20.5	62.9	18.2	62.9	33.5	62.9	41.4
7	31.8	62.9	26.5	62.9	23.2	62.9	20.9	62.9	36.0	62.9	41.4
8	28.9	62.9	23.7	62.9	20.4	62.9	18.2	62.9	32.9	62.9	41.4
9	27.7	62.9	22.5	62.9	19.3	62.9	17.2	62.9	31.7	62.9	41.4
10	27.0	62.9	22.0	62.9	18.8	62.9	16.7	62.9	31.0	62.9	41.4
11	26.6	62.9	21.6	62.9	18.5	62.9	16.4	62.9	30.5	62.9	41.4
12	26.4	62.9	21.4	62.9	18.4	62.9	16.3	62.9	30.2	62.9	41.4
13	26.2	62.9	21.3	62.9	18.3	62.9	16.2	62.9	30.0	62.9	41.4
14	26.2	62.9	21.3	62.9	18.3	62.9	16.3	62.9	29.9	62.9	41.4

Figure 9.2: Longitudinal Moment Distribution at Critical Section for One-Lane Single Span Bridge Deck Span = 46 ft, Deck Width = 14 ft, One Railing with Edge Loading E1 (LEFT)

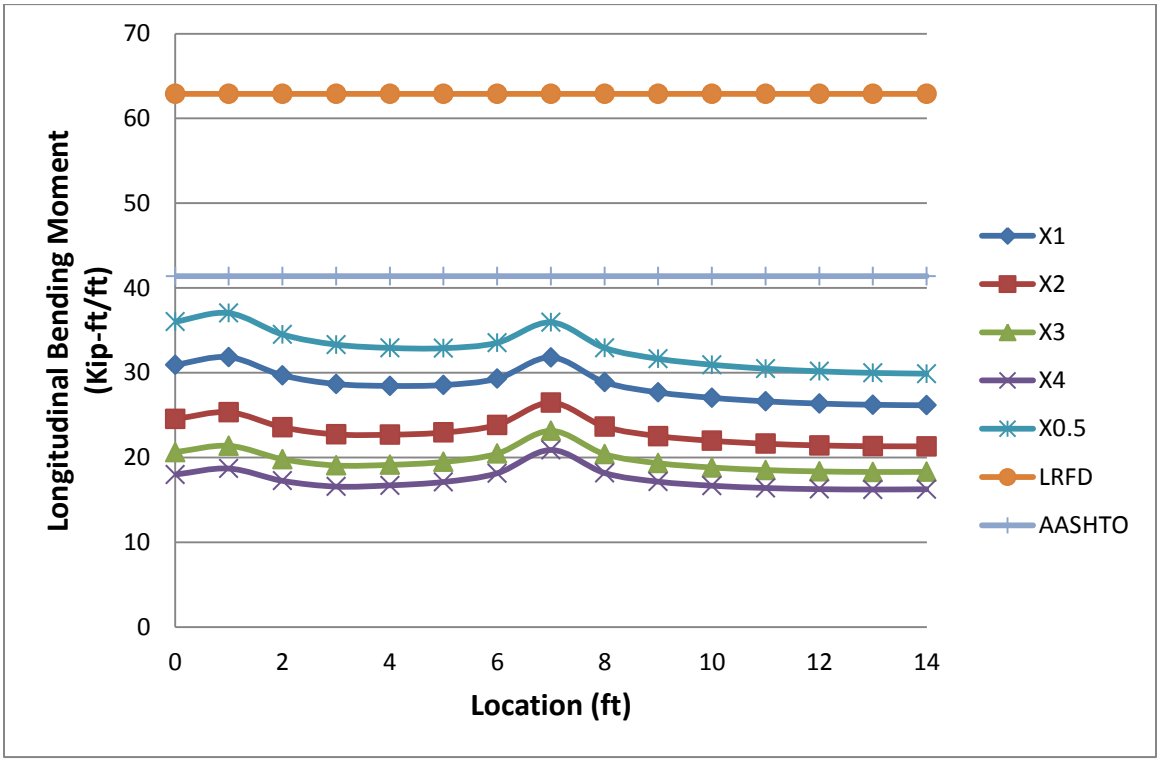

Table 9.3: Longitudinal Moment Distribution at Critical Section for One-Lane Single Span Bridge Deck Span = 46 ft, Deck Width = 14ft, One Railing with Edge Loading E1 (RIGHT)

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	36.1	62.9	31.8	62.9	29.1	62.9	27.2	62.9	39.4	62.9	41.4
1	37.4	62.9	33.0	62.9	30.3	62.9	28.4	62.9	40.7	62.9	41.4
2	33.6	62.9	29.2	62.9	26.5	62.9	24.6	62.9	37.0	62.9	41.4
3	32.0	62.9	27.5	62.9	24.7	62.9	22.8	62.9	35.4	62.9	41.4
4	31.1	62.9	26.5	62.9	23.7	62.9	21.8	62.9	34.6	62.9	41.4
5	30.7	62.9	26.1	62.9	23.2	62.9	21.2	62.9	34.2	62.9	41.4
6	30.9	62.9	26.3	62.9	23.3	62.9	21.4	62.9	34.5	62.9	41.4
7	33.0	62.9	28.2	62.9	25.3	62.9	23.3	62.9	36.7	62.9	41.4
8	29.7	62.9	24.8	62.9	21.8	62.9	19.7	62.9	33.4	62.9	41.4
9	28.0	62.9	23.1	62.9	20.0	62.9	17.9	62.9	31.9	62.9	41.4
10	27.0	62.9	21.9	62.9	18.8	62.9	16.6	62.9	30.9	62.9	41.4
11	26.2	62.9	21.0	62.9	17.8	62.9	15.6	62.9	30.2	62.9	41.4
12	25.6	62.9	20.3	62.9	17.0	62.9	14.7	62.9	29.7	62.9	41.4
13	24.9	62.9	19.4	62.9	16.0	62.9	13.6	62.9	29.2	62.9	41.4
14	24.9	62.9	19.4	62.9	16.0	62.9	13.7	62.9	29.1	62.9	41.4

Figure 9.3: Longitudinal Moment Distribution at Critical Section for One-Lane Single Span Bridge Deck Span = 46 ft, Deck Width = 14ft, One Railing with Edge Loading E1 (RIGHT)

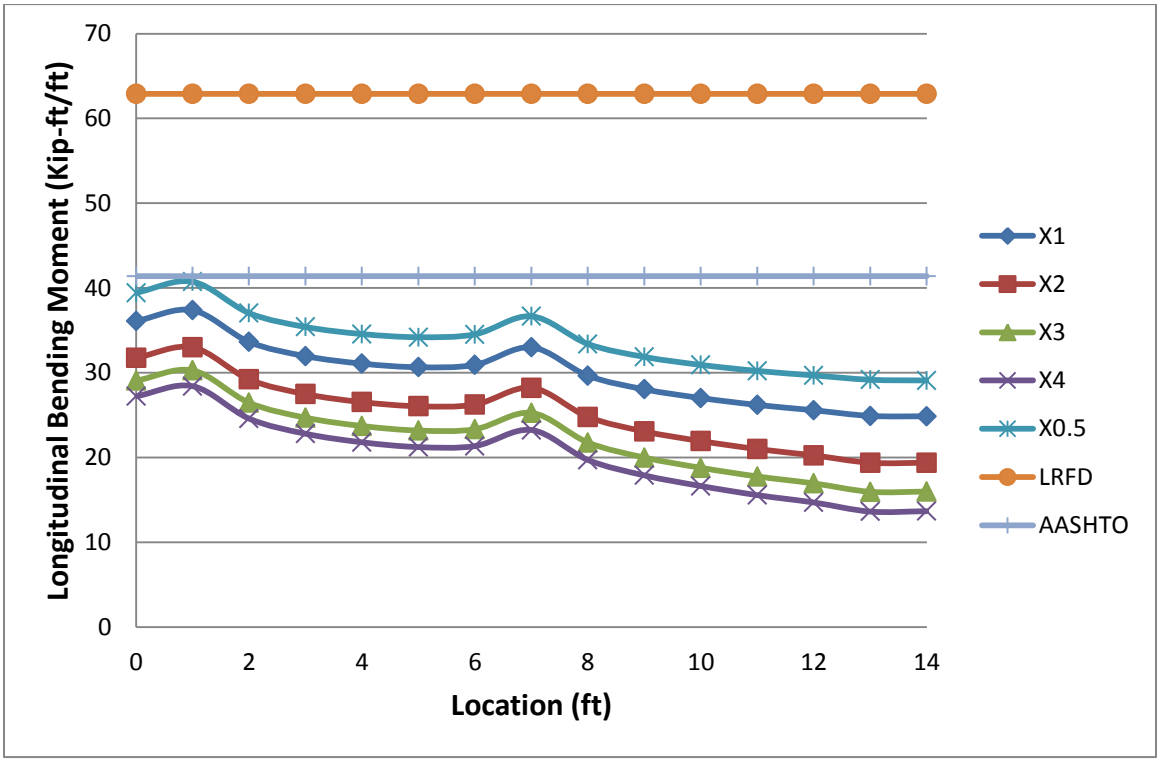

Table 9.4: Longitudinal Moment Distribution at Critical Section for one-Lane Single Span Bridge Deck Span = 46 ft, Deck Width = 14 ft. Two Railings with Edge Loading E1

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	26.4	62.9	19.8	62.9	16.3	62.9	14.1	62.9	32.6	62.9	41.4
1	27.3	62.9	20.6	62.9	17.0	62.9	14.7	62.9	33.6	62.9	41.4
2	25.0	62.9	18.6	62.9	15.1	62.9	13.0	62.9	31.0	62.9	41.4
3	23.9	62.9	17.5	62.9	14.1	62.9	12.0	62.9	29.7	62.9	41.4
4	23.5	62.9	17.3	62.9	14.0	62.9	11.9	62.9	29.3	62.9	41.4
5	23.5	62.9	17.3	62.9	14.1	62.9	12.0	62.9	29.2	62.9	41.4
6	24.1	62.9	18.0	62.9	14.8	62.9	12.7	62.9	29.7	62.9	41.4
7	26.4	62.9	20.4	62.9	17.2	62.9	15.2	62.9	32.0	62.9	41.4
8	23.3	62.9	17.3	62.9	14.1	62.9	12.1	62.9	28.9	62.9	41.4
9	21.9	62.9	15.9	62.9	12.7	62.9	10.8	62.9	27.5	62.9	41.4
10	21.1	62.9	15.1	62.9	11.9	62.9	9.9	62.9	26.7	62.9	41.4
11	20.5	62.9	14.4	62.9	11.2	62.9	9.3	62.9	26.1	62.9	41.4
12	20.0	62.9	13.9	62.9	10.7	62.9	8.8	62.9	25.6	62.9	41.4
13	19.5	62.9	13.4	62.9	10.1	62.9	8.1	62.9	25.2	62.9	41.4
14	19.5	62.9	13.4	62.9	10.2	62.9	8.2	62.9	25.1	62.9	41.4

Figure 9.4: Longitudinal Moment Distribution at Critical Section for one-Lane Single Span Bridge Deck Span = 46 ft, Deck Width = 14 ft. Two Railings with Edge Loading E1

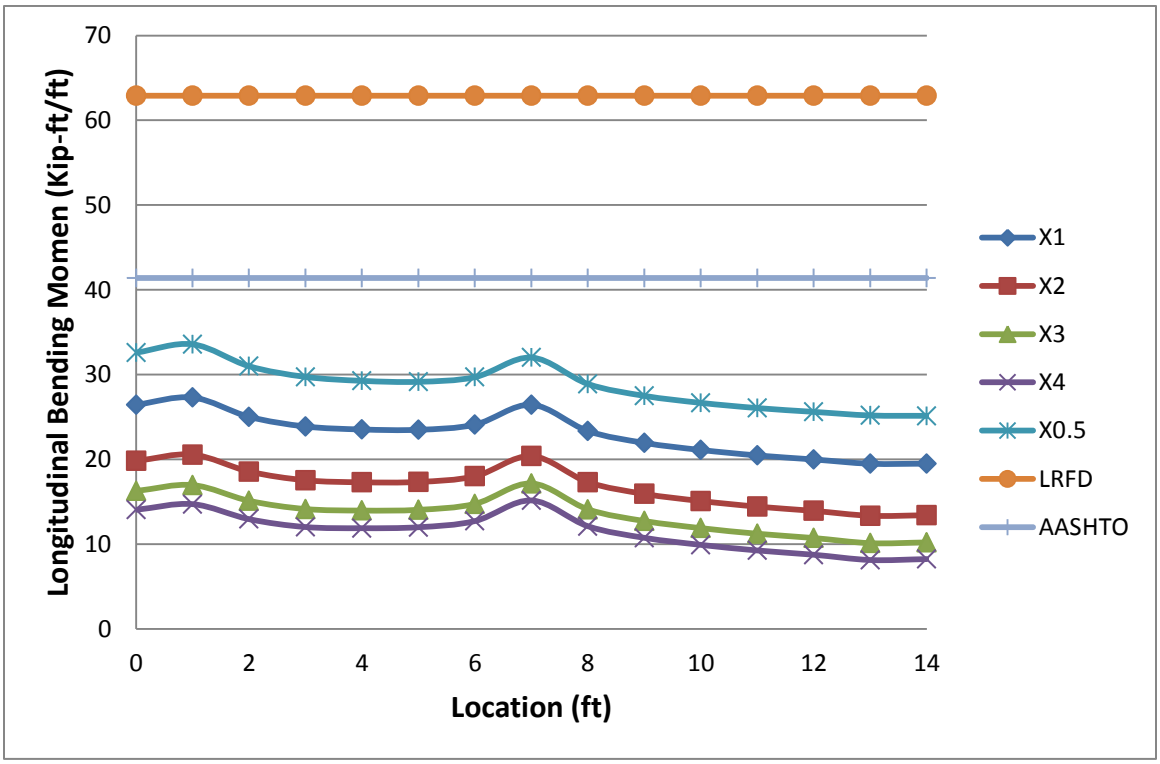

Table 10.1: Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge Deck Span = 46 ft, Deck Width = 24 ft, No Railings with Edge Loading E1

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	52.5	65.3	52.5	65.3	52.5	65.3	52.5	65.3	52.5	65.3	41.4
1	53.7	65.3	53.7	65.3	53.7	65.3	53.7	65.3	53.7	65.3	41.4
2	50.0	65.3	50.0	65.3	50.0	65.3	50.0	65.3	50.0	65.3	41.4
3	48.4	65.3	48.4	65.3	48.4	65.3	48.4	65.3	48.4	65.3	41.4
4	47.7	65.3	47.7	65.3	47.7	65.3	47.7	65.3	47.7	65.3	41.4
5	47.4	65.3	47.4	65.3	47.4	65.3	47.4	65.3	47.4	65.3	41.4
6	47.9	65.3	47.9	65.3	47.9	65.3	47.9	65.3	47.9	65.3	41.4
7	50.4	65.3	50.4	65.3	50.4	65.3	50.4	65.3	50.4	65.3	41.4
8	47.5	65.3	47.5	65.3	47.5	65.3	47.5	65.3	47.5	65.3	41.4
9	46.5	65.3	46.5	65.3	46.5	65.3	46.5	65.3	46.5	65.3	41.4
10	46.7	65.3	46.7	65.3	46.7	65.3	46.7	65.3	46.7	65.3	41.4
11	48.9	65.3	48.9	65.3	48.9	65.3	48.9	65.3	48.9	65.3	41.4
12	45.7	65.3	45.7	65.3	45.7	65.3	45.7	65.3	45.7	65.3	41.4
13	44.3	65.3	44.3	65.3	44.3	65.3	44.3	65.3	44.3	65.3	41.4
14	43.7	65.3	43.7	65.3	43.7	65.3	43.7	65.3	43.7	65.3	41.4
15	43.5	65.3	43.5	65.3	43.5	65.3	43.5	65.3	43.5	65.3	41.4
16	44.0	65.3	44.0	65.3	44.0	65.3	44.0	65.3	44.0	65.3	41.4
17	46.3	65.3	46.3	65.3	46.3	65.3	46.3	65.3	46.3	65.3	41.4
18	43.2	65.3	43.2	65.3	43.2	65.3	43.2	65.3	43.2	65.3	41.4
19	41.8	65.3	41.8	65.3	41.8	65.3	41.8	65.3	41.8	65.3	41.4
20	41.1	65.3	41.1	65.3	41.1	65.3	41.1	65.3	41.1	65.3	41.4
21	40.6	65.3	40.6	65.3	40.6	65.3	40.6	65.3	40.6	65.3	41.4
22	40.2	65.3	40.2	65.3	40.2	65.3	40.2	65.3	40.2	65.3	41.4
23	40.0	65.3	40.0	65.3	40.0	65.3	40.0	65.3	40.0	65.3	41.4
24	40.0	65.3	40.0	65.3	40.0	65.3	40.0	65.3	40.0	65.3	41.4

Figure 10.1: Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge Deck Span = 46 ft, Deck Width = 24 ft, No Railings with Edge Loading E1

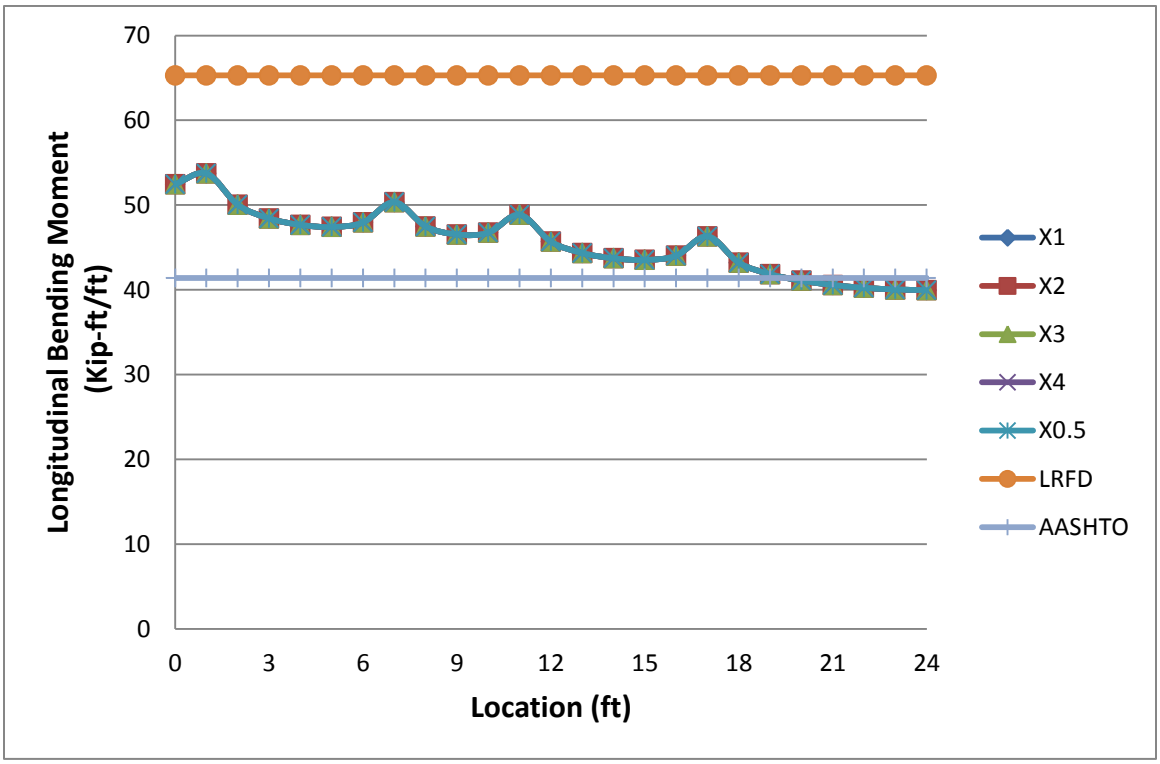

Table 10.2: Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge Deck Span = 46 ft, Deck Width = 24 ft, One Railing with Edge Loading E1 (LEFT)

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	39.7	65.3	32.8	65.3	28.2	65.3	25.0	65.3	44.8	65.3	41.4
1	40.5	65.3	33.5	65.3	28.8	65.3	25.5	65.3	45.7	65.3	41.4
2	38.5	65.3	31.9	65.3	27.6	65.3	24.5	65.3	43.2	65.3	41.4
3	37.5	65.3	31.3	65.3	27.1	65.3	24.1	65.3	42.1	65.3	41.4
4	37.4	65.3	31.4	65.3	27.4	65.3	24.5	65.3	41.7	65.3	41.4
5	37.7	65.3	31.9	65.3	28.1	65.3	25.3	65.3	41.8	65.3	41.4
6	38.7	65.3	33.1	65.3	29.4	65.3	26.7	65.3	42.6	65.3	41.4
7	41.5	65.3	36.1	65.3	32.5	65.3	30.0	65.3	45.3	65.3	41.4
8	39.0	65.3	33.8	65.3	30.3	65.3	27.8	65.3	42.6	65.3	41.4
9	38.3	65.3	33.3	65.3	30.0	65.3	27.6	65.3	41.9	65.3	41.4
10	38.8	65.3	34.0	65.3	30.7	65.3	28.4	65.3	42.2	65.3	41.4
11	41.2	65.3	36.5	65.3	33.4	65.3	31.1	65.3	44.5	65.3	41.4
12	38.2	65.3	33.7	65.3	30.7	65.3	28.5	65.3	41.4	65.3	41.4
13	37.1	65.3	32.7	65.3	29.8	65.3	27.7	65.3	40.2	65.3	41.4
14	36.7	65.3	32.4	65.3	29.6	65.3	27.5	65.3	39.7	65.3	41.4
15	36.7	65.3	32.5	65.3	29.7	65.3	27.7	65.3	39.7	65.3	41.4
16	37.4	65.3	33.3	65.3	30.6	65.3	28.6	65.3	40.2	65.3	41.4
17	39.8	65.3	35.9	65.3	33.2	65.3	31.3	65.3	42.6	65.3	41.4
18	36.9	65.3	33.0	65.3	30.4	65.3	28.5	65.3	39.6	65.3	41.4
19	35.6	65.3	31.8	65.3	29.3	65.3	27.4	65.3	38.3	65.3	41.4
20	35.0	65.3	31.3	65.3	28.8	65.3	27.0	65.3	37.6	65.3	41.4
21	34.6	65.3	30.9	65.3	28.5	65.3	26.7	65.3	37.2	65.3	41.4
22	34.4	65.3	30.8	65.3	28.3	65.3	26.6	65.3	36.9	65.3	41.4
23	34.2	65.3	30.7	65.3	28.3	65.3	26.6	65.3	36.8	65.3	41.4
24	34.2	65.3	30.7	65.3	28.4	65.3	26.7	65.3	36.7	65.3	41.4

Figure 10.2: Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge Deck Span = 46 ft, Deck Width = 24 ft, One Railing with Edge Loading E1 (LEFT)

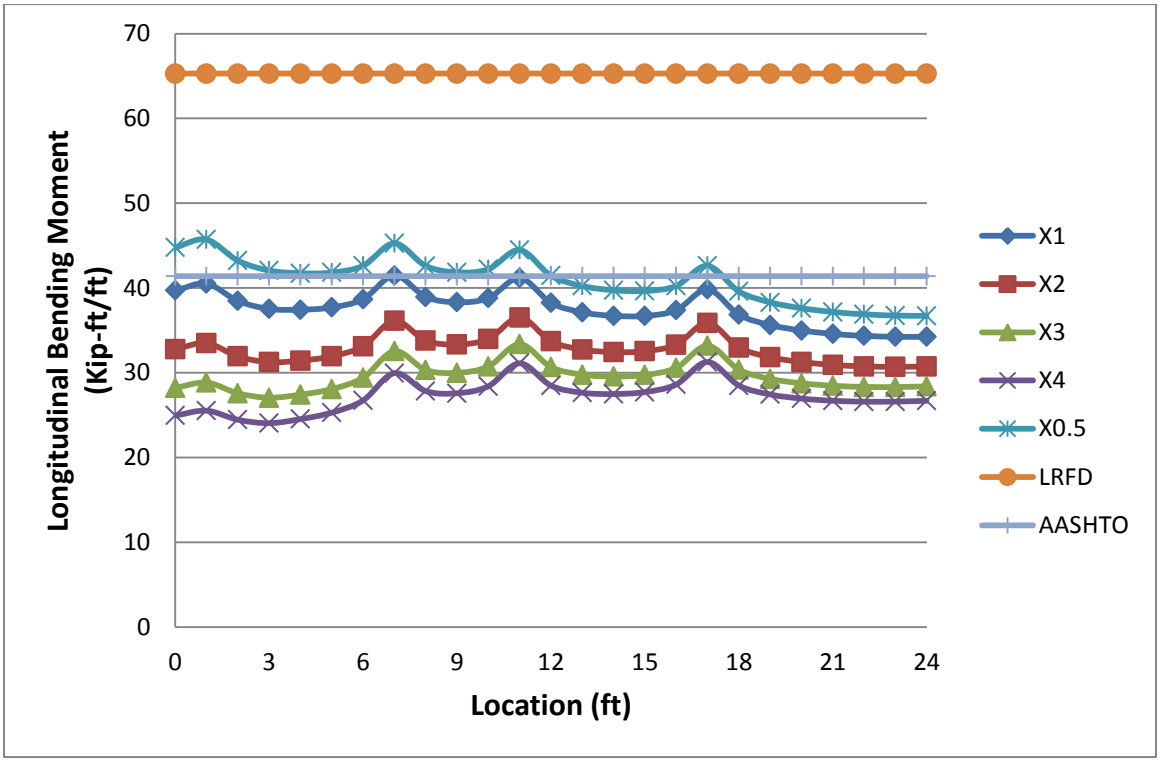

Table 10.3: Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge Deck Span = 46 ft, Deck Width = 24ft, One Railing with Edge Loading E1 (RIGHT)

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	47.6	65.3	44.7	65.3	42.7	65.3	41.3	65.3	49.7	65.3	41.4
1	48.8	65.3	45.9	65.3	43.9	65.3	42.4	65.3	50.9	65.3	41.4
2	45.1	65.3	42.0	65.3	40.0	65.3	38.5	65.3	47.2	65.3	41.4
3	43.4	65.3	40.3	65.3	38.2	65.3	36.8	65.3	45.6	65.3	41.4
4	42.5	65.3	39.4	65.3	37.3	65.3	35.8	65.3	44.7	65.3	41.4
5	42.2	65.3	39.0	65.3	36.8	65.3	35.3	65.3	44.4	65.3	41.4
6	42.6	65.3	39.3	65.3	37.2	65.3	35.6	65.3	44.9	65.3	41.4
7	44.9	65.3	41.6	65.3	39.3	65.3	37.7	65.3	47.2	65.3	41.4
8	41.9	65.3	38.5	65.3	36.2	65.3	34.5	65.3	44.3	65.3	41.4
9	40.8	65.3	37.3	65.3	34.9	65.3	33.3	65.3	43.3	65.3	41.4
10	40.8	65.3	37.2	65.3	34.8	65.3	33.1	65.3	43.4	65.3	41.4
11	42.8	65.3	39.1	65.3	36.6	65.3	34.8	65.3	45.4	65.3	41.4
12	39.4	65.3	35.6	65.3	33.1	65.3	31.2	65.3	42.1	65.3	41.4
13	37.9	65.3	34.0	65.3	31.4	65.3	29.5	65.3	40.7	65.3	41.4
14	37.1	65.3	33.0	65.3	30.3	65.3	28.4	65.3	39.9	65.3	41.4
15	36.7	65.3	32.5	65.3	29.7	65.3	27.7	65.3	39.6	65.3	41.4
16	36.9	65.3	32.6	65.3	29.7	65.3	27.6	65.3	40.0	65.3	41.4
17	39.0	65.3	34.5	65.3	31.5	65.3	29.3	65.3	42.1	65.3	41.4
18	35.6	65.3	31.0	65.3	27.9	65.3	25.6	65.3	38.9	65.3	41.4
19	33.9	65.3	29.2	65.3	25.9	65.3	23.6	65.3	37.3	65.3	41.4
20	32.9	65.3	27.9	65.3	24.6	65.3	22.2	65.3	36.4	65.3	41.4
21	32.0	65.3	26.9	65.3	23.4	65.3	20.9	65.3	35.7	65.3	41.4
22	31.4	65.3	26.0	65.3	22.4	65.3	19.9	65.3	35.2	65.3	41.4
23	30.7	65.3	25.0	65.3	21.3	65.3	18.5	65.3	34.7	65.3	41.4
24	30.7	65.3	25.1	65.3	21.4	65.3	18.7	65.3	34.7	65.3	41.4

Figure 10.3: Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge Deck Span = 46 ft, Deck Width = 24ft, One Railing with Edge Loading E1 (RIGHT)

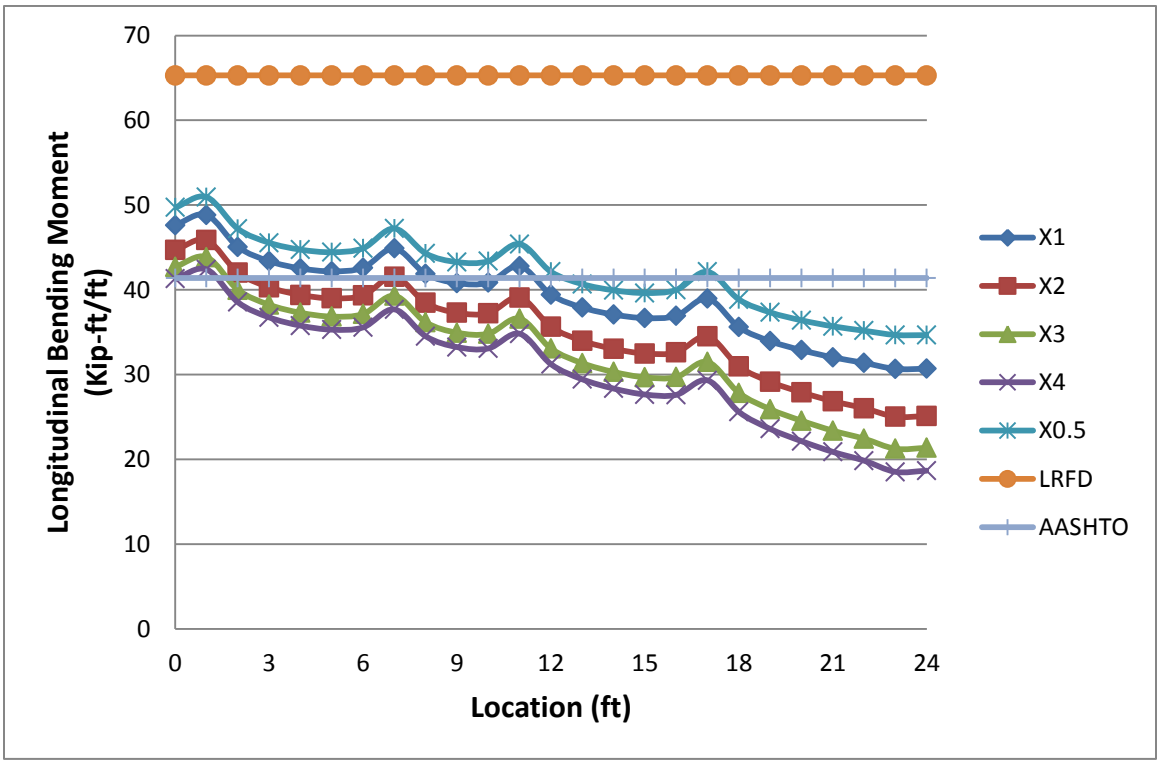

Table 10.4: Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge Deck Span = 46 ft, Deck Width = 24 ft. Two Railings with Edge Loading E1

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	36.5	65.3	28.9	65.3	24.3	65.3	21.2	65.3	42.6	65.3	41.4
1	37.2	65.3	29.5	65.3	24.9	65.3	21.7	65.3	43.5	65.3	41.4
2	35.1	65.3	27.8	65.3	23.3	65.3	20.3	65.3	40.9	65.3	41.4
3	34.1	65.3	26.9	65.3	22.6	65.3	19.6	65.3	39.7	65.3	41.4
4	33.9	65.3	26.9	65.3	22.7	65.3	19.8	65.3	39.3	65.3	41.4
5	34.0	65.3	27.2	65.3	23.1	65.3	20.3	65.3	39.4	65.3	41.4
6	34.8	65.3	28.2	65.3	24.1	65.3	21.4	65.3	40.1	65.3	41.4
7	37.5	65.3	31.0	65.3	27.0	65.3	24.3	65.3	42.7	65.3	41.4
8	34.8	65.3	28.4	65.3	24.5	65.3	21.8	65.3	39.9	65.3	41.4
9	34.1	65.3	27.7	65.3	23.8	65.3	21.2	65.3	39.1	65.3	41.4
10	34.4	65.3	28.1	65.3	24.3	65.3	21.7	65.3	39.4	65.3	41.4
11	36.6	65.3	30.4	65.3	26.6	65.3	24.0	65.3	41.5	65.3	41.4
12	33.5	65.3	27.3	65.3	23.5	65.3	21.0	65.3	38.4	65.3	41.4
13	32.2	65.3	26.0	65.3	22.3	65.3	19.8	65.3	37.1	65.3	41.4
14	31.6	65.3	25.4	65.3	21.7	65.3	19.2	65.3	36.5	65.3	41.4
15	31.4	65.3	25.2	65.3	21.5	65.3	19.0	65.3	36.3	65.3	41.4
16	31.8	65.3	25.6	65.3	21.9	65.3	19.4	65.3	36.7	65.3	41.4
17	34.0	65.3	27.8	65.3	24.1	65.3	21.6	65.3	39.0	65.3	41.4
18	30.8	65.3	24.6	65.3	20.8	65.3	18.3	65.3	35.8	65.3	41.4
19	29.3	65.3	23.0	65.3	19.2	65.3	16.7	65.3	34.4	65.3	41.4
20	28.4	65.3	22.0	65.3	18.2	65.3	15.7	65.3	33.5	65.3	41.4
21	27.7	65.3	21.2	65.3	17.4	65.3	14.8	65.3	32.9	65.3	41.4
22	27.2	65.3	20.7	65.3	16.8	65.3	14.2	65.3	32.4	65.3	41.4
23	26.6	65.3	19.9	65.3	15.9	65.3	13.3	65.3	32.0	65.3	41.4
24	26.7	65.3	20.1	65.3	16.1	65.3	13.5	65.3	32.0	65.3	41.4

Figure 10.4: Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge Deck Span = 46 ft, Deck Width = 24 ft. Two Railings with Edge Loading E1

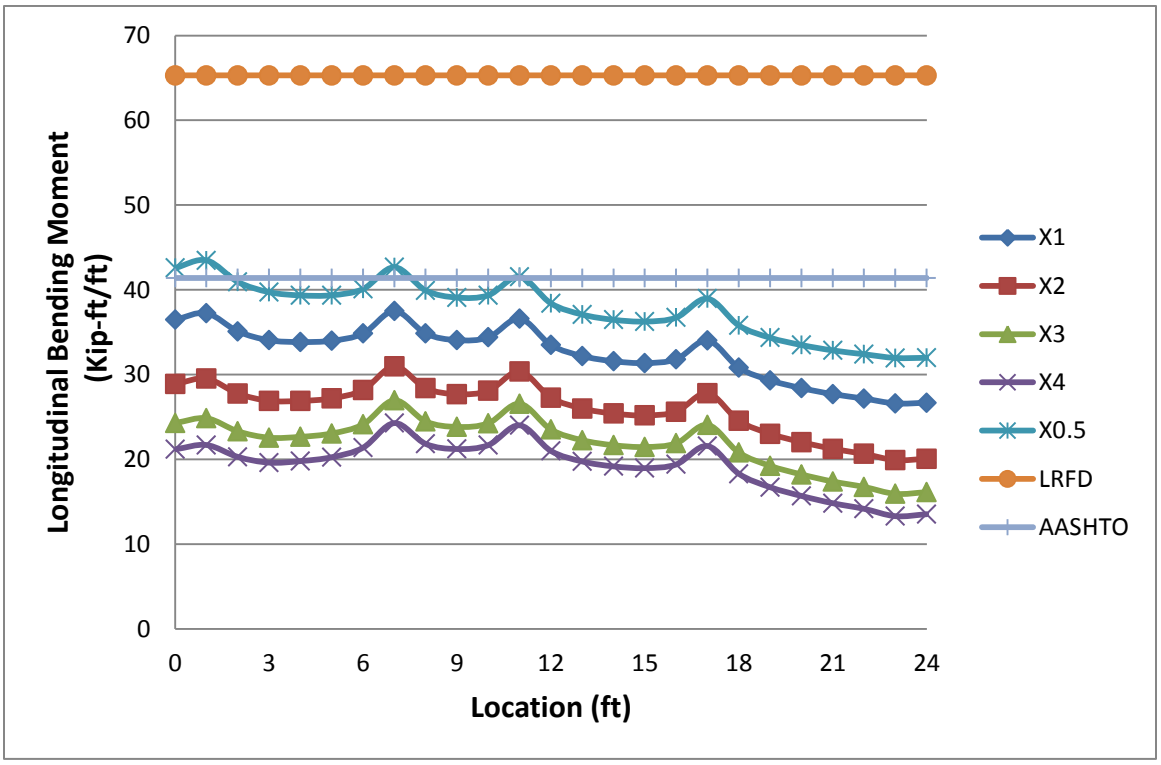

Table 11.1: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 46 ft, Deck Width = 36 ft, No Railings with Edge Loading E1

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	55.3	60.4	55.3	60.4	55.3	60.4	55.3	60.4	55.3	60.4	41.4
1	56.5	60.4	56.5	60.4	56.5	60.4	56.5	60.4	56.5	60.4	41.4
2	52.7	60.4	52.7	60.4	52.7	60.4	52.7	60.4	52.7	60.4	41.4
3	51.1	60.4	51.1	60.4	51.1	60.4	51.1	60.4	51.1	60.4	41.4
4	50.3	60.4	50.3	60.4	50.3	60.4	50.3	60.4	50.3	60.4	41.4
5	50.0	60.4	50.0	60.4	50.0	60.4	50.0	60.4	50.0	60.4	41.4
6	50.5	60.4	50.5	60.4	50.5	60.4	50.5	60.4	50.5	60.4	41.4
7	52.9	60.4	52.9	60.4	52.9	60.4	52.9	60.4	52.9	60.4	41.4
8	50.0	60.4	50.0	60.4	50.0	60.4	50.0	60.4	50.0	60.4	41.4
9	49.1	60.4	49.1	60.4	49.1	60.4	49.1	60.4	49.1	60.4	41.4
10	49.2	60.4	49.2	60.4	49.2	60.4	49.2	60.4	49.2	60.4	41.4
11	51.3	60.4	51.3	60.4	51.3	60.4	51.3	60.4	51.3	60.4	41.4
12	48.2	60.4	48.2	60.4	48.2	60.4	48.2	60.4	48.2	60.4	41.4
13	46.8	60.4	46.8	60.4	46.8	60.4	46.8	60.4	46.8	60.4	41.4
14	46.2	60.4	46.2	60.4	46.2	60.4	46.2	60.4	46.2	60.4	41.4
15	46.1	60.4	46.1	60.4	46.1	60.4	46.1	60.4	46.1	60.4	41.4
16	46.7	60.4	46.7	60.4	46.7	60.4	46.7	60.4	46.7	60.4	41.4
17	49.1	60.4	49.1	60.4	49.1	60.4	49.1	60.4	49.1	60.4	41.4
18	46.2	60.4	46.2	60.4	46.2	60.4	46.2	60.4	46.2	60.4	41.4
19	45.3	60.4	45.3	60.4	45.3	60.4	45.3	60.4	45.3	60.4	41.4
20	45.5	60.4	45.5	60.4	45.5	60.4	45.5	60.4	45.5	60.4	41.4
21	47.5	60.4	47.5	60.4	47.5	60.4	47.5	60.4	47.5	60.4	41.4
22	44.3	60.4	44.3	60.4	44.3	60.4	44.3	60.4	44.3	60.4	41.4
23	42.9	60.4	42.9	60.4	42.9	60.4	42.9	60.4	42.9	60.4	41.4
24	42.2	60.4	42.2	60.4	42.2	60.4	42.2	60.4	42.2	60.4	41.4
25	42.0	60.4	42.0	60.4	42.0	60.4	42.0	60.4	42.0	60.4	41.4
26	42.4	60.4	42.4	60.4	42.4	60.4	42.4	60.4	42.4	60.4	41.4
27	44.5	60.4	44.5	60.4	44.5	60.4	44.5	60.4	44.5	60.4	41.4
28	41.3	60.4	41.3	60.4	41.3	60.4	41.3	60.4	41.3	60.4	41.4
29	39.8	60.4	39.8	60.4	39.8	60.4	39.8	60.4	39.8	60.4	41.4
30	39.0	60.4	39.0	60.4	39.0	60.4	39.0	60.4	39.0	60.4	41.4
31	38.3	60.4	38.3	60.4	38.3	60.4	38.3	60.4	38.3	60.4	41.4
32	37.8	60.4	37.8	60.4	37.8	60.4	37.8	60.4	37.8	60.4	41.4
33	37.5	60.4	37.5	60.4	37.5	60.4	37.5	60.4	37.5	60.4	41.4
34	37.2	60.4	37.2	60.4	37.2	60.4	37.2	60.4	37.2	60.4	41.4
35	37.1	60.4	37.1	60.4	37.1	60.4	37.1	60.4	37.1	60.4	41.4
36	37.0	60.4	37.0	60.4	37.0	60.4	37.0	60.4	37.0	60.4	41.4

Figure 11.1: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 46 ft, Deck Width = 36 ft, No Railings with Edge Loading E1

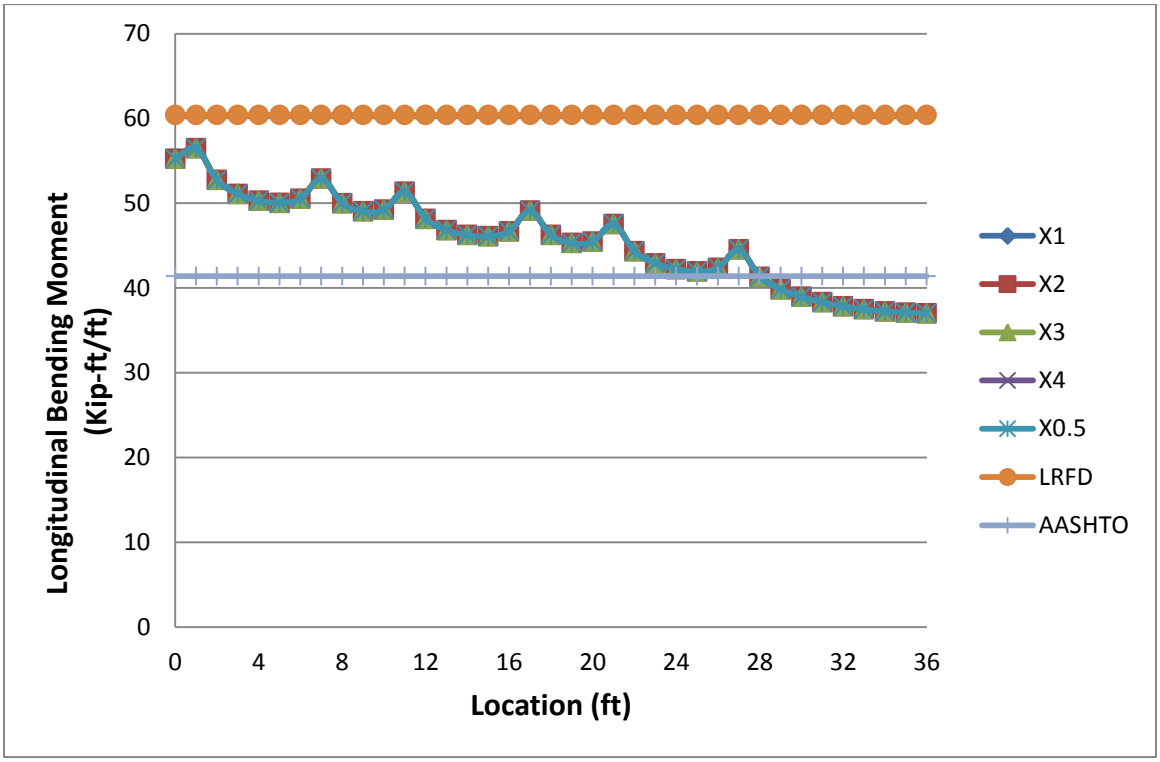

Table 11.2: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 46 ft, Deck Width = 36 ft, One Railing with Edge Loading E1 (LEFT)

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	42.9	60.4	36.0	60.4	31.3	60.4	27.8	60.4	47.9	60.4	41.4
1	43.7	60.4	36.6	60.4	31.8	60.4	28.3	60.4	48.8	60.4	41.4
2	41.7	60.4	35.1	60.4	30.7	60.4	27.4	60.4	46.3	60.4	41.4
3	40.7	60.4	34.5	60.4	30.2	60.4	27.1	60.4	45.1	60.4	41.4
4	40.7	60.4	34.8	60.4	30.7	60.4	27.7	60.4	44.8	60.4	41.4
5	40.9	60.4	35.3	60.4	31.4	60.4	28.6	60.4	44.8	60.4	41.4
6	41.9	60.4	36.6	60.4	32.9	60.4	30.1	60.4	45.6	60.4	41.4
7	44.8	60.4	39.6	60.4	36.1	60.4	33.5	60.4	48.3	60.4	41.4
8	42.3	60.4	37.4	60.4	34.0	60.4	31.5	60.4	45.6	60.4	41.4
9	41.7	60.4	37.0	60.4	33.7	60.4	31.4	60.4	44.9	60.4	41.4
10	42.2	60.4	37.7	60.4	34.6	60.4	32.3	60.4	45.3	60.4	41.4
11	44.6	60.4	40.3	60.4	37.3	60.4	35.2	60.4	47.5	60.4	41.4
12	41.7	60.4	37.6	60.4	34.8	60.4	32.7	60.4	44.5	60.4	41.4
13	40.7	60.4	36.7	60.4	34.0	60.4	32.0	60.4	43.4	60.4	41.4
14	40.3	60.4	36.6	60.4	34.0	60.4	32.0	60.4	42.9	60.4	41.4
15	40.4	60.4	36.8	60.4	34.3	60.4	32.5	60.4	42.9	60.4	41.4
16	41.3	60.4	37.8	60.4	35.4	60.4	33.6	60.4	43.6	60.4	41.4
17	43.9	60.4	40.6	60.4	38.3	60.4	36.6	60.4	46.2	60.4	41.4
18	41.2	60.4	38.0	60.4	35.8	60.4	34.2	60.4	43.4	60.4	41.4
19	40.5	60.4	37.4	60.4	35.3	60.4	33.7	60.4	42.6	60.4	41.4
20	40.8	60.4	37.9	60.4	35.8	60.4	34.3	60.4	42.9	60.4	41.4
21	43.1	60.4	40.2	60.4	38.3	60.4	36.8	60.4	45.0	60.4	41.4
22	40.0	60.4	37.3	60.4	35.4	60.4	34.0	60.4	41.9	60.4	41.4
23	38.8	60.4	36.1	60.4	34.3	60.4	32.9	60.4	40.6	60.4	41.4
24	38.2	60.4	35.7	60.4	33.9	60.4	32.6	60.4	40.0	60.4	41.4
25	38.1	60.4	35.6	60.4	33.9	60.4	32.6	60.4	39.8	60.4	41.4
26	38.6	60.4	36.2	60.4	34.5	60.4	33.3	60.4	40.2	60.4	41.4
27	40.9	60.4	38.6	60.4	37.0	60.4	35.8	60.4	42.5	60.4	41.4
28	37.8	60.4	35.5	60.4	34.0	60.4	32.8	60.4	39.3	60.4	41.4
29	36.4	60.4	34.2	60.4	32.7	60.4	31.6	60.4	37.9	60.4	41.4
30	35.6	60.4	33.5	60.4	32.0	60.4	30.9	60.4	37.1	60.4	41.4
31	35.0	60.4	33.0	60.4	31.5	60.4	30.4	60.4	36.5	60.4	41.4
32	34.6	60.4	32.6	60.4	31.2	60.4	30.2	60.4	36.0	60.4	41.4
33	34.4	60.4	32.4	60.4	31.0	60.4	30.0	60.4	35.7	60.4	41.4
34	34.2	60.4	32.2	60.4	30.9	60.4	29.9	60.4	35.5	60.4	41.4
35	34.1	60.4	32.2	60.4	30.8	60.4	29.9	60.4	35.4	60.4	41.4
36	34.1	60.4	32.2	60.4	30.9	60.4	29.9	60.4	35.4	60.4	41.4

Figure 11.2: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 46 ft, Deck Width = 36 ft, One Railing with Edge Loading E1 (LEFT)

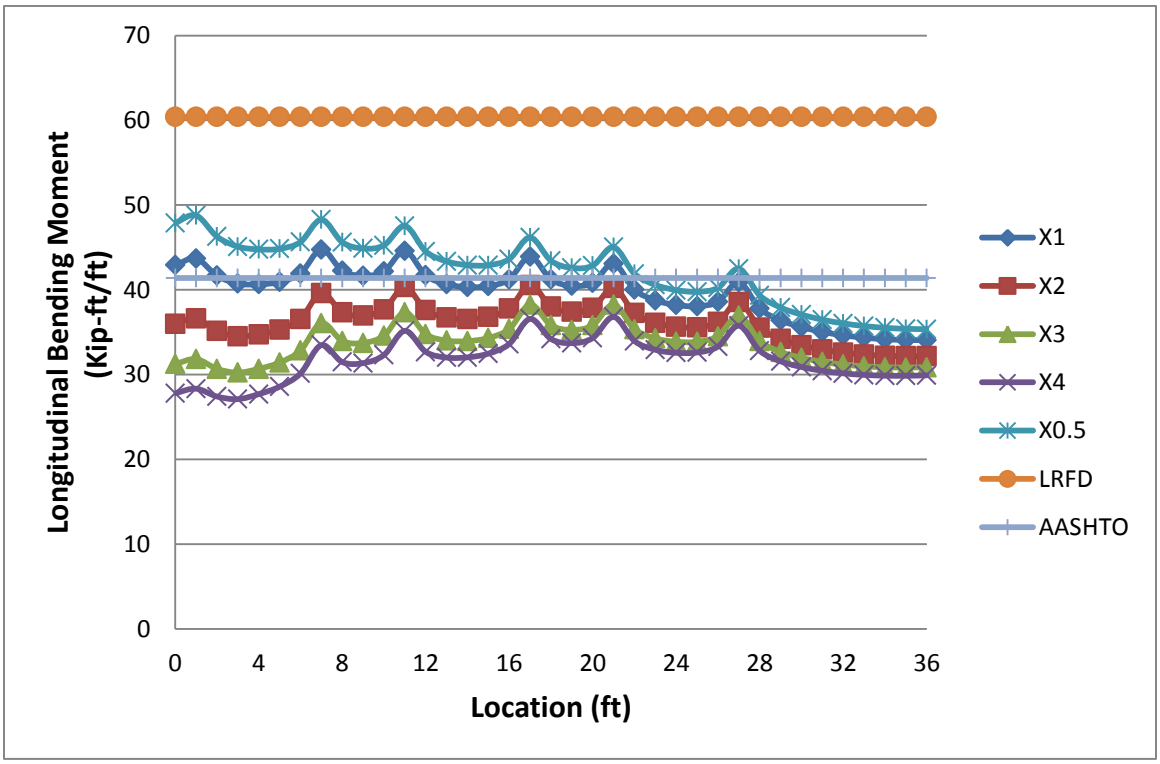

Table 11.3: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 46 ft, Deck Width = 36ft, One Railing with Edge Loading E1 (RIGHT)

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	53.1	60.4	51.7	60.4	50.7	60.4	50.0	60.4	54.0	60.4	41.4
1	54.3	60.4	52.8	60.4	51.9	60.4	51.1	60.4	55.2	60.4	41.4
2	50.5	60.4	49.0	60.4	48.0	60.4	47.3	60.4	51.5	60.4	41.4
3	48.8	60.4	47.3	60.4	46.3	60.4	45.5	60.4	49.8	60.4	41.4
4	47.9	60.4	46.4	60.4	45.4	60.4	44.6	60.4	49.0	60.4	41.4
5	47.6	60.4	46.1	60.4	45.0	60.4	44.2	60.4	48.7	60.4	41.4
6	48.0	60.4	46.5	60.4	45.4	60.4	44.6	60.4	49.1	60.4	41.4
7	50.4	60.4	48.7	60.4	47.6	60.4	46.8	60.4	51.5	60.4	41.4
8	47.4	60.4	45.7	60.4	44.6	60.4	43.7	60.4	48.5	60.4	41.4
9	46.4	60.4	44.6	60.4	43.4	60.4	42.6	60.4	47.5	60.4	41.4
10	46.4	60.4	44.7	60.4	43.4	60.4	42.5	60.4	47.7	60.4	41.4
11	48.5	60.4	46.6	60.4	45.4	60.4	44.4	60.4	49.7	60.4	41.4
12	45.2	60.4	43.3	60.4	42.0	60.4	41.0	60.4	46.5	60.4	41.4
13	43.8	60.4	41.8	60.4	40.4	60.4	39.5	60.4	45.1	60.4	41.4
14	43.1	60.4	41.0	60.4	39.6	60.4	38.6	60.4	44.5	60.4	41.4
15	42.8	60.4	40.7	60.4	39.2	60.4	38.2	60.4	44.2	60.4	41.4
16	43.3	60.4	41.1	60.4	39.6	60.4	38.4	60.4	44.8	60.4	41.4
17	45.6	60.4	43.3	60.4	41.7	60.4	40.6	60.4	47.1	60.4	41.4
18	42.5	60.4	40.2	60.4	38.5	60.4	37.3	60.4	44.2	60.4	41.4
19	41.4	60.4	39.0	60.4	37.3	60.4	36.0	60.4	43.1	60.4	41.4
20	41.5	60.4	38.9	60.4	37.1	60.4	35.8	60.4	43.2	60.4	41.4
21	43.4	60.4	40.7	60.4	38.8	60.4	37.5	60.4	45.2	60.4	41.4
22	40.0	60.4	37.2	60.4	35.2	60.4	33.8	60.4	41.9	60.4	41.4
23	38.4	60.4	35.5	60.4	33.4	60.4	32.0	60.4	40.4	60.4	41.4
24	37.5	60.4	34.4	60.4	32.3	60.4	30.8	60.4	39.6	60.4	41.4
25	37.0	60.4	33.8	60.4	31.6	60.4	30.0	60.4	39.2	60.4	41.4
26	37.2	60.4	33.9	60.4	31.6	60.4	29.9	60.4	39.4	60.4	41.4
27	39.1	60.4	35.7	60.4	33.3	60.4	31.5	60.4	41.5	60.4	41.4
28	35.7	60.4	32.1	60.4	29.6	60.4	27.7	60.4	38.1	60.4	41.4
29	33.9	60.4	30.2	60.4	27.6	60.4	25.6	60.4	36.5	60.4	41.4
30	32.8	60.4	28.8	60.4	26.1	60.4	24.1	60.4	35.5	60.4	41.4
31	31.9	60.4	27.7	60.4	24.9	60.4	22.8	60.4	34.7	60.4	41.4
32	31.1	60.4	26.8	60.4	23.8	60.4	21.6	60.4	34.0	60.4	41.4
33	30.4	60.4	25.9	60.4	22.8	60.4	20.5	60.4	33.5	60.4	41.4
34	29.9	60.4	25.2	60.4	21.9	60.4	19.6	60.4	33.1	60.4	41.4
35	29.3	60.4	24.3	60.4	20.9	60.4	18.3	60.4	32.7	60.4	41.4
36	29.3	60.4	24.3	60.4	20.9	60.4	18.4	60.4	32.6	60.4	41.4

Figure 11.3: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 46 ft, Deck Width = 36ft, One Railing with Edge Loading E1 (RIGHT)

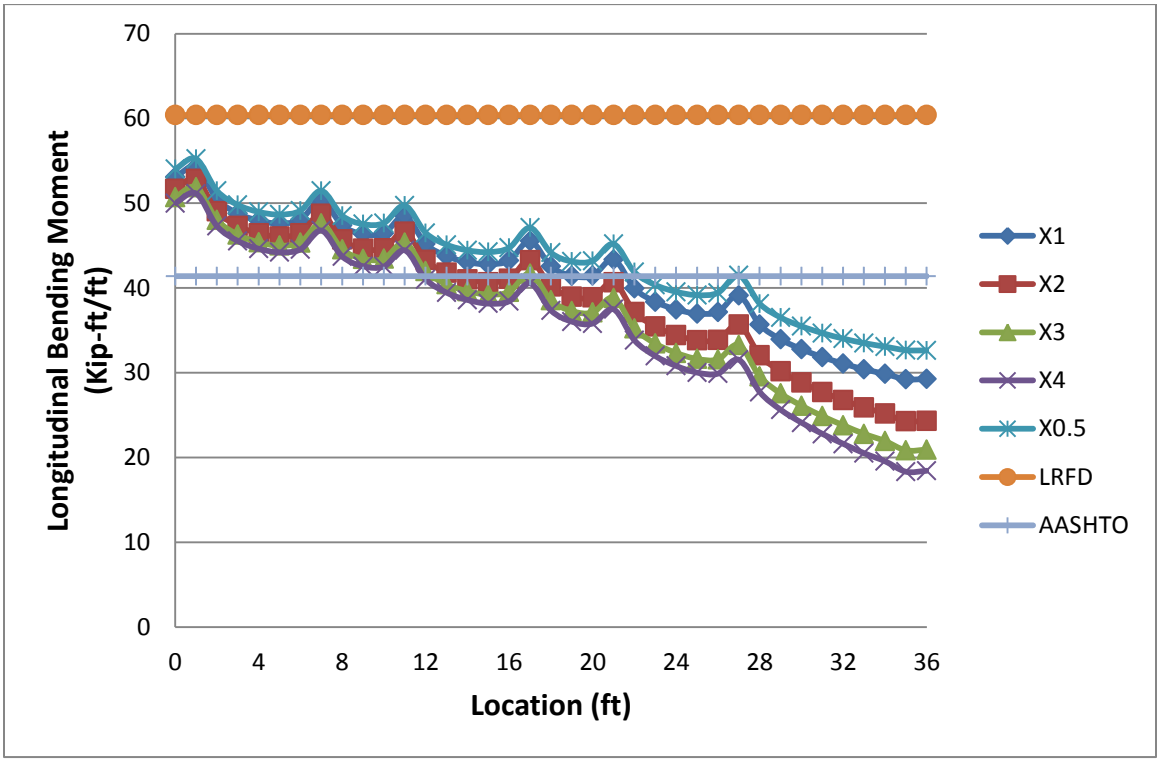

Table 11.4: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 46 ft, Deck Width = 36 ft. Two Railings with Edge Loading E1

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	41.3	60.4	33.9	60.4	29.1	60.4	25.7	60.4	46.9	60.4	41.4
1	42.1	60.4	34.5	60.4	29.6	60.4	26.1	60.4	47.7	60.4	41.4
2	40.0	60.4	32.9	60.4	28.3	60.4	25.0	60.4	45.2	60.4	41.4
3	39.0	60.4	32.2	60.4	27.7	60.4	24.5	60.4	44.0	60.4	41.4
4	38.8	60.4	32.3	60.4	28.0	60.4	24.9	60.4	43.6	60.4	41.4
5	39.1	60.4	32.7	60.4	28.6	60.4	25.6	60.4	43.7	60.4	41.4
6	40.0	60.4	33.9	60.4	29.8	60.4	27.0	60.4	44.4	60.4	41.4
7	42.7	60.4	36.8	60.4	32.9	60.4	30.1	60.4	47.0	60.4	41.4
8	40.1	60.4	34.4	60.4	30.6	60.4	27.9	60.4	44.3	60.4	41.4
9	39.5	60.4	33.9	60.4	30.2	60.4	27.6	60.4	43.5	60.4	41.4
10	39.9	60.4	34.4	60.4	30.8	60.4	28.3	60.4	43.9	60.4	41.4
11	42.2	60.4	36.9	60.4	33.4	60.4	30.9	60.4	46.1	60.4	41.4
12	39.2	60.4	34.0	60.4	30.6	60.4	28.1	60.4	43.0	60.4	41.4
13	38.1	60.4	33.0	60.4	29.6	60.4	27.2	60.4	41.8	60.4	41.4
14	37.6	60.4	32.6	60.4	29.3	60.4	27.0	60.4	41.3	60.4	41.4
15	37.6	60.4	32.7	60.4	29.4	60.4	27.1	60.4	41.2	60.4	41.4
16	38.3	60.4	33.4	60.4	30.2	60.4	28.0	60.4	41.9	60.4	41.4
17	40.8	60.4	36.0	60.4	32.8	60.4	30.6	60.4	44.3	60.4	41.4
18	38.0	60.4	33.2	60.4	30.1	60.4	27.9	60.4	41.5	60.4	41.4
19	37.1	60.4	32.4	60.4	29.3	60.4	27.1	60.4	40.6	60.4	41.4
20	37.3	60.4	32.6	60.4	29.5	60.4	27.3	60.4	40.8	60.4	41.4
21	39.4	60.4	34.7	60.4	31.6	60.4	29.5	60.4	42.8	60.4	41.4
22	36.2	60.4	31.4	60.4	28.4	60.4	26.2	60.4	39.6	60.4	41.4
23	34.7	60.4	30.0	60.4	26.9	60.4	24.8	60.4	38.2	60.4	41.4
24	34.0	60.4	29.2	60.4	26.2	60.4	24.0	60.4	37.5	60.4	41.4
25	33.6	60.4	28.9	60.4	25.8	60.4	23.6	60.4	37.2	60.4	41.4
26	34.0	60.4	29.1	60.4	26.0	60.4	23.8	60.4	37.5	60.4	41.4
27	36.1	60.4	31.2	60.4	28.0	60.4	25.8	60.4	39.6	60.4	41.4
28	32.7	60.4	27.8	60.4	24.6	60.4	22.3	60.4	36.3	60.4	41.4
29	31.1	60.4	26.1	60.4	22.8	60.4	20.6	60.4	34.8	60.4	41.4
30	30.0	60.4	24.9	60.4	21.7	60.4	19.4	60.4	33.8	60.4	41.4
31	29.2	60.4	24.0	60.4	20.7	60.4	18.3	60.4	33.0	60.4	41.4
32	28.5	60.4	23.2	60.4	19.8	60.4	17.5	60.4	32.4	60.4	41.4
33	28.0	60.4	22.5	60.4	19.1	60.4	16.6	60.4	32.0	60.4	41.4
34	27.5	60.4	22.0	60.4	18.4	60.4	15.9	60.4	31.6	60.4	41.4
35	27.0	60.4	21.2	60.4	17.6	60.4	15.0	60.4	31.2	60.4	41.4
36	27.0	60.4	21.4	60.4	17.7	60.4	15.2	60.4	31.2	60.4	41.4

Figure 11.4: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 46 ft, Deck Width = 36 ft. Two Railings with Edge Loading E1

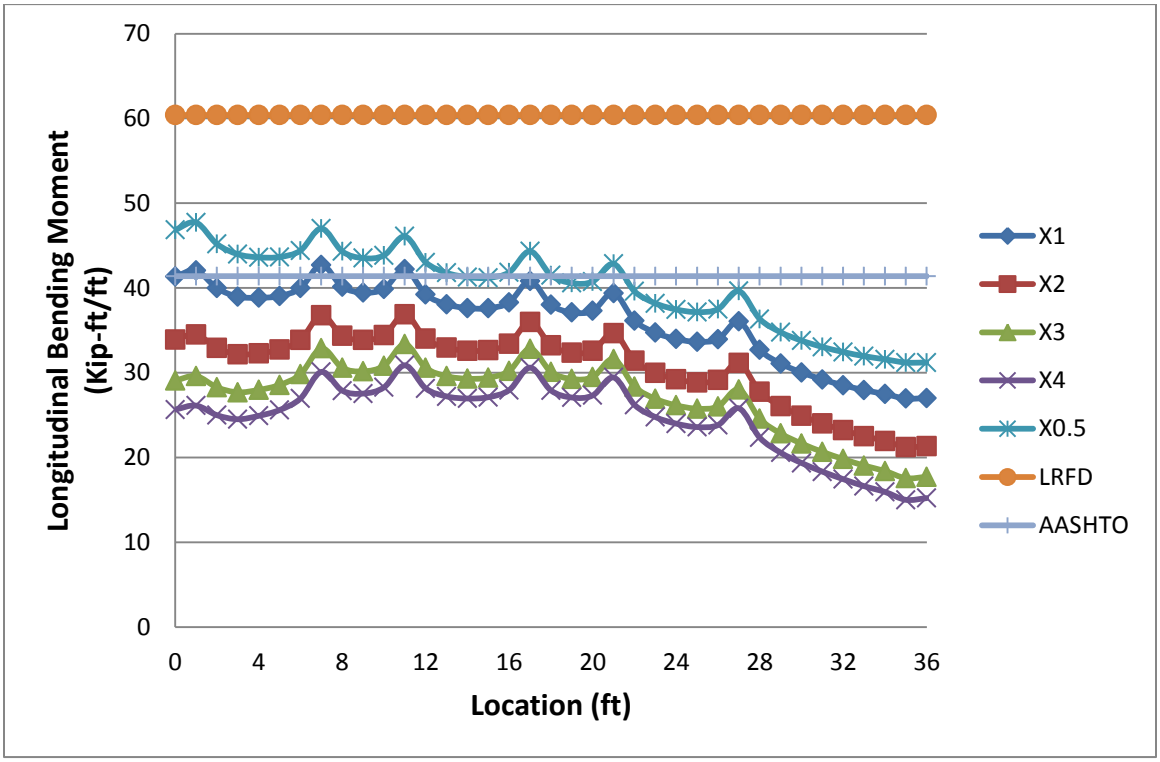

Table 12.1: Longitudinal Moment Distribution at Critical Section for Four-Lane Single Span Bridge Deck Span = 46 ft, Deck Width = 48 ft, No Railings with Edge Loading E1

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	57.5	59.8	57.5	59.8	57.5	59.8	57.5	59.8	57.5	59.8	41.4
1	58.8	59.8	58.8	59.8	58.8	59.8	58.8	59.8	58.8	59.8	41.4
2	55.0	59.8	55.0	59.8	55.0	59.8	55.0	59.8	55.0	59.8	41.4
3	53.4	59.8	53.4	59.8	53.4	59.8	53.4	59.8	53.4	59.8	41.4
4	52.6	59.8	52.6	59.8	52.6	59.8	52.6	59.8	52.6	59.8	41.4
5	52.3	59.8	52.3	59.8	52.3	59.8	52.3	59.8	52.3	59.8	41.4
6	52.8	59.8	52.8	59.8	52.8	59.8	52.8	59.8	52.8	59.8	41.4
7	55.2	59.8	55.2	59.8	55.2	59.8	55.2	59.8	55.2	59.8	41.4
8	52.4	59.8	52.4	59.8	52.4	59.8	52.4	59.8	52.4	59.8	41.4
9	51.4	59.8	51.4	59.8	51.4	59.8	51.4	59.8	51.4	59.8	41.4
10	51.6	59.8	51.6	59.8	51.6	59.8	51.6	59.8	51.6	59.8	41.4
11	53.8	59.8	53.8	59.8	53.8	59.8	53.8	59.8	53.8	59.8	41.4
12	50.6	59.8	50.6	59.8	50.6	59.8	50.6	59.8	50.6	59.8	41.4
13	49.3	59.8	49.3	59.8	49.3	59.8	49.3	59.8	49.3	59.8	41.4
14	48.8	59.8	48.8	59.8	48.8	59.8	48.8	59.8	48.8	59.8	41.4
15	48.6	59.8	48.6	59.8	48.6	59.8	48.6	59.8	48.6	59.8	41.4
16	49.3	59.8	49.3	59.8	49.3	59.8	49.3	59.8	49.3	59.8	41.4
17	51.7	59.8	51.7	59.8	51.7	59.8	51.7	59.8	51.7	59.8	41.4
18	48.9	59.8	48.9	59.8	48.9	59.8	48.9	59.8	48.9	59.8	41.4
19	48.0	59.8	48.0	59.8	48.0	59.8	48.0	59.8	48.0	59.8	41.4
20	48.2	59.8	48.2	59.8	48.2	59.8	48.2	59.8	48.2	59.8	41.4
21	50.3	59.8	50.3	59.8	50.3	59.8	50.3	59.8	50.3	59.8	41.4
22	47.2	59.8	47.2	59.8	47.2	59.8	47.2	59.8	47.2	59.8	41.4
23	45.8	59.8	45.8	59.8	45.8	59.8	45.8	59.8	45.8	59.8	41.4
24	45.2	59.8	45.2	59.8	45.2	59.8	45.2	59.8	45.2	59.8	41.4
25	45.1	59.8	45.1	59.8	45.1	59.8	45.1	59.8	45.1	59.8	41.4
26	45.6	59.8	45.6	59.8	45.6	59.8	45.6	59.8	45.6	59.8	41.4
27	48.0	59.8	48.0	59.8	48.0	59.8	48.0	59.8	48.0	59.8	41.4
28	45.1	59.8	45.1	59.8	45.1	59.8	45.1	59.8	45.1	59.8	41.4
29	44.1	59.8	44.1	59.8	44.1	59.8	44.1	59.8	44.1	59.8	41.4
30	44.2	59.8	44.2	59.8	44.2	59.8	44.2	59.8	44.2	59.8	41.4
31	46.3	59.8	46.3	59.8	46.3	59.8	46.3	59.8	46.3	59.8	41.4
32	43.0	59.8	43.0	59.8	43.0	59.8	43.0	59.8	43.0	59.8	41.4
33	41.5	59.8	41.5	59.8	41.5	59.8	41.5	59.8	41.5	59.8	41.4
34	40.7	59.8	40.7	59.8	40.7	59.8	40.7	59.8	40.7	59.8	41.4
35	40.3	59.8	40.3	59.8	40.3	59.8	40.3	59.8	40.3	59.8	41.4
36	40.7	59.8	40.7	59.8	40.7	59.8	40.7	59.8	40.7	59.8	41.4
37	42.8	59.8	42.8	59.8	42.8	59.8	42.8	59.8	42.8	59.8	41.4
38	39.4	59.8	39.4	59.8	39.4	59.8	39.4	59.8	39.4	59.8	41.4

39	37.8	59.8	37.8	59.8	37.8	59.8	37.8	59.8	37.8	59.8	41.4
40	36.8	59.8	36.8	59.8	36.8	59.8	36.8	59.8	36.8	59.8	41.4
41	36.1	59.8	36.1	59.8	36.1	59.8	36.1	59.8	36.1	59.8	41.4
42	35.5	59.8	35.5	59.8	35.5	59.8	35.5	59.8	35.5	59.8	41.4
43	35.0	59.8	35.0	59.8	35.0	59.8	35.0	59.8	35.0	59.8	41.4
44	34.6	59.8	34.6	59.8	34.6	59.8	34.6	59.8	34.6	59.8	41.4
45	34.3	59.8	34.3	59.8	34.3	59.8	34.3	59.8	34.3	59.8	41.4
46	34.1	59.8	34.1	59.8	34.1	59.8	34.1	59.8	34.1	59.8	41.4
47	33.9	59.8	33.9	59.8	33.9	59.8	33.9	59.8	33.9	59.8	41.4
48	33.8	59.8	33.8	59.8	33.8	59.8	33.8	59.8	33.8	59.8	41.4

Figure 12.1: Longitudinal Moment Distribution at Critical Section for Four-Lane Single Span Bridge Deck Span = 46 ft, Deck Width = 48 ft, No Railings with Edge Loading E1

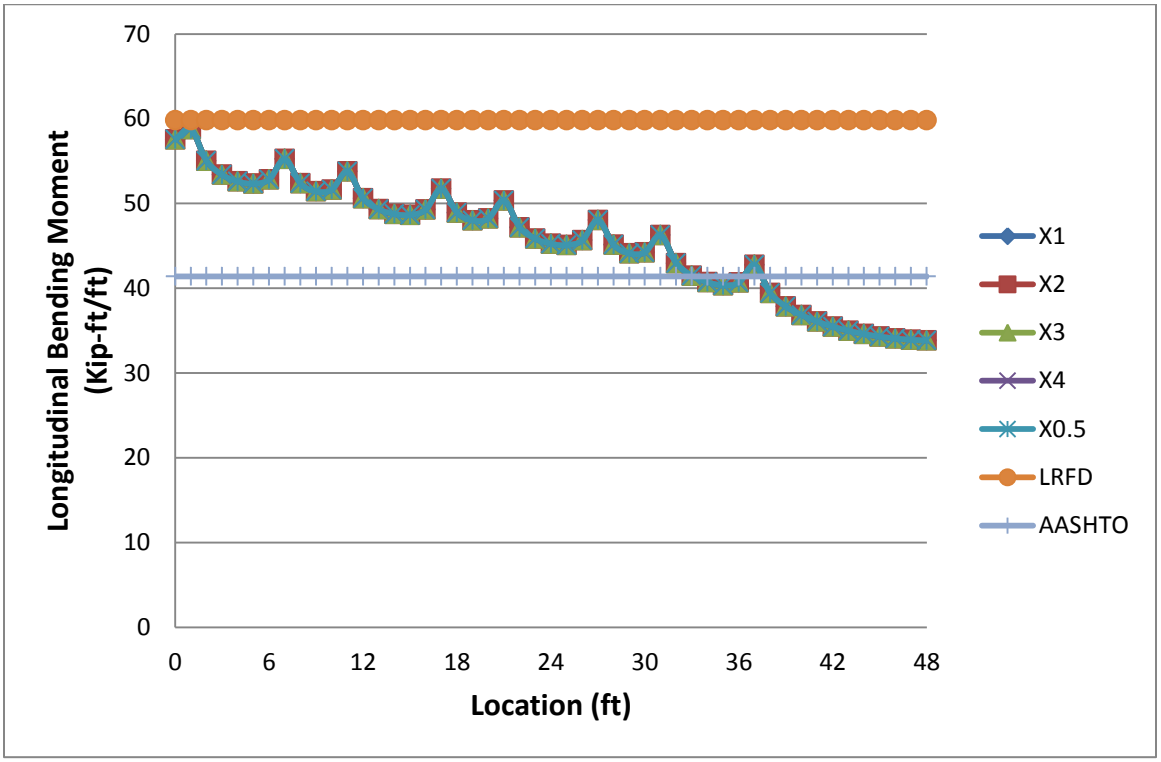

Table 12.2: Longitudinal Moment Distribution at Critical Section for Four-Lane Single Span Bridge Deck Span = 46 ft, Deck Width = 48 ft, One Railing with Edge Loading E1 (LEFT)

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	45.0	59.8	37.9	59.8	33.0	59.8	27.8	59.8	50.1	59.8	41.4
1	45.8	59.8	38.5	59.8	33.5	59.8	25.7	59.8	51.0	59.8	41.4
2	43.8	59.8	37.1	59.8	32.5	59.8	27.9	59.8	48.5	59.8	41.4
3	42.9	59.8	36.5	59.8	32.1	59.8	28.2	59.8	47.3	59.8	41.4
4	42.8	59.8	36.8	59.8	32.6	59.8	28.9	59.8	47.0	59.8	41.4
5	43.2	59.8	37.4	59.8	33.4	59.8	29.8	59.8	47.1	59.8	41.4
6	44.2	59.8	38.7	59.8	34.9	59.8	30.8	59.8	47.9	59.8	41.4
7	47.1	59.8	41.9	59.8	38.3	59.8	30.9	59.8	50.6	59.8	41.4
8	44.6	59.8	39.7	59.8	36.2	59.8	32.2	59.8	48.0	59.8	41.4
9	44.1	59.8	39.4	59.8	36.1	59.8	32.7	59.8	47.3	59.8	41.4
10	44.6	59.8	40.2	59.8	37.0	59.8	33.2	59.8	47.7	59.8	41.4
11	47.1	59.8	42.8	59.8	39.9	59.8	32.9	59.8	50.0	59.8	41.4
12	44.3	59.8	40.2	59.8	37.4	59.8	33.8	59.8	47.1	59.8	41.4
13	43.3	59.8	39.4	59.8	36.7	59.8	33.9	59.8	45.9	59.8	41.4
14	43.0	59.8	39.3	59.8	36.7	59.8	34.1	59.8	45.5	59.8	41.4
15	43.2	59.8	39.7	59.8	37.2	59.8	34.5	59.8	45.6	59.8	41.4
16	44.1	59.8	40.7	59.8	38.4	59.8	35.2	59.8	46.4	59.8	41.4
17	46.8	59.8	43.6	59.8	41.4	59.8	34.9	59.8	49.0	59.8	41.4
18	44.2	59.8	41.1	59.8	39.0	59.8	35.9	59.8	46.3	59.8	41.4
19	43.5	59.8	40.6	59.8	38.6	59.8	36.0	59.8	45.5	59.8	41.4
20	43.9	59.8	41.2	59.8	39.2	59.8	36.2	59.8	45.8	59.8	41.4
21	46.3	59.8	43.6	59.8	41.8	59.8	35.6	59.8	48.1	59.8	41.4
22	43.3	59.8	40.8	59.8	39.0	59.8	36.2	59.8	45.0	59.8	41.4
23	42.1	59.8	39.7	59.8	38.0	59.8	35.9	59.8	43.8	59.8	41.4
24	41.7	59.8	39.4	59.8	37.8	59.8	35.8	59.8	43.3	59.8	41.4
25	41.7	59.8	39.5	59.8	38.0	59.8	36.0	59.8	43.2	59.8	41.4
26	42.4	59.8	40.3	59.8	38.8	59.8	36.3	59.8	43.8	59.8	41.4
27	44.9	59.8	42.9	59.8	41.5	59.8	35.8	59.8	46.3	59.8	41.4
28	42.2	59.8	40.3	59.8	38.9	59.8	36.4	59.8	43.5	59.8	41.4
29	41.3	59.8	39.5	59.8	38.2	59.8	36.2	59.8	42.5	59.8	41.4
30	41.5	59.8	39.8	59.8	38.5	59.8	36.1	59.8	42.7	59.8	41.4
31	43.7	59.8	42.0	59.8	40.8	59.8	35.2	59.8	44.8	59.8	41.4
32	40.5	59.8	38.8	59.8	37.7	59.8	35.4	59.8	41.6	59.8	41.4
33	39.1	59.8	37.5	59.8	36.5	59.8	34.9	59.8	40.1	59.8	41.4
34	38.4	59.8	36.9	59.8	35.9	59.8	34.4	59.8	39.4	59.8	41.4
35	38.1	59.8	36.7	59.8	35.7	59.8	34.2	59.8	39.1	59.8	41.4
36	38.5	59.8	37.1	59.8	36.2	59.8	34.1	59.8	39.5	59.8	41.4
37	40.7	59.8	39.4	59.8	38.4	59.8	33.1	59.8	41.6	59.8	41.4
38	37.4	59.8	36.2	59.8	35.3	59.8	33.3	59.8	38.3	59.8	41.4

39	35.9	59.8	34.7	59.8	33.8	59.8	32.5	59.8	36.8	59.8	41.4
40	35.0	59.8	33.8	59.8	32.9	59.8	31.8	59.8	35.8	59.8	41.4
41	34.3	59.8	33.1	59.8	32.3	59.8	31.2	59.8	35.1	59.8	41.4
42	33.7	59.8	32.6	59.8	31.8	59.8	30.8	59.8	34.5	59.8	41.4
43	33.3	59.8	32.2	59.8	31.4	59.8	30.5	59.8	34.0	59.8	41.4
44	32.9	59.8	31.9	59.8	31.1	59.8	30.2	59.8	33.7	59.8	41.4
45	32.7	59.8	31.6	59.8	30.9	59.8	30.0	59.8	33.4	59.8	41.4
46	32.5	59.8	31.5	59.8	30.8	59.8	29.9	59.8	33.2	59.8	41.4
47	32.4	59.8	31.4	59.8	30.7	59.8	29.8	59.8	33.1	59.8	41.4
48	32.3	59.8	31.3	59.8	30.7	59.8	29.8	59.8	33.0	59.8	41.4

Figure 12.2: Longitudinal Moment Distribution at Critical Section for Four-Lane Single Span Bridge Deck Span = 46 ft, Deck Width = 48 ft, One Railing with Edge Loading E1 (LEFT)

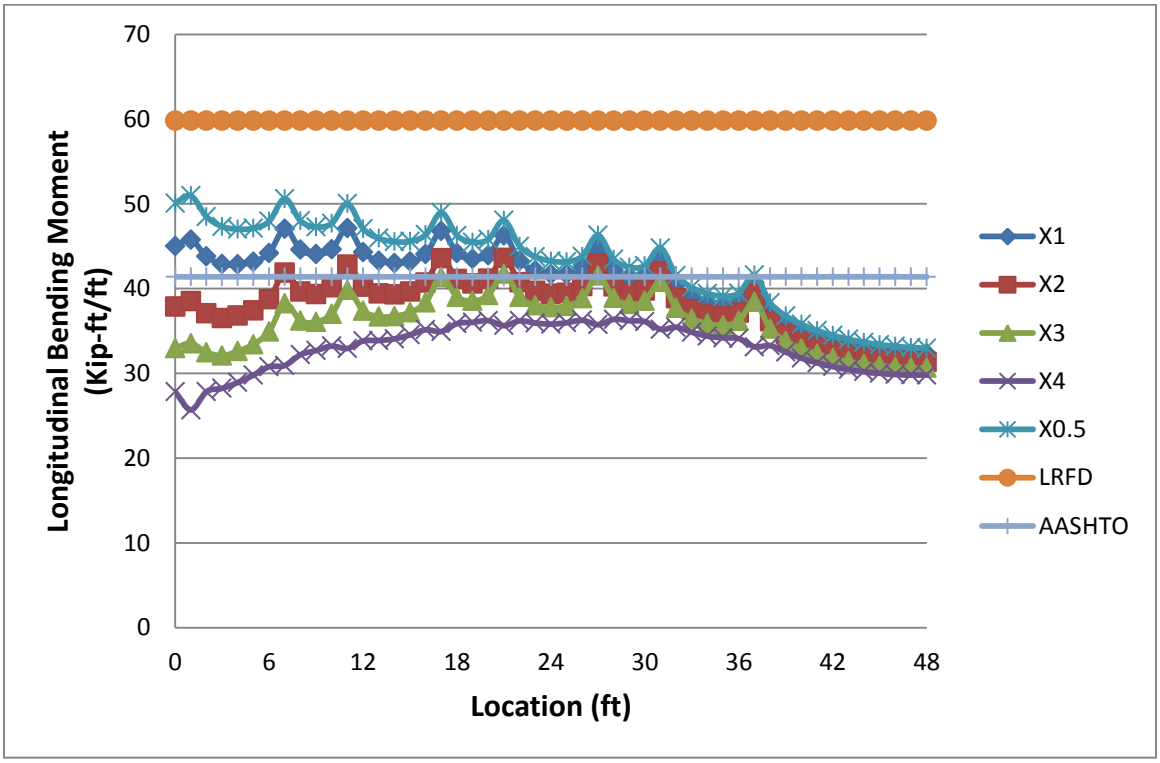

Table 12.3: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 46 ft, Deck Width = 48ft, One Railing with Edge Loading E1 (RIGHT)

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	56.5	59.8	55.9	59.8	55.5	59.8	55.1	59.8	57.0	59.8	41.4
1	57.7	59.8	57.1	59.8	56.7	59.8	56.3	59.8	58.2	59.8	41.4
2	54.0	59.8	53.3	59.8	52.9	59.8	52.5	59.8	54.4	59.8	41.4
3	52.3	59.8	51.6	59.8	51.2	59.8	50.8	59.8	52.8	59.8	41.4
4	51.5	59.8	50.8	59.8	50.3	59.8	50.0	59.8	52.0	59.8	41.4
5	51.2	59.8	50.5	59.8	50.0	59.8	49.6	59.8	51.7	59.8	41.4
6	51.7	59.8	51.0	59.8	50.5	59.8	50.1	59.8	52.2	59.8	41.4
7	54.1	59.8	53.3	59.8	52.8	59.8	52.4	59.8	54.6	59.8	41.4
8	51.1	59.8	50.4	59.8	49.8	59.8	49.4	59.8	51.7	59.8	41.4
9	50.2	59.8	49.4	59.8	48.8	59.8	48.4	59.8	50.7	59.8	41.4
10	50.3	59.8	49.5	59.8	48.9	59.8	48.5	59.8	50.9	59.8	41.4
11	52.4	59.8	51.6	59.8	51.0	59.8	50.5	59.8	53.0	59.8	41.4
12	49.2	59.8	48.3	59.8	47.7	59.8	47.3	59.8	49.8	59.8	41.4
13	47.9	59.8	47.0	59.8	46.3	59.8	45.8	59.8	48.5	59.8	41.4
14	47.3	59.8	46.3	59.8	45.6	59.8	45.1	59.8	47.9	59.8	41.4
15	47.1	59.8	46.1	59.8	45.4	59.8	44.9	59.8	47.8	59.8	41.4
16	47.7	59.8	46.6	59.8	45.9	59.8	45.3	59.8	48.4	59.8	41.4
17	50.1	59.8	49.0	59.8	48.2	59.8	47.6	59.8	50.8	59.8	41.4
18	47.2	59.8	46.0	59.8	45.2	59.8	44.6	59.8	47.9	59.8	41.4
19	46.2	59.8	45.0	59.8	44.2	59.8	43.5	59.8	47.0	59.8	41.4
20	46.3	59.8	45.1	59.8	44.2	59.8	43.6	59.8	47.1	59.8	41.4
21	48.3	59.8	47.0	59.8	46.1	59.8	45.5	59.8	49.2	59.8	41.4
22	45.1	59.8	43.7	59.8	42.8	59.8	42.1	59.8	46.0	59.8	41.4
23	43.7	59.8	42.2	59.8	41.2	59.8	40.5	59.8	44.6	59.8	41.4
24	42.9	59.8	41.5	59.8	40.4	59.8	39.7	59.8	44.0	59.8	41.4
25	42.7	59.8	41.1	59.8	40.0	59.8	39.2	59.8	43.7	59.8	41.4
26	43.1	59.8	41.5	59.8	40.3	59.8	39.5	59.8	44.2	59.8	41.4
27	45.4	59.8	43.7	59.8	42.5	59.8	41.6	59.8	46.5	59.8	41.4
28	42.3	59.8	40.5	59.8	39.3	59.8	38.4	59.8	43.6	59.8	41.4
29	41.2	59.8	39.3	59.8	38.0	59.8	37.0	59.8	42.5	59.8	41.4
30	41.2	59.8	39.2	59.8	37.8	59.8	36.8	59.8	42.5	59.8	41.4
31	43.0	59.8	41.0	59.8	39.5	59.8	38.5	59.8	44.5	59.8	41.4
32	39.6	59.8	37.4	59.8	35.9	59.8	34.8	59.8	41.1	59.8	41.4
33	37.9	59.8	35.7	59.8	34.1	59.8	32.9	59.8	39.5	59.8	41.4
34	37.0	59.8	34.6	59.8	32.9	59.8	31.7	59.8	38.6	59.8	41.4
35	36.5	59.8	33.9	59.8	32.2	59.8	30.9	59.8	38.2	59.8	41.4
36	36.6	59.8	33.9	59.8	32.1	59.8	30.7	59.8	38.4	59.8	41.4
37	38.5	59.8	35.7	59.8	33.8	59.8	32.3	59.8	40.3	59.8	41.4
38	34.9	59.8	32.0	59.8	30.0	59.8	28.5	59.8	36.9	59.8	41.4

39	33.1	59.8	30.1	59.8	28.0	59.8	26.4	59.8	35.2	59.8	41.4
40	31.9	59.8	28.7	59.8	26.5	59.8	24.8	59.8	34.1	59.8	41.4
41	30.9	59.8	27.5	59.8	25.2	59.8	23.5	59.8	33.2	59.8	41.4
42	30.0	59.8	26.5	59.8	24.1	59.8	22.3	59.8	32.4	59.8	41.4
43	29.3	59.8	25.6	59.8	23.0	59.8	21.2	59.8	31.8	59.8	41.4
44	28.6	59.8	24.8	59.8	22.1	59.8	20.1	59.8	31.3	59.8	41.4
45	28.0	59.8	24.0	59.8	21.2	59.8	19.1	59.8	30.8	59.8	41.4
46	27.5	59.8	23.3	59.8	20.4	59.8	18.2	59.8	30.4	59.8	41.4
47	27.0	59.8	22.5	59.8	19.4	59.8	17.1	59.8	30.0	59.8	41.4
48	26.9	59.8	22.5	59.8	19.4	59.8	17.1	59.8	30.0	59.8	41.4

Figure 12.3: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 46 ft, Deck Width = 48ft, One Railing with Edge Loading E1 (RIGHT)

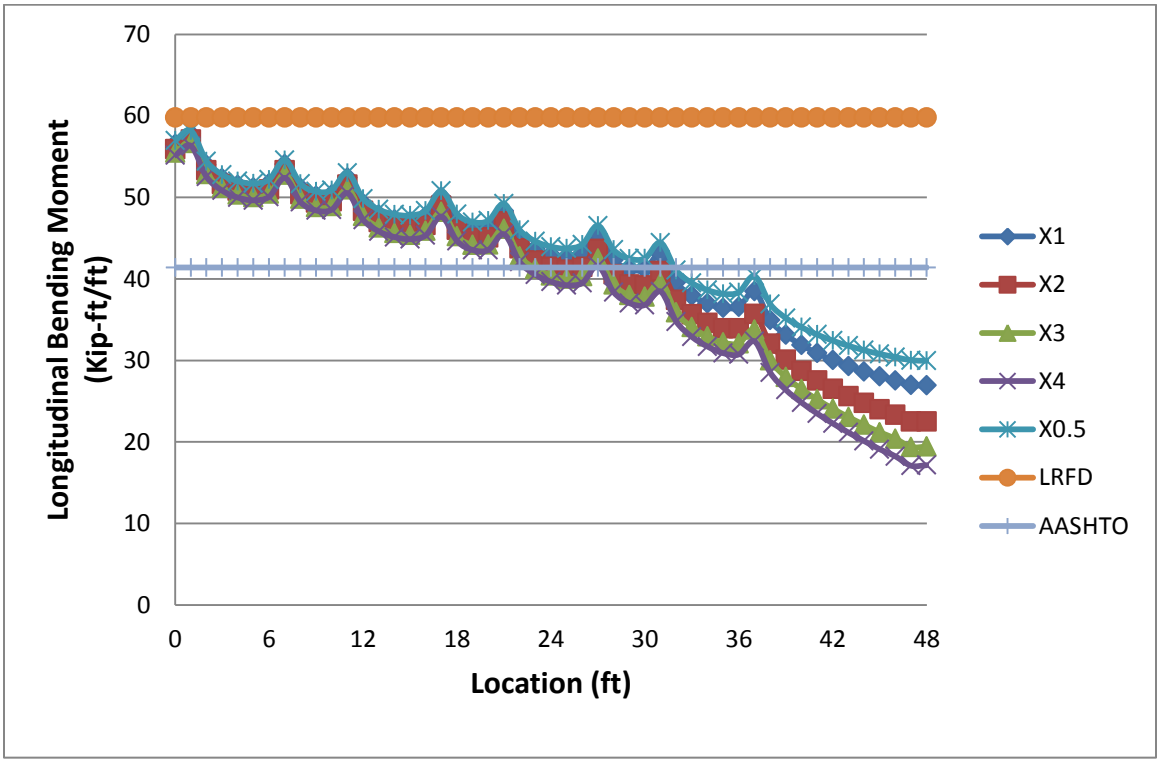

Table 12.4: Longitudinal Moment Distribution at Critical Section for Four-Lane Single Span Bridge Deck Span = 46 ft, Deck Width = 48 ft. Two Railings with Edge Loading E1

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	44.3	59.8	36.9	59.8	31.9	59.8	28.3	59.8	49.6	59.8	41.4
1	45.0	59.8	37.5	59.8	32.4	59.8	28.8	59.8	50.5	59.8	41.4
2	43.0	59.8	36.0	59.8	31.3	59.8	27.9	59.8	48.0	59.8	41.4
3	42.1	59.8	35.4	59.8	30.8	59.8	27.5	59.8	46.8	59.8	41.4
4	42.0	59.8	35.6	59.8	31.3	59.8	28.1	59.8	46.5	59.8	41.4
5	42.3	59.8	36.2	59.8	32.0	59.8	29.0	59.8	46.6	59.8	41.4
6	43.3	59.8	37.4	59.8	33.4	59.8	30.5	59.8	47.4	59.8	41.4
7	46.1	59.8	40.5	59.8	36.6	59.8	33.8	59.8	50.0	59.8	41.4
8	43.6	59.8	38.2	59.8	34.5	59.8	31.8	59.8	47.4	59.8	41.4
9	43.0	59.8	37.8	59.8	34.3	59.8	31.7	59.8	46.6	59.8	41.4
10	43.5	59.8	38.5	59.8	35.1	59.8	32.6	59.8	47.0	59.8	41.4
11	46.0	59.8	41.1	59.8	37.8	59.8	35.4	59.8	49.3	59.8	41.4
12	43.1	59.8	38.4	59.8	35.2	59.8	32.9	59.8	46.3	59.8	41.4
13	42.0	59.8	37.5	59.8	34.4	59.8	32.2	59.8	45.2	59.8	41.4
14	41.7	59.8	37.3	59.8	34.3	59.8	32.2	59.8	44.8	59.8	41.4
15	41.8	59.8	37.6	59.8	34.7	59.8	32.6	59.8	44.8	59.8	41.4
16	42.6	59.8	38.5	59.8	35.7	59.8	33.6	59.8	45.5	59.8	41.4
17	45.3	59.8	41.2	59.8	38.5	59.8	36.5	59.8	48.1	59.8	41.4
18	42.6	59.8	38.7	59.8	36.0	59.8	34.1	59.8	45.3	59.8	41.4
19	41.8	59.8	38.0	59.8	35.4	59.8	33.5	59.8	44.5	59.8	41.4
20	42.2	59.8	38.4	59.8	35.9	59.8	34.1	59.8	44.8	59.8	41.4
21	44.4	59.8	40.7	59.8	38.3	59.8	36.5	59.8	47.0	59.8	41.4
22	41.3	59.8	37.7	59.8	35.3	59.8	33.5	59.8	43.9	59.8	41.4
23	40.1	59.8	36.5	59.8	34.1	59.8	32.4	59.8	42.6	59.8	41.4
24	39.6	59.8	36.0	59.8	33.7	59.8	32.0	59.8	42.0	59.8	41.4
25	39.4	59.8	36.0	59.8	33.6	59.8	31.9	59.8	41.9	59.8	41.4
26	40.0	59.8	36.6	59.8	34.3	59.8	32.6	59.8	42.5	59.8	41.4
27	42.5	59.8	39.0	59.8	36.7	59.8	35.1	59.8	44.9	59.8	41.4
28	39.6	59.8	36.1	59.8	33.8	59.8	32.2	59.8	42.0	59.8	41.4
29	38.6	59.8	35.1	59.8	32.8	59.8	31.2	59.8	41.0	59.8	41.4
30	38.6	59.8	35.2	59.8	32.9	59.8	31.3	59.8	41.1	59.8	41.4
31	40.6	59.8	37.2	59.8	34.9	59.8	33.2	59.8	43.1	59.8	41.4
32	37.3	59.8	33.8	59.8	31.5	59.8	29.8	59.8	39.7	59.8	41.4
33	35.7	59.8	32.2	59.8	29.9	59.8	28.2	59.8	38.2	59.8	41.4
34	34.9	59.8	31.4	59.8	29.0	59.8	27.3	59.8	37.4	59.8	41.4
35	34.4	59.8	30.9	59.8	28.4	59.8	26.7	59.8	37.0	59.8	41.4
36	34.7	59.8	31.0	59.8	28.6	59.8	26.8	59.8	37.2	59.8	41.4
37	36.6	59.8	32.9	59.8	30.4	59.8	28.6	59.8	39.3	59.8	41.4
38	33.2	59.8	29.4	59.8	26.8	59.8	25.0	59.8	35.9	59.8	41.4

39	31.4	59.8	27.6	59.8	25.0	59.8	23.1	59.8	34.2	59.8	41.4
40	30.3	59.8	26.3	59.8	23.7	59.8	21.8	59.8	33.1	59.8	41.4
41	29.3	59.8	25.3	59.8	22.5	59.8	20.6	59.8	32.2	59.8	41.4
42	28.5	59.8	24.4	59.8	21.6	59.8	19.6	59.8	31.5	59.8	41.4
43	27.9	59.8	23.6	59.8	20.7	59.8	18.6	59.8	30.9	59.8	41.4
44	27.3	59.8	22.8	59.8	19.9	59.8	17.8	59.8	30.4	59.8	41.4
45	26.7	59.8	22.1	59.8	19.1	59.8	16.9	59.8	30.0	59.8	41.4
46	26.3	59.8	21.6	59.8	18.4	59.8	16.2	59.8	29.6	59.8	41.4
47	25.8	59.8	20.8	59.8	17.6	59.8	15.2	59.8	29.3	59.8	41.4
48	25.8	59.8	20.9	59.8	17.7	59.8	15.4	59.8	29.2	59.8	41.4

Figure 12.4: Longitudinal Moment Distribution at Critical Section for Four-Lane Single Span Bridge Deck Span = 46 ft, Deck Width = 48 ft. Two Railings with Edge Loading E1

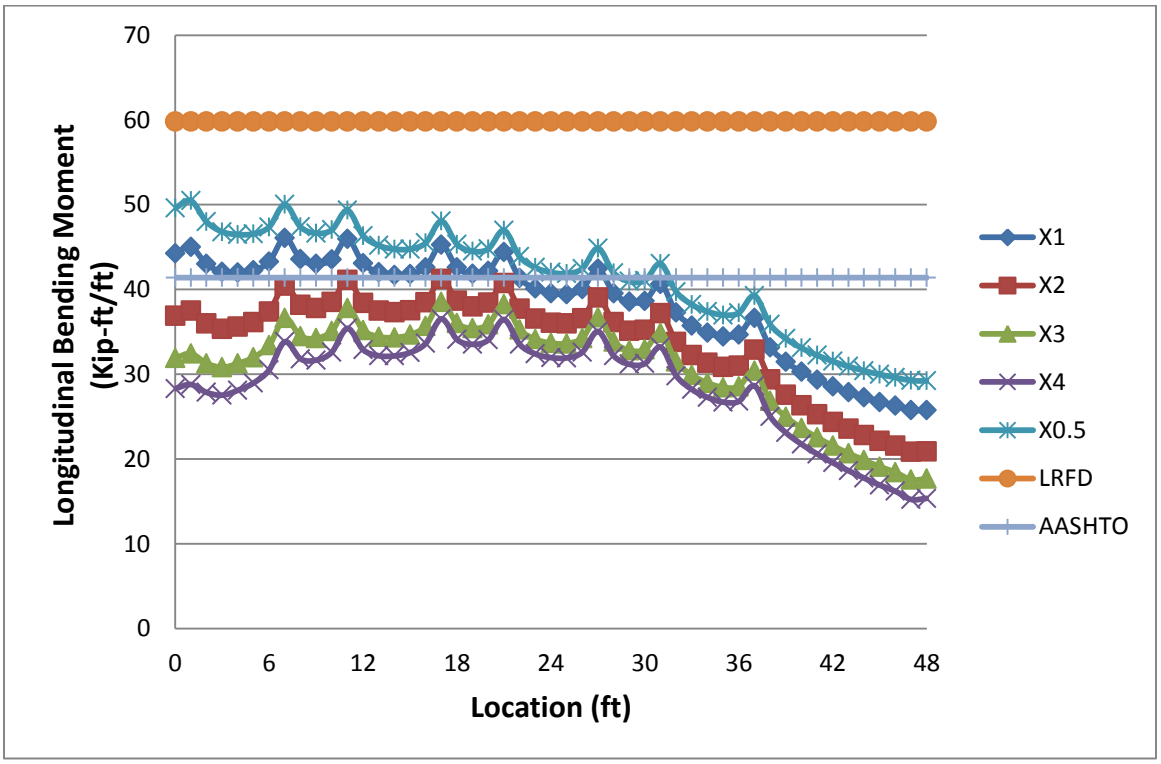

Table 13.1: Longitudinal Moment Distribution at Critical Section for One-Lane Single Span Bridge Deck Span = 54 ft, Deck Width = 14 ft, No Railings with Edge Loading E1

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	54.5	75.3	54.5	75.3	54.5	75.3	54.5	75.3	54.5	75.3	50.2
1	55.9	75.3	55.9	75.3	55.9	75.3	55.9	75.3	55.9	75.3	50.2
2	52.2	75.3	52.2	75.3	52.2	75.3	52.2	75.3	52.2	75.3	50.2
3	50.6	75.3	50.6	75.3	50.6	75.3	50.6	75.3	50.6	75.3	50.2
4	49.9	75.3	49.9	75.3	49.9	75.3	49.9	75.3	49.9	75.3	50.2
5	49.6	75.3	49.6	75.3	49.6	75.3	49.6	75.3	49.6	75.3	50.2
6	50.0	75.3	50.0	75.3	50.0	75.3	50.0	75.3	50.0	75.3	50.2
7	52.2	75.3	52.2	75.3	52.2	75.3	52.2	75.3	52.2	75.3	50.2
8	49.1	75.3	49.1	75.3	49.1	75.3	49.1	75.3	49.1	75.3	50.2
9	47.7	75.3	47.7	75.3	47.7	75.3	47.7	75.3	47.7	75.3	50.2
10	46.9	75.3	46.9	75.3	46.9	75.3	46.9	75.3	46.9	75.3	50.2
11	46.3	75.3	46.3	75.3	46.3	75.3	46.3	75.3	46.3	75.3	50.2
12	45.9	75.3	45.9	75.3	45.9	75.3	45.9	75.3	45.9	75.3	50.2
13	45.7	75.3	45.7	75.3	45.7	75.3	45.7	75.3	45.7	75.3	50.2
14	45.5	75.3	45.5	75.3	45.5	75.3	45.5	75.3	45.5	75.3	50.2

Figure 13.1: Longitudinal Moment Distribution at Critical Section for One-Lane Single Span Bridge Deck Span = 54 ft, Deck Width = 14 ft, No Railings with Edge Loading E1

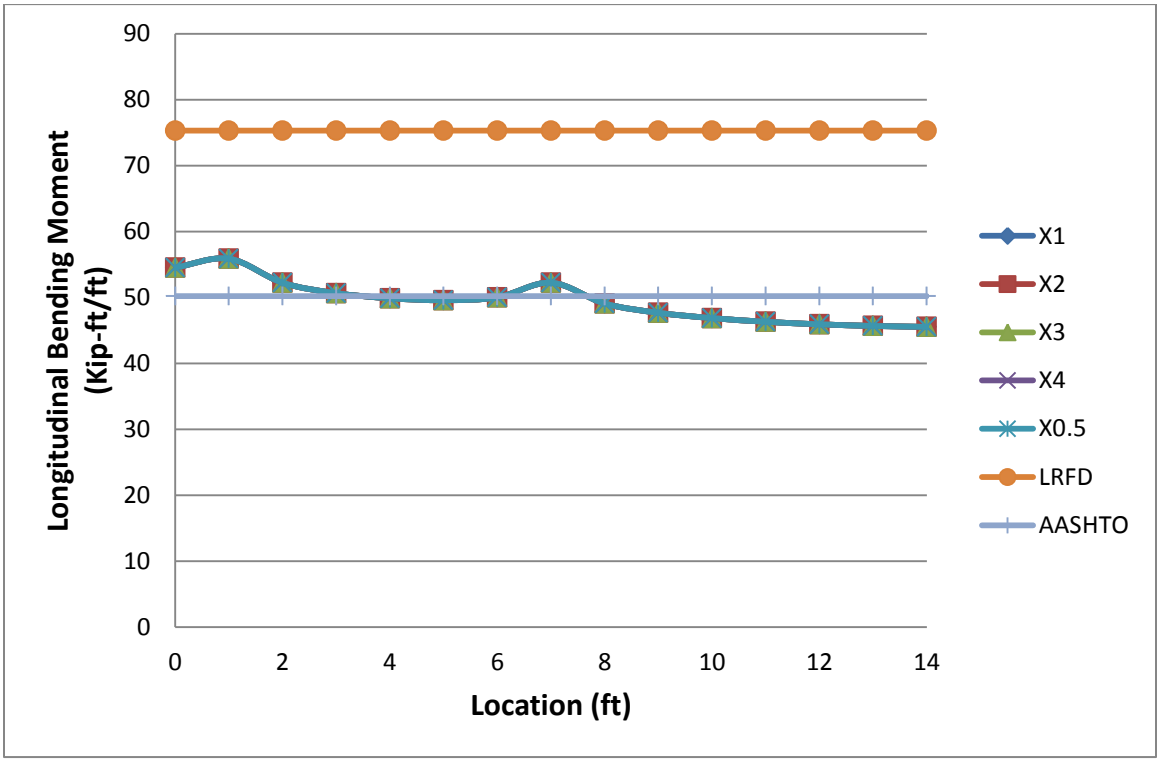

Table 13.2: Longitudinal Moment Distribution at Critical Section for One-Lane Single Span Bridge Deck Span = 54 ft, Deck Width = 14 ft, One Railing with Edge Loading E1 (LEFT)

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	42.0	75.3	34.8	75.3	30.0	75.3	26.4	75.3	47.2	75.3	50.2
1	42.8	75.3	35.5	75.3	30.6	75.3	27.0	75.3	48.1	75.3	50.2
2	40.5	75.3	33.6	75.3	28.9	75.3	25.5	75.3	45.5	75.3	50.2
3	39.4	75.3	32.6	75.3	28.0	75.3	24.7	75.3	44.2	75.3	50.2
4	39.1	75.3	32.5	75.3	28.0	75.3	24.7	75.3	43.7	75.3	50.2
5	39.1	75.3	32.7	75.3	28.3	75.3	25.1	75.3	43.6	75.3	50.2
6	39.8	75.3	33.5	75.3	29.2	75.3	26.0	75.3	44.2	75.3	50.2
7	42.3	75.3	36.1	75.3	31.8	75.3	28.7	75.3	46.6	75.3	50.2
8	39.3	75.3	33.2	75.3	29.0	75.3	25.9	75.3	43.5	75.3	50.2
9	38.0	75.3	32.0	75.3	27.9	75.3	24.9	75.3	42.2	75.3	50.2
10	37.4	75.3	31.4	75.3	27.3	75.3	24.4	75.3	41.5	75.3	50.2
11	36.9	75.3	31.0	75.3	27.0	75.3	24.0	75.3	41.0	75.3	50.2
12	36.6	75.3	30.8	75.3	26.8	75.3	23.9	75.3	40.7	75.3	50.2
13	36.5	75.3	30.7	75.3	26.7	75.3	23.8	75.3	40.5	75.3	50.2
14	36.4	75.3	30.6	75.3	26.7	75.3	23.8	75.3	40.4	75.3	50.2

Figure 13.2: Longitudinal Moment Distribution at Critical Section for One-Lane Single Span Bridge Deck Span = 54 ft, Deck Width = 14 ft, One Railing with Edge Loading E1 (LEFT)

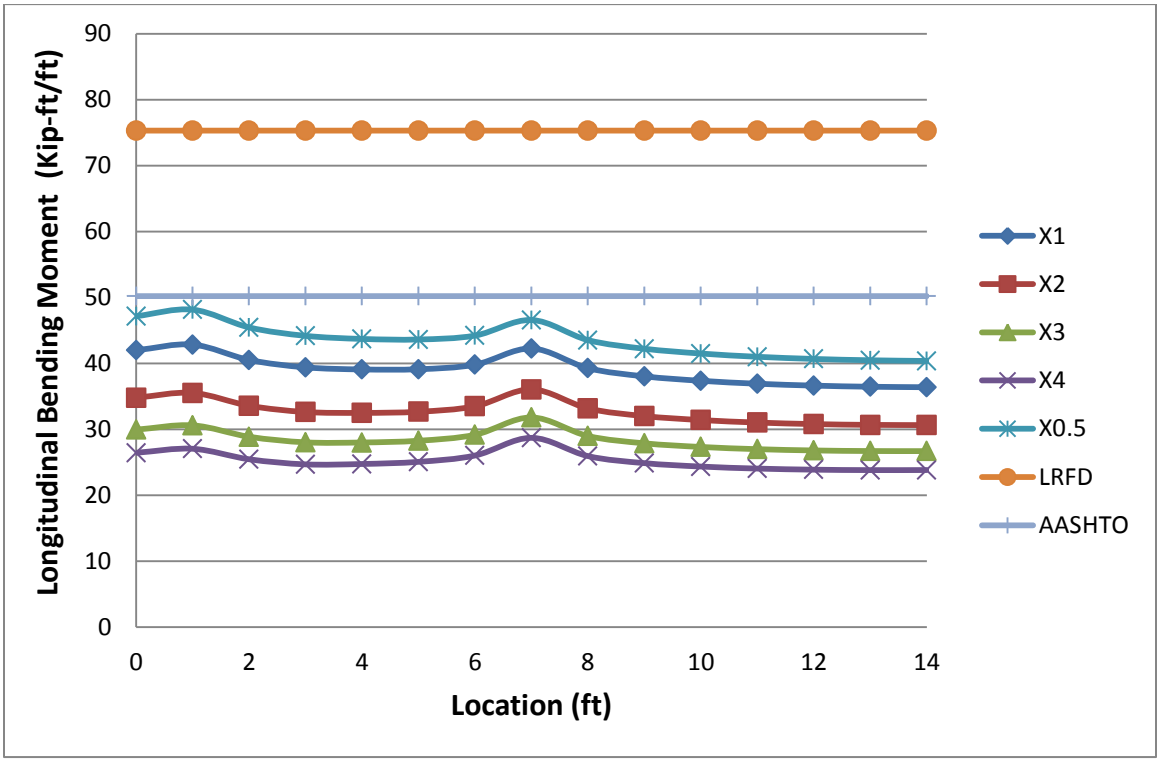

Table 13.3: Longitudinal Moment Distribution at Critical Section for One-Lane Single Span Bridge Deck Span = 54 ft, Deck Width = 14 ft, One Railing with Edge Loading E1 (RIGHT)

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	46.1	75.3	40.8	75.3	37.2	75.3	34.6	75.3	49.8	75.3	50.2
1	47.4	75.3	42.1	75.3	38.4	75.3	35.8	75.3	51.1	75.3	50.2
2	43.7	75.3	38.3	75.3	34.6	75.3	32.0	75.3	47.4	75.3	50.2
3	42.0	75.3	36.6	75.3	32.9	75.3	30.2	75.3	45.8	75.3	50.2
4	41.2	75.3	35.7	75.3	31.9	75.3	29.2	75.3	45.0	75.3	50.2
5	40.8	75.3	35.2	75.3	31.4	75.3	28.7	75.3	44.6	75.3	50.2
6	41.1	75.3	35.5	75.3	31.6	75.3	28.8	75.3	45.0	75.3	50.2
7	43.2	75.3	37.5	75.3	33.6	75.3	30.8	75.3	47.1	75.3	50.2
8	39.9	75.3	34.1	75.3	30.2	75.3	27.3	75.3	43.9	75.3	50.2
9	38.3	75.3	32.5	75.3	28.4	75.3	25.5	75.3	42.4	75.3	50.2
10	37.3	75.3	31.4	75.3	27.3	75.3	24.3	75.3	41.5	75.3	50.2
11	36.6	75.3	30.5	75.3	26.3	75.3	23.3	75.3	40.8	75.3	50.2
12	36.0	75.3	29.8	75.3	25.6	75.3	22.5	75.3	40.3	75.3	50.2
13	35.4	75.3	29.1	75.3	24.7	75.3	21.5	75.3	39.9	75.3	50.2
14	35.4	75.3	29.1	75.3	24.7	75.3	21.6	75.3	39.8	75.3	50.2

Figure 13.3: Longitudinal Moment Distribution at Critical Section for One-Lane Single Span Bridge Deck Span = 54 ft, Deck Width = 14 ft, One Railing with Edge Loading E1 (RIGHT)

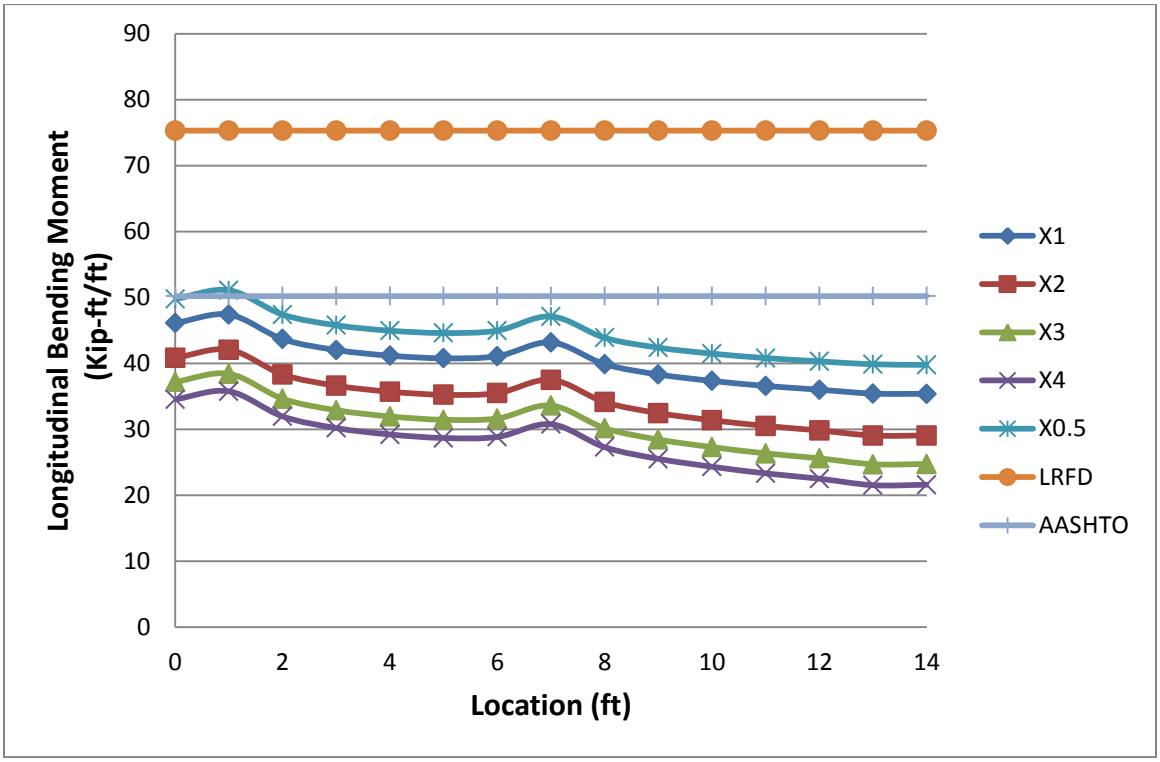

Table 13.4: Longitudinal Moment Distribution at Critical Section for One-Lane Single Span Bridge Deck Span = 54 ft, Deck Width = 14 ft. Two Railings with Edge Loading E1

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	36.6	75.3	28.3	75.3	23.5	75.3	20.3	75.3	43.4	75.3	50.2
1	37.4	75.3	29.0	75.3	24.1	75.3	20.9	75.3	44.4	75.3	50.2
2	35.0	75.3	26.9	75.3	22.1	75.3	19.0	75.3	41.7	75.3	50.2
3	33.8	75.3	25.8	75.3	21.1	75.3	18.0	75.3	40.3	75.3	50.2
4	33.3	75.3	25.5	75.3	20.9	75.3	17.8	75.3	39.8	75.3	50.2
5	33.3	75.3	25.5	75.3	20.9	75.3	17.9	75.3	39.7	75.3	50.2
6	33.8	75.3	26.1	75.3	21.6	75.3	18.6	75.3	40.2	75.3	50.2
7	36.2	75.3	28.5	75.3	24.0	75.3	21.0	75.3	42.5	75.3	50.2
8	33.1	75.3	25.4	75.3	20.9	75.3	17.9	75.3	39.4	75.3	50.2
9	31.7	75.3	24.0	75.3	19.5	75.3	16.5	75.3	38.0	75.3	50.2
10	30.8	75.3	23.1	75.3	18.6	75.3	15.7	75.3	37.1	75.3	50.2
11	30.2	75.3	22.5	75.3	18.0	75.3	15.0	75.3	36.5	75.3	50.2
12	29.7	75.3	22.0	75.3	17.5	75.3	14.5	75.3	36.1	75.3	50.2
13	29.3	75.3	21.5	75.3	16.9	75.3	13.9	75.3	35.7	75.3	50.2
14	29.3	75.3	21.5	75.3	17.0	75.3	14.0	75.3	35.6	75.3	50.2

Figure 13.4: Longitudinal Moment Distribution at Critical Section for One-Lane Single Span Bridge Deck Span = 54 ft, Deck Width = 14 ft. Two Railings with Edge Loading E1

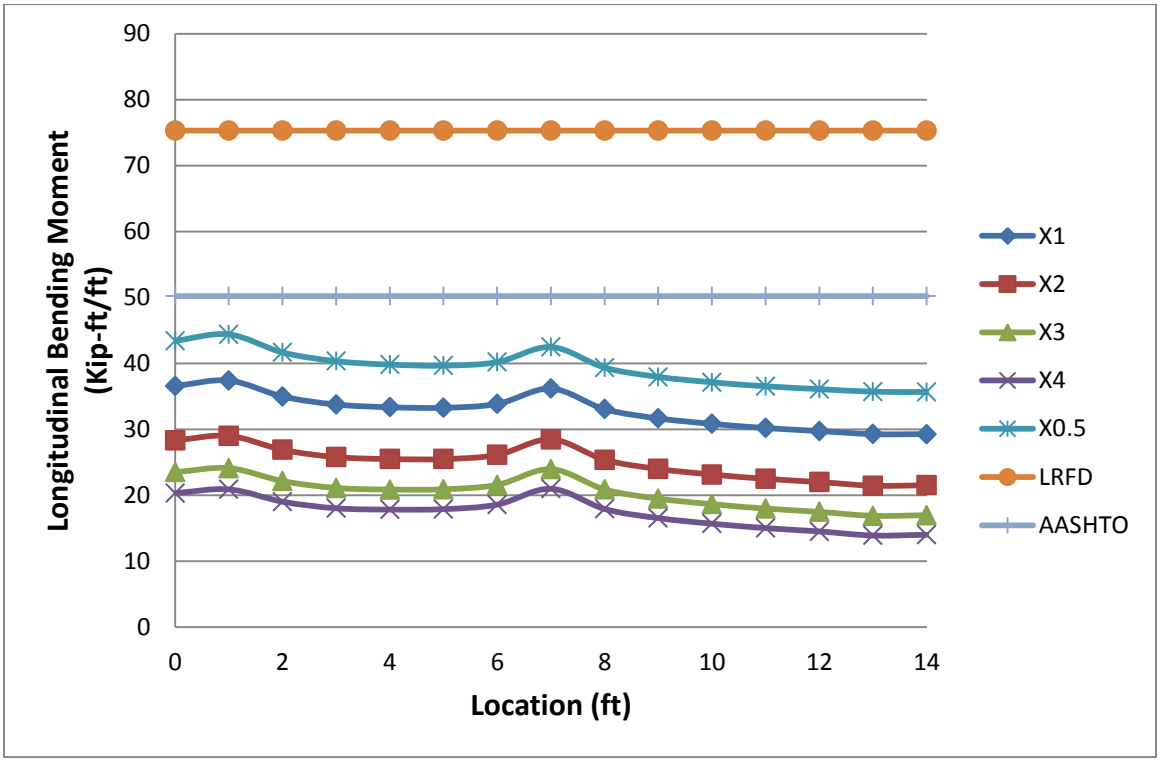

Table 14.1: Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge Deck Span = 54 ft, Deck Width = 24 ft, No Railings with Edge Loading E1

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	64.5	81.7	64.5	81.7	64.5	81.7	64.5	81.7	64.5	81.7	50.2
1	65.8	81.7	65.8	81.7	65.8	81.7	65.8	81.7	65.8	81.7	50.2
2	62.1	81.7	62.1	81.7	62.1	81.7	62.1	81.7	62.1	81.7	50.2
3	60.5	81.7	60.5	81.7	60.5	81.7	60.5	81.7	60.5	81.7	50.2
4	59.7	81.7	59.7	81.7	59.7	81.7	59.7	81.7	59.7	81.7	50.2
5	59.4	81.7	59.4	81.7	59.4	81.7	59.4	81.7	59.4	81.7	50.2
6	60.0	81.7	60.0	81.7	60.0	81.7	60.0	81.7	60.0	81.7	50.2
7	62.3	81.7	62.3	81.7	62.3	81.7	62.3	81.7	62.3	81.7	50.2
8	59.5	81.7	59.5	81.7	59.5	81.7	59.5	81.7	59.5	81.7	50.2
9	58.5	81.7	58.5	81.7	58.5	81.7	58.5	81.7	58.5	81.7	50.2
10	58.7	81.7	58.7	81.7	58.7	81.7	58.7	81.7	58.7	81.7	50.2
11	60.8	81.7	60.8	81.7	60.8	81.7	60.8	81.7	60.8	81.7	50.2
12	57.7	81.7	57.7	81.7	57.7	81.7	57.7	81.7	57.7	81.7	50.2
13	56.3	81.7	56.3	81.7	56.3	81.7	56.3	81.7	56.3	81.7	50.2
14	55.7	81.7	55.7	81.7	55.7	81.7	55.7	81.7	55.7	81.7	50.2
15	55.5	81.7	55.5	81.7	55.5	81.7	55.5	81.7	55.5	81.7	50.2
16	56.0	81.7	56.0	81.7	56.0	81.7	56.0	81.7	56.0	81.7	50.2
17	58.3	81.7	58.3	81.7	58.3	81.7	58.3	81.7	58.3	81.7	50.2
18	55.2	81.7	55.2	81.7	55.2	81.7	55.2	81.7	55.2	81.7	50.2
19	53.8	81.7	53.8	81.7	53.8	81.7	53.8	81.7	53.8	81.7	50.2
20	53.1	81.7	53.1	81.7	53.1	81.7	53.1	81.7	53.1	81.7	50.2
21	52.6	81.7	52.6	81.7	52.6	81.7	52.6	81.7	52.6	81.7	50.2
22	52.3	81.7	52.3	81.7	52.3	81.7	52.3	81.7	52.3	81.7	50.2
23	52.1	81.7	52.1	81.7	52.1	81.7	52.1	81.7	52.1	81.7	50.2
24	52.0	81.7	52.0	81.7	52.0	81.7	52.0	81.7	52.0	81.7	50.2

Figure 14.1: Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge Deck Span = 54 ft, Deck Width = 24 ft, No Railings with Edge Loading E1

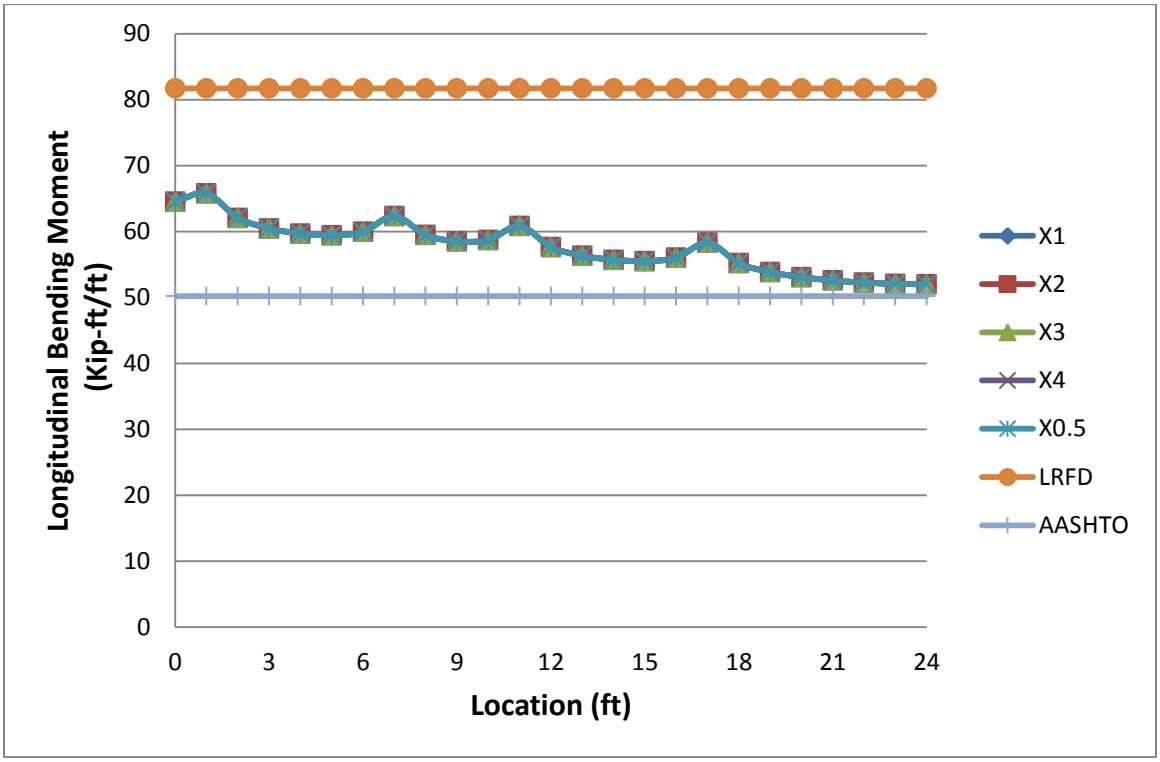

Table 14.2: Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge Deck Span = 54 ft, Deck Width = 24 ft, One Railing with Edge Loading E1 (LEFT)

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	53.1	81.7	45.9	81.7	40.6	81.7	36.6	81.7	57.9	81.7	50.2
1	53.9	81.7	46.5	81.7	41.2	81.7	37.1	81.7	58.8	81.7	50.2
2	51.6	81.7	44.7	81.7	39.7	81.7	35.8	81.7	56.2	81.7	50.2
3	50.5	81.7	43.9	81.7	39.0	81.7	35.2	81.7	54.9	81.7	50.2
4	50.3	81.7	43.9	81.7	39.2	81.7	35.5	81.7	54.5	81.7	50.2
5	50.4	81.7	44.2	81.7	39.7	81.7	36.1	81.7	54.5	81.7	50.2
6	51.3	81.7	45.3	81.7	40.9	81.7	37.4	81.7	55.2	81.7	50.2
7	54.0	81.7	48.2	81.7	43.9	81.7	40.5	81.7	57.8	81.7	50.2
8	51.4	81.7	45.7	81.7	41.5	81.7	38.3	81.7	55.0	81.7	50.2
9	50.7	81.7	45.2	81.7	41.1	81.7	37.9	81.7	54.2	81.7	50.2
10	51.1	81.7	45.7	81.7	41.8	81.7	38.7	81.7	54.5	81.7	50.2
11	53.4	81.7	48.2	81.7	44.3	81.7	41.3	81.7	56.8	81.7	50.2
12	50.4	81.7	45.3	81.7	41.5	81.7	38.6	81.7	53.7	81.7	50.2
13	49.2	81.7	44.3	81.7	40.5	81.7	37.7	81.7	52.5	81.7	50.2
14	48.8	81.7	43.9	81.7	40.3	81.7	37.4	81.7	51.9	81.7	50.2
15	48.7	81.7	43.9	81.7	40.4	81.7	37.6	81.7	51.8	81.7	50.2
16	49.4	81.7	44.7	81.7	41.2	81.7	38.5	81.7	52.4	81.7	50.2
17	51.8	81.7	47.2	81.7	43.7	81.7	41.1	81.7	54.7	81.7	50.2
18	48.8	81.7	44.2	81.7	40.9	81.7	38.3	81.7	51.7	81.7	50.2
19	47.5	81.7	43.1	81.7	39.7	81.7	37.2	81.7	50.4	81.7	50.2
20	46.9	81.7	42.5	81.7	39.2	81.7	36.7	81.7	49.7	81.7	50.2
21	46.4	81.7	42.1	81.7	38.9	81.7	36.4	81.7	49.2	81.7	50.2
22	46.2	81.7	41.9	81.7	38.7	81.7	36.2	81.7	48.9	81.7	50.2
23	46.1	81.7	41.8	81.7	38.7	81.7	36.2	81.7	48.8	81.7	50.2
24	46.1	81.7	41.9	81.7	38.7	81.7	36.3	81.7	48.8	81.7	50.2

Figure 14.2: Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge Deck Span = 54 ft, Deck Width = 24 ft, One Railing with Edge Loading E1 (LEFT)

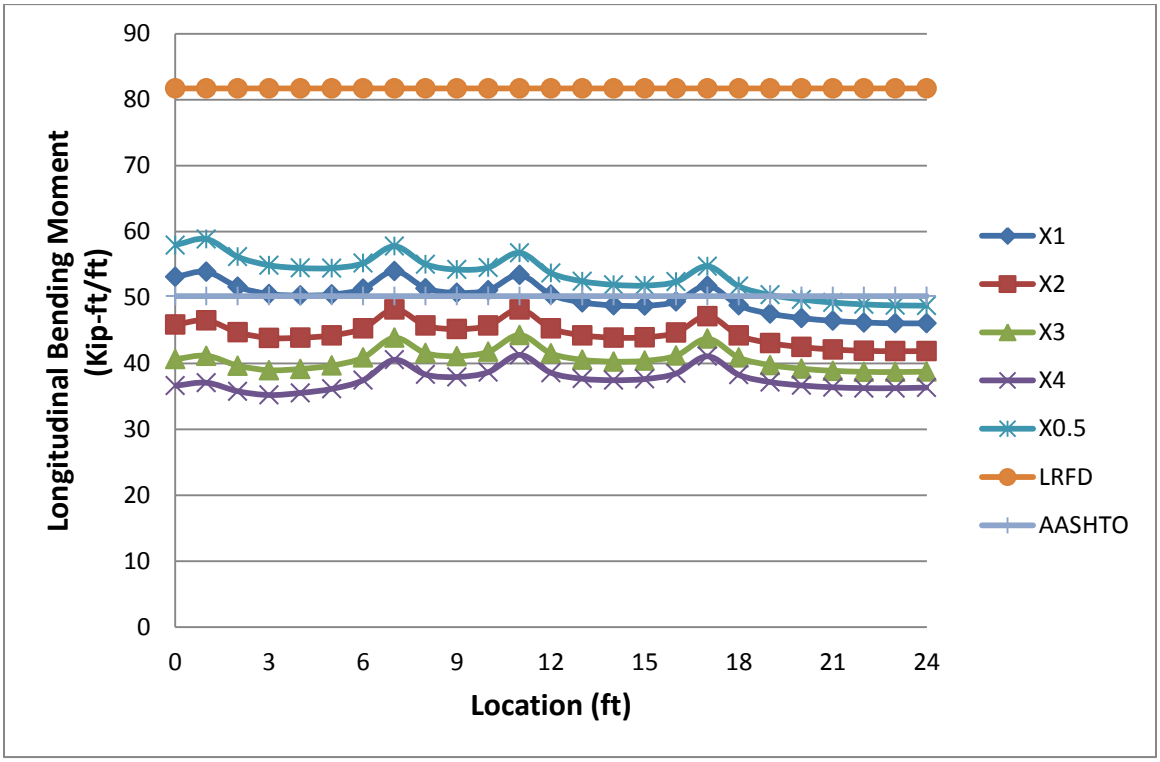

Table 14.3: Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge Deck Span = 54 ft, Deck Width = 24 ft, One Railing with Edge Loading E1 (RIGHT)

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	59.3	81.7	55.6	81.7	52.9	81.7	50.8	81.7	61.7	81.7	50.2
1	60.5	81.7	56.8	81.7	54.0	81.7	51.9	81.7	62.9	81.7	50.2
2	56.8	81.7	53.0	81.7	50.2	81.7	48.0	81.7	59.2	81.7	50.2
3	55.1	81.7	51.3	81.7	48.4	81.7	46.2	81.7	57.5	81.7	50.2
4	54.2	81.7	50.4	81.7	47.5	81.7	45.3	81.7	56.7	81.7	50.2
5	53.9	81.7	50.0	81.7	47.1	81.7	44.8	81.7	56.4	81.7	50.2
6	54.3	81.7	50.4	81.7	47.4	81.7	45.1	81.7	56.9	81.7	50.2
7	56.6	81.7	52.6	81.7	49.6	81.7	47.2	81.7	59.2	81.7	50.2
8	53.6	81.7	49.5	81.7	46.5	81.7	44.1	81.7	56.3	81.7	50.2
9	52.6	81.7	48.4	81.7	45.3	81.7	42.9	81.7	55.3	81.7	50.2
10	52.7	81.7	48.4	81.7	45.2	81.7	42.7	81.7	55.4	81.7	50.2
11	54.7	81.7	50.3	81.7	47.0	81.7	44.5	81.7	57.5	81.7	50.2
12	51.3	81.7	46.9	81.7	43.5	81.7	41.0	81.7	54.2	81.7	50.2
13	49.8	81.7	45.3	81.7	41.9	81.7	39.2	81.7	52.8	81.7	50.2
14	49.1	81.7	44.4	81.7	40.9	81.7	38.2	81.7	52.1	81.7	50.2
15	48.7	81.7	43.9	81.7	40.3	81.7	37.6	81.7	51.8	81.7	50.2
16	49.0	81.7	44.1	81.7	40.4	81.7	37.6	81.7	52.2	81.7	50.2
17	51.1	81.7	46.1	81.7	42.3	81.7	39.4	81.7	54.4	81.7	50.2
18	47.8	81.7	42.6	81.7	38.8	81.7	35.8	81.7	51.2	81.7	50.2
19	46.2	81.7	40.9	81.7	36.9	81.7	33.8	81.7	49.7	81.7	50.2
20	45.3	81.7	39.8	81.7	35.7	81.7	32.5	81.7	48.8	81.7	50.2
21	44.5	81.7	38.8	81.7	34.6	81.7	31.3	81.7	48.1	81.7	50.2
22	43.9	81.7	38.1	81.7	33.8	81.7	30.4	81.7	47.7	81.7	50.2
23	43.3	81.7	37.2	81.7	32.7	81.7	29.2	81.7	47.3	81.7	50.2
24	43.4	81.7	37.3	81.7	32.9	81.7	29.4	81.7	47.2	81.7	50.2

Figure14.3: Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge Deck Span = 54 ft, Deck Width = 24 ft, One Railing with Edge Loading E1 (RIGHT)

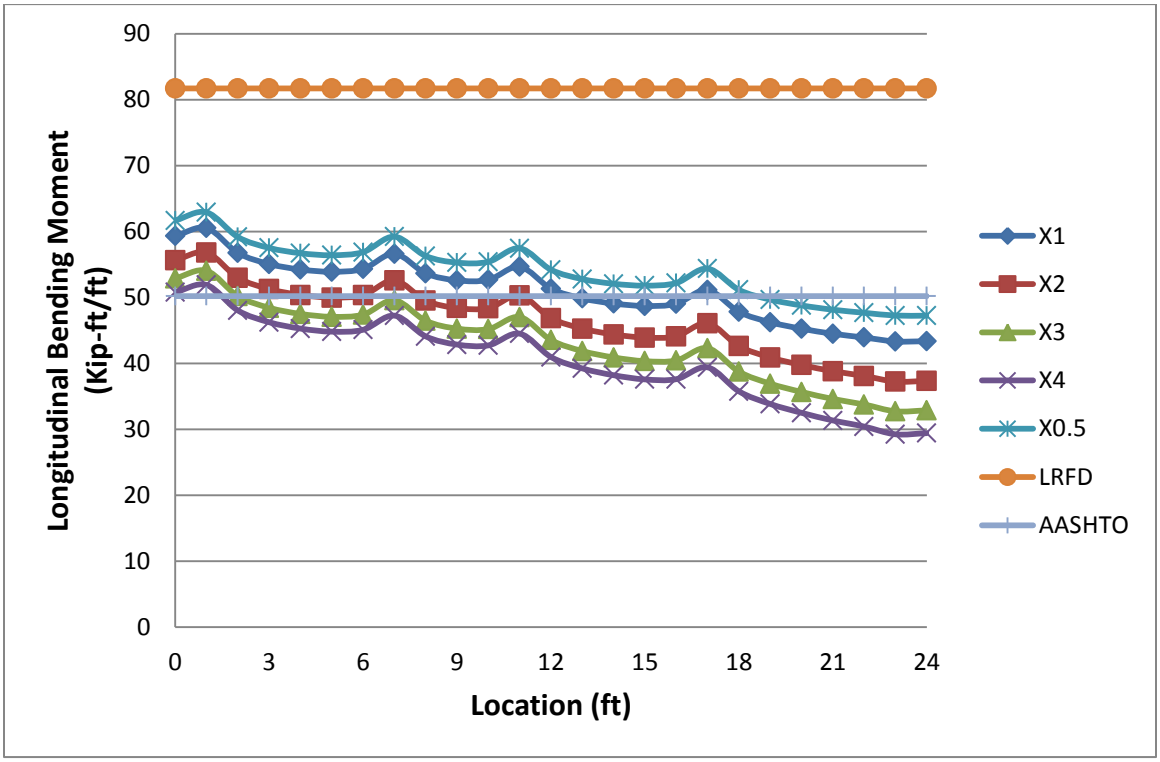

Table 14.4: Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge Deck Span = 54 ft, Deck Width = 24 ft. Two Railings with Edge Loading E1

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	49.2	81.7	40.6	81.7	34.9	81.7	30.8	81.7	55.5	81.7	50.2
1	49.9	81.7	41.2	81.7	35.3	81.7	31.2	81.7	56.4	81.7	50.2
2	47.6	81.7	39.2	81.7	33.6	81.7	29.6	81.7	53.7	81.7	50.2
3	46.4	81.7	38.2	81.7	32.7	81.7	28.8	81.7	52.3	81.7	50.2
4	46.1	81.7	38.1	81.7	32.7	81.7	28.8	81.7	51.9	81.7	50.2
5	46.2	81.7	38.3	81.7	33.0	81.7	29.2	81.7	51.8	81.7	50.2
6	46.9	81.7	39.2	81.7	33.9	81.7	30.2	81.7	52.5	81.7	50.2
7	49.5	81.7	41.9	81.7	36.7	81.7	33.0	81.7	55.0	81.7	50.2
8	46.8	81.7	39.2	81.7	34.1	81.7	30.5	81.7	52.2	81.7	50.2
9	46.0	81.7	38.5	81.7	33.4	81.7	29.8	81.7	51.4	81.7	50.2
10	46.3	81.7	38.8	81.7	33.8	81.7	30.2	81.7	51.6	81.7	50.2
11	48.5	81.7	41.0	81.7	36.0	81.7	32.5	81.7	53.8	81.7	50.2
12	45.3	81.7	37.9	81.7	33.0	81.7	29.4	81.7	50.6	81.7	50.2
13	44.0	81.7	36.6	81.7	31.7	81.7	28.1	81.7	49.3	81.7	50.2
14	43.4	81.7	36.0	81.7	31.1	81.7	27.5	81.7	48.7	81.7	50.2
15	43.2	81.7	35.8	81.7	30.9	81.7	27.3	81.7	48.5	81.7	50.2
16	43.7	81.7	36.2	81.7	31.3	81.7	27.8	81.7	49.0	81.7	50.2
17	45.9	81.7	38.4	81.7	33.5	81.7	29.9	81.7	51.2	81.7	50.2
18	42.7	81.7	35.2	81.7	30.2	81.7	26.7	81.7	48.1	81.7	50.2
19	41.2	81.7	33.7	81.7	28.7	81.7	25.1	81.7	46.6	81.7	50.2
20	40.4	81.7	32.7	81.7	27.7	81.7	24.1	81.7	45.8	81.7	50.2
21	39.7	81.7	32.0	81.7	26.9	81.7	23.3	81.7	45.2	81.7	50.2
22	39.2	81.7	31.5	81.7	26.3	81.7	22.7	81.7	44.8	81.7	50.2
23	38.7	81.7	30.8	81.7	25.6	81.7	21.8	81.7	44.4	81.7	50.2
24	38.8	81.7	31.0	81.7	25.8	81.7	22.1	81.7	44.4	81.7	50.2

Figure 14.4: Longitudinal Moment Distribution at Critical Section for Two-Lane Single Span Bridge Deck Span = 54 ft, Deck Width = 24 ft. Two Railings with Edge Loading E1

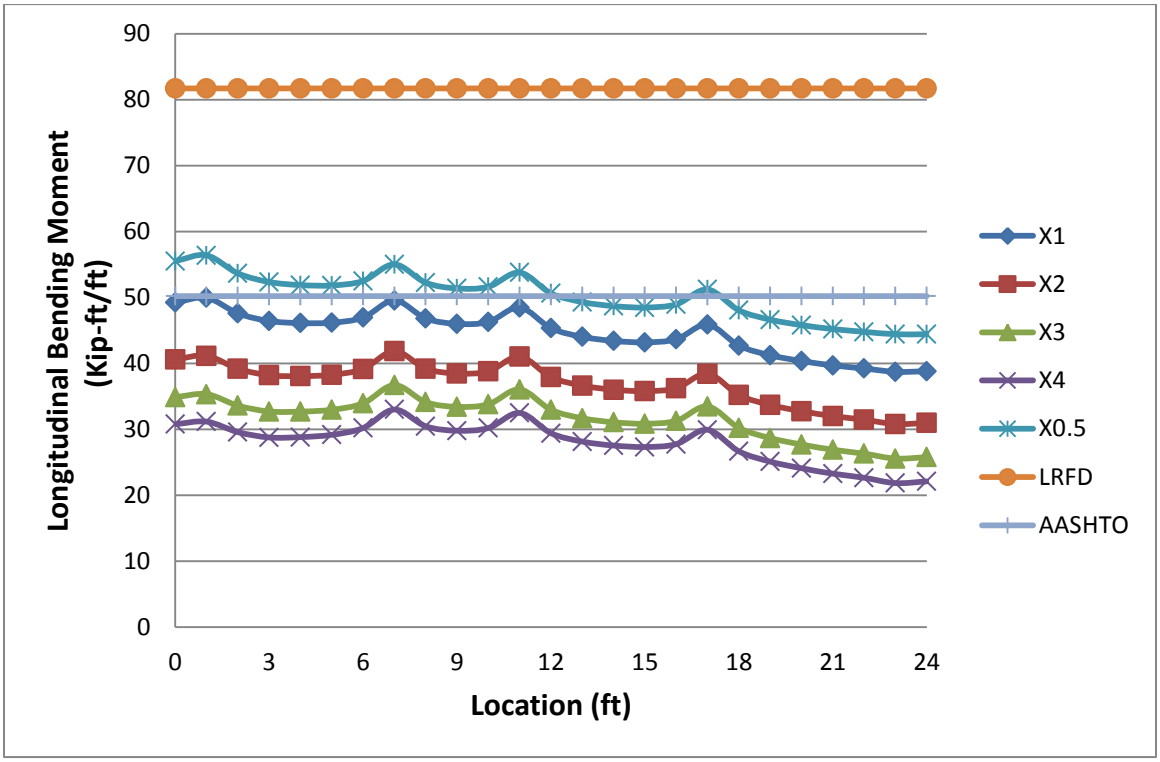

Table 15.1: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 54 ft, Deck Width = 36 ft, No Railings with Edge Loading E1

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	67.6	77.1	67.6	77.1	67.6	77.1	67.6	77.1	67.6	77.1	50.2
1	68.8	77.1	68.8	77.1	68.8	77.1	68.8	77.1	68.8	77.1	50.2
2	65.0	77.1	65.0	77.1	65.0	77.1	65.0	77.1	65.0	77.1	50.2
3	63.3	77.1	63.3	77.1	63.3	77.1	63.3	77.1	63.3	77.1	50.2
4	62.5	77.1	62.5	77.1	62.5	77.1	62.5	77.1	62.5	77.1	50.2
5	62.2	77.1	62.2	77.1	62.2	77.1	62.2	77.1	62.2	77.1	50.2
6	62.7	77.1	62.7	77.1	62.7	77.1	62.7	77.1	62.7	77.1	50.2
7	65.0	77.1	65.0	77.1	65.0	77.1	65.0	77.1	65.0	77.1	50.2
8	62.1	77.1	62.1	77.1	62.1	77.1	62.1	77.1	62.1	77.1	50.2
9	61.1	77.1	61.1	77.1	61.1	77.1	61.1	77.1	61.1	77.1	50.2
10	61.3	77.1	61.3	77.1	61.3	77.1	61.3	77.1	61.3	77.1	50.2
11	63.4	77.1	63.4	77.1	63.4	77.1	63.4	77.1	63.4	77.1	50.2
12	60.2	77.1	60.2	77.1	60.2	77.1	60.2	77.1	60.2	77.1	50.2
13	58.8	77.1	58.8	77.1	58.8	77.1	58.8	77.1	58.8	77.1	50.2
14	58.2	77.1	58.2	77.1	58.2	77.1	58.2	77.1	58.2	77.1	50.2
15	58.0	77.1	58.0	77.1	58.0	77.1	58.0	77.1	58.0	77.1	50.2
16	58.6	77.1	58.6	77.1	58.6	77.1	58.6	77.1	58.6	77.1	50.2
17	61.0	77.1	61.0	77.1	61.0	77.1	61.0	77.1	61.0	77.1	50.2
18	58.1	77.1	58.1	77.1	58.1	77.1	58.1	77.1	58.1	77.1	50.2
19	57.2	77.1	57.2	77.1	57.2	77.1	57.2	77.1	57.2	77.1	50.2
20	57.4	77.1	57.4	77.1	57.4	77.1	57.4	77.1	57.4	77.1	50.2
21	59.4	77.1	59.4	77.1	59.4	77.1	59.4	77.1	59.4	77.1	50.2
22	56.2	77.1	56.2	77.1	56.2	77.1	56.2	77.1	56.2	77.1	50.2
23	54.8	77.1	54.8	77.1	54.8	77.1	54.8	77.1	54.8	77.1	50.2
24	54.1	77.1	54.1	77.1	54.1	77.1	54.1	77.1	54.1	77.1	50.2
25	53.8	77.1	53.8	77.1	53.8	77.1	53.8	77.1	53.8	77.1	50.2
26	54.3	77.1	54.3	77.1	54.3	77.1	54.3	77.1	54.3	77.1	50.2
27	56.4	77.1	56.4	77.1	56.4	77.1	56.4	77.1	56.4	77.1	50.2
28	53.2	77.1	53.2	77.1	53.2	77.1	53.2	77.1	53.2	77.1	50.2
29	51.8	77.1	51.8	77.1	51.8	77.1	51.8	77.1	51.8	77.1	50.2
30	50.9	77.1	50.9	77.1	50.9	77.1	50.9	77.1	50.9	77.1	50.2
31	50.3	77.1	50.3	77.1	50.3	77.1	50.3	77.1	50.3	77.1	50.2
32	49.8	77.1	49.8	77.1	49.8	77.1	49.8	77.1	49.8	77.1	50.2
33	49.5	77.1	49.5	77.1	49.5	77.1	49.5	77.1	49.5	77.1	50.2
34	49.2	77.1	49.2	77.1	49.2	77.1	49.2	77.1	49.2	77.1	50.2
35	49.1	77.1	49.1	77.1	49.1	77.1	49.1	77.1	49.1	77.1	50.2
36	49.0	77.1	49.0	77.1	49.0	77.1	49.0	77.1	49.0	77.1	50.2

Figure 15.1: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 54 ft, Deck Width = 36 ft, No Railings with Edge Loading E1

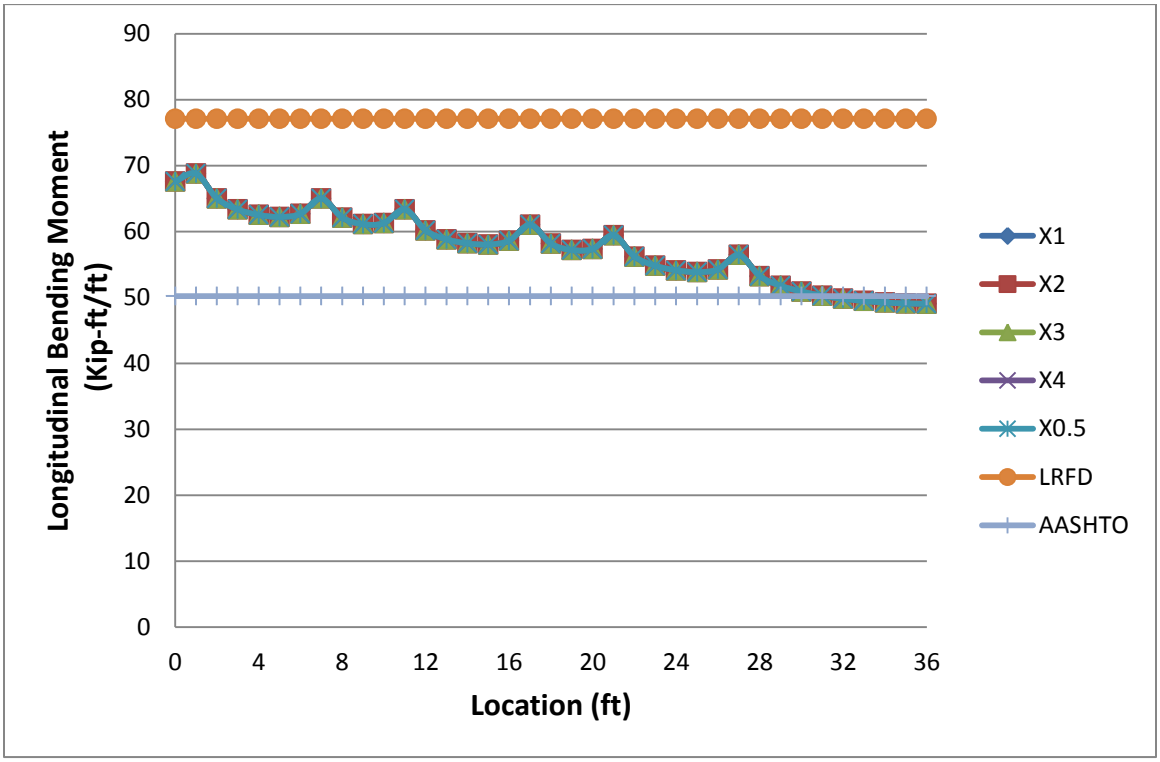

Table 15.2: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 54 ft, Deck Width = 36 ft, One Railing with Edge Loading E1 (LEFT)

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	57.0	77.1	50.1	77.1	44.9	77.1	40.8	77.1	61.5	77.1	50.2
1	57.7	77.1	50.6	77.1	45.3	77.1	41.2	77.1	62.4	77.1	50.2
2	55.4	77.1	48.8	77.1	43.9	77.1	40.0	77.1	59.6	77.1	50.2
3	54.3	77.1	48.0	77.1	43.2	77.1	39.5	77.1	58.3	77.1	50.2
4	54.0	77.1	48.0	77.1	43.5	77.1	39.9	77.1	57.8	77.1	50.2
5	54.2	77.1	48.4	77.1	44.0	77.1	40.5	77.1	57.8	77.1	50.2
6	55.0	77.1	49.5	77.1	45.3	77.1	41.9	77.1	58.5	77.1	50.2
7	57.7	77.1	52.4	77.1	48.3	77.1	45.1	77.1	61.0	77.1	50.2
8	55.1	77.1	50.0	77.1	46.0	77.1	42.9	77.1	58.3	77.1	50.2
9	54.4	77.1	49.4	77.1	45.7	77.1	42.7	77.1	57.5	77.1	50.2
10	54.8	77.1	50.0	77.1	46.4	77.1	43.5	77.1	57.8	77.1	50.2
11	57.1	77.1	52.5	77.1	49.0	77.1	46.2	77.1	60.0	77.1	50.2
12	54.1	77.1	49.7	77.1	46.3	77.1	43.6	77.1	56.9	77.1	50.2
13	53.0	77.1	48.7	77.1	45.4	77.1	42.8	77.1	55.7	77.1	50.2
14	52.6	77.1	48.4	77.1	45.3	77.1	42.7	77.1	55.2	77.1	50.2
15	52.6	77.1	48.6	77.1	45.5	77.1	43.1	77.1	55.1	77.1	50.2
16	53.4	77.1	49.5	77.1	46.5	77.1	44.1	77.1	55.8	77.1	50.2
17	55.9	77.1	52.2	77.1	49.3	77.1	47.0	77.1	58.3	77.1	50.2
18	53.2	77.1	49.6	77.1	46.8	77.1	44.6	77.1	55.5	77.1	50.2
19	52.4	77.1	48.9	77.1	46.2	77.1	44.0	77.1	54.6	77.1	50.2
20	52.7	77.1	49.3	77.1	46.6	77.1	44.6	77.1	54.8	77.1	50.2
21	54.9	77.1	51.6	77.1	49.0	77.1	47.0	77.1	57.0	77.1	50.2
22	51.8	77.1	48.6	77.1	46.1	77.1	44.1	77.1	53.8	77.1	50.2
23	50.5	77.1	47.4	77.1	45.0	77.1	43.0	77.1	52.5	77.1	50.2
24	50.0	77.1	46.9	77.1	44.5	77.1	42.6	77.1	51.9	77.1	50.2
25	49.8	77.1	46.8	77.1	44.5	77.1	42.7	77.1	51.7	77.1	50.2
26	50.3	77.1	47.4	77.1	45.1	77.1	43.3	77.1	52.1	77.1	50.2
27	52.6	77.1	49.7	77.1	47.5	77.1	45.8	77.1	54.4	77.1	50.2
28	49.5	77.1	46.7	77.1	44.5	77.1	42.8	77.1	51.2	77.1	50.2
29	48.1	77.1	45.3	77.1	43.2	77.1	41.6	77.1	49.8	77.1	50.2
30	47.3	77.1	44.6	77.1	42.5	77.1	40.9	77.1	48.9	77.1	50.2
31	46.7	77.1	44.1	77.1	42.0	77.1	40.4	77.1	48.3	77.1	50.2
32	46.3	77.1	43.7	77.1	41.7	77.1	40.2	77.1	47.9	77.1	50.2
33	46.0	77.1	43.5	77.1	41.5	77.1	40.0	77.1	47.6	77.1	50.2
34	45.9	77.1	43.3	77.1	41.4	77.1	39.9	77.1	47.4	77.1	50.2
35	45.8	77.1	43.3	77.1	41.4	77.1	39.9	77.1	47.3	77.1	50.2
36	45.8	77.1	43.3	77.1	41.4	77.1	40.0	77.1	47.3	77.1	50.2

Figure 15.2: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 54 ft, Deck Width = 36 ft, One Railing with Edge Loading E1 (LEFT)

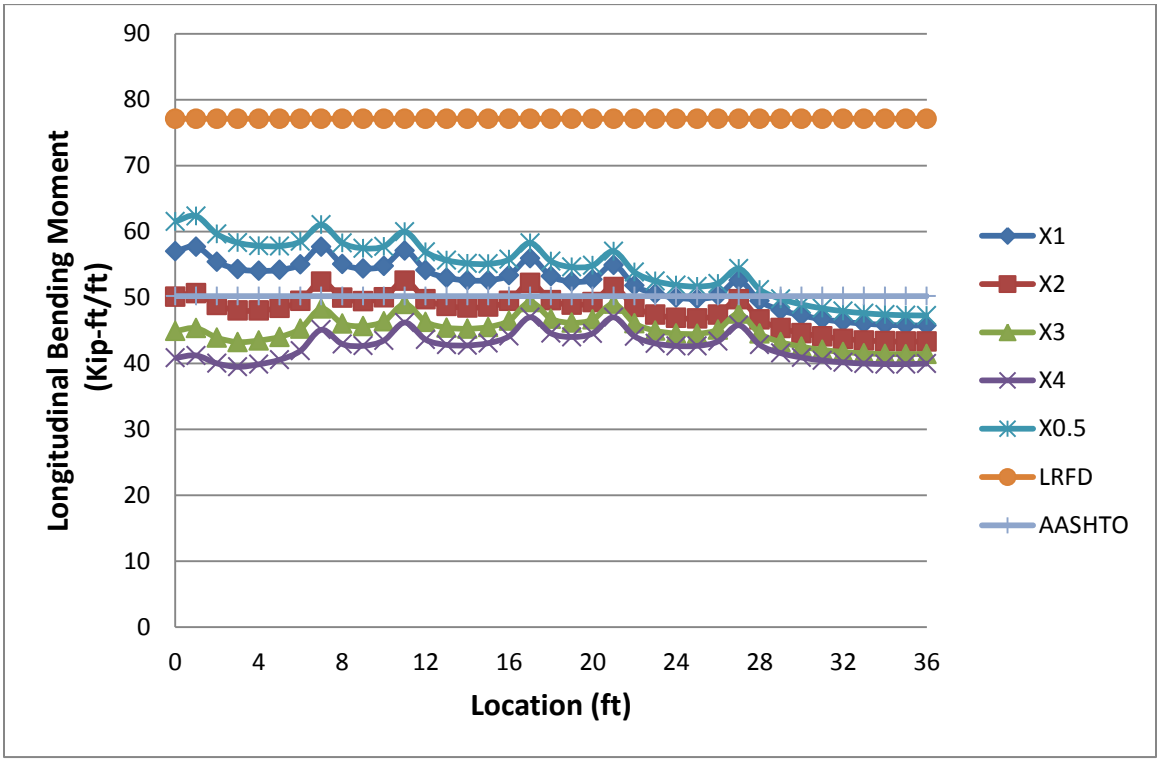

Table 15.3: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 54 ft, Deck Width = 36 ft, One Railing with Edge Loading E1 (RIGHT)

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	65.0	77.1	63.1	77.1	61.6	77.1	60.4	77.1	66.2	77.1	50.2
1	66.1	77.1	64.2	77.1	62.7	77.1	61.5	77.1	67.4	77.1	50.2
2	62.3	77.1	60.4	77.1	58.8	77.1	57.6	77.1	63.6	77.1	50.2
3	60.6	77.1	58.6	77.1	57.1	77.1	55.8	77.1	61.9	77.1	50.2
4	59.7	77.1	57.7	77.1	56.1	77.1	54.9	77.1	61.0	77.1	50.2
5	59.4	77.1	57.3	77.1	55.7	77.1	54.4	77.1	60.7	77.1	50.2
6	59.8	77.1	57.7	77.1	56.1	77.1	54.8	77.1	61.1	77.1	50.2
7	62.1	77.1	59.9	77.1	58.3	77.1	56.9	77.1	63.4	77.1	50.2
8	59.1	77.1	56.9	77.1	55.2	77.1	53.9	77.1	60.5	77.1	50.2
9	58.1	77.1	55.8	77.1	54.1	77.1	52.7	77.1	59.5	77.1	50.2
10	58.1	77.1	55.8	77.1	54.0	77.1	52.6	77.1	59.6	77.1	50.2
11	60.1	77.1	57.8	77.1	56.0	77.1	54.5	77.1	61.6	77.1	50.2
12	56.9	77.1	54.4	77.1	52.6	77.1	51.1	77.1	58.4	77.1	50.2
13	55.4	77.1	52.9	77.1	51.0	77.1	49.5	77.1	57.0	77.1	50.2
14	54.7	77.1	52.2	77.1	50.2	77.1	48.6	77.1	56.3	77.1	50.2
15	54.5	77.1	51.8	77.1	49.8	77.1	48.2	77.1	56.1	77.1	50.2
16	54.9	77.1	52.2	77.1	50.1	77.1	48.5	77.1	56.6	77.1	50.2
17	57.2	77.1	54.5	77.1	52.3	77.1	50.6	77.1	59.0	77.1	50.2
18	54.3	77.1	51.4	77.1	49.2	77.1	47.4	77.1	56.0	77.1	50.2
19	53.2	77.1	50.2	77.1	47.9	77.1	46.1	77.1	55.0	77.1	50.2
20	53.2	77.1	50.1	77.1	47.8	77.1	45.9	77.1	55.1	77.1	50.2
21	55.1	77.1	52.0	77.1	49.6	77.1	47.6	77.1	57.1	77.1	50.2
22	51.8	77.1	48.5	77.1	46.0	77.1	44.0	77.1	53.8	77.1	50.2
23	50.2	77.1	46.8	77.1	44.3	77.1	42.2	77.1	52.3	77.1	50.2
24	49.4	77.1	45.9	77.1	43.2	77.1	41.1	77.1	51.6	77.1	50.2
25	48.9	77.1	45.3	77.1	42.5	77.1	40.3	77.1	51.2	77.1	50.2
26	49.2	77.1	45.4	77.1	42.6	77.1	40.3	77.1	51.5	77.1	50.2
27	51.2	77.1	47.3	77.1	44.3	77.1	42.0	77.1	53.6	77.1	50.2
28	47.8	77.1	43.8	77.1	40.7	77.1	38.3	77.1	50.3	77.1	50.2
29	46.1	77.1	42.0	77.1	38.8	77.1	36.2	77.1	48.7	77.1	50.2
30	45.1	77.1	40.7	77.1	37.4	77.1	34.8	77.1	47.7	77.1	50.2
31	44.2	77.1	39.7	77.1	36.3	77.1	33.6	77.1	47.0	77.1	50.2
32	43.5	77.1	38.9	77.1	35.3	77.1	32.5	77.1	46.4	77.1	50.2
33	42.9	77.1	38.1	77.1	34.4	77.1	31.5	77.1	45.9	77.1	50.2
34	42.5	77.1	37.5	77.1	33.7	77.1	30.7	77.1	45.6	77.1	50.2
35	42.0	77.1	36.7	77.1	32.7	77.1	29.6	77.1	45.2	77.1	50.2
36	42.0	77.1	36.8	77.1	32.9	77.1	29.7	77.1	45.2	77.1	50.2

Figure 15.3: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 54 ft, Deck Width = 36 ft, One Railing with Edge Loading E1 (RIGHT)

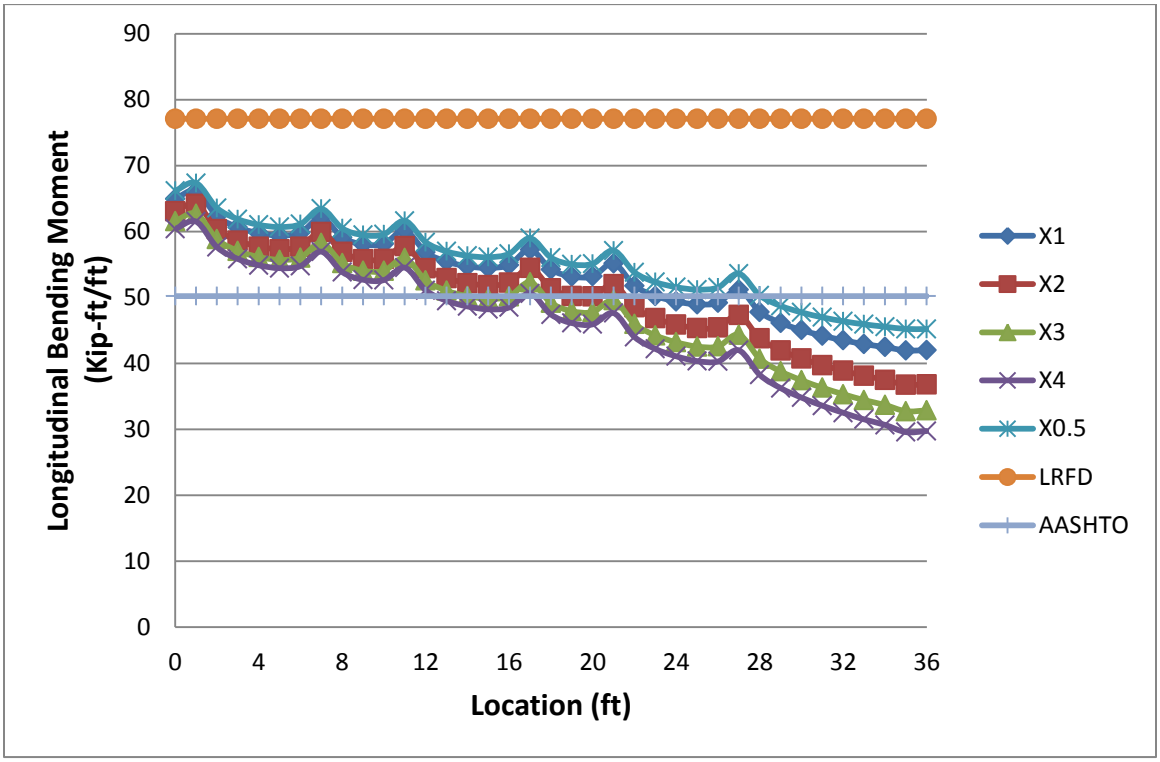

Table 15.4: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 54 ft, Deck Width = 36 ft. Two Railings with Edge Loading E1

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	54.9	77.1	47.1	77.1	41.4	77.1	37.2	77.1	60.3	77.1	50.2
1	55.6	77.1	47.5	77.1	41.8	77.1	37.5	77.1	61.1	77.1	50.2
2	53.2	77.1	45.7	77.1	40.2	77.1	36.1	77.1	58.3	77.1	50.2
3	52.1	77.1	44.7	77.1	39.4	77.1	35.4	77.1	57.0	77.1	50.2
4	51.8	77.1	44.6	77.1	39.5	77.1	35.6	77.1	56.5	77.1	50.2
5	51.8	77.1	44.9	77.1	39.9	77.1	36.1	77.1	56.4	77.1	50.2
6	52.6	77.1	45.9	77.1	41.0	77.1	37.3	77.1	57.1	77.1	50.2
7	55.2	77.1	48.7	77.1	43.9	77.1	40.3	77.1	59.6	77.1	50.2
8	52.6	77.1	46.1	77.1	41.5	77.1	37.9	77.1	56.8	77.1	50.2
9	51.8	77.1	45.5	77.1	40.9	77.1	37.4	77.1	55.9	77.1	50.2
10	52.1	77.1	45.9	77.1	41.4	77.1	38.0	77.1	56.2	77.1	50.2
11	54.4	77.1	48.3	77.1	43.8	77.1	40.5	77.1	58.4	77.1	50.2
12	51.3	77.1	45.3	77.1	40.9	77.1	37.7	77.1	55.2	77.1	50.2
13	50.1	77.1	44.1	77.1	39.9	77.1	36.6	77.1	54.0	77.1	50.2
14	49.6	77.1	43.7	77.1	39.5	77.1	36.3	77.1	53.4	77.1	50.2
15	49.5	77.1	43.7	77.1	39.5	77.1	36.3	77.1	53.3	77.1	50.2
16	50.1	77.1	44.4	77.1	40.2	77.1	37.1	77.1	53.9	77.1	50.2
17	52.6	77.1	46.9	77.1	42.8	77.1	39.7	77.1	56.4	77.1	50.2
18	49.8	77.1	44.1	77.1	40.0	77.1	36.9	77.1	53.5	77.1	50.2
19	48.8	77.1	43.2	77.1	39.1	77.1	36.1	77.1	52.6	77.1	50.2
20	49.0	77.1	43.4	77.1	39.3	77.1	36.3	77.1	52.7	77.1	50.2
21	51.1	77.1	45.5	77.1	41.4	77.1	38.4	77.1	54.8	77.1	50.2
22	47.9	77.1	42.2	77.1	38.2	77.1	35.1	77.1	51.6	77.1	50.2
23	46.4	77.1	40.8	77.1	36.7	77.1	33.7	77.1	50.2	77.1	50.2
24	45.7	77.1	40.0	77.1	36.0	77.1	32.9	77.1	49.5	77.1	50.2
25	45.4	77.1	39.7	77.1	35.6	77.1	32.5	77.1	49.1	77.1	50.2
26	45.7	77.1	40.0	77.1	35.9	77.1	32.8	77.1	49.5	77.1	50.2
27	47.8	77.1	42.0	77.1	37.9	77.1	34.8	77.1	51.7	77.1	50.2
28	44.5	77.1	38.7	77.1	34.5	77.1	31.4	77.1	48.4	77.1	50.2
29	42.9	77.1	37.0	77.1	32.8	77.1	29.6	77.1	46.9	77.1	50.2
30	41.9	77.1	36.0	77.1	31.7	77.1	28.5	77.1	45.9	77.1	50.2
31	41.2	77.1	35.1	77.1	30.8	77.1	27.5	77.1	45.2	77.1	50.2
32	40.6	77.1	34.4	77.1	30.0	77.1	26.7	77.1	44.7	77.1	50.2
33	40.0	77.1	33.8	77.1	29.3	77.1	25.9	77.1	44.2	77.1	50.2
34	39.7	77.1	33.3	77.1	28.7	77.1	25.3	77.1	43.9	77.1	50.2
35	39.2	77.1	32.7	77.1	28.0	77.1	24.5	77.1	43.6	77.1	50.2
36	39.3	77.1	32.8	77.1	28.2	77.1	24.8	77.1	43.6	77.1	50.2

Figure 15.4: Longitudinal Moment Distribution at Critical Section for Three-Lane Single Span Bridge Deck Span = 54 ft, Deck Width = 36 ft. Two Railings with Edge Loading E1

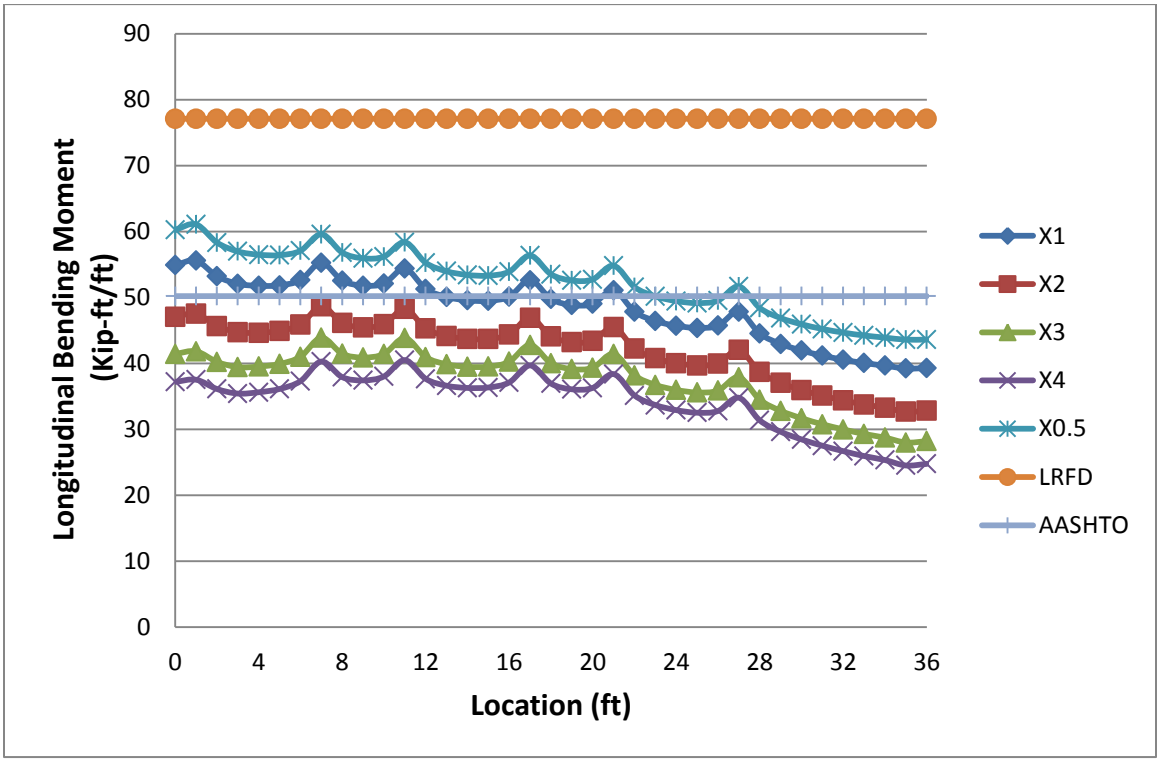

Table 16.1: Longitudinal Moment Distribution at Critical Section for Four-Lane Single Span Bridge Deck Span = 54 ft, Deck Width = 48 ft, No Railings with Edge Loading E1

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	70.3	77.1	70.3	77.1	70.3	77.1	70.3	77.1	70.3	77.1	50.2
1	71.5	77.1	71.5	77.1	71.5	77.1	71.5	77.1	71.5	77.1	50.2
2	67.7	77.1	67.7	77.1	67.7	77.1	67.7	77.1	67.7	77.1	50.2
3	66.0	77.1	66.0	77.1	66.0	77.1	66.0	77.1	66.0	77.1	50.2
4	65.2	77.1	65.2	77.1	65.2	77.1	65.2	77.1	65.2	77.1	50.2
5	64.9	77.1	64.9	77.1	64.9	77.1	64.9	77.1	64.9	77.1	50.2
6	65.3	77.1	65.3	77.1	65.3	77.1	65.3	77.1	65.3	77.1	50.2
7	67.7	77.1	67.7	77.1	67.7	77.1	67.7	77.1	67.7	77.1	50.2
8	64.8	77.1	64.8	77.1	64.8	77.1	64.8	77.1	64.8	77.1	50.2
9	63.8	77.1	63.8	77.1	63.8	77.1	63.8	77.1	63.8	77.1	50.2
10	63.9	77.1	63.9	77.1	63.9	77.1	63.9	77.1	63.9	77.1	50.2
11	66.0	77.1	66.0	77.1	66.0	77.1	66.0	77.1	66.0	77.1	50.2
12	62.8	77.1	62.8	77.1	62.8	77.1	62.8	77.1	62.8	77.1	50.2
13	61.5	77.1	61.5	77.1	61.5	77.1	61.5	77.1	61.5	77.1	50.2
14	60.9	77.1	60.9	77.1	60.9	77.1	60.9	77.1	60.9	77.1	50.2
15	60.7	77.1	60.7	77.1	60.7	77.1	60.7	77.1	60.7	77.1	50.2
16	61.3	77.1	61.3	77.1	61.3	77.1	61.3	77.1	61.3	77.1	50.2
17	63.8	77.1	63.8	77.1	63.8	77.1	63.8	77.1	63.8	77.1	50.2
18	60.9	77.1	60.9	77.1	60.9	77.1	60.9	77.1	60.9	77.1	50.2
19	60.0	77.1	60.0	77.1	60.0	77.1	60.0	77.1	60.0	77.1	50.2
20	60.1	77.1	60.1	77.1	60.1	77.1	60.1	77.1	60.1	77.1	50.2
21	62.2	77.1	62.2	77.1	62.2	77.1	62.2	77.1	62.2	77.1	50.2
22	59.0	77.1	59.0	77.1	59.0	77.1	59.0	77.1	59.0	77.1	50.2
23	57.7	77.1	57.7	77.1	57.7	77.1	57.7	77.1	57.7	77.1	50.2
24	57.0	77.1	57.0	77.1	57.0	77.1	57.0	77.1	57.0	77.1	50.2
25	56.9	77.1	56.9	77.1	56.9	77.1	56.9	77.1	56.9	77.1	50.2
26	57.4	77.1	57.4	77.1	57.4	77.1	57.4	77.1	57.4	77.1	50.2
27	59.8	77.1	59.8	77.1	59.8	77.1	59.8	77.1	59.8	77.1	50.2
28	56.9	77.1	56.9	77.1	56.9	77.1	56.9	77.1	56.9	77.1	50.2
29	55.8	77.1	55.8	77.1	55.8	77.1	55.8	77.1	55.8	77.1	50.2
30	55.9	77.1	55.9	77.1	55.9	77.1	55.9	77.1	55.9	77.1	50.2
31	58.0	77.1	58.0	77.1	58.0	77.1	58.0	77.1	58.0	77.1	50.2
32	54.7	77.1	54.7	77.1	54.7	77.1	54.7	77.1	54.7	77.1	50.2
33	53.2	77.1	53.2	77.1	53.2	77.1	53.2	77.1	53.2	77.1	50.2
34	52.4	77.1	52.4	77.1	52.4	77.1	52.4	77.1	52.4	77.1	50.2
35	52.0	77.1	52.0	77.1	52.0	77.1	52.0	77.1	52.0	77.1	50.2
36	52.4	77.1	52.4	77.1	52.4	77.1	52.4	77.1	52.4	77.1	50.2
37	54.5	77.1	54.5	77.1	54.5	77.1	54.5	77.1	54.5	77.1	50.2
38	51.1	77.1	51.1	77.1	51.1	77.1	51.1	77.1	51.1	77.1	50.2

39	49.6	77.1	49.6	77.1	49.6	77.1	49.6	77.1	49.6	77.1	50.2
40	48.6	77.1	48.6	77.1	48.6	77.1	48.6	77.1	48.6	77.1	50.2
41	47.8	77.1	47.8	77.1	47.8	77.1	47.8	77.1	47.8	77.1	50.2
42	47.2	77.1	47.2	77.1	47.2	77.1	47.2	77.1	47.2	77.1	50.2
43	46.8	77.1	46.8	77.1	46.8	77.1	46.8	77.1	46.8	77.1	50.2
44	46.4	77.1	46.4	77.1	46.4	77.1	46.4	77.1	46.4	77.1	50.2
45	46.1	77.1	46.1	77.1	46.1	77.1	46.1	77.1	46.1	77.1	50.2
46	45.9	77.1	45.9	77.1	45.9	77.1	45.9	77.1	45.9	77.1	50.2
47	45.8	77.1	45.8	77.1	45.8	77.1	45.8	77.1	45.8	77.1	50.2
48	45.7	77.1	45.7	77.1	45.7	77.1	45.7	77.1	45.7	77.1	50.2

Figure 16.1: Longitudinal Moment Distribution at Critical Section for Four-Lane Single Span Bridge Deck Span = 54 ft, Deck Width = 48 ft, No Railings with Edge Loading E1

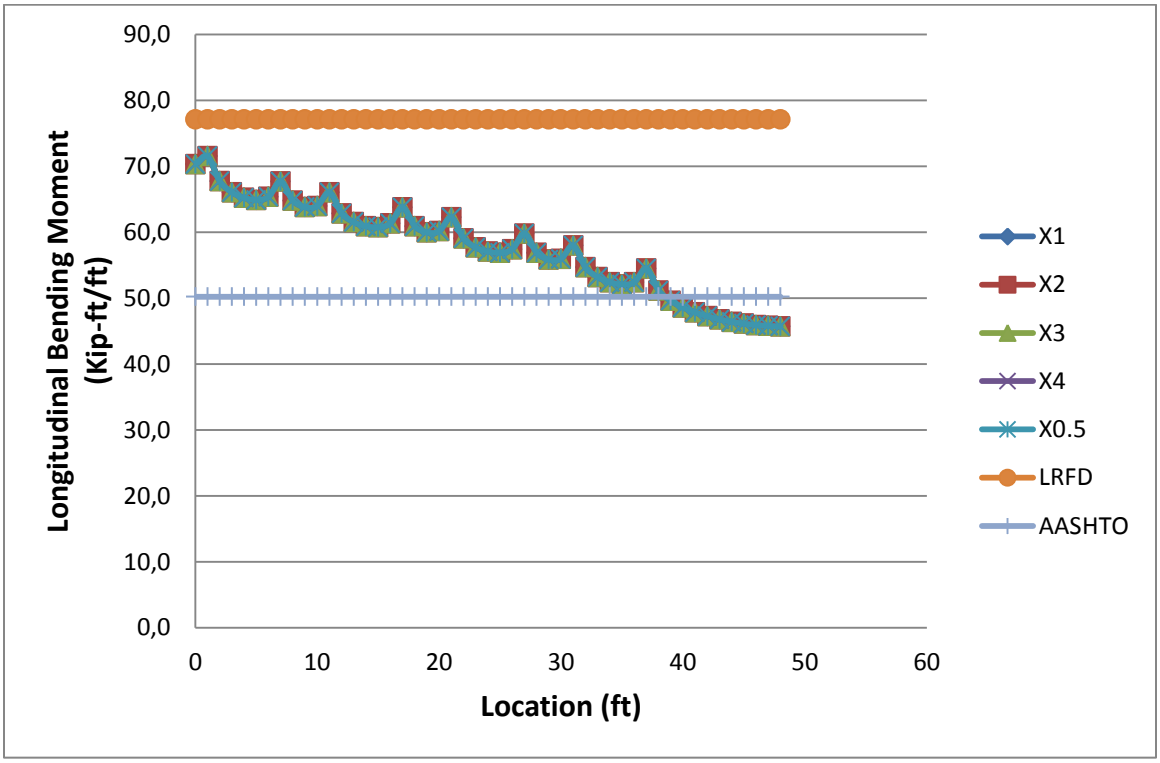

Table 16.2: Longitudinal Moment Distribution at Critical Section for Four-Lane Single Span Bridge Deck Span = 54 ft, Deck Width = 48 ft, One Railing with Edge Loading E1 (LEFT)

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	59.8	77.1	52.8	77.1	47.5	77.1	43.3	77.1	64.3	77.1	50.2
1	60.4	77.1	53.3	77.1	47.9	77.1	43.7	77.1	65.1	77.1	50.2
2	58.2	77.1	51.6	77.1	46.5	77.1	42.6	77.1	62.4	77.1	50.2
3	57.1	77.1	50.8	77.1	45.9	77.1	42.1	77.1	61.1	77.1	50.2
4	56.8	77.1	50.8	77.1	46.2	77.1	42.5	77.1	60.6	77.1	50.2
5	57.0	77.1	51.2	77.1	46.8	77.1	43.3	77.1	60.5	77.1	50.2
6	57.8	77.1	52.3	77.1	48.1	77.1	44.7	77.1	61.3	77.1	50.2
7	60.5	77.1	55.3	77.1	51.2	77.1	48.0	77.1	63.8	77.1	50.2
8	57.9	77.1	52.9	77.1	49.0	77.1	45.9	77.1	61.1	77.1	50.2
9	57.3	77.1	52.4	77.1	48.7	77.1	45.7	77.1	60.3	77.1	50.2
10	57.7	77.1	53.0	77.1	49.4	77.1	46.6	77.1	60.6	77.1	50.2
11	60.0	77.1	55.6	77.1	52.1	77.1	49.3	77.1	62.8	77.1	50.2
12	57.1	77.1	52.8	77.1	49.5	77.1	46.8	77.1	59.7	77.1	50.2
13	56.0	77.1	51.9	77.1	48.7	77.1	46.1	77.1	58.5	77.1	50.2
14	55.6	77.1	51.6	77.1	48.6	77.1	46.1	77.1	58.0	77.1	50.2
15	55.7	77.1	51.8	77.1	48.9	77.1	46.5	77.1	58.0	77.1	50.2
16	56.4	77.1	52.8	77.1	49.9	77.1	47.7	77.1	58.7	77.1	50.2
17	59.1	77.1	55.5	77.1	52.8	77.1	50.6	77.1	61.2	77.1	50.2
18	56.4	77.1	53.0	77.1	50.4	77.1	48.3	77.1	58.5	77.1	50.2
19	55.6	77.1	52.3	77.1	49.8	77.1	47.8	77.1	57.6	77.1	50.2
20	55.9	77.1	52.8	77.1	50.4	77.1	48.4	77.1	57.9	77.1	50.2
21	58.2	77.1	55.2	77.1	52.8	77.1	51.0	77.1	60.1	77.1	50.2
22	55.2	77.1	52.2	77.1	50.0	77.1	48.2	77.1	56.9	77.1	50.2
23	53.9	77.1	51.1	77.1	49.0	77.1	47.2	77.1	55.7	77.1	50.2
24	53.4	77.1	50.8	77.1	48.7	77.1	47.0	77.1	55.1	77.1	50.2
25	53.4	77.1	50.8	77.1	48.8	77.1	47.2	77.1	55.0	77.1	50.2
26	54.1	77.1	51.5	77.1	49.6	77.1	48.0	77.1	55.6	77.1	50.2
27	56.6	77.1	54.1	77.1	52.2	77.1	50.7	77.1	58.0	77.1	50.2
28	53.7	77.1	51.4	77.1	49.6	77.1	48.1	77.1	55.2	77.1	50.2
29	52.8	77.1	50.6	77.1	48.8	77.1	47.4	77.1	54.2	77.1	50.2
30	53.0	77.1	50.8	77.1	49.1	77.1	47.8	77.1	54.4	77.1	50.2
31	55.1	77.1	53.0	77.1	51.4	77.1	50.1	77.1	56.4	77.1	50.2
32	51.9	77.1	49.9	77.1	48.3	77.1	47.0	77.1	53.2	77.1	50.2
33	50.5	77.1	48.5	77.1	47.0	77.1	45.8	77.1	51.8	77.1	50.2
34	49.8	77.1	47.9	77.1	46.4	77.1	45.2	77.1	51.0	77.1	50.2
35	49.6	77.1	47.7	77.1	46.2	77.1	45.1	77.1	50.7	77.1	50.2
36	49.9	77.1	48.1	77.1	46.7	77.1	45.6	77.1	51.1	77.1	50.2
37	52.1	77.1	50.3	77.1	49.0	77.1	47.9	77.1	53.2	77.1	50.2
38	48.9	77.1	47.1	77.1	45.8	77.1	44.7	77.1	49.9	77.1	50.2

39	47.3	77.1	45.7	77.1	44.3	77.1	43.3	77.1	48.4	77.1	50.2
40	46.4	77.1	44.8	77.1	43.5	77.1	42.5	77.1	47.4	77.1	50.2
41	45.7	77.1	44.1	77.1	42.8	77.1	41.9	77.1	46.7	77.1	50.2
42	45.1	77.1	43.6	77.1	42.4	77.1	41.4	77.1	46.1	77.1	50.2
43	44.7	77.1	43.2	77.1	42.0	77.1	41.0	77.1	45.7	77.1	50.2
44	44.4	77.1	42.9	77.1	41.7	77.1	40.8	77.1	45.3	77.1	50.2
45	44.2	77.1	42.7	77.1	41.5	77.1	40.6	77.1	45.1	77.1	50.2
46	44.0	77.1	42.5	77.1	41.4	77.1	40.5	77.1	44.9	77.1	50.2
47	43.9	77.1	42.5	77.1	41.4	77.1	40.5	77.1	44.8	77.1	50.2
48	43.8	77.1	42.4	77.1	41.4	77.1	40.5	77.1	44.7	77.1	50.2

Figure 16.2: Longitudinal Moment Distribution at Critical Section for Four-Lane Single Span Bridge Deck Span = 54 ft, Deck Width = 48 ft, One Railing with Edge Loading E1 (LEFT)

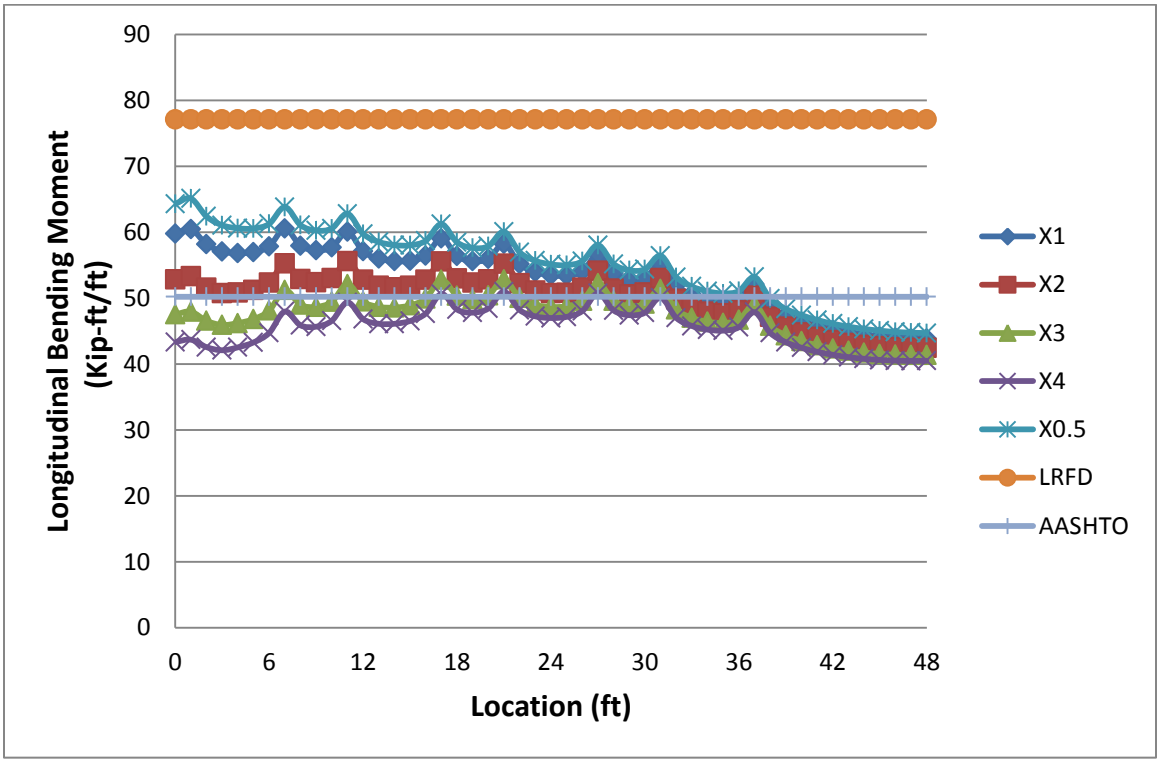

Table 16.3: Longitudinal Moment Distribution at Critical Section for Four-Lane Single Span Bridge Deck Span = 54 ft, Deck Width = 48ft, One Railing with Edge Loading E1 (RIGHT)

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	69.0	77.1	68.0	77.1	67.2	77.1	66.6	77.1	69.6	77.1	50.2
1	70.2	77.1	69.2	77.1	68.4	77.1	67.7	77.1	70.8	77.1	50.2
2	66.3	77.1	65.3	77.1	64.5	77.1	63.9	77.1	67.0	77.1	50.2
3	64.6	77.1	63.6	77.1	62.8	77.1	62.1	77.1	65.3	77.1	50.2
4	63.8	77.1	62.7	77.1	61.9	77.1	61.2	77.1	64.4	77.1	50.2
5	63.4	77.1	62.3	77.1	61.5	77.1	60.8	77.1	64.1	77.1	50.2
6	63.9	77.1	62.8	77.1	61.9	77.1	61.2	77.1	64.5	77.1	50.2
7	66.2	77.1	65.0	77.1	64.2	77.1	63.5	77.1	66.9	77.1	50.2
8	63.2	77.1	62.1	77.1	61.2	77.1	60.4	77.1	63.9	77.1	50.2
9	62.2	77.1	61.0	77.1	60.1	77.1	59.3	77.1	62.9	77.1	50.2
10	62.3	77.1	61.1	77.1	60.1	77.1	59.4	77.1	63.1	77.1	50.2
11	64.4	77.1	63.1	77.1	62.1	77.1	61.4	77.1	65.1	77.1	50.2
12	61.1	77.1	59.8	77.1	58.8	77.1	58.0	77.1	61.9	77.1	50.2
13	59.7	77.1	58.4	77.1	57.4	77.1	56.6	77.1	60.5	77.1	50.2
14	59.1	77.1	57.7	77.1	56.7	77.1	55.8	77.1	59.9	77.1	50.2
15	58.9	77.1	57.5	77.1	56.4	77.1	55.5	77.1	59.7	77.1	50.2
16	59.4	77.1	57.9	77.1	56.8	77.1	55.9	77.1	60.3	77.1	50.2
17	61.8	77.1	60.3	77.1	59.1	77.1	58.2	77.1	62.7	77.1	50.2
18	58.8	77.1	57.3	77.1	56.1	77.1	55.1	77.1	59.8	77.1	50.2
19	57.8	77.1	56.2	77.1	55.0	77.1	54.0	77.1	58.8	77.1	50.2
20	57.9	77.1	56.3	77.1	55.0	77.1	54.0	77.1	58.9	77.1	50.2
21	59.9	77.1	58.2	77.1	56.9	77.1	55.8	77.1	61.0	77.1	50.2
22	56.7	77.1	54.9	77.1	53.5	77.1	52.4	77.1	57.8	77.1	50.2
23	55.2	77.1	53.4	77.1	52.0	77.1	50.8	77.1	56.4	77.1	50.2
24	54.5	77.1	52.6	77.1	51.1	77.1	49.9	77.1	55.7	77.1	50.2
25	54.2	77.1	52.2	77.1	50.7	77.1	49.5	77.1	55.4	77.1	50.2
26	54.7	77.1	52.6	77.1	51.0	77.1	49.7	77.1	55.9	77.1	50.2
27	56.9	77.1	54.8	77.1	53.1	77.1	51.8	77.1	58.2	77.1	50.2
28	53.9	77.1	51.7	77.1	50.0	77.1	48.6	77.1	55.3	77.1	50.2
29	52.8	77.1	50.5	77.1	48.7	77.1	47.2	77.1	54.2	77.1	50.2
30	52.8	77.1	50.4	77.1	48.5	77.1	47.0	77.1	54.2	77.1	50.2
31	54.6	77.1	52.1	77.1	50.2	77.1	48.7	77.1	56.2	77.1	50.2
32	51.2	77.1	48.6	77.1	46.6	77.1	45.0	77.1	52.8	77.1	50.2
33	49.6	77.1	46.9	77.1	44.8	77.1	43.1	77.1	51.2	77.1	50.2
34	48.7	77.1	45.9	77.1	43.7	77.1	42.0	77.1	50.4	77.1	50.2
35	48.2	77.1	45.3	77.1	43.0	77.1	41.2	77.1	50.0	77.1	50.2
36	48.3	77.1	45.3	77.1	43.0	77.1	41.1	77.1	50.2	77.1	50.2
37	50.3	77.1	47.1	77.1	44.7	77.1	42.7	77.1	52.2	77.1	50.2
38	46.8	77.1	43.5	77.1	41.0	77.1	38.9	77.1	48.8	77.1	50.2

39	45.0	77.1	41.6	77.1	39.0	77.1	36.9	77.1	47.1	77.1	50.2
40	43.9	77.1	40.3	77.1	37.6	77.1	35.4	77.1	46.0	77.1	50.2
41	42.9	77.1	39.2	77.1	36.4	77.1	34.1	77.1	45.2	77.1	50.2
42	42.1	77.1	38.3	77.1	35.3	77.1	32.9	77.1	44.5	77.1	50.2
43	41.4	77.1	37.5	77.1	34.4	77.1	31.9	77.1	43.9	77.1	50.2
44	40.9	77.1	36.7	77.1	33.5	77.1	30.9	77.1	43.4	77.1	50.2
45	40.3	77.1	36.0	77.1	32.7	77.1	30.0	77.1	43.0	77.1	50.2
46	39.9	77.1	35.5	77.1	32.0	77.1	29.2	77.1	42.7	77.1	50.2
47	39.5	77.1	34.8	77.1	31.1	77.1	28.2	77.1	42.4	77.1	50.2
48	39.5	77.1	34.8	77.1	31.2	77.1	28.3	77.1	42.3	77.1	50.2

Figure 16.3: Longitudinal Moment Distribution at Critical Section for Four-Lane Single Span Bridge Deck Span = 54 ft, Deck Width = 48ft, One Railing with Edge Loading E1 (RIGHT)

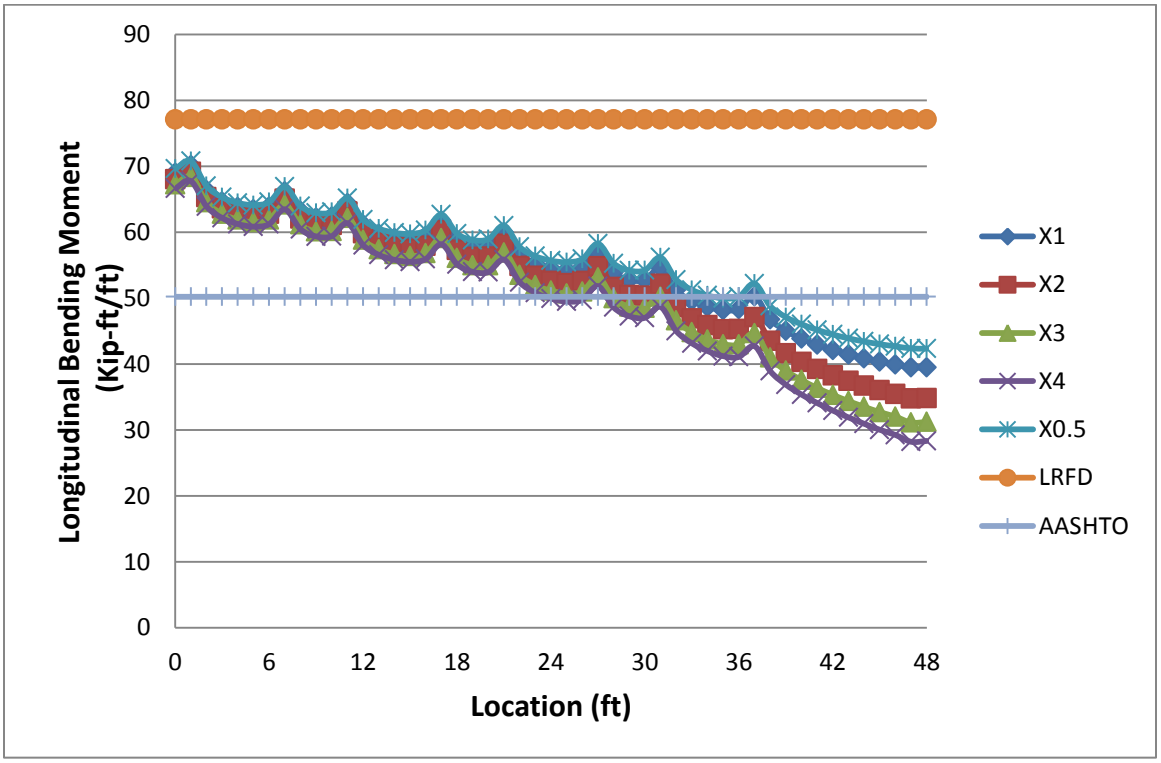

Table 16.4: Longitudinal Moment Distribution at Critical Section for Four-Lane Single Span Bridge Deck Span = 54 ft, Deck Width = 48 ft. Two Railings with Edge Loading E1

Longitudinal Moment at Critical Section(kip.ft/ft)											
Location (ft)	Stiffness										AASHTO Moment (kip.ft/ft)
	Stiffnessx1		Stiffnessx2		Stiffnessx3		Stiffnessx4		Stiffnessx0.5		
	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	FEA	LRFD	
0	58.7	77.1	51.2	77.1	45.6	77.1	41.3	77.1	63.6	77.1	50.2
1	59.3	77.1	51.6	77.1	46.0	77.1	41.6	77.1	64.4	77.1	50.2
2	57.0	77.1	49.8	77.1	44.5	77.1	40.3	77.1	61.7	77.1	50.2
3	55.9	77.1	49.0	77.1	43.8	77.1	39.8	77.1	60.4	77.1	50.2
4	55.6	77.1	49.0	77.1	44.0	77.1	40.1	77.1	59.9	77.1	50.2
5	55.7	77.1	49.3	77.1	44.5	77.1	40.7	77.1	59.8	77.1	50.2
6	56.6	77.1	50.4	77.1	45.7	77.1	42.1	77.1	60.5	77.1	50.2
7	59.2	77.1	53.2	77.1	48.7	77.1	45.2	77.1	63.0	77.1	50.2
8	56.6	77.1	50.8	77.1	46.4	77.1	43.0	77.1	60.3	77.1	50.2
9	55.9	77.1	50.2	77.1	46.0	77.1	42.6	77.1	59.5	77.1	50.2
10	56.2	77.1	50.8	77.1	46.6	77.1	43.4	77.1	59.7	77.1	50.2
11	58.6	77.1	53.2	77.1	49.2	77.1	46.0	77.1	62.0	77.1	50.2
12	55.6	77.1	50.3	77.1	46.4	77.1	43.3	77.1	58.9	77.1	50.2
13	54.4	77.1	49.3	77.1	45.5	77.1	42.5	77.1	57.6	77.1	50.2
14	54.0	77.1	49.0	77.1	45.2	77.1	42.3	77.1	57.1	77.1	50.2
15	54.0	77.1	49.1	77.1	45.4	77.1	42.6	77.1	57.0	77.1	50.2
16	54.7	77.1	49.9	77.1	46.3	77.1	43.5	77.1	57.7	77.1	50.2
17	57.2	77.1	52.6	77.1	49.0	77.1	46.3	77.1	60.2	77.1	50.2
18	54.5	77.1	49.9	77.1	46.4	77.1	43.8	77.1	57.4	77.1	50.2
19	53.6	77.1	49.1	77.1	45.7	77.1	43.1	77.1	56.5	77.1	50.2
20	53.9	77.1	49.5	77.1	46.1	77.1	43.5	77.1	56.7	77.1	50.2
21	56.1	77.1	51.7	77.1	48.4	77.1	45.8	77.1	58.9	77.1	50.2
22	53.0	77.1	48.6	77.1	45.4	77.1	42.8	77.1	55.7	77.1	50.2
23	51.7	77.1	47.4	77.1	44.1	77.1	41.6	77.1	54.4	77.1	50.2
24	51.1	77.1	46.8	77.1	43.6	77.1	41.1	77.1	53.8	77.1	50.2
25	50.9	77.1	46.7	77.1	43.5	77.1	41.1	77.1	53.6	77.1	50.2
26	51.5	77.1	47.3	77.1	44.1	77.1	41.7	77.1	54.2	77.1	50.2
27	53.9	77.1	49.7	77.1	46.5	77.1	44.1	77.1	56.6	77.1	50.2
28	51.0	77.1	46.8	77.1	43.6	77.1	41.2	77.1	53.6	77.1	50.2
29	49.9	77.1	45.7	77.1	42.6	77.1	40.2	77.1	52.6	77.1	50.2
30	50.0	77.1	45.8	77.1	42.7	77.1	40.2	77.1	52.7	77.1	50.2
31	52.0	77.1	47.8	77.1	44.6	77.1	42.2	77.1	54.7	77.1	50.2
32	48.7	77.1	44.4	77.1	41.2	77.1	38.8	77.1	51.4	77.1	50.2
33	47.1	77.1	42.9	77.1	39.7	77.1	37.2	77.1	49.9	77.1	50.2
34	46.3	77.1	42.0	77.1	38.8	77.1	36.3	77.1	49.1	77.1	50.2
35	45.9	77.1	41.5	77.1	38.3	77.1	35.7	77.1	48.7	77.1	50.2
36	46.1	77.1	41.7	77.1	38.4	77.1	35.9	77.1	49.0	77.1	50.2
37	48.1	77.1	43.6	77.1	40.3	77.1	37.7	77.1	51.0	77.1	50.2
38	44.7	77.1	40.2	77.1	36.8	77.1	34.2	77.1	47.6	77.1	50.2

39	43.0	77.1	38.4	77.1	35.0	77.1	32.3	77.1	46.0	77.1	50.2
40	41.9	77.1	37.2	77.1	33.7	77.1	31.0	77.1	44.9	77.1	50.2
41	41.0	77.1	36.2	77.1	32.7	77.1	29.9	77.1	44.1	77.1	50.2
42	40.3	77.1	35.4	77.1	31.7	77.1	29.0	77.1	43.4	77.1	50.2
43	39.7	77.1	34.7	77.1	30.9	77.1	28.1	77.1	42.9	77.1	50.2
44	39.1	77.1	34.0	77.1	30.2	77.1	27.3	77.1	42.4	77.1	50.2
45	38.7	77.1	33.4	77.1	29.5	77.1	26.6	77.1	42.0	77.1	50.2
46	38.3	77.1	32.9	77.1	29.0	77.1	25.9	77.1	41.7	77.1	50.2
47	37.9	77.1	32.3	77.1	28.2	77.1	25.1	77.1	41.4	77.1	50.2
48	37.9	77.1	32.4	77.1	28.4	77.1	25.3	77.1	41.4	77.1	50.2

Figure 16.4: Longitudinal Moment Distribution at Critical Section for Four-Lane Single Span Bridge Deck Span = 54 ft, Deck Width = 48 ft. Two Railings with Edge Loading E1