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Load Distribution In Adjacent Precast "Deck Free" Concrete Box-Girder Bridges

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LOAD DISTRIBUTION IN ADJACENT PRECAST “DECK FREE” CONCRETE BOX-GIRDER BRIDGES

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ABSTRACT

Bridges built with adjacent precast, prestressed concrete box-girders are a popular and economical solution for short-span bridges because they can be constructed rapidly. The top flanges of the precast box girders form the bridge deck surface. A shear key is introduced between the adjacent boxes over the depth of the top flange (i.e. 225 mm thick as the thickness of the box's top flange). Canadian Highway Bridge Design Code, CHBDC specifies empirical equations for the moment and shear distribution factors for selected bridge configurations but not for adjacent precast concrete box-girder bridge type. In this study, a parametric study was conducted, using the 3D finite-element modeling, and a set of simplified equations for the moment, shear and deflection distribution factors for the studied bridge configuration was developed.

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DEDICATED

TO MY FAMILY

TABLE OF CONTENTS

NOTATIONS

A	Bridge width
B	The clear spacing between girders
Be	Effective concrete slab width
E	Modulus of Elasticity
F	Width dimension factor
Fm	Moment distribution factor
Fv	Shear distribution factor
Fd	Deflection distribution factor
I_t	The moment of inertia of the composite girder
L	Centre line span of a simply supported bridge
M_{DL}	The mid-span moment for a straight simply supported girder due to a single girder dead load
M_T	The mid-span moment for a straight simply supported girder due to a single CHBDC truck loading
V_T	The max. shear force for a straight simply supported girder due to a single CHBDC truck loading
D_T	The Max. Deflection for a straight simply supported girder due to a single CHBDC truck loading
n	Number of design lanes
N	Number of girders
[P]	Applied loads vector at the nodes
R	Radius of curvature of the centre span of the curved bridge
R_L	Multi-lane factor based on the number of the design lanes
R_L'	Multi-lane factor based on the number of the loaded lanes
S	Girders spacing
[U]	Displacement vector at the nodes
W_c	Deck width
W_e	Width of design lane
Y_b	The distance from the neutral axis to the bottom flange
$(R_{straight})_{DL}$	Maximum shear forces calculated for straight simply supported beam due to Dead Load
$(R_{straight})_{truck}$,	Maximum shear forces calculated for straight simply supported beam due to truck loading
$(R_{FE.})_{DL}$	The greater reaction at the girder supports found from the finite-element analysis due to dead load

$(R_{FE.})_{FL}$	The greater reaction at the girder supports found from the finite-element analysis due to Fully loaded lanes
$(R_{FE.})_{PL}$	The greater reaction at the girder supports found from the finite-element analysis due to Partially loaded lanes
$(R_{FE.ext})_{Fat}$	The greater reaction at the exterior girder supports found from the finite-element analysis due to Fatigue loading
$(R_{FE.mid})_{Fat}$	The greater reaction at the middle girder supports found from the finite-element analysis due to Fatigue loading
$(SDF)_{DL}$	Shear distribution factor for the girder due to Deal Load
$(SDF)_{FL}$	Shear distribution factor for the girder due to Fully Loaded lanes
$(SDF)_{PL}$	Shear distribution factor for the girder due to Partially Loaded lanes
$(SDF)_{Fat\ ext}$	Shear distribution factor for the exterior girder due to Fatigue Loading
$(SDF)_{Fat\ int}$	Shear distribution factor for the interior girder due to Fatigue Loading
$(\sigma_{straight})_{DL}$	Maximum flexural stresses in bottom flange fibers, for the straight simply supported beam due to Deal Load
$(\sigma_{straight})_{truck}$	Maximum flexural stresses in bottom flange fibers, for the straight simply supported beam due to CHBDC truck loading
$(\sigma_{FE.})_{FL}$	The bigger flexural stresses of r girder due to Fully loaded lanes case
$(\sigma_{FE.})_{PL}$	The bigger flexural stresses of e girder due to Partially loaded lanes case
$(\sigma_{FE.})_{Fat}$	The bigger flexural stresses of girder due to Fatigue loading case
$(MDF)_{DL}$	Moment distribution factor of girder for dead load case
$(MDF)_{FL}$	Moment distribution factor of girder for full load case
$(MDF)_{PL}$	Moment distribution factor of girder for partial load case
$(MDF)_{Fat.ext}$	Moment distribution factor of exterior girder for fatigue case
$(MDF)_{Fat.int}$	Moment distribution factor of interior girder for fatigue case
$(\Delta_{imple})_{DL}$	Mid-span deflection in bottom flange fibers, for a straight simply supported girder subject to dead load
$(\Delta_{simple})_{truck}$	Mid-span deflection in bottom flange fibers, for a straight simply supported girder subject to CHBDC truck loading
$(\Delta_{FE\ ext})_{DL}$	Mid-span deflection in bottom flange fibers at point 2 of exterior girder, for the dead load case, obtained from finite-element analysis
$(\Delta_{FE})_{FL}$	Mid-span deflection in bottom flange fibers of girder, for the full lane loading case, obtained from finite-element analysis
$(\Delta_{FE})_{PL}$	Mid-span deflection in bottom flange fibers of girder, for the partial lane loading case, obtained from finite-element analysis
$(\Delta_{FE\ ext})_{Fat}$	Mid-span deflection in bottom flange fibers at exterior girder, for the fatigue case, obtained from finite-element analysis
$(DDF)_{DL}$	Deflection distribution factor of exterior girder for dead load case
$(DDF)_{FL}$	Deflection distribution factor of exterior girder for full load case
$(DDF)_{PL}$	Deflection distribution factor of exterior girder for partial load case
$(DDF)_{Fat.ext}$	Deflection distribution factor of exterior girder for fatigue case

LIST OF TABLES

Table No. Page

LIST OF FIGURES

CHAPTER I

INTRODUCTION

1.1 General

In densely populated cities, elevated freeways and multi-level interchange structures are necessary. Nowadays, precast bridges have become an important component in highway bridges, especially where construction time and staging restrictions are often encountered. Precast prestressed bridges allow for rapid construction, less disturbance to the traffic flow and significant improvement in the quality and the durability of the structure with less environmental effect. Precast prestressed concrete bridges have become increasingly popular. Approximately two-third of the bridges, with spans between 18 m and 36 m, are constructed using prestressed girders.

Bridges built with adjacent precast, prestressed concrete box-girders are a popular and economical solution for short-span bridges because they can be constructed rapidly and most deck forming is eliminated. The box girders are generally connected by partial-depth or full-depth keyways between each of the boxes, incorporating grouts. Transverse ties, grouted or un-grouted, vary in the form of (i) limited number of reinforcing steel bars with ends embedded in full-depth reinforced concrete edge beams, (ii) a limited number of non-tensioned threaded rods anchored to the out webs of the edge boxes, or (iii) few high-strength tendons post-tensioned in multiple stages. A non-composite concrete topping or a composite structural slab is added. Such bridges have been in service for many years and have generally performed well. A recurring problem, however, is cracking in the longitudinal grouted joints between adjacent box girders, resulting in reflective cracks forming in the wearing surface. This in turn may lead to leakage which allows chloride-laden water to saturate the sides and bottom of the beams, eventually causing corrosion of the non-prestressing reinforcement, prestressing strand, and transverse ties. In severe cases, complete cracking of joints and loss of load transfer occur. To improve long-term durability and reduce long-term maintenance, precast "deck free" adjacent box girders can be used in such a way the top flanges of the precast box girders form the final bridge deck surface. In this system, the precast box girders with thick top flanges are cast in a controlled environment at the fabrication facility and then shipped to the bridge site. Box girders are then placed beside each other over the abutment and piers with 15 mm gaps. This system requires a closure strip to be poured on site between the precast box girders to make it continuous for live load distribution. A shear key is introduced between the adjacent boxes over the depth of the top flange (i.e. 225 mm thick as the thickness of the box's top flange). Lateral bending strength of the closure strip is maintained using U bars projecting from each box's top flange and embedded in a 200 mm width joint. Such durable system has been implemented by Ontario Ministry of Transportation in Ontario bridges since 2006. Figure 1.1 shows cross-section of Sucker Creek Bridge, County Road 41, built in Ontario in 2006 with deck-free adjacent precast box beams. While Figure 1.2 shows view of deck-free precast box beams used in this bridge before fiiling the closure strips with concrete grout. Figure 1.3 shows view of the deck-free precast box beam used in Suneshine Creek Bridge Hwy 11/17 built in Ontario in Summer 2007. Joint details between adjacent precast box beams used in this bridge is shown in Fig. 1.4.

1.2 The Problem

The Canadian Highway Bridge Design Code (CHBDC, 2006) specifies empirical equations for the moment, shear and deflection distribution factors for selected bridge configurations, including slab-on-girders, multiples-spine bridges, cellular or voided slab bridge and solid slab bridges (Fig. 1.5). However, a simplified method of analysis of adjacent precast concrete box-girder bridge is as yet unavailable. Despite the general availability of computers and computer software programs for the bridge analysis, bridge designers strongly prefer simplified methods of analysis to reduce the time spent in the design that would be reflected in a considerable reduction in design cost. In addition, most engineers are not familiar with the finite-element modeling and are reluctant to use this technique, especially in the preliminary designs because of its time consuming in terms of modeling assumptions and verifications and results interpretation. In this study, a parametric study was conducted to investigate the applicability of the simplified analysis method specified in CHBDC for multiple-spine or voided slab bridge configuration on adjacent precast box beams with longitudinal joints that can transfer both bending and shear between each adjacent box girders. In this study, the 3D finite element modelling, using SAP2000 software (Computers and Structures, 2009) was conducted on wide range of adjacent box girders to obtain their moment and shear distribution factors when subjected to CHBDC truck loading conditions. Then, the obtained results were correlated with those available in CHDBC for slab-on-girder bridges, voided slab bridges and multiple-spine bridges. Correlation between the obtained FEA results and CHBDC equations were conducted.

1.3 Objectives

The objectives of this study are:

1. Conduct a parametric study, using the three-dimensional finite-element modeling, on selected deck-free box girder bridge prototypes, to find out the maximum bottom flange flexural stresses, support reaction forces and deflection to provide database for the evaluation of their moment, shear and deflection distribution factors.
2. Develop simplified formulas for shear, moment, and deflection distribution factors for precast box girder bridges with joints between their top flanges.

1.4 Scope

The scope of this study includes the following:

1. A literature review of previous research, textbooks, and design codes of practice related to the study.

   Conduct a practical-design-oriented study to investigate the key parameters affecting the load distribution among girders. The range of studied parameters include: (i) span of the bridge; (ii) total width of bridge (as a function of number of girders); (iii) number of design lanes; and (vi) truck loading conditions. The parametric study was performed using the commercially-available Finite-Element Software “SAP2000” on 192 box girder bridges subjected to CHBDC truck loading, leading to more than 2000 loading cases.
2. Preparation of database that can be correlated with the available CHBDC simplified method of analysis.
3. Developing shear, moment, and deflection distribution factor formulas for the studied bridge configuration.

1.5 Contents and Arrangement of this study

Chapter II : Contains the literature review which is a thorough explanation of lateral load distribution factor concept and review of previous work.

Chapter III: Describes the finite-element method and "SAP2000" software used in the analysis, modeling, bridge configurations, loading cases, and the methodology to calculate the load distribution factors.

Chapter IV: Presents the outcome of the parametric study performed on the bridge prototypes, and the developed empirical equations for load distribution factors.

Chapter V: Includes the summary and conclusions drawn from this study.

CHAPTER II

LITERATURE REVIEW

2.1 Concept of Lateral Load Distribution Factor

In the analysis and designing of bridge, the calculation of structural response of a bridge to live loads is a complicated and lengthy task. The design values for bending moment, shear or deflection force for box girders depend on the location and the number of moving trucks on the bridge, boundary conditions and the cross section properties of bridge components. These values vary with the change in girder span, width of bridge, number of girders and load cases.

In order to calculate the live load carried by each girder in case of a straight bridge, lateral load distribution factor is a key element and important in analyzing existing bridges and designing new ones. To simplify the design process, North American bridge codes, such as CAN/CSA-S6-06 (CHBDC, 2006), AASHTO-LRFD Bridge Design Specification (AASHTO, 2004), Load and Resistance Factor Design Specifications (AASHTO, 2007, 2004 and 2000), and AASHTO Standard Specifications (AASHTO, 1996), treat the longitudinal and transverse effects of wheel loads as uncoupled phenomena. Based on these codes, to obtain the design moment, deflection and shear force, we calculate the maximum moment, deflection, and shear force caused by a single truck live load using a single girder. Then the values are to be amplified by a factor, which is usually referred to as the live load distribution factor.

The literature survey conducted is presented as follows:

(a) Bridge types
(b) History of prestressed concrete girders
(c) Fabrication of prestressed concrete box girders
(d) Previous research work

(e) Simplified methods of analysis

(f) Load distribution and codes of practice for precast box girders

2.2 Bridge Types

Bridge is not a construction but it is a concept, the concept of crossing over large spans of land or huge masses of water. The idea behind a bridge is to connect two far-off points eventually reducing the distance between them. Apart from this poetic aspect of 'bridges', there is a technical aspect to them that classifies bridges on the basis of the techniques of their construction. Bridges can be constructed entirely from reinforced concrete, pre-stressed, post-tensioned concrete, steel, wood or composite concrete deck-steel girders. These bridges may be comprised of a wood deck, concrete slab or steel deck on wood, concrete or steel girders. The box girder bridge can be used in such a way the top flanges of the precast box girders form the bridge deck surface. Many types of bridges have been used significantly on highway and road to facilitate the traffic flow. The bridge types covered by the simplified methods of analysis in the CHBDC are as follows:

(a) Reinforced / post-tensioned solid slab

(b) Post-tensioned circular / trapezoidal voided deck

(c) Deck-on-girders, including concrete slab-on-girder, steel grid deck on girder and wood deck on girder

(d) Truss and arch

(e) Rigid frame and integral abutment types

(f) Bridges incorporating wood beams

(g) Multi-cell and multi-spine

(h) Cable Stayed

(i) Suspension

Bridges built with adjacent precast, prestressed concrete box bridges are one of the most popular and economical solution because they can be constructed rapidly, and deck forming is eliminated. Adjacent box girders are widely used in most part of the world for span up to 32m, due to ease of erection, shallow superstructure depth and aesthetic appeal.

2.3 History of Prestressed Box Girders

The concept of prestressed concrete was discovered by the engineer P.H. Jackson, San Francisco, California, who patented the concept in 1872 and used it for tightening concrete blocks for floor slabs. The German Engineer C.E.W Doehring obtained a patent for prestressed concrete slab using metal wires concept about 1888. All these attempts were unsuccessful, because the prestressing force was lost due to shrinkage and creep of concrete. In 1927, the French engineer E. Fressynet (1879-1962) demonstrated the usefulness of prestressing using high-strength steel to control prestress losses (Steinman and Watson, 1957; Raafat, 1958; Lin, 1963; O’Connor, 1971; Naaman, 1982).

Composite concrete deck slabs with precast prestressed girders have been extensively used in Canadian highways Since the 1950's, various configurations of precast prestressed concrete girders have been developed in many countries around the world for short-span bridges between 20 m and 36 m. In 1950, three types of these girders; I-, U-, and box-girders, were adopted in North America Standards which became known as AASHTO/PCI girders (Dunker and Rabbat, 1990).

Precast prestressed box girders have been extensively used in Canadian highways. The use of prestressed concrete adjacent box girders started in about 1950 for bridges with span lengths of 9m to 32m, and these box girders are widely used today for these span lengths. The girders design evolved from an open channel design. Shear keys or construction in the top flange were used to transfer the load between adjacent girders. Macioce et al. (2007) reported that adjacent box beam bridges constructed of non-composite prestressed concrete with an asphalt wearing surface were developed during the interstate construction period to provide a shallow superstructure, rapid uncomplicated construction, and low initial costs.

2.4 Fabrication of Precast Prestressed Concrete Box Girders

Precast prestressed box girders are constructed with constant dimensions in a steel form. Strands are placed after the reinforcing steel, and then pre-tensioned by using jacks from out side the form. Hold-down points at defined locations are used to allow bending the strands from bottom layers at the middle of the girder to the upper surface at both ends.

CPCI box girder types are the most commonly used prefabricated girders for bridges in Canada. We have four different sections of box girders i.e. B700, B800, B900 and B1000. All dimensions of these box girders are same except depth which varies from 700mm to 1000mm. These girders comprise of 1220 mm width, top and bottom flanges with thickness of 140mm, and the webs are 125mm thick (Precon, 2007).

2.5 Review of Previous Research on Load Distribution

2.5.1 Review of Study on Distribution Factors for Straight Bridges

This section summarizes previous research work pertained to load distribution in bridges. According to the level of bridge lateral rigidity, different methodologies are implemented in practice, including lever rule, eccentric compression method, hinged joint method, fixed joint method, orthotropic plate analogy, AASHTO Standard, AASHTO-LRFD and CHBDC simplified method.

2.5.1.1 Elastic Theory Method (Newmark, 1948)

An analytical procedure for determining shear and moment due to live load for both composite and non-composite bridges was developed by Newmark et al. (1948). They analyzed a number of bridges using simplified assumptions based on elastic theory. They recommended the following relationship for the transverse distribution of total longitudinal moment at a cross section in multi-girder bridges and presented the result of their work in a series of tables containing the fixed-end moment, distribution factors, and the carryover factors for both non-composite and composite slab-on-girder bridges.

$$M_G = D_f \; M_T \tag{2.1}$$

$$D_f = \frac{S}{K} \tag{2.2}$$

Where M_G is the design moment of a given girder due to the live load at the section of interest, M_T is the maximum moment of the same girder due to a single design truck, D_f is the distribution factor, S is the girder spacing and K is a constant. Newmark et al. suggested K of

1.676. The 1996 version of AASHTO standard (AASHTO, 1996) uses the same formula for girder spacing up to 1.829 m in order to determine the design moment for each girder in composite bridges. Experimental research work was carried out by Newmark et. al. at the University of Illinois to verify the above equations (Newmark et. Al, 1948). The Canadian Highway Bridge Design Code (CHBDC, 2006) adopts the basic approach of Newmark et al. for calculating the live load design moment for girders. The maximum live load moment in each girder is obtained by multiplying the maximum moment due to the design live load by distribution factor D_f.

2.5.1.2 Orthotropic Plate Analogy (Bakht, 1979)

In 1979, Bakht et al. used the concept of orthotropic plate to develop a simplified method for calculating the design live load longitudinal moments, see Figure 2.1. In their research, they conducted extensive parametric studies, which led them to find out that the distribution factor of bridges is related to a torsional parameter α and a flexural parameter θ, which are functions of geometry and material properties of the bridge. These parameters are given by:

$$\alpha = \frac{D_{xy} + D_{yx} + D_1 + D_2}{2\left(D_x D_y\right)^{0.5}} \tag{2.3}$$

$$\theta = \frac{b}{2L}\left(\frac{D_x}{D_y}\right)^{0.25} \tag{2.4}$$

Where b is the bridge width, L is the span length of the bridge and the various rigidities are given by:

$$D_x = \frac{E_G\, I_G}{S} + \frac{E_c t^3}{12} \tag{2.5}$$

$$D_y = \frac{E_c\, t^3}{12(1-\nu_c^2)} \tag{2.6}$$

$$D_{xy} = \frac{G_G\ J_G}{S} + \frac{G_c\, t^3}{6} \tag{2.7}$$

$$D_{yx} = \frac{G_c\, t^3}{6} \tag{2.8}$$

$$D_1 = D_2 = \nu_c D_y \tag{2.9}$$

Which E_c, G_c and ν_c are the Young's modulus, the shear modulus and the Poisson's ratio, respectively, t is the concrete slab thickness, S is the girder spacing, I_G and J_G are the flexural and torsional moment of inertia of the girder cross section, respectively. The subscript G refers to girder and c refers to the concrete slab. This method gives better results than the AASHTO recommendations that assume the girder spacing S is the only parameter that affects load distribution in slab-on-girder bridges. This method formed the basis of the 1991 version of the OHBDC as well as the CHBDC provisions.

In 1982, Jaeger and Bakht used the grillage analogy method for the idealization of slab and beam bridges (Jaeger and Bakht, 1982). In grillage analogy method, the longitudinal members were positioned to coincide with the actual girders centrelines and were given the properties of the composite section. The transverse members were considered as beams replacing the strips of the top slab. The moment of inertia, I_y, of the transverse beam is considered as follows:

$$I_y = \frac{L_x\, t^3}{12} I_x \tag{2.10}$$

And the torsional inertia, J_x, is given by the relationship:

$$G_c\, J_x = E_c\, I_y \tag{2.11}$$

In which results to:

$$J_x = \left(\frac{E_c}{G_c}\right)\left(\frac{L_x\, t^3}{12}\right) \tag{2.12}$$

Where L_x is the length of the strip in the longitudinal direction, t is the thickness of the strip, E_c and G_c are the concrete material modulus of elasticity and the shear modulus respectively. Details of simplified methods of analysis, which are also applicable for AASHTO loading, are given by Bakht and Jaeger (Bakht and Jaeger, 1985).

2.5.1.3 Lever Rule Method (Yao, 1990)

The lever rule is one of the most frequently used methods for calculation of distribution factors. In this method the deck between the girders is assumed to acts as a simply supported beam or cantilever beam, as shown in Figure 2.2. In this case, the load on each girder shall be taken as the reaction of the wheel loads. Lever rule is very accurate for two girder bridges. Lever rule can also be used for shear distribution near support, since the load would pass to the pier or abutment mostly through the adjacent two girders. Lever rule can also give very good results when the bridge transverse stiffness is relatively flexible. However, the results usually would be slightly conservative for the interior girders and unconservative for the exterior girders.

2.5.1.4 Hinged Joint Method (Yao, 1990)

The hinged joint method can also be used for small span concrete T-shaped girder bridges without intermediate diaphragms. Figures 2.3 demonstrate the free body diagrams of unit length section at bridge middle span of the hinged T-shaped girder bridge under unit sinusoidal load. Unlike the case of slab bridges, the deflection of the T-shaped girder flanges must be considered, as shown in Figures 2.3. When the cantilever length is within 0.80 m and the span length is greater than 10 m, the tables for calculating transverse influence line values for hinged slab bridges can also be used for hinged girder bridges. For better accuracy, detailed calculation is required for bridges beyond this range.

2.5.1.5 Fixed Joint Girder method (Yao, 1990)

In case when the lateral connection between girders is stiffer, the joint can be considered as a fixed joint. In addition to shear force at the joint, moment must also be considered, as shown in Figure 2.4. For n-girder bridge, a $2(n-1)$ order of indeterminate problem is to be solved to obtain the shear and moment at each joint. However, only shearing force g_i is considered for calculating distribution factor. Once g_i is known, the same procedure as in hinged joint method can be followed to obtain the transverse influence line as well as the distribution factors.

2.5.1.6 Grillage Method (Zokaie, 2000)

In 2000, Zokaie (Zokaie, 2000) carried out extensive analysis using grillage and finite element analysis to verify and evaluate the formulas, developed earlier in 1991. In the finite element model, shell element was used to represent the deck slab and frame element to represent the precast girders. In his study, Zokaie calibrated the developed formulas for moment and shear distribution factors to the interior and the exterior girders for bridges designed for one traffic lane and for bridges designed for two or more traffic lanes. According to this study, the distribution factor of longitudinal bending moment for slab-on-girder bridges for interior girders was given by the following equations:

For one traffic lane:

$$D_f = 0.1 + \left(\frac{S}{4f}\right)^{0.4}\left(\frac{S}{L}\right)^{0.3}\left[\frac{K_g}{Lt_s^3}\right]^{0.1} \tag{2.13}$$

For two or more traffic lanes:

$$D_f = 0.15 + \left(\frac{S}{3f}\right)^{0.6}\left(\frac{S}{L}\right)^{0.2}\left[\frac{K_g}{Lt_s^3}\right]^{0.1} \tag{2.14}$$

The distribution factor of the longitudinal shear for slab-on-girder bridges for interior was given by the following equations:

For one traffic lane:

$$D_f = 0.6 + \left(\frac{S}{15f}\right) \tag{2.15}$$

For two or more traffic lanes:

$$D_f = 0.4 + \left(\frac{S}{6f}\right) - \left(\frac{S}{25f}\right)^2 \tag{2.16}$$

Where: S, L, K_g and t_s are the spacing between girders, the span length, the longitudinal stiffness parameter, and the slab thickness, respectively. The factor f is a conversion factor between metric and imperial systems which equal to 304.8 mm and 1.0 ft. For exterior girders for one traffic lane, the factor 1.0 was provided for moment and shear related to the single beam distribution. For exterior girders for two or more traffic lanes, multiplication factors to the factors provided for interior girders are given as follows:

For bending moment for two or more traffic lanes:

$$e = \frac{7f + d_e}{9.1f} \geq 1.0 \tag{2.17}$$

For shear for two or more traffic lanes:

$$e = \frac{6f + d_e}{10f} \tag{2.18}$$

Where: d_e is the edge distance. The factor f is a conversion factor between metric and imperial systems which equal to 304.8 mm. Zokaie concluded that the results from the formulas previously provided in 1991 were within 5% of the results from the finite element analysis that he performed in his study in the year 2000.

2.5.1.7 The Finite-Element Method (Logan 2002)

This is the most famous and widely used method in many engineering applications. The principal of this numerical method is discretizing the structure into small divisions, or elements, where each element is defined by specific number of nodes (hence this process of modeling a body by dividing it into an equivalent system of smaller bodies or units called finite elements). The finite-element method is a numerical acceptable solution, it formulation of the problem results in a system of simultaneous algebraic equations for solution, rather than requiring analytical solutions (solutions of ordinary or differential equations), which because of the complicated geometries, loadings, and material properties, are not usually obtainable. The behavior of each element, and ultimately the structure, is assumed to be a function of its nodal quantities (displacements and/or stresses), which considered as the primary unknown of its nodal quantities. The modern development of the finite-element method began by Hrennikoff in the 1941 and McHenry in 1943 using (one-dimensional) elements (bars and beams) in the field of structural engineering. In 1947 Levy developed the flexibility or force method, and in 1953 he suggested that another method (the stiffness or displacement method) could be a promising alternative for use in analyzing statically redundant aircraft structures. However his equations were cumbersome to solve by hand, and hence it only became popular after the advent of the high speed computers. Turner et al. was the first who introduced the treatment of two-dimensional elements in 1956, they derived stiffness matrices for truss elements, beam elements, and two-dimensional triangular and rectangular elements in plane stress. The finite-element method extended to cover three-dimensional problems only after the development of tetrahedral stiffness matrix which was done by Martin in 1961.

2.5.1.8 Erin Hughs and Rola Idriss Study 2006

This study presents an evaluation of shear and moment live-load distribution factors for a new, prestressed concrete, spread box-girder bridge. The shear and moment distribution factors were measured under a live-load test using embedded fiber-optic sensors and used to verify a finite element model. The model was then loaded with the American Association of State Highway and Transportation (AASHTO) design truck. The resulting maximum girder distribution factors were compared to those calculated from both the AASHTO standard specifications and the AASHTO LRFD bridge design specifications. The LRFD specifications predictions of girder distribution factors were accurate to conservative when compared to the finite element model for all distribution factors. The standard specifications predictions of girder distribution factors ranged from highly unconservative to highly conservative when compared to the finite element model. For the study bridge, the LRFD specifications would result in a safe design, though exterior girders would be overdesigned. The standard Specifications, however, would result in an unsafe design for interior girders and overdesigned exterior girders.

2.5.1.9 Song, Chai and Hida Study 2003

The current American Association of State Highway and Transportation Officials (AASHTO) Load and Resistance Factor Design (LRFD) Specifications impose fairly strict limits on the use of its live-load distribution factor for design of highway bridges. These limits include requirements for a prismatic cross section, a large span-length-to-width ratio, and a small plan curvature. Refined analyses using 3D models are required for bridges outside of these limits. These limits place severe restrictions on the routine design of bridges in California, as box-girder bridges outside of these limits are frequently constructed. This paper presents the results of a study investigating the live-load distribution characteristics of box-girder bridges and the limits imposed by the LRFD specifications. Distribution factors determined from a set of bridges with parameters outside of the LRFD limits are compared with the distribution factors suggested by the LRFD specifications. For the range of parameters investigated, results indicated that the current LRFD distribution factor formulas generally provide a conservative estimate of the design bending moment and shear force.

2.5.1.10 AASHTO Methods

AASHTO introduced empirical methods which are more convenient to use as compared with the theoretical methods mentioned above. AASHTO defines the distribution factor as the ratio of the moment or shear obtained from the bridge system to the moment or shear obtained from a single girder loaded by one truck wheel line (*AASHTO Standard* 1996) or the axle loads (*AASHTO-LRFD* 2004). It should be noted that AASHTO Standard Specifications and AASHTO LRFD Specifications define the live load differently. The live load in the Standard specifications consists of an HS 20 truck or a lane load. While, the live load in the LRFD specifications consists of an HS 20 truck in conjunction with a lane load.

2.5.1.10.1 AASHTO Standard Method 1996

AASHTO Standard specifications contain simple procedures used in the analysis and design of highway bridges. AASHTO adopted the simplified formulas for distribution factors based on the work done in the 1940s by Newmark (1948). AASHTO typical procedure is used to calculate the maximum bending moment based on a single line of wheel loads from the HS20 design truck or lane loading. This calculated bending moment is then multiplied by the load distribution factor (S/5.5) or in the format of (*S/D)*, where *S* is the girder spacing in feet and *D* is a constant based on the bridge type to obtain the moment in an individual girder. This method is applicable to straight and right (non-skewed) bridges only. It was proved to be accurate when girder spacing was near 1.8m and span length was about 18 m (Zokaie, 2000). For relatively medium or long bridges, these formulas would lose accuracy.

2.5.1.10.2 AASHTO LRFD Method

The specifications outlined in Load and Resistance Factor Design, LRFD Design specifications were adopted (AASHTO, 2004). This code introduced another load distribution factors based on a comprehensive research project, National Cooperation

Highway Research Program (NCHRP) 12-26 which was entitled "Distribution of Live Loads on Highway Bridges" and initiated in 1985, consequently the guide specification for Distribution of Loads for Highway Bridges (AASHTO, 1994) was found. This guide recommends the use of simplified formulas, simplified computer analysis, and/or detailed finite-element analysis (FEA) in calculating the actual distribution of loads in highway bridges. It was noted that those new formulas were generally more complicated than those recommended by the Standard Specifications for Highway Bridges (AASHTO 1996), but their use is associated with a greater degree of accuracy (Munir, 1997). For example the lateral load distribution factor for bending moment in interior girders of concrete slab on steel girder bridge superstructure is:

$$g = 0.15 + (S/3)^{0.6} \ (S/L)^{0.2} \ (Kg/12Lt^3{}_s)^{0.1} \qquad (2.19)$$

Where g = wheel load distribution factor; S = girder spacing in feet, ($3.5 < S < 16$); L = span length of the beam in feet ($20 < L < 200$); t_s = concrete slab thickness in inches ($4.5 < t < 12$); Kg = longitudinal stiffness parameter = $n(I + Ae^2{}_g)$; n = modular ratio between beam and deck material; I = moment of inertia of beam (in.^{4}); A = cross-sectional area of beam (in.^{2}) and e_g = distance between the center of gravity of the basic beam and deck (in.).

AASHTO LRFD Specifications have become highly attractive for bridge engineers because of its incentive permitting the better and more economical use of material. The rationality of LRFD and its many advantages over the Allowable Stress Design method, ASD, are indicative that the design philosophy will downgrade ASD to the background in the next few years (Salmon and Johnson, 1996). The research results were first adopted by AASHTO

Standards in 1994 and were then officially adopted by AASHTO-LRFD in 1998. More parameters, such as girder spacing, bridge length, slab thickness, girder longitudinal stiffness, and skew effect are considered in the developed formulas which earned them sound accuracy. The AASHTO-LRFD formulas were evaluated by Shahawy and Huang (2001), their evaluation showed a good agreement with test results for bridges with two or more loaded design lanes, provided that girder spacing and overhang deck did not exceed 2.4 m and 0.9 m, respectively. Outside of these ranges, the error could be as much as up to 30%. For one loaded design lane, the relative error was less than 10% for interior girders and could be as high as 100% and as low as –30% for exterior girders. Shahawy and Huang presented modification factors for the AASHTO LRFD formulas and the results of the modified formulas showed good agreement with their test results (Shahawy and Huang, 2001).

2.5.1.11 Simplified Methods of Analysis (CHBDC 2006)

The Canadian Highway Bridge Design Code (CHBDC, 2006), as well as the 1991 version of the Ontario Highway Bridge Design Code (OHBDC, 1991)), specifies simplified method of analysis for live load using load distribution factors for slab-on-girder bridges. For OHBDC, the simplified method of analysis for the live load is based on considering the bridge as a rectangular orthotropic plate that was simply supported at two opposite ends on unyielding line supports which were continuous across the width of the plate and did not impose moment restraint. For CHBDC, the simplified method of analysis for the live load is based on the results from many bridge structures using grillage, semi-continuum and finite element methods for which the idealized structure was essentially an orthotropic plate. There are conditions and limitations for the use of simplified method of analysis, which are specified in the CHBDC. Conditions for applying simplified methods of analysis on straight bridges are as follows:

1. The bridge width is constant;
2. The support conditions are closely equivalent to line support;
3. The skew Parameter ($\varepsilon = S \tan \omega / L$) does not exceed 1/18 where "S" is the spacing between girders, "ω" is the skew angle and "L" is the span length;
4. There shall be at least three longitudinal girders that are of equal flexural rigidity and equally spaced or with variation from the mean of not more than 10% in each case; and
5. The overhang does not exceed 60% of the spacing between longitudinal girders and not more than 1.80 m.

These restrictions have been provided for the consistency between the methods of analysis in CHBDC and OHBDC. Shear-connected beam bridges are analyzed by the methods applicable to shallow superstructure provided that continuity of transverse flexural rigidity across the cross-section is present. If not, analysis for longitudinal moments and shears is by the same method as for multispine box girders.

When the skew angle "ω" of a bridge is less than 20^{o}, it has usually been considered safe to ignore the skew angle and analyze the bridge as a right bridge whose span is equal to the skew span. The implication of this practice is that the angle of skew is considered to be the only necessary measure of the "skewness" of the bridge with respect to its load distribution characteristics. Extensive comparative analyses of skew and equivalent right bridges conducted by Jaeger and Bakht showed that the angle of skew of the bridge is not the only necessary measure of its skew ness, which is also affected by its span, width and girder spacing, if present. In particular, it has been shown that a dimensionless parameter characterizing the skewness of a slab-on-girder bridge is $S \tan \omega / L$. For permitting the analysis of a skew bridge as an equivalent right bridge, the Code has imposed the upper limits of 1/18 for this parameter to ensure that the shear values in particular are not in unsafe error by more than 5%. CHBDC noted that the force effects in skewed, slab-on-girder type bridges may be analyzed by the simplified methods presented, if the other conditions of the simplified method are met. The simplified method presented in the CODE enable the designer to calculate the increased shear effects that occur with increase in skewness.

CHBDC stated that the two limitations pertaining to an overhanging deck slab, noted in condition 5, relate to the need to have the structure remain such that the orthotropic plate approximation is closely applicable. For a slab-on-girder bridge with equally spaced girders a distance S apart, a cantilever overhang of S/2 on either side is the desired condition, since each longitudinal girder can then be associated in a width S/2 of deck on either side of its centreline; a uniformly distributed load over the entire deck area would then result in the girders sharing equally in accepting the total longitudinal responses. If the overhang is permitted to be a maximum of 0.6S, the outer girders then accept rather more bending moment and shear force than the interior ones, but the departure from uniformity is still acceptable. So far as the limitation on the deck overhang of 1.80 m is concerned, when due allowance is made for barrier walls, curbs, etc. this limitation means that when a vehicle is travelling as far over in the outside lane as possible, its centre of gravity will not be significantly outside the centreline of the outermost girder. This limitation is necessary if the orthotropic plate representation is to be realistic. The bridges selected for establishing analysis results for the simplified methods in this Code had the same limitations for the deck slab overhang, being equal to or less than 60% of the girder spacing, S, with a maximum overhang equal to 1.8 m.

The Canadian Highway Bridge Design Code (CHBDC, 2006) specifies equations for the simplified method of analysis to determine the longitudinal bending moments and vertical shear in slab-on-girder bridges due to live load for ultimate, serviceability and fatigue limit states using load distribution factors. The CHBDC distribution factor equations used for slab-on-prestressed-girders are as follows:

For the longitudinal bending moment per girder, M_g, for ultimate and serviceability limit states:

$$M_g = F_m M_{g\,avg} \tag{2.20}$$

Where $M_{g\,avg}$ is the average moment per girder and F_m is an amplification factor for the transverse variation in maximum longitudinal moment intensity (Distribution Factor).

$$M_{g\,avg} = \frac{nM_T R_L}{N} \tag{2.21}$$

$$F_m = \frac{S\,N}{F\left(1+\dfrac{\mu C_f}{100}\right)} \geq 1.05 \tag{2.22}$$

$$\mu = \frac{W_e - 3.3}{0.6} \leq 1.0 \tag{2.23}$$

Where M_T is the maximum moment per design lane, n is the number of design lanes, R_L is a modification factor for multilane loading, N is the number of longitudinal girders, S is centre-to-centre girder spacing in meter, W_e is the width of the design lane in meter, C_f is a correction factor obtained from tables and F is the width dimension that characterizes the load distribution for the bridge.

For the longitudinal bending moment per girder, M_g, for Fatigue Limit State:

$$M_g = F_m M_{g\,avg} \tag{2.24}$$

Where: $M_{g\,avg}$ is the average moment per girder and F_m is an amplification factor for the transverse variation in maximum longitudinal moment intensity (Distribution Factor).

$$M_{g\,avg} = \frac{M_T}{N} \tag{2.25}$$

$$F_m = \frac{S\,N}{F\left(1+\dfrac{\mu C_f}{100}+\dfrac{C_e}{100}\right)} \geq 1.05 \tag{2.26}$$

$$\mu = \frac{W_e - 3.3}{0.6} \leq 1.0 \tag{2.27}$$

Where M_T is the maximum moment per design lane, n is the number of design lanes, R_L is a modification factor for multilane loading, N is the number of longitudinal girders, S is centre-to-centre girder spacing in meter, W_e is the width of the design lane in meter, C_f is a correction factor obtained from tables, C_e is a correction factor for vehicle edge distance obtained from tables and F is the width dimension that characterizes the load distribution for the bridge. Expressions for F, C_f and C_e for slab-on-girder bridges are shown in Table 2.2.

For the longitudinal vertical shear per girder, V_g, for ultimate, serviceability and fatigue limit states:

$$V_g = F_v V_{g\,avg} \tag{2.28}$$

Where $V_{g\,avg}$ is the average shear per girder and F_v is an amplification factor for the transverse variation in maximum longitudinal vertical shear intensity (Distribution Factor).

$$V_{g\,avg} = \frac{nV_T R_L}{N} \tag{2.29}$$

$$F_v = \frac{S\,N}{F} \tag{2.30}$$

Where V_T is the maximum vertical shear per design lane, n is the number of design lanes, R_L is a modification factor for multilane loading, N is the number of longitudinal girders, S is centre-to-centre girder spacing in meter, W_e is the width of the design lane in meter and F is the width dimension that characterizes the load distribution for the bridge and can be obtained from provided tables.

CHAPTER III

FINITE-ELEMENT ANALYSIS

3.1 General

The advancement of computers in terms of hardware and software engineering let the structural engineering enter into a new era. More extensive and approximate numerical solutions to complicated engineering problems were initiated due to the wide use of the finite element method. The finite element method is considered the most powerful and versatile method of analysis available nowadays. In early 1980's, the grillage analogy method was extensively used and was very popular. Because of the recent development in the finite element method, and the large capacities of high-speed computers, it is possible to model a bridge in a very realistic manner and to provide a full description of its structural response due to different loading conditions. One of the most important advantages of the finite element method is the ability to deal with problems that have arbitrary arrangements of structural elements, material properties, and boundary conditions. Finite element analysis has proven to give reliable results when compared to experimental findings; this built up trust encouraged the designers and code writers to allow the implementation of the finite element method in the analysis and design of different engineering structures. The finite element analysis software "SAP2000" version 10 was used throughout this study to determine the structural behaviour of the prestressed concrete box girder bridges under truck loads. A general description of this software is presented further in this chapter. The developed finite element methods described herein were used to perform extensive parametric study on the structural response of precast prestressed concrete box girder bridges due to CHBDC truck loading conditions.

The Canadian Highway Bridge Design Code (CHBDC 2006), section 5.9, permits the use of six different refined methods of analysis for short and medium span bridges. The finite element method is one of the methods recognized by CHBDC. From all the six permitted methods, the finite element method is considered to be the most powerful, and versatile. In finite element method solutions can be find out without the use of governing differential equations, It permits the combination of various structural elements such as plates, beams, and shells, It is able to analyze structures having arbitrary geometries with any material variations thereof, and It is possible to automate every step involved in the method.

In this chapter a brief description of finite-element approach will be reviewed as well as descriptions of modeling the different components of the composite box-girder bridges. The available commercial finite-element program, SAP2000, was utilized through this study to determine the structural response of the modeled bridge prototypes. A general description of this software is presented later in this chapter. The procedure to perform an extensive parametric study on selected straight and curved bridge prototypes, loading cases, and different bridge configurations, to evaluate loads distribution characteristics is explained also in this chapter.

3.2 Finite-Element Approach

The finite-element method is a numerical method for solving problems of engineering and mathematical physics. In structural engineering problems, the solution is typically concerned with determining stresses and displacements and will yield approximate values of the unknowns at discrete number of points in a continuum. This numerical method of analysis starts by discretizing a model. This numerical method of analysis which begins by dividing a body into an equivalent system of smaller bodies or units (finite-elements) interconnected at points (nodes) common to two or more elements and/or boundary lines and/or surfaces is called discretization. Hence, instead of solving the problem for the entire body in one operation, it facilitates the formation of equations for each finite-element and at the end; it will combine them to obtain the solution of the whole body. For the purpose of simplifying the formulation of the above elements equations, matrix methods are implemented. Matrix methods are considered as an important tools used to structure the program of the finite-element methods to facilitate their computation process in high-speed computers.

In general there are two approaches associated with the finite-element; (1) force or flexibility method, and (2) displacement or stiffness method. It has been shown that for computational purposes, the latter method is more desirable because its formulation is simpler for most structural analysis problems; moreover a vast majority of general-purpose finite-element programs have incorporated the displacement formulation for solving structure problems. The finite-element method uses different types of elements; (1) one dimensional element or so called linear element; (2) two-dimensional element which can be in the forms of plane element or triangular and quadrilateral shape elements; and (3) three-dimensional solid shape elements.

Selecting the most appropriate element type should be to model the most closely to the actual physical behaviour. An equation is then formulated combining all the elements to obtain a solution for one whole body. Using a displacement formulation, the stiffness matrix of each element is derived and the global stiffness matrix of the entire structure can be formulated by the direct stiffness method. This global stiffness matrix, along with the given displacement boundary conditions and applied loads is then solved, thus that the displacements and stresses for the entire system are determined. The global stiffness matrix represents the nodal force-displacement relationships and is expressed in a matrix equation form as follows:

$$[P] = [K][U] \tag{3.1}$$

Where:

[P] = nodal load vector;

[K] = the global stiffness matrix;

[U] = the nodal displacement vector;

The steps for deriving the above equation can be summarized in the following basic relationships:

a) $$\upsilon(x,y) = [\phi(x,y)][\alpha] \tag{3.2}$$

Where:

$\upsilon(x,y)$ = the internal displacement vector of the element;

$[\phi(x,y)]$ = the displacement function matrix; and

$[\alpha]$ = the generalized coordinates matrix.

b) $$[U] = [A][\alpha] \qquad \text{then, } [\alpha] = [A]^{-1}[U] \tag{3.3}$$

Where $[A]$ is the transformation matrix from local to global coordinates,

c) $$[\varepsilon(x,y)] = [B(x,y)][\alpha] = [B(x,y)][A]^{-1}[U] \tag{3.4}$$

Where:

$[B(x,y)]$ = The strain-displacement matrix; and

$[\varepsilon(x,y)]$ = The strain matrix.

d) $$[\sigma(x,y)] = [D][\varepsilon(x,y)] = [D][B(x,y)][A]^{-1}[U] \tag{3.5}$$

Where:

$[D]$ = the constitutive matrix or the elasticity matrix.

From the principle of minimization of the local potential energy, the total external work is equal to $\frac{1}{2}[U]^T[P]$, then

e) I - $$W_E = [U']^T\ [P] \tag{3.6}$$

II - $$W_I = \int_{vol} [\varepsilon]^T [\sigma] = [u']^T [A]^{-1}[k'][A]^{-1}[U] \tag{3.7}$$

$$[k'] = \int_{vol} [B(x,y)]^T [D][B(x,y)] \tag{3.8}$$

Where:

W_E = the external virtual work;

W_I = the internal virtual work;

$[u']$ = the vector of virtual displacement; and

$[k']$ = the element stiffness matrix.

f) From the principle of virtual work, $W_E = W_I$. By taking one element of virtual nodal displacement vector $[u']$ equal to unity successfully, the solution becomes:

$$[P] = [K][U] \tag{3.9}$$

Where $[K] = \Sigma[k']$, so the global structural stiffness matrix is an assemblage of the element stiffness matrix $[k']$.

g) The solution of the resulting system of equations yields the values of nodal displacement $[U]$ and the internal forces for each element can be obtained from equation (3.4).

In the case of a linear (elastic) structural problem, loads are first applied on a model and the solution is obtained directly. In a non-linear case, the analysis follows a different numerical method to obtain a solution. However, such analysis is beyond the scope of this thesis and is not discussed.

3.3 SAP2000 Computer Program

The software "SAP2000" is a structural analysis program that employs the finite-element method in the analysis and designs of complicated structures. During the 1980's and 1990's SAP engineering software become a popular choice for finite element analysis. The program is used worldwide to estimate structural responses of structures due to various applied loads. This program has a range of capabilities depending on the version used. SAP2000 is also capable of analyzing structures in static and/or dynamic modes. Its finite-element library consists of six elements.

1. *FRAME Element*: The Frame element is a two-node three-dimensional element, which includes the effect of biaxial bending, tension, axial deformation, and biaxial shear deformation.

2. *Shell Element*: The Shell element is a three or four-node three-dimensional element, which combines separate membrane and plate-bending behaviour. The membrane behaviour includes translational in-plane stiffness components and rotational stiffness component in the direction normal to the plane of the element. The plate bending behaviour includes two-way, out of plane, plate rotational stiffness components and translational stiffness component in the direction normal to the plane of the element. The program allows using pure membrane, pure plate, or full shell behaviour.

3. *Plane Element*: The Plane element is a three- to nine-node two-dimensional element, which contributes stiffness only in the two translational degrees of freedom at each of its connected joints. Plane element is used for modeling thin plane stress structures and long plane strain structures.

4. *Solid* Element: The Solid element is an eight-node three-dimensional element, which includes nine optional incompatible bending modes. The solid element contributes stiffness in all three translational degrees of freedom at each of its connected joints.

5. *Asolid* Element: The Asolid element is a three- to nine-node two-dimensional element, which contributes stiffness only in the two translational degrees of freedom at each of its connected joints. Asolid element is used for modeling axisymmetric structures under axisymmetric loading.

6. *Nllink* Element: The Nllink element is a one joint grounded spring or two joint link which is composed of six separate springs, one of each of the six deformational degrees of freedom. The Nllink element is used for modeling linear or nonlinear structural behaviour. The nonlinear behaviour is used only for the time-history analysis.

In addition, subsets of these elements with varying degrees of freedom are available in the form of truss, frame, membrane, beam, strain, gap, and hook elements.

3.4 Finite Element Modeling of Box Girder Bridges

A three dimensional finite element model was used to analyze the box girder bridges in this study. A sensitivity study was conducted to choose the finite element mesh. The finite element mesh is usually chosen based on pilot runs and is a compromise between economy and accuracy. In the finite modeling process, the structure is first divided into several components. In this research, the bridges were divided into: concrete bottom flange, concrete top flange (deck slab), concrete webs, concrete diaphragms and concrete connection joints, as shown in Figures 3.10 and 3.11.

3.4.1 Geometric Modeling

3.4.1.1 Modeling of Webs, Top and Bottom Flanges, and Diaphragms

To analyze box girder bridges and to determine their structural response, a three-dimensional finite-element model was adopted. To facilitate the analysis, the structure was divided into major components as follows: top flange, bottom flange, web, and connection joints. From SAP2000 library, the four-node shell element was chosen to model all bridge components, see Figure 3.9. The four-node shell element has six degrees of freedom at each node that are three displacements (U1, U2, U3) and three rotations (Φ1, Φ2, Φ3). Four horizontal elements were used to model each top and bottom flanges, three vertical elements were used to model the web. It should be noted that web and bottom flange thicknesses were taken as those specified in the Precon Manual, while the thickness of top flange was taken as 225 mm. One horizontal shell element was used for connection joint between the box girders at top flange centre-line. The thickness of this shell element was taken as 225 mm as the flange thickness. End diaphragms between the webs of each box were modeled with a total of twelve elements comprised of five elements in the lateral direction and two elements in the vertical direction. A diaphragm thickness of 300 mm was considered in this study. No intermediate diaphragms were used along the bridge span between supports. In the longitudinal direction of the bridge, number of elements are depends on the length of bridge.

A case sensitivity study has been carried out to investigate the accuracy of the results from the finite element analysis. In this study, various numbers of elements, in the longitudinal, vertical and transverse directions of the bridge model, have been considered. The various number and types of boundary conditions were used to find the accurate results. The level of accuracy of the developed FEA model was examined against results from simple beam analysis for the following loading cases: (i) self-weight of the bridge superstructure; (ii) a uniform superimposed loading of 10 kN/m^2; and a line load at the mid-span section of total value of 100 kN. The straining actions considered for comparison were maximum bending stresses at mid-span location, maximum mid-span deflection and support reaction. The results from the sensitivity study are presented in Table A.1 through A.8 for a bridge prototype of 6 box girders and 7.396 bridge width. The analysis was conducted for different span lengths and box girder depth. The results shown in these tables indicate that the proposed finite-element models for this parametric study provides results within $\pm$2.0% differences from those obtained from simple-beam analysis.

3.4.1.2 Aspect Ratio

The aspect ratio is defined as the ratio of the longest dimension to the shortest dimension of a quadrilateral element. In many cases, as the aspect ratio increases, the inaccuracy of the solution increases (Logan, 2002). Logan presented a graph showing that as the aspect ratio rises above 4, the percentage of error from the exact solution increases greater than 15%. By maintaining the length of the shell elements in the direction of bridge as 500 mm, the maximum aspect ratio used in the modeling of elements in this study was 2.5.

3.4.1.3 Modeling of Moving Load Paths

SAP2000 software has the ability to run a moving load along a defined frame element path. The program shifts a group of loads, previously defined as static loads, certain interval along a defined path and provides the extreme straining actions at each node. Therefore, Frame elements are provided in the longitudinal direction at the top of the shell elements for the paths of the moving loads. These frame elements are modeled with a very small section dimensions so that they do not affect the finite element model of the structure. Static loads on frame elements were used to reduce the time of computer runs and placed to provide equivalent maximum bending moment, deflection and shear force resulted from SAP2000 moving loads runs.

3.4.2 Boundary Conditions

Nodal constraints were used in the analysis as boundary conditions to represent the supports of the bridge. The roller support condition at the every node of the bottom flange of the box girder was provided at the one end of the bridge to restrain both vertical and lateral displacements. While, the hinged support condition at every node of the bottom flange of the box girder was provided at the other end of the bridge to restrain displacements in all directions.

3.4.3 Material Modeling

The material properties can highly affect the results of the analysis. Therefore, it is important that the material properties are defined so that SAP2000 software can provide suitable properties for elements. Material properties are considered linear elastic and isotropic for these structures. The required properties for SAP2000 software are the elastic modulus, Poisson's ratio, the weight density, the mass density and the coefficient of the thermal expansion in three directions. In SAP2000 software, the shear modulus is defined in terms of Young's modulus and Poisson's ratio as per the following equation:

$$G = \frac{E}{2(1+\upsilon)} \tag{3.10}$$

Where:

$G =$ the shear modulus;

$E =$ Young's modulus; and

$\upsilon =$ Poisson's ratio.

Materials and their properties are chosen based on the CHBDC and the common materials available in Ontario. The compressive strength of concrete (f'_c) is considered 35 MPa. As per CHBDC, the weight density (γ_c) for normal prestressed concrete is considered 24.0 kN/m^3. The modulus of elasticity of concrete (E_c) is calculated from the following equation:

$$E_c = \left(3000\sqrt{f'_c} + 6900\right)\left(\gamma_c / 2300\right)^{1.5} \quad (3.11)$$

$$E_c = 27{,}900.0 \text{ MPa} \quad (3.12)$$

Poisson's ratio for elastic strains of concrete is taken as 0.2.

Mass density for concrete is taken as 2500 kg/m^3.

3.5 CHBDC Design Loading

The design of Highways and Bridges in Canada has its own criteria in terms of the critical live loads selected in the design. Two types of live loads were specified in the Canadian Highway Bridge Design Code (CHBDC, 2006); namely: truck loading and lane loading. Both above mentioned loads were investigated in this study. Figure 3.3 shows a view the above mentioned CHBDC live truck and lane loads namely; CL-W truck loading and the CL-W lane loading. The CL-W truck is an idealized five-axle truck, the number ”W” indicates the gross load (625) of the CL-W truck in KN. Wheel and axle loads are shown in terms of W, and are also shown specifically for CL-625 truck. Whereas the CL-W lane loading consists of CL-W truck loading, with each axle load reduced to 80% of its original value, and superimposed within a uniformly distributed load of 9 KN/m over 3.0 m width.

For the purpose of this study, the following different CHBDC truck loading configurations were considered:

Figure 3.4 presents a schematic diagram of truck axle load locations to produce maximum bending moment. By inspection, Level 2 loading was used in the analysis of the 16m and 20m span bridges, while Level 4 was used to analyze bridges of 24, 26, 30 and 32m spans. Figure 3.5 presents a schematic diagram of truck axle load locations to produce maximum reaction force. By inspection, Level 2 loading was used in the analysis of the 16m span bridges, while Level 4 was used to analyze bridges of 20, 24, 26, 30 and 32m spans. In studying the moment, shear and deflection distributions, the loading on the bridge prototypes was applied in such a way to produce maximum reaction forces and longitudinal flexural stresses.

3.6 CHBDC Specifications for Truck Loading

The live load specified in the Canadian Highway Bridge Design Code, CHBDC, consists of CL-W Truck or CL-W Lane Load. CL-W Truck, provided for all other provinces, in the axle loads. The selection between the two different CHBDC types of live loads (CL-625 truck and CL-625 lane) depends on whichever gives the greatest design values. Dynamic load allowance is applied to both CL-W and CL-625-ONT Trucks. The CL-W Lane Load consists of 80% of the value given for each axle of the CL-W Truck superimposed within a uniformly distributed load of 9 kN/m and a space of 3.0 m wide (Figure 3.3). No dynamic load allowance is considered for both CL-W and CL-625-ONT Lane Loads. A sensitivity study was carried out in this regard showed that the CL-625 truck loading is governing the extreme design values for the box girder of 16, 20, 24, 26, 30 and 32m span lengths. CL-625 truck loading giving higher values, accordingly the CL-625 lane loading was utilized in this study. CHBDC requires considering three limit states in bridge designs; namely:

a. The Ultimate Limit State (ULS), that involve failure, including rupture, overturning, sliding, and other instability,

b. The Serviceability Limit State (SLS), at which the effect of vibration, permanent deformation, and cracking on the usability or condition of the structure are considered,

c. The Fatigue Limit State (FLS), at which the effect of fatigue on the strength or condition of the structure are considered.

For fatigue analysis, an equivalent static load is specified in the CHBDC. Only one truck, either CL-W Truck or CL-625-ONT Truck, can be placed at the centre of one travelling lane. The lane load is not considered for the fatigue limit state. CHBDC states that for longitudinal bending moments and associated deflections for Fatigue Limit State and superstructure vibration, the vehicle edge distance (the distance from the centre of the outer wheel load to the edge of the bridge) shall not be greater than 3.0 m.

Dead load and truck load cases were considered for each of the above three CHBDC requirements. Different loading configurations were also considered in this study represented by: two-lanes, three-lane and four-lane bridges. As a result, a total of 48 different load cases were employed of the above mentioned design requirements. Figures 3.6, 3.7 and 3.8 presents the loading cases considered in this study for two-, three-, and four-lane bridges, respectively.

3.7 Composite Bridge Configurations

192 concrete box girder bridge prototypes with were considered for the finite-element analysis in this parametric study.

Below are the major parameters were considered:

a. Span length **(L)**: 16, 20, 24, 26, 30, and 32 m

b. Girder spacing **(S)**: 1.235 m based on the commercial size of precast box girders

c. Number of precast box girders **(N)**: 6 to 14

Based on CHBDC code which specifies number of design lanes as a basis for bridge width (see Tables 3.1), some of the above diversity of parameters were determined. Other bridge configurations are listed as below:

- The deck slab (Top flange) thickness was taken as 225 mm,
- The bottom flange thickness was taken as 140 mm,
- The girder web thickness was considered equal to 125 mm,
- The thickness of joints between boxed was maintained 225 mm, and width 140 mm. The later represents a 15 mm gap between boxes and half the web thickness on each side.
- The deck slab width (W_c) was taken equal to the total bridge width minus 1.0 m to allow for barrier wall thickness of 0.5 m on each side of the bridge,

3.8 Load Distribution Factor

3.8.1 Calculation of the Moment Distribution Factors

We calculated the longitudinal stresses (σ_{FE}) in girders at the bottom surface of the bottom flange in order to determine load distribution factor for longitudinal bending moment (F_m) due to truck loadings. The maximum flexural stresses $(\sigma_{straight})_{truck}$, were calculated for the straight simply-supported beam due to CHBDC truck loading.

$$(\sigma_{straight})_{truck} = M_T (y_b) / I_t \tag{3.13}$$

- where M_T = the mid-span moment for a straight simply supported girder due to a single CHBDC truck loading.
- y_b = the distance from the neutral axis to the bottom flange.
- I_t = the moment of inertia of the box girder.

Also the results of the above equations were verified by SAP2000 program using the developed FEA model. The finite-element modeling was then used to calculate the maximum longitudinal flexural stresses along the bottom flange for dead loads, fully-loaded lanes, partially loaded lanes, and fatigue loading conditions presented in Figs. 3.6 to 3.8. Consequently, the moment distribution factors (Fm,) due to dead loading, fatigue loading conditions and various truck loading conditions, respectively, were calculated as follows:

- $(F_m)_{DL} = (\sigma_{FE.})_{DL} / (\sigma_{straight})_{DL}$ (3.14)
- $(F_m)_{FL} = (\sigma_{FE.})_{FL} \text{ x } N / ((\sigma_{straight})_{truck} \text{ x } n)$ (3.15)
- $(F_m)_{PL} = (\sigma_{FE.})_{PL} \text{ x } N \text{ x } R_L' / ((\sigma_{straight})_{truck} \text{ x } n \text{ x } R_L)$ (3.17)

Where:

N = number of girders;

n = number of design lanes;

R_L = multi-lane factor based on the number of the design lanes; as shown in Table 3.2, considering Class A highway.

R_L' = multi-lane factor based on the number of the loaded lanes; as shown in Table 3.2,

$(\sigma_{FE.})_{PL}$ = the maximum average flexure stress, resulting from FEA bridge analysis, at the bottom surface of the bottom flange of the girders;

$(\sigma_{FE.})_{FL}$ = the maximum average flexure stress, resulting from FEA bridge analysis, at the bottom surface of the bottom flange of the girder due to fatigue Loadings;

3.8.2 Calculation of the Shear Distribution Factors

In determining the shear distribution factor (Fv) for box girder, the maximum shear forces, $(R_{straight})_{truck}$, were calculated for straight simply supported beam due to a single CHBDC truck loading. By using finite-element modeling, the maximum shear forces (R_{FE}) for dead load, fully loaded lanes, partially loaded lanes, and fatigue loading were determined. Consequently, the shear distribution factors (F_v) were calculated as follows:

$$(F_v)_{DL} = (R_{FE.\ ext})_{DL} / (R_{straight})_{DL} \quad (3.18)$$

$$(F_v)_{FL} = (R_{FE.})_{FL} \text{ x } N / ((R_{straight})_{truck} \text{ x } n) \quad (3.19)$$

$$(F_v)_{PL} = (R_{FE.})_{PL} \text{ x } N \text{ x } R_L' / ((R_{straight})_{truck} \text{ x } n \text{ x } R_L) \quad (3.20)$$

$$(F_v)_{Fat} = (R_{FE.})_{Fat} \text{ x } N / (R_{straight})_{truck} \quad (3.21)$$

N = number of girders;

n = number of design lanes;

R_L = multi-lane factor based on the number of the design lanes; as shown in Table 3.2,

R_L' = multi-lane factor based on the number of the loaded lanes; as shown in Table 3.2,

$(R_{FE.})_{FL}$ = the maximum total reaction, resulting from bridge analysis, at the box girder supports;

$(R_{FE.})_{FL}$ = the maximum total reaction, resulting from bridge analysis, at the exterior girder supports due to fatigue Loadings;

3.8.3 Calculation of the Deflection Distribution Factors

In order to determine the load distribution factor for deflections (F_d) for the exterior girders, the deflection resulting from bridge analysis at the critical section (Δ_{FE}), due to truck loadings at fatigue load case was identified. Also, the deflection for the corresponding single girder, resulting from the analysis at the corresponding critical section of the bridge $(\Delta_{straight})_{truck}$, due to single truck loading was identified. The maximum deflection at the bottom flange was identified from the average vertical displacements for the three nodal joints adjacent to the chosen section. The distribution factors for deflections were calculated in accordance with CHBDC as follows:

For deflection at exterior girders for fatigue ($F_{f\delta\ ext}$):

$$(F_d)_{Fat.ext} = (\Delta_{FE\ ext})_{Fat} \times N / (\Delta_{straight})_{truck} \tag{3.22}$$

Where:

N = number of girders;

$\Delta_{FE\ ext}$ = the maximum average deflection, resulting from bridge analysis, at the bottom surface of the bottom flange of the exterior girder due to fatigue

CHAPTER IV
RESULTS FROM THE PARAMETRIC STUDY

4.1 General

A practical-design-oriented parametric study on 192 simply-supported straight, deck-free, adjacent precast box-girder bridge prototypes was conducted to investigate the moment, shear and deflection distribution factors at the ultimate, serviceability and fatigue limit states. The bridges were analyzed to evaluate their structural responses when subjected to the Canadian Highway Bridge Design truck loading, CHBDC truck CL-625. Based on the results generated from the parametric study, new simplified formulas for Moment, shear and deflection Distribution Factors for such bridges were developed. These equations will be useful for code writers and bridge engineers designing such bridge superstructure.

In this study the following major key parameters were considered:

a) Number of girders **(N)**,
b) Girder spacing **(S)**,
c) Girder size (**I,** $\mathbf{Y_b}$,… **etc)**,
d) Bridge span length **(L)**,
e) Number of design lanes (***n***), and
f) Truck loading conditions

The following sections present the results from the parametric study as compared to the available equations in CHBDC for voided slab bridges, slab-on-girder bridges and multiple-spine composite steel box girder bridges. The chapter will conclude with the developed equations and their limitation of use along with correlation between the FEA values and those from the developed equation to stand on the latter's level of accuracy.

4.2 Effect of Number of Girders

To form a cross section of the bridge, precast box beams were used. These beams are of fixed width of 1.22 m. considering 15 mm gap between boxes, the served width of the box would be 1.235 m. As such, the bridge width is a multiplier of the box width and increases with increase in number of girders. Therefore, changes in bridge width and number of girders are assumed to have similar effect of the structural response of such bridges. Bridge width, deck width and the numbers of girders for different design lanes considered in this study are given below.

For bridge cross-section with two design lanes:

a) Bridge width = 7.396m, deck width = 6.396 m and number of box girders = 6
b) Bridge width = 8.631m, deck width = 7.631m and number of box girders = 7
c) Bridge width = 9.866m, deck width = 8.866m and number of box girders = 8

For bridge cross-section with three design lanes:

a) Bridge width = 11.101m, deck width = 10.101m and number of box girders = 9
b) Bridge width = 12.336m, deck width = 11.336m and number of box girders =10
c) Bridge width = 13.571m, deck width = 12.571m and number of box girders =11

For bridge cross-section with four design lanes:

a) Bridge width = 14.806m, deck width = 13.806m and number of box girders = 12
b) Bridge width = 16.041m, deck width = 15.041m and number of box girders =13
c) Bridge width = 17.276m, deck width = 16.276m and number of box girders =14

The following subsections explain the effect of number of girders on the moment, shear and deflection distribution factors.

4.2.1 Moment Distribution Factor

Figures 4.1 to 4.24 show the relationship between the number of girders and moment distribution factor, F_m, of selected bridge geometries. The results are introduced for both ULS and SLS design and FLS design. As an example, Figure 4.1 depicts the change in moment distribution factor with increase in number of girders for a two-lane, 16-m span, bridge made of B700 box girders. It can be observed that F_m changes from 1.17 to 1.28 when increasing number of girders from 6 to 8 (or increasing bridge width) for FLS design. This considers an increase of 9.4%. On the other hand, F_m increases from 1.09 to 1.13 when increasing number of girders from 6 to 8 (an increase of 3.7%) for ULS and SLS designs. It should be noted that the change in bridge width and corresponding number of girders is implied in the parameter μ in equation 2.27 in the CHBDC simplified method.

4.2.2 Shear Distribution Factor

Figures 4.25 to 4.48 show the relationship between the number of girders and the shear distribution factor, F_v, of selected bridge geometries. The results are introduced for both ULS and SLS design and FLS design. To explain the trend, Figure 4.25 is taken here as an example. This figure shows the change in shear distribution factor with increase in number of girders for a two-lane, 16-m span, bridge made of B700 box girders. It can be observed that F_v changes from 1.99 to 2.74 when increasing number of girders from 6 to 8 for FLS design. This considers an increase of 37.7%. On the other hand, F_v increases from 1.29 to 1.68 when increasing number of girders from 6 to 8 (an increase of 30%) for ULS and SLS designs.

4.2.3 Deflection Distribution Factor

Figures 4.49 through 4.60 depicts the change in deflection distribution factor, F_d, with increase in number of girders. As an example, Figure 4.49 depicts the change in deflection distribution factor with increase in number of girders for a two-lane, 16-m span, bridge made of B700 box girders. It can be observed that F_d changes from 1.14 to 1.19 when increasing number of girders from 6 to 7, then it decrease to 1.16 when increasing number of girders to 8 for FLS designs. By inspection, it can be observed that the rate of change of F_d values with change in number of girders is less than that for moment and shear distribution factors presented in the previous subsections.

4. 3 Effect of Span Length

To study bridge span effect of the structural response of studied bridges, 6 different span length were considered, namely: 16, 20, 24, 26, 30 and 32 m. To maintain realistic bridge flexural stiffness with increase in bridge span, four different box girder sizes (B700, B800, B900 and B1000) were considered in the FEA modeling as follows:

a) B700 box girder for 16 and 24 m spans,

b) B800 box girder for 20 and 26 m spans,

c) B900 box girder for 24 and 30 m spans, and

d) B1000 box girder for 26 and 32 m spans.

The following subsections explain the effect of span length of the moment, shear and deflection distribution factors of the studied bridges.

4.3.1 Moment Distribution Factor

Figures 4.61 to 4.69 show the relationship between the change in span length and moment distribution factor, F_m, of selected bridge geometries. To explain the trend, Figure 4.68 depicts the change in moment distribution factor with increase in span length of a four-lane bridge made of 13 box girders and 16 m bridge width. It can be observed that F_m changes from 1.15 to 1.04 when increasing span length from 16 to 32 m for ULS design. This considers a decrease of 9.6%. In the same sense, F_m decreases from 1.87 to 1.41 when increasing bridge span from 16 to 32 m (a decrease of 24.6%) for FLS design. It should be noted that the change in bridge width and corresponding number of girders is implied in the parameters F and C_f in equation 2.22 in the CHBDC simplified method.

4.3.2 Shear Distribution Factor

Figures 4.70 to 4.78 show the relationship between the span length and the shear distribution factor, F_v, of selected bridge geometries. To explain the trend, Figure 4.72 is taken here as an example. This figure shows the change in shear distribution factor with increase in span length from 16 to 32 m for a two-lane bridge made of eight girders. It can be observed that F_v changes from 2.74 to 1.97 when increasing bridge span from 16 to 32 m for FLS design, a decrease of 28%. Also, F_v changes from 1.68 to 1.50 when increasing bridge span from 16 to 32 m for ULS and SLS designs, a decrease of 10.7%.

4.3.3 Deflection Distribution Factor

Figures 4.79 through 4.87 depicts the change in deflection distribution factor, F_d, with increase in bridge span length. As an example, Figure 4.86 depicts the change in deflection distribution factor with increase in bridge span a four-lane bridge made of 13 box girders. It can be observed that F_d changes from 1.83 to 1.43 when increasing bridge span from 16 to 32 m, a decrease of 21.9%.

4.4 Effect of Number of Design Lanes

As stated earlier, three different numbers of design lanes were considered in this study, namely, 2, 3 and 4. Bridge width is dependent on the lanes of bridge as given in CHBDC Table 3.1. It should be noted the simplified method of analysis specified in CHBDC provides sets of F and C_f parameters shown in Equation 2.22 for bridges made of one-design lane to more that four-design lanes. This effect directly include the effect of change in bridge width, in addition to change in design lane width implied in the parameter μ in Equation 2.27.

4.4.1 Moment Distribution Factor

Figures 4.88 to 4.95 present the effect of change in number of design lanes on the moment distribution factor of selected bridges. One may observe the general trend of insignificant effect of change in number of design lanes on F_m values at the ULS design as compared to those at FLS design. As an example, Figure 4.95 depicts the change in F_m values with increase in number of design lanes for a 32-m span bridge made of B1000 box girders. It can be observed that F_m changes from 1.09 to 1.45 (an increase of 33%) when changing the number of design lanes from 2 to 4. While the increase in F_m for ULS was 3.9% (i.e. change from 1.02 to 1.06) when increasing the number of design lanes from 2 to 4.

4.4.2 Shear Distribution Factor

Similar trend for shear distribution factors and the moment distribution factor when studying the effect on number of design lanes as depicted in Figs. 4.96 to 4.103. As an example, Figure 4.103 depicts the change in F_v values with increase in number of design lanes for a 32-m span bridge made of B1000 box girders. It can be observed that F_v changes from 2.10 to 3.77 (an increase of 79.5%) when changing the number of design lanes from 2 to 4. While the increase in F_v for ULS was 9.2% (i.e. change from 1.53 to 1.67) when increasing the number of design lanes from 2 to 4.

4.4.3 Deflection Distribution Factor

Figures 4.104 through 4.111 depicts the change in deflection distribution factor, F_d, with increase in number of design lanes. As an example, Figure 4.111 depicts the change in deflection distribution factor with increase in number of design lanes for 32-m span bridge made of B1000 box girders. It can be observed that F_d changes from 1.07 to 1.41 when increasing the number of design lanes from 2 to 4, an increase of 31.8%.

4. 5 Effect of Girder Spacing

In this study the spacing between the girders is constant 15mm, box girders are placed adjacent to each other. The width of box girder is 1.22m and centre to centre spacing between the girders is considered 1.235m for all the bridge models. Due to the constant box girder spacing in all the bridges, the effect of girder spacing is not applicable in this study.

4.6 Effect of Load Cases

Few loading cases for CHBDC truck loading were considered in the analysis to obtain the maximum effect of each girder. These loading cases were presented in Chapter III and can be divided into two main groups; namely: bridges with fully loaded lanes and bridges with partially loaded lanes. Tables A.36 to A.123 in Appendix A summarize the values of the moment, shear and deflection distribution factors obtained from the parametric study due to fully loaded lanes and partially loaded lanes. There is no specific trend to reach regarding which type of loading provide the maximum effect on girders. However, the greatest value of the distribution factor for each bridge geometric was considered for further analysis to developed new expressions for designers. It should be noted that the F_m, F_v and F_d determined in this study were the greatest values occurred in all girders. As such, the current study does not differentiate between exterior girder and interior girder as used to be in CHBDC simplified method of analysis.

4.7 Comparison between the Results from the studied Deck-Free Precast Box-Girder Bridges and CHBDC Simplified Method for I-Girder, Voided Slab and Multi Spine Bridges.

The Canadian Highway Bridge Design Code specifies equations for calculating the moment, shear and deflection distribution factors for straight slab-on-girder bridges, voided slab and multi-spine bridges. It should be noted that CHBDC specifies the F_d values for such bridges can be taken as those for F_m values for simplicity. Figures 4.112 to 4.126 presents correlation between the results from the current study for deck-free precast box girders and those obtained from the CHDBC simplified method for straight slab-on-girder bridges, voided slab and multi-spine bridges. It should be noted that for the sake of obtained load distribution factors for the equations for slab-on-girder bridges, the number girders were considered as the number of boxes in the studied bridges. By inspection of these figures, it can be observed that the moment, shear and deflection distribution factors for the studied deck-free precast box-girder bridges are close to those for multispine and voided slab bridge values. The results obtained based on the CHBDC equations for slab-on-girder bridges are much higher than those obtained from FEA analysis of the deck-free precast box girder bridges. Due to these discrepancies in correlation, it was decided to develop new empirical expressions for the studied bridge geometries to provide bridge engineers and code writers of more economical and reliable simplified method of analysis.

4.8 Development of New Load Distribution Factor Equations

The following general equation of the load distribution factors for moment or deflection specified in CHBDC for the simplified method of analysis was proposed in the current study.

$$F_m = \frac{SN}{F\left(1 + \frac{\mu C_f}{100}\right)} \tag{4.1}$$

Where

F_m : is the moment distribution factor, (for deflection distribution factor, use F_d)

S : is the girder spacing in meters,

N : is the number of girders,

F : is a width dimension factor that characterizes load distribution for a bridge.

$$\mu = \frac{W_e - 3.3}{0.6} \quad but \leq 1.0$$

W_e : is the width of a design lane in meters, calculated with CHBDC clause 3.8.2;

C_f : is a correction factor, in %.

In this study, it was decided to have two sets of empirical equations for moment and deflection for SLS designs since it have been proved from the data generated from the parametric study that the deflection distribution factors were generally less than those for moment distribution factors. This conclusion was observed in Figs. 4.127 to 4.135 for different bridge configurations. In case of shear shear distribution factor the following equation was used:

$$F_v = S \text{ x } N / F \tag{4.2}$$

Using statistical package for curve fit (Microsoft Excel), the data generated from the parametric study was used to developed new parameters F and C_f for the deck-free precast box girder bridges. A linear function was assumed for both parameters and yielded good accuracy. Tables 4.1 to 4.5 provide summary of these developed parameters in a similar format of CHDBC simplified method of analysis. These equations were developed with a condition that the resulting values underestimates the response by a maximum 5%. To provide confidence on the developed equations, Figs. 4.136 to 4.140 present the correlation between the FEA results and those resulting from the developed equations at the ULS, SLS2 and FLS designs.

The limitations of use of the developed expressions are:

1- Span length ranges from 16 to 32 m.

2- Number of design lanes ranges from 2 to 4.

3- Values of shear distribution factors are per box. So, shear force in the web is considered half the obtained value for the box.

4- Bridges are simply-supported over bearings representing almost line supports.

5- The proposed values are applicable to Classes A and B highways. However, they can conservatively be applied to Classes C and D highways since the difference would be on the applicable factor for multi-presence of vehicles on design lanes and the intensity of the uniformly distributed portion of the lane loading. The latter is considered insignificant since the design of such critical values for moment, shear and deflection are governed by the truck loading conditions rather that the lane loading conditions for such bridge span length.

CHAPTER V

CONCLUSIONS, AND RECOMMENDATIONS FOR FUTURE RESEARCH

5.1 General

A practical-design-oriented parametric study, using finite element method, was conducted to investigate the static response of simply-supported deck-free precast box-girder bridges. A literature review was provided in order to establish the basis of this study. The influence of few key parameters on the moment, deflection and shear distribution factors for ultimate, serviceability and fatigue limit states designs was investigated using commercially-available finite-element computer program "SAP2000". The key parameters considered in this study included span length, number of design lanes, number of girders, and loading conditions.

5.2 Conclusions

Based on the results from the parametric study, the following conclusions are drawn:

1. Bridge span length, number of girders as related to bridge width and number of design lanes play a significant role on the values of the load distribution factors.
2. Deflection distribution factors are generally smaller than the corresponding moment distribution factors for a typical bridge configuration.
3. Results from the parametric study on deck-free precast box beams showed that they are closer to those for multiple-spine steel box girders and the voided-slab bridges than for slab-on-girder bridges based on CHBDC simplified methods of analysis.

4. The database generated from the parametric study was used to develop empirical expressions for moment, shear and deflection distribution factors at ULS, SLS2 and FLS designs. The proposed expressions can be used with confidence to design new bridges more economically and reliably.

5.3 Recommendations for Future Research

It is recommended that further research efforts be directed towards the following:

1- Extend the proposed empirical equations for bridges with design lanes more that 4 and for continuous spans.

2- Investigate the critical lateral bending moment and vertical shear force that can be used to design the closure strip between precast beams at the top flange locations.

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Table 3.1 Number of Design Lanes (CHDBC, 2006)

Wc	n
6.0 m or less	1
Over 6.0 m to 10.0 m incl.	2
Over 10.0 m to 13.5 m incl.	2 or 3
Over 13.5 m to 17.0 m incl.	4
Over 17.0 m to 20.5 m incl.	5
Over 20.5 m to 24.0 m incl.	6
Over 24.0 m to 27.5 m incl.	7
Over 27.5 m	8

Table 3.2 Modification Factors for Multilane Loading (CHDBC, 2006)

Number of Loaded Design Lanes	Modification Factor
1	1.00
2	0.90
3	0.80
4	0.70
5	0.60
6 or more	0.55

Table 3.3 Box Girder Span Length Range (Precon Manual, 2004)

Girder Name	Minimum Span Length	Maximum Span Length
B700	15	24
B800	20	27
B900	24	30
B1000	26	32

Table 4.1 Proposed Moment Distribution Factors at Ultimate Limit State For Deck-Free, Precast Box Girder Bridges

Number of design lanes	Value of F	Value of C_f
2	6.15 + 0.04L	19 + 0.04L
3	9.0 + 0.04L	13.5 + 0.15L
4	1.07 + 0.09L	17

Table 4.2 Proposed Moment Distribution Factors at Fatigue Limit State For Deck-Free, Precast Box Girder Bridges

Number of design lanes	Value of F	Value of C_f
2	5.55 + 0.005L	11 + 0.25L
3	5.5 + 0.09L	7.4 + 0.37L
4	5.6 + 0.15L	2.3 + 0.25L

Table 4.3 Proposed Shear Distribution Factors at Ultimate Limit State For Deck-Free, Precast Box Girder Bridges

Number of design lanes	Value of F	Value of C_f
2	5.2 + 0.04L	0
3	7.13 + 0.05L	0
4	8.6 + 0.05L	0

Table 4.4 Proposed Shear Distribution Factors at Fatigue Limit State For Deck-Free, Precast Box Girder Bridges

Number of design lanes	Value of F	Value of C_f
2	2.5 + 0.07L	0
3	2.55 + 0.07L	0
4	2.3 + 0.08L	0

Table 4.5 Proposed Deflection Distribution Factors at Fatigue Limit State For Deck-Free, Precast Box Girder Bridges

Number of design lanes	Value of F	Value of C_f
2	5.85 + 0.04L	19.7
3	5.3 + 0.12L	28 -0.4L
4	5 + 0.16L	25 – 0.25L

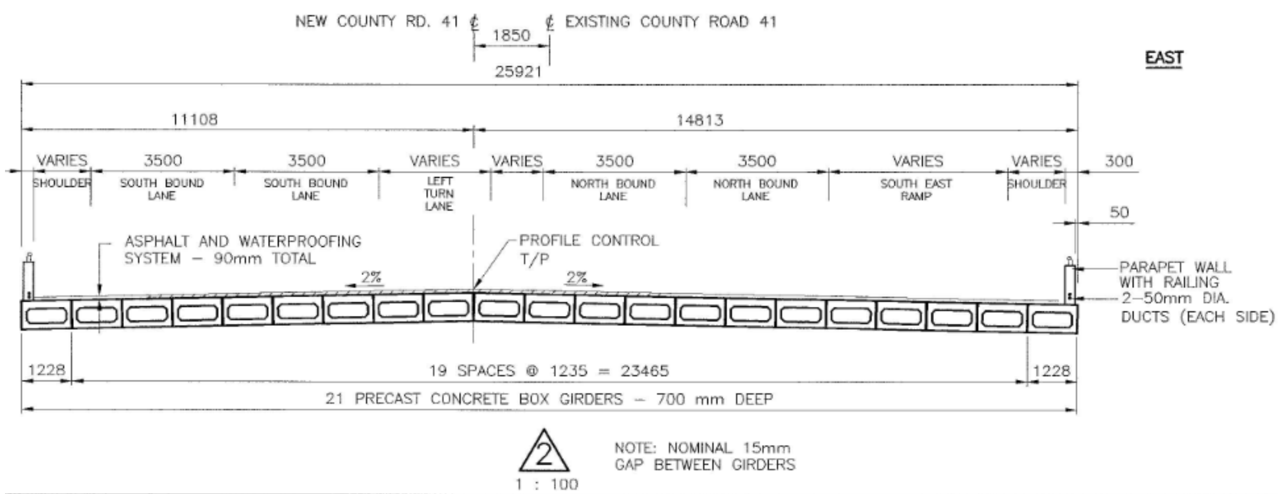


Figure 1.1 Cross-Section of Sucker Creek Bridge Built in 2006
(Supplied by Clifford Lam, MTO)

Figure 1.2 View of Deck-Free Precast Box Beams Used in Sucker Creek Bridge
(Supplied by Gene Latour of Pultrall-Trancels Inc.)

Figure 1.3 View of the Deck-Free Precast Box Girders Used in Suneshine Creek Bridge Hwy 11/17 Built in Summer 2007 (Supplied by Gene Latour of Pultrall-Trancels Inc.)

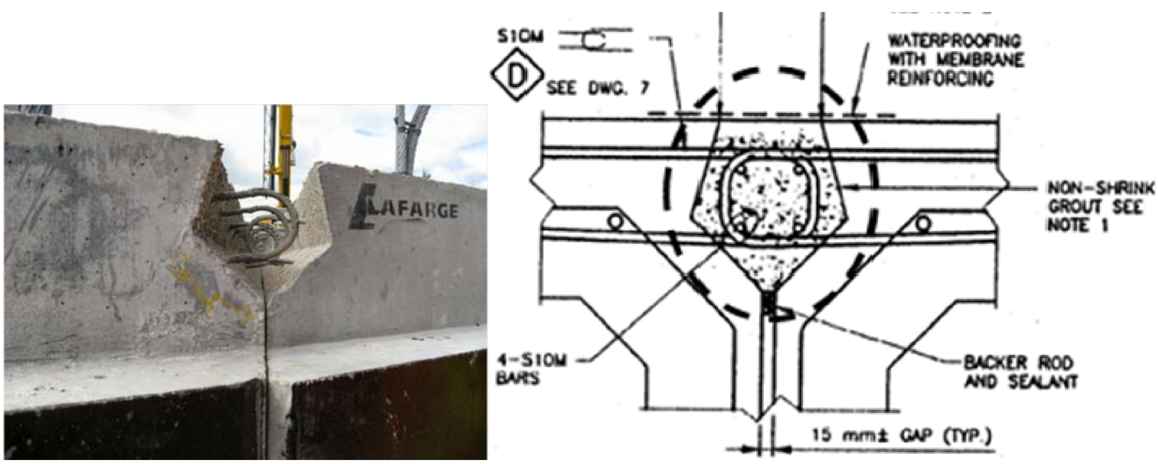


Figure 1.4 Close-up View of the Closure-Strip Between the Top Portion of Two Adjacent Box Girders in Suneshine Creek Bridge

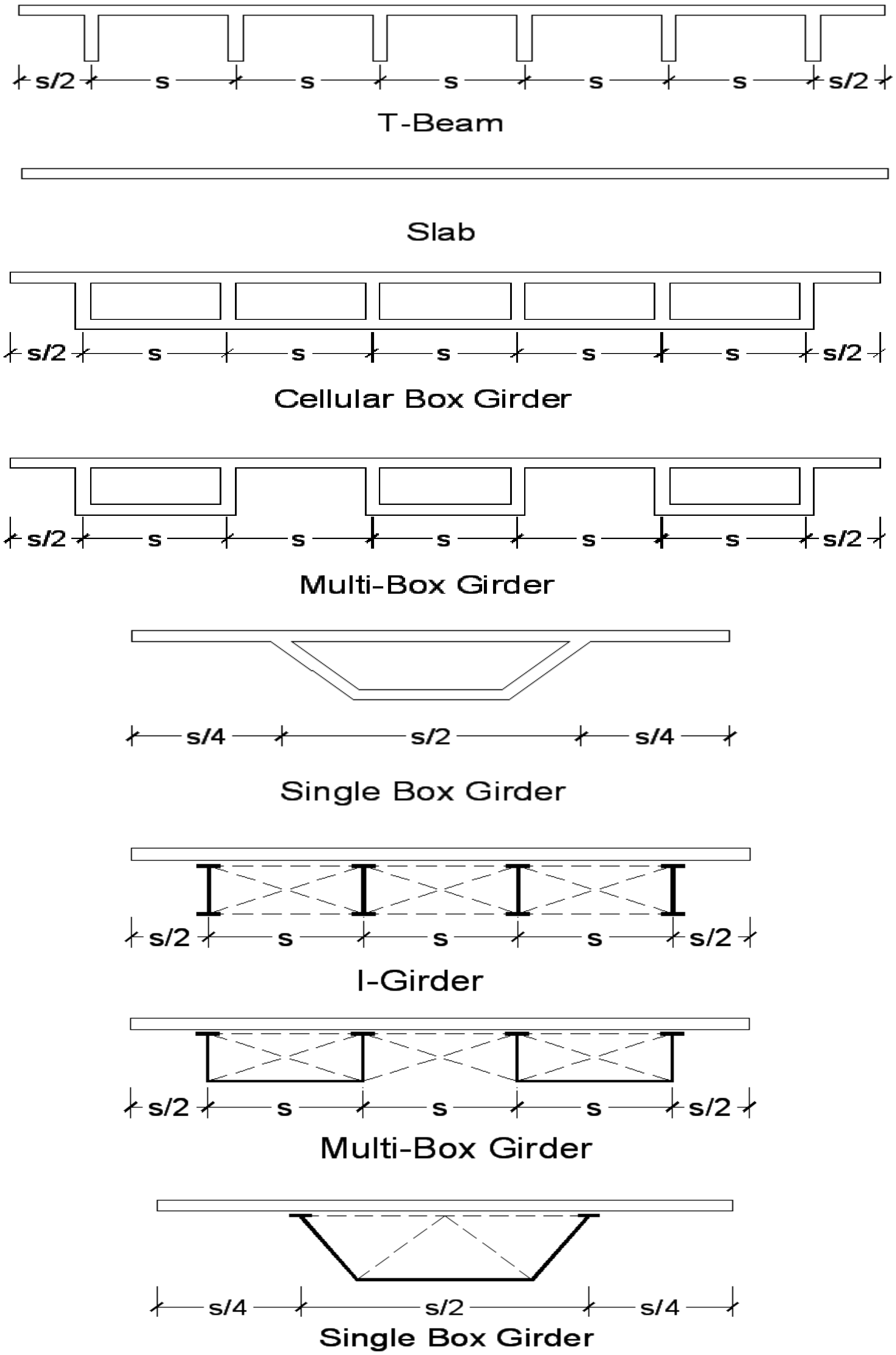


Figure 1.5 Views of Common Bridge Cross-Sections in CHBDC

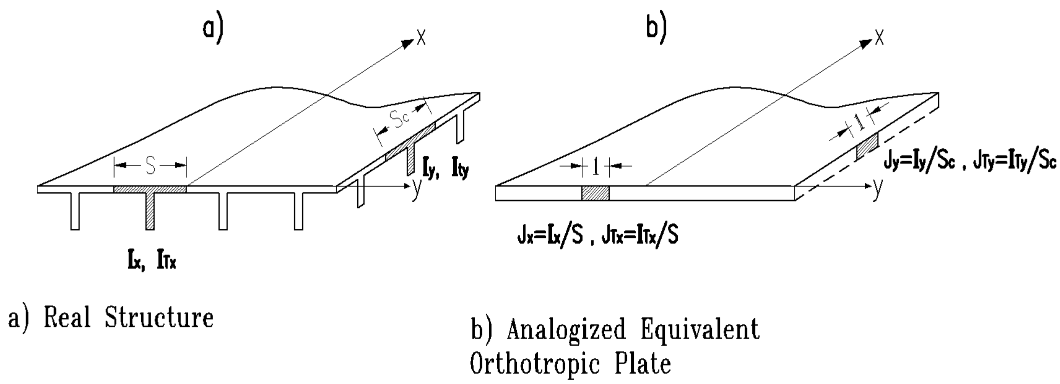


Figure 2.1 Real Structure and Orthotropic Plate Analogy

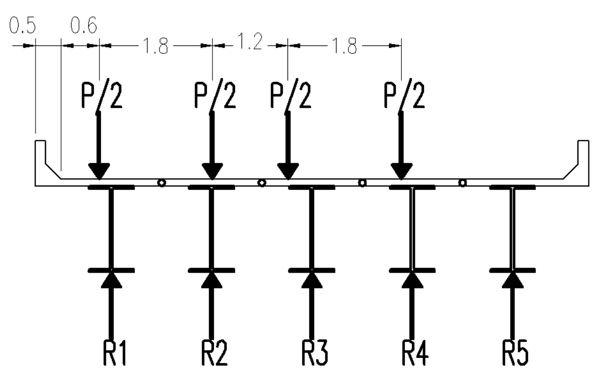


Figure 2.2 Free Body Diagram of Lever Rule Method

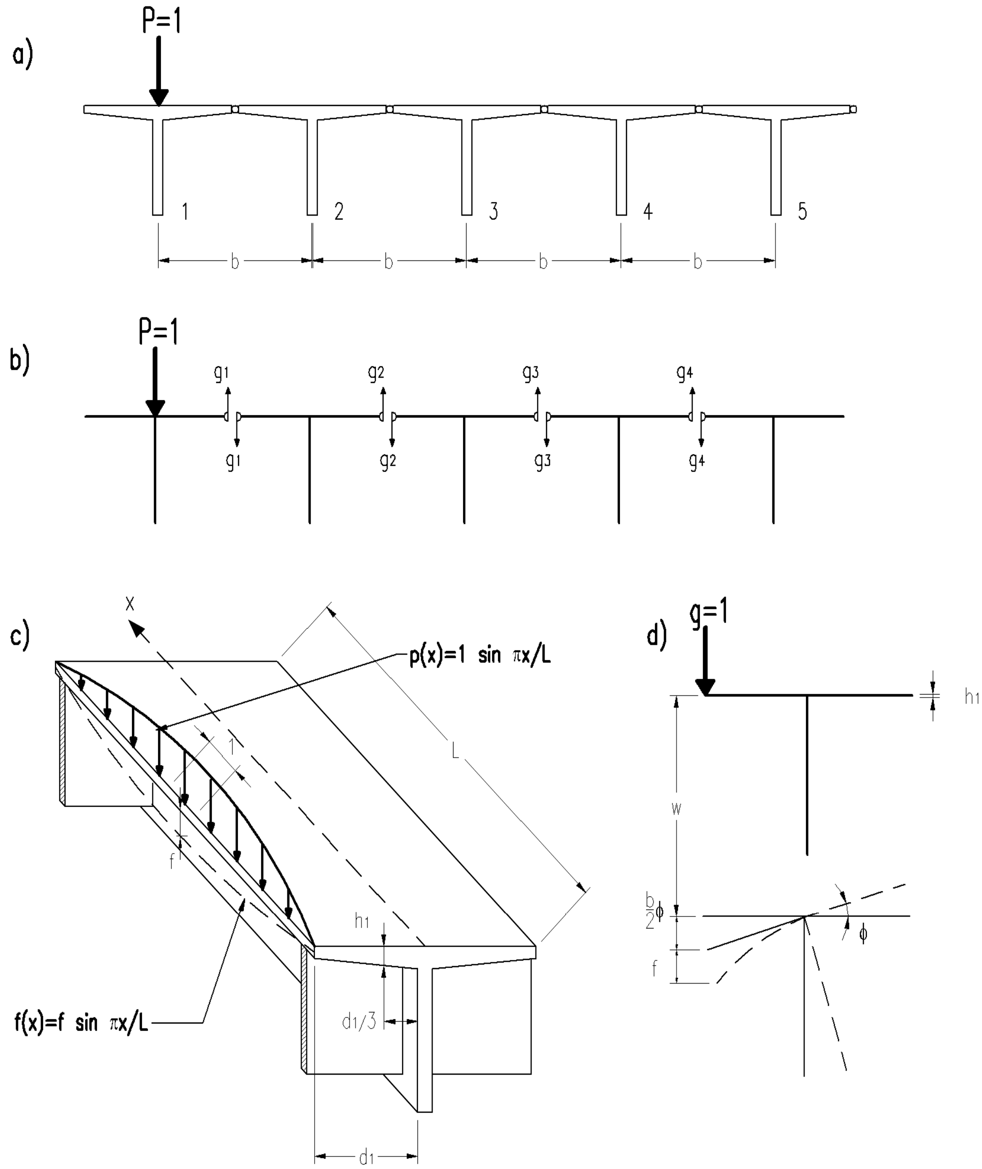


Figure 2.3 Free Body Diagram for Hinged T-shaped Girder Bridge

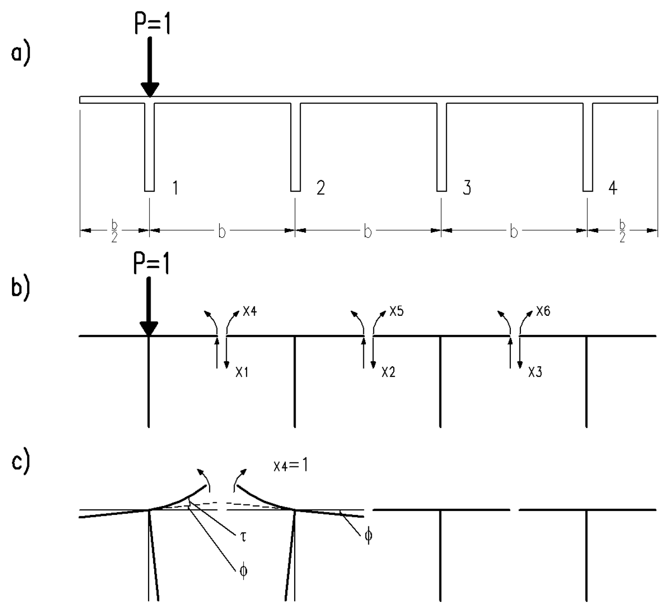


Figure 2.4 Free Body Diagram of Fixed Joint Girder Bridge

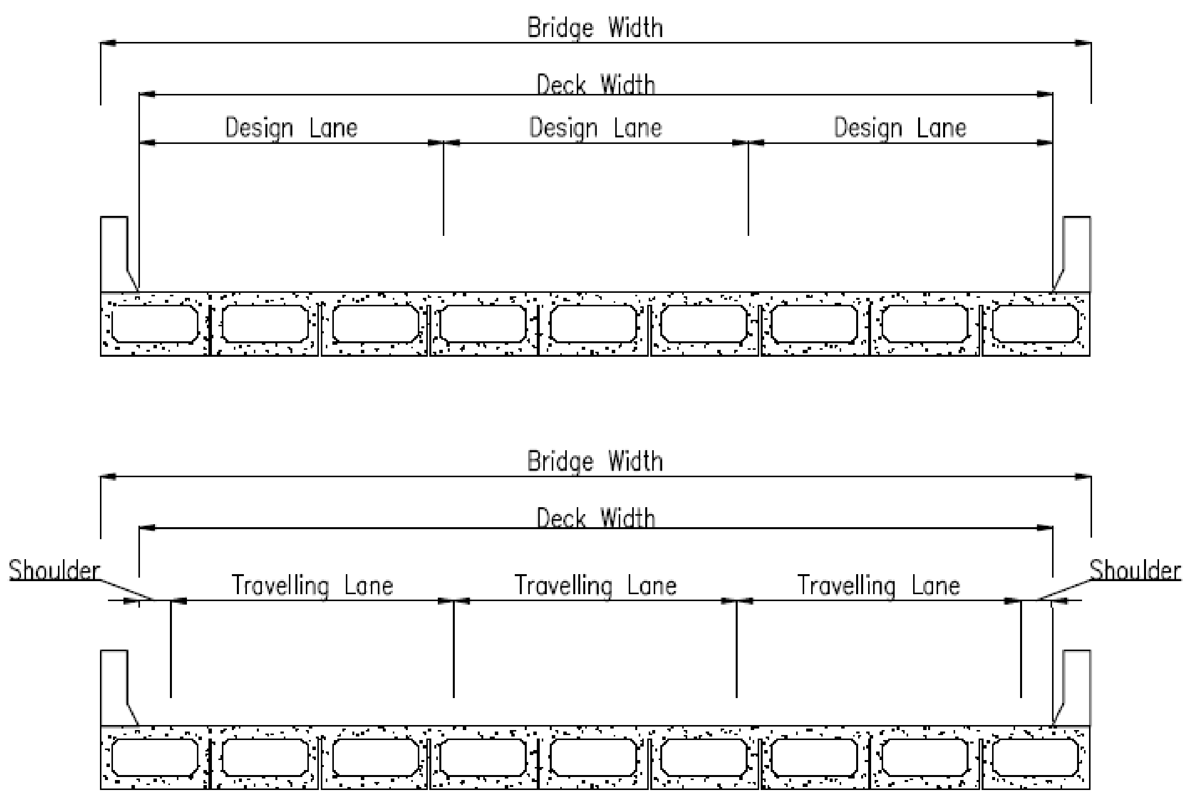


Figure 3.1 Box Girder Bridge Cross Section

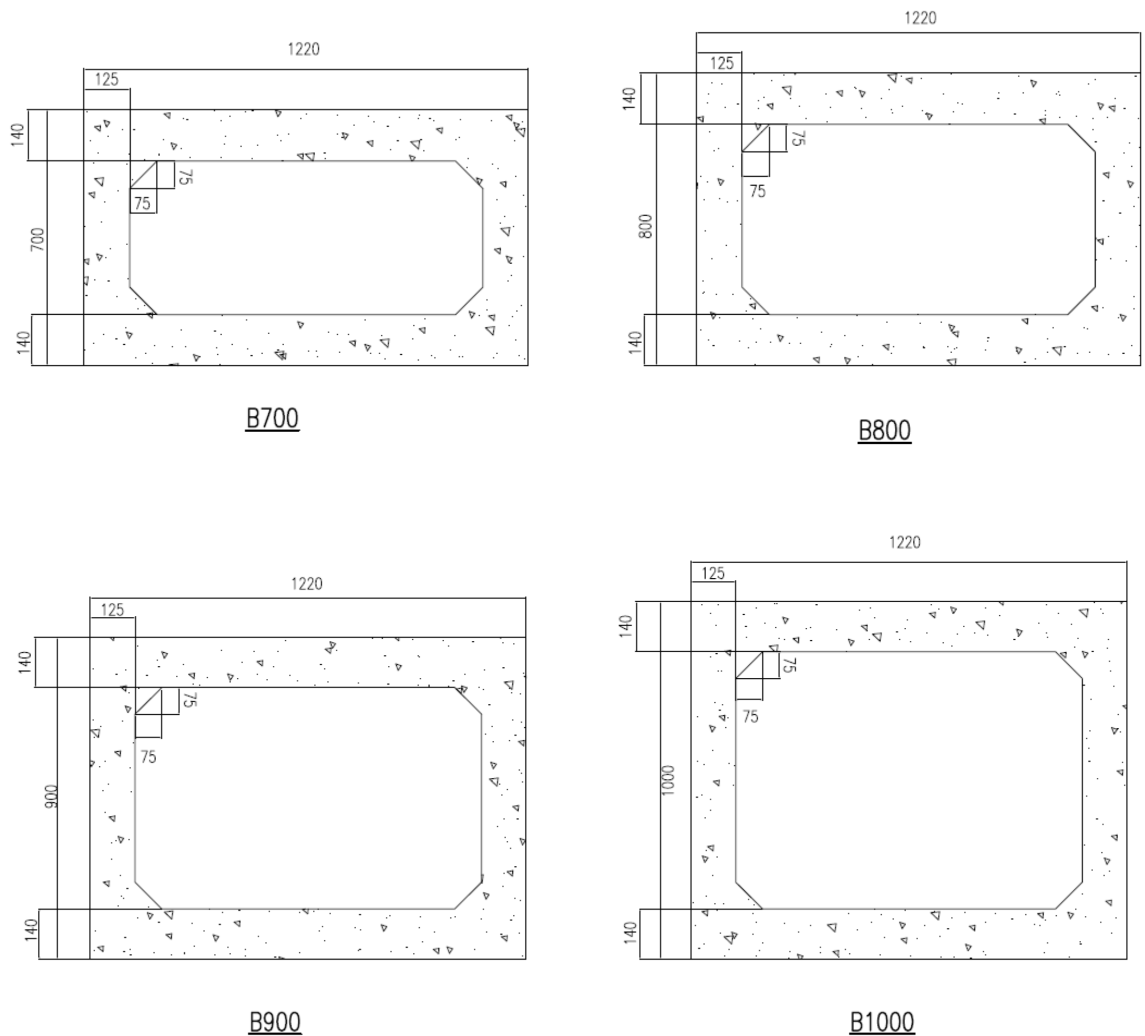


Figure 3.2   Box Girder Section Details

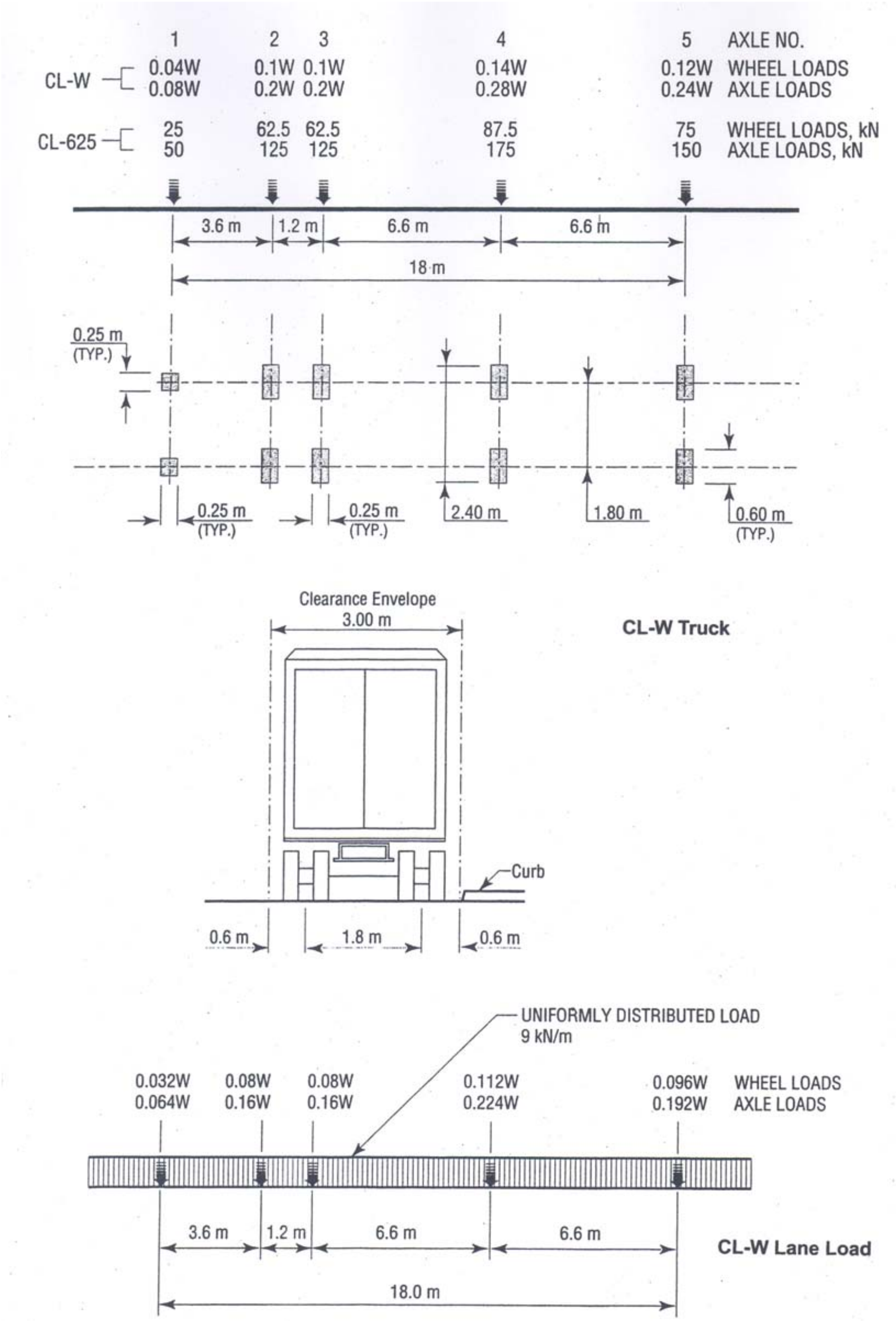


Figure 3.3 CL-W Truck and Lane Loading, CHBDC

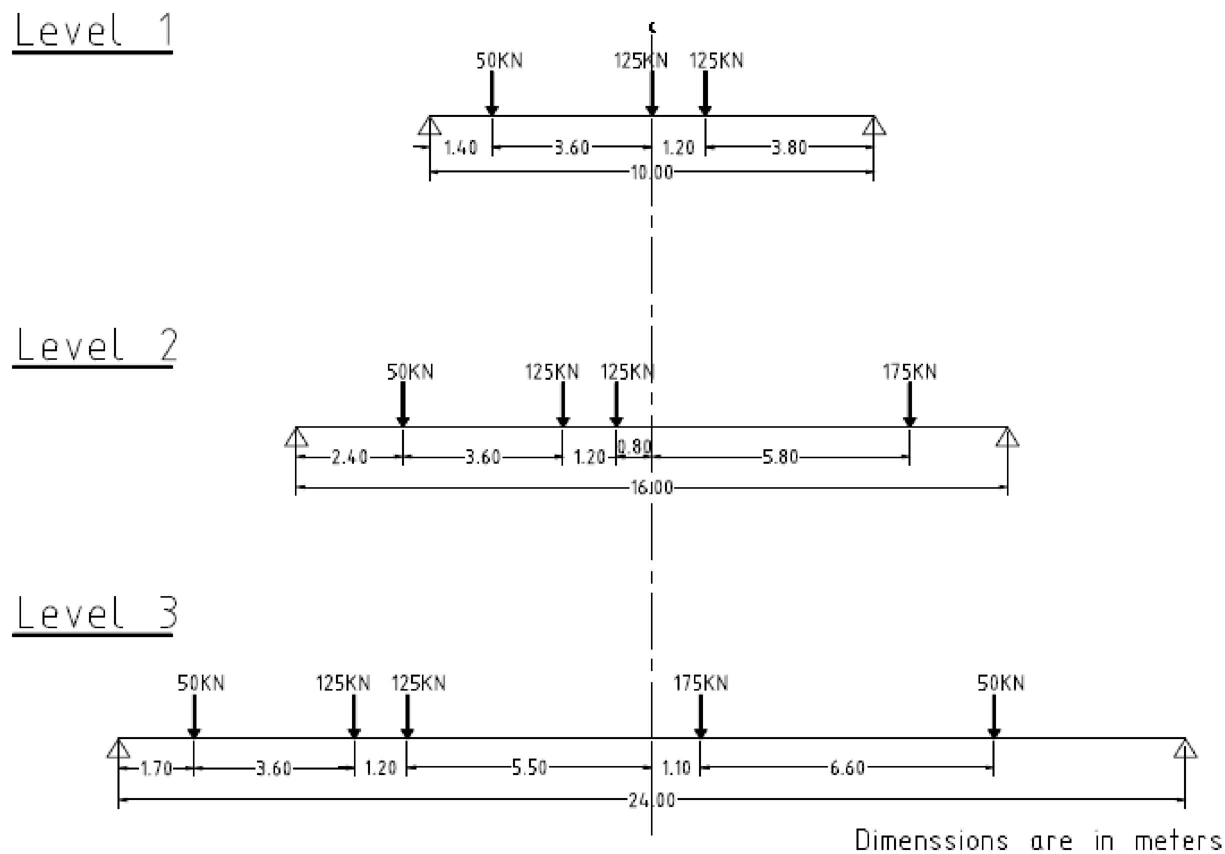


Figure 3.4 Maximum Moment Locations

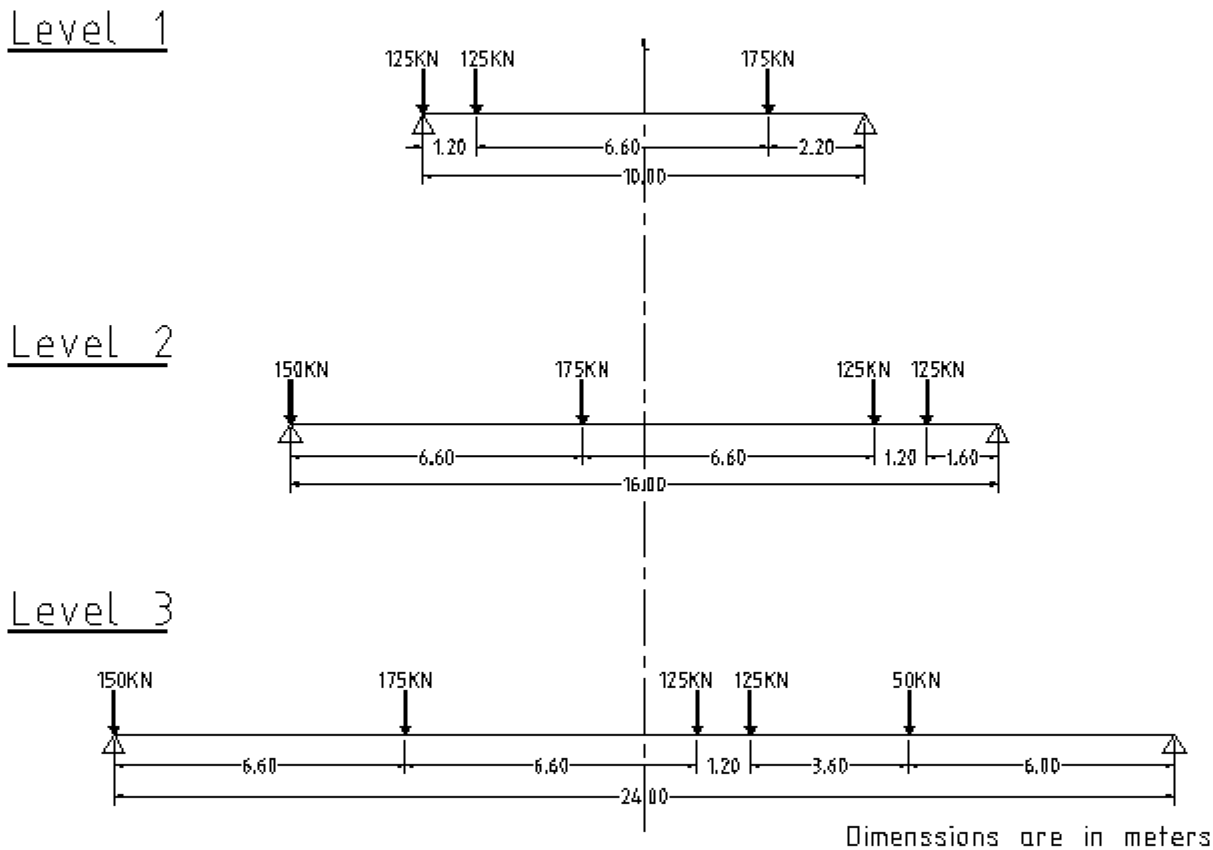


Figure 3.5 Maximum Shear Locations

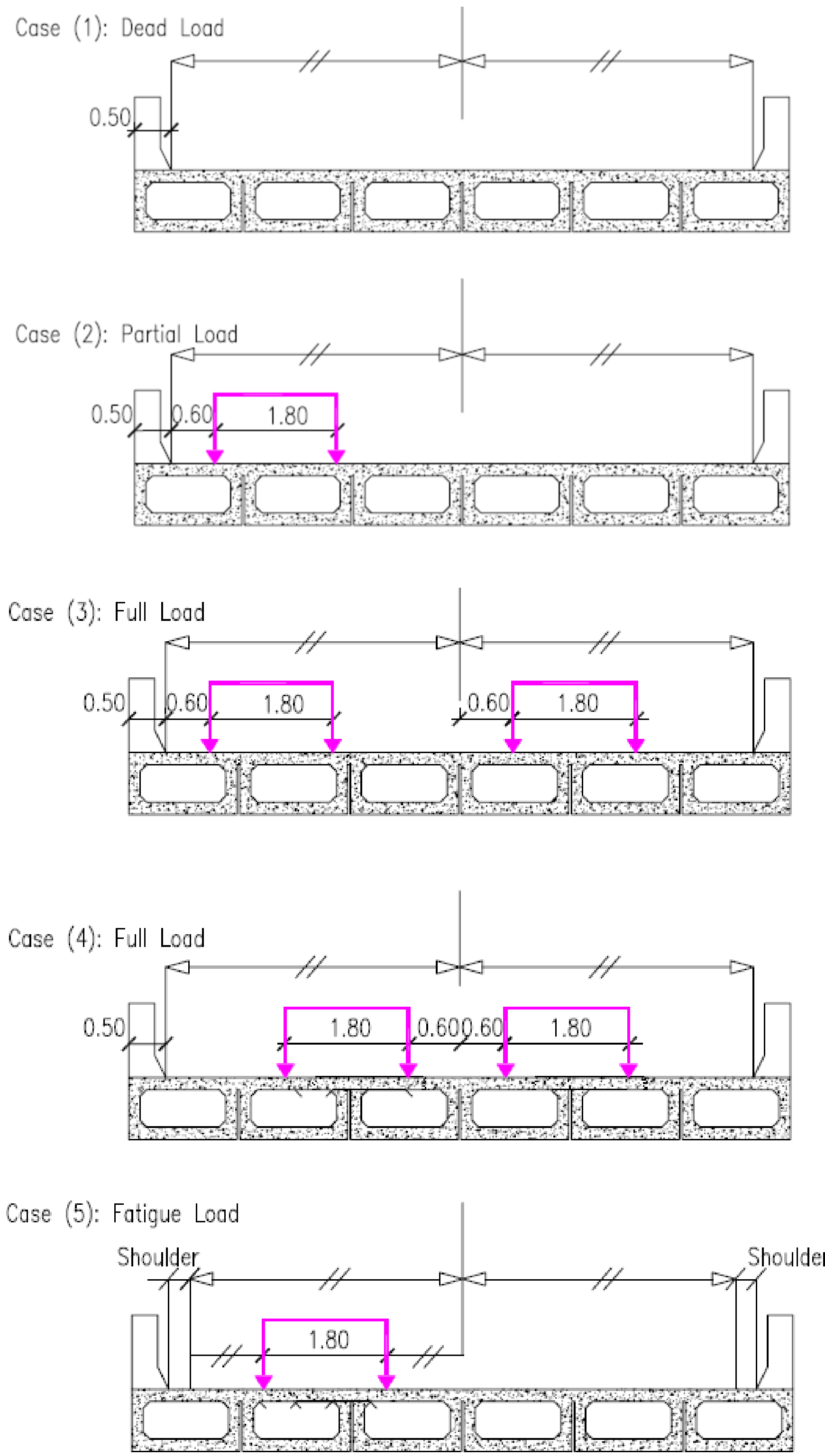


Figure 3.6 Live Loading Cases for Two-Lane Bridges

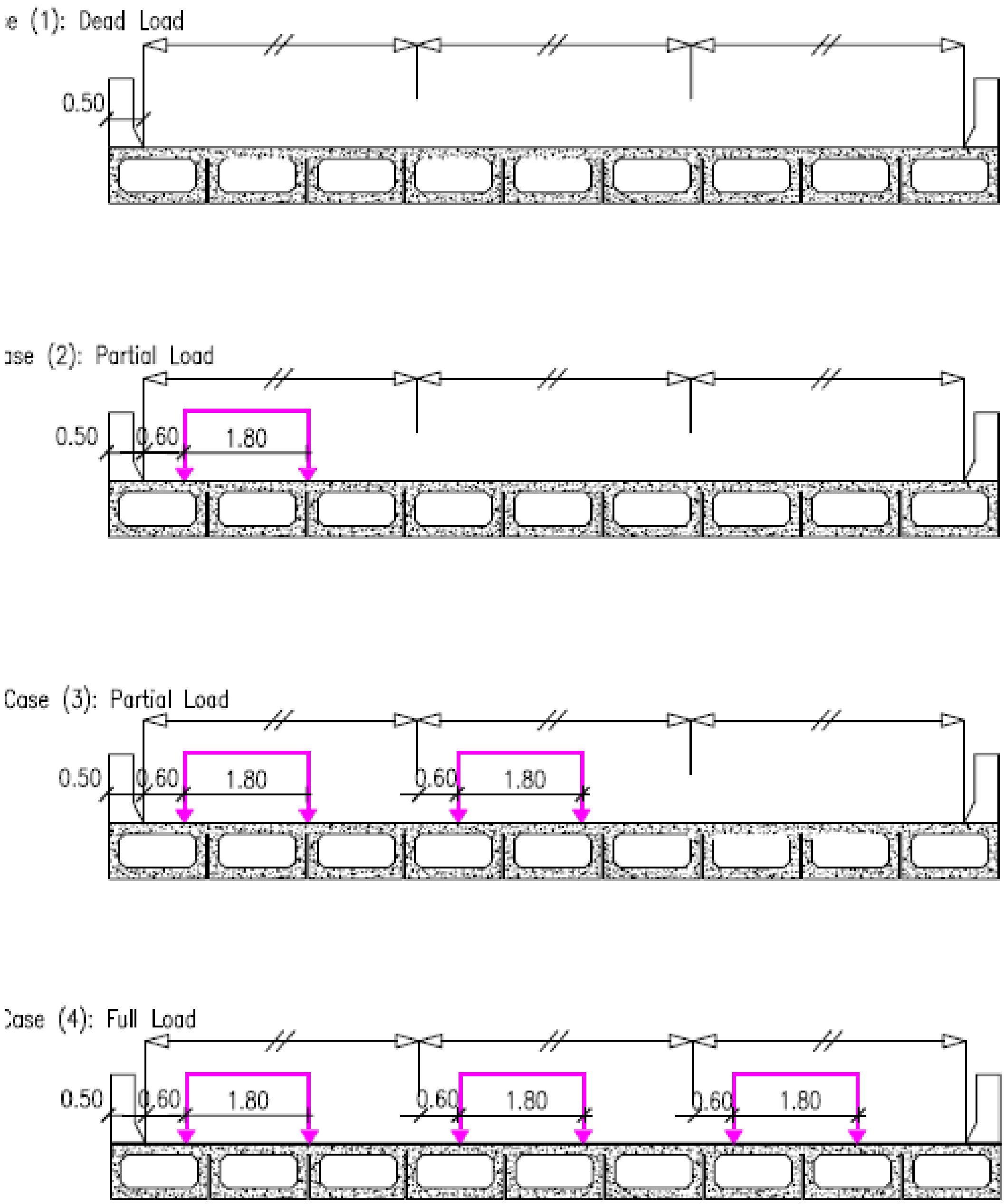


Figure 3.7 Live Loading Cases for Three-Lane Bridges

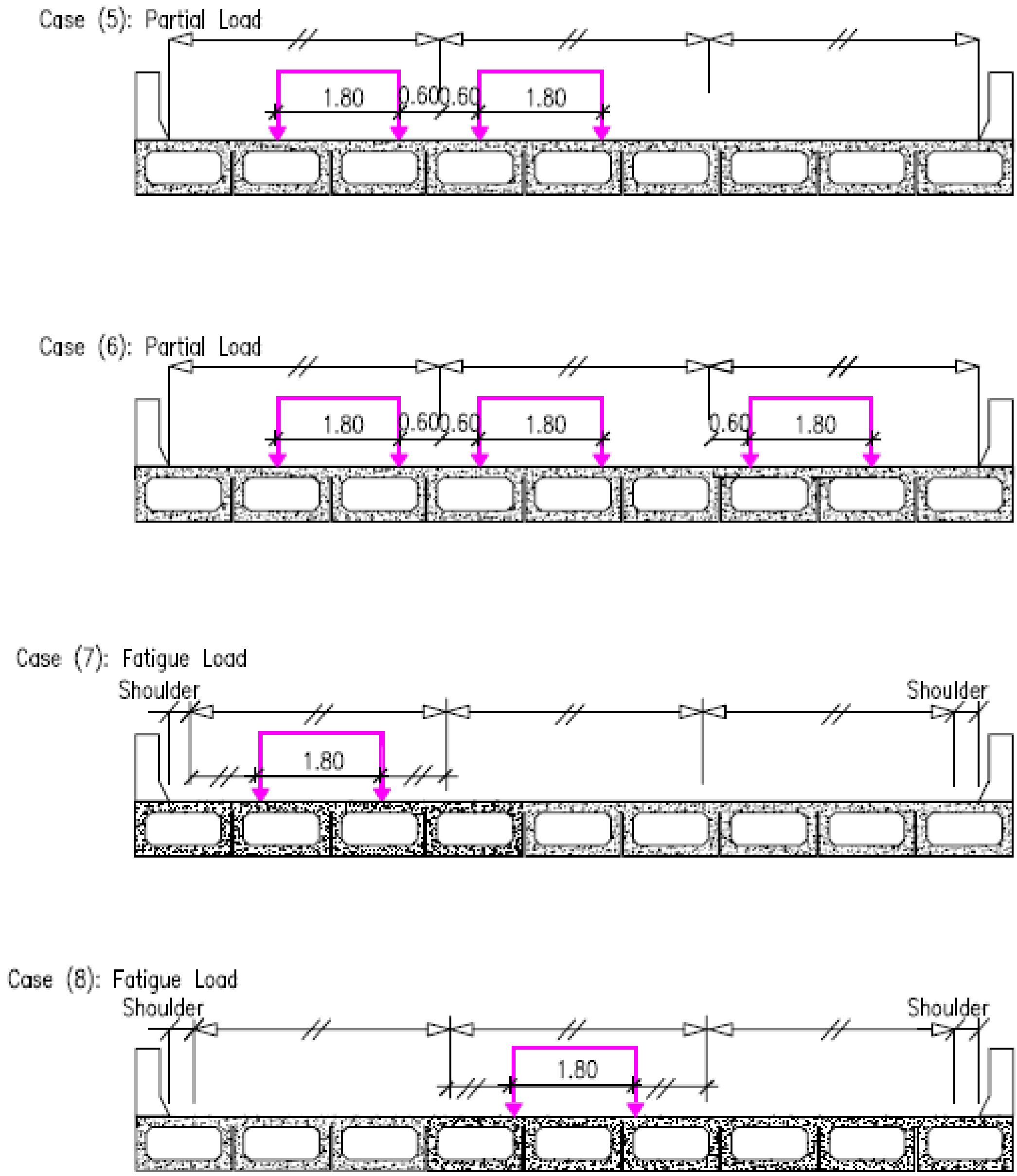


Figure 3.7 Live Loading Cases for Three-Lane Bridge (Continue)

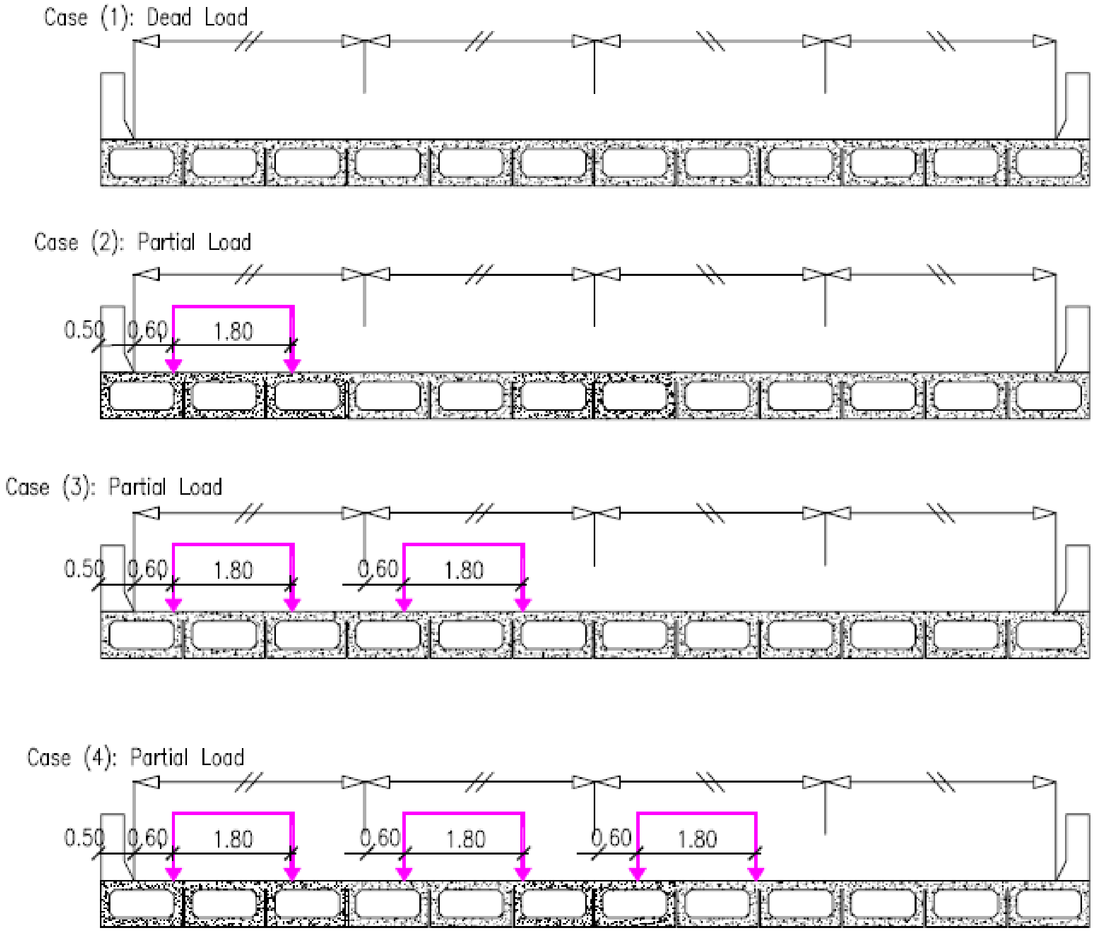


Figure 3.8 Live Loading Cases for Four-Lane Bridge

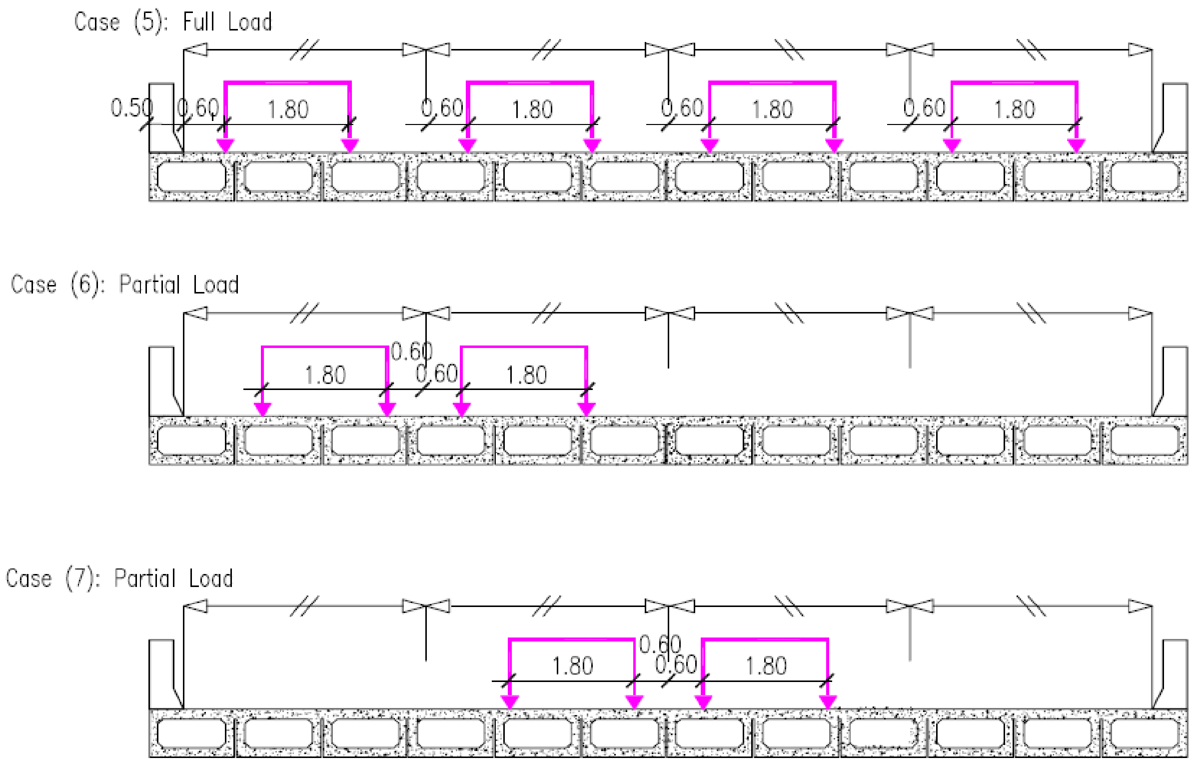


Figure 3.8 Live Loading Cases for Four-Lane Bridge (Continue)

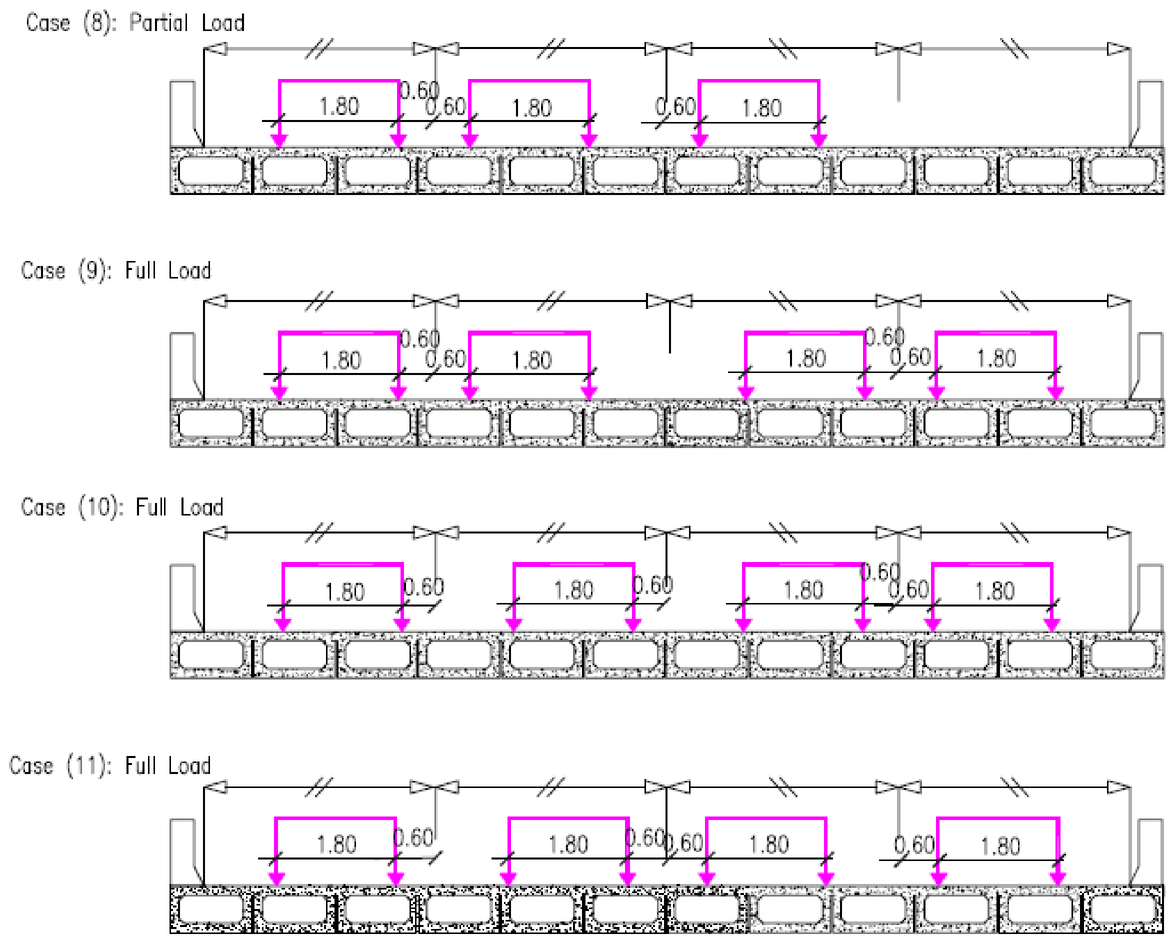


Figure 3.8 Live Loading Cases for Four-Lane Bridge (Continue)

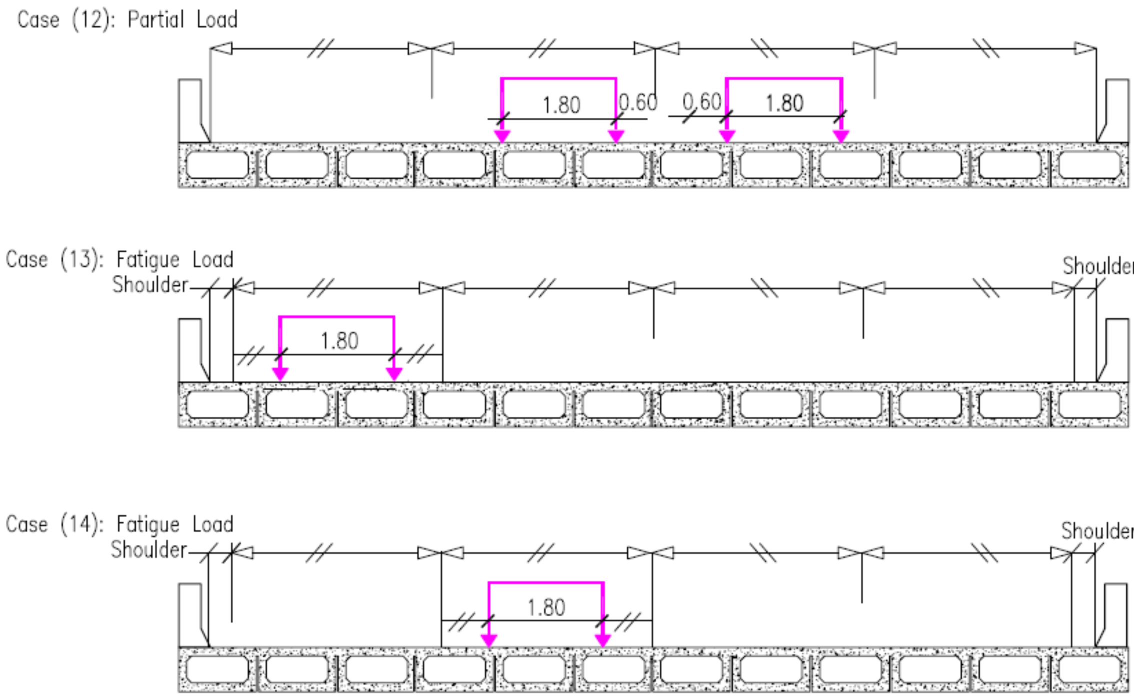
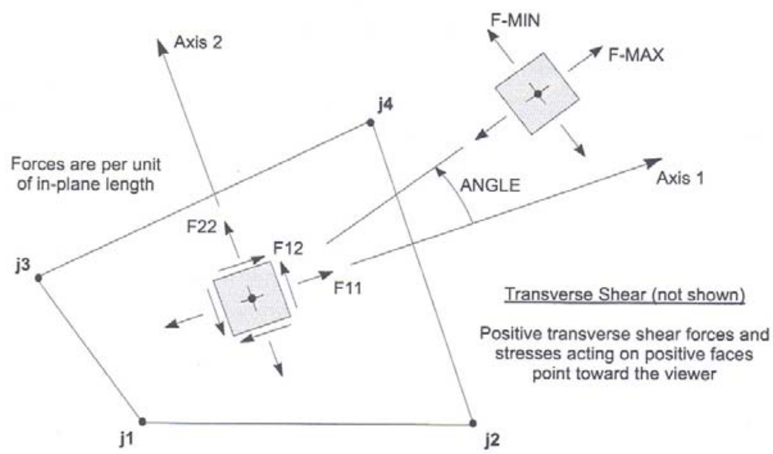
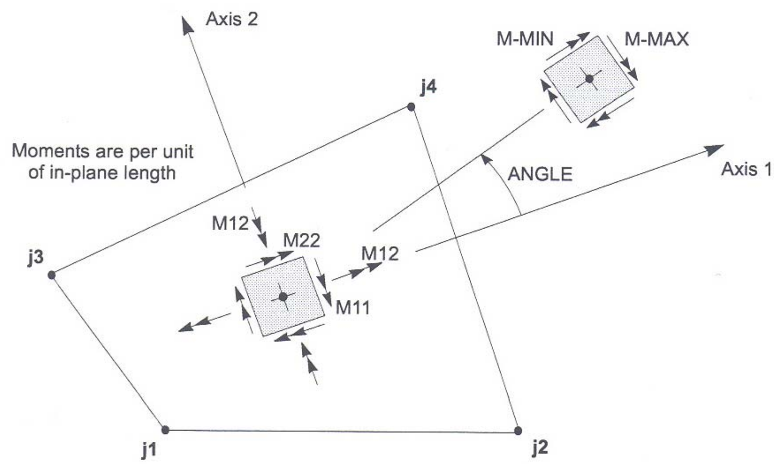


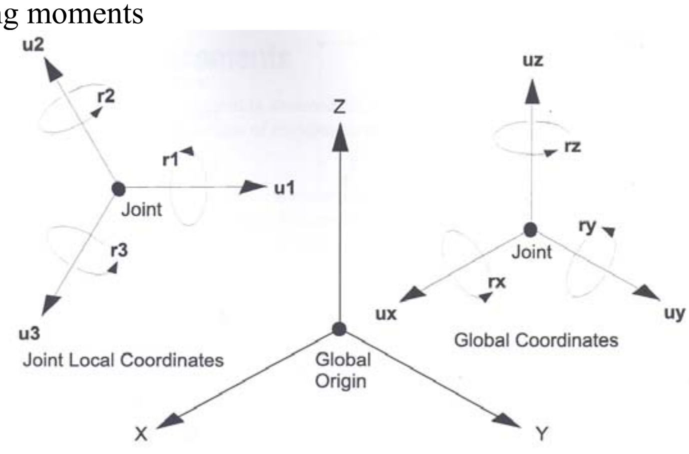
Figure 3.8 Live Loading Cases for Four-Lane Bridge (Continue)



a) Stress and membrane forces



b) Plate bending moments



c) Global and local coordinates

Figure 3.9 Sketch of the four-node shell element used in the analysis, (SAP2000)

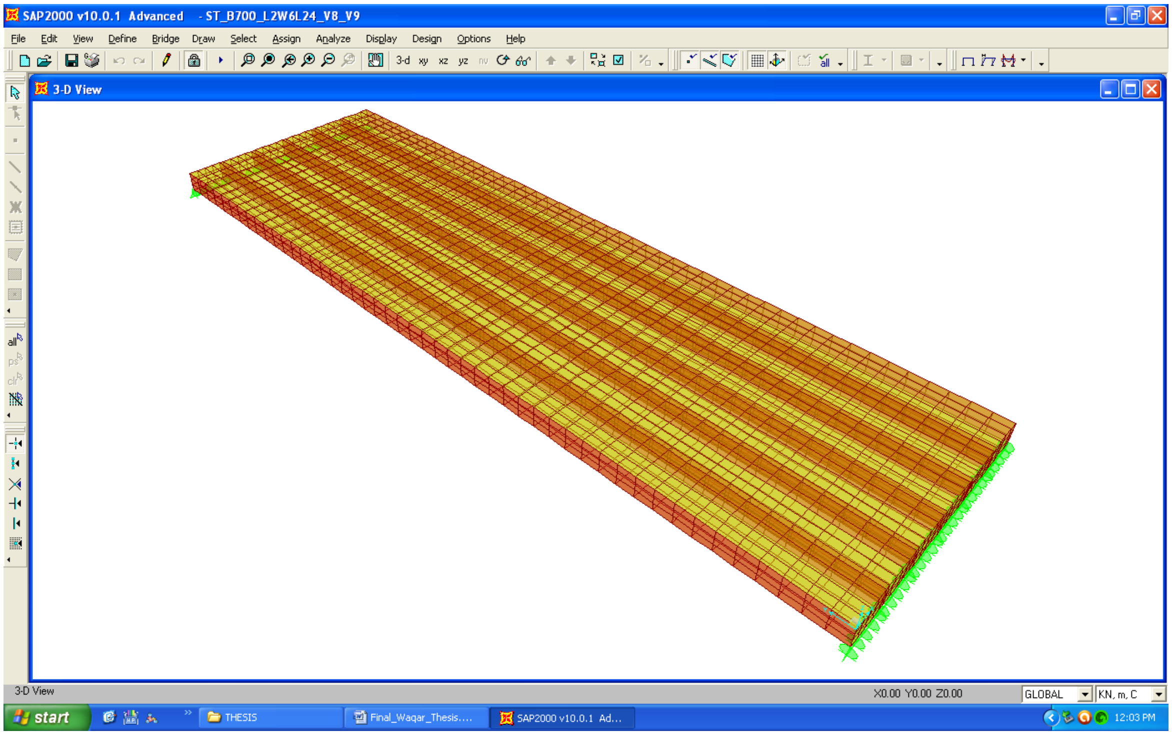


Figure 3.10 View of 3D Model of Box Girder Bridge (6 Box Girders, 24m Span)

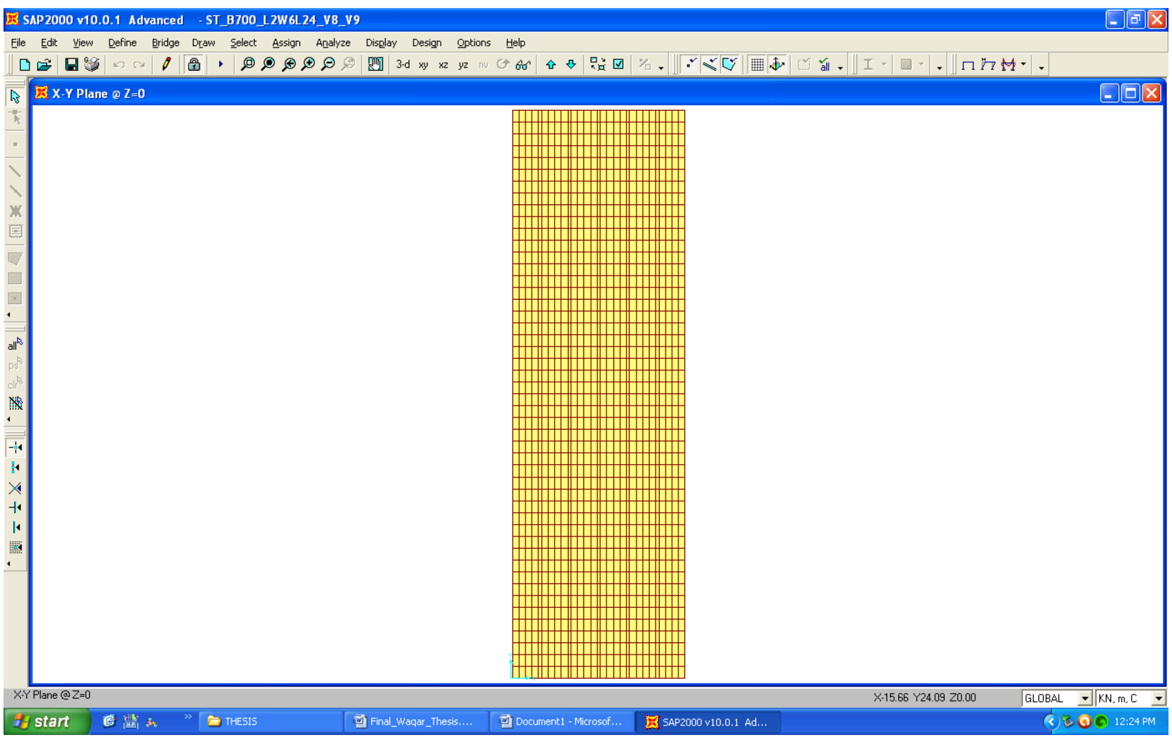


Figure 3.11 View of X-Y Plane of Box Girder Bridge (6 Box Girders, 24m Span)

Figure 4.1 Effect of Number of Girders on the Moment Distribution Factor B700 Girder, 2-Lane, 16m Length Bridge

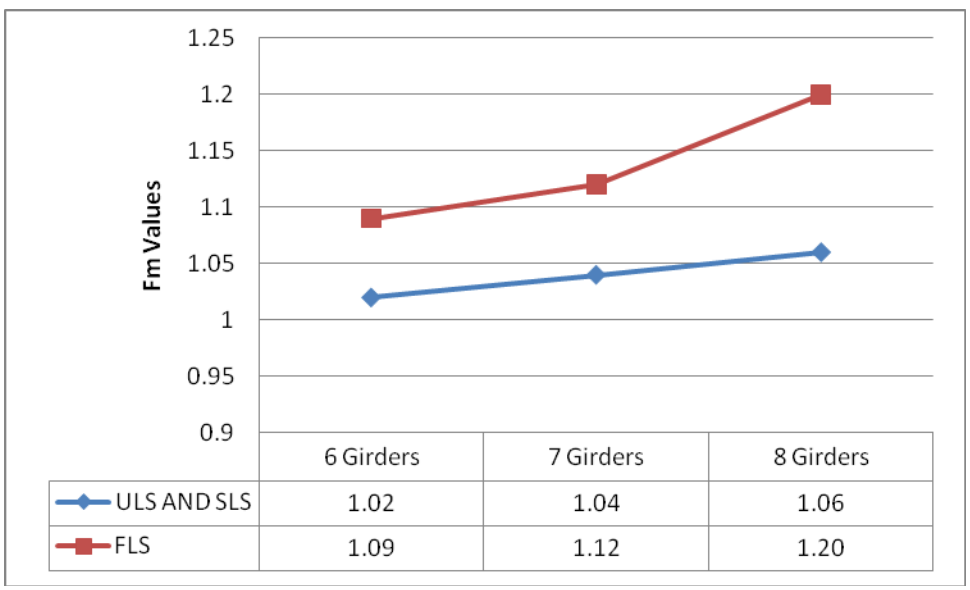


Figure 4.2 Effect of Number of Girders on the Moment Distribution Factor B700 Girder, 2-Lane, 24m Length Bridge

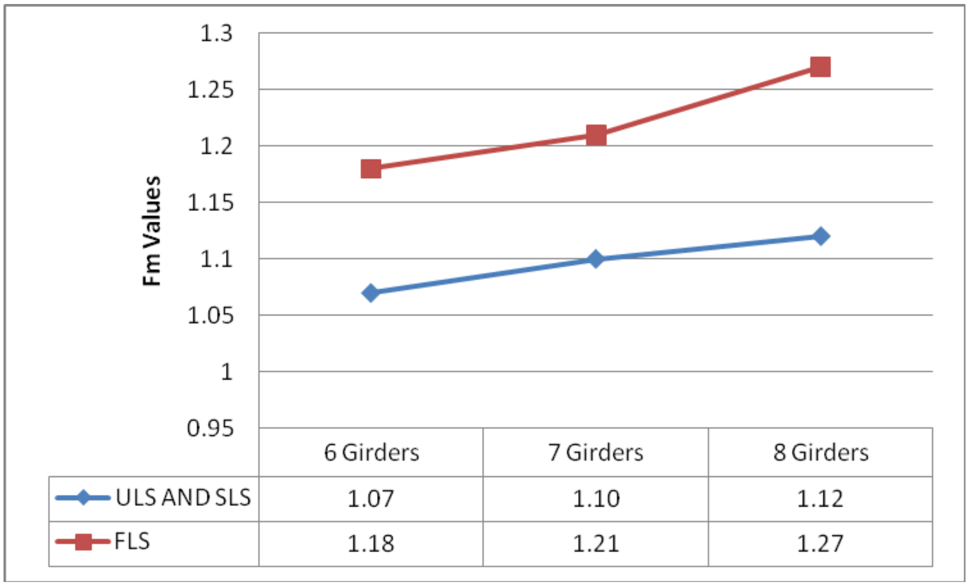


Figure 4.3 Effect of Number of Girders on the Moment Distribution Factor For B800 Girder, 2-Lane, 20m Length Bridge

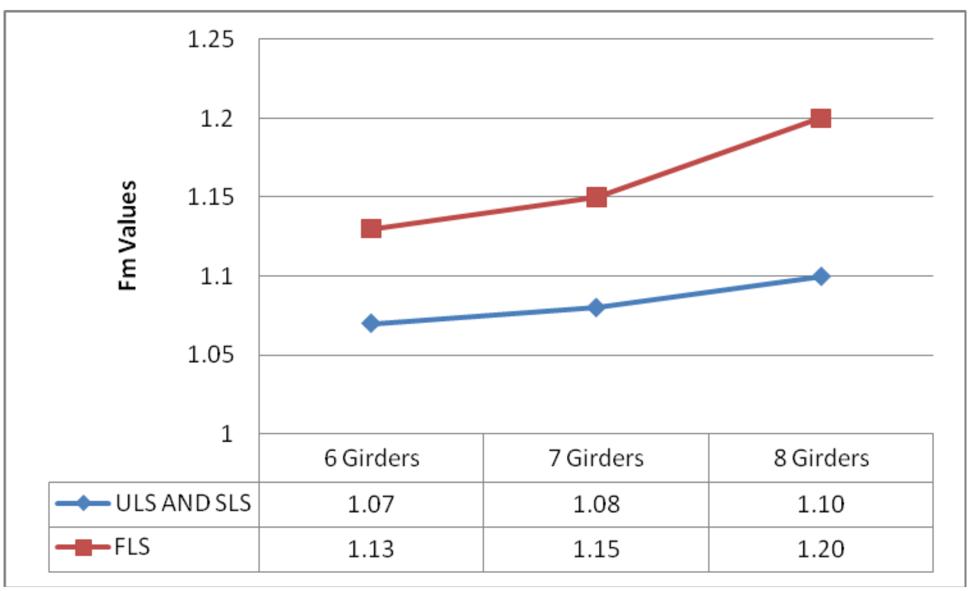


Figure 4.4 Effect of Number of Girders on the Moment Distribution Factor For B800 Girder, 2-Lane, 26m Length Bridge

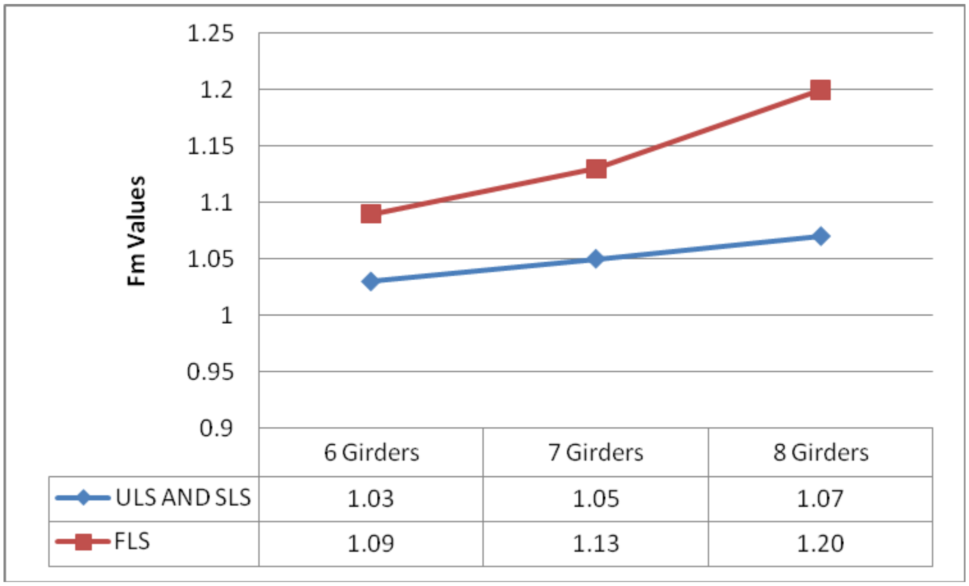


Figure 4.5 Effect of Number of Girders on the Moment Distribution Factor For B900 Girder, 2-Lane, 24m Length Bridge

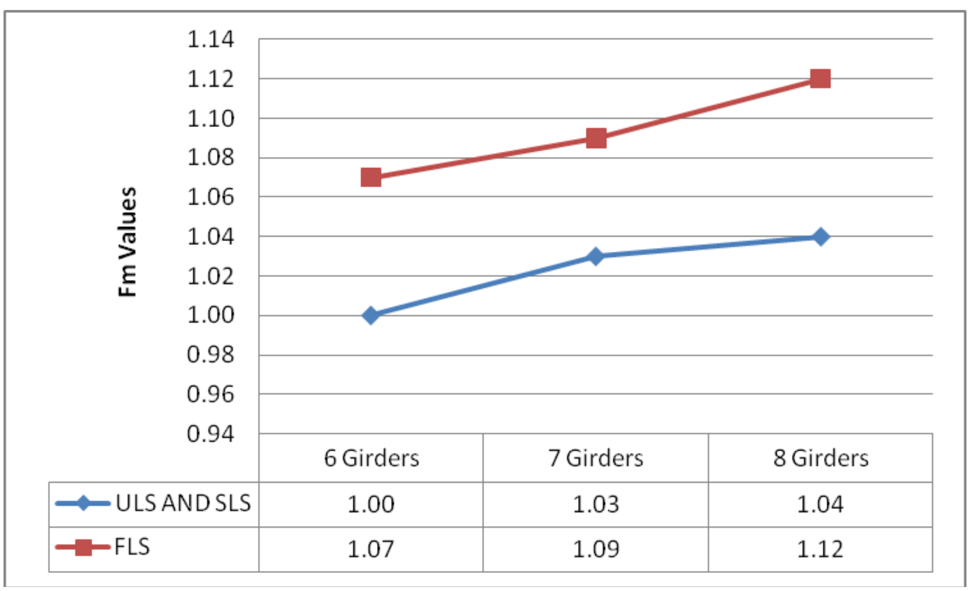


Figure 4.6 Effect of Number of Girders on the Moment Distribution Factor For B900 Girder, 2-Lane, 30m Length Bridge

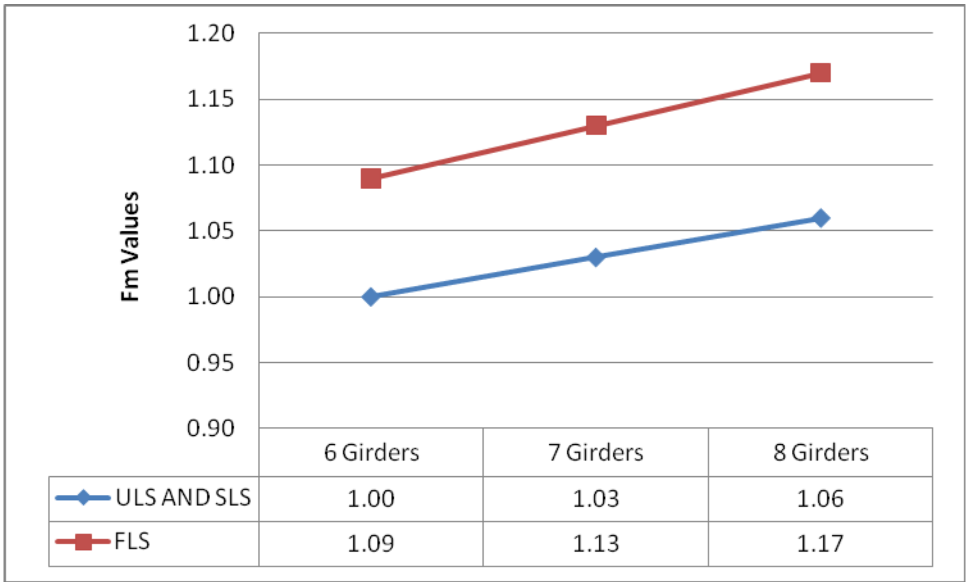


Figure 4.7 Effect of Number of Girders on the Moment Distribution Factor For B1000 Girder, 2-Lane, 26m Length Bridge

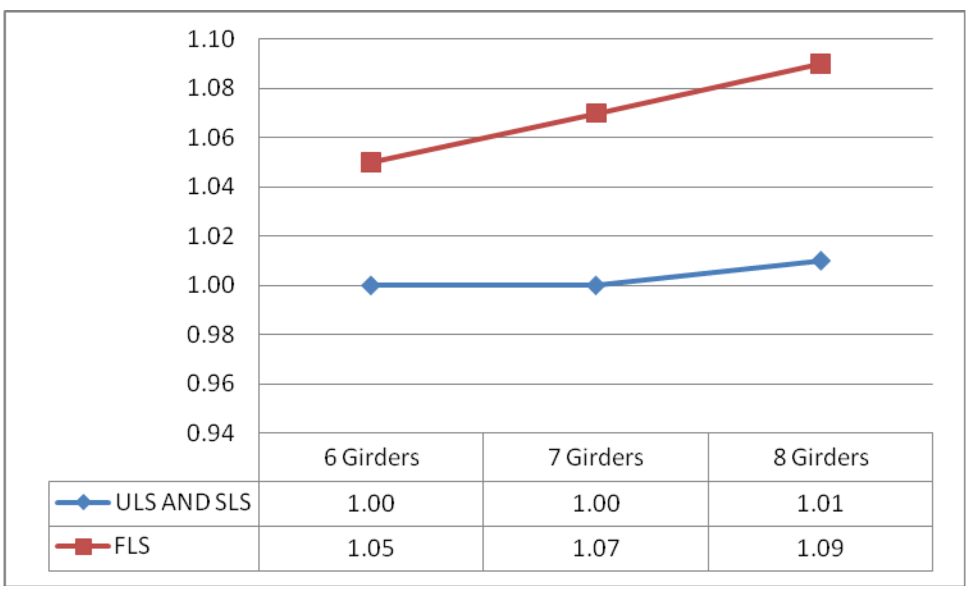


Figure 4.8 Effect of Number of Girders on the Moment Distribution Factor For B1000 Girder, 2-Lane, 32m Length Bridge

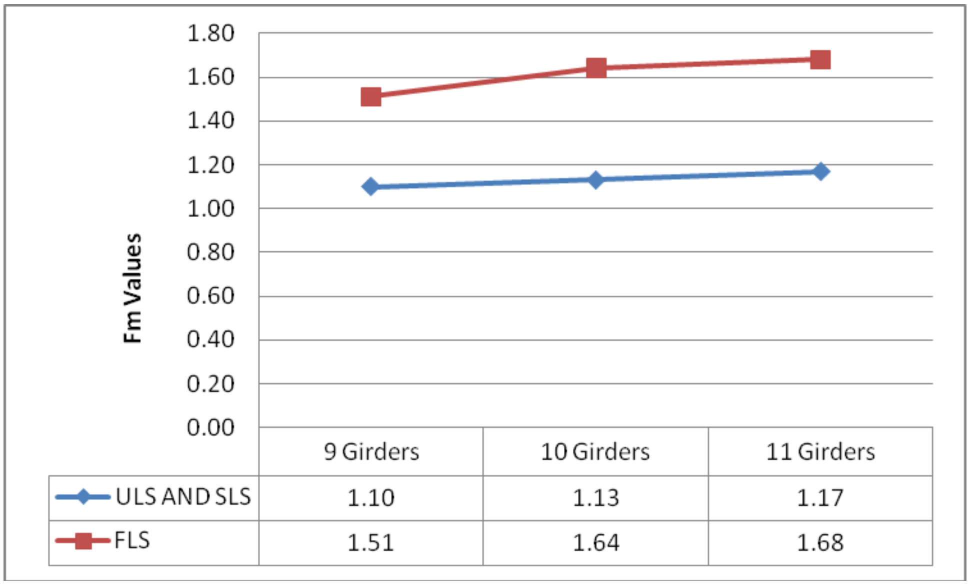


Figure 4.9 Effect of Number of Girders on the Moment Distribution Factor For B700 Girder, 3-Lane, 16m Length Bridge

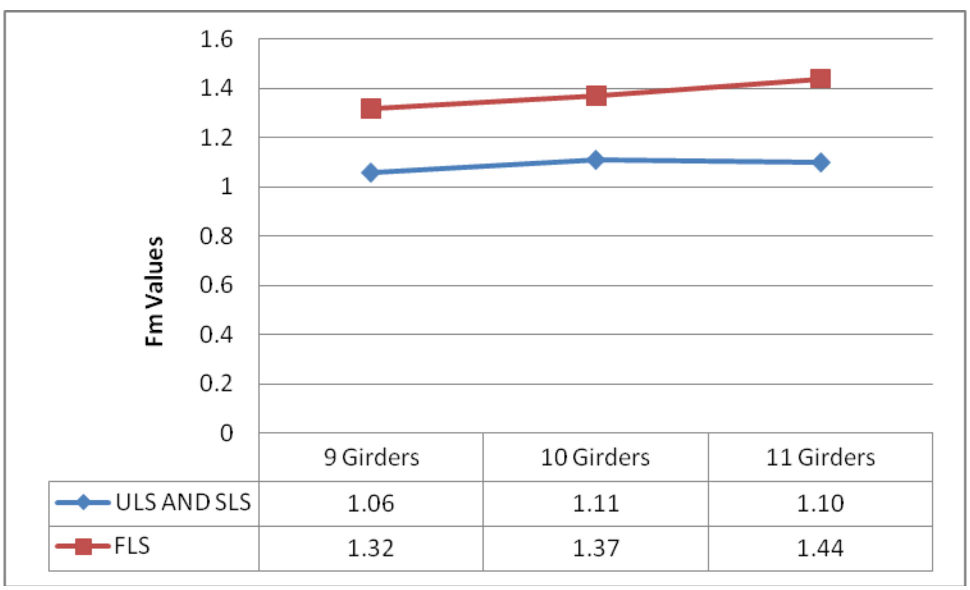


Figure 4.10 Effect of Number of Girders on the Moment Distribution Factor For B700 Girder, 3-Lane, 24m Length Bridge

Figure 4.11 Effect of Number of Girders on the Moment Distribution Factor For B800 Girder, 3-Lane, 20m Length Bridge

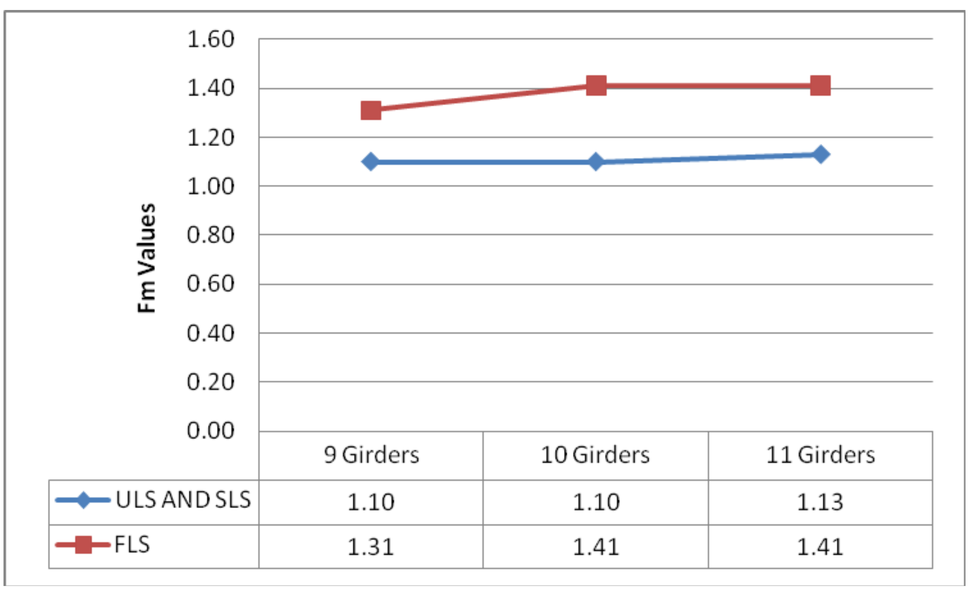


Figure 4.12 Effect of Number of Girders on the Moment Distribution Factor For B800 Girder, 3-Lane, 26m Length Bridge

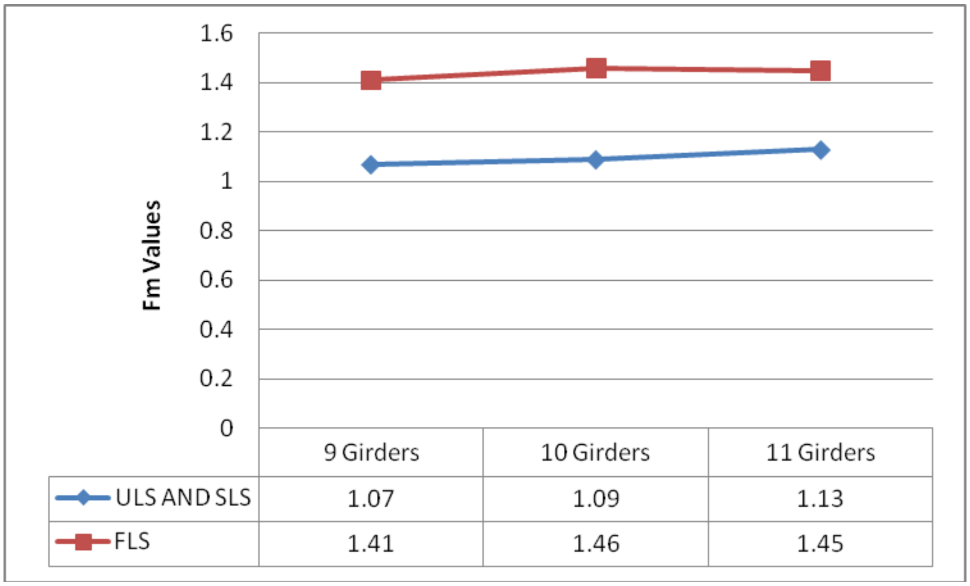


Figure 4.13 Effect of Number of Girders on the Moment Distribution Factor For B900 Girder, 3-Lane, 24m Length Bridge

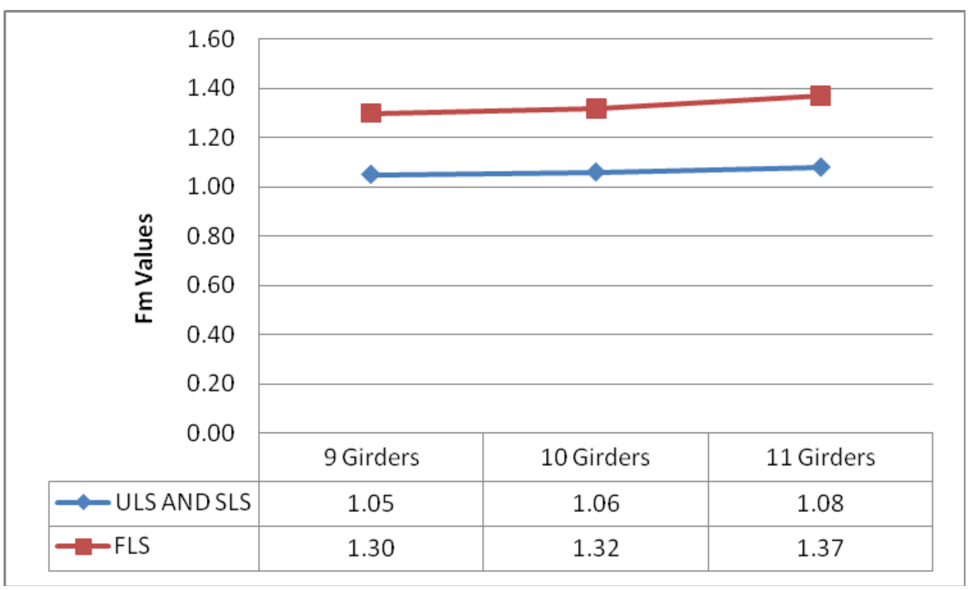


Figure 4.14 Effect of Number of Girders on the Moment Distribution Factor For B900 Girder, 3-Lane, 30m Length Bridge

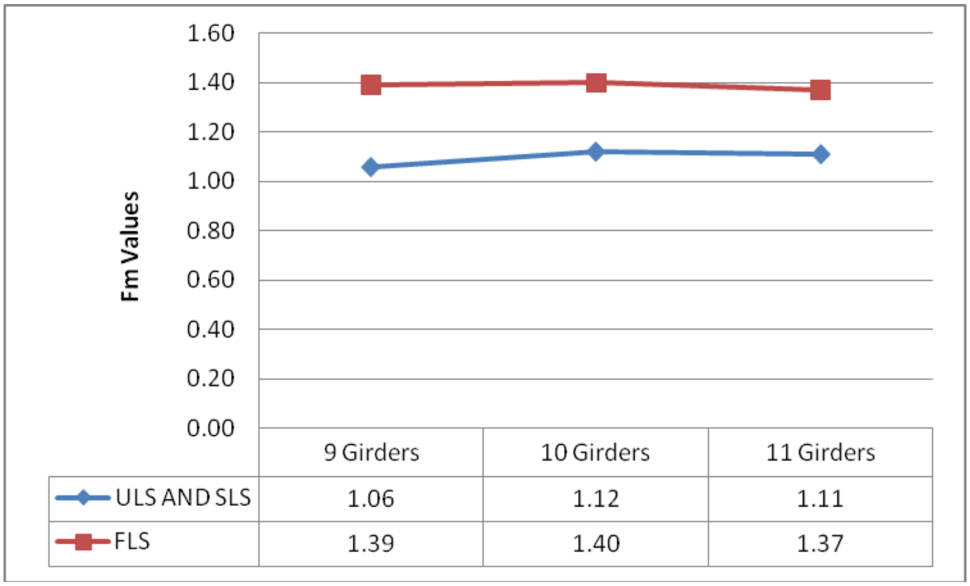


Figure 4.15 Effect of Number of Girders on the Moment Distribution Factor For B1000 Girder, 3-Lane, 26m Length Bridge

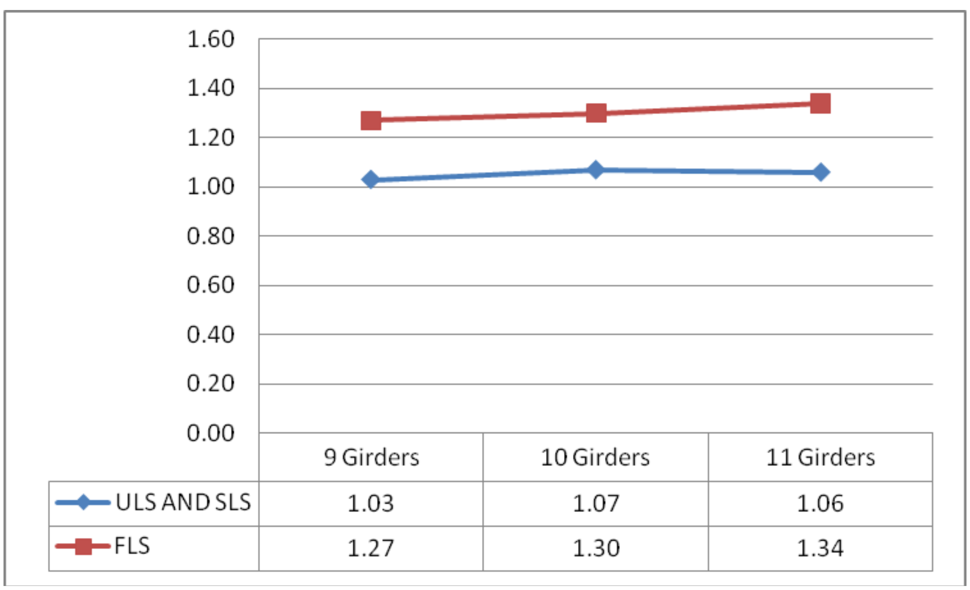


Figure 4.16 Effect of Number of Girders on the Moment Distribution Factor For B1000 Girder, 3-Lane, 32m Length Bridge

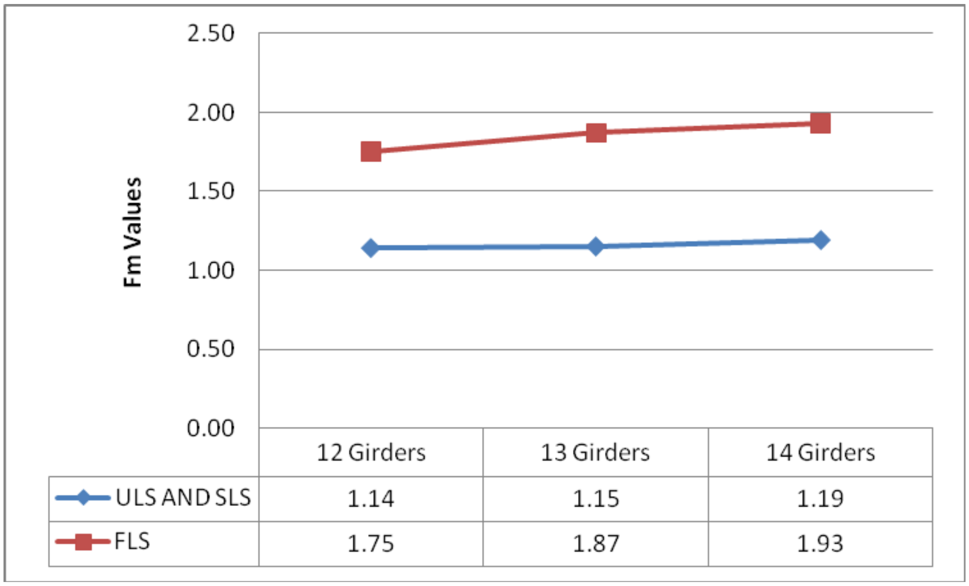


Figure 4.17 Effect of Number of Girders on the Moment Distribution Factor For B700 Girder, 4-Lanes, 16m Length Bridge

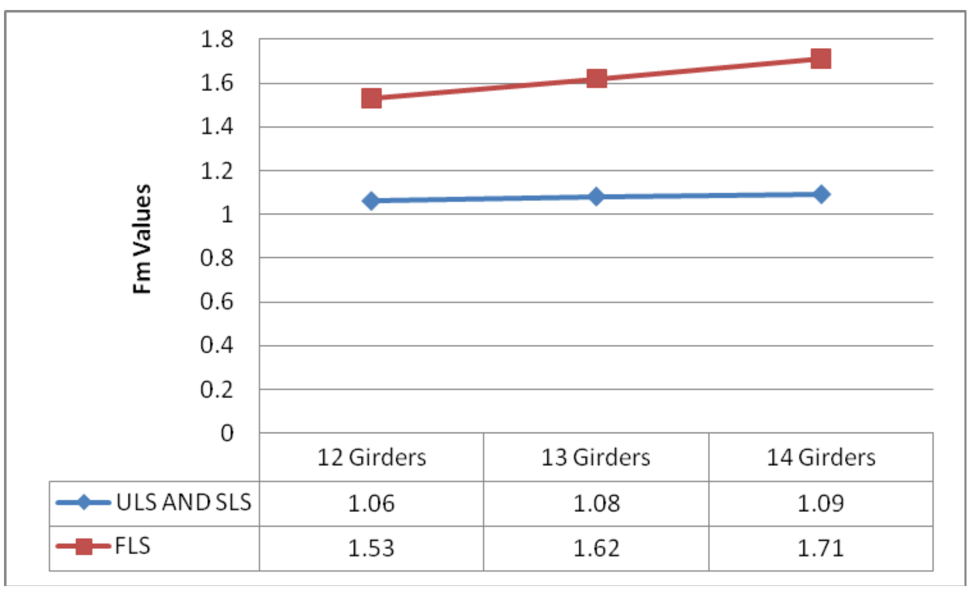


Figure 4.18 Effect of Number of Girders on the Moment Distribution Factor For B700 Girder, 4-Lanes, 24m Length Bridge

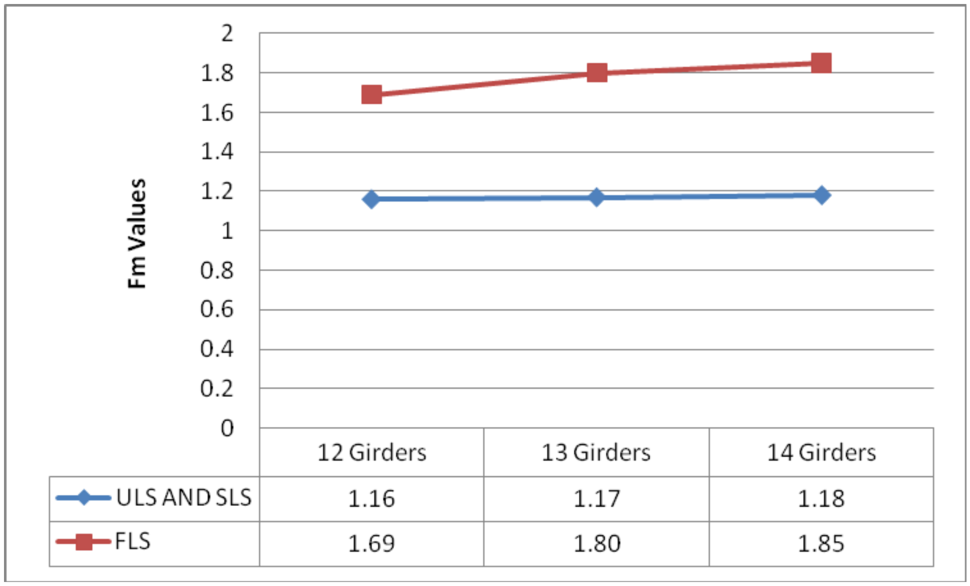


Figure 4.19 Effect of Number of Girders on the Moment Distribution Factor For B800 Girder, 4-Lanes, 20m Length Bridge

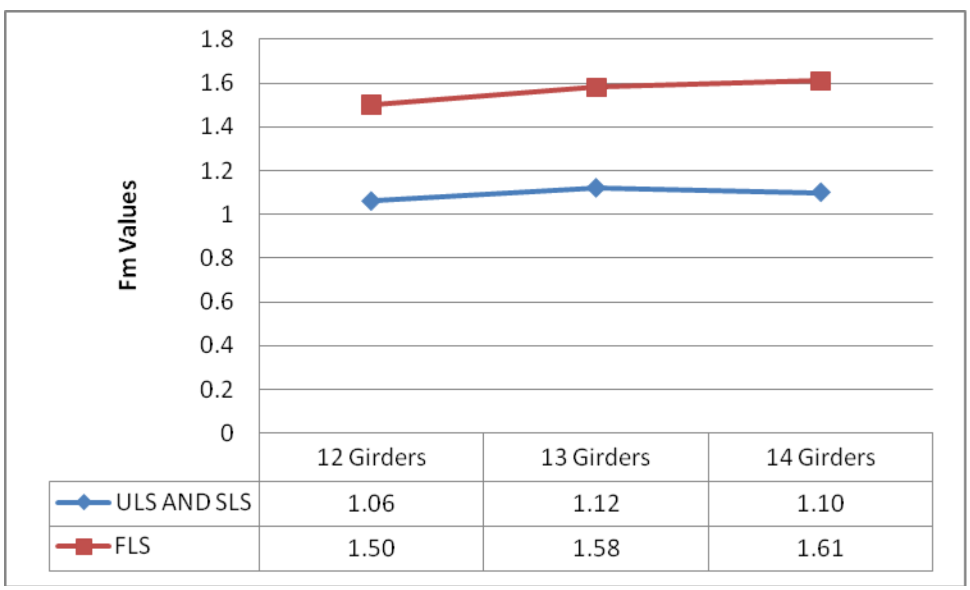


Figure 4.20 Effect of Number of Girders on the Moment Distribution Factor For B800 Girder, 4-Lanes, 26m Length Bridge

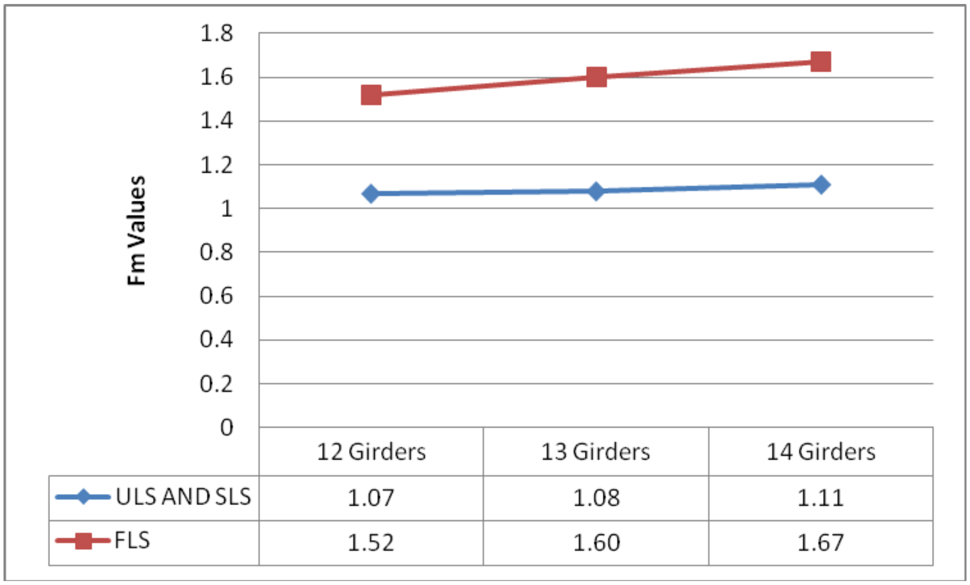


Figure 4.21 Effect of Number of Girders on the Moment Distribution Factor For B900 Girder, 4-Lanes, 24m Length Bridge

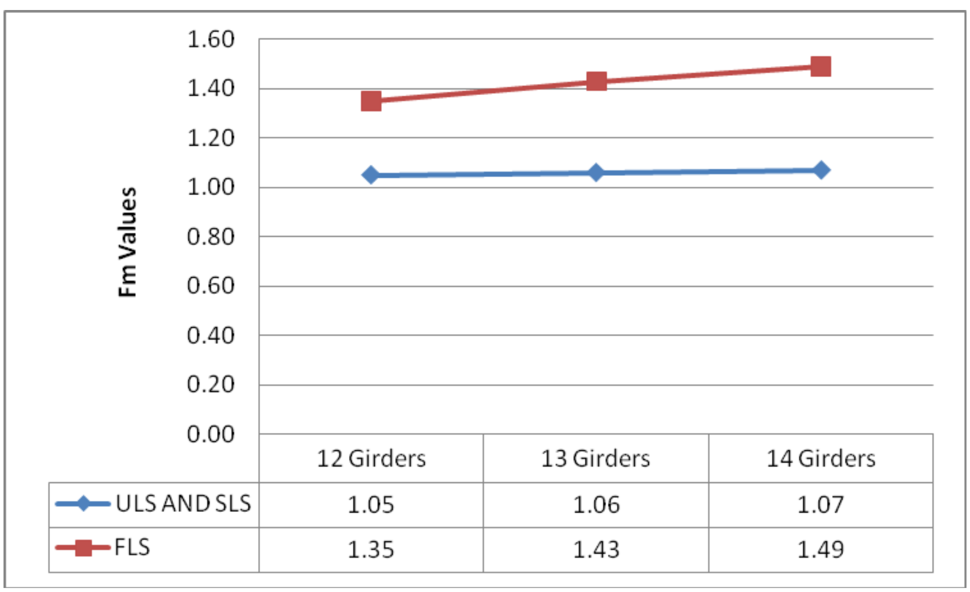
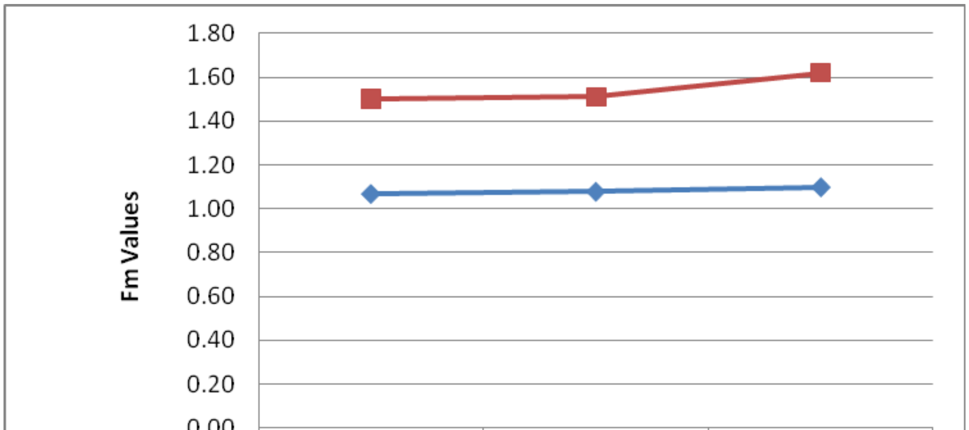
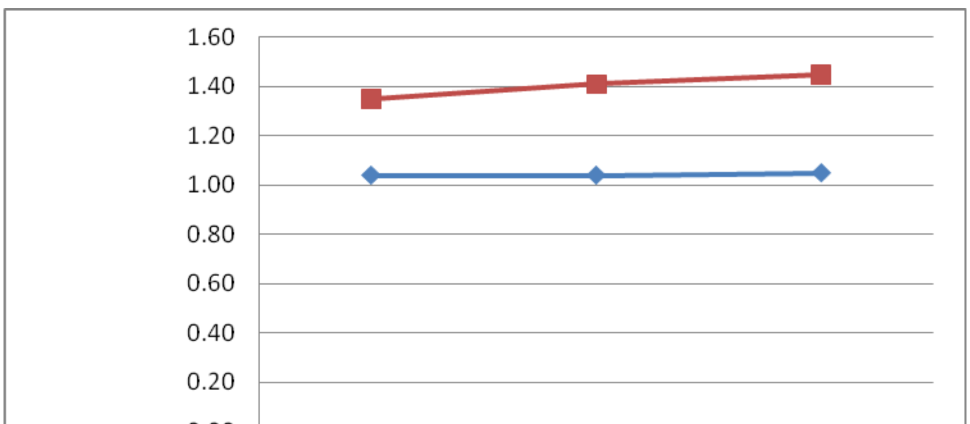


Figure 4.22 Effect of Number of Girders on the Moment Distribution Factor For B900 Girder, 4-Lanes, 30m Length Bridge



	12 Girders	13 Girders	14 Girders
ULS AND SLS	1.07	1.08	1.10
FLS	1.50	1.51	1.62

Figure 4.23 Effect of Number of Girders on the Moment Distribution Factor For B1000 Girder, 4-Lanes, 26m Length Bridge



	12 Girders	13 Girders	14 Girders
ULS AND SLS	1.04	1.04	1.05
FLS	1.35	1.41	1.45

Figure 4.24 Effect of Number of Girders on the Moment Distribution Factor For B1000 Girder, 4-Lanes, 32m Length Bridge

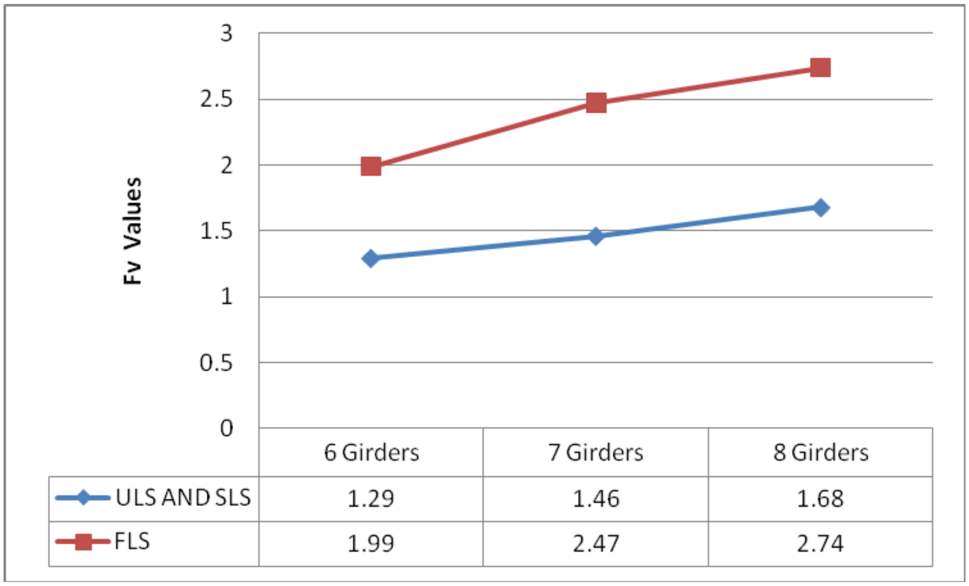


Figure 4.25 Effect of Number of Girders on the Shear Distribution Factor For B700 Girder, 2-Lane, 16m Length Bridge

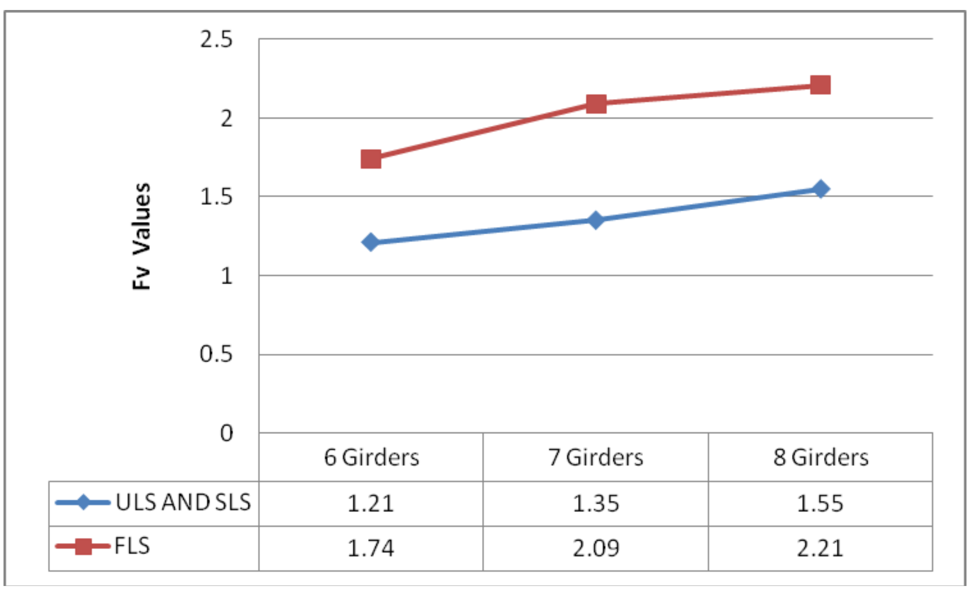


Figure 4.26 Effect of Number of Girders on the Shear Distribution Factor For B700 Girder, 2-Lane, 24m Length Bridge

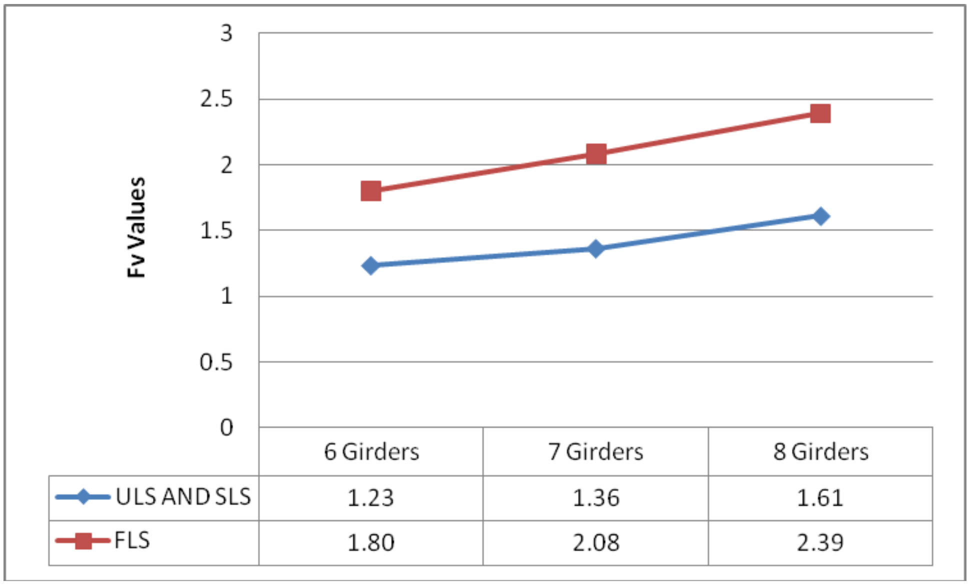


Figure 4.27 Effect of Number of Girders on the Shear Distribution Factor For B800 Girder, 2-Lane, 20m Length Bridge

Figure 4.28 Effect of Number of Girders on the Shear Distribution Factor For B800 Girder, 2-Lane, 26m Length Bridge

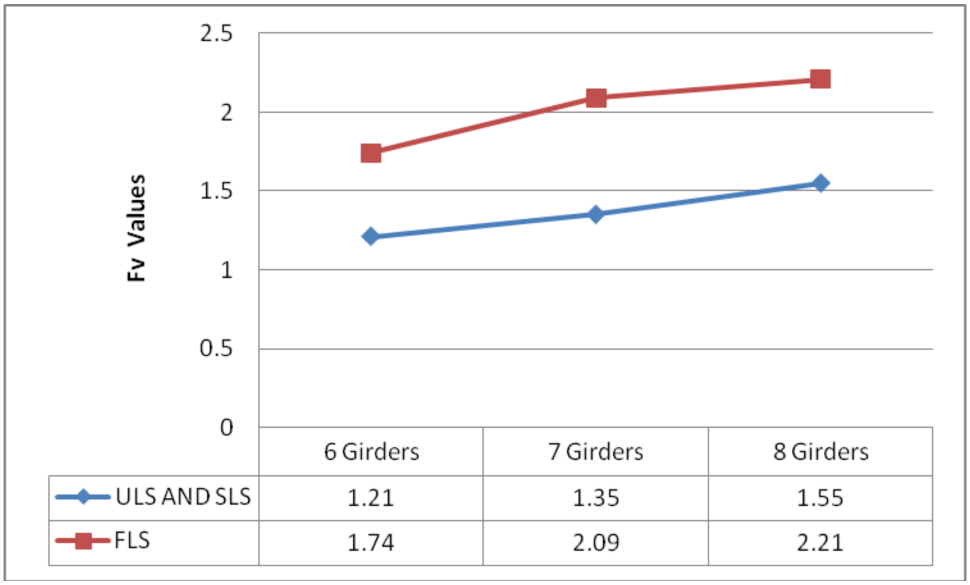


Figure 4.29 Effect of Number of Girders on the Shear Distribution Factor For B900 Girder, 2-Lane, 24m Length Bridge

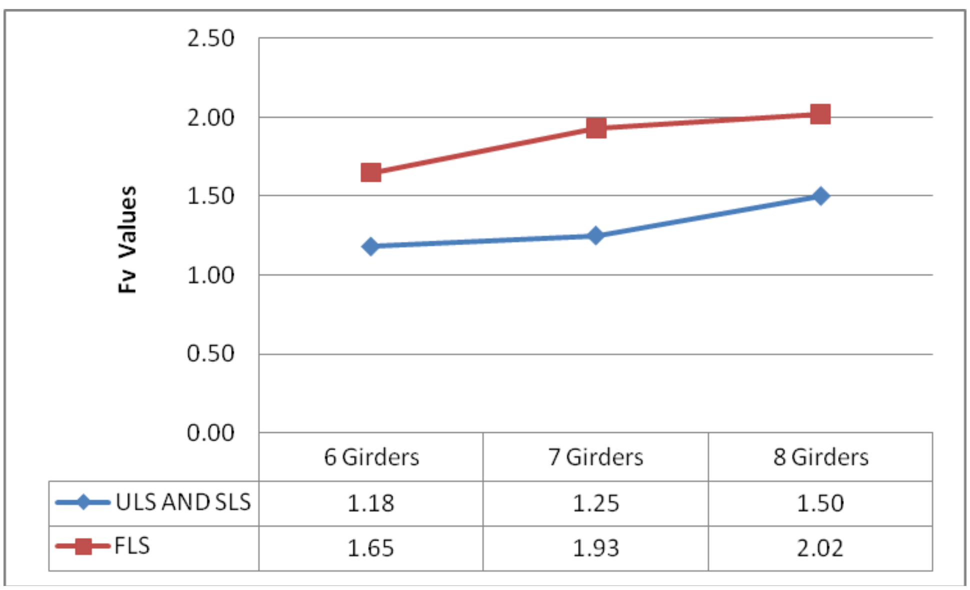


Figure 4.30 Effect of Number of Girders on the Shear Distribution Factor For B900 Girder, 2-Lane, 30m Length Bridge

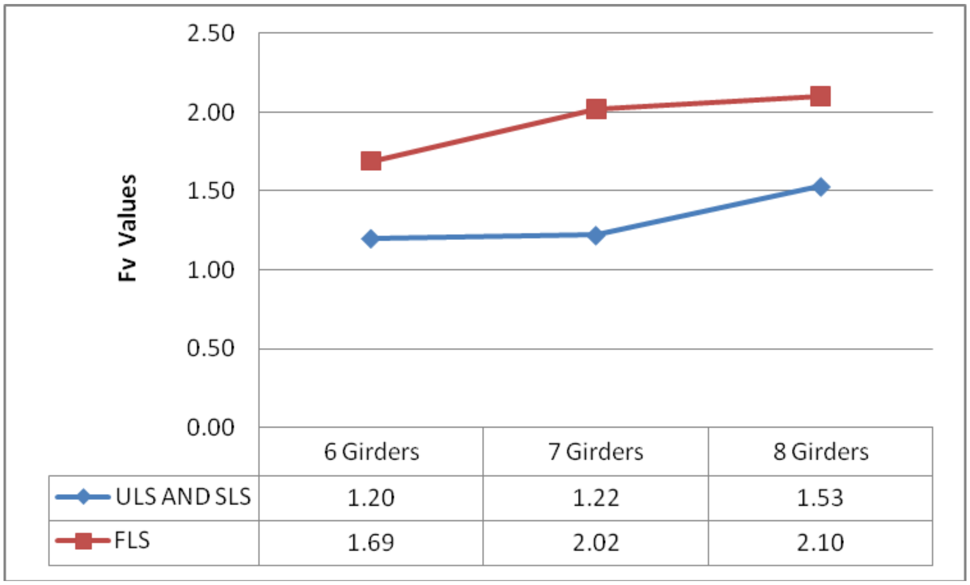


Figure 4.31 Effect of Number of Girders on the Shear Distribution Factor For B1000 Girder, 2-Lane, 26m Length Bridge

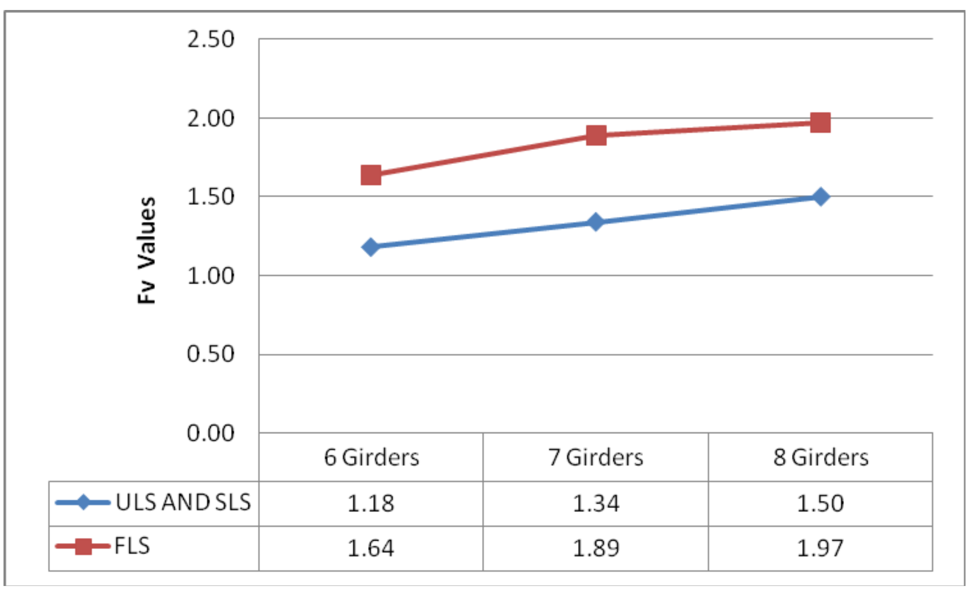


Figure 4.32 Effect of Number of Girders on the Shear Distribution Factor For B1000 Girder, 2-Lane, 32m Length Bridge

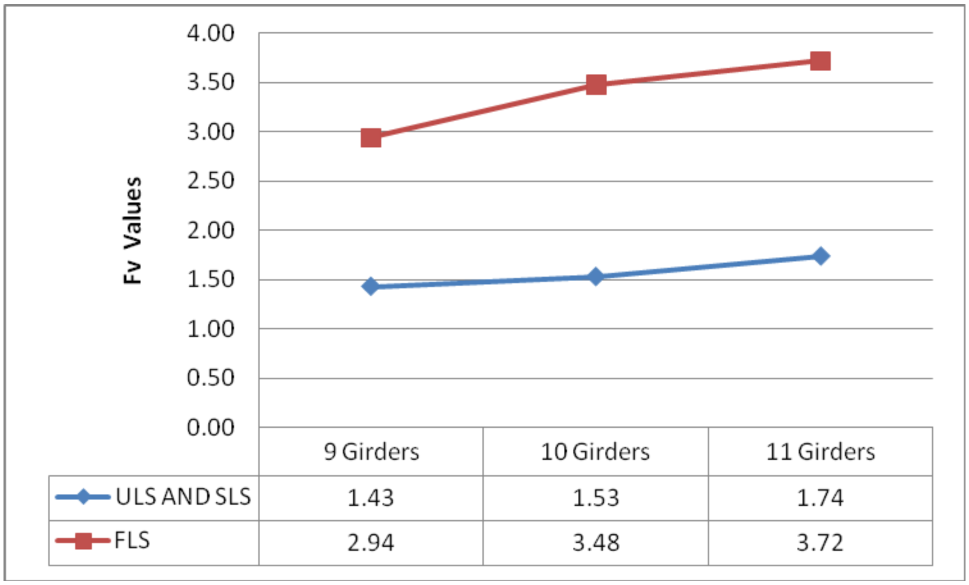


Figure 4.33 Effect of Number of Girders on the Shear Distribution Factor For B700 Girder, 3-Lane, 16m Length Bridge

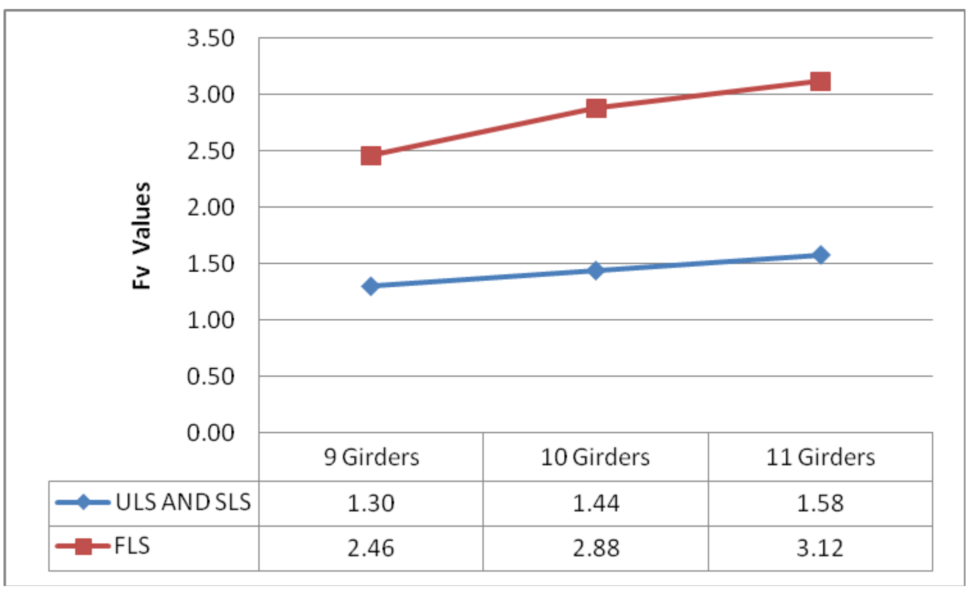


Figure 4.34 Effect of Number of Girders on the Shear Distribution Factor For B700 Girder, 3-Lane, 24m Length Bridge

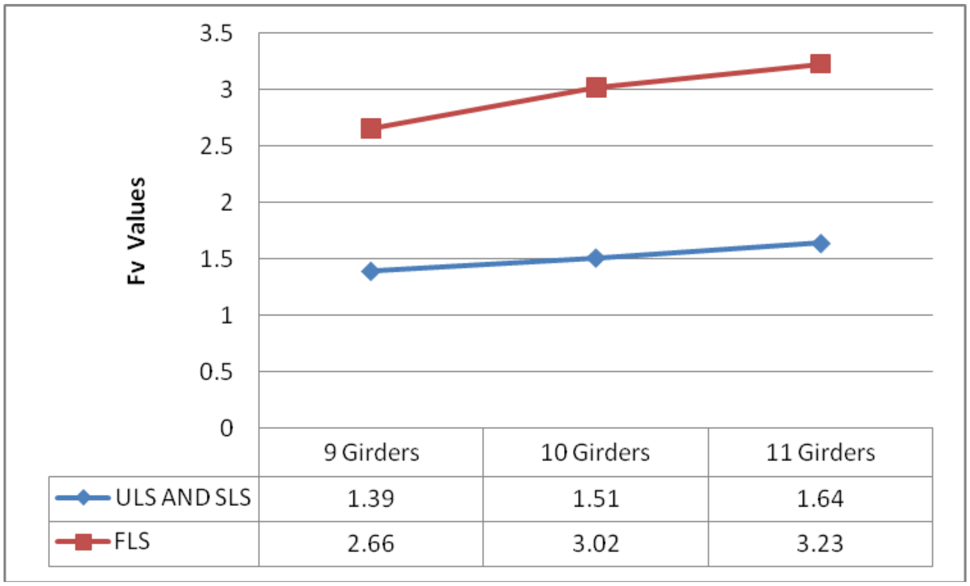


Figure 4.35 Effect of Number of Girders on the Shear Distribution Factor For B800 Girder, 3-Lane, 20m Length Bridge

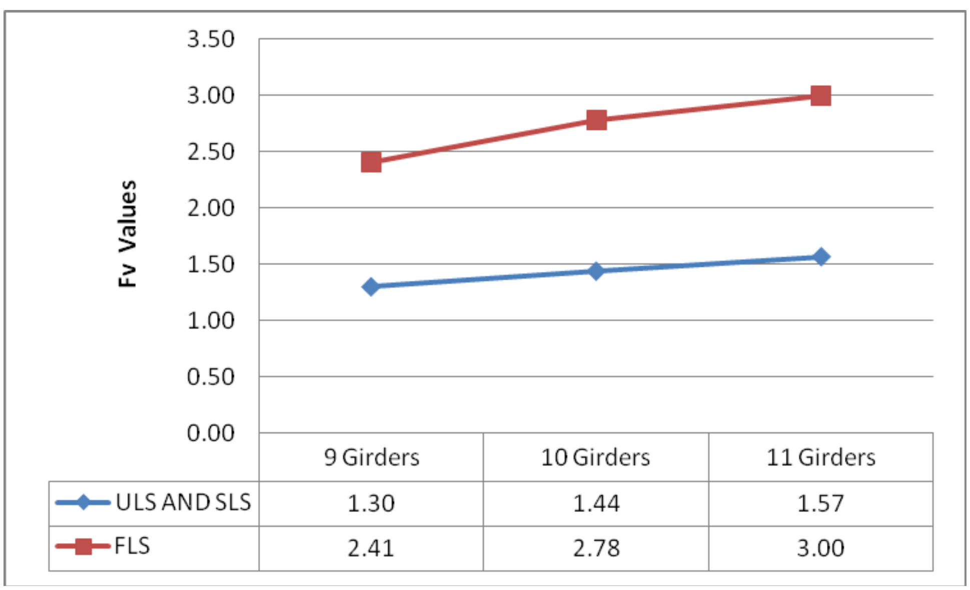


Figure 4.36 Effect of Number of Girders on the Shear Distribution Factor For B800 Girder, 3-Lane, 26m Length Bridge

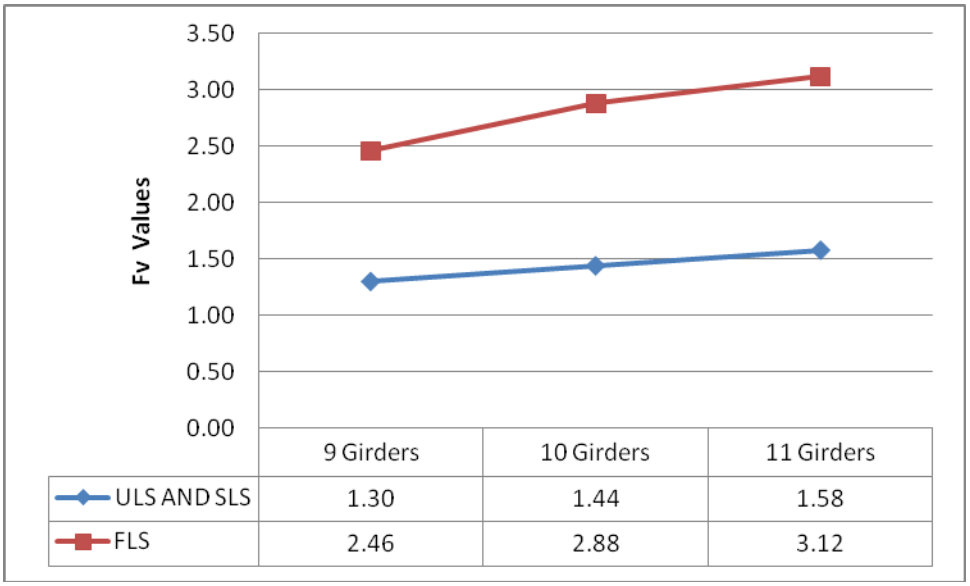


Figure 4.37 Effect of Number of Girders on the Shear Distribution Factor For B900 Girder, 3-Lane, 24m Length Bridge

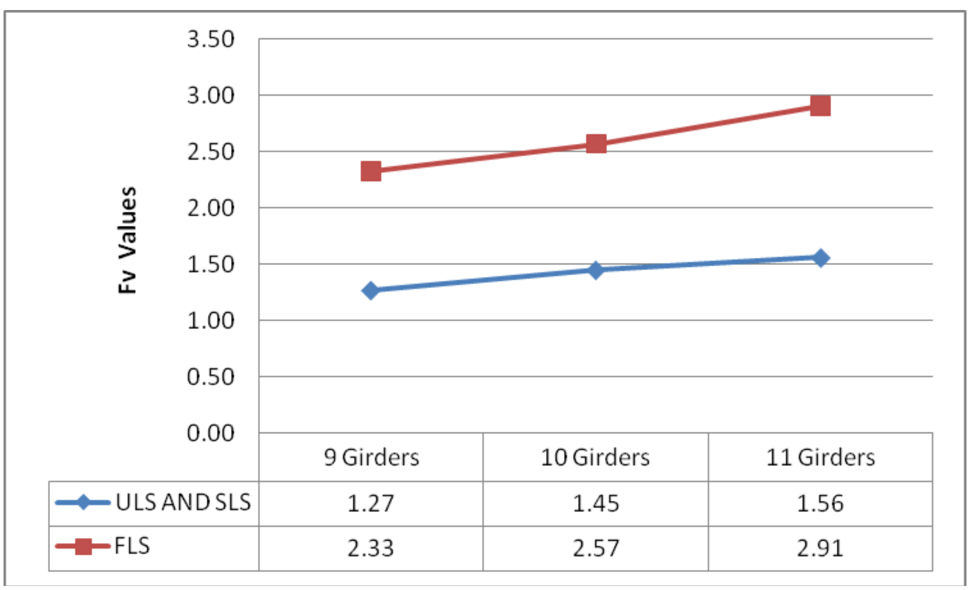


Figure 4.38 Effect of Number of Girders on the Shear Distribution Factor For B900 Girder, 3-Lane, 30m Length Bridge

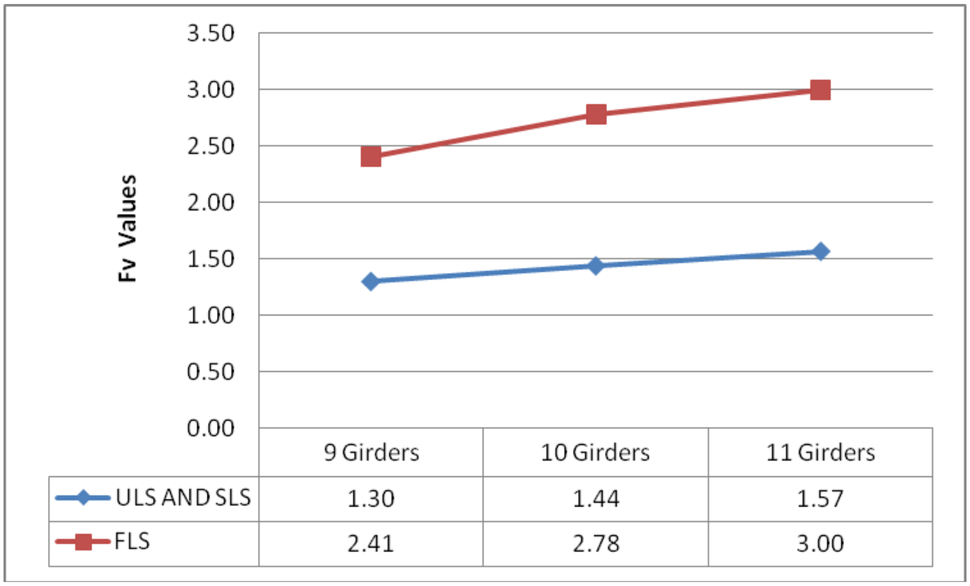


Figure 4.39 Effect of Number of Girders on the Shear Distribution Factor For B1000 Girder, 3-Lane, 26m Length Bridge

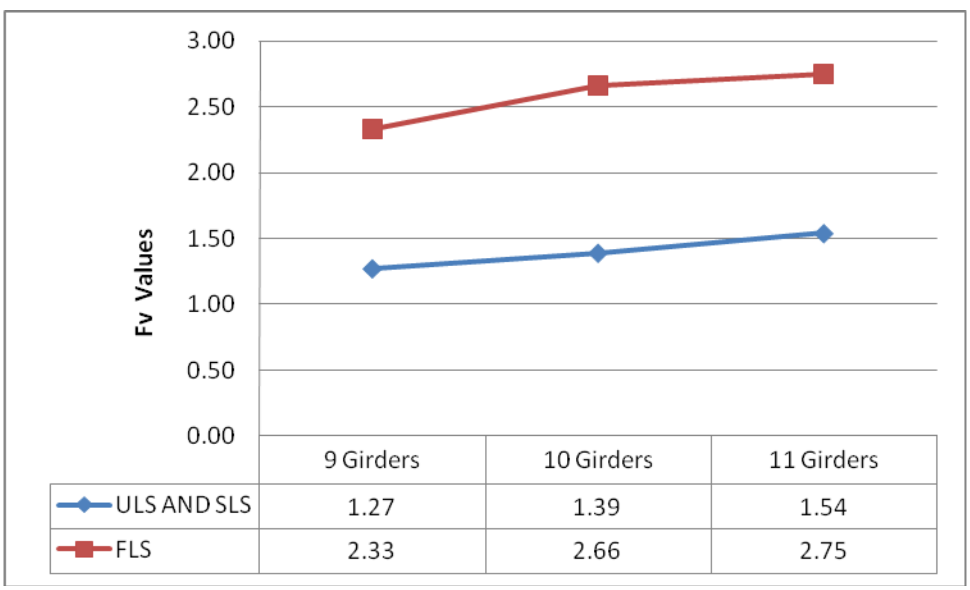


Figure 4.40 Effect of Number of Girders on the Shear Distribution Factor For B1000 Girder, 3-Lane, 32m Length Bridge

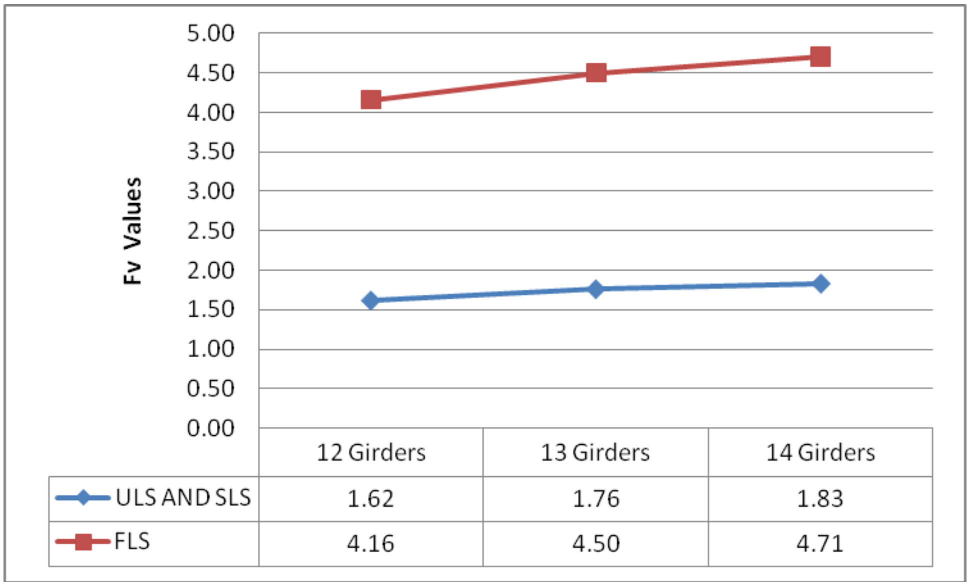


Figure 4.41 Effect of Number of Girders on the Shear Distribution Factor For B700 Girder, 4-Lanes, 16m Length Bridge

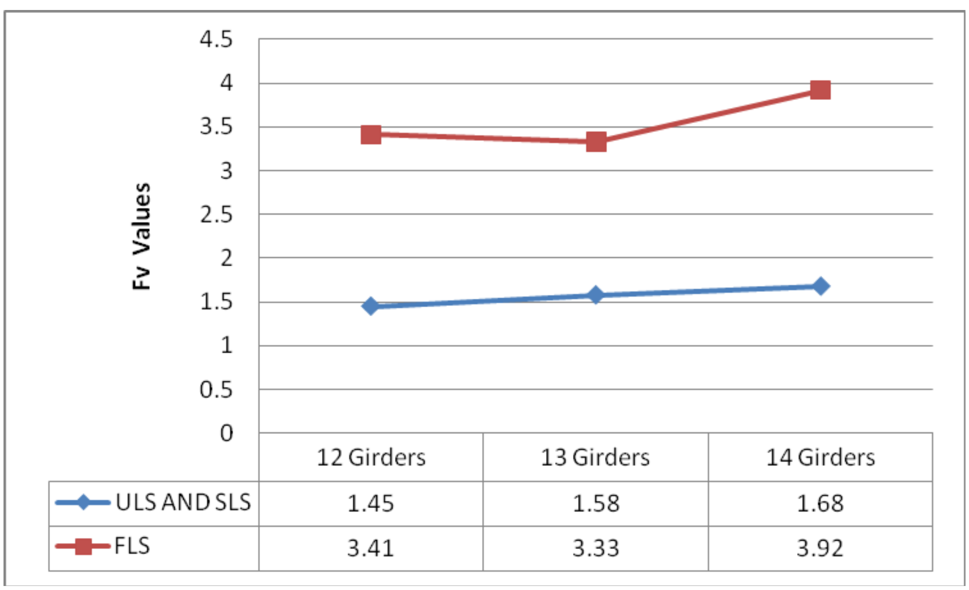


Figure 4.42 Effect of Number of Girders on the Shear Distribution Factor For B700 Girder, 4-Lanes, 24m Length Bridge

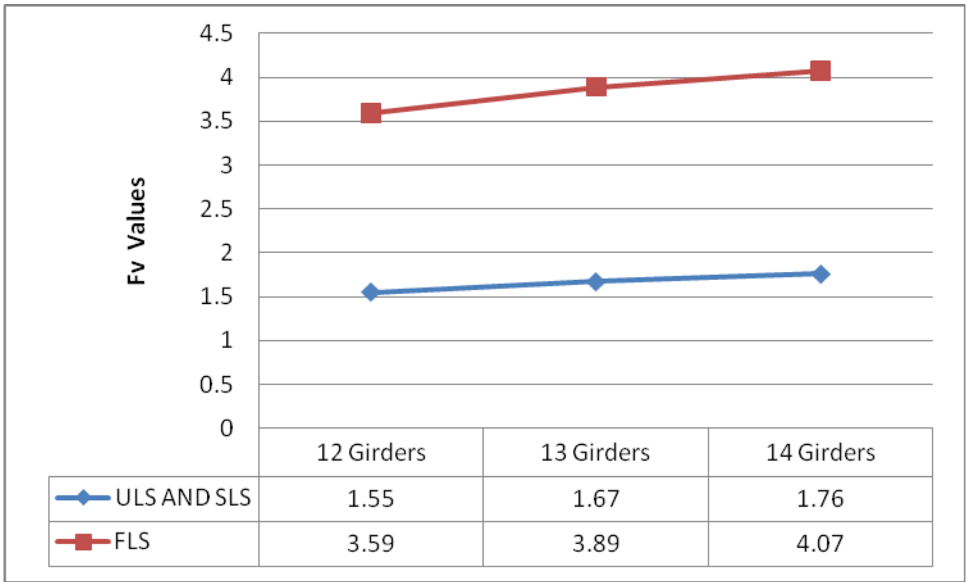


Figure 4.43 Effect of Number of Girders on the Shear Distribution Factor For B800 Girder, 4-Lanes, 20m Length Bridge

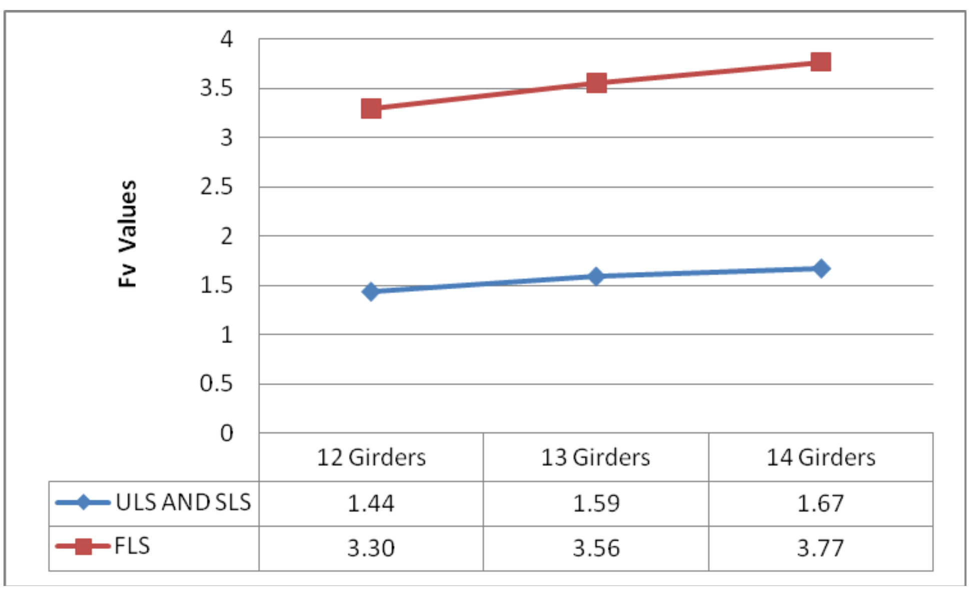


Figure 4.44 Effect of Number of Girders on the Shear Distribution Factor For B800 Girder, 4-Lanes, 26m Length Bridge

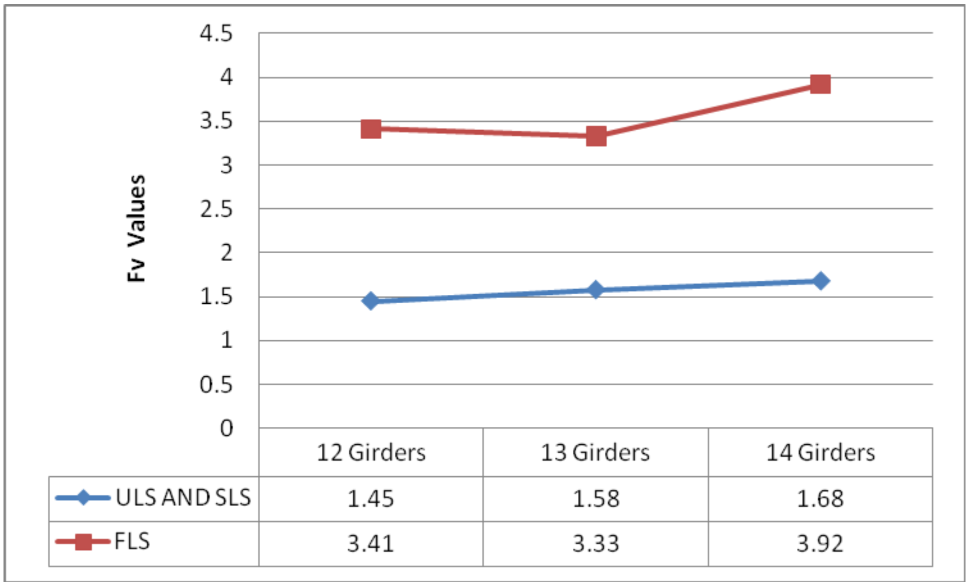


Figure 4.45 Effect of Number of Girders on the Shear Distribution Factor For B900 Girder, 4-Lanes, 24m Length Bridge

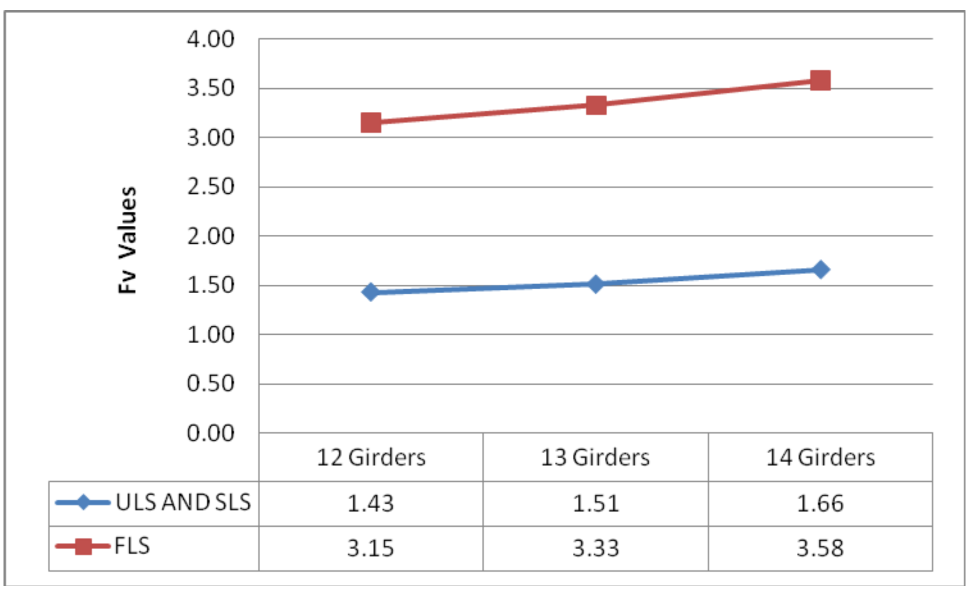


Figure 4.46 Effect of Number of Girders on the Shear Distribution Factor For B900 Girder, 4-Lanes, 30m Length Bridge

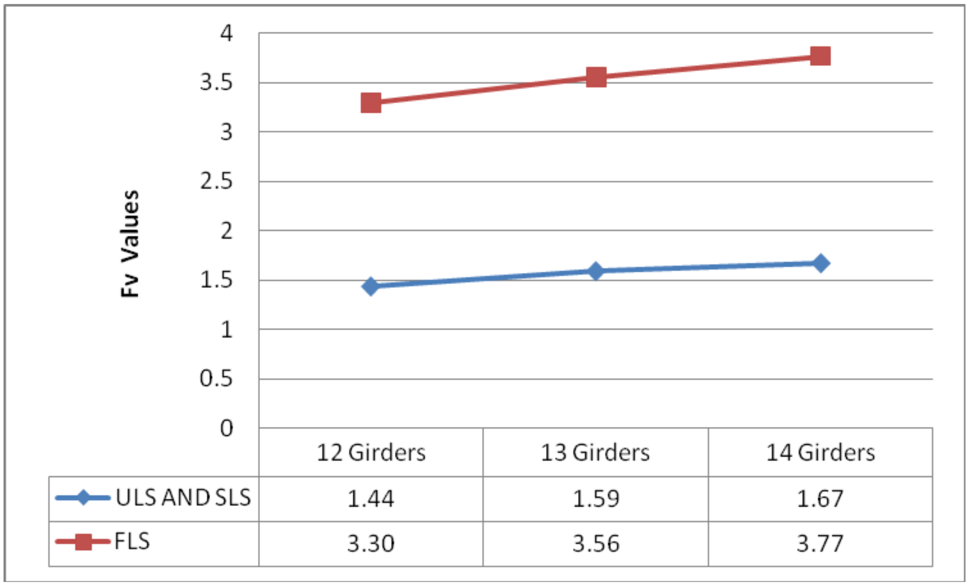


Figure 4.47 Effect of Number of Girders on the Shear Distribution Factor For B1000 Girder, 4-Lanes, 26m Length Bridge

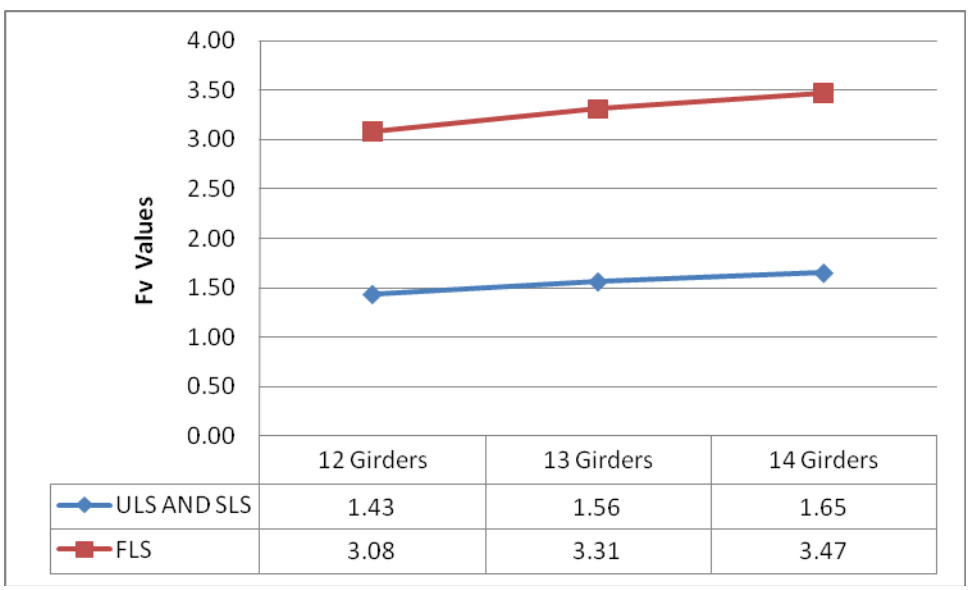


Figure 4.48 Effect of Number of Girders on the Shear Distribution Factor For B1000 Girder, 4-Lanes, 32m Length Bridge

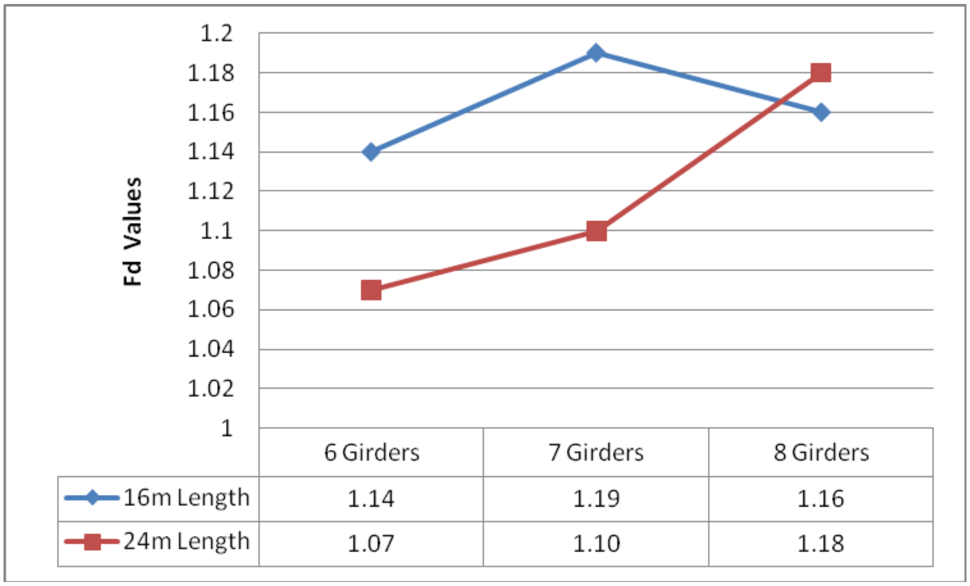


Figure 4.49 Effect of Number of Girders on the Deflection Distribution Factor For B700 Girder, 2-Lane Bridge

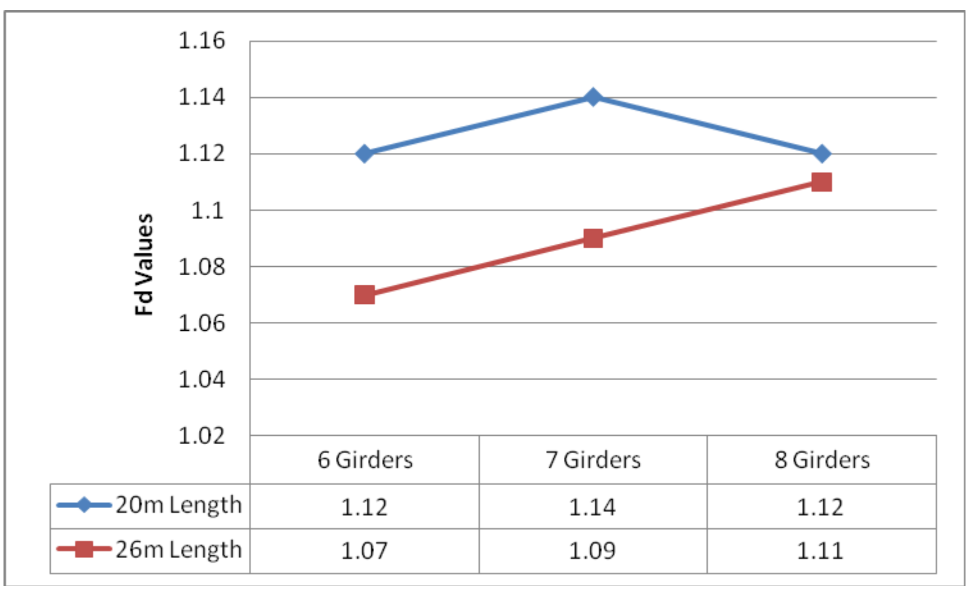


Figure 4.50 Effect of Number of Girders on the Deflection Distribution Factor For B800 Girder, 2-Lane Bridge

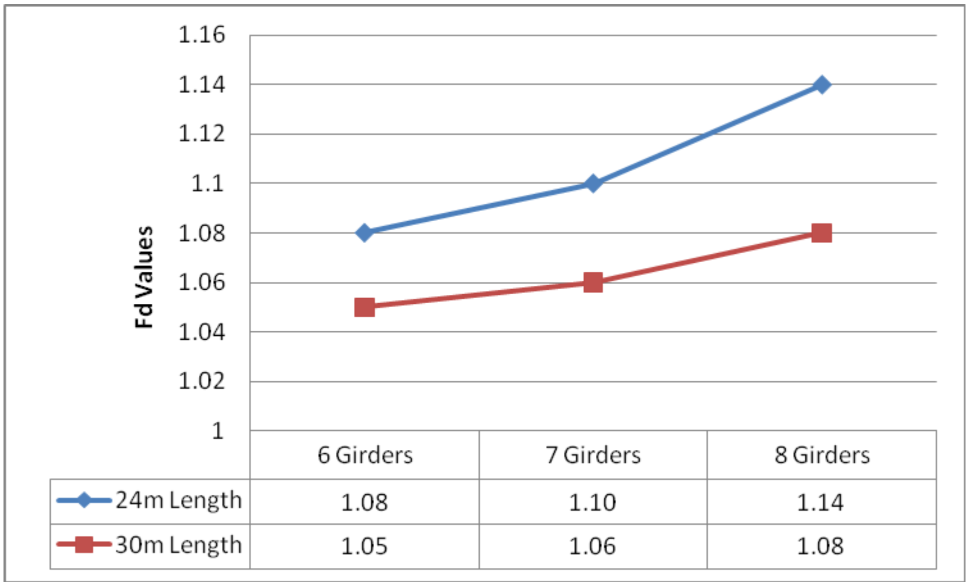


Figure 4.51 Effect of Number of Girders on the Deflection Distribution Factor For B900 Girder, 2-Lane Bridge

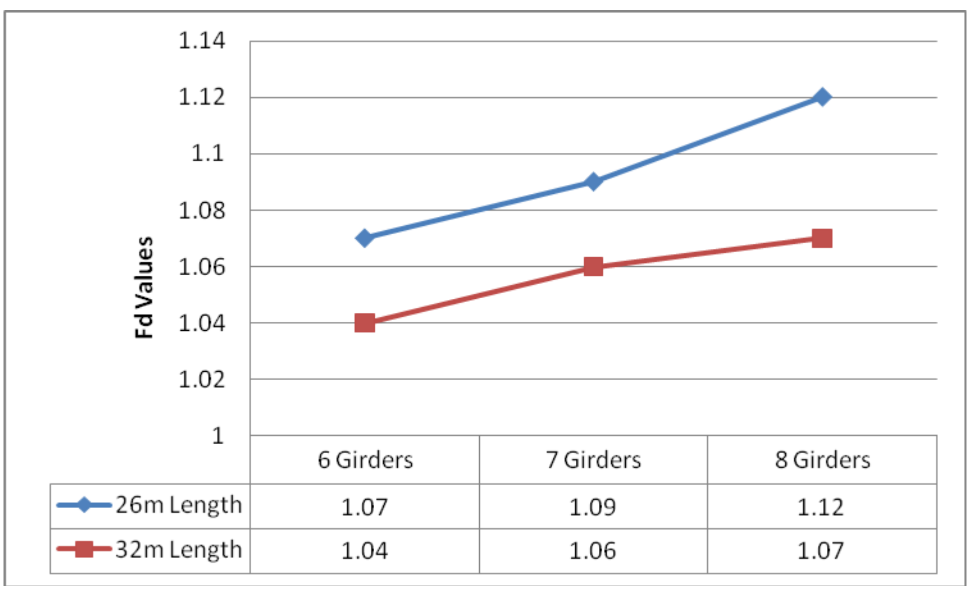


Figure 4.52 Effect of Number of Girders on the Deflection Distribution Factor For B1000 Girder, 2-Lane Bridge

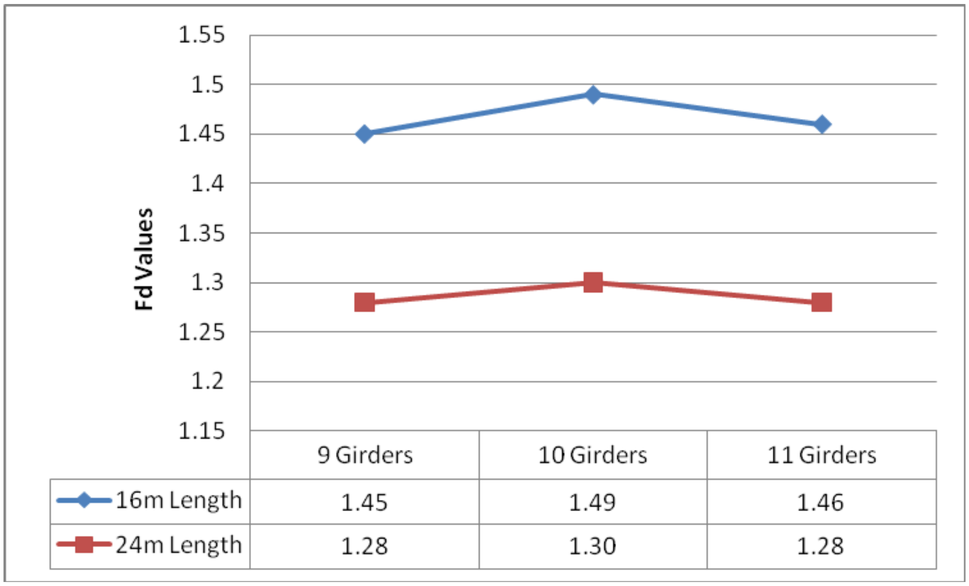


Figure 4.53 Effect of Number of Girders on the Deflection Distribution Factor For B700 Girder, 3-Lane Bridge

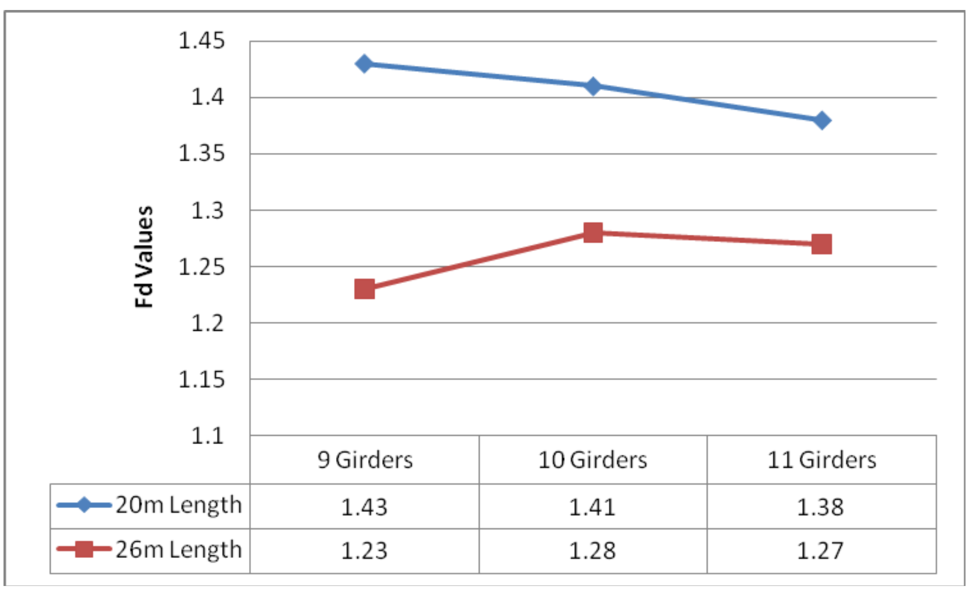
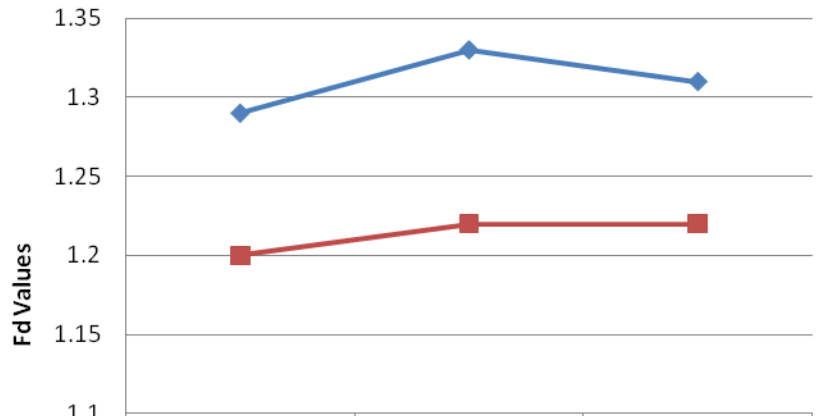
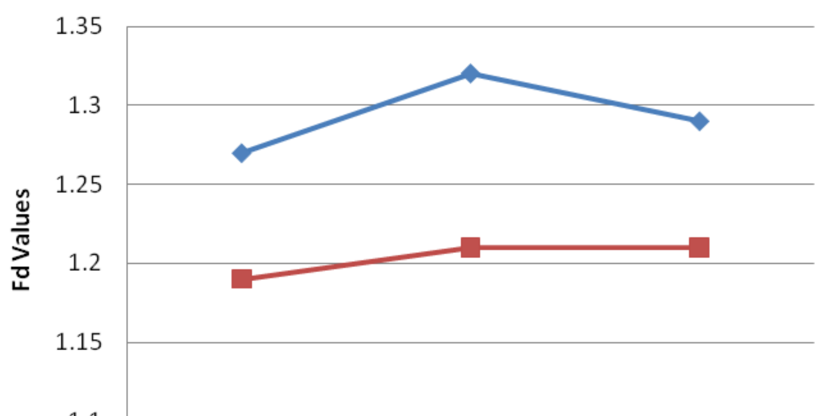


Figure 4.54 Effect of Number of Girders on the Deflection Distribution Factor For B800 Girder, 3-Lane Bridge



	9 Girders	10 Girders	11 Girders
24m Length	1.29	1.33	1.31
30m Length	1.2	1.22	1.22

Figure 4.55 Effect of Number of Girders on the Deflection Distribution Factor For B900 Girder, 3-Lane Bridge



	9 Girders	10 Girders	11 Girders
26m Length	1.27	1.32	1.29
32m Length	1.19	1.21	1.21

Figure 4.56 Effect of Number of Girders on the Deflection Distribution Factor For B1000 Girder, 3-Lane Bridge

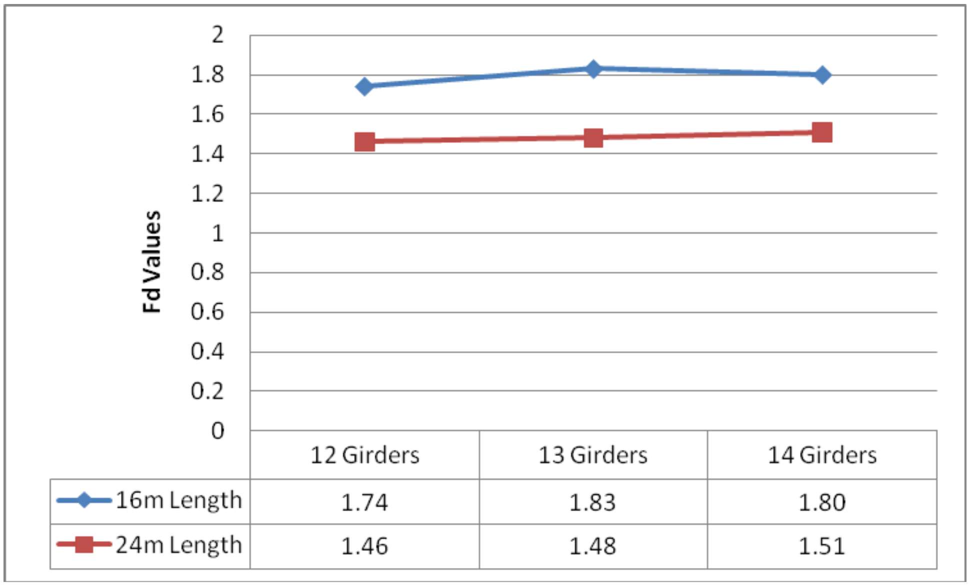


Figure 4.57 Effect of Number of Girders on the Deflection Distribution Factor For B700 Girder, 4-Lanes Bridge

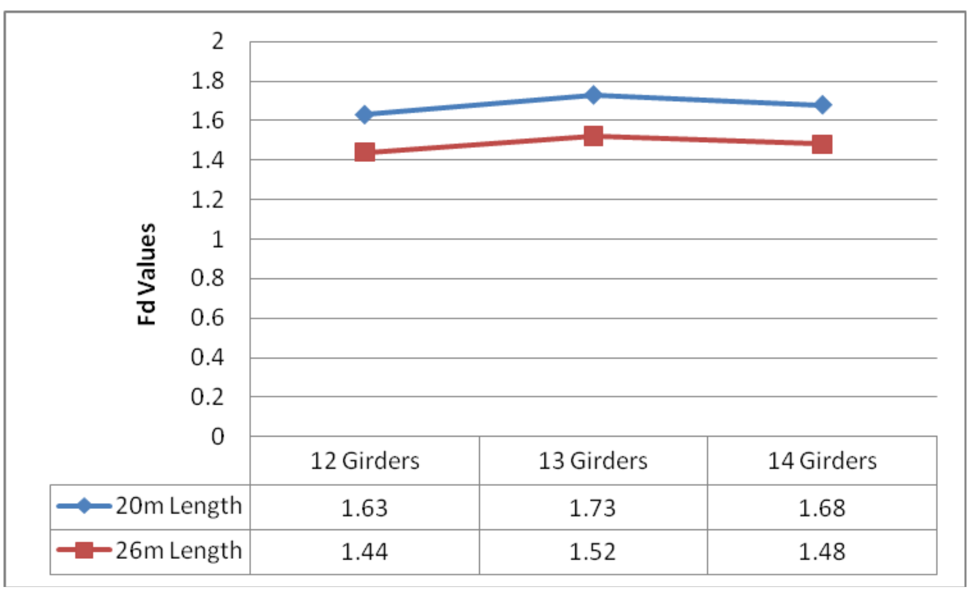


Figure 4.58 Effect of Number of Girders on the Deflection Distribution Factor For B800 Girder, 4-Lanes Bridge

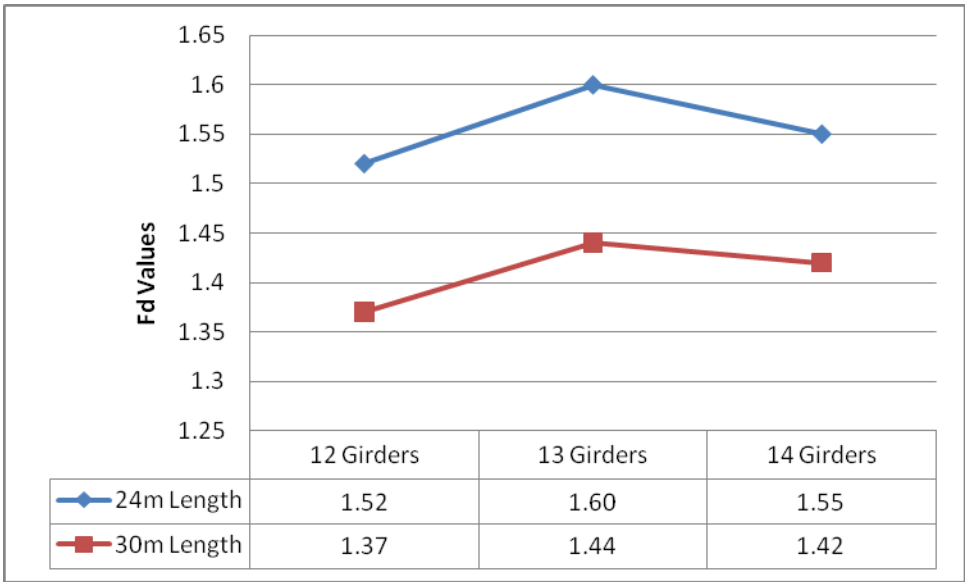


Figure 4.59 Effect of Number of Girders on the Deflection Distribution Factor For B900 Girder, 4-Lanes Bridge

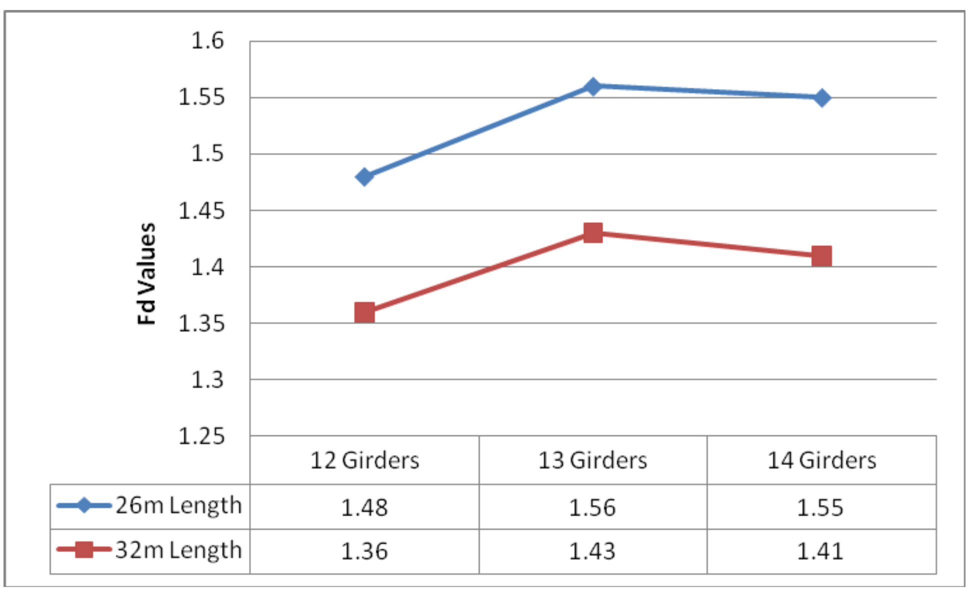
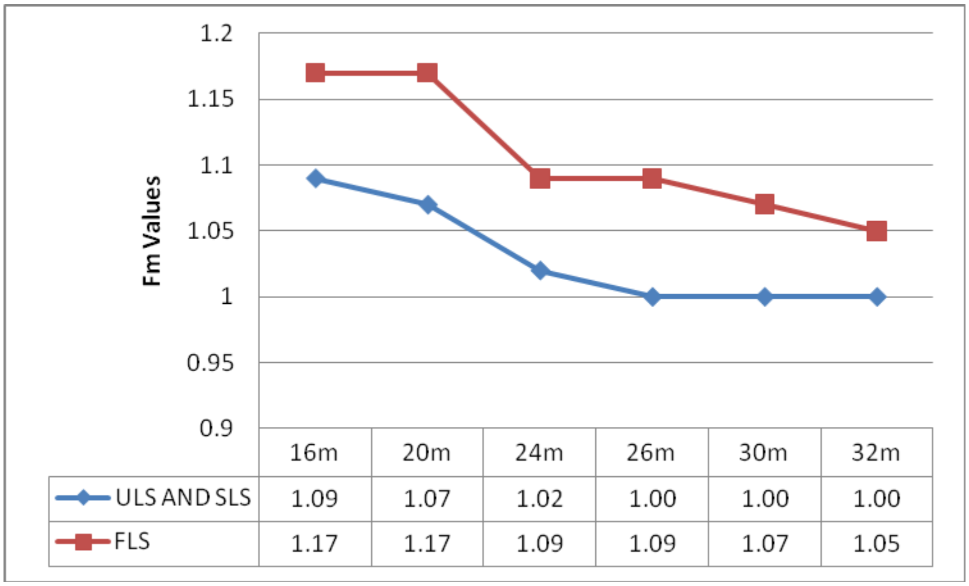
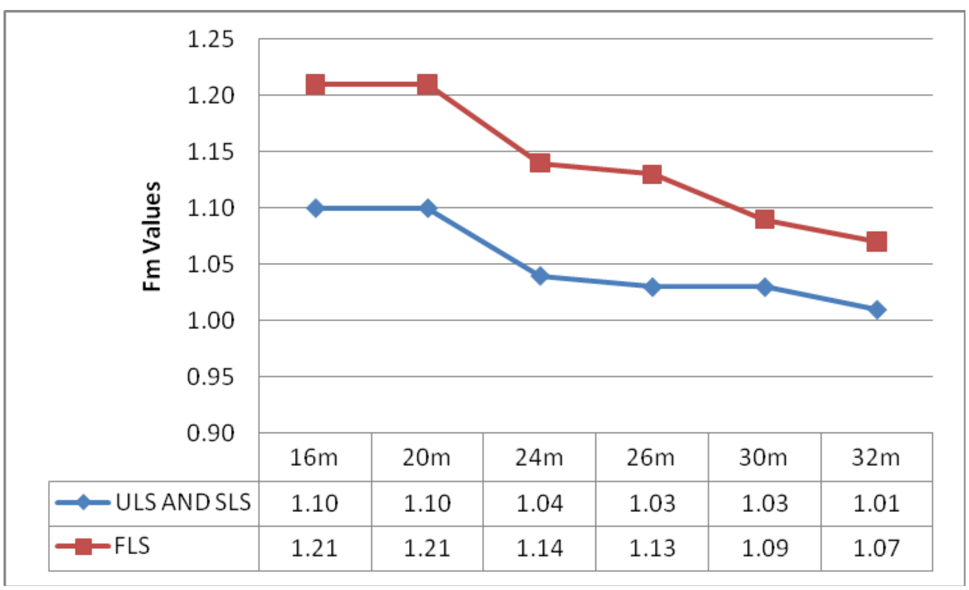


Figure 4.60 Effect of Number of Girders on the Deflection Distribution Factor For B1000 Girder, 4-Lanes Bridge



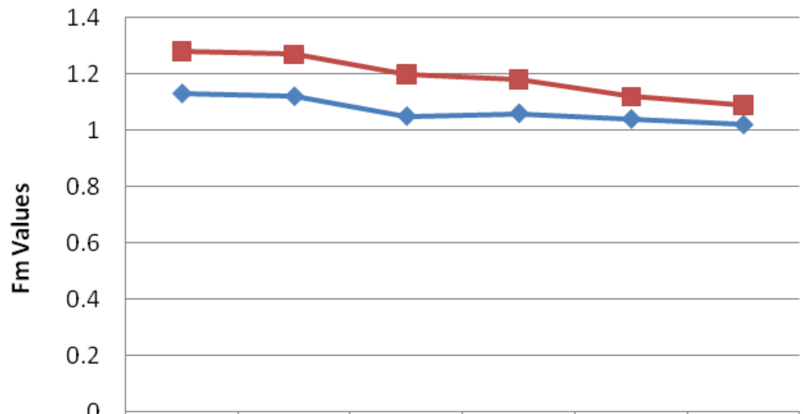
	16m	20m	24m	26m	30m	32m
ULS AND SLS	1.09	1.07	1.02	1.00	1.00	1.00
FLS	1.17	1.17	1.09	1.09	1.07	1.05

Figure 4.61 Effect of Span Length on the Moment Distribution Factor For 2-Lane Bridge, Width 7.396m, 6 Box Girders



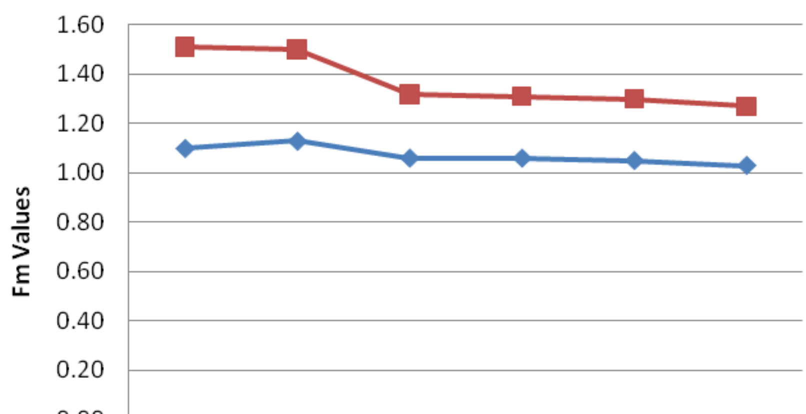
	16m	20m	24m	26m	30m	32m
ULS AND SLS	1.10	1.10	1.04	1.03	1.03	1.01
FLS	1.21	1.21	1.14	1.13	1.09	1.07

Figure 4.62 Effect of Span Length on the Moment Distribution Factor For 2-Lane Bridge, Width 8.631m, 7 Box Girders



	16m	20m	24m	26m	30m	32m
ULS AND SLS	1.13	1.12	1.05	1.06	1.04	1.02
FLS	1.28	1.27	1.20	1.18	1.12	1.09

Figure 4.63 Effect of Span Length on the Moment Distribution Factor For 2-Lane Bridge, Width 9.866m, 8 Box Girders



	16m	20m	24m	26m	30m	32m
ULS AND SLS	1.10	1.13	1.06	1.06	1.05	1.03
FLS	1.51	1.50	1.32	1.31	1.30	1.27

Figure 4.64 Effect of Span Length on the Moment Distribution Factor For 3-Lane Bridge, Width 11.101m, 9 Box Girders

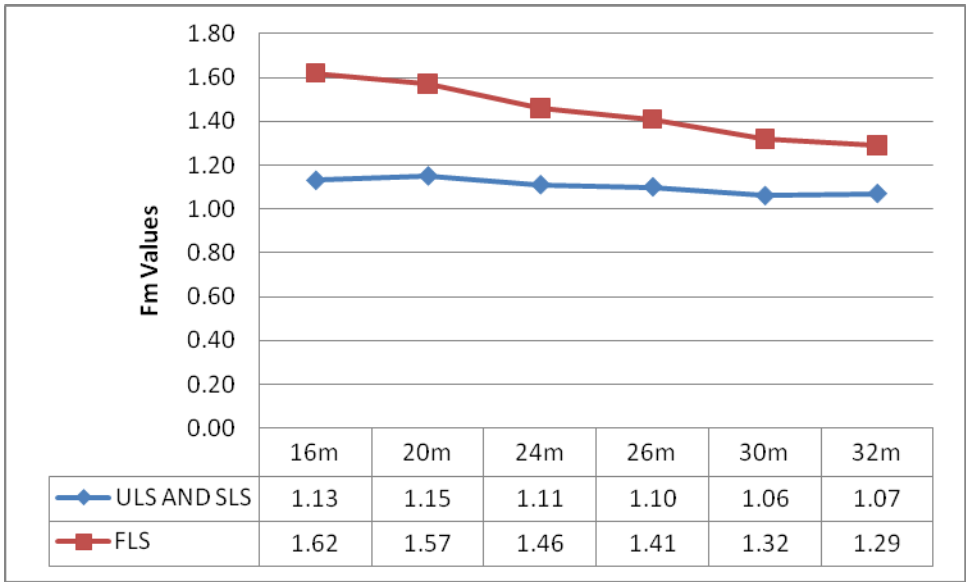


Figure 4.65 Effect of Span Length on the Moment Distribution Factor For 3-Lane Bridge, Width 12.336m, 10 Box Girders

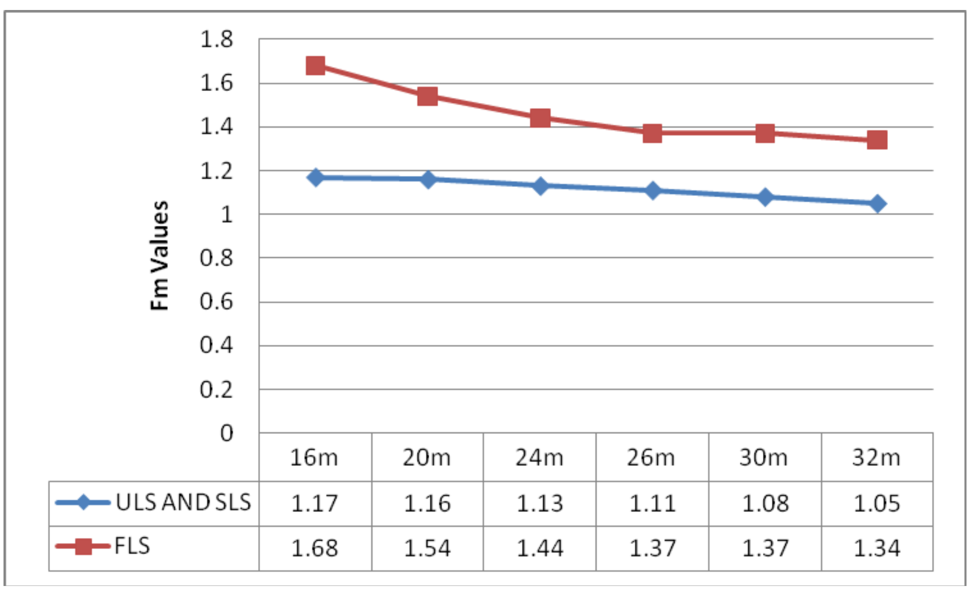
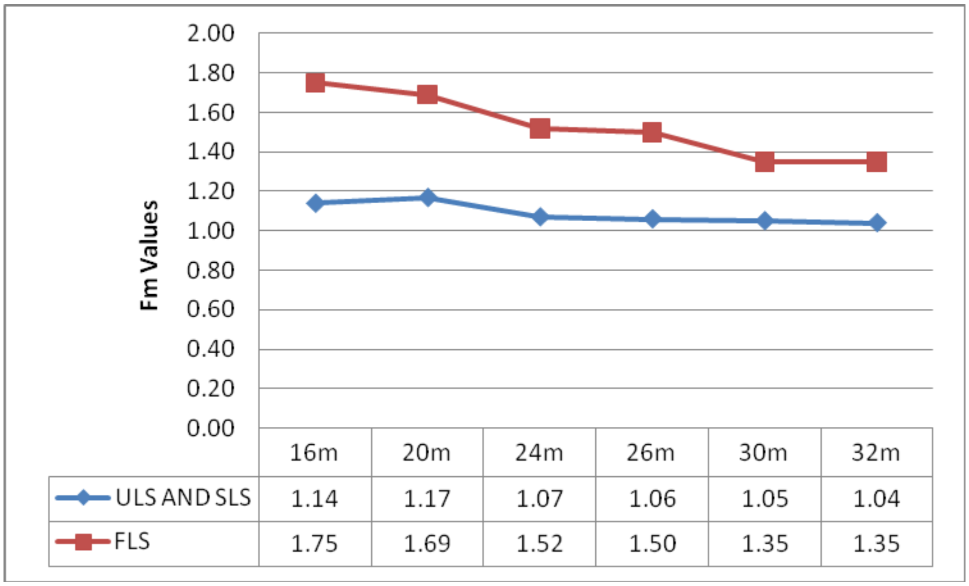
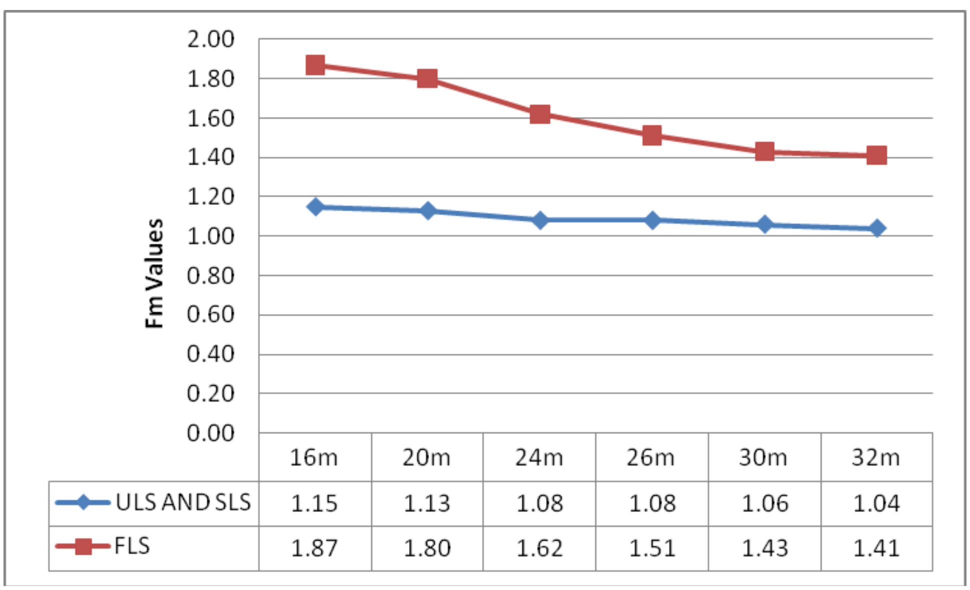


Figure 4.66 Effect of Span Length on the Moment Distribution Factor For 3-Lane Bridge, Width 13.571m, 11 Box Girders



	16m	20m	24m	26m	30m	32m
ULS AND SLS	1.14	1.17	1.07	1.06	1.05	1.04
FLS	1.75	1.69	1.52	1.50	1.35	1.35

Figure 4.67 Effect of Span Length on the Moment Distribution Factor For 4-Lanes Bridge, Width 14.806m, 12 Box Girders



	16m	20m	24m	26m	30m	32m
ULS AND SLS	1.15	1.13	1.08	1.08	1.06	1.04
FLS	1.87	1.80	1.62	1.51	1.43	1.41

Figure 4.68 Effect of Span Length on the Moment Distribution Factor For 4-Lanes Bridge, Width 16.041m, 13 Box Girders

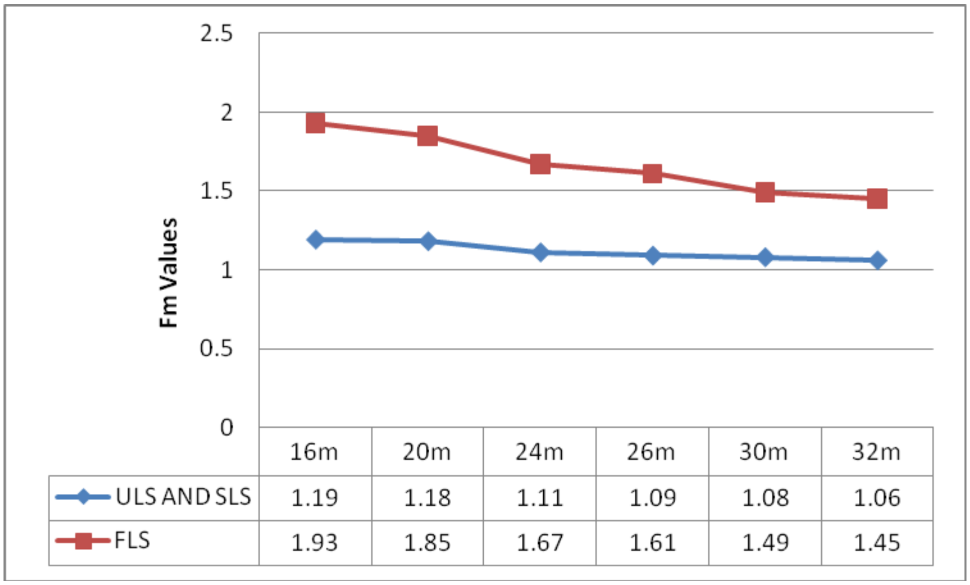


Figure 4.69 Effect of Span Length on the Moment Distribution Factor For 4-Lanes Bridge, Width 17.276m, 14 Box Girders

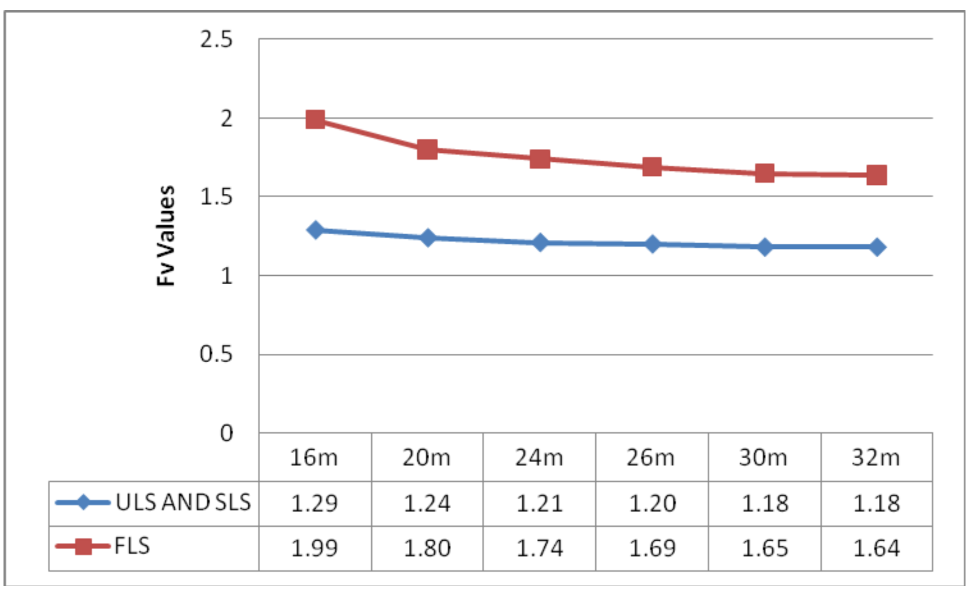
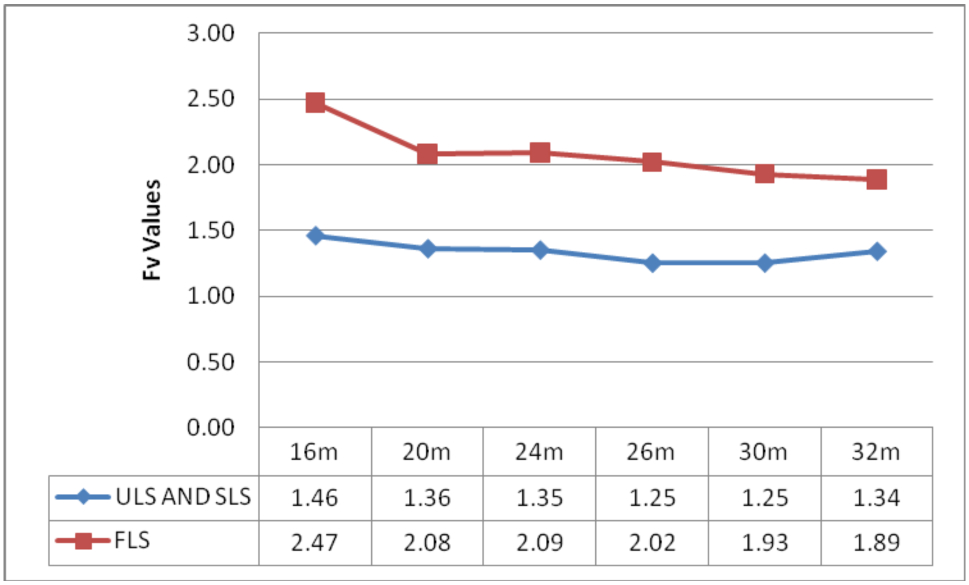
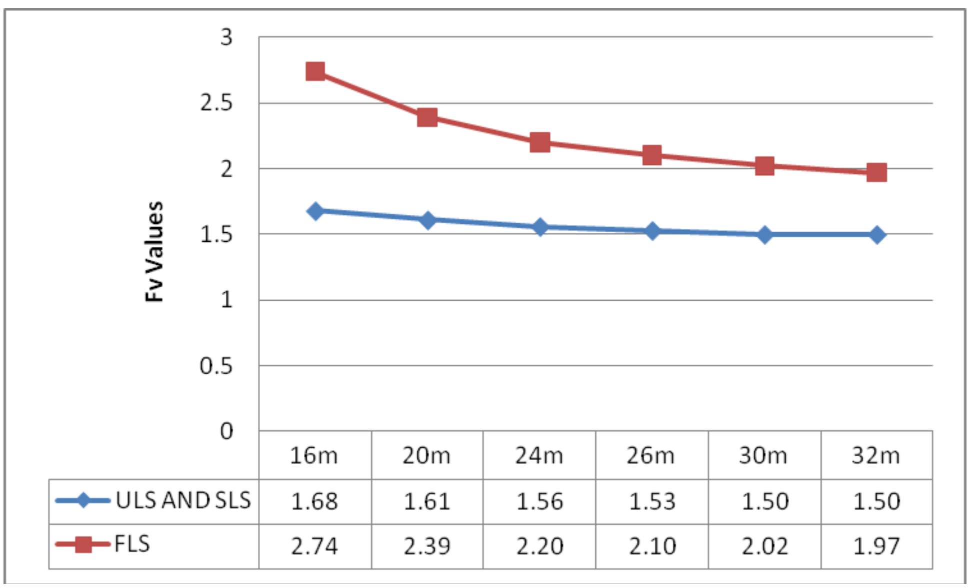


Figure 4.70 Effect of Span Length on the Shear Distribution Factor For 2-Lane Bridge, Width 7.396m, 6 Box Girders



	16m	20m	24m	26m	30m	32m
ULS AND SLS	1.46	1.36	1.35	1.25	1.25	1.34
FLS	2.47	2.08	2.09	2.02	1.93	1.89

Figure 4.71 Effect of Span Length on the Shear Distribution Factor For 2-Lane Bridge, Width 8.631m, 7 Box Girders



	16m	20m	24m	26m	30m	32m
ULS AND SLS	1.68	1.61	1.56	1.53	1.50	1.50
FLS	2.74	2.39	2.20	2.10	2.02	1.97

Figure 4.72 Effect of Span Length on the Shear Distribution Factor For 2-Lane Bridge, Width 9.866m, 8 Box Girders

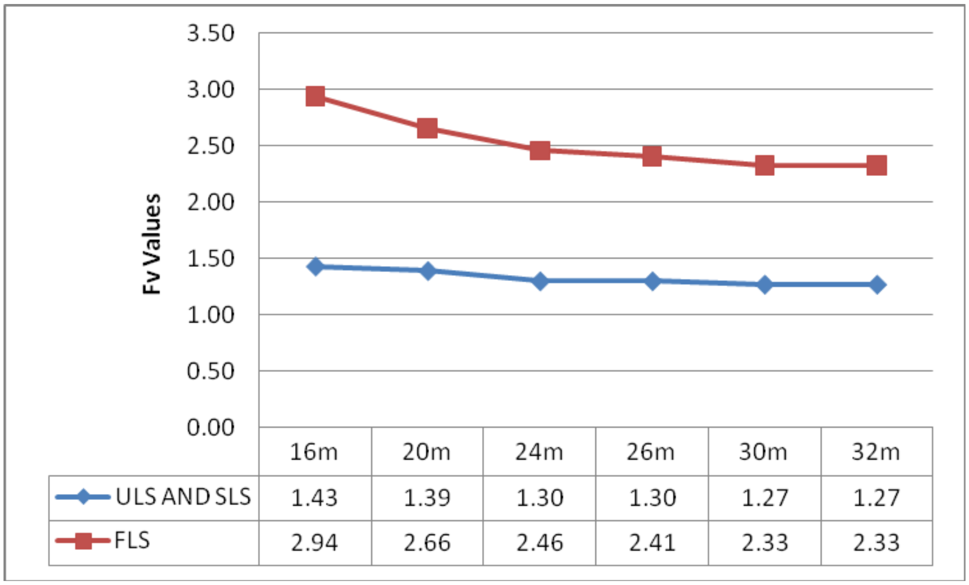


Figure 4.73 Effect of Span Length on the Shear Distribution Factor For 3-Lane Bridge, Width 11.101m, 9 Box Girders

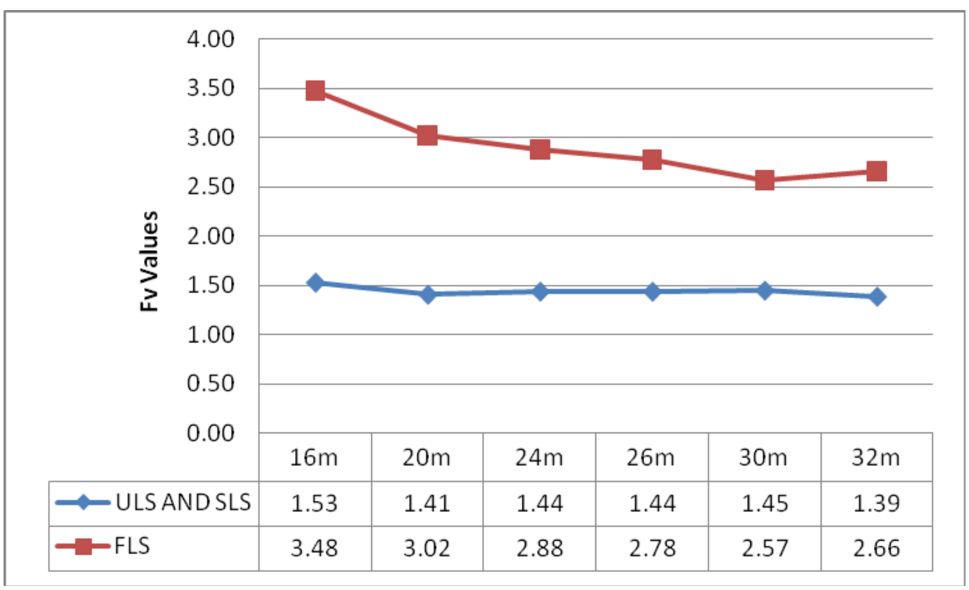


Figure 4.74 Effect of Span Length on the Shear Distribution Factor For 3-Lane Bridge, Width 12.336m, 10 Box Girders

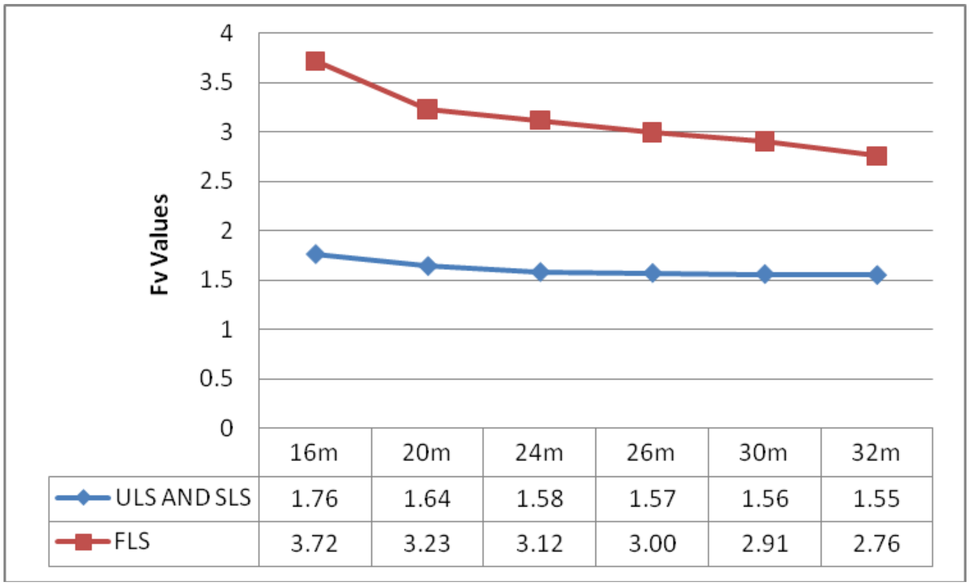


Figure 4.75 Effect of Span Length on the Shear Distribution Factor For 3-Lane Bridge, Width 13.571m, 11 Box Girders

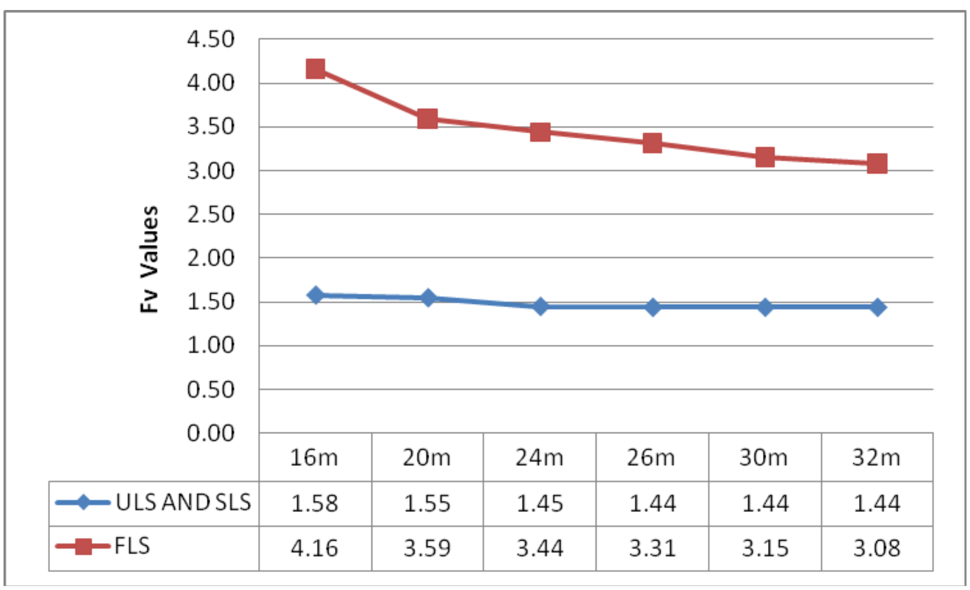
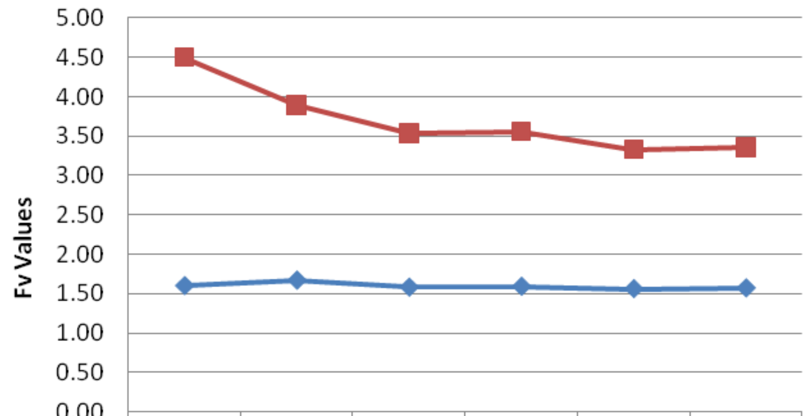
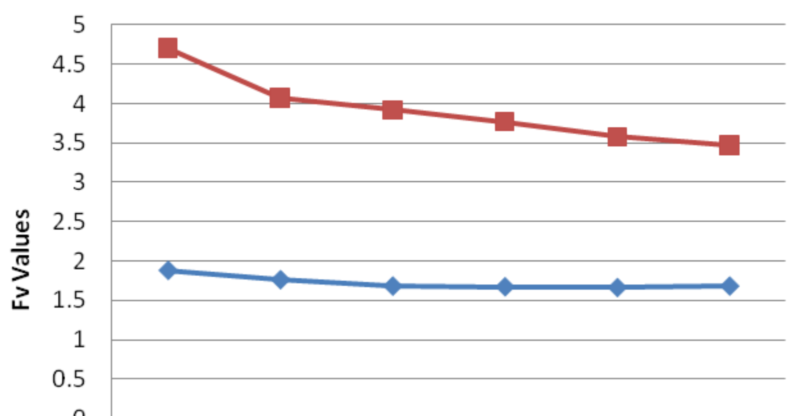


Figure 4.76 Effect of Span Length on the Shear Distribution Factor For 4-Lanes Bridge, Width 14.806m, 12 Box Girders



	16m	20m	24m	26m	30m	32m
ULS AND SLS	1.60	1.67	1.58	1.59	1.56	1.57
FLS	4.5	3.89	3.54	3.56	3.33	3.36

Figure 4.77 Effect of Span Length on the Shear Distribution Factor For 4-Lanes Bridge, Width 16.041m, 13 Box Girders



	16m	20m	24m	26m	30m	32m
ULS AND SLS	1.88	1.76	1.68	1.67	1.66	1.68
FLS	4.71	4.07	3.92	3.77	3.58	3.47

Figure 4.78 Effect of Span Length on the Shear Distribution Factor For 4-Lanes Bridge, Width 17.276m, 14 Box Girders

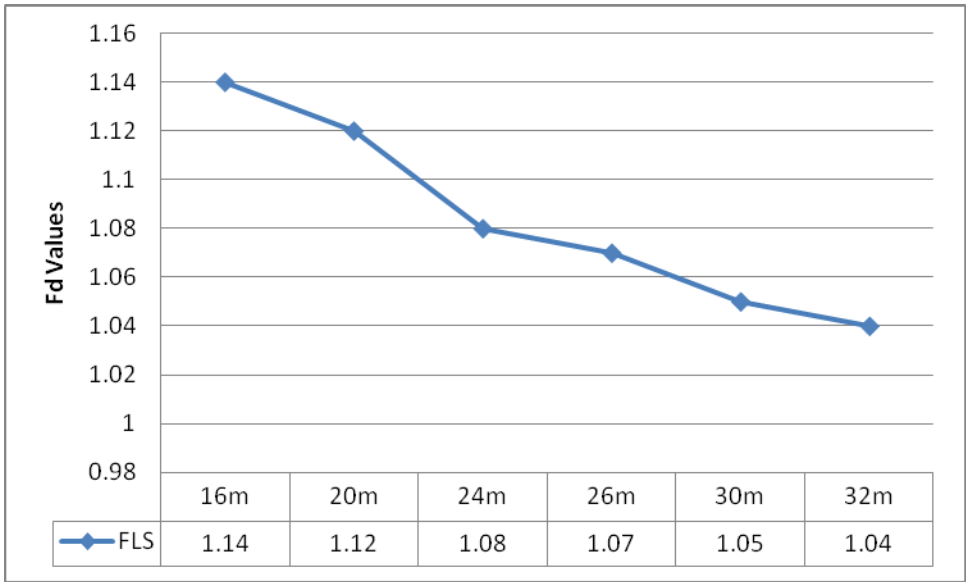


Figure 4.79 Effect of Span Length on the Deflection Distribution Factor For 2-Lane Bridge, Width 7.396m, 6 Box Girders

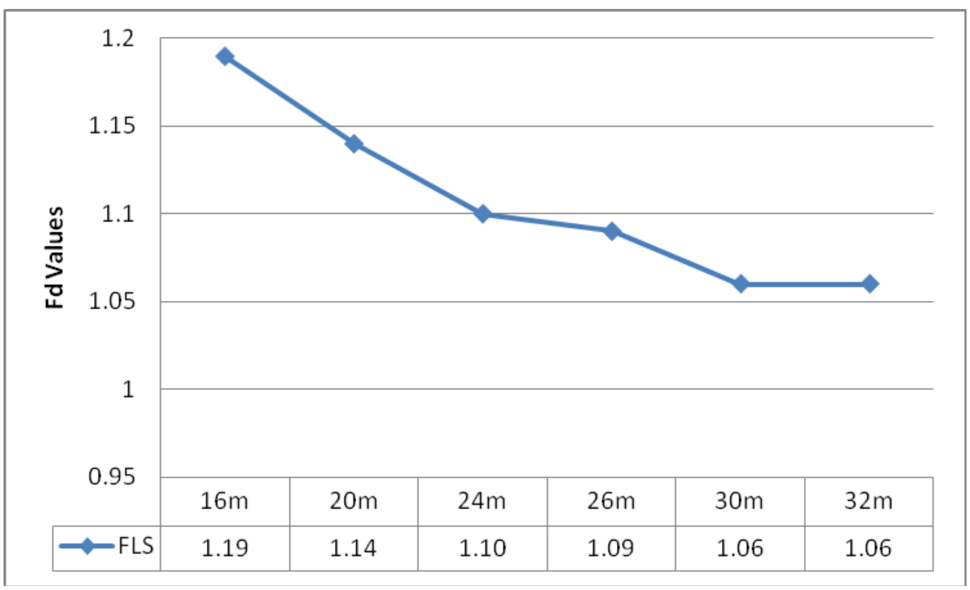


Figure 4.80 Effect of Span Length on the Deflection Distribution Factor For 2-Lane Bridge, Width 8.631m, 7 Box Girders

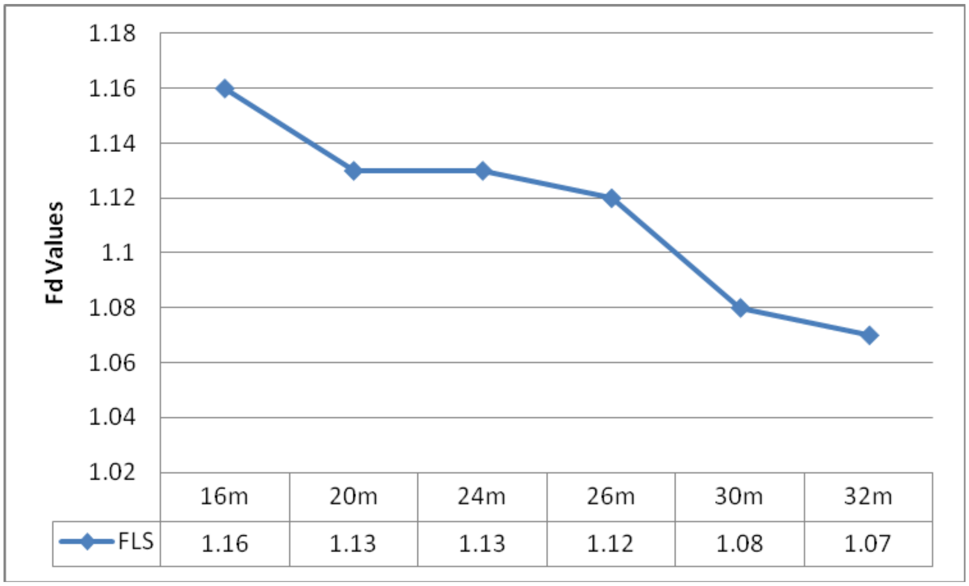


Figure 4.81 Effect of Span Length on the Deflection Distribution Factor For 2-Lane Bridge, Width 9.866m, 8 Box Girders

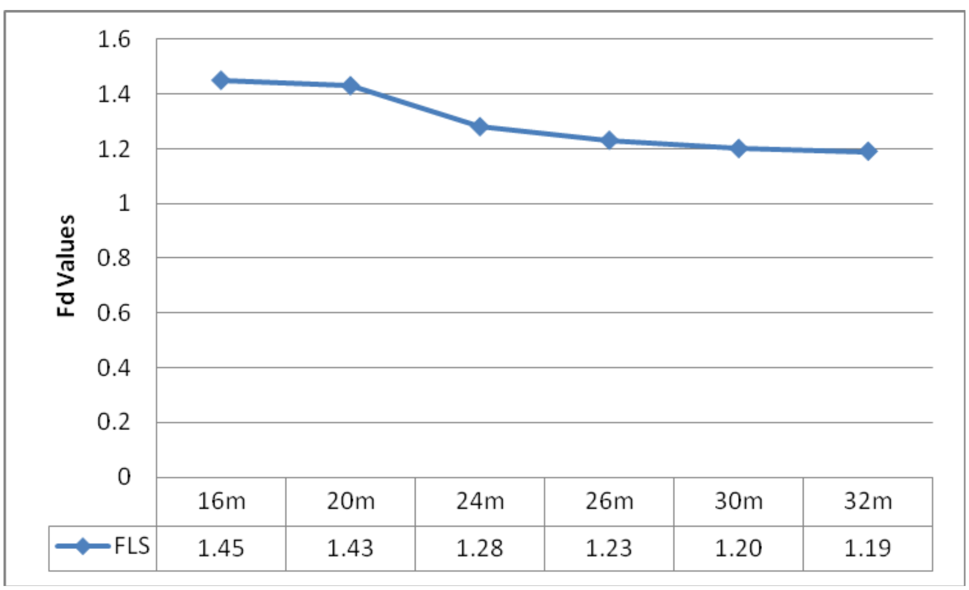


Figure 4.82 Effect of Span Length on the Deflection Distribution Factor For 3-Lane Bridge, Width 11.101m, 9 Box Girders

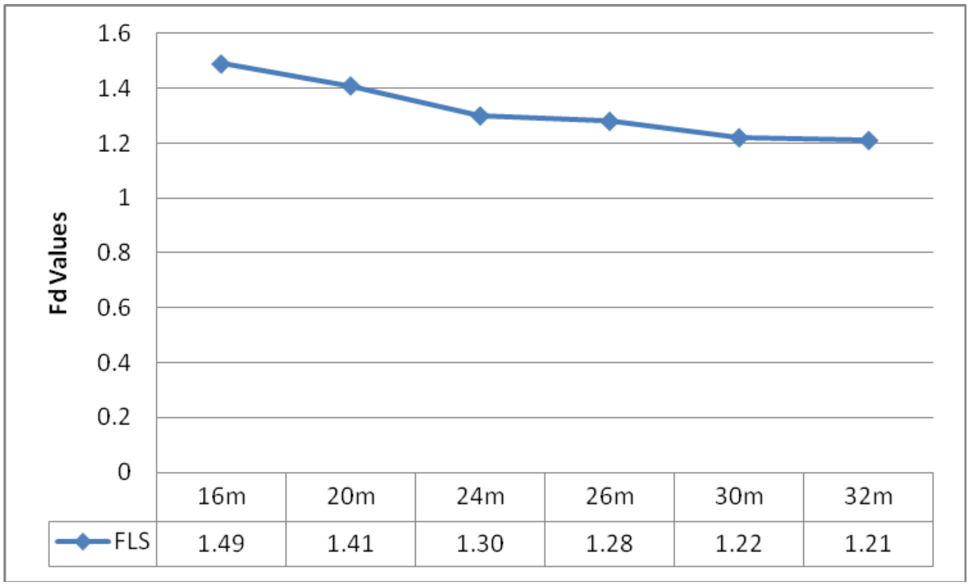


Figure 4.83 Effect of Span Length on the Deflection Distribution Factor For 3-Lane Bridge, Width 12.336m, 10 Box Girders

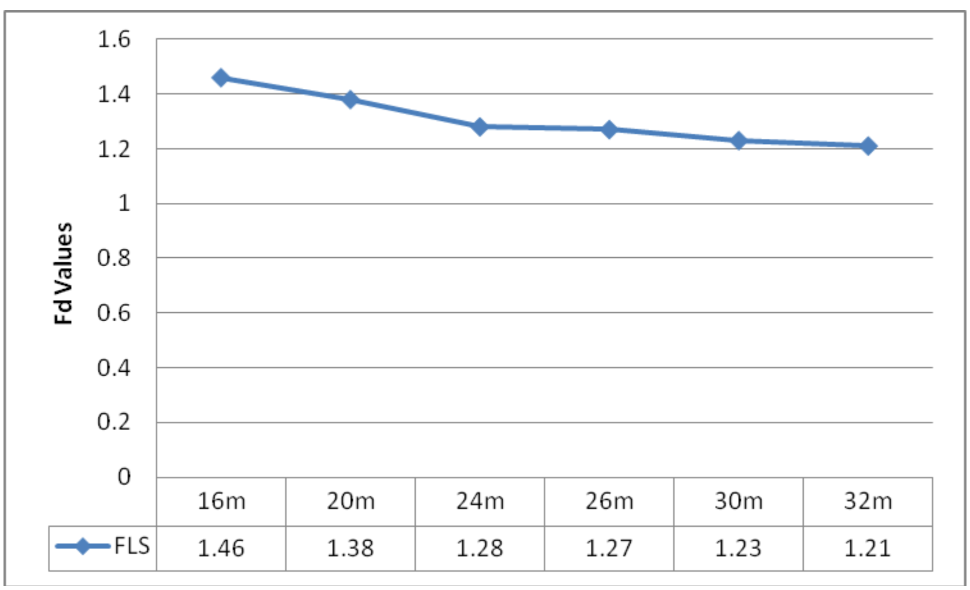


Figure 4.84 Effect of Span Length on the Deflection Distribution Factor For 3-Lane Bridge, Width 13.571m, 11 Box Girders

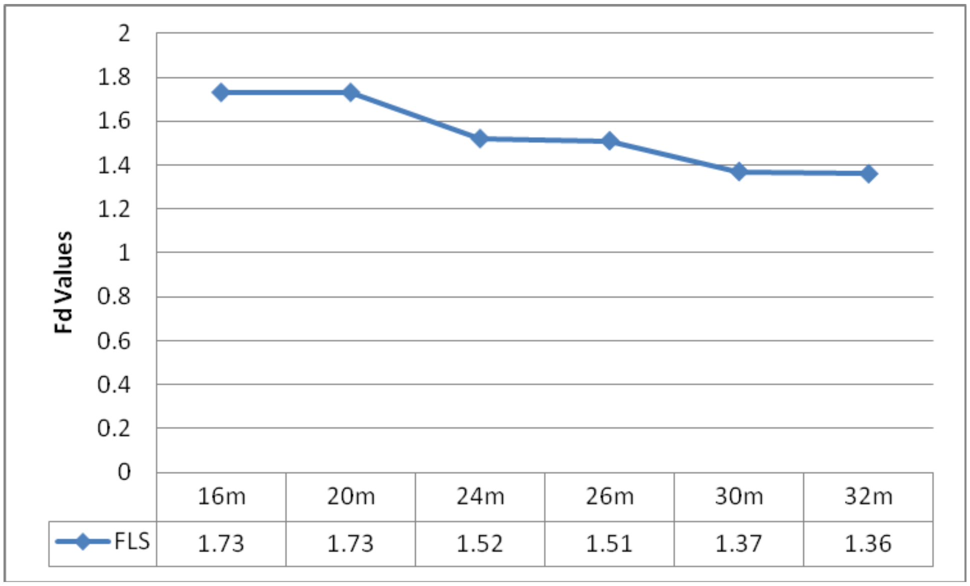


Figure 4.85 Effect of Span Length on the Deflection Distribution Factor For 4-Lanes Bridge, Width 14.806m, 12 Box Girders

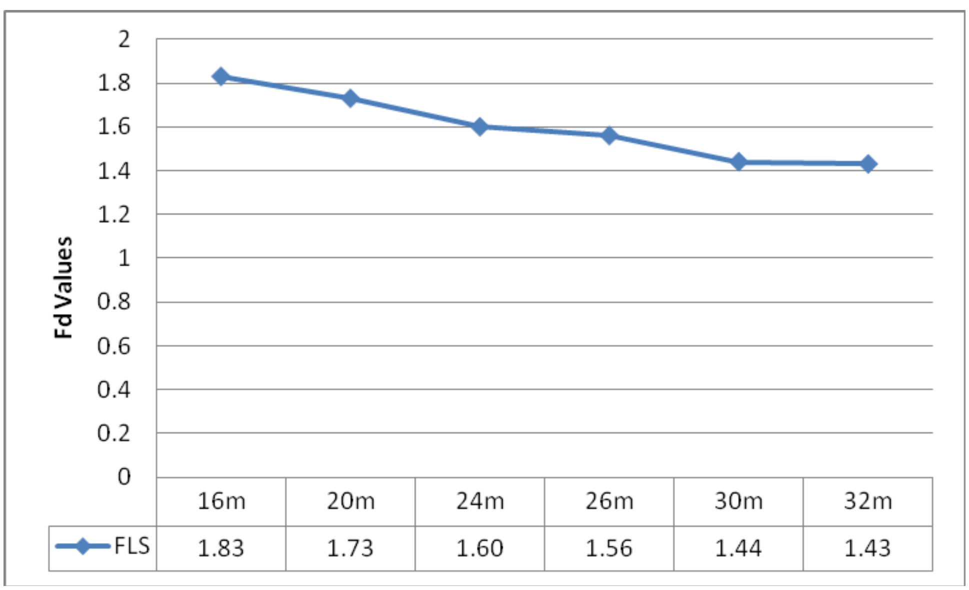


Figure 4.86 Effect of Span Length on the Deflection Distribution Factor For 4-Lanes Bridge, Width 16.041m, 13 Box Girders

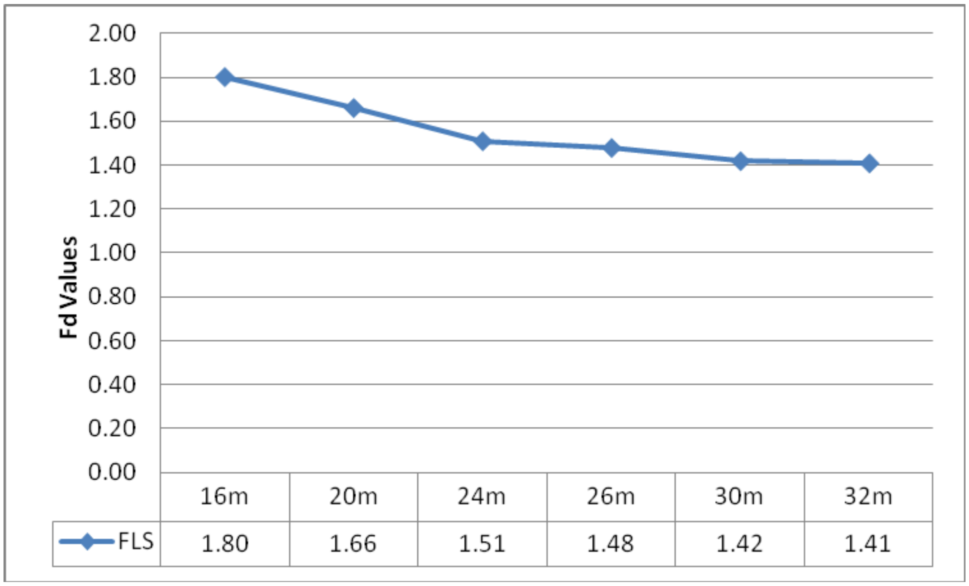


Figure 4.87 Effect of Span Length on the Deflection Distribution Factor For 4-Lanes Bridge, Width 17.276m, 14 Box Girders

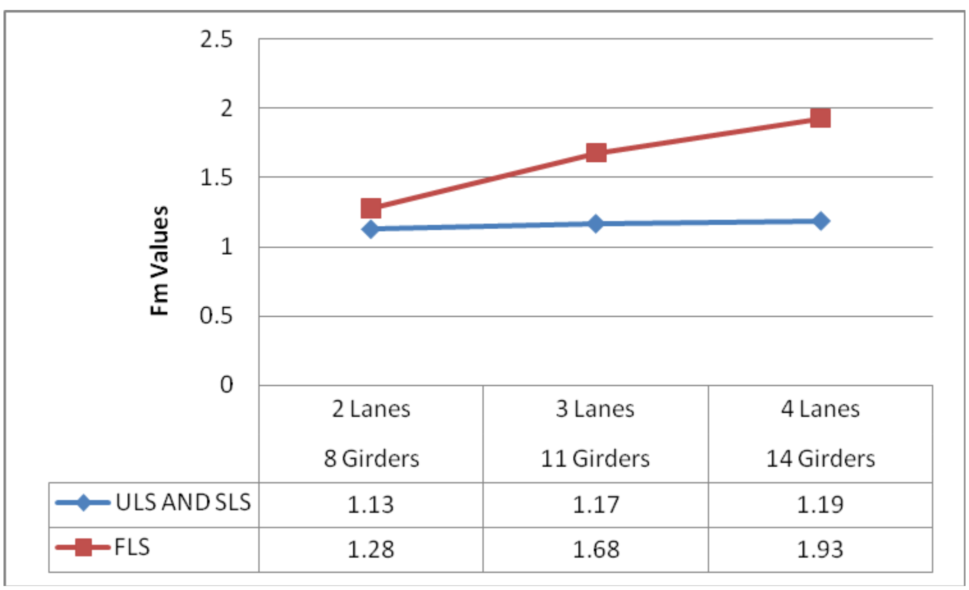


Figure 4.88 Effect of Number of Lanes on the Moment Distribution Factor For B700, 16m Span Bridge

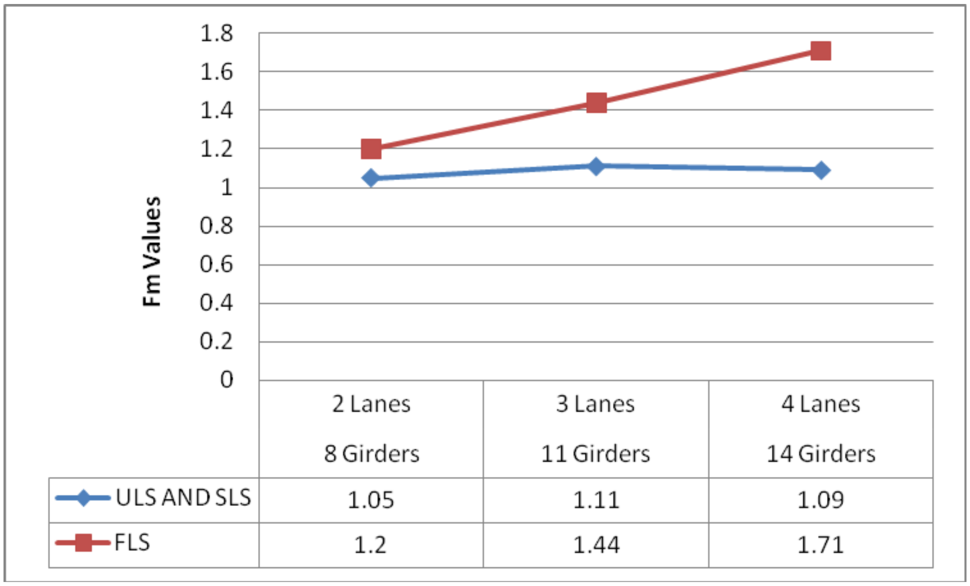


Figure 4.89 Effect of Number of Lanes on the Moment Distribution Factor For B700, 24m Span Bridge

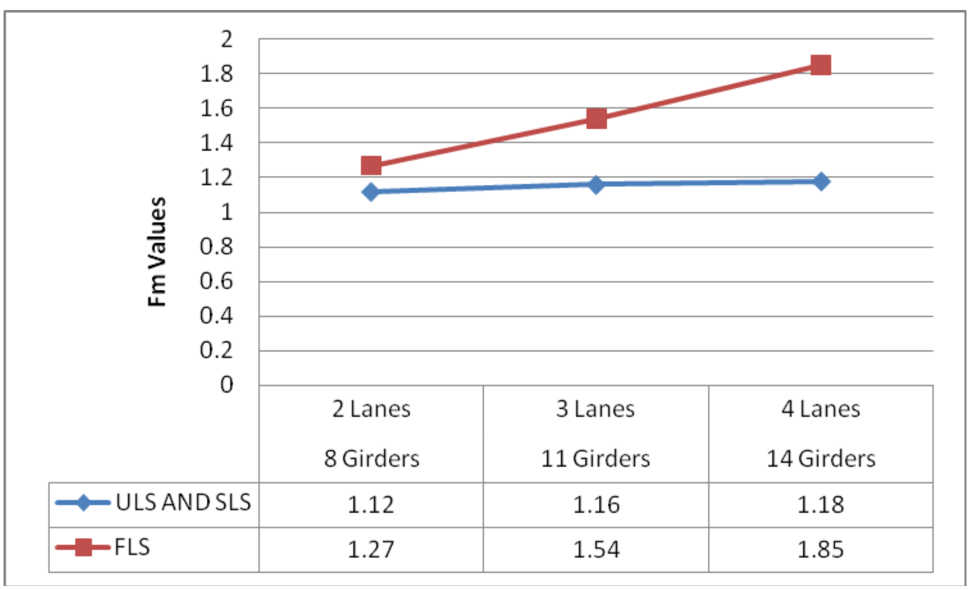


Figure 4.90 Effect of Number of Lanes on the Moment Distribution Factor For B800, 20m Span Bridge

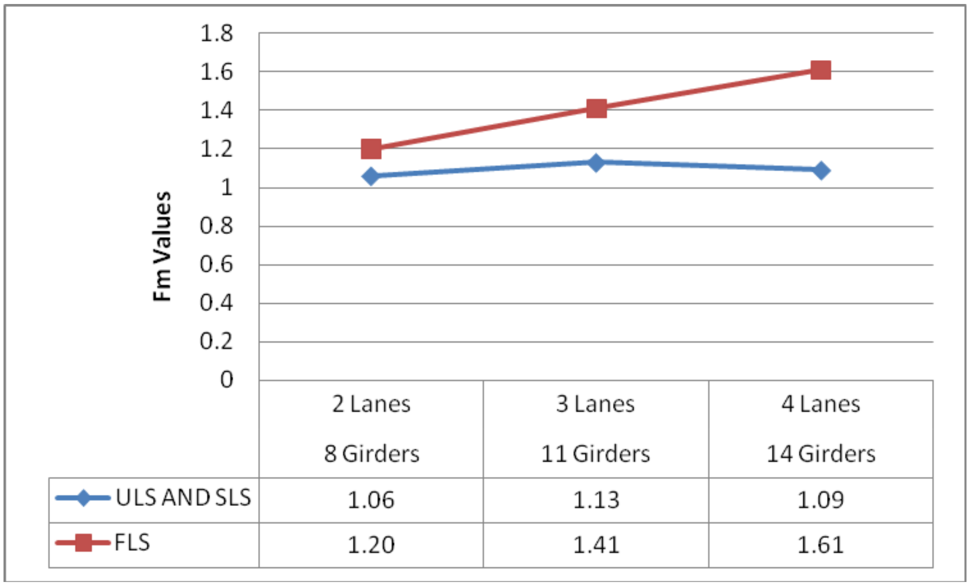


Figure 4.91 Effect of Number of Lanes on the Moment Distribution Factor For B800, 26m Span Bridge

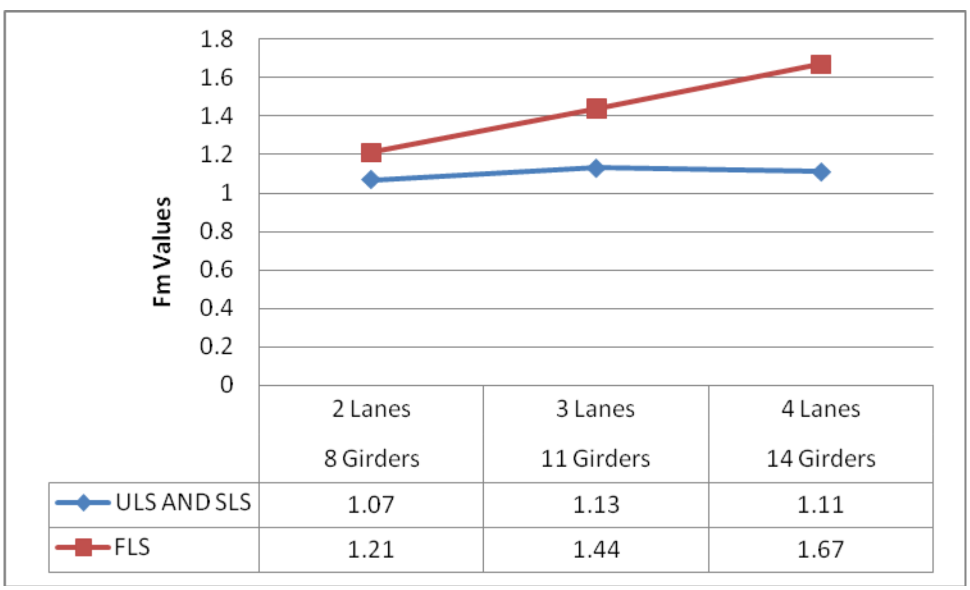


Figure 4.92 Effect of Number of Lanes on the Moment Distribution Factor For B900, 24m Span Bridge

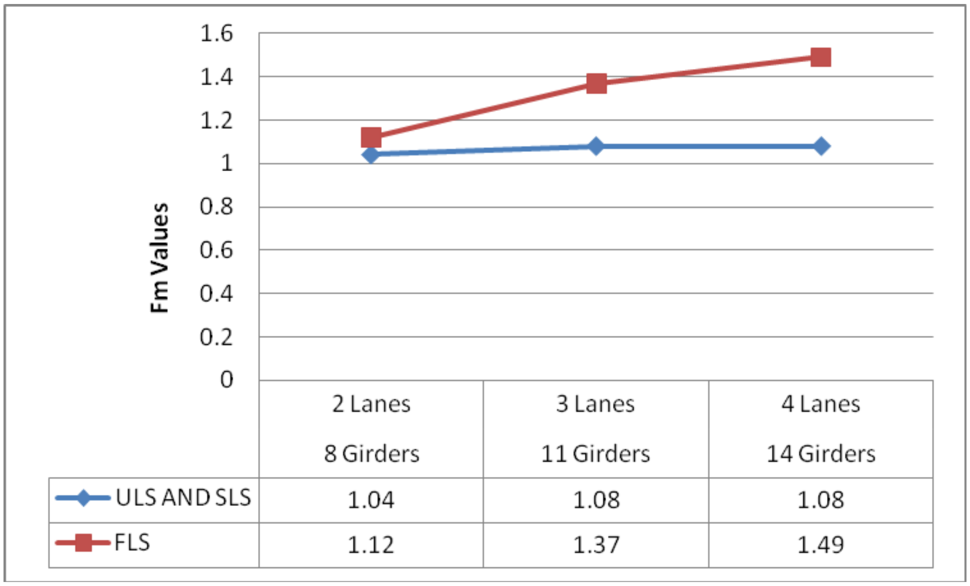


Figure 4.93 Effect of Number of Lanes on the Moment Distribution Factor For B900, 30m Span Bridge

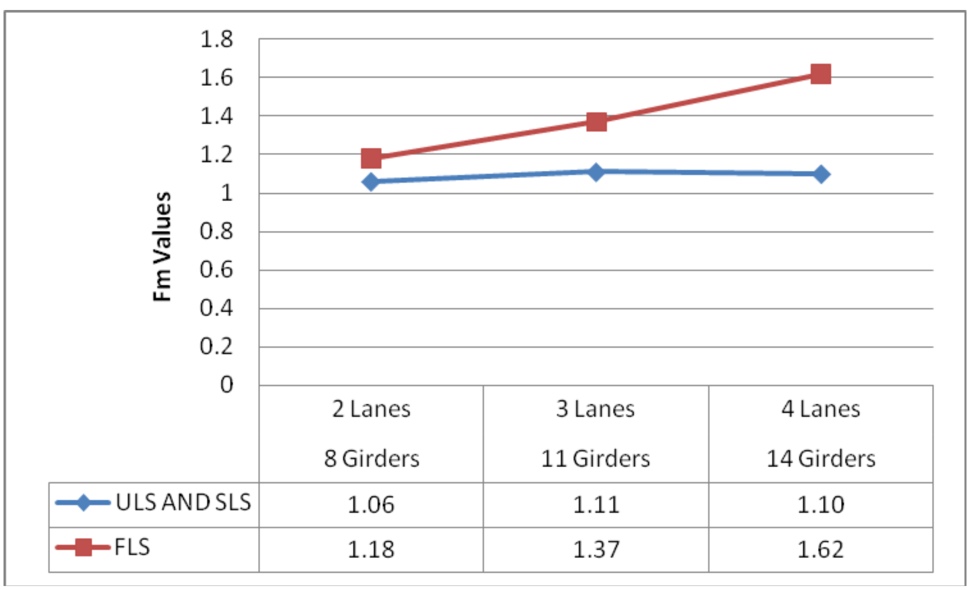


Figure 4.94 Effect of Number of Lanes on the Moment Distribution Factor For B1000, 26m Span Bridge

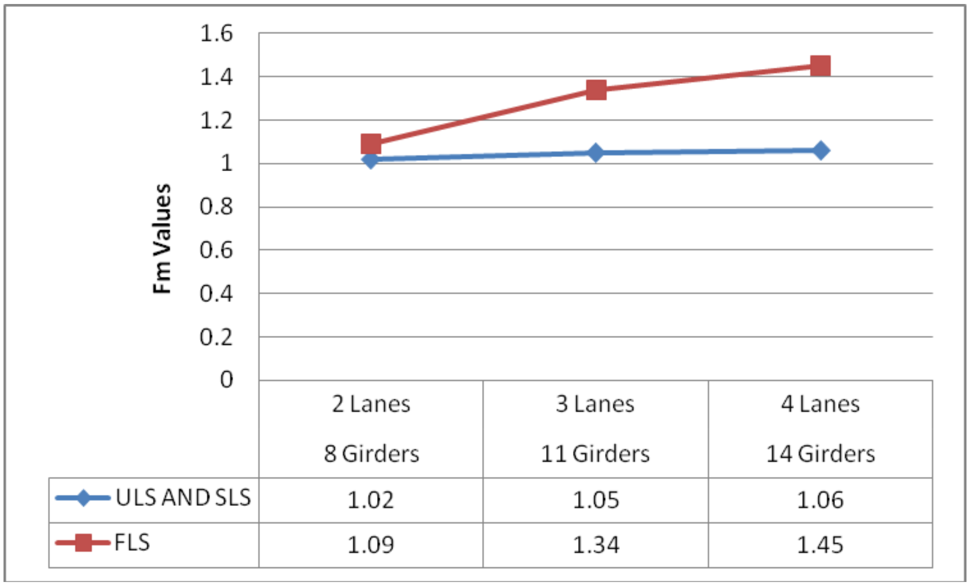


Figure 4.95 Effect of Number of Lanes on the Moment Distribution Factor For B1000, 32m Span Bridge

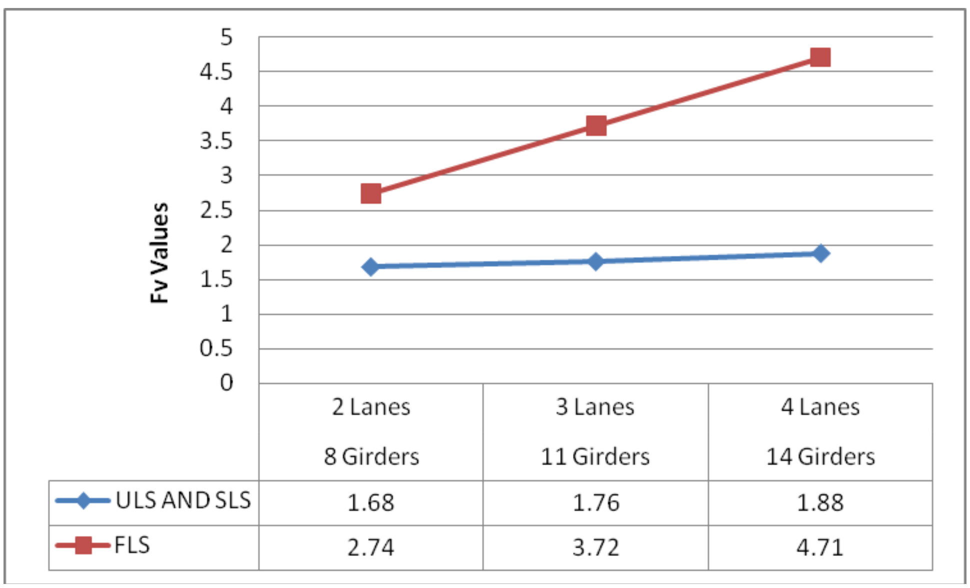


Figure 4.96 Effect of Number of Lanes on the Shear Distribution Factor For B700, 16m Span Bridge

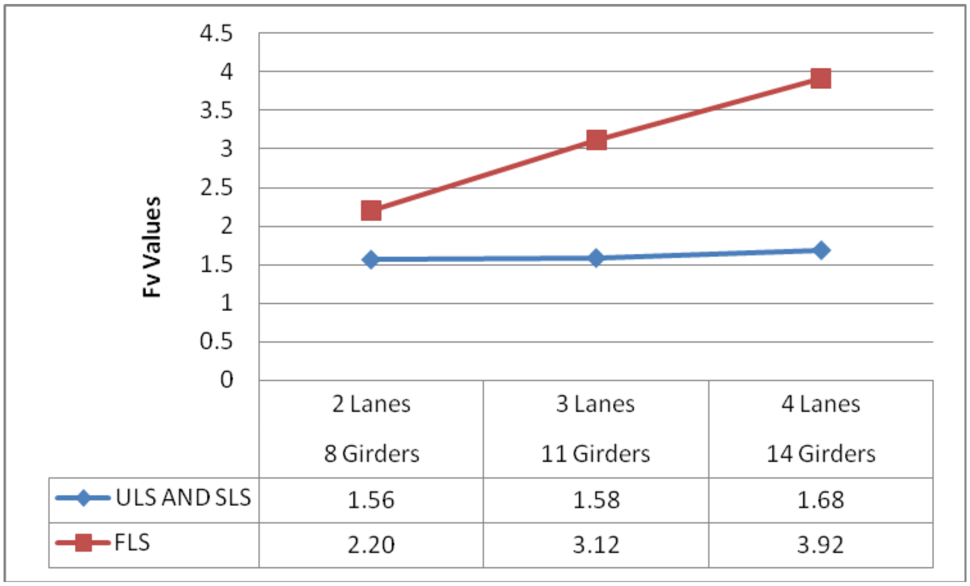


Figure 4.97 Effect of Number of Lanes on the Shear Distribution Factor For B700, 24m Span Bridge

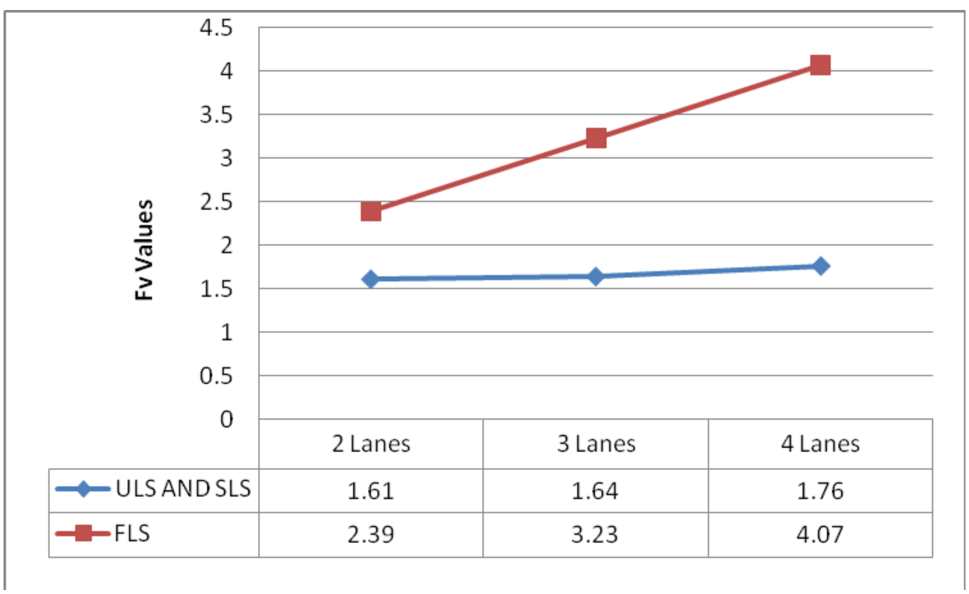
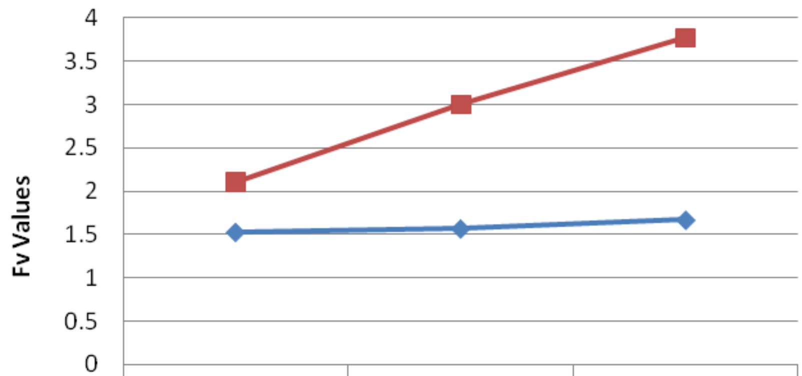
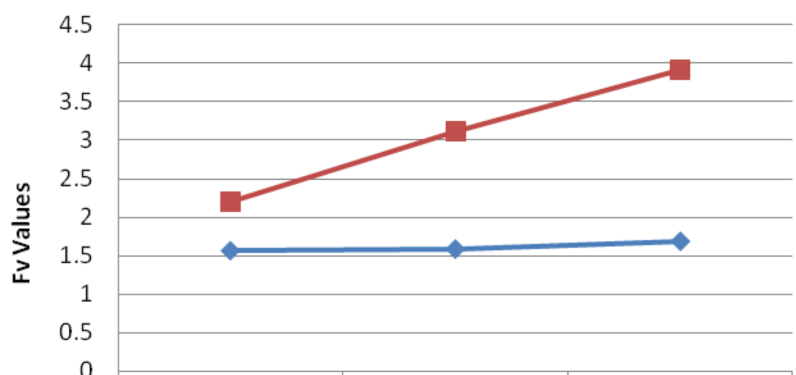


Figure 4.98 Effect of Number of Lanes on the Shear Distribution Factor For B800, 20m Span Bridge



	2 Lanes 8 Girders	3 Lanes 11 Girders	4 Lanes 14 Girders
ULS AND SLS	1.53	1.57	1.67
FLS	2.10	3.00	3.77

Figure 4.99 Effect of Number of Lanes on the Shear Distribution Factor For B800, 26m Span Bridge



	2 Lanes 8 Girders	3 Lanes 11 Girders	4 Lanes 14 Girders
ULS AND SLS	1.56	1.58	1.68
FLS	2.20	3.12	3.92

Figure 4.100 Effect of Number of Lanes on the Shear Distribution Factor For B900, 24m Span Bridge

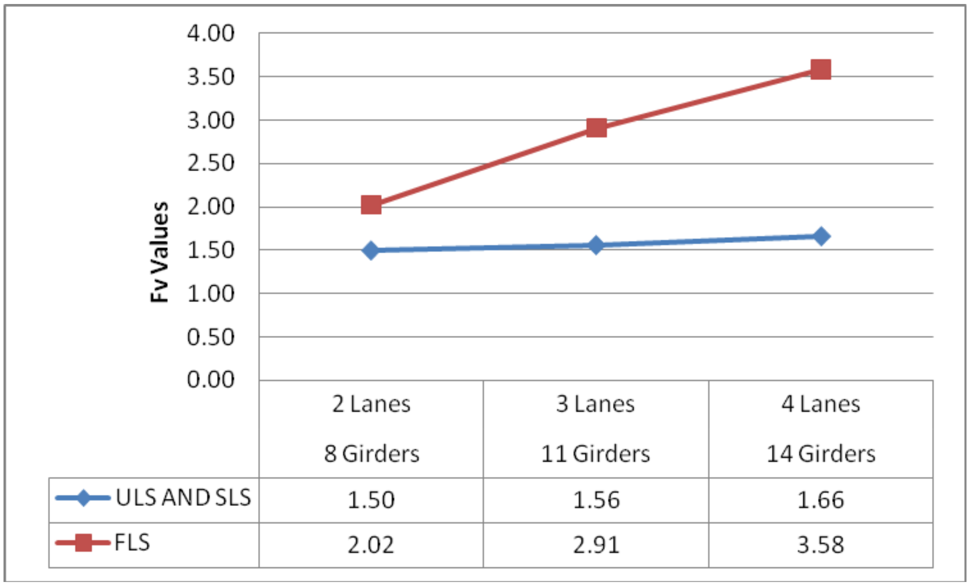


Figure 4.101 Effect of Number of Lanes on the Shear Distribution Factor For B900, 30m Span Bridge

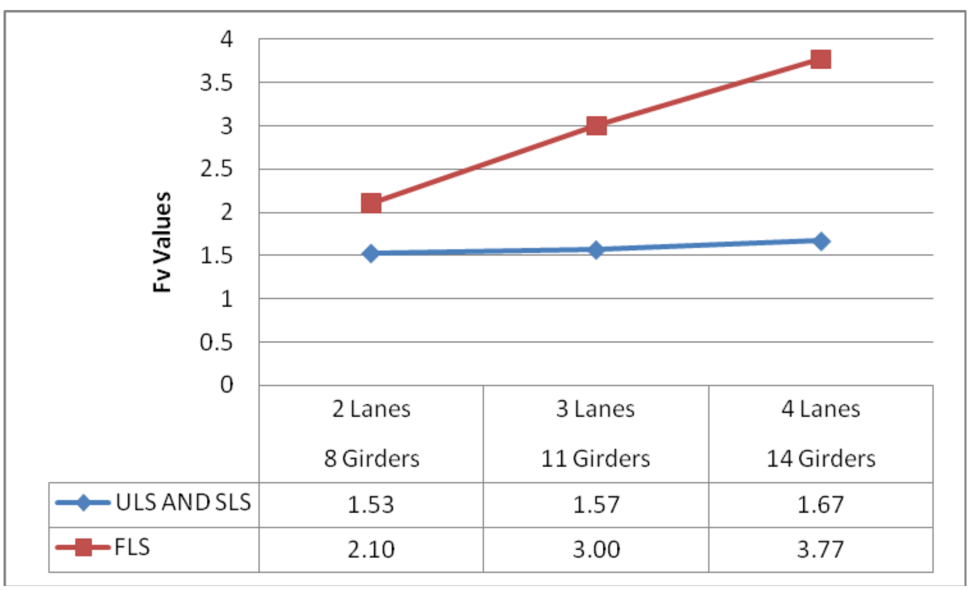


Figure 4.102 Effect of Number of Lanes on the Shear Distribution Factor For B1000, 26m Span Bridge

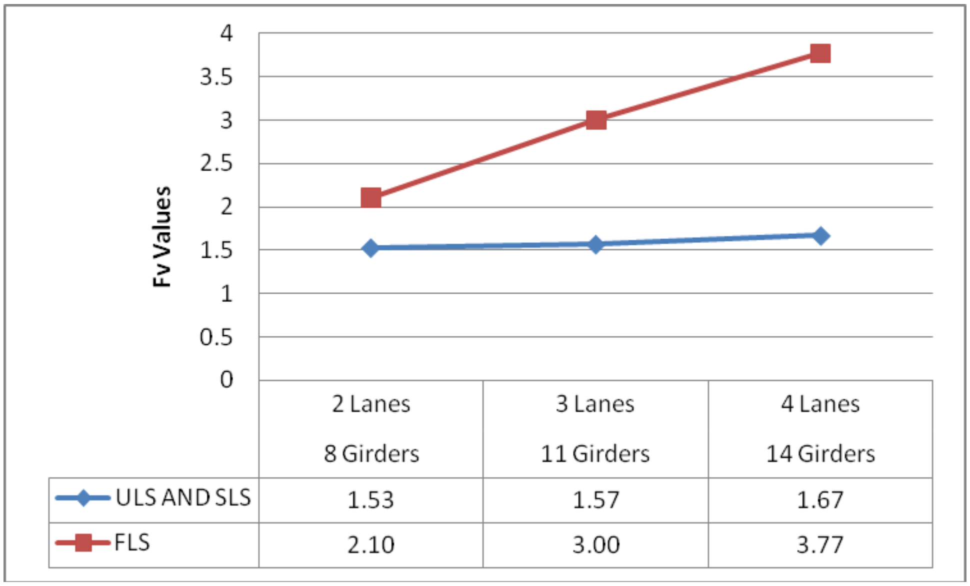


Figure 4.103 Effect of Number of Lanes on the Shear Distribution Factor For B1000, 32m Span Bridge

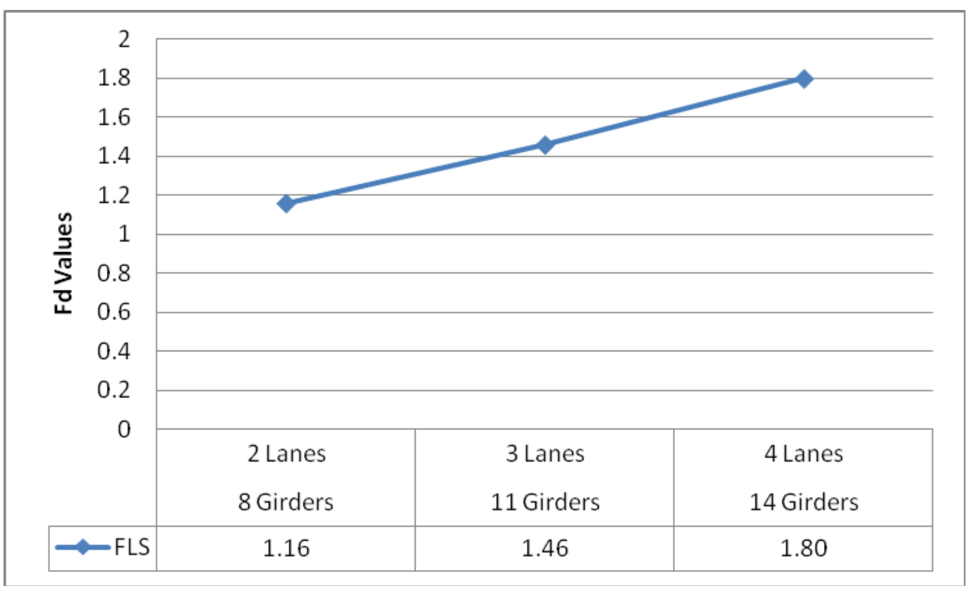


Figure 4.104 Effect of Number of Lanes on the Deflection Distribution Factor For B700, 16m Span Bridge

Figure 4.105 Effect of Number of Lanes on the Deflection Distribution Factor For B700, 24m Span Bridge

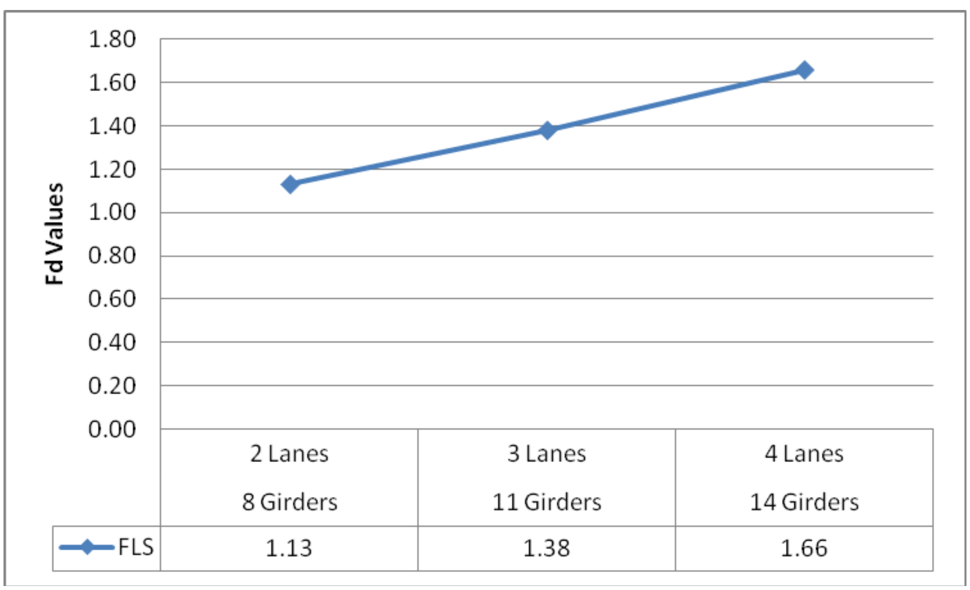


Figure 4.106 Effect of Number of Lanes on the Deflection Distribution Factor For B800, 20m Span Bridge

Figure 4.107 Effect of Number of Lanes on the Deflection Distribution Factor For B800, 26m Span Bridge

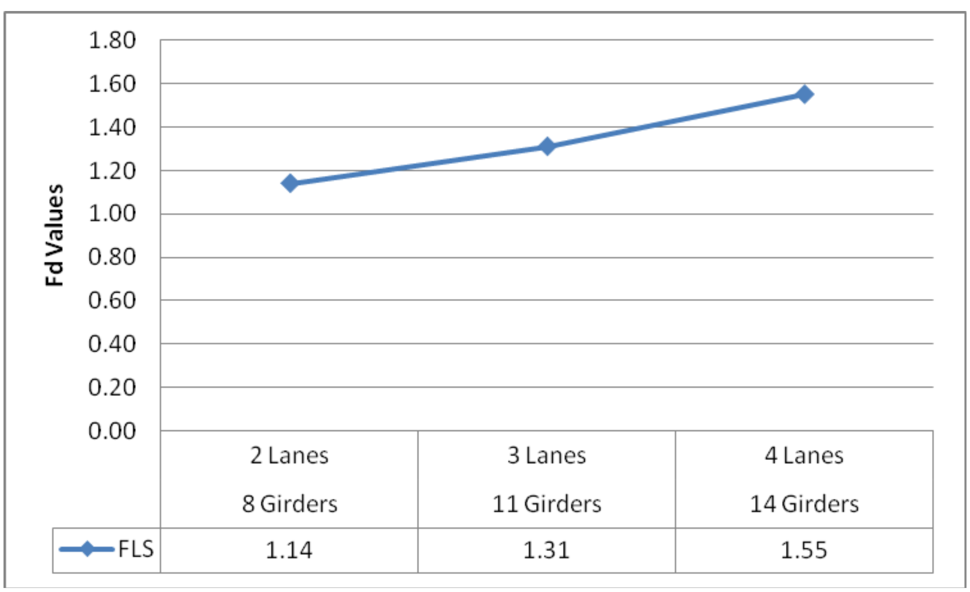


Figure 4.108 Effect of Number of Lanes on the Deflection Distribution Factor For B900, 24m Span Bridge

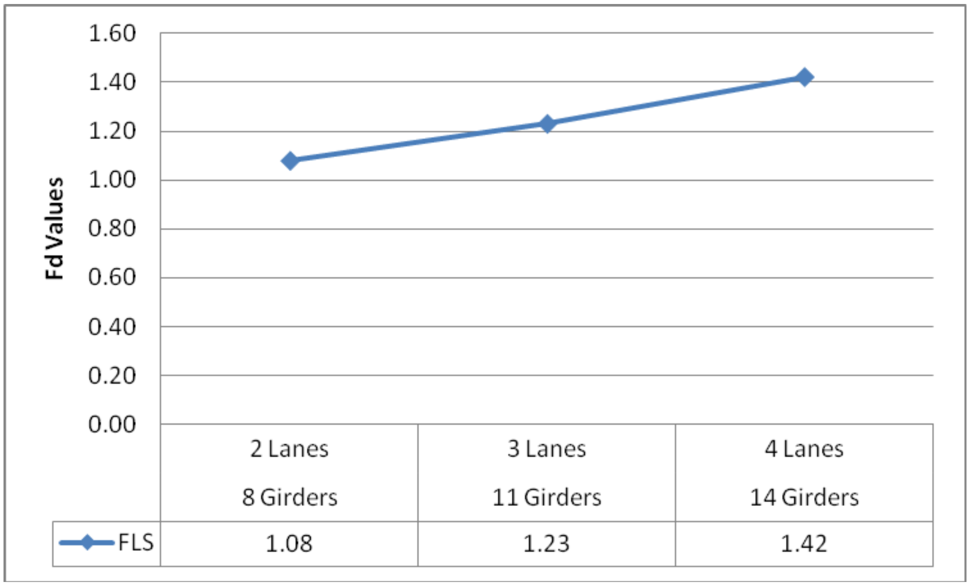


Figure 4.109 Effect of Number of Lanes on the Deflection Distribution Factor For B900, 30m Span Bridge

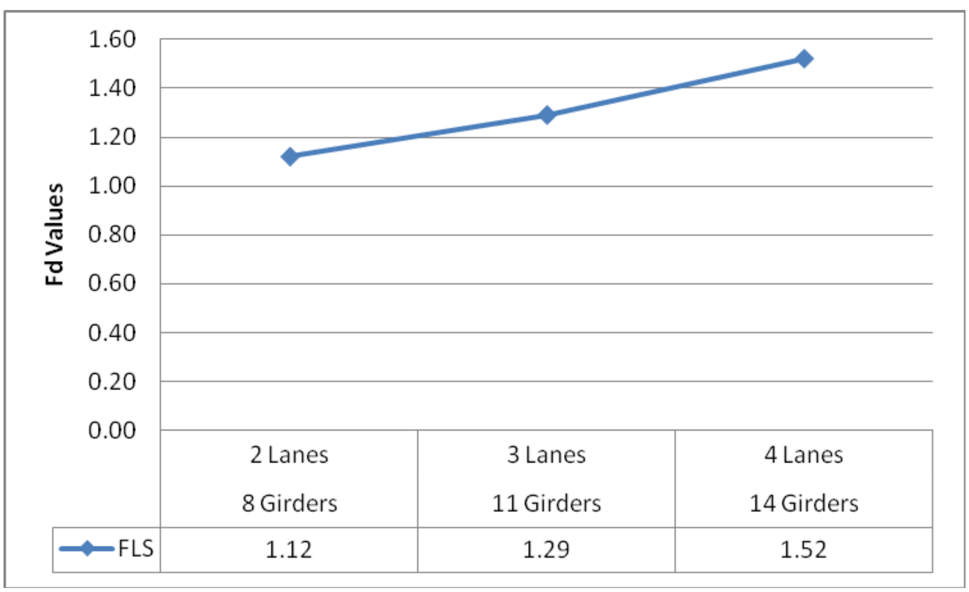
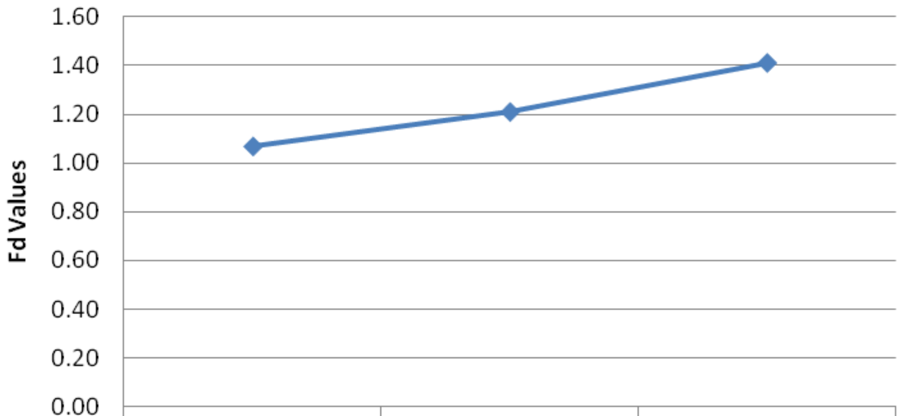
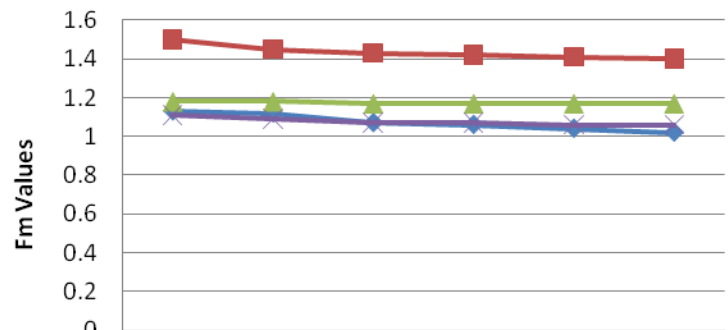


Figure 4.110 Effect of Number of Lanes on the Deflection Distribution Factor For B1000, 26m Span Bridge



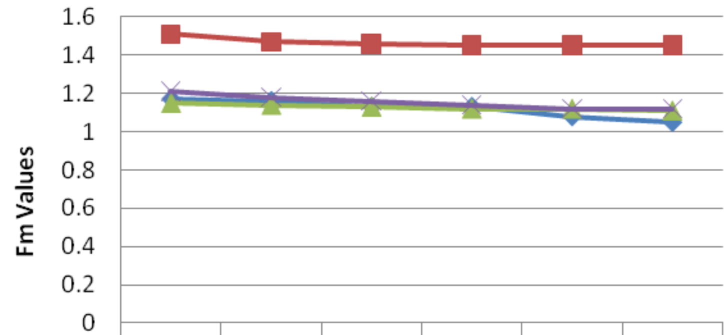
	2 Lanes 8 Girders	3 Lanes 11 Girders	4 Lanes 14 Girders
FLS	1.07	1.21	1.41

Figure 4.111 Effect of Number of Lanes on the Deflection Distribution Factor For B1000, 32m Span Bridge



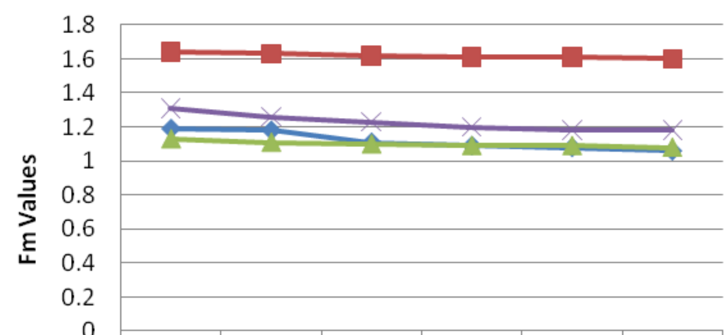
	16m	20m	24m	26m	30m	32m
Box Girder Bridge	1.13	1.12	1.07	1.06	1.04	1.02
I-Girder Bridge	1.50	1.45	1.43	1.42	1.41	1.40
Hollow Slab Bridge	1.18	1.18	1.17	1.17	1.17	1.17
Multispine Bridge	1.11	1.09	1.07	1.07	1.06	1.06

Figure 4.112 Comparisons of Fm Values between Different Kinds of Bridges For ULS & SLS, 2-Lane Bridges, Width 9.866m, 8 Box Girders



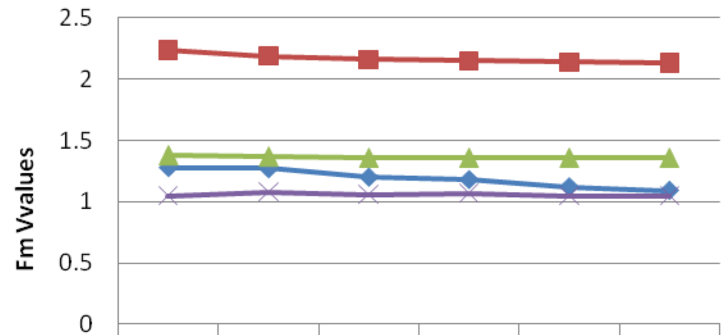
	16m	20m	24m	26m	30m	32m
Box Girders Bridge	1.17	1.16	1.13	1.13	1.08	1.05
I-Girders Bridge	1.51	1.47	1.46	1.45	1.45	1.45
Hollow Slab Bridge	1.15	1.14	1.13	1.12	1.12	1.11
Multispine Bridge	1.21	1.18	1.16	1.14	1.12	1.12

Figure 4.113 Comparisons of Fm Values between Different Kinds of Bridges For ULS & SLS, 3-Lane Bridges, Width 13.571m, 11 Box Girders



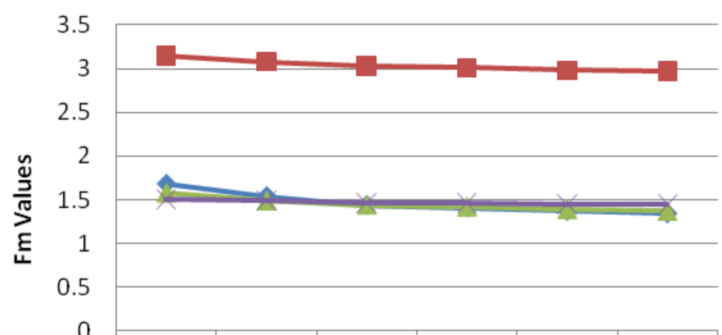
	16m	20m	24m	26m	30m	32m
Box Girder Bridge	1.19	1.18	1.11	1.09	1.08	1.06
I-Girder Bridge	1.64	1.63	1.62	1.61	1.61	1.60
Hollow Slab Bridge	1.13	1.11	1.10	1.09	1.09	1.08
Multispine Bridge	1.31	1.26	1.23	1.2	1.18	1.18

Figure 4.114 Comparisons of Fm Values between Different Kinds of Bridges For ULS & SLS, 4-Lanes Bridges, Width 17.276m, 14 Box Girders



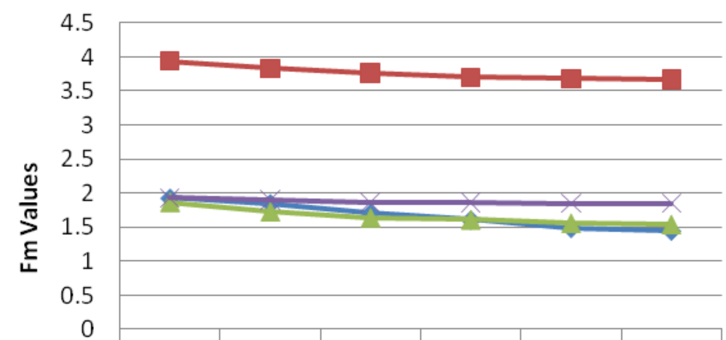
	16m	20m	24m	26m	30m	32m
Box Girder Bridge	1.28	1.27	1.20	1.18	1.12	1.09
I-Girder Bridge	2.24	2.19	2.16	2.15	2.14	2.13
Hollow Slab Bridge	1.38	1.37	1.36	1.36	1.36	1.36
Multispine Bridge	1.05	1.08	1.06	1.07	1.05	1.05

Figure 4.115 Comparisons of Fm Values between Different Kinds of Bridges For FLS, 2-Lane Bridges, Width 9.866m, 8 Box Girders



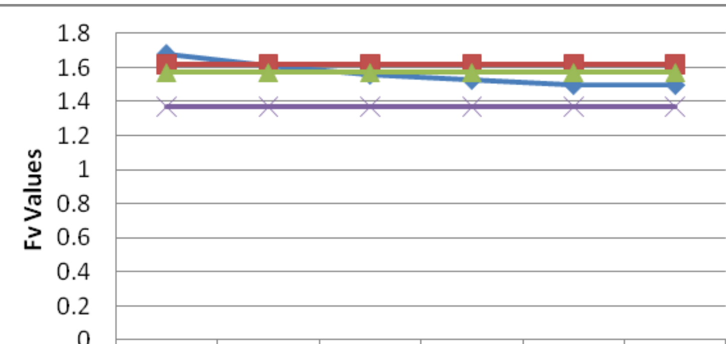
	16m	20m	24m	26m	30m	32m
Box Girder Bridge	1.68	1.54	1.44	1.41	1.37	1.34
I-Girder Bridge	3.15	3.08	3.03	3.01	2.98	2.97
Hollow Slab Bridge	1.58	1.49	1.44	1.42	1.39	1.37
Multispine Bridge	1.51	1.49	1.46	1.46	1.45	1.45

Figure 4.116 Comparisons of Fm Values between Different Kinds of Bridges For FLS, 3-Lane Bridges, Width 13.571m, 11 Box Girders



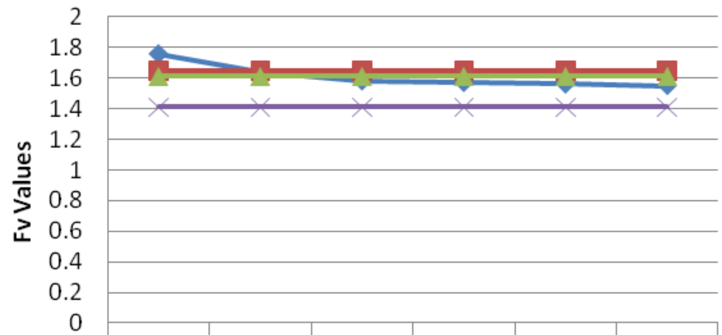
	16m	20m	24m	26m	30m	32m
Box Girder Bridge	1.93	1.85	1.71	1.61	1.49	1.45
I-Girder Bridge	3.94	3.83	3.76	3.7	3.68	3.67
Hollow Slab Bridge	1.87	1.73	1.64	1.61	1.56	1.54
Multispine Bridge	1.93	1.90	1.86	1.86	1.85	1.85

Figure 4.117 Comparisons of Fm Values between Different Kinds of Bridges For FLS, 4-Lanes Bridges, Width 17.276m, 14 Box Girders



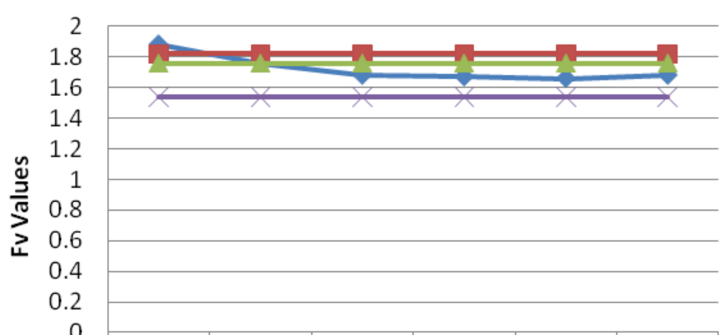
	16m	20m	24m	26m	30m	32m
Box Girder Bridge	1.68	1.61	1.56	1.53	1.50	1.50
I-Girder Bridge	1.62	1.62	1.62	1.62	1.62	1.62
Hollow Slab Bridge	1.57	1.57	1.57	1.57	1.57	1.57
Multispine Bridge	1.37	1.37	1.37	1.37	1.37	1.37

Figure 4.118 Comparisons of Fv Values between Different Kinds of Bridges For ULS & SLS, 2-Lane Bridges, Width 9.866m, 8 Box Girders



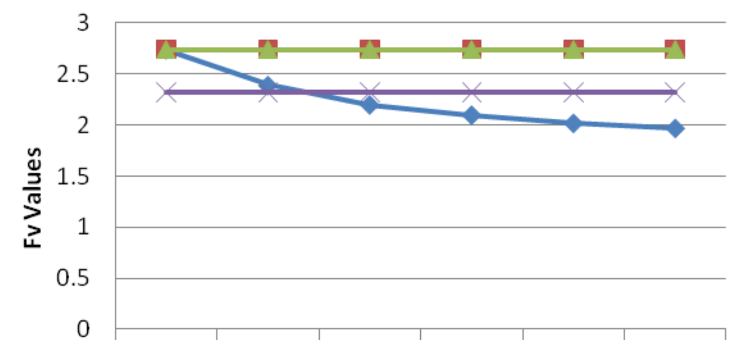
	16m	20m	24m	26m	30m	32m
Box Girder Bridge	1.76	1.64	1.58	1.57	1.56	1.55
I-Girder Bridge	1.65	1.65	1.65	1.65	1.65	1.65
Hollow Slab Bridge	1.61	1.61	1.61	1.61	1.61	1.61
Multispine Bridge	1.41	1.41	1.41	1.41	1.41	1.41

Figure 4.119 Comparisons of Fv Values between Different Kinds of Bridges For ULS & SLS, 3-Lane Bridges, Width 13.571m, 11 Box Girders



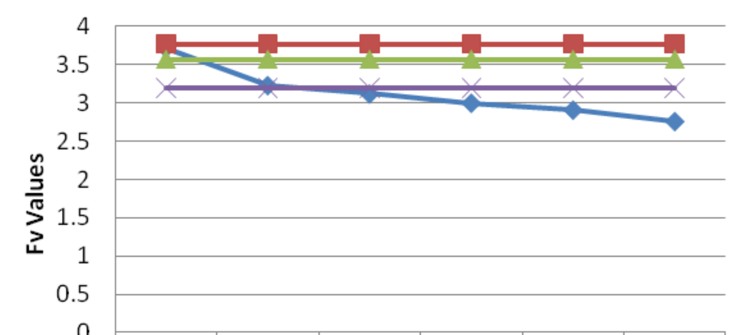
	16m	20m	24m	26m	30m	32m
Box Girder Bridge	1.88	1.76	1.68	1.67	1.66	1.68
I-Girder Bridge	1.82	1.82	1.82	1.82	1.82	1.82
Hollow Slab Bridge	1.76	1.76	1.76	1.76	1.76	1.76
Multispine Bridge	1.54	1.54	1.54	1.54	1.54	1.54

Figure 4.120 Comparisons of Fv Values between Different Kinds of Bridges For ULS & SLS, 4-Lanes Bridges, Width 17.276m, 14 Box Girders



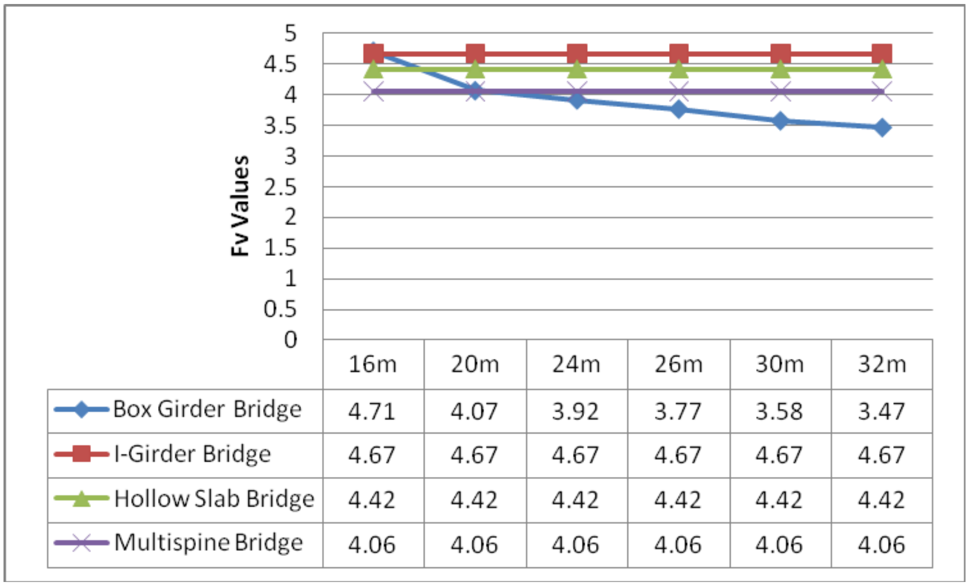
	16m	20m	24m	26m	30m	32m
Box Girder Bridge	2.74	2.39	2.20	2.10	2.02	1.97
I-Girder Bridge	2.74	2.74	2.74	2.74	2.74	2.74
Hollow Slab Bridge	2.74	2.74	2.74	2.74	2.74	2.74
Multispine Bridge	2.32	2.32	2.32	2.32	2.32	2.32

Figure 4.121 Comparisons of Fv Values between Different Kinds of Bridges For FLS, 2-Lane Bridges, Width 9.866m, 8 Box Girders



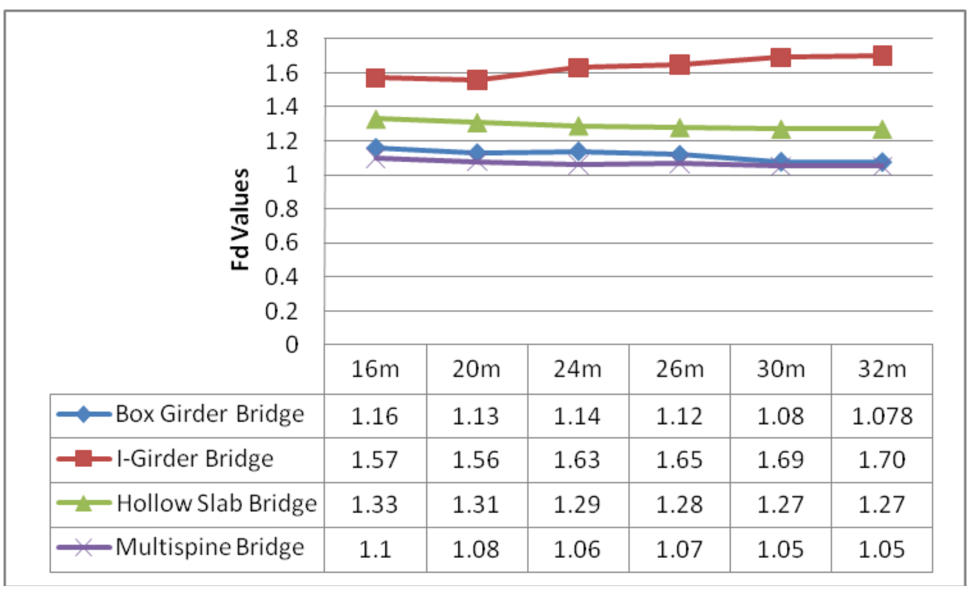
	16m	20m	24m	26m	30m	32m
Box Girder Bridge	3.72	3.23	3.12	3.00	2.91	2.76
I-Girder Bridge	3.77	3.77	3.77	3.77	3.77	3.77
Hollow Slab Bridge	3.57	3.57	3.57	3.57	3.57	3.57
Multispine Bridge	3.19	3.19	3.19	3.19	3.19	3.19

Figure 4.122 Comparisons of Fv Values between Different Kinds of Bridges For FLS, 3-Lane Bridges, Width 13.571, 11 Box Girders



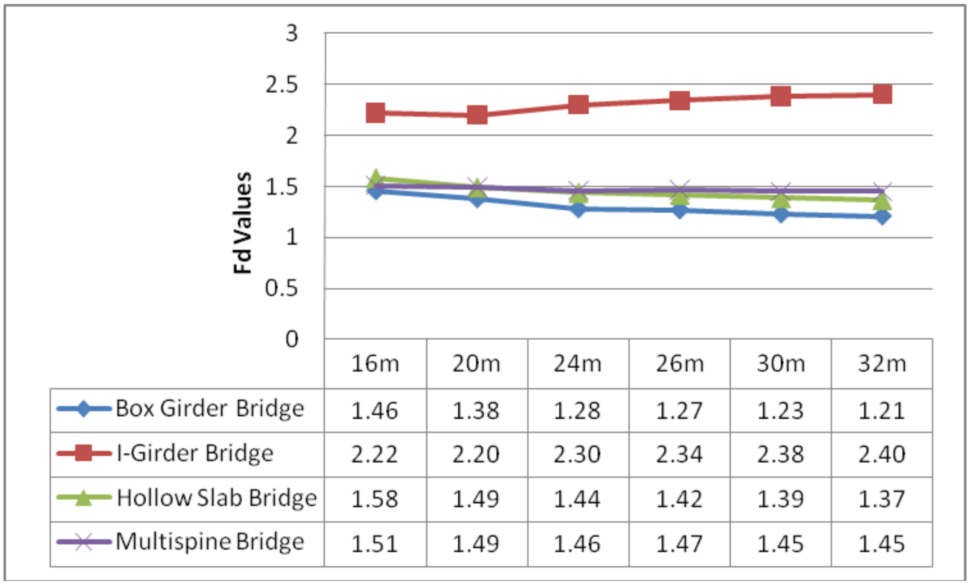
	16m	20m	24m	26m	30m	32m
Box Girder Bridge	4.71	4.07	3.92	3.77	3.58	3.47
I-Girder Bridge	4.67	4.67	4.67	4.67	4.67	4.67
Hollow Slab Bridge	4.42	4.42	4.42	4.42	4.42	4.42
Multispine Bridge	4.06	4.06	4.06	4.06	4.06	4.06

Figure 4.123 Comparisons of Fv Values between Different Kinds of Bridges For FLS, 4-Lanes Bridges, Width 17.276m, 14 Box Girders



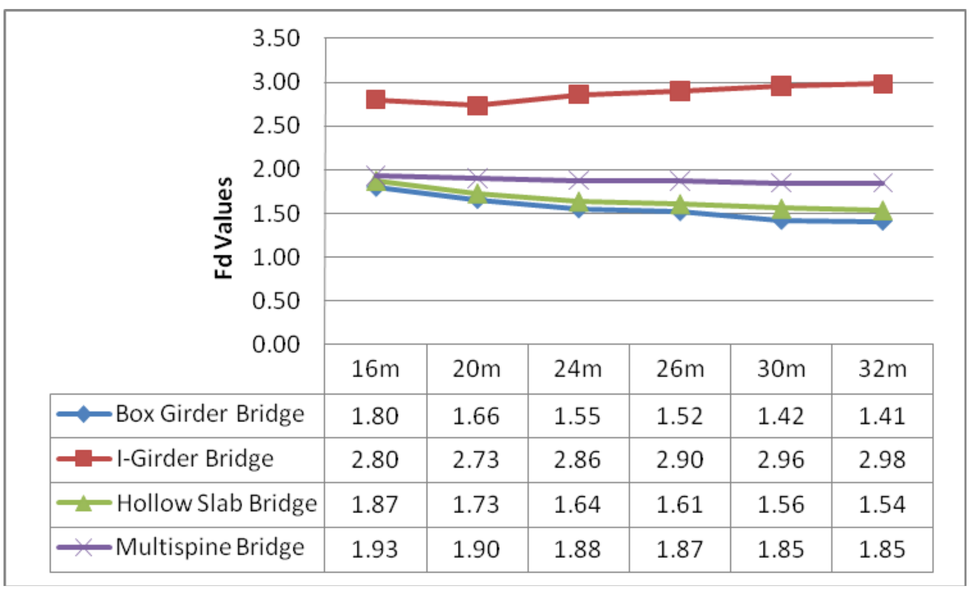
	16m	20m	24m	26m	30m	32m
Box Girder Bridge	1.16	1.13	1.14	1.12	1.08	1.078
I-Girder Bridge	1.57	1.56	1.63	1.65	1.69	1.70
Hollow Slab Bridge	1.33	1.31	1.29	1.28	1.27	1.27
Multispine Bridge	1.1	1.08	1.06	1.07	1.05	1.05

Figure 4.124 Comparisons of Fd Values between Different Kinds of Bridges For FLS, 2-Lane Bridges, Width 9.866m, 8 Box Girders



	16m	20m	24m	26m	30m	32m
Box Girder Bridge	1.46	1.38	1.28	1.27	1.23	1.21
I-Girder Bridge	2.22	2.20	2.30	2.34	2.38	2.40
Hollow Slab Bridge	1.58	1.49	1.44	1.42	1.39	1.37
Multispine Bridge	1.51	1.49	1.46	1.47	1.45	1.45

Figure 4.125 Comparisons of Fd Values between Different Kinds Of Bridges For FLS, 3-Lane Bridges, Width 13.571m, 11 Box Girders



	16m	20m	24m	26m	30m	32m
Box Girder Bridge	1.80	1.66	1.55	1.52	1.42	1.41
I-Girder Bridge	2.80	2.73	2.86	2.90	2.96	2.98
Hollow Slab Bridge	1.87	1.73	1.64	1.61	1.56	1.54
Multispine Bridge	1.93	1.90	1.88	1.87	1.85	1.85

Figure 4.126 Comparisons of Fd Values between Different Kinds Of Bridges For FLS, 4-Lanes Bridges, Width 17.276m, 14 Box Girders

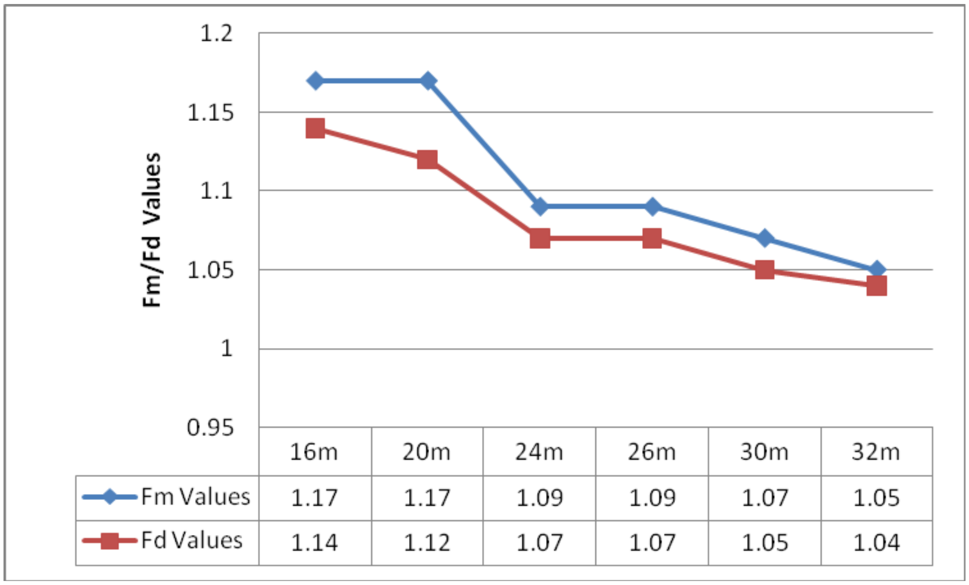


Figure 4.127 Comparison of Fm and Fd Values of Box Girder Bridges For FLS, 2-Lane Bridges, Width 7.396m, 6 Box Girders

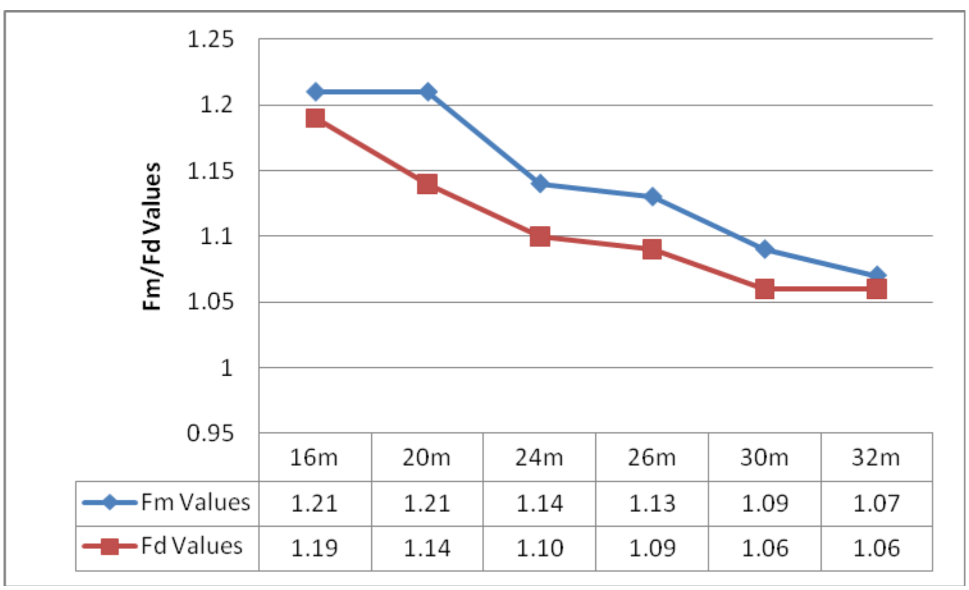


Figure 4.128 Comparison of Fm and Fd Values of Box Girder Bridges For FLS, 2-Lane Bridges, Width 8.631m, 7 Box Girders

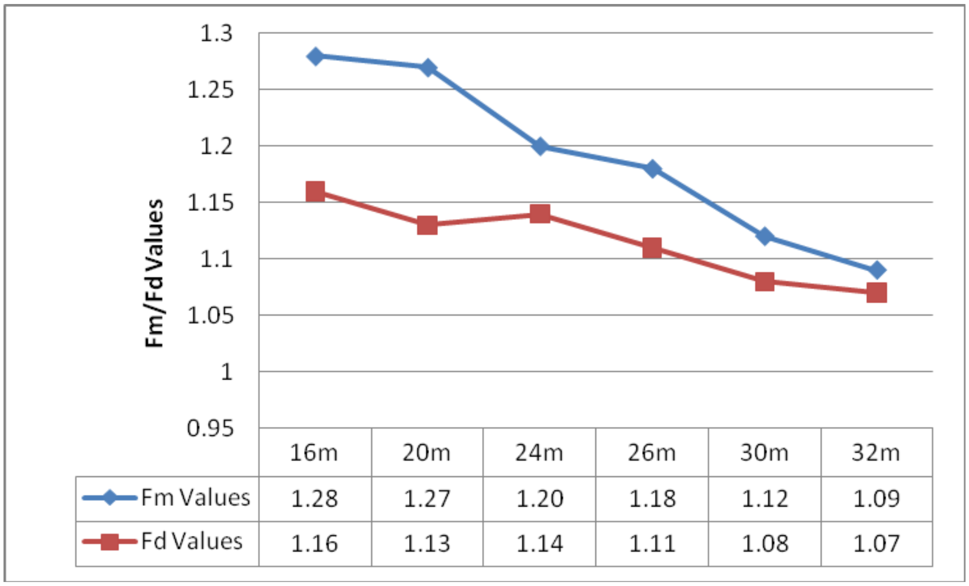


Figure 4.129 Comparison of Fm and Fd Values of Box Girder Bridges For FLS, 2-Lane Bridges, Width 9.866m, 8 Box Girders

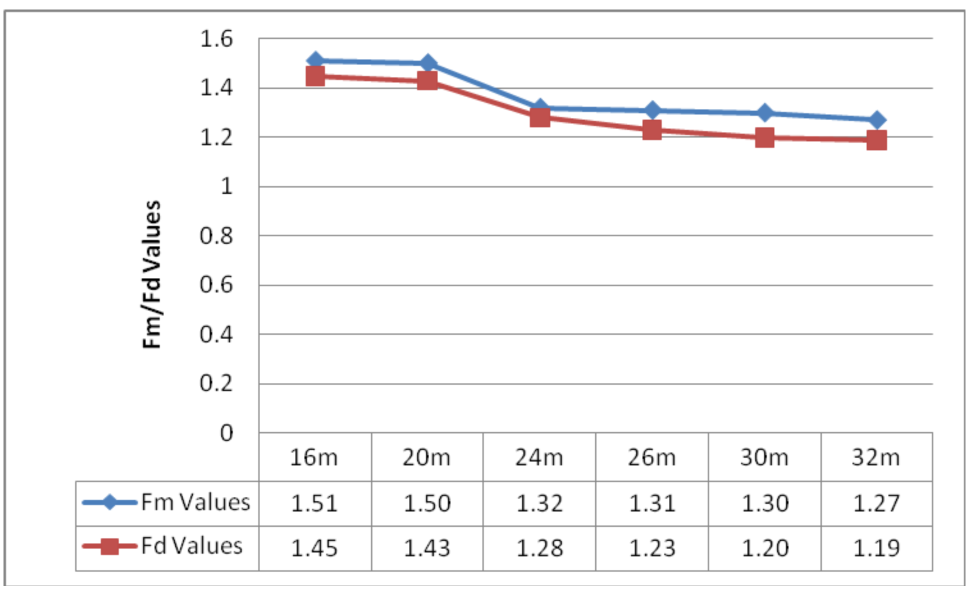


Figure 4.130 Comparison of Fm and Fd Values of Box Girder Bridges For FLS, 3-Lane Bridges, Width 11.101m, 9 Box Girders

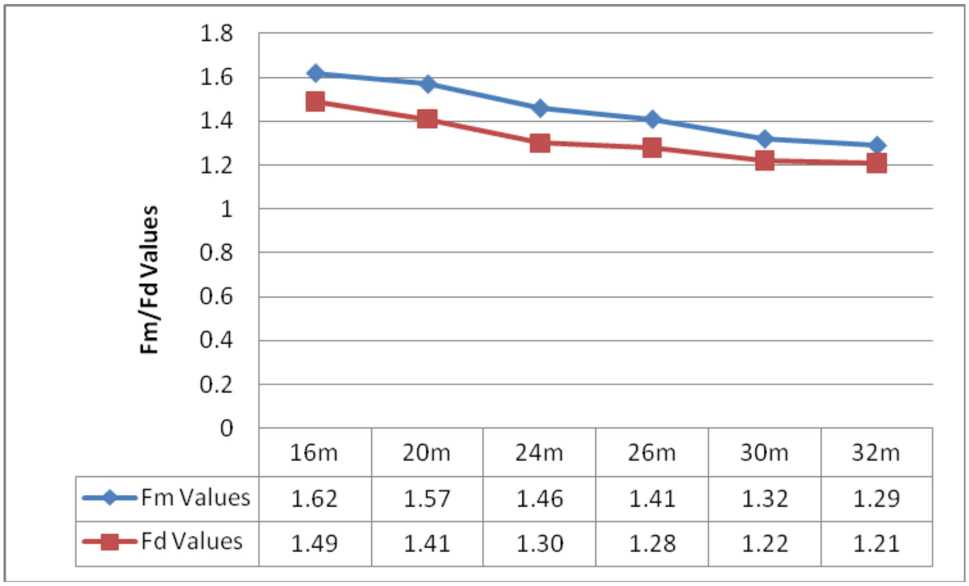


Figure 4.131 Comparison of Fm and Fd Values of Box Girder Bridges For FLS, 3-Lane Bridges, Width 12.336m, 10 Box Girders

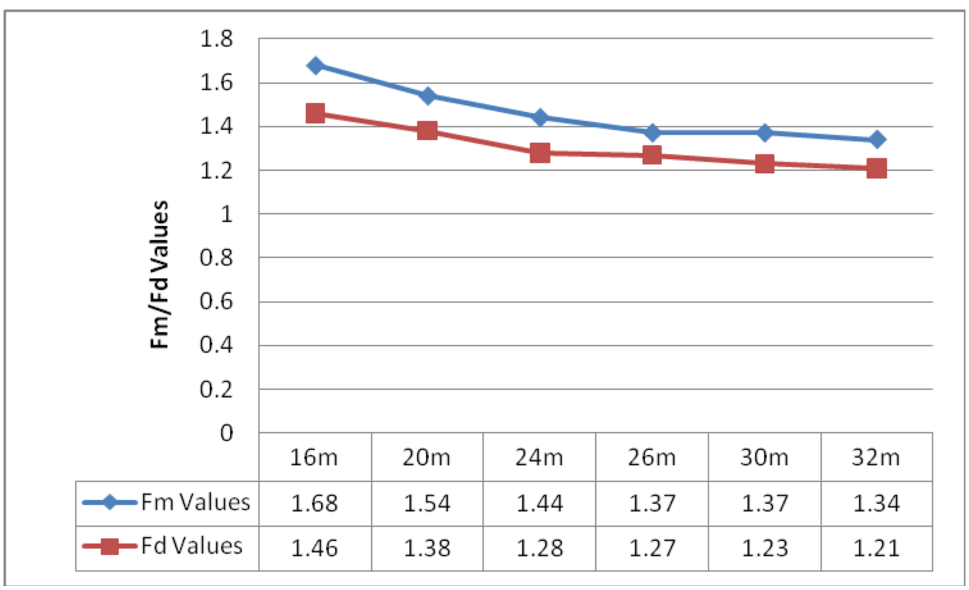


Figure 4.132 Comparison of Fm and Fd Values of Box Girder Bridges For FLS, 3-Lane Bridges, Width 13.571m, 11 Box Girders

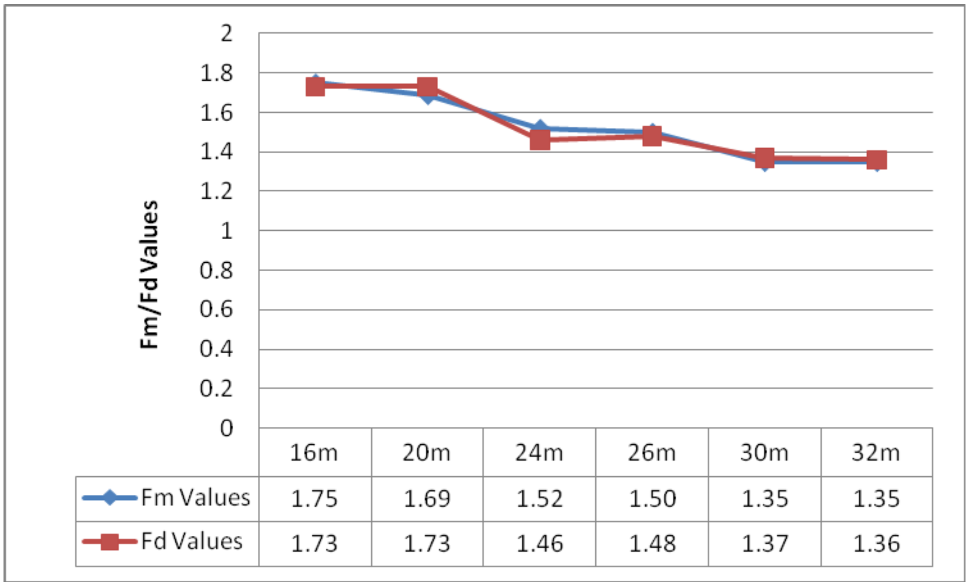


Figure 4.133 Comparison of Fm and Fd Values of Box Girder Bridges For FLS, 4-Lanes Bridges, Width 14.806m, 12 Box Girders

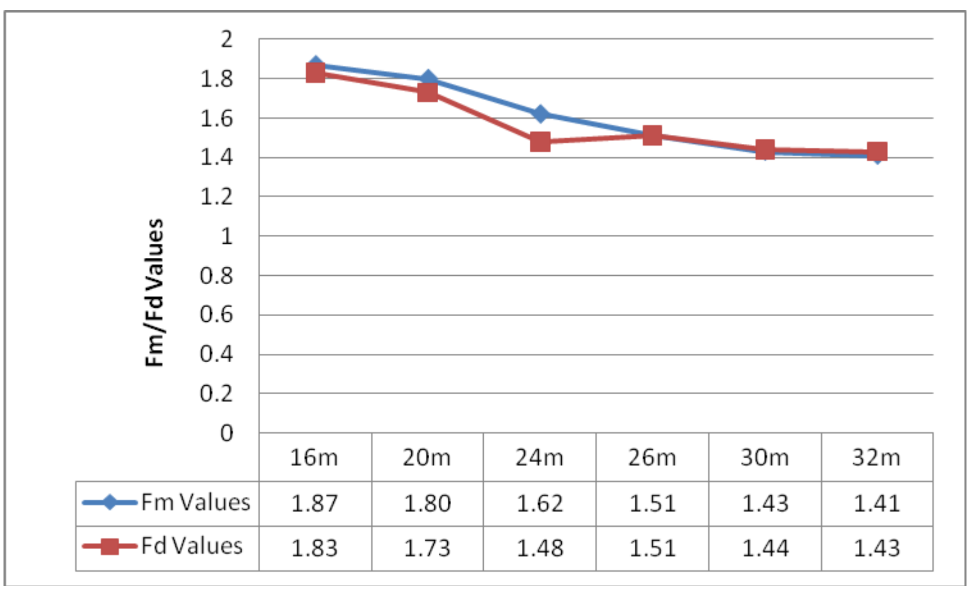


Figure 4.134 Comparison of Fm and Fd Values of Box Girder Bridges For FLS, 4-Lanes Bridges, Width 16.041m, 13 Box Girders

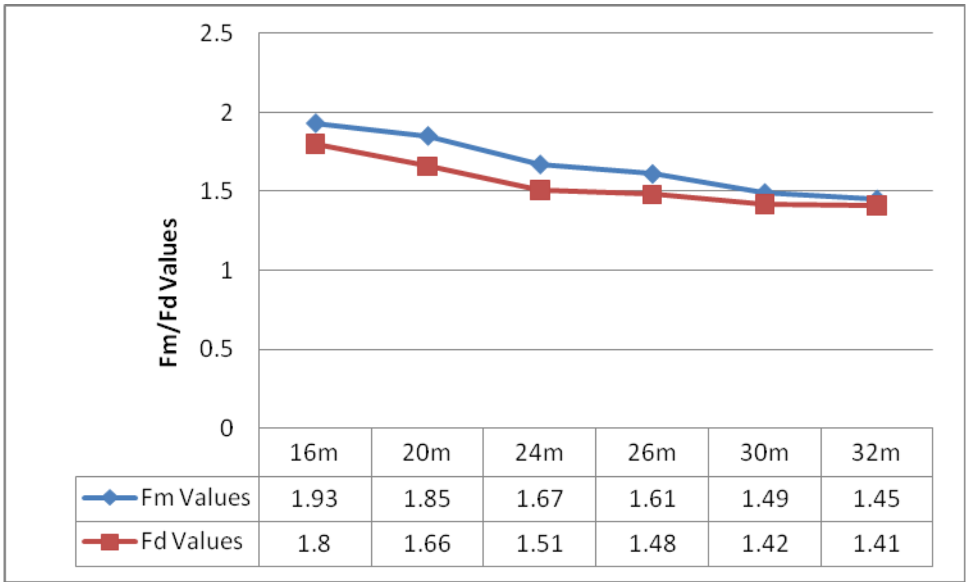


Figure 4.135 Comparison of Fm and Fd Values of Box Girder Bridges For FLS, 4-Lanes Bridges, Width 17.276m, 14 Box Girders

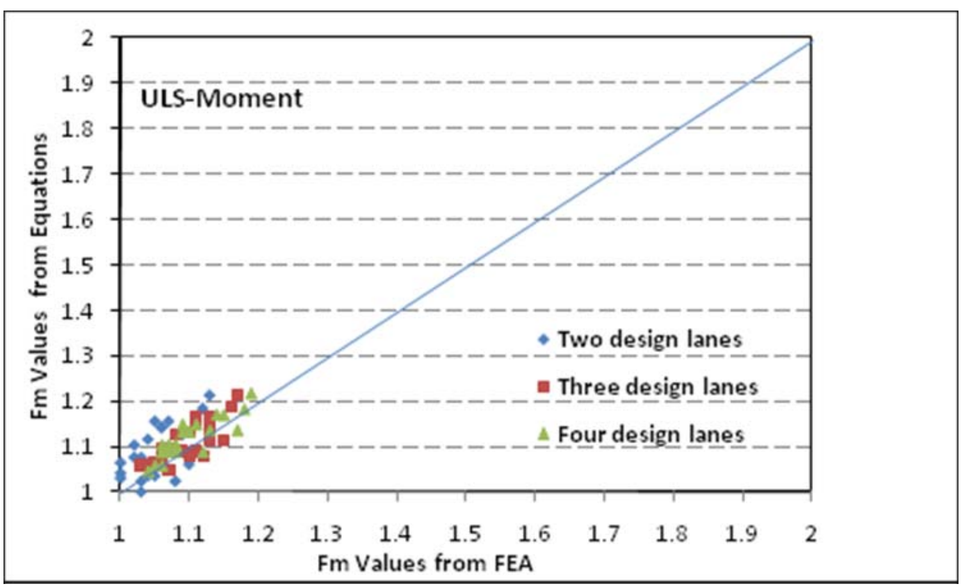


Figure 4.136 Correlation between the FEA results and those from the proposed equations for Box Girder Bridges for ULS design for moment

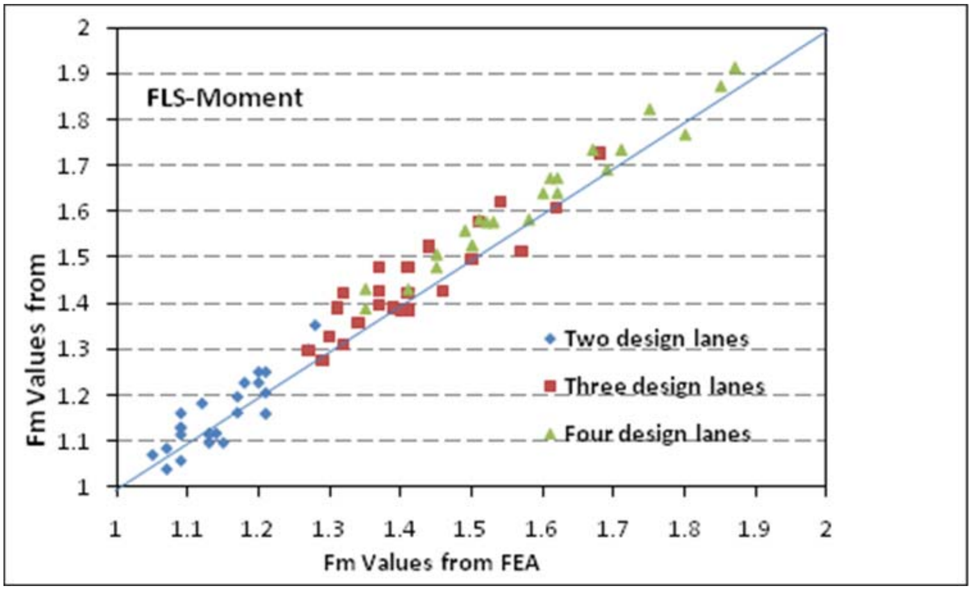


Figure 4.137 Correlation between the FEA results and those from the proposed equations for Box Girder Bridges for FLS design for moment

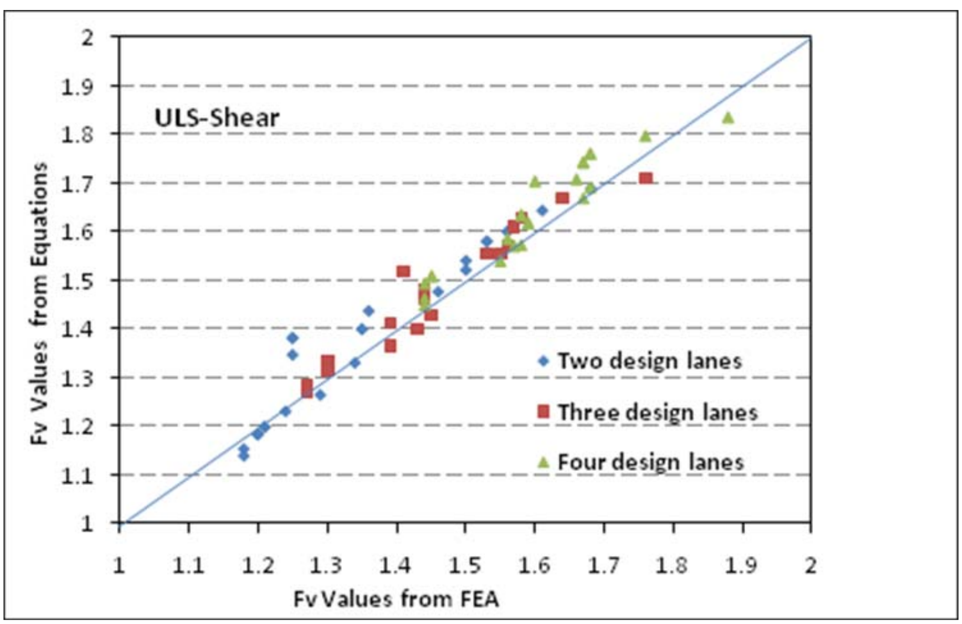


Figure 4.138 Correlation between the FEA results and those from the proposed equations for Box Girder Bridges for ULS design for shear

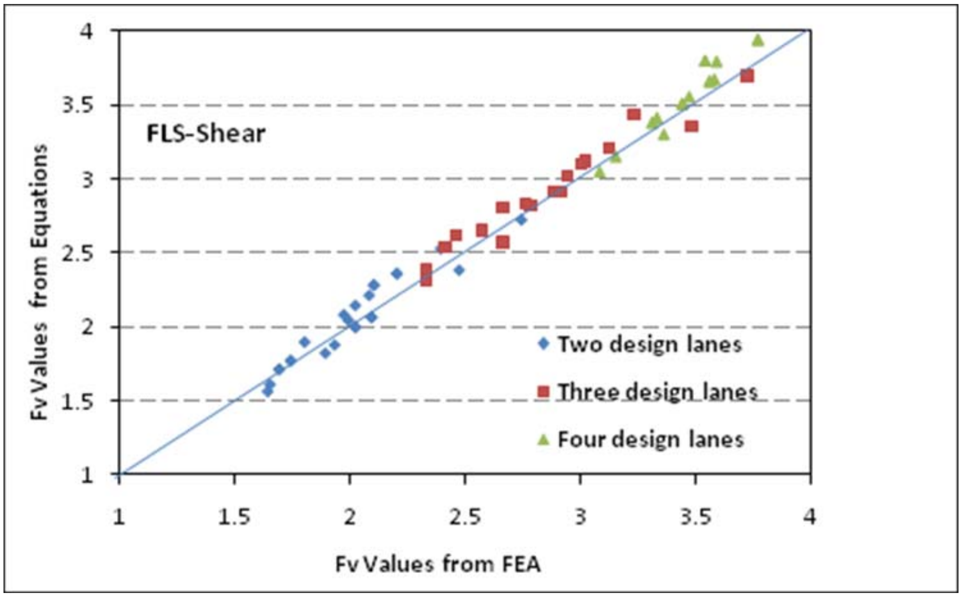


Figure 4.139 Correlation between the FEA results and those from the proposed equations for Box Girder Bridges for FLS design for shear

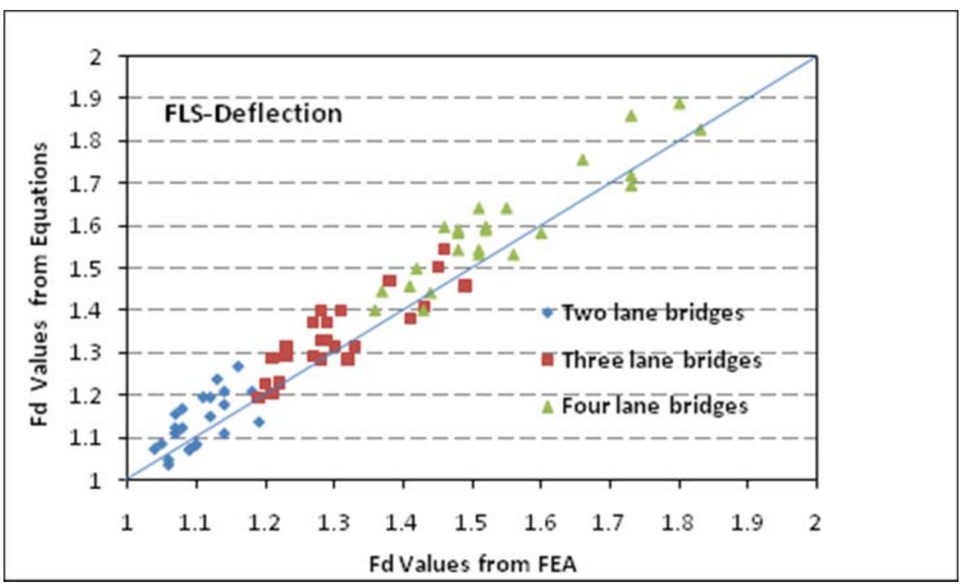


Figure 4.140 Correlation between the FEA results and those from the proposed equations for Box Girder Bridges for FLS design for deflection

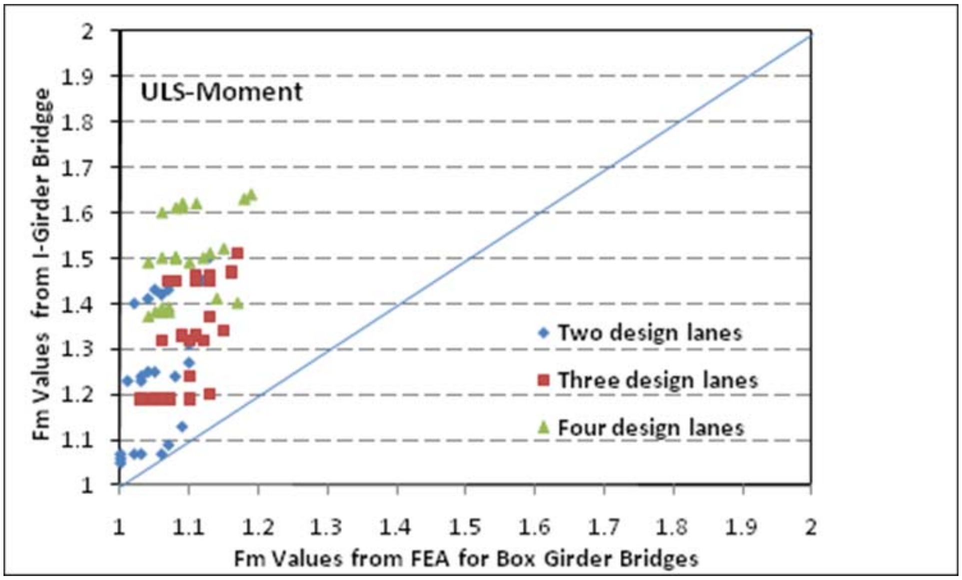


Figure 4.141 Correlation between the FEA results and those from the I-Girder Bridges for ULS design for Moment

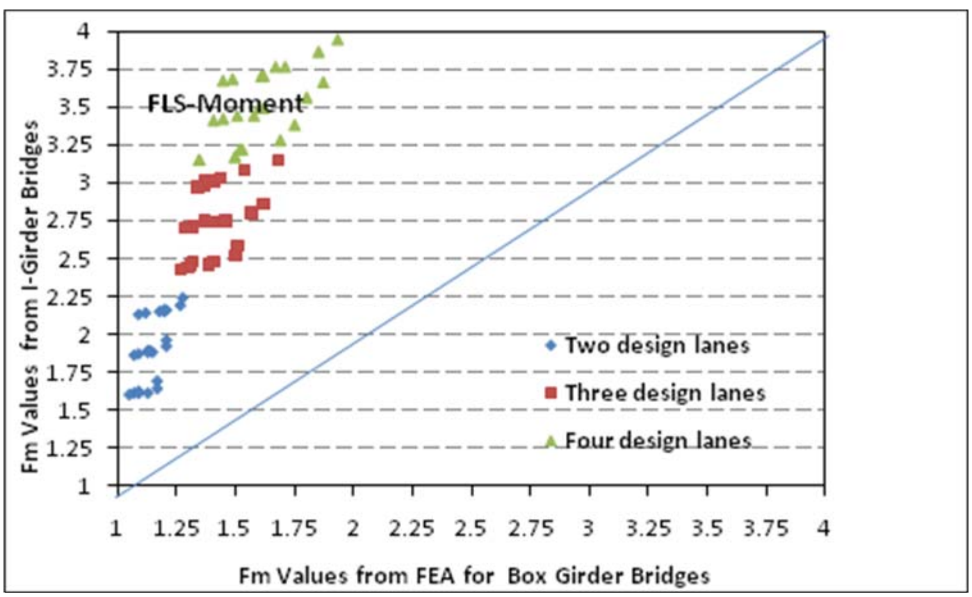


Figure 4.142 Correlation between the FEA results and those from the I-Girder Bridges for FLS design for Moment

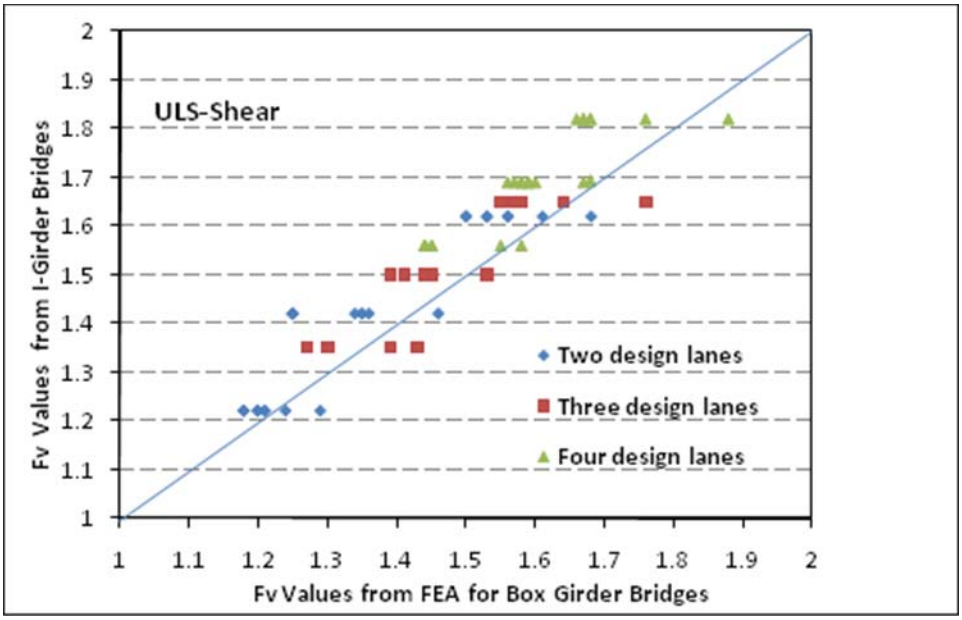


Figure 4.143 Correlation between the FEA results and those from the I-Girder Bridges for ULS design for Shear

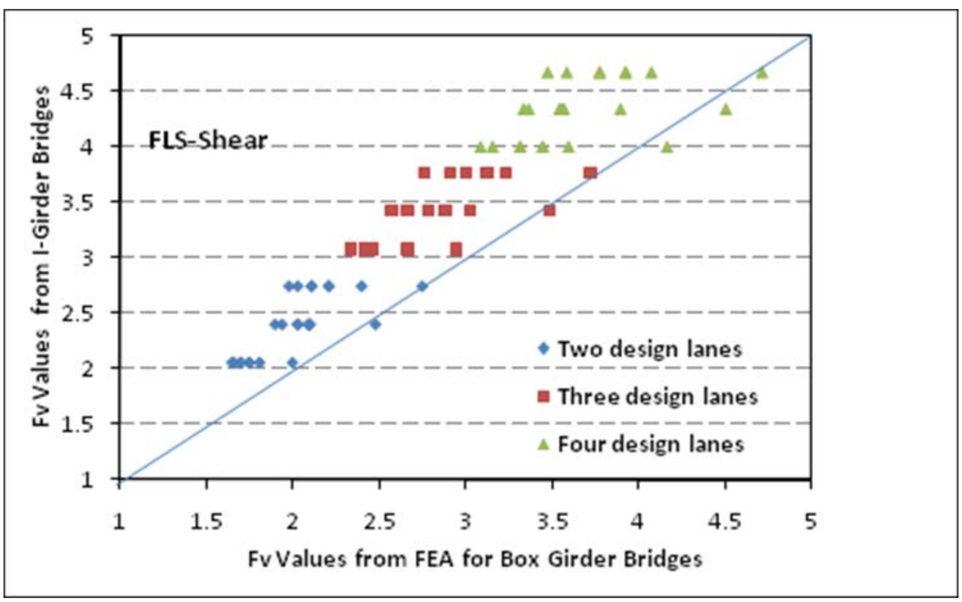


Figure 4.144 Correlation between the FEA results and those from the I-Girder Bridges for FLS design for Shear

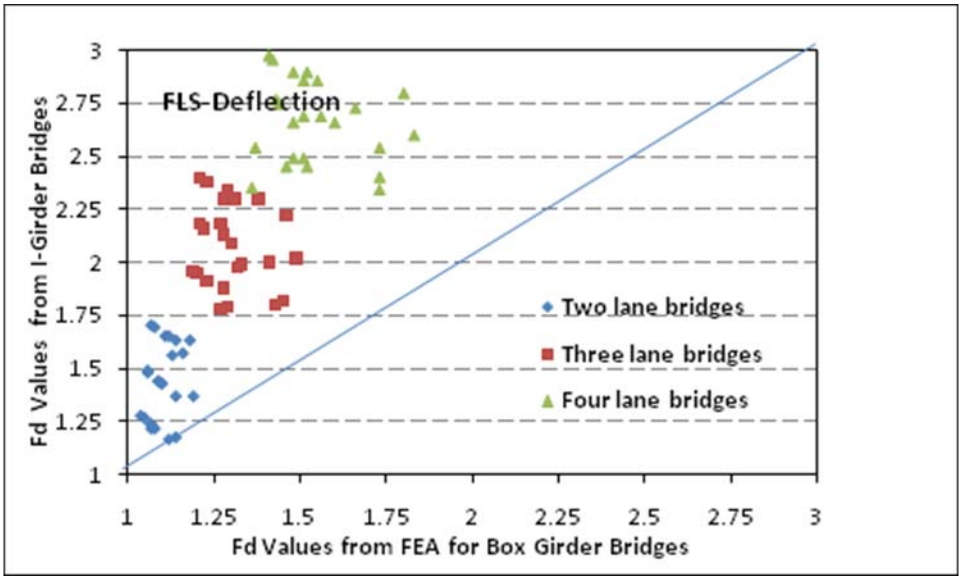


Figure 4.145 Correlation between the FEA results and those from the I-Girder Bridges for FLS design for Deflection

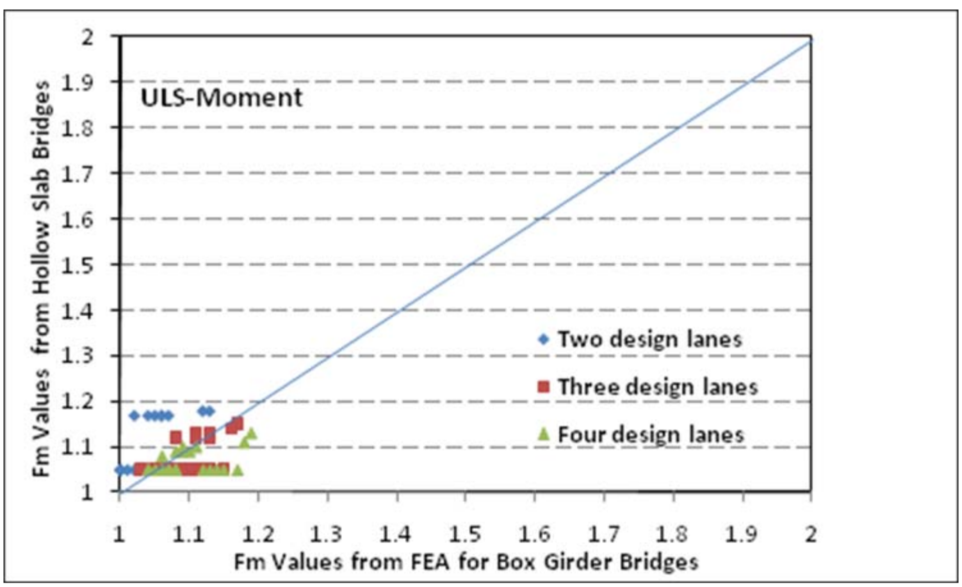


Figure 4.146 Correlation between the FEA results and those from the Hollow Slab Bridges for ULS design for Moment

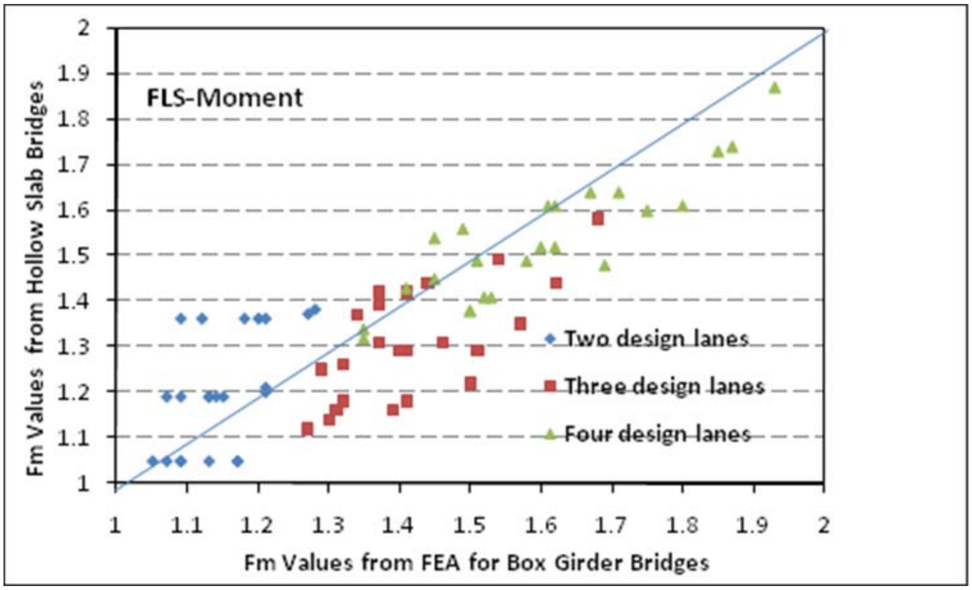


Figure 4.147 Correlation between the FEA results and those from the Hollow Slab Bridges for FLS design for Moment

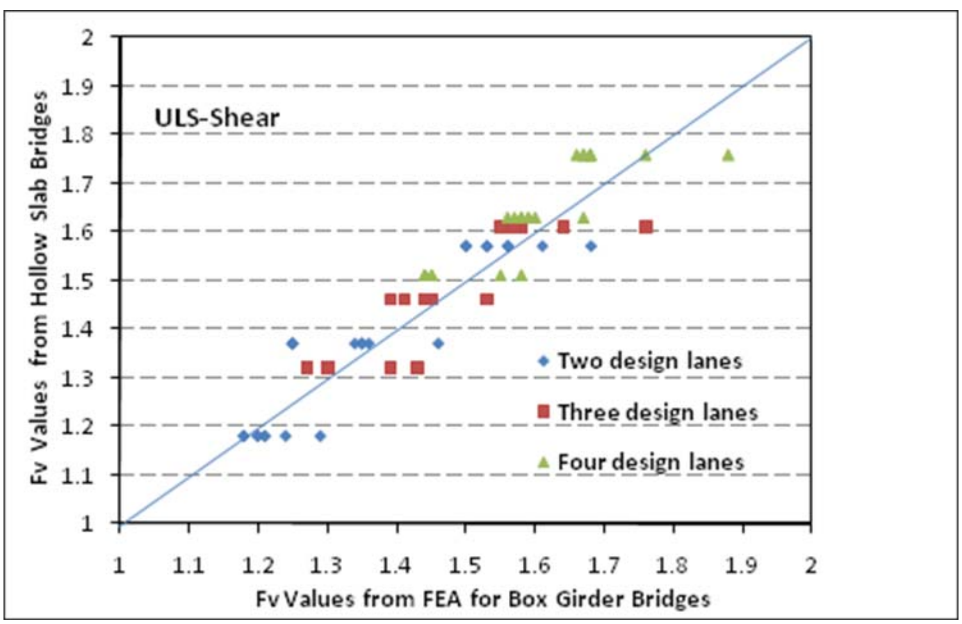


Figure 4.148 Correlation between the FEA results and those from the Hollow Slab Bridges for ULS design for Shear

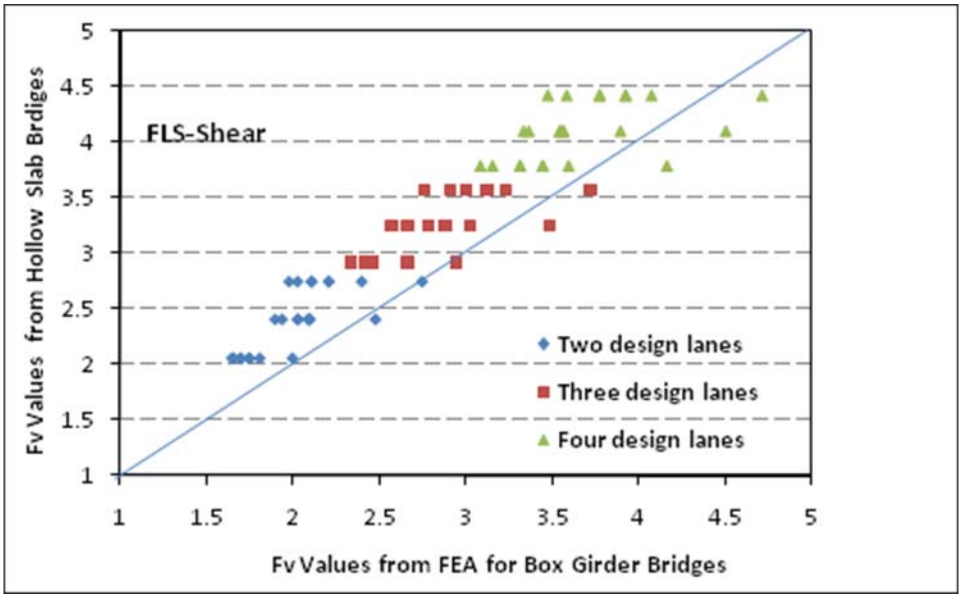


Figure 4.149 Correlation between the FEA results and those from the Hollow Slab Bridges for FLS design for Shear

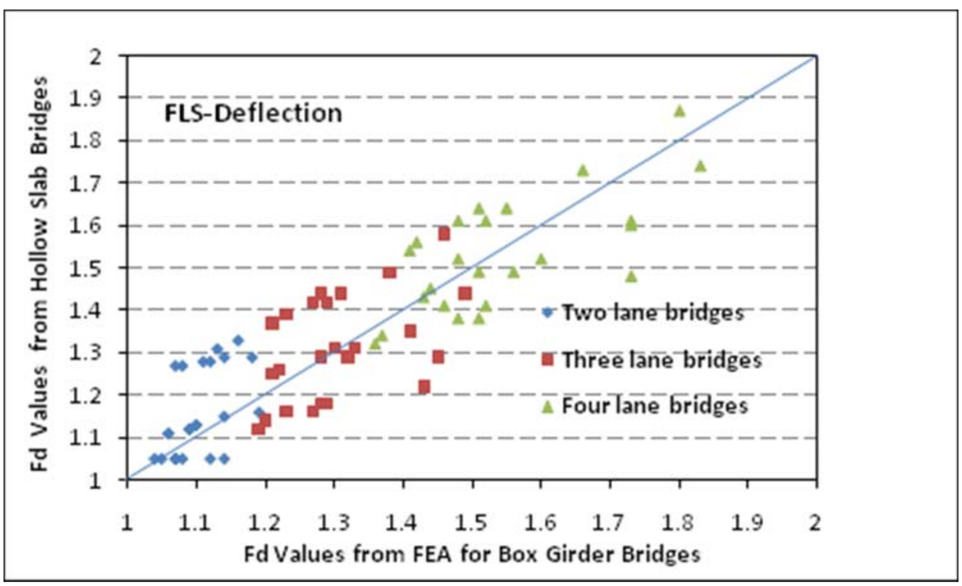


Figure 4.150 Correlation between the FEA results and those from the Hollow Slab Bridges for FLS design for Deflection

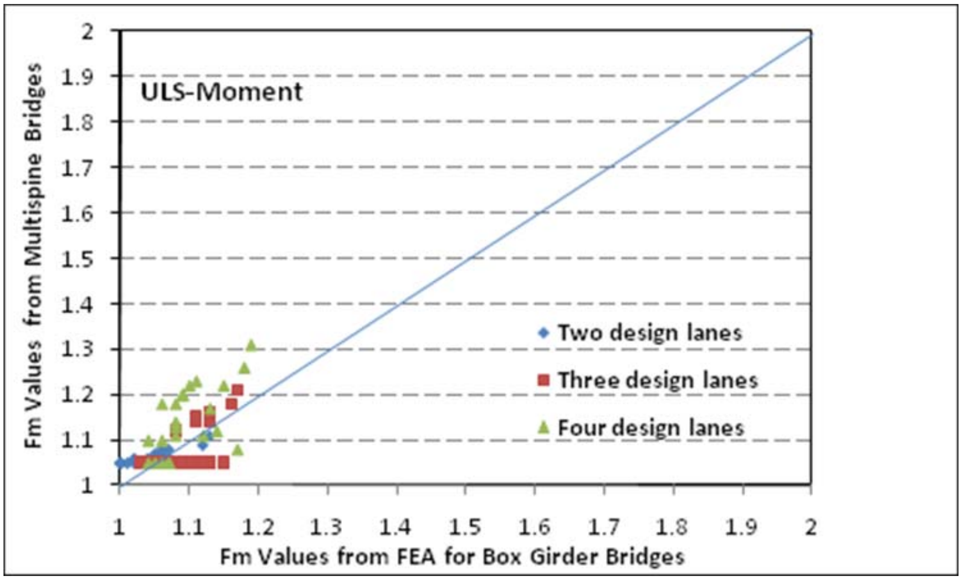


Figure 4.151 Correlation between the FEA results and those from the Multispine Bridges for ULS design for Moment

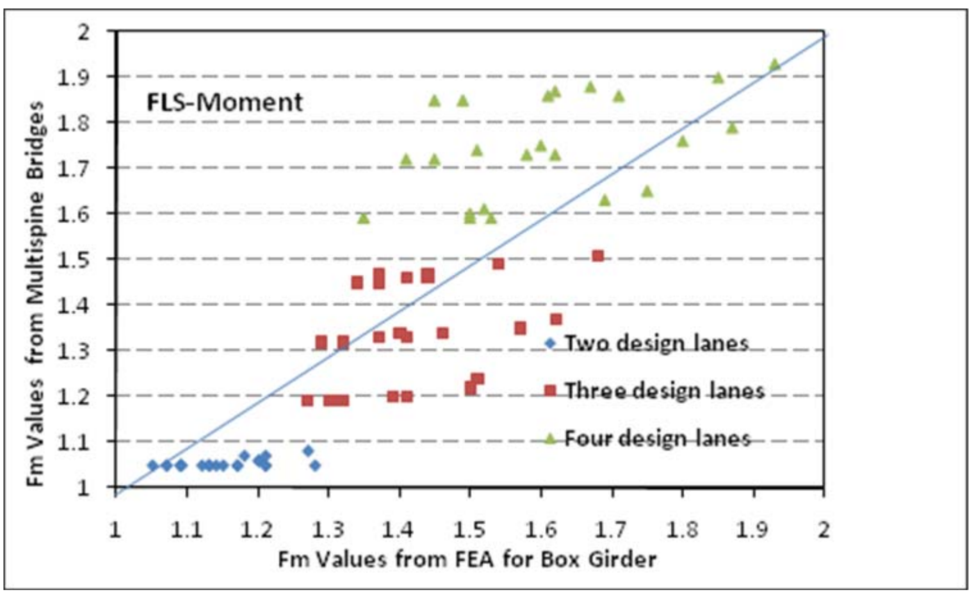


Figure 4.152 Correlation between the FEA results and those from the Multispine Bridges for FLS design for Moment

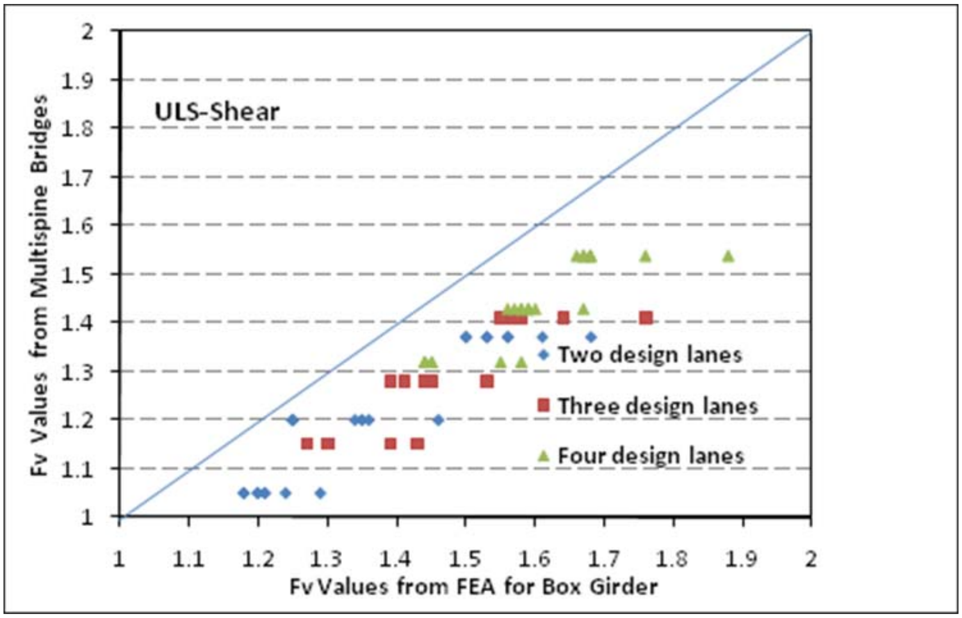


Figure 4.153 Correlation between the FEA results and those from the Multispine Bridges for ULS design for Shear

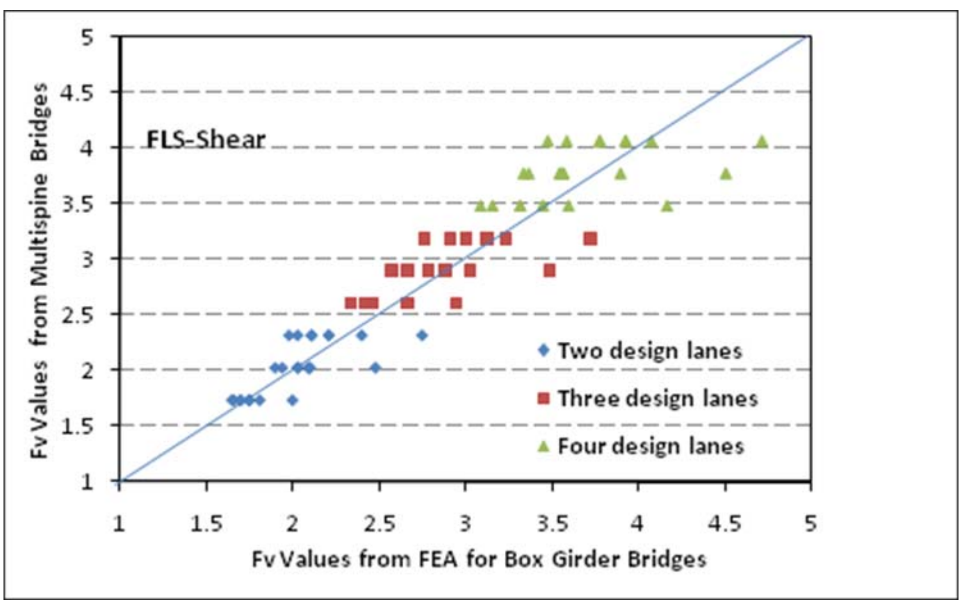


Figure 4.154 Correlation between the FEA results and those from the Multispine Bridges for FLS design for Shear

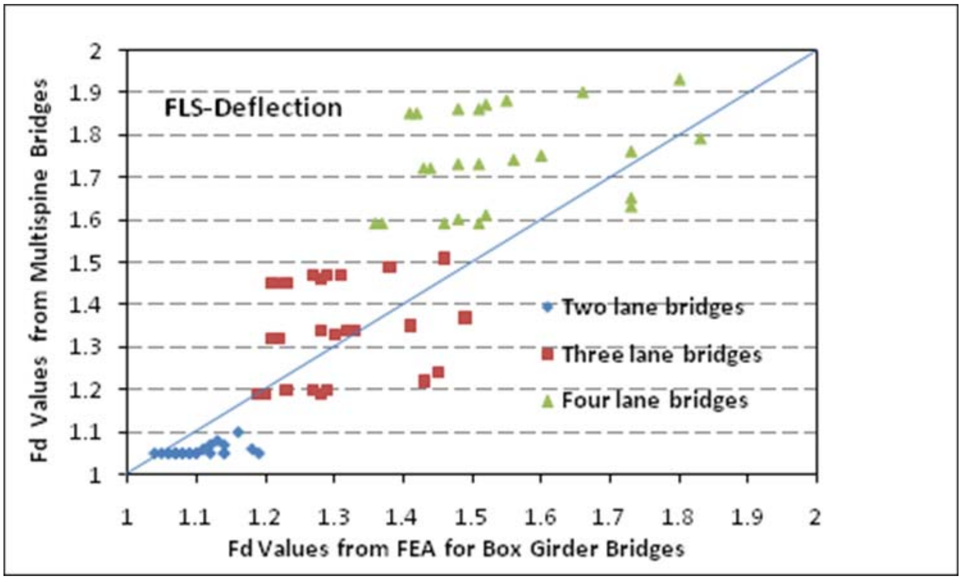


Figure 4.155 Correlation between the FEA results and those from the Multispine Bridges for FLS design for Deflection

APPENDIX (A)

SUMMARY OF SENSITIVITY AND PARAMETRIC STUDIES

Table A.1: CASE SENSITIVITY STUDY FOR MODEL

B700 TWO-LANE BRIDGE : 7.396m WIDTH, 6 GIRDERS, 16m LENGTH

COMPARISON OF SELF LOAD OF MODEL (13.74 kN/m) BY SIMPLE BEAM FORMULA

OPTION	MAX STRESSES	MAX DEFORMATION	REACTION
BOX GIRDER MODEL	4481.2 KN/m2	10.0 mm	1328.12 KN
SIMPLE BEAM FORMULA	4465.5 KN/m2	9.97 mm	1310.1 KN

COMPARISION OF UDL (10 KN/m2) ON MODEL BY SIMPLE BEAM FORMULA

OPTION	MAX STRESSES	MAX DEFORMATION	REACTION
BOX GIRDER MODEL	3979.6 KN/m2	8.9 mm	1165.0 KN
SIMPLE BEAM FORMULA	3964.0 KN/m2	8.8 mm	1164.0 KN

COMPARISION OF POINT LOADS (100 KN) ON MODEL BY SIMPLE BEAM FORMULA

OPTION	MAX STRESSES	MAX DEFORMATION	REACTION
BOX GIRDER MODEL	8149.7 KN/m2	15.0 mm	1200.0 KN
SIMPLE BEAM FORMULA	8124.7 KN/m2	14.6 mm	1200 KN

Table A.2: CASE SENSITIVITY STUDY FOR MODEL

B700 TWO-LANE BRIDGE : 7.396m WIDTH, 6 GIRDERS, 24m LENGTH

COMPARISON OF SELF LOAD OF MODEL (13.74 KN/m) BY SIMPLE BEAM FORMULA

OPTION	MAX STRESSES	MAX DEFORMATION	REACTION
BOX GIRDER MODEL	10129.1 KN/m2	51.0 mm	1995.5 KN
SIMPLE BEAM FORMULA	10047.0 KN/m2	50.8 mm	2024.4 KN

COMPARISON OF UDL (10 KN/m2) ON MODEL BY SIMPLE BEAM FORMULA

OPTION	MAX STRESSES	MAX DEFORMATION	REACTION
BOX GIRDER MODEL	8995.7 KN/m2	45.0 mm	1747.2 KN
SIMPLE BEAM FORMULA	8920.9 KN/m2	45.1 mm	1745.0 KN

COMPARISON OF POINT LOADS (100 KN) ON MODEL BY SIMPLE BEAM FORMULA

OPTION	MAX STRESSES	MAX DEFORMATION	REACTION
BOX GIRDER MODEL	12254.5 KN/m2	49.2 mm	1199.9 KN
SIMPLE BEAM FORMULA	12187.0 KN/m2	49.3 mm	1200.0 KN

Table A.3: CASE SENSITIVITY STUDY FOR MODEL

B800 TWO-LANE BRIDGE : 7.396m WIDTH, 6 GIRDERS, 20m LENGTH

COMPARISON OF SELF LOAD OF MODEL (14.25 KN/m) BY SIMPLE BEAM FORMULA

OPTION	MAX STRESSES	MAX DEFORMATION	REACTION
BOX GIRDER MODEL	5934.5 KN/m2	19.0 mm	1805.9 KN
SIMPLE BEAM FORMULA	5881.4 KN/m2	19.1 mm	1772.8 KN

COMPARISON OF UDL (10 KN/m2) ON MODEL BY SIMPLE BEAM FORMULA

OPTION	MAX STRESSES	MAX DEFORMATION	REACTION
BOX GIRDER MODEL	4965.4 KN/m2	16.0 mm	1452.0 KN
SIMPLE BEAM FORMULA	4819.8 KN/m2	15.8 mm	1454.2 KN

COMPARISON OF POINT LOADS (100 KN) ON MODEL BY SIMPLE BEAM FORMULA

OPTION	MAX STRESSES	MAX DEFORMATION	REACTION
BOX GIRDER MODEL	8168.4 KN/m2	21.0 mm	1200.4 KN
SIMPLE BEAM FORMULA	8033.1 KN/m2	20.7 mm	1200.0 KN

Table A.4: CASE SENSITIVITY STUDY FOR MODEL

B800 TWO-LANE BRIDGE : 7.396m WIDTH, 6 GIRDERS, 26m LENGTH

COMPARISON OF SELF LOAD OF MODEL (14.25 KN/m) BY SIMPLE BEAM FORMULA

OPTION	MAX STRESSES	MAX DEFORMATION	REACTION
BOX GIRDER MODEL	10240.7 KN/m2	54.0 mm	2325.6 KN
SIMPLE BEAM FORMULA	10032.5 KN/m2	54.6 mm	2305.5 KN

COMPARISON OF UDL (10 KN/m2) ON MODEL BY SIMPLE BEAM FORMULA

OPTION	MAX STRESSES	MAX DEFORMATION	REACTION
BOX GIRDER MODEL	8363.2 KN/m2	45.0 mm	1850.02 KN
SIMPLE BEAM FORMULA	8281.2 KN/m2	45.1 mm	1845.47 KN

COMPARISON OF POINT LOADS (100 KN) ON MODEL BY SIMPLE BEAM FORMULA

OPTION	MAX STRESSES	MAX DEFORMATION	REACTION
BOX GIRDER MODEL	10614.3 KN/m2	46.0 mm	1200.2 KN
SIMPLE BEAM FORMULA	10442.9 KN/m2	45.4 mm	1200.0 KN

Table A.5: CASE SENSITIVITY STUDY FOR MODEL

B900 TWO-LANE BRIDGE : 7.396m WIDTH, 6 GIRDERS, 24m LENGTH

COMPARISON OF SELF LOAD OF MODEL (14.84 KN/m) BY SIMPLE BEAM FORMULA

OPTION	MAX STRESSES	MAX DEFORMATION	REACTION
BOX GIRDER MODEL	7635.2 KN/m2	31.0 mm	2140.3 KN
SIMPLE BEAM FORMULA	7561.3 KN/m2	30.2 mm	2135.2 KN

COMPARISON OF UDL (10 KN/m2) ON MODEL BY SIMPLE BEAM FORMULA

OPTION	MAX STRESSES	MAX DEFORMATION	REACTION
BOX GIRDER MODEL	6260.2 KN/m2	25.0 mm	1745.9 KN
SIMPLE BEAM FORMULA	6216.2 KN/m2	24.9 mm	1745.0 KN

COMPARISON OF POINT LOADS (100 KN) ON MODEL BY SIMPLE BEAM FORMULA

OPTION	MAX STRESSES	MAX DEFORMATION	REACTION
BOX GIRDER MODEL	8470.4 KN/m2	27.0 mm	1200 KN
SIMPLE BEAM FORMULA	8492.0 KN/m2	27.2 mm	1200 KN

Table A.6: CASE SENSITIVITY STUDY FOR MODEL

B900 TWO-LANE BRIDGE : 7.396m WIDTH, 6 GIRDERS, 30m LENGTH

COMPARISON OF SELF LOAD OF MODEL (14.84 KN/m) BY SIMPLE BEAM FORMULA

OPTION	MAX STRESSES	MAX DEFORMATION	REACTION
BOX GIRDER MODEL	12070.1 KN/m2	75.0 mm	2682.0 KN
SIMPLE BEAM FORMULA	11814.6 KN/m2	73.9 mm	2669.0 KN

COMPARISON OF UDL (10 KN/m2) ON MODEL BY SIMPLE BEAM FORMULA

OPTION	MAX STRESSES	MAX DEFORMATION	REACTION
BOX GIRDER MODEL	9752.8 KN/m2	60.0 mm	2182.4 KN
SIMPLE BEAM FORMULA	9712.8 KN/m2	60.7 mm	2181.3 KN

COMPARISON OF POINT LOADS (100 KN) ON MODEL BY SIMPLE BEAM FORMULA

OPTION	MAX STRESSES	MAX DEFORMATION	REACTION
BOX GIRDER MODEL	10605.7 KN/m2	53.0 mm	1200.1 KN
SIMPLE BEAM FORMULA	10615.7 KN/m2	53.1 mm	1200.0 KN

Table A.7: CASE SENSITIVITY STUDY FOR MODEL

B1000 TWO-LANE BRIDGE : 7.396m WIDTH, 6 GIRDERS, 26m LENGTH

COMPARISON OF SELF LOAD OF MODEL (15.46 KN/m) BY SIMPLE BEAM FORMULA

OPTION	MAX STRESSES	MAX DEFORMATION	REACTION
BOX GIRDER MODEL	8073.8 KN/m2	34.0 mm	2406.9 KN
SIMPLE BEAM FORMULA	7954.2 KN/m2	33.9 mm	2410.7 KN

COMPARISON OF UDL (10 KN/m2) ON MODEL BY SIMPLE BEAM FORMULA

OPTION	MAX STRESSES	MAX DEFORMATION	REACTION
BOX GIRDER MODEL	6299.7 KN/m2	26.4 mm	1779.3 KN
SIMPLE BEAM FORMULA	6276.7 KN/m2	26.7 mm	1745.0 KN

COMPARISON OF POINT LOADS (100 KN) ON MODEL BY SIMPLE BEAM FORMULA

OPTION	MAX STRESSES	MAX DEFORMATION	REACTION
BOX GIRDER MODEL	7968.4.1 KN/m2	27.0 mm	1200 KN
SIMPLE BEAM FORMULA	7915.41 KN/m2	26.9 mm	1200 KN

Table A.8: CASE SENSITIVITY STUDY FOR MODEL

B1000 TWO-LANE BRIDGE : 7.396m WIDTH, 6 GIRDERS, 32m LENGTH

COMPARISON OF SELF LOAD OF MODEL (15.46 KN/m) BY SIMPLE BEAM FORMULA

OPTION	MAX STRESSES	MAX DEFORMATION	REACTION
BOX GIRDER MODEL	12261.3 KN/m2	78.0 mm	2987.6 KN
SIMPLE BEAM FORMULA	12048.9 KN/m2	77.8 mm	2967.0 KN

COMPARISON OF UDL (10 KN/m2) ON MODEL BY SIMPLE BEAM FORMULA

OPTION	MAX STRESSES	MAX DEFORMATION	REACTION
BOX GIRDER MODEL	9519.9 KN/m2	60.0 mm	2325.6 KN
SIMPLE BEAM FORMULA	9508.2 KN/m2	61.4 mm	2326.7 KN

COMPARISON OF POINT LOADS (100 KN) ON MODEL BY SIMPLE BEAM FORMULA

OPTION	MAX STRESSES	MAX DEFORMATION	REACTION
BOX GIRDER MODEL	9702.2 KN/m2	50.0 mm	1200 KN
SIMPLE BEAM FORMULA	9742.0 KN/m2	50.3 mm	1200 KN

TABLE A.9: COMPARISON OF Fm VALUES FOR TWO-LANE, 6 BOX GIRDERS BRIDGES

COMPARISON OF Fm VALUES FOR B700 TWO-LANE BRIDGES (WIDTH 7.396m, LENGTH 16.0m)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.09**	1.13	1.05	1.05
FLS	**1.17**	1.69	1.05	1.05

COMPARISON OF Fm VALUES FOR B700 TWO-LANE BRIDGES (WIDTH 7.396m, LENGTH 24.0m)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.02**	1.07	1.05	1.05
FLS	**1.09**	1.62	1.05	1.05

COMPARISON OF Fm VALUES FOR B800 TWO-LANE BRIDGES (WIDTH 7.396m, LENGTH 20.0m)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.07**	1.09	1.05	1.05
FLS	**1.17**	1.64	1.05	1.05

COMPARISON OF Fm VALUES FOR B800 TWO-LANE BRIDGES (WIDTH 7.396m, LENGTH 26.0m)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.06**	1.07	1.05	1.05
FLS	**1.13**	1.61	1.05	1.05

COMPARISON OF Fm VALUES FOR B900 TWO-LANE BRIDGES (WIDTH 7.396m, LENGTH 24.0m)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.03**	1.07	1.05	1.05
FLS	**1.09**	1.62	1.05	1.05

COMPARISON OF Fm VALUES FOR B900 TWO-LANE BRIDGES (WIDTH 7.396m, LENGTH 30.0m)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.00**	1.06	1.05	1.05
FLS	**1.07**	1.61	1.05	1.05

COMPARISON OF Fm VALUES FOR B1000 TWO-LANE BRIDGES (WIDTH 7.396m, LENGTH 26.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.00**	1.07	1.05	1.05
FLS	**1.09**	1.61	1.05	1.05

COMPARISON OF Fm VALUES FOR B1000 TWO-LANE BRIDGES (WIDTH 7.396m, LENGTH 32.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.00**	1.05	1.05	1.05
FLS	**1.05**	1.60	1.05	1.05

TABLE A.10: COMPARISON OF Fm VALUES FOR TWO-LANE, 7 BOX GIRDERS BRIDGES

COMPARISON OF Fm VALUES FOR B700 TWO-LANE BRIDGES (WIDTH 8.631m, LENGTH 16.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.10**	1.31	1.05	1.05
FLS	**1.21**	1.96	1.21	1.05

COMPARISON OF Fm VALUES FOR B700 TWO-LANE BRIDGES (WIDTH 8.631m, LENGTH 24.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.04**	1.25	1.05	1.05
FLS	**1.14**	1.89	1.19	1.05

COMPARISON OF Fm VALUES FOR B800 TWO-LANE BRIDGES (WIDTH 8.631m, LENGTH 20.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.10**	1.27	1.05	1.05
FLS	**1.21**	1.92	1.20	1.05

COMPARISON OF Fm VALUES FOR B800 TWO-LANE BRIDGES (WIDTH 8.631m, LENGTH 26.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.08**	1.24	1.05	1.05
FLS	**1.15**	1.88	1.19	1.05

COMPARISON OF Fm VALUES FOR B900 TWO-LANE BRIDGES (WIDTH 8.631m, LENGTH 24.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.05**	1.25	1.05	1.05
FLS	**1.13**	1.89	1.19	1.05

COMPARISON OF Fm VALUES FOR B900 TWO-LANE BRIDGES (WIDTH 8.631m, LENGTH 30.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.03**	1.23	1.05	1.05
FLS	**1.09**	1.87	1.19	1.05

COMPARISON OF Fm VALUES FOR B1000 TWO-LANE BRIDGES (WIDTH 8.631m, LENGTH 26.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.03**	1.24	1.05	1.05
FLS	**1.13**	1.88	1.19	1.05

COMPARISON OF Fm VALUES FOR B1000 TWO-LANE BRIDGES (WIDTH 8.631m, LENGTH 32.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.01**	1.23	1.05	1.05
FLS	**1.07**	1.86	1.19	1.05

TABLE A.11: COMPARISON OF Fm VALUES FOR TWO-LANE, 8 BOX GIRDERS BRIDGES

COMPARISON OF Fm VALUES FOR B700 TWO-LANE BRIDGES (WIDTH 9.866m, LENGTH 16.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.13**	1.5	1.18	1.11
FLS	**1.28**	2.24	1.38	1.05

COMPARISON OF Fm VALUES FOR B700 TWO-LANE BRIDGES (WIDTH 9.866m, LENGTH 24.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.05**	1.43	1.17	1.07
FLS	**1.20**	2.16	1.36	1.06

COMPARISON OF Fm VALUES FOR B800 TWO-LANE BRIDGES (WIDTH 9.866m, LENGTH 20.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.12**	1.45	1.18	1.09
FLS	**1.27**	2.19	1.37	1.08

COMPARISON OF Fm VALUES FOR B800 TWO-LANE BRIDGES (WIDTH 9.866m, LENGTH 26.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.06**	1.42	1.17	1.07
FLS	**1.20**	2.15	1.36	1.06

COMPARISON OF Fm VALUES FOR B900 TWO-LANE BRIDGES (WIDTH 9.866m, LENGTH 24.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.07**	1.43	1.17	1.08
FLS	**1.21**	2.16	1.36	1.07

COMPARISON OF Fm VALUES FOR B900 TWO-LANE BRIDGES (WIDTH 9.866m, LENGTH 30.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.04**	1.41	1.17	1.06
FLS	**1.12**	2.14	1.36	1.05

COMPARISON OF Fm VALUES FOR B1000 TWO-LANE BRIDGES (WIDTH 9.866m, LENGTH 26.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.06**	1.42	1.17	1.08
FLS	**1.18**	2.15	1.36	1.07

COMPARISON OF Fm VALUES FOR B1000 TWO-LANE BRIDGES (WIDTH 9.866m, LENGTH 32.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.02**	1.4	1.17	1.06
FLS	**1.09**	2.13	1.36	1.05

TABLE A.12: COMPARISON OF Fv VALUES FOR TWO-LANE, 6 BOX GIRDERS BRIDGES

COMPARISON OF Fv VALUES FOR B700 TWO-LANE BRIDGES (WIDTH 7.396m, LENGTH 16.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.29**	1.22	1.18	1.05
FLS	**1.99**	2.06	2.05	1.74

COMPARISON OF Fv VALUES FOR B700 TWO-LANE BRIDGES (WIDTH 7.396m, LENGTH 24.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.21**	1.22	1.18	1.05
FLS	**1.74**	2.06	2.05	1.74

COMPARISON OF Fv VALUES FOR B800 TWO-LANE BRIDGES (WIDTH 7.396m, LENGTH 20.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.24**	1.22	1.18	1.05
FLS	**1.80**	2.06	2.05	1.74

COMPARISON OF Fv VALUES FOR B800 TWO-LANE BRIDGES (WIDTH 7.396m, LENGTH 26.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.20**	1.22	1.18	1.05
FLS	**1.69**	2.06	2.05	1.74

COMPARISON OF Fv VALUES FOR B900 TWO-LANE BRIDGES (WIDTH 7.396m, LENGTH 24.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.21**	1.22	1.18	1.05
FLS	**1.74**	2.06	2.05	1.74

COMPARISON OF Fv VALUES FOR B900 TWO-LANE BRIDGES (WIDTH 7.396m, LENGTH 30.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.18**	1.22	1.18	1.05
FLS	**1.65**	2.06	2.05	1.74

COMPARISON OF Fv VALUES FOR B1000 TWO-LANE BRIDGES (WIDTH 7.396m, LENGTH 26.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.20**	1.22	1.18	1.05
FLS	**1.69**	2.06	2.05	1.74

COMPARISON OF Fv VALUES FOR B1000 TWO-LANE BRIDGES (WIDTH 7.396m, LENGTH 32.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.18**	1.22	1.18	1.05
FLS	**1.64**	2.06	2.05	1.74

TABLE A.13: COMPARISON OF Fv VALUES FOR TWO-LANE, 7 BOX GIRDERS BRIDGES

COMPARISON OF Fv VALUES FOR B700 TWO-LANES BRIDGES (WIDTH 8.631m, LENGTH 16.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.46**	1.42	1.37	1.20
FLS	**2.47**	2.40	2.40	2.03

COMPARISON OF Fv VALUES FOR B700 TWO-LANES BRIDGES (WIDTH 8.631m, LENGTH 24.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.35**	1.42	1.37	1.20
FLS	**2.09**	2.40	2.40	2.03

COMPARISON OF Fv VALUES FOR B800 TWO-LANE BRIDGES (WIDTH 8.631m, LENGTH 20.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.36**	1.42	1.37	1.20
FLS	**2.08**	2.40	2.40	2.03

COMPARISON OF Fv VALUES FOR B800 TWO-LANE BRIDGES (WIDTH 8.631m, LENGTH 26.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.25**	1.42	1.37	1.20
FLS	**2.02**	2.40	2.40	2.03

COMPARISON OF Fv VALUES FOR B900 TWO-LANE BRIDGES (WIDTH 8.631m, LENGTH 24.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.35**	1.42	1.37	1.20
FLS	**2.09**	2.40	2.40	2.03

COMPARISON OF Fv VALUES FOR B900 TWO-LANE BRIDGES (WIDTH 8.631m, LENGTH 30.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.25**	1.42	1.37	1.20
FLS	**1.93**	2.40	2.40	2.03

COMPARISON OF Fv VALUES FOR B1000 TWO-LANE BRIDGES (WIDTH 8.631m, LENGTH 26.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.25**	1.42	1.37	1.20
FLS	**2.02**	2.40	2.40	2.03

COMPARISON OF Fv VALUES FOR B1000 TWO-LANE BRIDGES (WIDTH 8.631m, LENGTH 32.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.34**	1.42	1.37	1.20
FLS	**1.89**	2.40	2.40	2.03

TABLE A.14: COMPARISON OF Fv VALUES FOR TWO-LANE, 8 BOX GIRDERS BRIDGES

COMPARISON OF Fv VALUES FOR B700 TWO-LANE BRIDGES (WIDTH 9.866m, LENGTH 16.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.68**	1.62	1.57	1.37
FLS	**2.74**	2.74	2.74	2.32

COMPARISON OF Fv VALUES FOR B700 TWO-LANE BRIDGES (WIDTH 9.866m, LENGTH 24.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.56**	1.62	1.57	1.37
FLS	**2.20**	2.74	2.74	2.32

COMPARISON OF Fv VALUES FOR B800 TWO-LANE BRIDGES (WIDTH 9.866m, LENGTH 20.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.61**	1.62	1.57	1.37
FLS	**2.39**	2.74	2.74	2.32

COMPARISON OF Fv VALUES FOR B800 TWO-LANE BRIDGES (WIDTH 9.866m, LENGTH 26.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.53**	1.62	1.57	1.37
FLS	**2.10**	2.74	2.74	2.32

COMPARISON OF Fv VALUES FOR B900 TWO-LANE BRIDGES (WIDTH 9.866m, LENGTH 24.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.56**	1.62	1.57	1.37
FLS	**2.20**	2.74	2.74	2.32

COMPARISON OF Fv VALUES FOR B900 TWO-LANE BRIDGES (WIDTH 9.866m, LENGTH 30.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.50**	1.62	1.57	1.37
FLS	**2.02**	2.74	2.74	2.32

COMPARISON OF Fv VALUES FOR B1000 TWO-LANE BRIDGES (WIDTH 9.866m, LENGTH 26.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.53**	1.62	1.57	1.37
FLS	**2.10**	2.74	2.74	2.32

COMPARISON OF Fv VALUES FOR B1000 TWO-LANE BRIDGES (WIDTH 9.866m, LENGTH 32.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.50**	1.62	1.57	1.37
FLS	**1.97**	2.74	2.74	2.32

TABLE A.15: COMPARISON OF Fd VALUES FOR TWO-LANE, 6 BOX GIRDERS BRIDGES

COMPARISON OF Fd VALUES FOR B700 TWO-LANE BRIDGES (WIDTH 7.396m, LENGTH 16.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.14**	1.18	1.05	1.05

COMPARISON OF Fd VALUES FOR B700 TWO-LANE BRIDGES (WIDTH 7.396m, LENGTH 24.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.07**	1.22	1.05	1.05

COMPARISON OF Fd VALUES FOR B800 TWO-LANE BRIDGES (WIDTH 7.396m, LENGTH 20.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.12**	1.17	1.05	1.05

COMPARISON OF Fd VALUES FOR B800 TWO-LANE BRIDGES (WIDTH 7.396m, LENGTH 26.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.07**	1.24	1.05	1.05

COMPARISON OF Fd VALUES FOR B900 TWO-LANE BRIDGES (WIDTH 7.396m, LENGTH 24.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.08**	1.22	1.05	1.05

COMPARISON OF Fd VALUES FOR B900 TWO-LANE BRIDGES (WIDTH 7.396m, LENGTH 30.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.05**	1.27	1.05	1.05

COMPARISON OF Fd VALUES FOR B1000 TWO-LANE BRIDGES (WIDTH 7.396m, LENGTH 26.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.07**	1.24	1.05	1.05

COMPARISON OF Fd VALUES FOR B1000 TWO-LANE BRIDGES (WIDTH 7.396m, LENGTH 32.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.04**	1.28	1.05	1.05

TABLE A.16: COMPARISON OF Fd VALUES FOR TWO-LANE, 7 BOX GIRDERS BRIDGES

COMPARISON OF Fd VALUES FOR B700 TWO-LANE BRIDGES (WIDTH 8.631m., LENGTH 16.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.19**	1.37	1.16	1.05

COMPARISON OF Fd VALUES FOR B700 TWO-LANE BRIDGES (WIDTH 8.631m, LENGTH 24.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.10**	1.43	1.13	1.05

COMPARISON OF Fd VALUES FOR B800 TWO-LANE BRIDGES (WIDTH 8.631m, LENGTH 20.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.14**	1.37	1.15	1.05

COMPARISON OF Fd VALUES FOR B800 TWO-LANE BRIDGES (WIDTH 8.631m, LENGTH 26.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.09**	1.44	1.12	1.05

COMPARISON OF Fd VALUES FOR B900 TWO-LANE BRIDGES (WIDTH 8.631m, LENGTH 24.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.10**	1.43	1.13	1.05

COMPARISON OF Fd VALUES FOR B900 TWO-LANE BRIDGES (WIDTH 8.631m, LENGTH 30.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.06**	1.48	1.11	1.05

COMPARISON OF Fd VALUES FOR B1000 TWO-LANE BRIDGES (WIDTH 8.631m, LENGTH 26.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.09**	1.44	1.12	1.05

COMPARISON OF Fd VALUES FOR B1000 TWO-LANE BRIDGES (WIDTH 8.631m, LENGTH 32.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.06**	1.49	1.11	1.05

TABLE A.17: COMPARISON OF Fd VALUES FOR TWO-LANE, 8 BOX GIRDERS BRIDGES

COMPARISON OF Fd VALUES FOR B700 TWO-LANE BRIDGES (WIDTH 9.866m, LENGTH 16.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.16**	1.57	1.33	1.10

COMPARISON OF Fd VALUES FOR B700 TWO-LANE BRIDGES (WIDTH 9.866m, LENGTH 24.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.18**	1.63	1.29	1.06

COMPARISON OF Fd VALUES FOR B800 TWO-LANE BRIDGES (WIDTH 9.866m, LENGTH 20.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.13**	1.56	1.31	1.08

COMPARISON OF Fd VALUES FOR B800 TWO-LANE BRIDGES (WIDTH 9.866m, LENGTH 26.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.11**	1.65	1.28	1.06

COMPARISON OF Fd VALUES FOR B900 TWO-LANE BRIDGES (WIDTH 9.866m, LENGTH 24.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.14**	1.63	1.29	1.07

COMPARISON OF Fd VALUES FOR B900 TWO-LANE BRIDGES (WIDTH 9.866m, LENGTH 30.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.08**	1.69	1.27	1.05

COMPARISON OF Fd VALUES FOR B1000 TWO-LANE BRIDGES (WIDTH 9.866m, LENGTH 26.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.12**	1.65	1.28	1.07

COMPARISON OF Fd VALUES FOR B1000 TWO-LANE BRIDGES (WIDTH 9.866m, LENGTH 32.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.07**	1.70	1.27	1.05

TABLE A.18: COMPARISON OF Fm VALUES FOR THREE-LANE, 9 BOX GIRDERS BRIDGES

COMPARISON OF Fm VALUES FOR B700 THREE-LANE BRIDGES (WIDTH 11.101m, LENGTH 16.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.10**	1.24	1.05	1.05
FLS	**1.51**	2.58	1.29	1.24

COMPARISON OF Fm VALUES FOR B700 THREE-LANE BRIDGES (WIDTH 11.101m, LENGTH 24.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	1.06	1.19	1.05	1.05
FLS	**1.32**	2.48	1.18	1.19

COMPARISON OF Fm VALUES FOR B800 THREE-LANE BRIDGES (WIDTH 11.101m, LENGTH 20.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.13**	1.20	1.05	1.05
FLS	**1.50**	2.52	1.22	1.22

COMPARISON OF Fm VALUES FOR B800 THREE-LANE BRIDGES (WIDTH 11.101m, LENGTH 26.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.10**	1.19	1.05	1.05
FLS	**1.31**	2.46	1.16	1.19

COMPARISON OF Fm VALUES FOR B900 THREE-LANE BRIDGES (WIDTH 11.101m, LENGTH 24.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.07**	1.19	1.05	1.05
FLS	**1.41**	2.48	1.18	1.20

COMPARISON OF Fm VALUES FOR B900 THREE-LANE BRIDGES (WIDTH 11.101m, LENGTH 30.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.05**	1.19	1.05	1.05
FLS	**1.30**	2.44	1.14	1.19

COMPARISON OF Fm VALUES FOR B1000 THREE-LANE BRIDGES (WIDTH 11.101m, LENGTH 26.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.06**	1.19	1.05	1.05
FLS	**1.39**	2.46	1.16	1.20

COMPARISON OF Fm VALUES FOR B1000 THREE-LANE BRIDGES (WIDTH 11.101m, LENGTH 32.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.03**	1.19	1.05	1.05
FLS	**1.27**	2.43	1.12	1.19

TABLE A.19: COMPARISON OF Fm VALUES FOR THREE-LANE, 10 BOX GIRDERS BRIDGES

COMPARISON OF Fm VALUES FOR B700 THREE-LANE BRIDGES (WIDTH 12.336, LENGTH 16.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.13**	1.37	1.05	1.10
FLS	**1.62**	2.86	1.44	1.37

COMPARISON OF Fm VALUES FOR B700 THREE-LANE BRIDGES (WIDTH 12.336, LENGTH 24.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.11**	1.33	1.05	1.05
FLS	**1.37**	2.75	1.31	1.33

COMPARISON OF Fm VALUES FOR B800 THREE-LANE BRIDGES (WIDTH 12.336, LENGTH 20.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.15**	1.34	1.05	1.07
FLS	**1.57**	2.80	1.35	1.35

COMPARISON OF Fm VALUES FOR B800 THREE-LANE BRIDGES (WIDTH 12.336, LENGTH 26.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.10**	1.32	1.05	1.05
FLS	**1.41**	2.74	1.29	1.33

COMPARISON OF Fm VALUES FOR B900 THREE-LANE BRIDGES (WIDTH 12.336, LENGTH 24.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.09**	1.33	1.05	1.05
FLS	**1.46**	2.75	1.31	1.34

COMPARISON OF Fm VALUES FOR B900 THREE-LANE BRIDGES (WIDTH 12.336, LENGTH 30.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.06**	1.32	1.05	1.05
FLS	**1.32**	2.71	1.26	1.32

COMPARISON OF Fm VALUES FOR B1000 THREE-LANE BRIDGES (WIDTH 12.336, LENGTH 26.0))

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.12**	1.32	1.05	1.05
FLS	**1.40**	2.74	1.29	1.34

COMPARISON OF Fm VALUES FOR B1000 THREE-LANE BRIDGES (WIDTH 12.336, LENGTH 32.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.07**	1.32	1.05	1.05
FLS	**1.29**	2.70	1.25	1.32

TABLE A.20: COMPARISON OF Fm VALUES FOR THREE-LANE, 11 BOX GIRDERS BRIDGES

COMPARISON OF Fm VALUES FOR B700 THREE-LANE BRIDGES (WIDTH 13.571, LENGTH 16.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.17**	1.51	1.15	1.21
FLS	**1.68**	3.15	1.58	1.51

COMPARISON OF Fm VALUES FOR B700 THREE-LANE BRIDGES (WIDTH 13.571, LENGTH 24.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	1.11	1.46	1.13	1.14
FLS	**1.44**	3.03	1.44	1.46

COMPARISON OF Fm VALUES FOR B800 THREE-LANE BRIDGES (WIDTH 13.571, LENGTH 20.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.16**	1.47	1.14	1.18
FLS	**1.54**	3.08	1.49	1.49

COMPARISON OF Fm VALUES FOR B800 THREE-LANE BRIDGES (WIDTH 13.571, LENGTH 26.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.13**	1.45	1.12	1.14
FLS	**1.41**	3.01	1.42	1.46

COMPARISON OF Fm VALUES FOR B900 THREE-LANE BRIDGES (WIDTH 13.571, LENGTH 24.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.13**	1.46	1.13	1.16
FLS	**1.44**	3.03	1.44	1.47

COMPARISON OF Fm VALUES FOR B900 THREE-LANE BRIDGES (WIDTH 13.571, LENGTH 30.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.08**	1.45	1.12	1.12
FLS	**1.37**	2.98	1.39	1.45

COMPARISON OF Fm VALUES FOR B1000 THREE-LANE BRIDGES (WIDTH 13.571, LENGTH 26.0))

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.11**	1.45	1.12	1.15
FLS	**1.37**	3.01	1.42	1.47

COMPARISON OF Fm VALUES FOR B1000 THREE-LANE BRIDGES (WIDTH 13.571, LENGTH 32.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.05**	1.45	1.11	1.12
FLS	**1.34**	2.97	1.37	1.45

TABLE A.21: COMPARISON OF Fv VALUES FOR THREE-LANE, 9 BOX GIRDERS BRIDGES

COMPARISON OF Fv VALUES FOR B700 THREE-LANE BRIDGES (WIDTH 11.101m, LENGTH 16.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.43**	1.35	1.32	1.15
FLS	**2.94**	3.08	2.92	2.61

COMPARISON OF Fv VALUES FOR B700 THREE-LANE BRIDGES (WIDTH 11.101m, LENGTH 24.0

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.30**	1.35	1.32	1.15
FLS	**2.46**	3.08	2.92	2.61

COMPARISON OF Fv VALUES FOR B800 THREE-LANE BRIDGES (WIDTH 11.101m, LENGTH 20.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.39**	1.35	1.32	1.15
FLS	**2.66**	3.08	2.92	2.61

COMPARISON OF Fv VALUES FOR B800 THREE-LANES BRIDGES (WIDTH 11.101m, LENGTH 26.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.30**	1.35	1.32	1.15
FLS	**2.41**	3.08	2.92	2.61

COMPARISON OF Fv VALUES FOR B900 THREE-LANE BRIDGES (WIDTH 11.101m, LENGTH 24.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.30**	1.35	1.32	1.15
FLS	**2.46**	3.08	2.92	2.61

COMPARISON OF Fv VALUES FOR B900 THREE-LANE BRIDGES (WIDTH 11.101m, LENGTH 30.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.27**	1.35	1.32	1.15
FLS	**2.33**	3.08	2.92	2.61

COMPARISON OF Fv VALUES FOR B1000 THREE-LANE BRIDGES (WIDTH 11.101m, LENGTH 26.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.30**	1.35	1.32	1.15
FLS	**2.41**	3.08	2.92	2.61

COMPARISON OF Fv VALUES FOR B1000 THREE-LANE BRIDGES (WIDTH 11.101m, LENGTH 32.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.27**	1.35	1.32	1.15
FLS	**2.33**	3.08	2.92	2.61

TABLE A.22: COMPARISON OF Fv VALUES FOR THREE-LANE, 10 BOX GIRDERS BRIDGES

COMPARISON OF Fv VALUES FOR B700 THREE-LANE BRIDGES (WIDTH 12.336m, LENGTH 16.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.53**	1.50	1.46	1.28
FLS	**3.48**	3.43	3.25	2.90

COMPARISON OF Fv VALUES FOR B700 THREE-LANE BRIDGES (WIDTH 12.336m, LENGTH 24.0

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.44**	1.50	1.46	1.28
FLS	**2.88**	3.43	3.25	2.90

COMPARISON OF Fv VALUES FOR B800 THREE-LANE BRIDGES (WIDTH 12.336m, LENGTH 20.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.41**	1.50	1.46	1.28
FLS	**3.02**	3.43	3.25	2.90

COMPARISON OF Fv VALUES FOR B800 THREE-LANE BRIDGES (WIDTH 12.336m, LENGTH 26.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.44**	1.50	1.46	1.28
FLS	**2.78**	3.43	3.25	2.90

COMPARISON OF Fv VALUES FOR B900 THREE-LANE BRIDGES (WIDTH 12.336m, LENGTH 24.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.44**	1.50	1.46	1.28
FLS	**2.88**	3.43	3.25	2.90

COMPARISON OF Fv VALUES FOR B900 THREE-LANE BRIDGES (WIDTH 12.336m, LENGTH 30.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.45**	1.50	1.46	1.28
FLS	**2.57**	3.43	3.25	2.90

COMPARISON OF Fv VALUES FOR B1000 THREE-LANE BRIDGES (WIDTH 12.336m, LENGTH 26.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.44**	1.50	1.46	1.28
FLS	**2.78**	3.43	3.25	2.90

COMPARISON OF Fv VALUES FOR B1000 THREE-LANE BRIDGES (WIDTH 12.336m, LENGTH 32.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.39**	1.50	1.46	1.28
FLS	**2.66**	3.43	3.25	2.90

TABLE A.23: COMPARISON OF Fv VALUES FOR THREE-LANE, 11 BOX GIRDERS BRIDGES

COMPARISON OF Fv VALUES FOR B700 THREE-LANE BRIDGES (WIDTH 13.571, LENGTH 16.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.76**	1.65	1.61	1.41
FLS	**3.72**	3.77	3.57	3.19

COMPARISON OF Fv VALUES FOR B700 THREE-LANE BRIDGES (WIDTH 13.571, LENGTH 24.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.58**	1.65	1.61	1.41
FLS	**3.12**	3.77	3.57	3.19

COMPARISON OF Fv VALUES FOR B800 THREE-LANE BRIDGES (WIDTH 13.571, LENGTH 20.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.64**	1.65	1.61	1.41
FLS	**3.23**	3.77	3.57	3.19

COMPARISON OF Fv VALUES FOR B800 THREE-LANE BRIDGES (WIDTH 13.571, LENGTH 26.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.57**	1.65	1.61	1.41
FLS	**3.00**	3.77	3.57	3.19

COMPARISON OF Fv VALUES FOR B900 THREE-LANE BRIDGES (WIDTH 13.571, LENGTH 24.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.58**	1.65	1.61	1.41
FLS	**3.12**	3.77	3.57	3.19

COMPARISON OF Fv VALUES FOR B900 THREE-LANE BRIDGES (WIDTH 13.571, LENGTH 30.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.56**	1.65	1.61	1.41
FLS	**2.91**	3.77	3.57	3.19

COMPARISON OF Fv VALUES FOR B1000 THREE-LANE BRIDGES (WIDTH 13.571, LENGTH 26.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.57**	1.65	1.61	1.41
FLS	**3.00**	3.77	3.57	3.19

COMPARISON OF Fv VALUES FOR B1000 THREE-LANE BRIDGES (WIDTH 13.571, LENGTH 32.0)

Options	Fv For Box Girders	Fv For I-Girders	Fv For Hollow Slab	Fv For Multi Spine
ULS AND SLS	**1.55**	1.65	1.61	1.41
FLS	**2.76**	3.77	3.57	3.19

TABLE A.24: COMPARISON OF Fd VALUES FOR THREE-LANE, 9 BOX GIRDERS BRIDGES

COMPARISON OF Fd VALUES FOR B700 THREE-LANE BRIDGES (WIDTH 11.101m, LENGTH 16.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.45**	1.82	1.29	1.24

COMPARISON OF Fd VALUES FOR B700 THREE-LANE BRIDGES (WIDTH 11.101m, LENGTH 24.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.28**	1.88	1.18	1.19

COMPARISON OF Fd VALUES FOR B800 THREE-LANE BRIDGES (WIDTH 11.101m, LENGTH 20.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.43**	1.80	1.22	1.22

COMPARISON OF Fd VALUES FOR B800 THREE-LANE BRIDGES (WIDTH 11.101m, LENGTH 26.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.23**	1.91	1.16	1.20

COMPARISON OF Fd VALUES FOR B900 THREE-LANE BRIDGES (WIDTH 11.101m, LENGTH 24.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.29**	1.79	1.18	1.20

COMPARISON OF Fd VALUES FOR B900 THREE-LANE BRIDGES (WIDTH 11.101m, LENGTH 30.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.20**	1.95	1.14	1.19

COMPARISON OF Fd VALUES FOR B1000 THREE-LANE BRIDGES (WIDTH 11.101m, LENGTH 26.0))

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.27**	1.78	1.16	1.20

COMPARISON OF Fd VALUES FOR B1000 THREE-LANE BRIDGES (WIDTH 11.101m, LENGTH 32.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.19**	1.96	1.12	1.19

TABLE A.25: COMPARISON OF Fd VALUES FOR THREE-LANE, 10 BOX GIRDERS BRIDGES

COMPARISON OF Fd VALUES FOR B700 THREE-LANE BRIDGES (WIDTH 12.336m, LENGTH 16.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.49**	2.02	1.44	1.37

COMPARISON OF Fd VALUES FOR B700 THREE-LANE BRIDGES (WIDTH 12.336m, LENGTH 24.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.30**	2.09	1.31	1.33

COMPARISON OF Fd VALUES FOR B800 THREE-LANE BRIDGES (WIDTH 12.336m, LENGTH 20.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.41**	2.00	1.35	1.35

COMPARISON OF Fd VALUES FOR B800 THREE-LANE BRIDGES (WIDTH 12.336m, LENGTH 26.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.28**	2.13	1.29	1.34

COMPARISON OF Fd VALUES FOR B900 THREE-LANE BRIDGES (WIDTH 12.336m, LENGTH 24.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.33**	1.99	1.31	1.34

COMPARISON OF Fd VALUES FOR B900 THREE-LANE BRIDGES (WIDTH 12.336m, LENGTH 30.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.22**	2.16	1.26	1.32

COMPARISON OF Fd VALUES FOR B1000 THREE-LANE BRIDGES (WIDTH 12.336m, LENGTH 26.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.32**	1.98	1.29	1.34

COMPARISON OF Fd VALUES FOR B1000 THREE-LANE BRIDGES (WIDTH 12.336m, LENGTH 32.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.21**	2.18	1.25	1.32

TABLE A.26: COMPARISON OF Fd VALUES FOR THREE-LANE, 11 BOX GIRDERS BRIDGES

COMPARISON OF Fd VALUES FOR B700 THREE-LANE BRIDGES (WIDTH 13.571m, LENGTH 16.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.46**	2.22	1.58	1.51

COMPARISON OF Fd VALUES FOR B700 THREE-LANE BRIDGES (WIDTH 13.571m, LENGTH 24.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.28**	2.30	1.44	1.46

COMPARISON OF Fd VALUES FOR B800 THREE-LANE BRIDGES (WIDTH 13.571m, LENGTH 20.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.38**	2.20	1.49	1.49

COMPARISON OF Fd VALUES FOR B800 THREE-LANE BRIDGES (WIDTH 13.571m, LENGTH 26.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.27**	2.34	1.42	1.47

COMPARISON OF Fd VALUES FOR B900 THREE-LANE BRIDGES (WIDTH 13.571m, LENGTH 24.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.31**	2.3	1.44	1.47

COMPARISON OF Fd VALUES FOR B900 THREE-LANE BRIDGES (WIDTH 13.571m, LENGTH 30.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.23**	2.38	1.39	1.45

COMPARISON OF Fd VALUES FOR B1000 THREE-LANE BRIDGES (WIDTH 13.571m, LENGTH 26.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.29**	2.34	1.42	1.47

COMPARISON OF Fd VALUES FOR B1000 THREE-LANE BRIDGES (WIDTH 13.571m, LENGTH 32.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.21**	2.40	1.37	1.45

TABLE A.27: COMPARISON OF Fm VALUES FOR FOUR-LANE, 12 BOX GIRDERS BRIDGES

COMPARISON OF Fm VALUES FOR B700 FOUR-LANE BRIDGES (WIDTH 14.806m, LENGTH 16.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.14**	1.41	1.05	1.12
FLS	**1.75**	3.38	1.60	1.65

COMPARISON OF Fm VALUES FOR B700 FOUR-LANE BRIDGES (WIDTH 17.276, LENGTH 24.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.06**	1.39	1.05	1.05
FLS	**1.53**	3.22	1.41	1.59

COMPARISON OF Fm VALUES FOR B800 FOUR-LANE BRIDGES (WIDTH 17.276, LENGTH 20.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.17**	1.40	1.05	1.08
FLS	**1.69**	3.28	1.48	1.63

COMPARISON OF Fm VALUES FOR B800 FOUR-LANE BRIDGES (WIDTH 17.276, LENGTH 26.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.06**	1.38	1.05	1.05
FLS	**1.50**	3.17	1.38	1.59

COMPARISON OF Fm VALUES FOR B900 FOUR-LANE BRIDGES (WIDTH 17.276, LENGTH 24.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.07**	1.39	1.05	1.05
FLS	**1.52**	3.22	1.41	1.61

COMPARISON OF Fm VALUES FOR B900 FOUR-LANE BRIDGES (WIDTH 17.276, LENGTH 30.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.05**	1.38	1.05	1.05
FLS	**1.35**	3.15	1.34	1.59

COMPARISON OF Fm VALUES FOR B1000 FOUR-LANE BRIDGES (WIDTH 17.276, LENGTH 26.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.07**	1.38	1.05	1.05
FLS	**1.50**	3.17	1.38	1.60

COMPARISON OF Fm VALUES FOR B1000 FOUR-LANE BRIDGES (WIDTH 17.276, LENGTH 32.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.04**	1.37	1.05	1.05
FLS	**1.35**	3.15	1.32	1.59

TABLE A.28: COMPARISON OF Fm VALUES FOR FOUR-LANE, 13 BOX GIRDERS BRIDGES

COMPARISON OF Fm VALUES FOR B700 FOUR-LANE BRIDGES (WIDTH 16.041m, LENGTH 16.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.15**	1.52	1.05	1.22
FLS	**1.87**	3.66	1.74	1.79

COMPARISON OF Fm VALUES FOR B700 FOUR-LANE BRIDGES (WIDTH 16.041m, LENGTH 24.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.08**	1.50	1.05	1.11
FLS	**1.62**	3.49	1.52	1.73

COMPARISON OF Fm VALUES FOR B800 FOUR-LANE BRIDGES (WIDTH 16.041m, LENGTH 20.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.13**	1.51	1.05	1.17
FLS	**1.80**	3.56	1.61	1.76

COMPARISON OF Fm VALUES FOR B800 FOUR-LANE BRIDGES (WIDTH 16.041m, LENGTH 26.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.12**	1.50	1.05	1.11
FLS	**1.58**	3.44	1.49	1.73

COMPARISON OF Fm VALUES FOR B900 FOUR-LANE BRIDGES (WIDTH 16.041m, LENGTH 24.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.08**	1.50	1.05	1.14
FLS	**1.60**	3.49	1.52	1.75

COMPARISON OF Fm VALUES FOR B900 FOUR-LANE BRIDGES (WIDTH 16.041m, LENGTH 30.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.06**	1.50	1.05	1.10
FLS	**1.43**	3.42	1.45	1.72

COMPARISON OF Fm VALUES FOR B1000 FOUR-LANE BRIDGES (WIDTH 16.041m, LENGTH 26.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.08**	1.50	1.05	1.13
FLS	**1.51**	3.44	1.49	1.74

COMPARISON OF Fm VALUES FOR B1000 FOUR-LANE BRIDGES (WIDTH 16.041m, LENGTH 32.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.04**	1.49	1.05	1.10
FLS	**1.41**	3.41	1.43	1.72

TABLE A.29: COMPARISON OF Fm VALUES FOR FOUR-LANE, 14 BOX GIRDERS BRIDGES

COMPARISON OF Fm VALUES FOR B700 FOUR-LANE BRIDGES (WIDTH 17.276m, LENGTH 16.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.19**	1.64	1.13	1.31
FLS	**1.93**	3.94	1.87	1.93

COMPARISON OF Fm VALUES FOR B700 FOUR-LANE BRIDGES (WIDTH 17.276m, LENGTH 24.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.09**	1.62	1.10	1.20
FLS	**1.71**	3.76	1.64	1.86

COMPARISON OF Fm VALUES FOR B800 FOUR-LANE BRIDGES (WIDTH 17.276m, LENGTH 20.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.18**	1.63	1.11	1.26
FLS	**1.85**	3.83	1.73	1.90

COMPARISON OF Fm VALUES FOR B800 FOUR-LANE BRIDGES (WIDTH 17.276m, LENGTH 26.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.09**	1.61	1.09	1.20
FLS	**1.61**	3.70	1.61	1.86

COMPARISON OF Fm VALUES FOR B900 FOUR-LANE BRIDGES (WIDTH 17.276m, LENGTH 24.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.11**	1.62	1.10	1.23
FLS	**1.67**	3.76	1.64	1.88

COMPARISON OF Fm VALUES FOR B900 FOUR-LANE BRIDGES (WIDTH 17.276m, LENGTH 30.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.08**	1.61	1.09	1.18
FLS	**1.49**	3.68	1.56	1.85

COMPARISON OF Fm VALUES FOR B1000 FOUR-LANE BRIDGES (WIDTH 17.276m, LENGTH 26.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.10**	1.61	1.09	1.22
FLS	**1.62**	3.70	1.61	1.87

COMPARISON OF Fm VALUES FOR B1000 FOUR-LANE BRIDGES (WIDTH 17.276m, LENGTH 32.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.06**	1.6	1.08	1.18
FLS	**1.45**	3.67	1.54	1.85

TABLE A.30: COMPARISON OF Fv VALUES FOR FOUR-LANE, 12 BOX GIRDERS BRIDGES

COMPARISON OF Fv VALUES FOR B700 FOUR-LANE BRIDGES (WIDTH 14.806m, LENGTH 16.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.58**	1.56	1.51	1.32
FLS	**4.16**	4.00	3.79	3.48

COMPARISON OF Fv VALUES FOR B700 FOUR-LANE BRIDGES (WIDTH 14.806m, LENGTH 24.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.45**	1.56	1.51	1.32
FLS	**3.44**	4.00	3.79	3.48

COMPARISON OF Fv VALUES FOR B800 FOUR-LANE BRIDGES (WIDTH 14.806m, LENGTH 20.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.55**	1.56	1.51	1.32
FLS	**3.59**	4.00	3.79	3.48

COMPARISON OF Fv VALUES FOR B800 FOUR-LANE BRIDGES (WIDTH 14.806m, LENGTH 26.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.44**	1.56	1.51	1.32
FLS	**3.31**	4.00	3.79	3.48

COMPARISON OF Fv VALUES FOR B900 FOUR-LANE BRIDGES (WIDTH 14.806m, LENGTH 24.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.45**	1.56	1.51	1.32
FLS	**3.44**	4.00	3.79	3.48

COMPARISON OF Fv VALUES FOR B900 FOUR-LANE BRIDGES (WIDTH 14.806m, LENGTH 30.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.44**	1.56	1.51	1.32
FLS	**3.15**	4.00	3.79	3.48

COMPARISON OF Fv VALUES FOR B1000 FOUR-LANE BRIDGES (WIDTH 14.806m, LENGTH 26.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.44**	1.56	1.51	1.32
FLS	**3.31**	4.00	3.79	3.48

COMPARISON OF Fv VALUES FOR B1000 FOUR-LANE BRIDGES (WIDTH 14.806m, LENGTH 32.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.44**	1.56	1.51	1.32
FLS	**3.08**	4.00	3.79	3.48

TABLE A.31: COMPARISON OF Fv VALUES FOR FOUR-LANE, 13 BOX GIRDERS BRIDGES

COMPARISON OF Fv VALUES FOR B700 FOUR-LANE BRIDGES (WIDTH 16.041m, LENGTH 16.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.60**	1.69	1.63	1.43
FLS	**4.50**	4.34	4.10	3.77

COMPARISON OF Fv VALUES FOR B700 FOUR-LANE BRIDGES (WIDTH 16.041m, LENGTH 24.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.58**	1.69	1.63	1.43
FLS	**3.54**	4.34	4.10	3.77

COMPARISON OF Fv VALUES FOR B800 FOUR-LANE BRIDGES (WIDTH 16.041m, LENGTH 20.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.67**	1.69	1.63	1.43
FLS	**3.89**	4.34	4.10	3.77

COMPARISON OF Fv VALUES FOR B800 FOUR-LANE BRIDGES (WIDTH 16.041m, LENGTH 26.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.59**	1.69	1.63	1.43
FLS	**3.56**	4.34	4.10	3.77

COMPARISON OF Fv VALUES FOR B900 FOUR-LANE BRIDGES (WIDTH 16.041m, LENGTH 24.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.58**	1.69	1.63	1.43
FLS	**3.54**	4.34	4.10	3.77

COMPARISON OF Fv VALUES FOR B900 FOUR-LANE BRIDGES (WIDTH 16.041m, LENGTH 30.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.56**	1.69	1.63	1.43
FLS	**3.33**	4.34	4.10	3.77

COMPARISON OF Fv VALUES FOR B1000 FOUR-LANE BRIDGES (WIDTH 16.041m, LENGTH 26.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.59**	1.69	1.63	1.43
FLS	**3.56**	4.34	4.10	3.77

COMPARISON OF Fv VALUES FOR B1000 FOUR-LANE BRIDGES (WIDTH 16.041m, LENGTH 32.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.57**	1.69	1.63	1.43
FLS	**3.36**	4.34	4.10	3.77

TABLE A.32: COMPARISON OF Fv VALUES FOR FOUR-LANE, 14 BOX GIRDERS BRIDGES

COMPARISON OF Fv VALUES FOR B700 FOUR-LANE BRIDGES (WIDTH 17.276m, LENGTH 16.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.88**	1.82	1.76	1.54
FLS	**4.71**	4.67	4.42	4.06

COMPARISON OF Fv VALUES FOR B700 FOUR-LANE BRIDGES (WIDTH 17.276m, LENGTH 24.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.68**	1.82	1.76	1.54
FLS	**3.92**	4.67	4.42	4.06

COMPARISON OF Fv VALUES FOR B800 FOUR-LANE BRIDGES (WIDTH 17.276m, LENGTH 20.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.76**	1.82	1.76	1.54
FLS	**4.07**	4.67	4.42	4.06

COMPARISON OF Fv VALUES FOR B800 FOUR-LANE BRIDGES (WIDTH 17.276m, LENGTH 26.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.67**	1.82	1.76	1.54
FLS	**3.77**	4.67	4.42	4.06

COMPARISON OF Fv VALUES FOR B900 FOUR-LANE BRIDGES (WIDTH 17.276m, LENGTH 24.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.68**	1.82	1.76	1.54
FLS	**3.92**	4.67	4.42	4.06

COMPARISON OF Fv VALUES FOR B900 FOUR-LANE BRIDGES (WIDTH 17.276m, LENGTH 30.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.66**	1.82	1.76	1.54
FLS	**3.58**	4.67	4.42	4.06

COMPARISON OF Fv VALUES FOR B1000 FOUR-LANE BRIDGES (WIDTH 17.276m, LENGTH 26.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.67**	1.82	1.76	1.54
FLS	**3.77**	4.67	4.42	4.06

COMPARISON OF Fv VALUES FOR B1000 FOUR-LANE BRIDGES (WIDTH 17.276m, LENGTH 32.0)

Options	Fm For Box Girders	Fm For I-Girders	Fm For Hollow Slab	Fm For Multi Spine
ULS AND SLS	**1.68**	1.82	1.76	1.54
FLS	**3.47**	4.67	4.42	4.06

TABLE A.33: COMPARISON OF Fd VALUES FOR FOUR-LANE, 12 BOX GIRDERS BRIDGES

COMPARISON OF Fd VALUES FOR B700 FOUR-LANE BRIDGES (WIDTH 14.806m, LENGTH 16.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.73**	2.40	1.60	1.65

COMPARISON OF Fd VALUES FOR B700 FOUR-LANE BRIDGES (WIDTH 14.806m, LENGTH 24.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.46**	2.45	1.41	1.59

COMPARISON OF Fd VALUES FOR B800 FOUR-LANE BRIDGES (WIDTH 14.806m, LENGTH 20.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS		2.34	1.48	1.63

COMPARISON OF Fd VALUES FOR B800 FOUR-LANE BRIDGES (WIDTH 14.806m, LENGTH 26.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS		2.49	1.38	1.59

COMPARISON OF Fd VALUES FOR B900 FOUR-LANE BRIDGES (WIDTH 14.806m, LENGTH 24.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.52**	2.45	1.41	1.61

COMPARISON OF Fd VALUES FOR B900 FOUR-LANE BRIDGES (WIDTH 14.806m, LENGTH 30.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.37**	2.54	1.34	1.59

COMPARISON OF Fd VALUES FOR B1000 FOUR-LANE BRIDGES (WIDTH 14.806m, LENGTH 26.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.48**	2.49	1.38	1.60

COMPARISON OF Fd VALUES FOR B1000 FOUR-LANE BRIDGES (WIDTH 14.806m, LENGTH 32.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.36**	2.55	1.32	1.59

TABLE A.34: COMPARISON OF Fd VALUES FOR FOUR-LANE, 13 BOX GIRDERS BRIDGES

COMPARISON OF Fd VALUES FOR B700 FOUR-LANE BRIDGES (WIDTH 16.041m, LENGTH 16.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.83**	2.60	1.74	1.79

COMPARISON OF Fd VALUES FOR B700 FOUR-LANE BRIDGES (WIDTH 16.041m, LENGTH 24.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.48**	2.66	1.52	1.73

COMPARISON OF Fd VALUES FOR B800 FOUR-LANE BRIDGES (WIDTH 16.041m, LENGTH 20.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.73**	2.54	1.61	1.76

COMPARISON OF Fd VALUES FOR B800 FOUR-LANE BRIDGES (WIDTH 16.041m, LENGTH 26.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.52**	2.69	1.49	1.73

COMPARISON OF Fd VALUES FOR B900 FOUR-LANE BRIDGES (WIDTH 16.041m, LENGTH 24.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.60**	2.66	1.52	1.75

COMPARISON OF Fd VALUES FOR B900 FOUR-LANE BRIDGES (WIDTH 16.041m, LENGTH 30.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.44**	2.75	1.45	1.72

COMPARISON OF Fd VALUES FOR B1000 FOUR-LANE BRIDGES (WIDTH 16.041m, LENGTH 26.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.56**	2.69	1.49	1.74

COMPARISON OF Fd VALUES FOR B1000 FOUR-LANE BRIDGES (WIDTH 16.041m, LENGTH 32.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.43**	2.77	1.43	1.72

TABLE A.35: COMPARISON OF Fd VALUES FOR FOUR-LANE, 14 BOX GIRDERS BRIDGES

COMPARISON OF Fd VALUES FOR B700 FOUR-LANE BRIDGES (WIDTH 17.2766m, LENGTH 16.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.80**	2.80	1.87	1.93

COMPARISON OF Fd VALUES FOR B700 FOUR-LANE BRIDGES (WIDTH 17.2766m, LENGTH 24.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.51**	2.86	1.64	1.86

COMPARISON OF Fd VALUES FOR B800 FOUR-LANE BRIDGES (WIDTH 17.2766m, LENGTH 20.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.66**	2.73	1.73	1.90

COMPARISON OF Fd VALUES FOR B800 FOUR-LANE BRIDGES (WIDTH 17.2766m, LENGTH 26.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.48**	2.90	1.61	1.86

COMPARISON OF Fd VALUES FOR B900 FOUR-LANE BRIDGES (WIDTH 17.2766m, LENGTH 24.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.55**	2.86	1.64	1.88

COMPARISON OF Fd VALUES FOR B900 FOUR-LANE BRIDGES (WIDTH 17.2766m, LENGTH 30.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.42**	2.96	1.56	1.85

COMPARISON OF Fd VALUES FOR B1000 FOUR-LANE BRIDGE (WIDTH 17.2766m, LENGTH 26.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.52**	2.90	1.61	1.87

COMPARISON OF Fd VALUES FOR B1000 FOUR-LANE BRIDGE (WIDTH 17.2766m, LENGTH 32.0)

Options	Fd For Box Girders	Fd For I-Girders	Fd For Hollow Slab	Fd For Multi Spine
FLS	**1.41**	2.98	1.54	1.85

TABLE A.36: Fm VALUES FOR B700 TWO-LANE BRIDGE 16m LENGTH

TWO-LANE BRIDGE : 6 Girders, 7.396m Width, 16m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	6	1147.2	0.0417	0.4235	2676.6	0.76578
2-ULS	2	0.9	0.9	6	1147.2	0.0417	0.4235	4260.8	1.09712
3-ULS	2	0.9	0.9	6	1147.2	0.0417	0.4235	3996.8	1.02915
4-FLS	2	0.9	1	6	1147.2	0.0417	0.4235	2265.4	1.16665

TWO-LANE BRIDGE : 7 Girders, 8.631m Width, 16m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	7	1147.2	0.0417	0.4235	2210.3	0.73777
2-ULS	2	0.9	0.9	7	1147.2	0.0417	0.4235	3527.4	1.05966
3-ULS	2	0.9	0.9	7	1147.2	0.0417	0.4235	3674.2	1.10376
4-FLS	2	0.9	1	7	1147.2	0.0417	0.4235	2020.5	1.21395

TWO-LANE BRIDGE : 8 Girders, 9.866m Width, 16m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	8	1147.2	0.0417	0.4235	2104.2	0.80269
2-ULS	2	0.9	0.9	8	1147.2	0.0417	0.4235	3192.3	1.09599
3-ULS	2	0.9	0.9	8	1147.2	0.0417	0.4235	3290.8	1.12981
4-FLS	2	0.9	1	8	1147.2	0.0417	0.4235	1864.3	1.28012

TABLE A.37: Fm VALUES FOR B700 TWO-LANE BRIDGE 24m LENGTH

TWO-LANE BRIDGE : 6 Girders, 7.396m Width, 24m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	6	2113.9	0.0417	0.4235	4061.2	0.63057
2-ULS	2	0.9	0.9	6	2113.9	0.0417	0.4235	7316.5	1.0224
3-ULS	2	0.9	0.9	6	2113.9	0.0417	0.4235	7272.6	1.01627
4-FLS	2	0.9	1	6	2113.9	0.0417	0.4235	3914.8	1.09411

TWO-LANE BRIDGE : 7 Girders, 8.631m Width, 24m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	7	2113.9	0.0417	0.4235	3667.1	0.66427
2-ULS	2	0.9	0.9	7	2113.9	0.0417	0.4235	6304.5	1.02782
3-ULS	2	0.9	0.9	7	2113.9	0.0417	0.4235	6409.4	1.04492
4-FLS	2	0.9	1	7	2113.9	0.0417	0.4235	3438.2	1.12106

TWO-LANE BRIDGE : 8 Girders, 9.866m Width, 24m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	8	2113.9	0.0417	0.4235	3397.2	0.70329
2-ULS	2	0.9	0.9	8	2113.9	0.0417	0.4235	5622.3	1.04754
3-ULS	2	0.9	0.9	8	2113.9	0.0417	0.4235	5673.4	1.05706
4-FLS	2	0.9	1	8	2113.9	0.0417	0.4235	3230.6	1.20385

TABLE A.38: Fm VALUES FOR B800 TWO-LANE BRIDGE 20m LENGTH

TWO-LANE BRIDGE : 6 Girders, 7.396m Width, 20m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	6	1617.9	0.0575	0.4619	2655.5	0.68107
2-ULS	2	0.9	0.9	6	1617.9	0.0575	0.4619	4656.3	1.07481
3-ULS	2	0.9	0.9	6	1617.9	0.0575	0.4619	4663.2	1.0764
4-FLS	2	0.9	1	6	1617.9	0.0575	0.4619	2555.6	1.17981

TWO-LANE BRIDGE : 7 Girders, 8.631m Width, 20m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	7	1617.9	0.0575	0.4619	2442.6	0.73088
2-ULS	2	0.9	0.9	7	1617.9	0.0575	0.4619	4050.2	1.09072
3-ULS	2	0.9	0.9	7	1617.9	0.0575	0.4619	4089.5	1.1013
4-FLS	2	0.9	1	7	1617.9	0.0575	0.4619	2263.9	1.21934

TWO-LANE BRIDGE : 8 Girders, 9.866m Width, 20m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	8	1617.9	0.0575	0.4619	2300	0.78653
2-ULS	2	0.9	0.9	8	1617.9	0.0575	0.4619	3619.9	1.1141
3-ULS	2	0.9	0.9	8	1617.9	0.0575	0.4619	3644.2	1.12158
4-FLS	2	0.9	1	8	1617.9	0.0575	0.4619	2067.8	1.27282

TABLE A.39: Fm VALUES FOR B800 TWO-LANE BRIDGE 26m LENGTH

TWO-LANE BRIDGE : 6 Girders, 7.396m Width, 26m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	6	2415.8	0.0575	0.4619	3797.4	0.65226
2-ULS	2	0.9	0.9	6	2415.8	0.0575	0.4619	6874.6	1.06274
3-ULS	2	0.9	0.9	6	2415.8	0.0575	0.4619	6883.4	1.0641
4-FLS	2	0.9	1	6	2415.8	0.0575	0.4619	3676.4	1.13667

TWO-LANE BRIDGE : 7 Girders, 8.631m Width, 26m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	7	2415.8	0.0575	0.4619	3422.7	0.68589
2-ULS	2	0.9	0.9	7	2415.8	0.0575	0.4619	5981.5	1.07879
3-ULS	2	0.9	0.9	7	2415.8	0.0575	0.4619	6035.4	1.08851
4-FLS	2	0.9	1	7	2415.8	0.0575	0.4619	3211.7	1.15849

TWO-LANE BRIDGE : 8 Girders, 9.866m Width, 26m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	8	2415.8	0.0575	0.4619	3164.7	0.72478
2-ULS	2	0.9	0.9	8	2415.8	0.0575	0.4619	5364.2	1.10567
3-ULS	2	0.9	0.9	8	2415.8	0.0575	0.4619	5367.5	1.10635
4-FLS	2	0.9	1	8	2415.8	0.0575	0.4619	2924.6	1.20563

TABLE A.40: Fm VALUES FOR B900 TWO-LANE BRIDGE 24m LENGTH

B900 TWO-LANE BRIDGE : 6 Girders, 7.396m Width, 24m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	6	2113.9	0.0756	0.535	2791.5	0.62201
2-ULS	2	0.9	0.9	6	2113.9	0.0756	0.535	5138.6	1.0305
3-ULS	2	0.9	0.9	6	2113.9	0.0756	0.535	5143.7	1.03153
4-FLS	2	0.9	1	6	2113.9	0.0756	0.535	2731.4	1.09552

B900 TWO-LANE BRIDGE : 7 Girders, 8.631m Width, 24m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	7	2113.9	0.0756	0.535	2597.8	0.67533
2-ULS	2	0.9	0.9	7	2113.9	0.0756	0.535	4447.8	1.04063
3-ULS	2	0.9	0.9	7	2113.9	0.0756	0.535	4501.7	1.05324
4-FLS	2	0.9	1	7	2113.9	0.0756	0.535	2424.9	1.13469

B900 2- LANE BRIDGE : 8 Girders, 9.866m Width, 24m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	8	2113.9	0.0756	0.535	2370.4	0.70424
2-ULS	2	0.9	0.9	8	2113.9	0.0756	0.535	3941.3	1.05386
3-ULS	2	0.9	0.9	8	2113.9	0.0756	0.535	4014.6	1.07346
4-FLS	2	0.9	1	8	2113.9	0.0756	0.535	2258.9	1.20801

TABLE A.41: Fm VALUES FOR B900 TWO-LANE BRIDGE 30m LENGTH

B900 TWO-LANE BRIDGE : 7.396m Width, 30m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	6	3025	0.0756	0.535	3952.2	0.6154
2-ULS	2	0.9	0.9	6	3025	0.0756	0.535	7134.6	0.99985
3-ULS	2	0.9	0.9	6	3025	0.0756	0.535	7149.5	1.00194
4-FLS	2	0.9	1	6	3025	0.0756	0.535	3840.8	1.0765

B900 TWO-LANE BRIDGE : 8.631m Width, 30m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	7	3025	0.0756	0.535	3541.2	0.64331
2-ULS	2	0.9	0.9	7	3025	0.0756	0.535	6308.5	1.03142
3-ULS	2	0.9	0.9	7	3025	0.0756	0.535	6338.9	1.03639
4-FLS	2	0.9	1	7	3025	0.0756	0.535	3333.7	1.0901

B900 TWO-LANE BRIDGE : 9.866m Width, 30m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	8	3025	0.0756	0.535	3189.4	0.66217
2-ULS	2	0.9	0.9	8	3025	0.0756	0.535	5541.2	1.0354
3-ULS	2	0.9	0.9	8	3025	0.0756	0.535	5618.9	1.04991
4-FLS	2	0.9	1	8	3025	0.0756	0.535	3005.8	1.12329

TABLE A.42: Fm VALUES FOR B1000 TWO-LANE BRIDGE 26m LENGTH

B1000 TWO-LANE BRIDGE : 6 Girders, 7.396m Width, 26m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	6	2415.8	0.0969	0.59	2729.4	0.61852
2-ULS	2	0.9	0.9	6	2415.8	0.0969	0.59	4918.4	1.00313
3-ULS	2	0.9	0.9	6	2415.8	0.0969	0.59	4924.5	1.00437
4-FLS	2	0.9	1	6	2415.8	0.0969	0.59	2688.7	1.09674

B1000 TWO-LANE BRIDGE : 7 Girders, 8.631m Width, 26m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	7	2415.8	0.0969	0.59	2522.1	0.6668
2-ULS	2	0.9	0.9	7	2415.8	0.0969	0.59	4270.8	1.01622
3-ULS	2	0.9	0.9	7	2415.8	0.0969	0.59	4342.5	1.03328
4-FLS	2	0.9	1	7	2415.8	0.0969	0.59	2376.4	1.13091

B1000 TWO-LANE BRIDGE : 8 Girders, 9.866m Width, 26m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	8	2415.8	0.0969	0.59	2345.6	0.70873
2-ULS	2	0.9	0.9	8	2415.8	0.0969	0.59	3854.4	1.04816
3-ULS	2	0.9	0.9	8	2415.8	0.0969	0.59	3930.1	1.06875
4-FLS	2	0.9	1	8	2415.8	0.0969	0.59	2165.9	1.17798

TABLE A.43: Fm VALUES FOR B1000 TWO-LANE BRIDGE 32m LENGTH

B1000 TWO-LANE BRIDGE : 6 Girders, 7.396m Width, 32m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	6	3382.2	0.0969	0.59	3725.4	0.603
2-ULS	2	0.9	0.9	6	3382.2	0.0969	0.59	6862.3	0.9997
3-ULS	2	0.9	0.9	6	3382.2	0.0969	0.59	6894.1	1.0043
4-FLS	2	0.9	1	6	3382.2	0.0969	0.59	3627.6	1.0569

B1000 TWO-LANE BRIDGE : 7 Girders, 8.631m Width, 32m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	7	3382.2	0.0969	0.59	3284.6	0.6203
2-ULS	2	0.9	0.9	7	3382.2	0.0969	0.59	5930.7	1.008
3-ULS	2	0.9	0.9	7	3382.2	0.0969	0.59	5961.2	1.0132
4-FLS	2	0.9	1	7	3382.2	0.0969	0.59	3152.4	1.0715

B1000 TWO-LANE BRIDGE : 8 Girders, 9.866m Width, 32m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	8	3382.2	0.0969	0.59	3006.1	0.6488
2-ULS	2	0.9	0.9	8	3382.2	0.0969	0.59	5221.6	1.0142
3-ULS	2	0.9	0.9	8	3382.2	0.0969	0.59	5240.4	1.0179
4-FLS	2	0.9	1	8	3382.2	0.0969	0.59	2823.4	1.0968

TABLE A.44: Fv VALUES FOR B700 TWO-LANE BRIDGE 16m LENGTH

TWO-LANE BRIDGE : 6 Girders, 7.396m Width, 16m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	6	326.8	98.1	1.00061
2-ULS	2	0.9	0.9	6	326.8	140.2	1.28703
3-ULS	2	0.9	0.9	6	326.8	141.3	1.29712
4-FLS	2	0.9	1	6	326.8	108.8	1.99755

TWO-LANE BRIDGE : 7 Girders, 8.631m Width, 16m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	7	326.8	97.5	1.16024
2-ULS	2	0.9	0.9	7	326.8	129.1	1.38265
3-ULS	2	0.9	0.9	7	326.8	136.8	1.46512
4-FLS	2	0.9	1	7	326.8	115.5	2.47399

TWO-LANE BRIDGE : 8 Girders, 9.866m Width, 16m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	8	326.8	97.2	1.32191
2-ULS	2	0.9	0.9	8	326.8	123.1	1.50673
3-ULS	2	0.9	0.9	8	326.8	137.6	1.68421
4-FLS	2	0.9	1	8	326.8	112.2	2.74663

TABLE A.45: Fv VALUES FOR B700 TWO-LANE BRIDGE 24m LENGTH

TWO-LANE BRIDGE : 6 Girders,7.396m Width, 24m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	6	395.6	129.3	1.08948
2-ULS	2	0.9	0.9	6	395.6	158.7	1.20349
3-ULS	2	0.9	0.9	6	395.6	159.9	1.21259
4-FLS	2	0.9	1	6	395.6	115.2	1.74722

TWO-LANE BRIDGE : 7 Girders, 8.631m Width, 24m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	7	395.6	130.3	1.2809
2-ULS	2	0.9	0.9	7	395.6	144.4	1.27755
3-ULS	2	0.9	0.9	7	395.6	153.6	1.35895
4-FLS	2	0.9	1	7	395.6	118.2	2.09151

TWO-LANE BRIDGE : 8 Girders, 9.866m Width, 24m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	8	395.6	130.8	1.4695
2-ULS	2	0.9	0.9	8	395.6	138.3	1.39838
3-ULS	2	0.9	0.9	8	395.6	154.1	1.55814
4-FLS	2	0.9	1	8	395.6	109.5	2.21436

TABLE A.46: Fv VALUES FOR B800 TWO-LANE BRIDGE 20m LENGTH

TWO-LANE BRIDGE : 6 Girders, 7.396m Width, 20m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	6	349.7	106.3	1.01325
2-ULS	2	0.9	0.9	6	349.7	143.1	1.22762
3-ULS	2	0.9	0.9	6	349.7	144.5	1.23963
4-FLS	2	0.9	1	6	349.7	105.4	1.80841

TWO-LANE BRIDGE : 7 Girders, 8.631m Width, 20m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	7	349.7	106.2	1.18101
2-ULS	2	0.9	0.9	7	349.7	128.6	1.2871
3-ULS	2	0.9	0.9	7	349.7	136.6	1.36717
4-FLS	2	0.9	1	7	349.7	104.2	2.08579

TWO-LANE BRIDGE : 8 Girders, 9.866m Width, 20m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	8	349.7	105.7	1.34337
2-ULS	2	0.9	0.9	8	349.7	120.4	1.37718
3-ULS	2	0.9	0.9	8	349.7	140.8	1.61052
4-FLS	2	0.9	1	8	349.7	104.9	2.39977

TABLE A.47: Fv VALUES FOR B800 TWO-LANE BRIDGE 26m LENGTH

TWO-LANE BRIDGE : 6 Girders, 7.396m Width, 26m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	6	413.3	134.2	1.08235
2-ULS	2	0.9	0.9	6	413.3	164.0	1.19042
3-ULS	2	0.9	0.9	6	413.3	165.5	1.20131
4-FLS	2	0.9	1	6	413.3	116.8	1.69562

TWO-LANE BRIDGE : 7 Girders, 8.631m Width, 26m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	7	413.3	133.3	1.25427
2-ULS	2	0.9	0.9	7	413.3	146.7	1.24232
3-ULS	2	0.9	0.9	7	413.3	144.4	1.22284
4-FLS	2	0.9	1	7	413.3	119.6	2.02565

TWO-LANE BRIDGE : 8 Girders, 9.866m Width, 26m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	8	413.3	136.2	1.46463
2-ULS	2	0.9	0.9	8	413.3	136.7	1.32301
3-ULS	2	0.9	0.9	8	413.3	158.7	1.53593
4-FLS	2	0.9	1	8	413.3	108.9	2.10791

TABLE A.48: Fv VALUES FOR B900 TWO-LANE BRIDGE 30m LENGTH

TWO-LANE BRIDGE : 6 Girders, 7.396m Width, 30m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	6	441.5	144.2	1.08841
2-ULS	2	0.9	0.9	6	441.5	172.2	1.1701
3-ULS	2	0.9	0.9	6	441.5	174.3	1.18437
4-FLS	2	0.9	1	6	441.5	122.1	1.65934

TWO-LANE BRIDGE : 7 Girders, 8.631m Width, 30m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	7	441.5	146.2	1.28778
2-ULS	2	0.9	0.9	7	441.5	151.9	1.20419
3-ULS	2	0.9	0.9	7	441.5	158.6	1.25730
4-FLS	2	0.9	1	7	441.5	122.3	1.93907

TWO-LANE BRIDGE : 8 Girders, 9.866m Width, 30m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	8	441.5	147.4	1.48383
2-ULS	2	0.9	0.9	8	441.5	160.5	1.45413
3-ULS	2	0.9	0.9	8	441.5	166.4	1.50759
4-FLS	2	0.9	1	8	441.5	111.5	2.02039

TABLE A.49: Fv VALUES FOR B1000 TWO-LANE BRIDGE 32m LENGTH

TWO-LANE BRIDGE : 6 Girders, 7.396m Width, 32m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	6	452.9	147.1	1.08265
2-ULS	2	0.9	0.9	6	452.9	175.3	1.16118
3-ULS	2	0.9	0.9	6	452.9	178.2	1.18039
4-FLS	2	0.9	1	6	452.9	124.3	1.64672

TWO-LANE BRIDGE : 7 Girders, 8.631m Width, 32m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	7	452.9	149.2	1.28113
2-ULS	2	0.9	0.9	7	452.9	152.7	1.18006
3-ULS	2	0.9	0.9	7	452.9	173.5	1.34080
4-FLS	2	0.9	1	7	452.9	122.4	1.89181

TWO-LANE BRIDGE : 8 Girders, 9.866m Width, 32m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	8	452.9	150.4	1.47592
2-ULS	2	0.9	0.9	8	452.9	140.2	1.23824
3-ULS	2	0.9	0.9	8	452.9	169.9	1.50055
4-FLS	2	0.9	1	8	452.9	111.8	1.97483

TABLE A.50: Fd VALUES FOR B700 TWO-LANE BRIDGE 16m LENGTH

TWO-LANE BRIDGE : 6 Girders, 7.396m Width, 16m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
4-FLS	2	0.9	1	6	24.09	4.6	1.1457

2-LANE BRIDGE : 7 Girders, 8.631m Width, 16m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
4-FLS	2	0.9	1	7	24.09	4.1	1.19137

TWO-LANE BRIDGE : 8 Girders, 9.866m Width, 16m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
4-FLS	2	0.9	1	8	24.09	3.5	1.16231

TABLE A.51: Fd VALUES FOR B700 TWO-LANE BRIDGE 24m LENGTH

TWO-LANE BRIDGE : 6 Girders, 7.396m Width, 24m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
4-FLS	2	0.9	1	6	104.25	18.7	1.07626

TWO-LANE BRIDGE : 7 Girders, 8.631m Width, 24m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
4-FLS	2	0.9	1	7	104.25	16.4	1.1012

TWO-LANE BRIDGE : 8 Girders, 9.866m Width, 24m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
4-FLS	2	0.9	1	8	104.25	15.4	1.18177

TABLE A.52: Fd VALUES FOR B800 TWO-LANE BRIDGE 20m LENGTH

TWO-LANE BRIDGE : 6 Girders, 7.396m Width, 20m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
4-FLS	2	0.9	1	6	38.97	7.3	1.12394

TWO-LANE BRIDGE : 7 Girders, 8.631m Width, 20m Length

Load Cases	n	RL	RL'	N	MT	Smax	Fd
4-FLS	2	0.9	1	7	38.97	6.4	1.1496

TWO-LANE BRIDGE : 8 Girders, 9.866m Width, 20m Length

Load Cases	n	RL	RL'	N	MT	Smax	Fd

TABLE A.53: Fd VALUES FOR B800 TWO-LANE BRIDGE 26m LENGTH

TWO-LANE BRIDGE : 6 Girders, 7.396m Width, 26m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
4-FLS	2	0.9	1	6	101.96	18.2	1.07101

TWO-LANE BRIDGE : 7 Girders, 8.631m Width, 26m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
4-FLS	2	0.9	1	7	101.96	16.0	1.09847

TWO-LANE BRIDGE : 8 Girders, 9.866m Width, 26m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
4-FLS	2	0.9	1	8	101.96	14.2	1.11416

TABLE A.54: Fd VALUES FOR B900 TWO-LANE BRIDGE 24m LENGTH

TWO-LANE BRIDGE : 6 Girders, 7.396m Width, 24m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
4-FLS	2	0.9	1	6	57.51	10.4	1.08503

TWO-LANE BRIDGE : 7 Girders, 8.631m Width, 24m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
4-FLS	2	0.9	1	7	57.51	9.1	1.10763

TWO-LANE BRIDGE : 8 Girders, 9.866m Width, 24m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
4-FLS	2	0.9	1	8	57.51	8.2	1.14067

TABLE A.55: Fd VALUES FOR B900 TWO-LANE BRIDGE 30m LENGTH

TWO-LANE BRIDGE : 7.396m Width, 30m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
4-FLS	2	0.9	1	6	129.7	22.7	1.05012

TWO-LANE BRIDGE : 8.631m Width, 30m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
4-FLS	2	0.9	1	7	129.7	19.8	1.06862

TWO-LANE BRIDGE : 9.866m Width, 30m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
4-FLS	2	0.9	1	8	129.7	17.6	1.08558

TABLE A.56: Fd VALUES FOR B1000 TWO-LANE BRIDGE 26m LENGTH

TWO-LANE BRIDGE : 6 Girders, 7.396m Width, 26m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
4-FLS	2	0.9	1	6	60.5	10.8	1.07107

TWO-LANE BRIDGE : 7 Girders, 8.631m Width, 26m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
4-FLS	2	0.9	1	7	60.5	9.5	1.09917

TWO-LANE BRIDGE : 8 Girders, 9.866m Width, 26m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
4-FLS	2	0.9	1	8	60.5	8.5	1.12397

TABLE A.57: Fd VALUES FOR B1000 TWO-LANE BRIDGE 32m LENGTH

TWO-LANE BRIDGE : 6 Girders, 7.396m Width, 32m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
4-FLS	2	0.9	1	6	126.75	22.0	1.04142

TWO-LANE BRIDGE : 7 Girders, 8.631m Width, 32m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
4-FLS	2	0.9	1	7	126.75	19.2	1.06036

TWO-LANE BRIDGE : 8 Girders, 9.866m Width, 32m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
4-FLS	2	0.9	1	8	126.75	17.1	1.07929

TABLE A.58: Fm VALUES FOR B700 THREE-LANE BRIDGE 16m LENGTH

THREE-LANE BRIDGE : 9 Girders, 11.101m Width, 16m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-USL	3	0.8	1	9	1147.2	0.0417	0.4235	2033.2	0.65442
2-ULS	3	0.8	0.9	9	1147.2	0.0417	0.4235	3327.1	0.96379
3-ULS	3	0.8	0.8	9	1147.2	0.0417	0.4235	4280.3	1.10215
4-ULS	3	0.8	0.9	9	1147.2	0.0417	0.4235	3327.4	0.96388
5-ULS	3	0.8	0.8	9	1147.2	0.0417	0.4235	4301.4	1.10758
6-FLS	3	0.8	1	9	1147.2	0.0417	0.4235	1957.6	1.5122
7-FLS	3	0.8	1	9	1147.2	0.0417	0.4235	1829.5	1.41325

THREE-LANE BRIDGE : 10 Girders, 12.336m Width, 16m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-USL	3	0.8	1	10	1147.2	0.0417	0.4235	1983.4	0.70932
2-ULS	3	0.8	0.9	10	1147.2	0.0417	0.4235	3174.3	1.0217
3-ULS	3	0.8	0.8	10	1147.2	0.0417	0.4235	3890.6	1.11311
4-ULS	3	0.8	0.9	10	1147.2	0.0417	0.4235	3117.9	1.00355
5-ULS	3	0.8	0.8	10	1147.2	0.0417	0.4235	3958.1	1.13242
6-FLS	3	0.8	1	10	1147.2	0.0417	0.4235	1896.5	1.62778
7-FLS	3	0.8	1	10	1147.2	0.0417	0.4235	1668.7	1.43226

THREE-LANE BRIDGE : 11 Girders, 13.571m Width, 16m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-USL	3	0.8	1	11	1147.2	0.0417	0.4235	1935.8	0.76153
2-ULS	3	0.8	0.9	11	1147.2	0.0417	0.4235	3047.6	1.07901
3-ULS	3	0.8	0.8	11	1147.2	0.0417	0.4235	3651.8	1.14927
4-ULS	3	0.8	0.9	11	1147.2	0.0417	0.4235	2981.4	1.05557
5-ULS	3	0.8	0.8	11	1147.2	0.0417	0.4235	3732.1	1.17454
6-FLS	3	0.8	1	11	1147.2	0.0417	0.4235	1785.3	1.68557
7-FLS	3	0.8	1	11	1147.2	0.0417	0.4235	1671.8	1.57841

TABLE A.59: Fm VALUES FOR B700 THREE-LANE BRIDGE 24m LENGTH

THREE-LANE BRIDGE : 9 Girders, 11.101m Width, 24m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-USL	3	0.8	1	9	2113.9	0.0417	0.4235	3205.4	0.5599
2-ULS	3	0.8	0.9	9	2113.9	0.0417	0.4235	5626.1	0.88446
3-ULS	3	0.8	0.8	9	2113.9	0.0417	0.4235	7591.2	1.06079
4-ULS	3	0.8	0.9	9	2113.9	0.0417	0.4235	5549.4	0.8724
5-ULS	3	0.8	0.8	9	2113.9	0.0417	0.4235	7617.1	1.06441
6-FLS	3	0.8	1	9	2113.9	0.0417	0.4235	3171.2	1.32943
7-FLS	3	0.8	1	9	2113.9	0.0417	0.4235	2916.7	1.22274

THREE-LANE BRIDGE : 10 Girders, 12.336m Width, 24m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-USL	3	0.8	1	10	2113.9	0.0417	0.4235	3066.5	0.59515
2-ULS	3	0.8	0.9	10	2113.9	0.0417	0.4235	5276.5	0.92167
3-ULS	3	0.8	0.8	10	2113.9	0.0417	0.4235	7129.1	1.10691
4-ULS	3	0.8	0.9	10	2113.9	0.0417	0.4235	5171.8	0.90338
5-ULS	3	0.8	0.8	10	2113.9	0.0417	0.4235	7172.9	1.11371
6-FLS	3	0.8	1	10	2113.9	0.0417	0.4235	2948.4	1.37336
7-FLS	3	0.8	1	10	2113.9	0.0417	0.4235	2637.3	1.22845

THREE-LANE BRIDGE : 11 Girders, 13.571m Width, 24m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-USL	3	0.8	1	11	2113.9	0.0417	0.4235	2962.3	0.63242
2-ULS	3	0.8	0.9	11	2113.9	0.0417	0.4235	4991.4	0.95906
3-ULS	3	0.8	0.8	11	2113.9	0.0417	0.4235	6422.9	1.09699
4-ULS	3	0.8	0.9	11	2113.9	0.0417	0.4235	4829.5	0.92795
5-ULS	3	0.8	0.8	11	2113.9	0.0417	0.4235	6423.7	1.09712
6-FLS	3	0.8	1	11	2113.9	0.0417	0.4235	2829.5	1.44977
7-FLS	3	0.8	1	11	2113.9	0.0417	0.4235	2560.9	1.31215

TABLE A.60: Fm VALUES FOR B800 THREE-LANE BRIDGE 20m LENGTH

THREE-LANE BRIDGE : 9 Girders, 11.101m Width, 20m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1	3	0.8	1	9	1617.9	0.0575	0.4619	2204.8	0.63616
2	3	0.8	0.9	9	1617.9	0.0575	0.4619	3696.7	0.95997
3	3	0.8	0.8	9	1617.9	0.0575	0.4619	4882.2	1.12695
4	3	0.8	0.9	9	1617.9	0.0575	0.4619	3697.3	0.96012
5	3	0.8	0.8	9	1617.9	0.0575	0.4619	4903.9	1.13196
6	3	0.8	1	9	1617.9	0.0575	0.4619	2174.4	1.50574
7	3	0.8	1	9	1617.9	0.0575	0.4619	2007.4	1.3901

THREE-LANE BRIDGE : 10 Girders, 12.336m Width, 20m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1	3	0.8	1	10	1617.9	0.0575	0.4619	2136.4	0.68492
2	3	0.8	0.9	10	1617.9	0.0575	0.4619	3502.7	1.01065
3	3	0.8	0.8	10	1617.9	0.0575	0.4619	4423.7	1.13457
4	3	0.8	0.9	10	1617.9	0.0575	0.4619	3469.6	1.0011
5	3	0.8	0.8	10	1617.9	0.0575	0.4619	4486.3	1.15063
6	3	0.8	1	10	1617.9	0.0575	0.4619	2048.1	1.57587
7	3	0.8	1	10	1617.9	0.0575	0.4619	1824.1	1.40351

THREE-LANE BRIDGE : 11 Girders, 13.571m Width, 20m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1	3	0.8	1	11	1617.9	0.0575	0.4619	2087.6	0.7362
2	3	0.8	0.9	11	1617.9	0.0575	0.4619	3342.7	1.06094
3	3	0.8	0.8	11	1617.9	0.0575	0.4619	4130.4	1.16528
4	3	0.8	0.9	11	1617.9	0.0575	0.4619	3284.4	1.04243
5	3	0.8	0.8	11	1617.9	0.0575	0.4619	4140.1	1.16802
6	3	0.8	1	11	1617.9	0.0575	0.4619	1877.9	1.58940
7	3	0.8	1	11	1617.9	0.0575	0.4619	1804.9	1.52762

TABLE A.61: Fm VALUES FOR B800 THREE-LANE BRIDGE 26m LENGTH

THREE-LANE BRIDGE : 9 Girders, 11.101m Width, 26m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1	3	0.8	1	9	2415.8	0.0575	0.4619	2980.1	0.57587
2	3	0.8	0.9	9	2415.8	0.0575	0.4619	5242.9	0.91181
3	3	0.8	0.8	9	2415.8	0.0575	0.4619	7134.1	1.10286
4	3	0.8	0.9	9	2415.8	0.0575	0.4619	5198.5	0.90409
5	3	0.8	0.8	9	2415.8	0.0575	0.4619	7157.9	1.10654
6	3	0.8	1	9	2415.8	0.0575	0.4619	2837.6	1.31599
7	3	0.8	1	9	2415.8	0.0575	0.4619	2750.5	1.2756

THREE-LANE BRIDGE : 10 Girders, 12.336m Width, 26m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1	3	0.8	1	10	2415.8	0.0575	0.4619	2847.4	0.61136
2	3	0.8	0.9	10	2415.8	0.0575	0.4619	4909.8	0.94875
3	3	0.8	0.8	10	2415.8	0.0575	0.4619	6379.5	1.09578
4	3	0.8	0.9	10	2415.8	0.0575	0.4619	4829.7	0.93328
5	3	0.8	0.8	10	2415.8	0.0575	0.4619	6441.7	1.10647
6	3	0.8	1	10	2415.8	0.0575	0.4619	2746.2	1.41511
7	3	0.8	1	10	2415.8	0.0575	0.4619	2480.3	1.27809

THREE-LANE BRIDGE : 11 Girders, 13.571m Width, 26m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1	3	0.8	1	11	2415.8	0.0575	0.4619	2746.3	0.64862
2	3	0.8	0.9	11	2415.8	0.0575	0.4619	4638.4	0.98594
3	3	0.8	0.8	11	2415.8	0.0575	0.4619	6015.7	1.13662
4	3	0.8	0.9	11	2415.8	0.0575	0.4619	4545.1	0.96611
5	3	0.8	0.8	11	2415.8	0.0575	0.4619	6028.7	1.13908
6	3	0.8	1	11	2415.8	0.0575	0.4619	2486.5	1.40942
7	3	0.8	1	11	2415.8	0.0575	0.4619	2414.3	1.36849

TABLE A.62: Fm VALUES FOR B900 THREE-LANE BRIDGE 24 LENGTH

THREE-LANE BRIDGE : 9 Girders, 11.101m Width, 24m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-USL	3	0.8	1	9	2113.9	0.0756	0.535	2467.1	0.61845
2-ULS	3	0.8	0.9	9	2113.9	0.0756	0.535	3947.8	0.89066
3-ULS	3	0.8	0.8	9	2113.9	0.0756	0.535	5337.7	1.07043
4-ULS	3	0.8	0.9	9	2113.9	0.0756	0.535	3948.4	0.8908
5-ULS	3	0.8	0.8	9	2113.9	0.0756	0.535	5357.9	1.07448
6-FLS	3	0.8	1	9	2113.9	0.0756	0.535	2353.2	1.41574
7-FLS	3	0.8	1	9	2113.9	0.0756	0.535	2079.8	1.25126

THREE-LANE BRIDGE : 10 Girders, 12.336m Width, 24m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-USL	3	0.8	1	10	2113.9	0.0756	0.535	2376.6	0.66195
2-ULS	3	0.8	0.9	10	2113.9	0.0756	0.535	3724.1	0.93355
3-ULS	3	0.8	0.8	10	2113.9	0.0756	0.535	4847.2	1.08007
4-ULS	3	0.8	0.9	10	2113.9	0.0756	0.535	3697.7	0.92693
5-ULS	3	0.8	0.8	10	2113.9	0.0756	0.535	4904.7	1.09289
6-FLS	3	0.8	1	10	2113.9	0.0756	0.535	2186.5	1.46162
7-FLS	3	0.8	1	10	2113.9	0.0756	0.535	1928.1	1.28888

THREE-LANE BRIDGE : 11 Girders, 13.571m Width, 24m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-USL	3	0.8	1	11	2113.9	0.0756	0.535	2140.8	0.65591
2-ULS	3	0.8	0.9	11	2113.9	0.0756	0.535	3393.7	0.9358
3-ULS	3	0.8	0.8	11	2113.9	0.0756	0.535	4527.5	1.10972
4-ULS	3	0.8	0.9	11	2113.9	0.0756	0.535	3574.3	0.9856
5-ULS	3	0.8	0.8	11	2113.9	0.0756	0.535	4616.8	1.13161
6-FLS	3	0.8	1	11	2113.9	0.0756	0.535	1969.5	1.44821
7-FLS	3	0.8	1	11	2113.9	0.0756	0.535	1904.3	1.40027

TABLE A.63: Fm VALUES FOR B900 THREE-LANE BRIDGE 30 LENGTH

THREE-LANE BRIDGE : 9 Girders, 11.101m Width, 30m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-USL	3	0.8	1	9	3025	0.0756	0.535	3235.8	0.56683
2-ULS	3	0.8	0.9	9	3025	0.0756	0.535	5430.4	0.85615
3-ULS	3	0.8	0.8	9	3025	0.0756	0.535	7482.16	1.04855
4-ULS	3	0.8	0.9	9	3025	0.0756	0.535	5397.6	0.85098
5-ULS	3	0.8	0.8	9	3025	0.0756	0.535	7504.8	1.05173
6-FLS	3	0.8	1	9	3025	0.0756	0.535	3106.8	1.30617
7-FLS	3	0.8	1	9	3025	0.0756	0.535	2760.7	1.16066

THREE-LANE BRIDGE : 10 Girders, 12.336m Width, 30m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-USL	3	0.8	1	10	3025	0.0756	0.535	3085.8	0.60062
2-ULS	3	0.8	0.9	10	3025	0.0756	0.535	5080.3	0.88995
3-ULS	3	0.8	0.8	10	3025	0.0756	0.535	6807.5	1.06001
4-ULS	3	0.8	0.9	10	3025	0.0756	0.535	5011.7	0.87793
5-ULS	3	0.8	0.8	10	3025	0.0756	0.535	6841.5	1.0653
6-FLS	3	0.8	1	10	3025	0.0756	0.535	2827.4	1.32078
7-FLS	3	0.8	1	10	3025	0.0756	0.535	2562.8	1.19717

THREE-LANE BRIDGE : 11 Girders, 13.571m Width, 30m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-USL	3	0.8	1	11	3025	0.0756	0.535	2787.4	0.59679
2-ULS	3	0.8	0.9	11	3025	0.0756	0.535	4806.9	0.92626
3-ULS	3	0.8	0.8	11	3025	0.0756	0.535	6319.0	1.08234
4-ULS	3	0.8	0.9	11	3025	0.0756	0.535	4775.3	0.92017
5-ULS	3	0.8	0.8	11	3025	0.0756	0.535	6359.1	1.08921
6-FLS	3	0.8	1	11	3025	0.0756	0.535	2670.8	1.37239
7-FLS	3	0.8	1	11	3025	0.0756	0.535	2485.4	1.27712

TABLE A.64: Fm VALUES FOR B1000 THREE-LANE BRIDGE 26 LENGTH

THREE-LANE BRIDGE : 9 Girders, 11.101m Width, 26m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1	3	0.8	1	9	2415.8	0.0969	0.59	2379.3	0.60658
2	3	0.8	0.9	9	2415.8	0.0969	0.59	3842.7	0.8817
3	3	0.8	0.8	9	2415.8	0.0969	0.59	5226.6	1.06599
4	3	0.8	0.9	9	2415.8	0.0969	0.59	3844.6	0.88214
5	3	0.8	0.8	9	2415.8	0.0969	0.59	5245.9	1.06992
6	3	0.8	1	9	2415.8	0.0969	0.59	2279.9	1.39498
7	3	0.8	1	9	2415.8	0.0969	0.59	2085.2	1.27585

THREE-LANE BRIDGE : 10 Girders, 12.336m Width, 26m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1	3	0.8	1	10	2415.8	0.0969	0.59	2293.5	0.64968
2	3	0.8	0.9	10	2415.8	0.0969	0.59	3605.1	0.91909
3	3	0.8	0.8	10	2415.8	0.0969	0.59	4943.3	1.12023
4	3	0.8	0.9	10	2415.8	0.0969	0.59	3587.3	0.91455
5	3	0.8	0.8	10	2415.8	0.0969	0.59	4980.2	1.12859
6	3	0.8	1	10	2415.8	0.0969	0.59	2062.3	1.40205
7	3	0.8	1	10	2415.8	0.0969	0.59	1874.4	1.2743

THREE-LANE BRIDGE : 11 Girders, 13.571m Width, 26m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1	3	0.8	1	11	2415.8	0.0969	0.59	2062.4	0.64264
2	3	0.8	0.9	11	2415.8	0.0969	0.59	3411.5	0.95671
3	3	0.8	0.8	11	2415.8	0.0969	0.59	4388.8	1.09403
4	3	0.8	0.9	11	2415.8	0.0969	0.59	3420.7	0.95929
5	3	0.8	0.8	11	2415.8	0.0969	0.59	4450.2	1.10933
6	3	0.8	1	11	2415.8	0.0969	0.59	1833.4	1.37107
7	3	0.8	1	11	2415.8	0.0969	0.59	1651.8	1.23527

TABLE A.65: Fm VALUES FOR B1000 THREE-LANE BRIDGE 32 LENGTH

THREE-LANE BRIDGE : 9 Girders, 11.101m Width, 32m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1	3	0.8	1	9	3382.2	0.0969	0.59	3041.3	0.55381
2	3	0.8	0.9	9	3382.2	0.0969	0.59	5107.4	0.83704
3	3	0.8	0.8	9	3382.2	0.0969	0.59	7074.3	1.03057
4	3	0.8	0.9	9	3382.2	0.0969	0.59	5093.2	0.83471
5	3	0.8	0.8	9	3382.2	0.0969	0.59	7095.1	1.0336
6	3	0.8	1	9	3382.2	0.0969	0.59	2928.2	1.27972
7	3	0.8	1	9	3382.2	0.0969	0.59	2696.8	1.17859

THREE-LANE BRIDGE : 10 Girders, 12.336m Width, 32m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1	3	0.8	1	10	3382.2	0.0969	0.59	3189.1	0.64525
2	3	0.8	0.9	10	3382.2	0.0969	0.59	4760.2	0.86682
3	3	0.8	0.8	10	3382.2	0.0969	0.59	6607.5	1.06952
4	3	0.8	0.9	10	3382.2	0.0969	0.59	4715.2	0.85863
5	3	0.8	0.8	10	3382.2	0.0969	0.59	6646.6	1.07585
6	3	0.8	1	10	3382.2	0.0969	0.59	2670.9	1.29697
7	3	0.8	1	10	3382.2	0.0969	0.59	2422.7	1.17645

THREE-LANE BRIDGE : 11 Girders, 13.571m Width, 32m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1	3	0.8	1	11	3382.2	0.0969	0.59	2988.5	0.66513
2	3	0.8	0.9	11	3382.2	0.0969	0.59	4481.1	0.8976
3	3	0.8	0.8	11	3382.2	0.0969	0.59	5925.2	1.05499
4	3	0.8	0.9	11	3382.2	0.0969	0.59	4454.7	0.89231
5	3	0.8	0.8	11	3382.2	0.0969	0.59	5951.2	1.05962
6	3	0.8	1	11	3382.2	0.0969	0.59	2523.2	1.34777
7	3	0.8	1	11	3382.2	0.0969	0.59	2353.4	1.25707

TABLE A.66: Fm VALUES FOR B700 THREE-LANE BRIDGE 16m LENGTH

THREE-LANE **BRIDGE : 9 Girders, 11.101m Width, 16m Length**

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	3	0.8	1	9	326.8	97.1	1.11421
2-ULS	3	0.8	0.9	9	326.8	129.0	1.33224
3-ULS	3	0.8	0.8	9	326.8	147.4	1.35312
4-ULS	3	0.8	0.9	9	326.8	139.4	1.43964
5-ULS	3	0.8	0.8	9	326.8	145.5	1.33568
6-FLS	3	0.8	1	9	326.8	107.1	2.94951
7-FLS	3	0.8	1	9	326.8	102.3	2.81732

THREE-LANE BRIDGE : 10 Girders, 12.336m Width, 16m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	3	0.8	1	10	326.8	96.7	1.23292
2-ULS	3	0.8	0.9	10	326.8	125.4	1.43895
3-ULS	3	0.8	0.8	10	326.8	129.8	1.32395
4-ULS	3	0.8	0.9	10	326.8	133.6	1.53305
5-ULS	3	0.8	0.8	10	326.8	131.9	1.34537
6-FLS	3	0.8	1	10	326.8	114.0	3.48837
7-FLS	3	0.8	1	10	326.8	106.1	3.24663

THREE-LANE BRIDGE : 11 Girders, 13.571m Width, 16m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	3	0.8	1	11	326.8	96.5	1.3534
2-ULS	3	0.8	0.9	11	326.8	122.0	1.53993
3-ULS	3	0.8	0.8	11	326.8	125.5	1.4081
4-ULS	3	0.8	0.9	11	326.8	138.2	1.74442
5-ULS	3	0.8	0.8	11	326.8	141.6	1.58874
6-FLS	3	0.8	1	11	326.8	110.8	3.7295
7-FLS	3	0.8	1	11	326.8	101.2	3.40636

TABLE A.67: Fm VALUES FOR B700 THREE-LANE BRIDGE 24m LENGTH

THREE-LANE BRIDGE : 9 Girders, 11.101m Width, 24m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	3	0.8	1	9	395.6	131.0	1.24178
2-ULS	3	0.8	0.9	9	395.6	142.6	1.21657
3-ULS	3	0.8	0.8	9	395.6	154.0	1.16785
4-ULS	3	0.8	0.9	9	395.6	153.1	1.30615
5-ULS	3	0.8	0.8	9	395.6	166.8	1.26491
6-FLS	3	0.8	1	9	395.6	108.5	2.4684
7-FLS	3	0.8	1	9	395.6	105.7	2.4047

THREE-LANE BRIDGE : 10 Girders, 12.336m Width, 24m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	3	0.8	1	10	395.6	131.3	1.38292
2-ULS	3	0.8	0.9	10	395.6	137.5	1.3034
3-ULS	3	0.8	0.8	10	395.6	149.5	1.25969
4-ULS	3	0.8	0.9	10	395.6	152.8	1.44843
5-ULS	3	0.8	0.8	10	395.6	167.8	1.41389
6-FLS	3	0.8	1	10	395.6	114.1	2.88423
7-FLS	3	0.8	1	10	395.6	109.8	2.77553

THREE-LANE BRIDGE : 11 Girders, 13.571m Width, 24m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	3	0.8	1	11	395.6	131.2	1.52005
2-ULS	3	0.8	0.9	11	395.6	132.7	1.38369
3-ULS	3	0.8	0.8	11	395.6	140.6	1.30317
4-ULS	3	0.8	0.9	11	395.6	151.6	1.58076
5-ULS	3	0.8	0.8	11	395.6	158.5	1.46908
6-FLS	3	0.8	1	11	395.6	112.5	3.12816
7-FLS	3	0.8	1	11	395.6	104.1	2.89459

TABLE A.68: Fv VALUES FOR B800 THREE-LANE BRIDGE 20m LENGTH

THREE-LANE BRIDGE : 9 Girders, 11.101m Width, 20m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	3	0.8	1	9	349.7	105.4	1.13025
2-ULS	3	0.8	0.9	9	349.7	128.2	1.23727
3-ULS	3	0.8	0.8	9	349.7	135.7	1.16414
4-ULS	3	0.8	0.9	9	349.7	144.1	1.39073
5-ULS	3	0.8	0.8	9	349.7	148.6	1.27481
6-FLS	3	0.8	1	9	349.7	103.7	2.66886
7-FLS	3	0.8	1	9	349.7	97.8	2.51701

THREE-LANE BRIDGE : 9 Girders, 12.336m Width, 20m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	3	0.8	1	10	349.7	105.1	1.25226
2-ULS	3	0.8	0.9	10	349.7	122.9	1.31792
3-ULS	3	0.8	0.8	10	349.7	129.9	1.2382
4-ULS	3	0.8	0.9	10	349.7	141.4	1.5163
5-ULS	3	0.8	0.8	10	349.7	148.4	1.41455
6-FLS	3	0.8	1	10	349.7	105.8	3.02545
7-FLS	3	0.8	1	10	349.7	104.2	2.9797

THREE-LANE BRIDGE : 9 Girders, 13.571m Width, 20m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	3	0.8	1	11	349.7	104.9	1.37487
2-ULS	3	0.8	0.9	11	349.7	118.0	1.39191
3-ULS	3	0.8	0.8	11	349.7	124.0	1.30016
4-ULS	3	0.8	0.9	11	349.7	139.3	1.64316
5-ULS	3	0.8	0.8	11	349.7	129.9	1.36202
6-FLS	3	0.8	1	11	349.7	102.9	3.23677
7-FLS	3	0.8	1	11	349.7	95.6	3.00715

TABLE A.69: Fv VALUES FOR B800 THREE-LANE BRIDGE 26m LENGTH

THREE-LANE BRIDGE : 9 Girders, 11.101m Width, 26m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	3	0.8	1	9	413.3	136.4	1.2376
2-ULS	3	0.8	0.9	9	413.3	145.8	1.1906
3-ULS	3	0.8	0.8	9	413.3	157.4	1.14251
4-ULS	3	0.8	0.9	9	413.3	159.4	1.30166
5-ULS	3	0.8	0.8	9	413.3	172.9	1.25502
6-FLS	3	0.8	1	9	413.3	111.1	2.41931
7-FLS	3	0.8	1	9	413.3	106.7	2.32349

THREE-LANE BRIDGE : 10 Girders, 12.336m Width, 26m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	3	0.8	1	10	413.3	136.7	1.37814
2-ULS	3	0.8	0.9	10	413.3	139.8	1.26845
3-ULS	3	0.8	0.8	10	413.3	151.5	1.22187
4-ULS	3	0.8	0.9	10	413.3	159.8	1.44992
5-ULS	3	0.8	0.8	10	413.3	174.3	1.40576
6-FLS	3	0.8	1	10	413.3	115.1	2.7849
7-FLS	3	0.8	1	10	413.3	111.4	2.69538

THREE-LANE BRIDGE : 11 Girders, 13.571m Width, 26m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	3	0.8	1	11	413.3	136.5	1.51373
2-ULS	3	0.8	0.9	11	413.3	134.2	1.3394
3-ULS	3	0.8	0.8	11	413.3	141.9	1.25889
4-ULS	3	0.8	0.9	11	413.3	157.4	1.57095
5-ULS	3	0.8	0.8	11	413.3	164.6	1.46028
6-FLS	3	0.8	1	11	413.3	112.8	3.00218
7-FLS	3	0.8	1	11	413.3	104.8	2.78926

TABLE A.70: Fv VALUES FOR B900 THREE-LANE BRIDGE 30m LENGTH

THREE-LANE BRIDGE : 9 Girders, 11.101m Width, 30m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	3	0.8	1	9	441.5	147.9	1.25623
2-ULS	3	0.8	0.9	9	441.5	151.7	1.15965
3-ULS	3	0.8	0.8	9	441.5	163.7	1.11234
4-ULS	3	0.8	0.9	9	441.5	167.4	1.27967
5-ULS	3	0.8	0.8	9	441.5	181.3	1.23194
6-FLS	3	0.8	1	9	441.5	114.6	2.33613
7-FLS	3	0.8	1	9	441.5	104.7	2.13431

THREE-LANE BRIDGE : 10 Girders, 12.336m Width, 30m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	3	0.8	1	10	441.5	148.4	1.40053
2-ULS	3	0.8	0.9	10	441.5	136.3	1.1577
3-ULS	3	0.8	0.8	10	441.5	138.6	1.04643
4-ULS	3	0.8	0.9	10	441.5	141.1	1.19847
5-ULS	3	0.8	0.8	10	441.5	192.9	1.45640
6-FLS	3	0.8	1	10	441.5	113.9	2.57984
7-FLS	3	0.8	1	10	441.5	106.6	2.4145

THREE-LANE BRIDGE : 11 Girders, 13.571m Width, 30m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	3	0.8	1	11	441.5	148.5	1.54162
2-ULS	3	0.8	0.9	11	441.5	141.5	1.32206
3-ULS	3	0.8	0.8	11	441.5	149.5	1.2416
4-ULS	3	0.8	0.9	11	441.5	165.5	1.54629
5-ULS	3	0.8	0.8	11	441.5	188.0	1.56134
6-FLS	3	0.8	1	11	441.5	116.9	2.91257
7-FLS	3	0.8	1	11	441.5	106.6	2.65595

TABLE A.71: Fv VALUES FOR B1000 THREE-LANE BRIDGE 32m LENGTH

THREE-LANE BRIDGE : 9 Girders, 11.101m Width, 32m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	3	0.8	1	9	452.9	151.5	1.25442
2-ULS	3	0.8	0.9	9	452.9	154.1	1.14835
3-ULS	3	0.8	0.8	9	452.9	166.1	1.10024
4-ULS	3	0.8	0.9	9	452.9	171.3	1.27652
5-ULS	3	0.8	0.8	9	452.9	186.1	1.23272
6-FLS	3	0.8	1	9	452.9	117.7	2.33893
7-FLS	3	0.8	1	9	452.9	108.4	2.15412

THREE-LANE BRIDGE : 10 Girders, 12.336m Width, 32m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	3	0.8	1	10	452.9	150.3	1.38276
2-ULS	3	0.8	0.9	10	452.9	150.6	1.24696
3-ULS	3	0.8	0.8	10	452.9	157.7	1.16067
4-ULS	3	0.8	0.9	10	452.9	166.0	1.37448
5-ULS	3	0.8	0.8	10	452.9	189.9	1.39766
6-FLS	3	0.8	1	10	452.9	120.5	2.66063
7-FLS	3	0.8	1	10	452.9	118.0	2.60543

THREE-LANE BRIDGE : 11 Girders, 13.571m Width, 32m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	3	0.8	1	11	452.9	152.2	1.54026
2-ULS	3	0.8	0.9	11	452.9	138.4	1.26054
3-ULS	3	0.8	0.8	11	452.9	146.2	1.18363
4-ULS	3	0.8	0.9	11	452.9	169.7	1.54562
5-ULS	3	0.8	0.8	11	452.9	183.1	1.48237
6-FLS	3	0.8	1	11	452.9	113.6	2.75911
7-FLS	3	0.8	1	11	452.9	100.8	2.44822

TABLE A.72: Fd VALUES FOR B700 THREE-LANE BRIDGE 16m LENGTH

THREE-LANE BRIDGE : 9 Girders, 11.101m Width, 16m Length

Load Case	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	3	0.8	1	9	24.09	3.9	1.45704

3-LANE BRIDGE : 10 Girders, 12.336m Width, 16m Length

Load Case	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	3	0.8	1	10	24.09	3.6	1.4944

THREE-LANE BRIDGE : 11 Girders, 13.571m Width, 16m Length

Load Case	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	3	0.8	1	11	24.09	3.2	1.46119

TABLE A.73: Fd VALUES FOR B700 THREE-LANE BRIDGE 24m LENGTH

THREE-LANE BRIDGE : 9 Girders, 11.101m Width, 24m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	3	0.8	1	9	104.25	14.9	1.28633

THREE-LANE BRIDGE : 10 Girders, 12.336m Width, 24m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	3	0.8	1	10	104.25	13.6	1.30456

3 LANE BRIDGE : 11 Girders, 13.571m Width, 24m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	3	0.8	1	11	104.25	12.2	1.28729

TABLE A.74: Fd VALUES FOR B800 THREE-LANE BRIDGE 20m LENGTH

THREE-LANE BRIDGE : 9 Girders, 11.101m Width, 20m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	3	0.8	1	9	38.97	6.2	1.43187

THREE-LANE BRIDGE : 10 Girders, 12.336m Width, 20m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	3	0.8	1	10	38.97	5.5	1.41134

THREE-LANE BRIDGE : 11 Girders, 13.571m Width, 20m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	3	0.8	1	11	38.97	4.9	1.38312

TABLE A.75: Fd VALUES FOR B800 THREE-LANE BRIDGE 26m LENGTH

THREE-LANE BRIDGE : 9 Girders, 11.101m Width, 26m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	3	0.8	1	9	101.96	14	1.23578

THREE-LANE BRIDGE : 10 Girders, 12.336m Width, 26m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	3	0.8	1	10	101.96	13.1	1.28482

THREE-LANE BRIDGE : 11 Girders, 13.571m Width, 26m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	3	0.8	1	11	101.96	11.8	1.27305

TABLE A.76: Fd VALUES FOR B900 THREE-LANE BRIDGE 24m LENGTH

THREE-LANE BRIDGE : 9 Girders, 11.101m Width, 24m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	3	0.8	1	9	57.51	8.3	1.2989

THREE-LANE BRIDGE : 10 Girders, 12.336m Width, 24m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	3	0.8	1	10	57.51	7.7	1.3389

THREE-LANE BRIDGE : 11 Girders, 13.571m Width, 24m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	3	0.8	1	11	57.51	6.9	1.31977

TABLE A.77: Fd VALUES FOR B900 THREE-LANE BRIDGE 30m LENGTH

THREE-LANE BRIDGE : 9 Girders, 11.101m Width, 30m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	3	0.8	1	9	129.7	17.3	1.20046

THREE-LANE BRIDGE : 10 Girders, 12.336m Width, 30m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	3	0.8	1	10	129.7	15.9	1.22591

THREE-LANE BRIDGE : 11 Girders, 13.571m Width, 30m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	3	0.8	1	11	129.7	14.5	1.22976

TABLE A.78: Fd VALUES FOR B1000 THREE-LANE BRIDGE 26m LENGTH

THREE-LANE BRIDGE : 9 Girders, 11.101m Width, 26m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	3	0.8	1	9	60.5	8.6	1.27934

THREE-LANE BRIDGE : 10 Girders, 12.336m Width, 26m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	3	0.8	1	10	60.5	8.0	1.32231

THREE-LANE BRIDGE : 11 Girders, 13.571m Width, 26m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	3	0.8	1	11	60.5	7.1	1.29091

TABLE A.79: Fd VALUES FOR B1000 THREE-LANE BRIDGE 32m LENGTH

THREE-LANE BRIDGE : 9 Girders, 11.101m Width, 32m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	3	0.8	1	9	126.75	16.8	1.1929

THREE-LANE BRIDGE : 10 Girders, 12.336m Width, 32m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	3	0.8	1	10	126.75	15.4	1.21499

THREE-LANE BRIDGE : 11 Girders, 13.571m Width, 32m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	3	0.8	1	11	126.75	14.0	1.21499

TABLE A.80: Fm VALUES FOR B700 TWO-LANE BRIDGE 16m LENGTH

TWO-LANE BRIDGE : 9 Girders, 11.101m Width, 16m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	9	1147.2	0.0417	0.4235	2226.6	0.95556
2-ULS	2	0.9	0.9	9	1147.2	0.0417	0.4235	3164.9	1.22241
3-ULS	2	0.9	0.9	9	1147.2	0.0417	0.4235	3167.1	1.22326
4-FLS	2	0.9	1	9	1147.2	0.0417	0.4235	1871.4	1.44561

TWO-LANE BRIDGE : 10 Girders, 12.336m Width, 16m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	10	1147.2	0.0417	0.4235	2177.1	1.03812
2-ULS	2	0.9	0.9	10	1147.2	0.0417	0.4235	2986.6	1.28171
3-ULS	2	0.9	0.9	10	1147.2	0.0417	0.4235	3024.5	1.29798
4-FLS	2	0.9	1	10	1147.2	0.0417	0.4235	1864.9	1.60066

TWO-LANE BRIDGE : 12 Girders, 13.571m Width, 16m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	11	1147.2	0.0417	0.4235	2142.9	1.124
2-ULS	2	0.9	0.9	11	1147.2	0.0417	0.4235	2845.7	1.34337
3-ULS	2	0.9	0.9	11	1147.2	0.0417	0.4235	2828.6	1.3353
4-FLS	2	0.9	1	11	1147.2	0.0417	0.4235	1760.3	1.66197

TABLE A.81: Fm VALUES FOR B700 TWO-LANE BRIDGE 24m LENGTH

TWO-LANE BRIDGE : 9 Girders, 11.101m Width, 24m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	9	2113.9	0.0417	0.4235	3428.1	0.7984
2-ULS	2	0.9	0.9	9	2113.9	0.0417	0.4235	5427.4	1.13763
3-ULS	2	0.9	0.9	9	2113.9	0.0417	0.4235	5368.5	1.12529
4-FLS	2	0.9	1	9	2113.9	0.0417	0.4235	2952.8	1.23787

TWO-LANE BRIDGE : 10 Girders, 12.336m Width, 24m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	10	2113.9	0.0417	0.4235	3288.8	0.85107
2-ULS	2	0.9	0.9	10	2113.9	0.0417	0.4235	5051.2	1.17642
3-ULS	2	0.9	0.9	10	2113.9	0.0417	0.4235	4978.9	1.15958
4-FLS	2	0.9	1	10	2113.9	0.0417	0.4235	2783.8	1.29669

TWO-LANE BRIDGE : 11 Girders, 13.571m Width, 24m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	11	2113.9	0.0417	0.4235	3185.1	0.90665
2-ULS	2	0.9	0.9	11	2113.9	0.0417	0.4235	4743.4	1.21521
3-ULS	2	0.9	0.9	11	2113.9	0.0417	0.4235	4633.8	1.18713
4-FLS	2	0.9	1	11	2113.9	0.0417	0.4235	2660.1	1.36298

TABLE A.82: Fm VALUES FOR B800 - TWO-LANE BRIDGE 20m LENGTH

TWO-LANE BRIDGE : 9 Girders, 11.101m Width, 20m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	9	1617.9	0.0575	0.4619	2204.8	0.84822
2-ULS	2	0.9	0.9	9	1617.9	0.0575	0.4619	3540.2	1.22577
3-ULS	2	0.9	0.9	9	1617.9	0.0575	0.4619	3565.8	1.23463
4-FLS	2	0.9	1	9	1617.9	0.0575	0.4619	2124.3	1.47105

TWO-LANE BRIDGE : 10 Girders, 12.336m Width, 20m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	10	1617.9	0.0575	0.4619	2136.4	0.91323
2-ULS	2	0.9	0.9	10	1617.9	0.0575	0.4619	3319.1	1.2769
3-ULS	2	0.9	0.9	10	1617.9	0.0575	0.4619	3397.5	1.30707
4-FLS	2	0.9	1	10	1617.9	0.0575	0.4619	1924.6	1.48084

TWO-LANE BRIDGE : 11 Girders,13.571m Width, 20m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	11	1617.9	0.0575	0.4619	2087.6	0.9816
2-ULS	2	0.9	0.9	11	1617.9	0.0575	0.4619	3143.3	1.3302
3-ULS	2	0.9	0.9	11	1617.9	0.0575	0.4619	3125.9	1.32284
4-FLS	2	0.9	1	11	1617.9	0.0575	0.4619	1891.9	1.60125

TABLE A.83: Fm VALUES FOR B800 TWO-LANE BRIDGE 26m LENGTH

TWO-LANE BRIDGE : 9 Girders, 11.101m Width, 26m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	9	2415.8	0.0575	0.4619	2980.1	0.76782
2-ULS	2	0.9	0.9	9	2415.8	0.0575	0.4619	5064.4	1.17436
3-ULS	2	0.9	0.9	9	2415.8	0.0575	0.4619	5029.1	1.16617
4-FLS	2	0.9	1	9	2415.8	0.0575	0.4619	2783.4	1.29085

TWO-LANE BRIDGE : 10 Girders, 12.336m Width, 26m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	10	2415.8	0.0575	0.4619	2847.4	0.81515
2-ULS	2	0.9	0.9	10	2415.8	0.0575	0.4619	4710.4	1.21363
3-ULS	2	0.9	0.9	10	2415.8	0.0575	0.4619	4680.1	1.20582
4-FLS	2	0.9	1	10	2415.8	0.0575	0.4619	2622.5	1.35137

TWO-LANE BRIDGE : 11 Girders, 13.571m Width, 26m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	11	2415.8	0.0575	0.4619	2746.3	0.86482
2-ULS	2	0.9	0.9	11	2415.8	0.0575	0.4619	4419.5	1.25255
3-ULS	2	0.9	0.9	11	2415.8	0.0575	0.4619	4345.7	1.23163
4-FLS	2	0.9	1	11	2415.8	0.0575	0.4619	2497.9	1.41588

TABLE A.84: Fm VALUES FOR B900 TWO-LANE BRIDGE 24m LENGTH

TWO-LANE BRIDGE : 9 Girders,11.101m Width, 24m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	9	2113.9	0.0756	0.535	2467.5	0.82473
2-ULS	2	0.9	0.9	9	2113.9	0.0756	0.535	3809.5	1.14595
3-ULS	2	0.9	0.9	9	2113.9	0.0756	0.535	3832.0	1.15271
4-FLS	2	0.9	1	9	2113.9	0.0756	0.535	2244.6	1.35041

TWO-LANE BRIDGE : 10 Girders, 12.336m Width, 24m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	10	2113.9	0.0756	0.535	2376.4	0.88253
2-ULS	2	0.9	0.9	10	2113.9	0.0756	0.535	3551.6	1.18707
3-ULS	2	0.9	0.9	10	2113.9	0.0756	0.535	3776.1	1.26211
4-FLS	2	0.9	1	10	2113.9	0.0756	0.535	2057.7	1.37552

TWO-LANE BRIDGE : 11 Girders, 13.571m Width, 24m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	11	2113.9	0.0756	0.535	2403.2	0.98173
2-ULS	2	0.9	0.9	11	2113.9	0.0756	0.535	3351.4	1.23218
3-ULS	2	0.9	0.9	11	2113.9	0.0756	0.535	3352.6	1.23262
4-FLS	2	0.9	1	11	2113.9	0.0756	0.535	1989.4	1.46285

TABLE A.85: Fm VALUES FOR B900 TWO-LANE BRIDGE 30m LENGTH

TWO-LANE BRIDGE : 9 Girders,11.101m Width, 30m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	9	3025.0	0.0756	0.535	3235.7	0.75575
2-ULS	2	0.9	0.9	9	3025.0	0.0756	0.535	5273.9	1.10863
3-ULS	2	0.9	0.9	9	3025.0	0.0756	0.535	5272.3	1.10829
4-FLS	2	0.9	1	9	3025.0	0.0756	0.535	2961.6	1.24512

TWO-LANE BRIDGE : 10 Girders, 12.336m Width, 30m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	10	3025.0	0.0756	0.535	3085.1	0.80064
2-ULS	2	0.9	0.9	10	3025.0	0.0756	0.535	4880.6	1.13995
3-ULS	2	0.9	0.9	10	3025.0	0.0756	0.535	4862.8	1.13579
4-FLS	2	0.9	1	10	3025.0	0.0756	0.535	2720.4	1.27079

TWO-LANE BRIDGE : 11 Girders, 13.571m Width, 30m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	11	3025.0	0.0756	0.535	3092.1	0.88271
2-ULS	2	0.9	0.9	11	3025.0	0.0756	0.535	4571.6	1.17456
3-ULS	2	0.9	0.9	11	3025.0	0.0756	0.535	4519.4	1.16114
4-FLS	2	0.9	1	11	3025.0	0.0756	0.535	2578.0	1.3247

TABLE A.86: Fm VALUES FOR B1000 TWO-LANE BRIDGE 26m LENGTH

TWO-LANE BRIDGE : 9 Girders,11.101m Width, 26m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	9	2415.8	0.0969	0.59	2379.3	0.80878
2-ULS	2	0.9	0.9	9	2415.8	0.0969	0.59	3713.5	1.13607
3-ULS	2	0.9	0.9	9	2415.8	0.0969	0.59	3762.5	1.15106
4-FLS	2	0.9	1	9	2415.8	0.0969	0.59	2182.4	1.33533

TWO-LANE BRIDGE : 10 Girders, 12.336m Width, 26m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	10	2415.8	0.0969	0.59	2393.7	0.90408
2-ULS	2	0.9	0.9	10	2415.8	0.0969	0.59	3450.2	1.1728
3-ULS	2	0.9	0.9	10	2415.8	0.0969	0.59	3496.3	1.18847
4-FLS	2	0.9	1	10	2415.8	0.0969	0.59	1996.2	1.35711

TWO-LANE BRIDGE : 11 Girders, 13.571m Width, 26m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	2	0.9	1	11	2415.8	0.0756	0.535	2462.1	0.8801
2-ULS	2	0.9	0.9	11	2415.8	0.0756	0.535	3250.4	1.0457
3-ULS	2	0.9	0.9	11	2415.8	0.0756	0.535	3268.7	1.05159
4-FLS	2	0.9	1	11	2415.8	0.0756	0.535	1982.5	1.2756

TABLE A.87: Fm VALUES FOR B1000 TWO-LANE BRIDGE 32m LENGTH

TWO-LANE BRIDGE : 9 Girders,11.101m Width, 32m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1	2	0.9	1	9	3382.2	0.0969	0.59	3041.2	0.73839
2	2	0.9	0.9	9	3382.2	0.0969	0.59	4964.9	1.08491
3	2	0.9	0.9	9	3382.2	0.0969	0.59	4970.3	1.08609
4	2	0.9	1	9	3382.2	0.0969	0.59	2797.6	1.22265

TWO-LANE BRIDGE : 10 Girders, 12.336m Width, 32m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1	2	0.9	1	10	3382.2	0.0969	0.59	3189.7	0.8605
2	2	0.9	0.9	10	3382.2	0.0969	0.59	4590.4	1.11453
3	2	0.9	0.9	10	3382.2	0.0969	0.59	4599.5	1.11674
4	2	0.9	1	10	3382.2	0.0969	0.59	2565.2	1.24564

TWO-LANE BRIDGE : 11 Girders, 13.571m Width, 32m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1	2	0.9	1	11	3382.2	0.0969	0.59	2988.5	0.88684
2	2	0.9	0.9	11	3382.2	0.0969	0.59	4299.2	1.14821
3	2	0.9	0.9	11	3382.2	0.0969	0.59	4276.4	1.14212
4	2	0.9	1	11	3382.2	0.0969	0.59	2442.1	1.30445

TABLE A.88: Fv VALUES FOR B700 TWO-LANE BRIDGE 16m LENGTH

TWO-LANE BRIDGE : 9 Girders, 11.101m Width, 16m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	9	326.8	110.6	1.69217
2-ULS	2	0.9	0.9	9	326.8	119.3	1.64275
3-ULS	2	0.9	0.9	9	326.8	142.8	1.96634
4-FLS	2	0.9	1	9	326.8	112.5	3.09823

TWO-LANE BRIDGE : 10 Girders, 12.336m Width, 16m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	10	326.8	110.0	1.86999
2-ULS	2	0.9	0.9	10	326.8	116.7	1.7855
3-ULS	2	0.9	0.9	10	326.8	136.3	2.08537
4-FLS	2	0.9	1	10	326.8	113.3	3.46695

TWO-LANE BRIDGE : 11 Girders, 13.571m Width, 16m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	11	326.8	109.8	2.05324
2-ULS	2	0.9	0.9	11	326.8	115.8	1.94890
3-ULS	2	0.9	0.9	11	326.8	125.4	2.11047
4-FLS	2	0.9	1	11	326.8	101.0	3.39963

TABLE A.89: Fv VALUES FOR B700 TWO-LANE BRIDGE 24m LENGTH

TWO-LANE BRIDGE : 9 Girders, 11.101m Width, 24m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	9	395.6	111.0	1.40293
2-ULS	2	0.9	0.9	9	395.6	127.4	1.44919
3-ULS	2	0.9	0.9	9	395.6	134.2	1.52654
4-FLS	2	0.9	1	9	395.6	116.6	2.65268

TWO-LANE BRIDGE : 10 Girders, 12.336m Width, 24m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	10	395.6	110.3	1.54898
2-ULS	2	0.9	0.9	10	395.6	124.3	1.57103
3-ULS	2	0.9	0.9	10	395.6	150.1	1.89712
4-FLS	2	0.9	1	10	395.6	116.0	2.93225

TWO-LANE BRIDGE : 11 Girders, 13.571m Width, 24m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	11	395.6	109.7	1.69461
2-ULS	2	0.9	0.9	11	395.6	123.1	1.71145
3-ULS	2	0.9	0.9	11	395.6	139.1	1.9339
4-FLS	2	0.9	1	11	395.6	109.8	3.05308

TABLE A.90: Fv VALUES FOR B800 TWO-LANE BRIDGE 20m LENGTH

TWO-LANE BRIDGE : 9 Girders, 11.101m Width, 20m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	9	349.7	102.2	1.46125
2-ULS	2	0.9	0.9	9	349.7	115.4	1.48499
3-ULS	2	0.9	0.9	9	349.7	143.3	1.84401
4-FLS	2	0.9	1	9	349.7	101.3	2.60709

TWO-LANE BRIDGE : 10 Girders, 12.336m Width, 20m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	10	349.7	101.2	1.60773
2-ULS	2	0.9	0.9	10	349.7	111.2	1.58993
3-ULS	2	0.9	0.9	10	349.7	136.9	1.95739
4-FLS	2	0.9	1	10	349.7	106.0	3.03117

TWO-LANE BRIDGE : 11 Girders, 13.571m Width, 20m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	11	349.7	100.9	1.76326
2-ULS	2	0.9	0.9	11	349.7	110.3	1.73477
3-ULS	2	0.9	0.9	11	349.7	135.4	2.12954
4-FLS	2	0.9	1	11	349.7	103.6	3.25879

TABLE A.91: Fv VALUES FOR B800 TWO-LANE BRIDGE 26m LENGTH

TWO-LANE BRIDGE : 9 Girders, 11.101m Width, 26m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	9	413.3	111.5	1.3489
2-ULS	2	0.9	0.9	9	413.3	127.9	1.39257
3-ULS	2	0.9	0.9	9	413.3	135.3	1.47314
4-FLS	2	0.9	1	9	413.3	117.5	2.55867

TWO-LANE BRIDGE : 10 Girders, 12.336m Width, 26m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	10	413.3	110.5	1.48533
2-ULS	2	0.9	0.9	10	413.3	125.4	1.51706
3-ULS	2	0.9	0.9	10	413.3	134.3	1.62473
4-FLS	2	0.9	1	10	413.3	116.7	2.82361

TWO-LANE BRIDGE : 11 Girders, 13.571m Width, 26m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	11	413.3	109.9	1.625
2-ULS	2	0.9	0.9	11	413.3	121.2	1.61287
3-ULS	2	0.9	0.9	11	413.3	130.3	1.73397
4-FLS	2	0.9	1	11	413.3	113	3.0075

TABLE A.92: Fv VALUES FOR B900 TWO-LANE BRIDGE 30m LENGTH

TWO-LANE BRIDGE : 9 Girders, 11.101m Width, 30m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	9	441.5	148.0	1.6761
2-ULS	2	0.9	0.9	9	441.5	139.7	1.4239
3-ULS	2	0.9	0.9	9	441.5	170.8	1.74088
4-FLS	2	0.9	1	9	441.5	117.7	2.39932

TWO-LANE BRIDGE : 10 Girders, 12.336m Width, 30m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	10	441.5	148.4	1.86737
2-ULS	2	0.9	0.9	10	441.5	140.1	1.58664
3-ULS	2	0.9	0.9	10	441.5	162.5	1.84032
4-FLS	2	0.9	1	10	441.5	117.0	2.65006

TWO-LANE BRIDGE : 11 Girders, 13.571m Width, 30m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	11	441.5	148.7	2.05826
2-ULS	2	0.9	0.9	11	441.5	140.8	1.75402
3-ULS	2	0.9	0.9	11	441.5	177.4	2.20997
4-FLS	2	0.9	1	11	441.5	118.1	2.94247

TABLE A.93: Fv VALUES FOR B1000 TWO-LANE BRIDGE 32m LENGTH

TWO-LANE BRIDGE : 9 Girders, 11.101m Width, 32m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	9	452.9	151.4	1.67145
2-ULS	2	0.9	0.9	9	452.9	142.0	1.41091
3-ULS	2	0.9	0.9	9	452.9	140.5	1.396
4-FLS	2	0.9	1	9	452.9	117.5	2.33495

TWO-LANE BRIDGE : 10 Girders, 12.336m Width, 32m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	10	452.9	150.3	1.84367
2-ULS	2	0.9	0.9	10	452.9	141.9	1.56657
3-ULS	2	0.9	0.9	10	452.9	141.4	1.56105
4-FLS	2	0.9	1	10	452.9	113.0	2.49503

TWO-LANE BRIDGE : 11 Girders, 13.571m Width, 32m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-USL	2	0.9	1	11	452.9	152.5	2.05773
2-ULS	2	0.9	0.9	11	452.9	143.6	1.74387
3-ULS	2	0.9	0.9	11	452.9	132.5	1.60907
4-FLS	2	0.9	1	11	452.9	118.9	2.88783

TABLE A.94: Fd VALUES FOR B700 TWO-LANE BRIDGE 16m LENGTH

TWO-LANE BRIDGE : 9 Girders, 11.101m Width, 16m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	2	0.9	1	9	24.09	3.0	1.1208

TWO-LANE BRIDGE : 10 Girders, 12.336m Width, 16m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	2	0.9	1	10	24.09	2.9	1.20382

TWO-LANE BRIDGE : 11 Girders, 13.571m Width, 16m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	2	0.9	1	11	24.09	2.6	1.1872

TABLE A.95: Fd VALUES FOR B700 TWO-LANE BRIDGE 24m LENGTH

TWO-LANE BRIDGE : 9 Girders, 11.101m Width, 24m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	2	0.9	1	9	104.25	12.5	1.07914

TWO-LANE BRIDGE : 10 Girders, 12.336m Width, 24m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	2	0.9	1	10	104.25	11.8	1.13189

TWO-LANE BRIDGE : 11 Girders, 13.571m Width, 24m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	2	0.9	1	11	104.25	10.6	1.11847

TABLE A.96: Fd VALUES FOR B800 TWO-LANE BRIDGE 20m LENGTH

TWO-LANE BRIDGE : 9 Girders, 11.101m Width, 20m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	2	0.9	1	9	38.97	5.7	1.3164

TWO-LANE BRIDGE : 10 Girders, 12.336m Width, 20m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	2	0.9	1	10	38.97	4.6	1.1804

TWO-LANE BRIDGE : 11 Girders, 13.571m Width, 20m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	2	0.9	1	11	38.97	4.0	1.1291

TABLE A.97: Fd VALUES FOR B800 TWO-LANE BRIDGE 26m LENGTH

TWO-LANE BRIDGE : 9 Girders, 11.101m Width, 26m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	2	0.9	1	9	101.96	12.2	1.07689

TWO-LANE BRIDGE : 10 Girders, 12.336m Width, 26m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	2	0.9	1	10	101.96	11.5	1.12789

TWO-LANE BRIDGE : 11 Girders, 13.571m Width, 26m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	2	0.9	1	11	101.96	10.3	1.11122

TABLE A.98: Fd VALUES FOR B900 TWO-LANE BRIDGE 24m LENGTH

TWO-LANE BRIDGE : 9 Girders, 11.101m Width, 24m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	2	0.9	1	9	57.51	7.5	1.17371

TWO-LANE BRIDGE : 10 Girders, 12.336m Width, 24m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	2	0.9	1	10	57.51	6.8	1.1824

TWO-LANE BRIDGE : 11 Girders, 13.571m Width, 24m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	2	0.9	1	11	57.51	6.3	1.20501

TABLE A.99: Fd VALUES FOR B900 TWO-LANE BRIDGE 30m LENGTH

TWO-LANE BRIDGE : 9 Girders, 11.101m Width, 30m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	3	0.8	1	9	129.7	17.3	1.20046

TWO-LANE BRIDGE : 10 Girders, 12.336m Width, 30m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	3	0.8	1	10	129.7	15.9	1.22591

TWO-LANE BRIDGE : 11 Girders, 13.571m Width, 30m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	3	0.8	1	11	129.7	14.5	1.22976

TABLE A.100: Fd VALUES FOR B900 TWO-LANE BRIDGE 26m LENGTH

TWO-LANE BRIDGE : 9 Girders, 11.101m Width, 26m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	2	0.9	1	9	60.5	7.8	1.16033

TWO-LANE BRIDGE : 10 Girders, 12.336m Width, 26m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	2	0.9	1	10	60.5	7.1	1.17355

TWO-LANE BRIDGE : 11 Girders, 13.571m Width, 26m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	2	0.9	1	11	60.5	6.6	1.2000

TABLE A.101: Fd VALUES FOR B900 TWO-LANE BRIDGE 32m LENGTH

TWO-LANE BRIDGE : 9 Girders, 11.101m Width, 32m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	2	0.9	1	9	126.75	15.4	1.09349

TWO-LANE BRIDGE : 10 Girders, 12.336m Width, 32m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	2	0.9	1	10	126.75	14.2	1.12032

TWO-LANE BRIDGE : 11 Girders, 13.571m Width, 32m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
6-FLS	2	0.9	1	11	126.75	13.2	1.14556

TABLE A.102: Fm VALUES FOR B700 FOUR-LANE BRIDGE 16m LENGTH

FOUR-LANE BRIDGE : 12 Girders, 14.806m Width, 16m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	4	0.7	1	12	1147.2	0.0417	0.4235	1925.7	0.70836
2-ULS	4	0.7	0.9	12	1147.2	0.0417	0.4235	3080.8	1.01994
3-ULS	4	0.7	0.8	12	1147.2	0.0417	0.4235	3713.6	1.09283
4-ULS	4	0.7	0.7	12	1147.2	0.0417	0.4235	4241.4	1.09213
5-ULS	4	0.7	0.9	12	1147.2	0.0417	0.4235	3331.3	1.10287
6-ULS	4	0.7	0.9	12	1147.2	0.0417	0.4235	2777.9	0.91966
7-ULS	4	0.7	0.8	12	1147.2	0.0417	0.4235	3872.4	1.13956
8-ULS	4	0.7	0.7	12	1147.2	0.0417	0.4235	4406.7	1.13469
9-ULS	4	0.7	0.7	12	1147.2	0.0417	0.4235	4409.4	1.13539
10-ULS	4	0.7	0.7	12	1147.2	0.0417	0.4235	4447.3	1.14515
11-ULS	4	0.7	0.9	12	1147.2	0.0417	0.4235	2649.3	0.87708
12-FLS	4	0.7	1	12	1147.2	0.0417	0.4235	1705.6	1.75672
13-FLS	4	0.7	1	12	1147.2	0.0417	0.4235	1490.8	1.53548

FOUR-LANE BRIDGE : 13 Girders, 16.041m Width, 16m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	4	0.7	1	13	1147.2	0.0417	0.4235	1910.2	0.76122
2-ULS	4	0.7	0.9	13	1147.2	0.0417	0.4235	2999.8	1.07588
3-ULS	4	0.7	0.8	13	1147.2	0.0417	0.4235	3556.7	1.13388
4-ULS	4	0.7	0.7	13	1147.2	0.0417	0.4235	4002.9	1.11661
5-ULS	4	0.7	0.9	13	1147.2	0.0417	0.4235	2957.5	1.06071
6-ULS	4	0.7	0.9	13	1147.2	0.0417	0.4235	2639.6	0.94669
7-ULS	4	0.7	0.8	13	1147.2	0.0417	0.4235	3589.1	1.14421
8-ULS	4	0.7	0.7	13	1147.2	0.0417	0.4235	4038.8	1.12662
9-ULS	4	0.7	0.7	13	1147.2	0.0417	0.4235	4097.4	1.14297
10-ULS	4	0.7	0.7	13	1147.2	0.0417	0.4235	4145.5	1.15639
11-ULS	4	0.7	0.9	13	1147.2	0.0417	0.4235	2509.6	0.90007
12-FLS	4	0.7	1	13	1147.2	0.0417	0.4235	1682.9	1.87778
13-FLS	4	0.7	1	13	1147.2	0.0417	0.4235	1405.7	1.56848

FOUR-LANE BRIDGE : 14 Girders, 17.276m Width, 16m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	4	0.7	1	14	1147.2	0.0417	0.4235	1898.4	0.81471
2-ULS	4	0.7	0.9	14	1147.2	0.0417	0.4235	2920.4	1.12797
3-ULS	4	0.7	0.8	14	1147.2	0.0417	0.4235	3421.1	1.17454
4-ULS	4	0.7	0.7	14	1147.2	0.0417	0.4235	3781.5	1.13599
5-ULS	4	0.7	0.9	14	1147.2	0.0417	0.4235	2805.4	1.08355
6-ULS	4	0.7	0.9	14	1147.2	0.0417	0.4235	2634.6	1.01759
7-ULS	4	0.7	0.8	14	1147.2	0.0417	0.4235	3433.6	1.17884
8-ULS	4	0.7	0.7	14	1147.2	0.0417	0.4235	3823.5	1.14861
9-ULS	4	0.7	0.7	14	1147.2	0.0417	0.4235	3890.5	1.16874
10-ULS	4	0.7	0.7	14	1147.2	0.0417	0.4235	3964.1	1.19085
11-ULS	4	0.7	0.9	14	1147.2	0.0417	0.4235	2435.8	0.9408
12-FLS	4	0.7	1	14	1147.2	0.0417	0.4235	1608.7	1.93307
13-FLS	4	0.7	1	14	1147.2	0.0417	0.4235	1374.8	1.652

TABLE A.103: Fm VALUES FOR B700 FOUR-LANE BRIDGE 24m LENGTH

FOUR-LANE BRIDGE : 12 Girders, 14.806m Width, 24m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	4	0.7	1	12	2113.9	0.0417	0.4235	3106.4	0.62012
2-ULS	4	0.7	0.9	12	2113.9	0.0417	0.4235	4922.5	0.8844
3-ULS	4	0.7	0.8	12	2113.9	0.0417	0.4235	6323.9	1.00994
4-ULS	4	0.7	0.7	12	2113.9	0.0417	0.4235	7583.3	1.05969
5-ULS	4	0.7	0.9	12	2113.9	0.0417	0.4235	4795.4	0.86157
6-ULS	4	0.7	0.9	12	2113.9	0.0417	0.4235	4402.8	0.79103
7-ULS	4	0.7	0.8	12	2113.9	0.0417	0.4235	6312.9	1.00819
8-ULS	4	0.7	0.7	12	2113.9	0.0417	0.4235	7596.5	1.06153
9-ULS	4	0.7	0.7	12	2113.9	0.0417	0.4235	7632.1	1.06651
10-ULS	4	0.7	0.7	12	2113.9	0.0417	0.4235	7616.5	1.06433
11-ULS	4	0.7	0.9	12	2113.9	0.0417	0.4235	4281.2	0.76918
12-FLS	4	0.7	1	12	2113.9	0.0417	0.4235	2752.9	1.53876
13-FLS	4	0.7	1	12	2113.9	0.0417	0.4235	2461.1	1.37565

FOUR-LANE BRIDGE : 13 Girders, 16.041m Width, 24m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	4	0.7	1	13	2113.9	0.0417	0.4235	3046.5	0.65885
2-ULS	4	0.7	0.9	13	2113.9	0.0417	0.4235	4741.8	0.92293
3-ULS	4	0.7	0.8	13	2113.9	0.0417	0.4235	6005.4	1.0390
4-ULS	4	0.7	0.7	13	2113.9	0.0417	0.4235	7113.6	1.07689
5-ULS	4	0.7	0.9	13	2113.9	0.0417	0.4235	4600.7	0.89547
6-ULS	4	0.7	0.9	13	2113.9	0.0417	0.4235	4183.1	0.81419
7-ULS	4	0.7	0.8	13	2113.9	0.0417	0.4235	5990.6	1.03644
8-ULS	4	0.7	0.7	13	2113.9	0.0417	0.4235	7080.2	1.07183
9-ULS	4	0.7	0.7	13	2113.9	0.0417	0.4235	7126.8	1.07889
10-ULS	4	0.7	0.7	13	2113.9	0.0417	0.4235	7157.6	1.08355
11-ULS	4	0.7	0.9	13	2113.9	0.0417	0.4235	4051.7	0.78861
12-FLS	4	0.7	1	13	2113.9	0.0417	0.4235	2686.7	1.6269
13-FLS	4	0.7	1	13	2113.9	0.0417	0.4235	2289.6	1.38644

FOUR-LANE BRIDGE : 14 Girders, 17.276m Width, 24m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	4	0.7	1	14	2113.9	0.0417	0.4235	2999.1	0.69849
2-ULS	4	0.7	0.9	14	2113.9	0.0417	0.4235	4578.6	0.95972
3-ULS	4	0.7	0.8	14	2113.9	0.0417	0.4235	5724.1	1.06651
4-ULS	4	0.7	0.7	14	2113.9	0.0417	0.4235	6705.2	1.09315
5-ULS	4	0.7	0.9	14	2113.9	0.0417	0.4235	4352.2	0.91226
6-ULS	4	0.7	0.9	14	2113.9	0.0417	0.4235	4019.3	0.84248
7-ULS	4	0.7	0.8	14	2113.9	0.0417	0.4235	5649.1	1.05254
8-ULS	4	0.7	0.7	14	2113.9	0.0417	0.4235	6612.4	1.07802
9-ULS	4	0.7	0.7	14	2113.9	0.0417	0.4235	6704.4	1.09302
10-ULS	4	0.7	0.7	14	2113.9	0.0417	0.4235	6705.5	1.09319
11-ULS	4	0.7	0.9	14	2113.9	0.0417	0.4235	3820.2	0.80075
12-FLS	4	0.7	1	14	2113.9	0.0417	0.4235	2625.6	1.7122
13-FLS	4	0.7	1	14	2113.9	0.0417	0.4235	2280.3	1.48702

TABLE A.104: Fm VALUES FOR B800 FOUR-LANE BRIDGE 20m LENGTH

FOUR-LANE BRIDGE : 12 Girders, 14.806m Width, 20m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	4	0.7	1	12	1617.9	0.0575	0.4619	2045.8	0.67461
2-ULS	4	0.7	0.9	12	1617.9	0.0575	0.4619	3345.6	0.99291
3-ULS	4	0.7	0.8	12	1617.9	0.0575	0.4619	4147.8	1.09421
4-ULS	4	0.7	0.7	12	1617.9	0.0575	0.4619	4806.6	1.1095
5-ULS	4	0.7	0.9	12	1617.9	0.0575	0.4619	3622.7	1.07514
6-ULS	4	0.7	0.9	12	1617.9	0.0575	0.4619	3026.6	0.89823
7-ULS	4	0.7	0.8	12	1617.9	0.0575	0.4619	4327.5	1.14161
8-ULS	4	0.7	0.7	12	1617.9	0.0575	0.4619	5081.4	1.17293
9-ULS	4	0.7	0.7	12	1617.9	0.0575	0.4619	5028.7	1.16077
10-ULS	4	0.7	0.7	12	1617.9	0.0575	0.4619	5051.4	1.16601
11-ULS	4	0.7	0.9	12	1617.9	0.0575	0.4619	2907.4	0.86286
12-FLS	4	0.7	1	12	1617.9	0.0575	0.4619	1834.8	1.6941
13-FLS	4	0.7	1	12	1617.9	0.0575	0.4619	1790.1	1.65282

FOUR-LANE BRIDGE : 13 Girders, 16.041m Width, 20m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	4	0.7	1	13	1617.9	0.0575	0.4619	2026.5	0.72394
2-ULS	4	0.7	0.9	13	1617.9	0.0575	0.4619	3244.6	1.04318
3-ULS	4	0.7	0.8	13	1617.9	0.0575	0.4619	3961.7	1.13221
4-ULS	4	0.7	0.7	13	1617.9	0.0575	0.4619	4533.5	1.13367
5-ULS	4	0.7	0.9	13	1617.9	0.0575	0.4619	3183.6	1.02356
6-ULS	4	0.7	0.9	13	1617.9	0.0575	0.4619	2892.7	0.93004
7-ULS	4	0.7	0.8	13	1617.9	0.0575	0.4619	3982.6	1.13818
8-ULS	4	0.7	0.7	13	1617.9	0.0575	0.4619	4418.4	1.10488
9-ULS	4	0.7	0.7	13	1617.9	0.0575	0.4619	4467.8	1.11724
10-ULS	4	0.7	0.7	13	1617.9	0.0575	0.4619	4414.3	1.10386
11-ULS	4	0.7	0.9	13	1617.9	0.0575	0.4619	2713.2	0.87232
12-FLS	4	0.7	1	13	1617.9	0.0575	0.4619	1807.6	1.80806
13-FLS	4	0.7	1	13	1617.9	0.0575	0.4619	1645.6	1.64602

FOUR-LANE BRIDGE : 14 Girders, 17.276m Width, 20m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	4	0.7	1	14	1617.9	0.0575	0.4619	2006.8	0.77204
2-ULS	4	0.7	0.9	14	1617.9	0.0575	0.4619	3149.8	1.0906
3-ULS	4	0.7	0.8	14	1617.9	0.0575	0.4619	3792.8	1.16732
4-ULS	4	0.7	0.7	14	1617.9	0.0575	0.4619	4351.9	1.17197
5-ULS	4	0.7	0.9	14	1617.9	0.0575	0.4619	3042.3	1.05337
6-ULS	4	0.7	0.9	14	1617.9	0.0575	0.4619	2809.4	0.97273
7-ULS	4	0.7	0.8	14	1617.9	0.0575	0.4619	3803.9	1.17073
8-ULS	4	0.7	0.7	14	1617.9	0.0575	0.4619	4328.6	1.16569
9-ULS	4	0.7	0.7	14	1617.9	0.0575	0.4619	4400.1	1.18495
10-ULS	4	0.7	0.7	14	1617.9	0.0575	0.4619	4207.8	1.13316
11-ULS	4	0.7	0.9	14	1617.9	0.0575	0.4619	2613.9	0.90504
12-FLS	4	0.7	1	14	1617.9	0.0575	0.4619	1722.8	1.8558
13-FLS	4	0.7	1	14	1617.9	0.0575	0.4619	1475.9	1.58984

TABLE A.105: Fm VALUES FOR B800 FOUR-LANE BRIDGE 26m LENGTH

FOUR-LANE BRIDGE : 12 Girders, 14.806m Width, 26m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	4	0.7	1	12	2415.8	0.0575	0.4619	2672.1	0.59011
2-ULS	4	0.7	0.9	12	2415.8	0.0575	0.4619	4345.6	0.86372
3-ULS	4	0.7	0.8	12	2415.8	0.0575	0.4619	5630.4	0.99474
4-ULS	4	0.7	0.7	12	2415.8	0.0575	0.4619	6906.4	1.06766
5-ULS	4	0.7	0.9	12	2415.8	0.0575	0.4619	4477.5	0.88994
6-ULS	4	0.7	0.9	12	2415.8	0.0575	0.4619	4134.8	0.82182
7-ULS	4	0.7	0.8	12	2415.8	0.0575	0.4619	5683.2	1.00407
8-ULS	4	0.7	0.7	12	2415.8	0.0575	0.4619	6858.9	1.06031
9-ULS	4	0.7	0.7	12	2415.8	0.0575	0.4619	6907.6	1.06784
10-ULS	4	0.7	0.7	12	2415.8	0.0575	0.4619	6910.8	1.06834
11-ULS	4	0.7	0.9	12	2415.8	0.0575	0.4619	4022.1	0.79942
12-FLS	4	0.7	1	12	2415.8	0.0575	0.4619	2428.6	1.50174
13-FLS	4	0.7	1	12	2415.8	0.0575	0.4619	2105.8	1.30214

FOUR-LANE BRIDGE : 13 Girders, 16.041m Width, 26m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	4	0.7	1	13	2415.8	0.0575	0.4619	2613.4	0.62524
2-ULS	4	0.7	0.9	13	2415.8	0.0575	0.4619	4210.8	0.90667
3-ULS	4	0.7	0.8	13	2415.8	0.0575	0.4619	5599.1	1.07165
4-ULS	4	0.7	0.7	13	2415.8	0.0575	0.4619	6427.8	1.07648
5-ULS	4	0.7	0.9	13	2415.8	0.0575	0.4619	4275.3	0.92056
6-ULS	4	0.7	0.9	13	2415.8	0.0575	0.4619	3928.4	0.84587
7-ULS	4	0.7	0.8	13	2415.8	0.0575	0.4619	5585.4	1.06903
8-ULS	4	0.7	0.7	13	2415.8	0.0575	0.4619	6398.6	1.07159
9-ULS	4	0.7	0.7	13	2415.8	0.0575	0.4619	6729.6	1.12702
10-ULS	4	0.7	0.7	13	2415.8	0.0575	0.4619	6580.4	1.10203
11-ULS	4	0.7	0.9	13	2415.8	0.0575	0.4619	3797.7	0.81773
12-FLS	4	0.7	1	13	2415.8	0.0575	0.4619	2366.4	1.58522
13-FLS	4	0.7	1	13	2415.8	0.0575	0.4619	2033.7	1.36235

FOUR-LANE BRIDGE : 14 Girders, 17.276m Width, 26m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	4	0.7	1	14	2415.8	0.0575	0.4619	2568.1	0.66167
2-ULS	4	0.7	0.9	14	2415.8	0.0575	0.4619	4236.8	0.98245
3-ULS	4	0.7	0.8	14	2415.8	0.0575	0.4619	4903.6	1.01073
4-ULS	4	0.7	0.7	14	2415.8	0.0575	0.4619	5887.4	1.06182
5-ULS	4	0.7	0.9	14	2415.8	0.0575	0.4619	4168.4	0.96659
6-ULS	4	0.7	0.9	14	2415.8	0.0575	0.4619	3770.9	0.87441
7-ULS	4	0.7	0.8	14	2415.8	0.0575	0.4619	5005.3	1.03169
8-ULS	4	0.7	0.7	14	2415.8	0.0575	0.4619	5910.2	1.06593
9-ULS	4	0.7	0.7	14	2415.8	0.0575	0.4619	6026.7	1.08694
10-ULS	4	0.7	0.7	14	2415.8	0.0575	0.4619	6061.8	1.09327
11-ULS	4	0.7	0.9	14	2415.8	0.0575	0.4619	3588.4	0.83209
12-FLS	4	0.7	1	14	2415.8	0.0575	0.4619	2240.5	1.61634
13-FLS	4	0.7	1	14	2415.8	0.0575	0.4619	1940.6	1.39998

TABLE A.106: Fm VALUES FOR B900 FOUR-LANE BRIDGE 24m LENGTH

FOUR-LANE BRIDGE : 12 Girders, 14.806m Width, 24m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	4	0.7	1	12	2113.9	0.0756	0.535	2090.7	0.59896
2-ULS	4	0.7	0.9	12	2113.9	0.0756	0.535	3485.9	0.8988
3-ULS	4	0.7	0.8	12	2113.9	0.0756	0.535	4446.5	1.0191
4-ULS	4	0.7	0.7	12	2113.9	0.0756	0.535	5282.5	1.05936
5-ULS	4	0.7	0.9	12	2113.9	0.0756	0.535	3455.8	0.89104
6-ULS	4	0.7	0.9	12	2113.9	0.0756	0.535	3206.4	0.82674
7-ULS	4	0.7	0.8	12	2113.9	0.0756	0.535	4492.6	1.02966
8-ULS	4	0.7	0.7	12	2113.9	0.0756	0.535	5338.1	1.07051
9-ULS	4	0.7	0.7	12	2113.9	0.0756	0.535	5365.1	1.07593
10-ULS	4	0.7	0.7	12	2113.9	0.0756	0.535	5362.6	1.07543
11-ULS	4	0.7	0.9	12	2113.9	0.0756	0.535	3097.1	0.79855
12-FLS	4	0.7	1	12	2113.9	0.0756	0.535	1896.7	1.52147
13-FLS	4	0.7	1	12	2113.9	0.0756	0.535	1686.4	1.35277

FOUR-LANE BRIDGE : 13 Girders, 16.041m Width, 24m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	4	0.7	1	13	2113.9	0.0756	0.535	2052.6	0.63705
2-ULS	4	0.7	0.9	13	2113.9	0.0756	0.535	3401.8	0.95021
3-ULS	4	0.7	0.8	13	2113.9	0.0756	0.535	4223.3	1.0486
4-ULS	4	0.7	0.7	13	2113.9	0.0756	0.535	4958.6	1.07727
5-ULS	4	0.7	0.9	13	2113.9	0.0756	0.535	3436.3	0.95985
6-ULS	4	0.7	0.9	13	2113.9	0.0756	0.535	3040.4	0.84926
7-ULS	4	0.7	0.8	13	2113.9	0.0756	0.535	4238.8	1.05245
8-ULS	4	0.7	0.7	13	2113.9	0.0756	0.535	4958.8	1.07732
9-ULS	4	0.7	0.7	13	2113.9	0.0756	0.535	5001.2	1.08653
10-ULS	4	0.7	0.7	13	2113.9	0.0756	0.535	5004.6	1.08727
11-ULS	4	0.7	0.9	13	2113.9	0.0756	0.535	2939.1	0.82097
12-FLS	4	0.7	1	13	2113.9	0.0756	0.535	1842.2	1.6009
13-FLS	4	0.7	1	13	2113.9	0.0756	0.535	1616.5	1.40476

FOUR-LANE BRIDGE : 14 Girders, 17.276m Width, 24m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	4	0.7	1	14	2113.9	0.0756	0.535	2023.4	0.67629
2-ULS	4	0.7	0.9	14	2113.9	0.0756	0.535	3328.1	1.00113
3-ULS	4	0.7	0.8	14	2113.9	0.0756	0.535	4032.9	1.07835
4-ULS	4	0.7	0.7	14	2113.9	0.0756	0.535	4684.5	1.09601
5-ULS	4	0.7	0.9	14	2113.9	0.0756	0.535	3382.1	1.01738
6-ULS	4	0.7	0.9	14	2113.9	0.0756	0.535	2952.5	0.88815
7-ULS	4	0.7	0.8	14	2113.9	0.0756	0.535	4052.6	1.08362
8-ULS	4	0.7	0.7	14	2113.9	0.0756	0.535	4669.5	1.0925
9-ULS	4	0.7	0.7	14	2113.9	0.0756	0.535	4731.1	1.10691
10-ULS	4	0.7	0.7	14	2113.9	0.0756	0.535	4756.4	1.11283
11-ULS	4	0.7	0.9	14	2113.9	0.0756	0.535	2779.9	0.83623
12-FLS	4	0.7	1	14	2113.9	0.0756	0.535	1784.6	1.67014
13-FLS	4	0.7	1	14	2113.9	0.0756	0.535	1518.4	1.42101

TABLE A.107: Fm VALUES FOR B900 FOUR-LANE BRIDGE 30m LENGTH

FOUR-LANE BRIDGE : 12 Girders, 14.806m Width, 30m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	4	0.7	1	12	3025.0	0.0756	0.535	2640.7	0.52867
2-ULS	4	0.7	0.9	12	3025.0	0.0756	0.535	4669.2	0.8413
3-ULS	4	0.7	0.8	12	3025.0	0.0756	0.535	6126.2	0.98118
4-ULS	4	0.7	0.7	12	3025.0	0.0756	0.535	7460.4	1.0455
5-ULS	4	0.7	0.9	12	3025.0	0.0756	0.535	4599.9	0.82881
6-ULS	4	0.7	0.9	12	3025.0	0.0756	0.535	4273.1	0.76993
7-ULS	4	0.7	0.8	12	3025.0	0.0756	0.535	6132.8	0.98223
8-ULS	4	0.7	0.7	12	3025.0	0.0756	0.535	7485.1	1.04897
9-ULS	4	0.7	0.7	12	3025.0	0.0756	0.535	7516.3	1.05334
10-ULS	4	0.7	0.7	12	3025.0	0.0756	0.535	7502.7	1.05143
11-ULS	4	0.7	0.9	12	3025.0	0.0756	0.535	4169.1	0.75119
12-FLS	4	0.7	1	12	3025.0	0.0756	0.535	2415.8	1.35421
13-FLS	4	0.7	1	12	3025.0	0.0756	0.535	1985.5	1.113

FOUR-LANE BRIDGE : 13 Girders, 16.041m Width, 30m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	4	0.7	1	13	3025.0	0.0756	0.535	2248.4	0.48764
2-ULS	4	0.7	0.9	13	3025.0	0.0756	0.535	3970.5	0.77502
3-ULS	4	0.7	0.8	13	3025.0	0.0756	0.535	4967.5	0.8619
4-ULS	4	0.7	0.7	13	3025.0	0.0756	0.535	5883.4	0.89321
5-ULS	4	0.7	0.9	13	3025.0	0.0756	0.535	3992.2	0.77926
6-ULS	4	0.7	0.9	13	3025.0	0.0756	0.535	3478.3	0.67895
7-ULS	4	0.7	0.8	13	3025.0	0.0756	0.535	4905.1	0.85107
8-ULS	4	0.7	0.7	13	3025.0	0.0756	0.535	5888.4	0.89397
9-ULS	4	0.7	0.7	13	3025.0	0.0756	0.535	5932.1	0.90061
10-ULS	4	0.7	0.7	13	3025.0	0.0756	0.535	7000.0	1.06273
11-ULS	4	0.7	0.9	13	3025.0	0.0756	0.535	3385.1	0.66076
12-FLS	4	0.7	1	13	3025.0	0.0756	0.535	2360.7	1.4336
13-FLS	4	0.7	1	13	3025.0	0.0756	0.535	1806.8	1.09723

FOUR-LANE BRIDGE : 14 Girders, 17.276m Width, 30m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	4	0.7	1	14	3025.0	0.0756	0.535	2585.7	0.60394
2-ULS	4	0.7	0.9	14	3025.0	0.0756	0.535	4054.6	0.85232
3-ULS	4	0.7	0.8	14	3025.0	0.0756	0.535	5503.2	1.0283
4-ULS	4	0.7	0.7	14	3025.0	0.0756	0.535	6565.9	1.07351
5-ULS	4	0.7	0.9	14	3025.0	0.0756	0.535	4433.4	0.93195
6-ULS	4	0.7	0.9	14	3025.0	0.0756	0.535	3877.1	0.81501
7-ULS	4	0.7	0.8	14	3025.0	0.0756	0.535	5492.1	1.02622
8-ULS	4	0.7	0.7	14	3025.0	0.0756	0.535	6494.1	1.06177
9-ULS	4	0.7	0.7	14	3025.0	0.0756	0.535	6569.7	1.07413
10-ULS	4	0.7	0.7	14	3025.0	0.0756	0.535	6591.5	1.07769
11-ULS	4	0.7	0.9	14	3025.0	0.0756	0.535	3711.3	0.78016
12-FLS	4	0.7	1	14	3025.0	0.0756	0.535	2284.4	1.49397
13-FLS	4	0.7	1	14	3025.0	0.0756	0.535	1720.9	1.12545

TABLE A.108: Fm VALUES FOR B1000 FOUR-LANE BRIDGE 26m LENGTH

FOUR-LANE BRIDGE : 12 Girders, 14.806m Width, 26m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	4	0.7	1	12	2415.8	0.0969	0.590	2112.6	0.6155
2-ULS	4	0.7	0.9	12	2415.8	0.0969	0.590	3465.8	0.9088
3-ULS	4	0.7	0.8	12	2415.8	0.0969	0.590	4324.4	1.008
4-ULS	4	0.7	0.7	12	2415.8	0.0969	0.590	5195.7	1.0597
5-ULS	4	0.7	0.9	12	2415.8	0.0969	0.590	3485.1	0.9139
6-ULS	4	0.7	0.9	12	2415.8	0.0969	0.590	3118.4	0.8177
7-ULS	4	0.7	0.8	12	2415.8	0.0969	0.590	4380.4	1.021
8-ULS	4	0.7	0.7	12	2415.8	0.0969	0.590	5247.1	1.0702
9-ULS	4	0.7	0.7	12	2415.8	0.0969	0.590	5272.5	1.0753
10-ULS	4	0.7	0.7	12	2415.8	0.0969	0.590	5278.9	1.0767
11-ULS	4	0.7	0.9	12	2415.8	0.0969	0.590	3017.8	0.7913
12-FLS	4	0.7	1	12	2415.8	0.0969	0.590	1847.3	1.5071
13-FLS	4	0.7	1	12	2415.8	0.0969	0.590	1640.4	1.3383

FOUR-LANE BRIDGE : 13 Girders, 16.041m Width, 26m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	4	0.7	1	13	2415.8	0.0969	0.590	1974.4	0.6232
2-ULS	4	0.7	0.9	13	2415.8	0.0969	0.590	3458.1	0.9824
3-ULS	4	0.7	0.8	13	2415.8	0.0969	0.590	4103.2	1.0361
4-ULS	4	0.7	0.7	13	2415.8	0.0969	0.590	4840.4	1.0695
5-ULS	4	0.7	0.9	13	2415.8	0.0969	0.590	3496.1	0.9932
6-ULS	4	0.7	0.9	13	2415.8	0.0969	0.590	2961.1	0.8412
7-ULS	4	0.7	0.8	13	2415.8	0.0969	0.590	4132.3	1.0435
8-ULS	4	0.7	0.7	13	2415.8	0.0969	0.590	4851.5	1.0719
9-ULS	4	0.7	0.7	13	2415.8	0.0969	0.590	4885.6	1.0795
10-ULS	4	0.7	0.7	13	2415.8	0.0969	0.590	4887.6	1.0799
11-ULS	4	0.7	0.9	13	2415.8	0.0969	0.590	2865.5	0.814
12-FLS	4	0.7	1	13	2415.8	0.0969	0.590	1713.4	1.5143
13-FLS	4	0.7	1	13	2415.8	0.0969	0.590	1513.1	1.3373

FOUR-LANE BRIDGE : 14 Girders, 17.276m Width, 26m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	4	0.7	1	14	2415.8	0.0969	0.590	1945.7	0.6614
2-ULS	4	0.7	0.9	14	2415.8	0.0969	0.590	3376.8	1.0331
3-ULS	4	0.7	0.8	14	2415.8	0.0969	0.590	3914.2	1.0644
4-ULS	4	0.7	0.7	14	2415.8	0.0969	0.590	4570.4	1.0875
5-ULS	4	0.7	0.9	14	2415.8	0.0969	0.590	3445.6	1.0541
6-ULS	4	0.7	0.9	14	2415.8	0.0969	0.590	2868.1	0.8774
7-ULS	4	0.7	0.8	14	2415.8	0.0969	0.590	3949.6	1.074
8-ULS	4	0.7	0.7	14	2415.8	0.0969	0.590	4563.2	1.0858
9-ULS	4	0.7	0.7	14	2415.8	0.0969	0.590	4615.1	1.0981
10-ULS	4	0.7	0.7	14	2415.8	0.0969	0.590	4644.1	1.105
11-ULS	4	0.7	0.9	14	2415.8	0.0969	0.590	2706.1	0.8279
12-FLS	4	0.7	1	14	2415.8	0.0969	0.590	1702.1	1.62
13-FLS	4	0.7	1	14	2415.8	0.0969	0.590	1480.6	1.4092

TABLE A.109: Fm VALUES FOR B1000 FOUR-LANE BRIDGE 32m LENGTH

FOUR-LANE BRIDGE : 12 Girders, 14.806m Width, 32m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	4	0.7	1	12	3382.2	0.0969	0.590	2537.4	0.52806
2-ULS	4	0.7	0.9	12	3382.2	0.0969	0.590	4379.7	0.82032
3-ULS	4	0.7	0.8	12	3382.2	0.0969	0.590	5667.5	0.94358
4-ULS	4	0.7	0.7	12	3382.2	0.0969	0.590	7121.7	1.03747
5-ULS	4	0.7	0.9	12	3382.2	0.0969	0.590	4334.7	0.81189
6-ULS	4	0.7	0.9	12	3382.2	0.0969	0.590	5518.4	1.0336
7-ULS	4	0.7	0.8	12	3382.2	0.0969	0.590	5790.3	0.96402
8-ULS	4	0.7	0.7	12	3382.2	0.0969	0.590	7148.5	1.04138
9-ULS	4	0.7	0.7	12	3382.2	0.0969	0.590	7176.4	1.04544
10-ULS	4	0.7	0.7	12	3382.2	0.0969	0.590	7183.3	1.04645
11-ULS	4	0.7	0.9	12	3382.2	0.0969	0.590	3943.8	0.73867
12-FLS	4	0.7	1	12	3382.2	0.0969	0.590	2333.7	1.35987
13-FLS	4	0.7	1	12	3382.2	0.0969	0.590	2255.1	1.31407

FOUR-LANE BRIDGE : 13 Girders, 16.041m Width, 32m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	4	0.7	1	13	3382.2	0.0969	0.590	2346.4	0.52901
2-ULS	4	0.7	0.9	13	3382.2	0.0969	0.590	4272.5	0.86693
3-ULS	4	0.7	0.8	13	3382.2	0.0969	0.590	5446.7	0.98238
4-ULS	4	0.7	0.7	13	3382.2	0.0969	0.590	6576.5	1.03789
5-ULS	4	0.7	0.9	13	3382.2	0.0969	0.590	4282.6	0.86898
6-ULS	4	0.7	0.9	13	3382.2	0.0969	0.590	3821.1	0.77533
7-ULS	4	0.7	0.8	13	3382.2	0.0969	0.590	5444.1	0.98191
8-ULS	4	0.7	0.7	13	3382.2	0.0969	0.590	6557.4	1.03487
9-ULS	4	0.7	0.7	13	3382.2	0.0969	0.590	6597.2	1.04116
10-ULS	4	0.7	0.7	13	3382.2	0.0969	0.590	6599.1	1.04146
11-ULS	4	0.7	0.9	13	3382.2	0.0969	0.590	3728.6	0.75656
12-FLS	4	0.7	1	13	3382.2	0.0969	0.590	2240.5	1.41436
13-FLS	4	0.7	1	13	3382.2	0.0969	0.590	1770.9	1.11792

FOUR-LANE BRIDGE : 14 Girders, 17.276m Width, 32m Length

Load Cases	n	RL	RL'	N	MT	I	y	Smax	Fm
1-ULS	4	0.7	1	14	3382.2	0.0969	0.590	2422.1	0.58808
2-ULS	4	0.7	0.9	14	3382.2	0.0969	0.590	4244.7	0.92754
3-ULS	4	0.7	0.8	14	3382.2	0.0969	0.590	5174.6	1.0051
4-ULS	4	0.7	0.7	14	3382.2	0.0969	0.590	6187.9	1.05168
5-ULS	4	0.7	0.9	14	3382.2	0.0969	0.590	4290.4	0.93752
6-ULS	4	0.7	0.9	14	3382.2	0.0969	0.590	3667.1	0.80132
7-ULS	4	0.7	0.8	14	3382.2	0.0969	0.590	5190.8	1.00825
8-ULS	4	0.7	0.7	14	3382.2	0.0969	0.590	6139.1	1.04339
9-ULS	4	0.7	0.7	14	3382.2	0.0969	0.590	6200.4	1.0538
10-ULS	4	0.7	0.7	14	3382.2	0.0969	0.590	6229.4	1.05873
11-ULS	4	0.7	0.9	14	3382.2	0.0969	0.590	3511.3	0.76728
12-FLS	4	0.7	1	14	3382.2	0.0969	0.590	2142.4	1.45647
13-FLS	4	0.7	1	14	3382.2	0.0969	0.590	1874.6	1.27441

TABLE A.110: Fv VALUES FOR B700 FOUR-LANE BRIDGE 16m LENGTH

FOUR-LANE BRIDGE : 12 Girders, 14.806m Width, 16m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-ULS	4	0.7	1	12	326.8	109.6	1.43731
2-ULS	4	0.7	0.9	12	326.8	126.1	1.48833
3-ULS	4	0.7	0.8	12	326.8	130.6	1.37017
4-ULS	4	0.7	0.7	12	326.8	135.0	1.23929
5-ULS	4	0.7	0.9	12	326.8	137.5	1.62288
6-ULS	4	0.7	0.9	12	326.8	134.5	1.58747
7-ULS	4	0.7	0.8	12	326.8	131.0	1.37437
8-ULS	4	0.7	0.7	12	326.8	145.2	1.33293
9-ULS	4	0.7	0.7	12	326.8	145.6	1.3366
10-ULS	4	0.7	0.7	12	326.8	141.7	1.3008
11-ULS	4	0.7	0.9	12	326.8	128.1	1.51193
12-FLS	4	0.7	1	12	326.8	113.4	4.16401
13-FLS	4	0.7	1	12	326.8	111.9	4.10894

FOUR-LANE BRIDGE : 13 Girders, 16.041m Width, 16m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-ULS	4	0.7	1	13	326.8	109.9	1.56135
2-ULS	4	0.7	0.9	13	326.8	124.1	1.58678
3-ULS	4	0.7	0.8	13	326.8	126.6	1.43889
4-ULS	4	0.7	0.7	13	326.8	131.3	1.30577
5-ULS	4	0.7	0.9	13	326.8	138.3	1.76835
6-ULS	4	0.7	0.9	13	326.8	124.6	1.59318
7-ULS	4	0.7	0.8	13	326.8	141.3	1.60596
8-ULS	4	0.7	0.7	13	326.8	127.6	1.26897
9-ULS	4	0.7	0.7	13	326.8	131.3	1.30577
10-ULS	4	0.7	0.7	13	326.8	130.1	1.29383
11-ULS	4	0.7	0.9	13	326.8	123.6	1.58039
12-FLS	4	0.7	1	13	326.8	113.2	4.50306
13-FLS	4	0.7	1	13	326.8	104.4	4.15300

FOUR-LANE BRIDGE : 14 Girders, 17.276m Width, 16m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-ULS	4	0.7	1	14	326.8	109.3	1.67228
2-ULS	4	0.7	0.9	14	326.8	120.6	1.66065
3-ULS	4	0.7	0.8	14	326.8	123.8	1.5153
4-ULS	4	0.7	0.7	14	326.8	126.7	1.35695
5-ULS	4	0.7	0.9	14	326.8	136.9	1.8851
6-ULS	4	0.7	0.9	14	326.8	133.6	1.83966
7-ULS	4	0.7	0.8	14	326.8	139.8	1.71114
8-ULS	4	0.7	0.7	14	326.8	141.7	1.51759
9-ULS	4	0.7	0.7	14	326.8	142.1	1.52188
10-ULS	4	0.7	0.7	14	326.8	139.0	1.48868
11-ULS	4	0.7	0.9	14	326.8	115.9	1.59593
12-FLS	4	0.7	1	14	326.8	110.1	4.71665
13-FLS	4	0.7	1	14	326.8	100.3	4.29682

TABLE A.111: Fv VALUES FOR B700 FOUR-LANE BRIDGE 24m LENGTH

FOUR-LANE BRIDGE : 12 Girders, 14.806m Width, 24m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-ULS	4	0.7	1	12	395.6	131.1	1.42027
2-ULS	4	0.7	0.9	12	395.6	138.2	1.34746
3-ULS	4	0.7	0.8	12	395.6	146.1	1.26621
4-ULS	4	0.7	0.7	12	395.6	156.1	1.18377
5-ULS	4	0.7	0.9	12	395.6	148.8	1.45082
6-ULS	4	0.7	0.9	12	395.6	141.5	1.37964
7-ULS	4	0.7	0.8	12	395.6	146.9	1.27315
8-ULS	4	0.7	0.7	12	395.6	164.4	1.24671
9-ULS	4	0.7	0.7	12	395.6	165.7	1.25657
10-ULS	4	0.7	0.7	12	395.6	163.7	1.24141
11-ULS	4	0.7	0.9	12	395.6	140.6	1.37087
12-FLS	4	0.7	1	12	395.6	112.7	3.4186
13-FLS	4	0.7	1	12	395.6	113.5	3.44287

FOUR-LANE BRIDGE : 13 Girders, 16.041m Width, 24m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-ULS	4	0.7	1	13	395.6	108.7	1.27573
2-ULS	4	0.7	0.9	13	395.6	134.3	1.41856
3-ULS	4	0.7	0.8	13	395.6	141.9	1.3323
4-ULS	4	0.7	0.7	13	395.6	148.1	1.2167
5-ULS	4	0.7	0.9	13	395.6	149.3	1.5770
6-ULS	4	0.7	0.9	13	395.6	150.5	1.58967
7-ULS	4	0.7	0.8	13	395.6	146.7	1.37737
8-ULS	4	0.7	0.7	13	395.6	145.0	1.19123
9-ULS	4	0.7	0.7	13	395.6	150.4	1.23559
10-ULS	4	0.7	0.7	13	395.6	150.3	1.23477
11-ULS	4	0.7	0.9	13	395.6	134.7	1.42278
12-FLS	4	0.7	1	13	395.6	101.6	3.33873
13-FLS	4	0.7	1	13	395.6	108.0	3.54904

FOUR-LANE BRIDGE : 14 Girders, 17.276m Width, 24m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-ULS	4	0.7	1	14	395.6	108.3	1.36881
2-ULS	4	0.7	0.9	14	395.6	130.2	1.48104
3-ULS	4	0.7	0.8	14	395.6	136.7	1.3822
4-ULS	4	0.7	0.7	14	395.6	142.3	1.25897
5-ULS	4	0.7	0.9	14	395.6	148.5	1.68921
6-ULS	4	0.7	0.9	14	395.6	145.9	1.65963
7-ULS	4	0.7	0.8	14	395.6	142.6	1.44186
8-ULS	4	0.7	0.7	14	395.6	136.1	1.20412
9-ULS	4	0.7	0.7	14	395.6	160.0	1.41557
10-ULS	4	0.7	0.7	14	395.6	157.8	1.39611
11-ULS	4	0.7	0.9	14	395.6	124.8	1.41962
12-FLS	4	0.7	1	14	395.6	110.8	3.92113
13-FLS	4	0.7	1	14	395.6	102.8	3.63802

TABLE A.112: Fv VALUES FOR B800 FOUR-LANE BRIDGE 20m LENGTH

FOUR-LANE BRIDGE : 12 Girders, 14.806m Width, 20m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-ULS	4	0.7	1	12	349.7	100.6	1.23289
2-ULS	4	0.7	0.9	12	349.7	124.5	1.37322
3-ULS	4	0.7	0.8	12	349.7	137.3	1.34613
4-ULS	4	0.7	0.7	12	349.7	143.8	1.23363
5-ULS	4	0.7	0.9	12	349.7	137.4	1.5155
6-ULS	4	0.7	0.9	12	349.7	141.3	1.55852
7-ULS	4	0.7	0.8	12	349.7	137.6	1.34907
8-ULS	4	0.7	0.7	12	349.7	148.9	1.27738
9-ULS	4	0.7	0.7	12	349.7	149.7	1.28424
10-ULS	4	0.7	0.7	12	349.7	152.1	1.30483
11-ULS	4	0.7	0.9	12	349.7	127.6	1.40741
12-FLS	4	0.7	1	12	349.7	104.9	3.59966
13-FLS	4	0.7	1	12	349.7	104.7	3.59279

FOUR-LANE BRIDGE : 13 Girders, 16.041m Width, 20m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-ULS	4	0.7	1	13	349.7	100.2	1.33032
2-ULS	4	0.7	0.9	13	349.7	120.0	1.43388
3-ULS	4	0.7	0.8	13	349.7	125.3	1.33086
4-ULS	4	0.7	0.7	13	349.7	129.8	1.20632
5-ULS	4	0.7	0.9	13	349.7	138.6	1.6561
6-ULS	4	0.7	0.9	13	349.7	140.0	1.67286
7-ULS	4	0.7	0.8	13	349.7	130.8	1.38927
8-ULS	4	0.7	0.7	13	349.7	167.1	1.55297
9-ULS	4	0.7	0.7	13	349.7	167.8	1.55948
10-ULS	4	0.7	0.7	13	349.7	133.1	1.23699
11-ULS	4	0.7	0.9	13	349.7	110.4	1.31917
12-FLS	4	0.7	1	13	349.7	104.7	3.89219
13-FLS	4	0.7	1	13	349.7	100.8	3.74721

FOUR-LANE BRIDGE : 14 Girders, 17.276m Width, 20m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-ULS	4	0.7	1	14	349.7	100.1	1.43123
2-ULS	4	0.7	0.9	14	349.7	115.8	1.49013
3-ULS	4	0.7	0.8	14	349.7	120.4	1.37718
4-ULS	4	0.7	0.7	14	349.7	125.5	1.25608
5-ULS	4	0.7	0.9	14	349.7	137.2	1.76551
6-ULS	4	0.7	0.9	14	349.7	132.7	1.70761
7-ULS	4	0.7	0.8	14	349.7	141.6	1.61967
8-ULS	4	0.7	0.7	14	349.7	145.1	1.45224
9-ULS	4	0.7	0.7	14	349.7	164.8	1.64941
10-ULS	4	0.7	0.7	14	349.7	168.0	1.68144
11-ULS	4	0.7	0.9	14	349.7	112.4	1.44638
12-FLS	4	0.7	1	14	349.7	101.8	4.07549
13-FLS	4	0.7	1	14	349.7	94.3	3.77524

TABLE A.113: Fv VALUES FOR B800 FOUR-LANE BRIDGE 26m LENGTH

FOUR-LANE BRIDGE : 12 Girders, 14.806m Width, 26m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-ULS	4	0.7	1	12	413.3	136.6	1.41647
2-ULS	4	0.7	0.9	12	413.3	141.7	1.32242
3-ULS	4	0.7	0.8	12	413.3	150.7	1.25015
4-ULS	4	0.7	0.7	12	413.3	157.3	1.14179
5-ULS	4	0.7	0.9	12	413.3	155.2	1.44841
6-ULS	4	0.7	0.9	12	413.3	152.8	1.42601
7-ULS	4	0.7	0.8	12	413.3	152.4	1.26425
8-ULS	4	0.7	0.7	12	413.3	150.0	1.0888
9-ULS	4	0.7	0.7	12	413.3	158.6	1.15122
10-ULS	4	0.7	0.7	12	413.3	168.9	1.22599
11-ULS	4	0.7	0.9	12	413.3	144.2	1.34575
12-FLS	4	0.7	1	12	413.3	113.7	3.30123
13-FLS	4	0.7	1	12	413.3	114.3	3.31865

FOUR-LANE BRIDGE : 13 Girders, 16.041m Width, 26m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-ULS	4	0.7	1	13	413.3	136.5	1.53339
2-ULS	4	0.7	0.9	13	413.3	136.6	1.38106
3-ULS	4	0.7	0.8	13	413.3	145.6	1.30849
4-ULS	4	0.7	0.7	13	413.3	152.8	1.20155
5-ULS	4	0.7	0.9	13	413.3	156.6	1.5833
6-ULS	4	0.7	0.9	13	413.3	157.8	1.5954
7-ULS	4	0.7	0.8	13	413.3	149.2	1.34085
8-ULS	4	0.7	0.7	13	413.3	157.8	1.24087
9-ULS	4	0.7	0.7	13	413.3	164.0	1.28962
10-ULS	4	0.7	0.7	13	413.3	176.2	1.38556
11-ULS	4	0.7	0.9	13	413.3	136.5	1.38005
12-FLS	4	0.7	1	13	413.3	113.4	3.5669
13-FLS	4	0.7	1	13	413.3	110.7	3.48197

FOUR-LANE BRIDGE : 14 Girders, 17.276m Width, 26m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-ULS	4	0.7	1	14	413.3	136.4	1.65013
2-ULS	4	0.7	0.9	14	413.3	131.5	1.43177
3-ULS	4	0.7	0.8	14	413.3	135.5	1.3114
4-ULS	4	0.7	0.7	14	413.3	143.6	1.21607
5-ULS	4	0.7	0.9	14	413.3	154.1	1.67784
6-ULS	4	0.7	0.9	14	413.3	143.2	1.55916
7-ULS	4	0.7	0.8	14	413.3	161.6	1.56400
8-ULS	4	0.7	0.7	14	413.3	164.8	1.3956
9-ULS	4	0.7	0.7	14	413.3	166.3	1.4083
10-ULS	4	0.7	0.7	14	413.3	163.3	1.38289
11-ULS	4	0.7	0.9	14	413.3	128.4	1.39802
12-FLS	4	0.7	1	14	413.3	111.3	3.77014
13-FLS	4	0.7	1	14	413.3	103.5	3.50593

TABLE A.114: Fv VALUES FOR B900 FOUR-LANE BRIDGE 30m LENGTH

FOUR-LANE BRIDGE : 12 Girders, 14.806m Width, 30m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-ULS	4	0.7	1	12	441.5	149.0	1.44637
2-ULS	4	0.7	0.9	12	441.5	147.8	1.29125
3-ULS	4	0.7	0.8	12	441.5	159.3	1.23708
4-ULS	4	0.7	0.7	12	441.5	164.2	1.11574
5-ULS	4	0.7	0.9	12	441.5	163.7	1.43016
6-ULS	4	0.7	0.9	12	441.5	160.6	1.40307
7-ULS	4	0.7	0.8	12	441.5	161.2	1.25184
8-ULS	4	0.7	0.7	12	441.5	179.9	1.22242
9-ULS	4	0.7	0.7	12	441.5	181.3	1.23194
10-ULS	4	0.7	0.7	12	441.5	178.1	1.21019
11-ULS	4	0.7	0.9	12	441.5	150.5	1.31484
12-FLS	4	0.7	1	12	441.5	116.2	3.15832
13-FLS	4	0.7	1	12	441.5	116.1	3.15561

FOUR-LANE BRIDGE : 13 Girders, 16.041m Width, 30m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-ULS	4	0.7	1	13	441.5	149.2	1.56900
2-ULS	4	0.7	0.9	13	441.5	135.5	1.28244
3-ULS	4	0.7	0.8	13	441.5	143.4	1.20641
4-ULS	4	0.7	0.7	13	441.5	149.5	1.10051
5-ULS	4	0.7	0.9	13	441.5	160.4	1.5181
6-ULS	4	0.7	0.9	13	441.5	152.1	1.43955
7-ULS	4	0.7	0.8	13	441.5	168.6	1.41841
8-ULS	4	0.7	0.7	13	441.5	171.7	1.26393
9-ULS	4	0.7	0.7	13	441.5	174.7	1.28601
10-ULS	4	0.7	0.7	13	441.5	163.9	1.20651
11-ULS	4	0.7	0.9	13	441.5	138.7	1.31272
12-FLS	4	0.7	1	13	441.5	113.2	3.33318
13-FLS	4	0.7	1	13	441.5	111.8	3.29196

FOUR-LANE BRIDGE : 14 Girders, 17.276m Width, 30m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-ULS	4	0.7	1	14	441.5	149.1	1.68856
2-ULS	4	0.7	0.9	14	441.5	146.2	1.49015
3-ULS	4	0.7	0.8	14	441.5	142.1	1.28743
4-ULS	4	0.7	0.7	14	441.5	148.1	1.17407
5-ULS	4	0.7	0.9	14	441.5	163.4	1.66546
6-ULS	4	0.7	0.9	14	441.5	159.5	1.62571
7-ULS	4	0.7	0.8	14	441.5	157.5	1.42695
8-ULS	4	0.7	0.7	14	441.5	173.3	1.37384
9-ULS	4	0.7	0.7	14	441.5	175.2	1.3889
10-ULS	4	0.7	0.7	14	441.5	171.8	1.36195
11-ULS	4	0.7	0.9	14	441.5	134.0	1.3658
12-FLS	4	0.7	1	14	441.5	112.9	3.58007
13-FLS	4	0.7	1	14	441.5	92.6	2.93635

TABLE A.115: Fv VALUES FOR B1000 FOUR-LANE BRIDGE 32m LENGTH

FOUR-LANE BRIDGE : 12 Girders, 14.806m Width, 32m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-ULS	4	0.7	1	12	452.9	152.4	1.44213
2-ULS	4	0.7	0.9	12	452.9	153.8	1.30984
3-ULS	4	0.7	0.8	12	452.9	150.7	1.14084
4-ULS	4	0.7	0.7	12	452.9	163.4	1.08236
5-ULS	4	0.7	0.9	12	452.9	168.9	1.43844
6-ULS	4	0.7	0.9	12	452.9	167.4	1.42567
7-ULS	4	0.7	0.8	12	452.9	164.1	1.24228
8-ULS	4	0.7	0.7	12	452.9	159.2	1.05454
9-ULS	4	0.7	0.7	12	452.9	186.9	1.23802
10-ULS	4	0.7	0.7	12	452.9	188.5	1.24862
11-ULS	4	0.7	0.9	12	452.9	152.8	1.30133
12-FLS	4	0.7	1	12	452.9	116.4	3.08412
13-FLS	4	0.7	1	12	452.9	116.0	3.07353

FOUR-LANE BRIDGE : 13 Girders, 16.041m Width, 32m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-ULS	4	0.7	1	13	452.9	153.7	1.57564
2-ULS	4	0.7	0.9	13	452.9	142.5	1.31474
3-ULS	4	0.7	0.8	13	452.9	150.0	1.23017
4-ULS	4	0.7	0.7	13	452.9	157.0	1.12663
5-ULS	4	0.7	0.9	13	452.9	169.9	1.56754
6-ULS	4	0.7	0.9	13	452.9	163.1	1.50480
7-ULS	4	0.7	0.8	13	452.9	179.3	1.47046
8-ULS	4	0.7	0.7	13	452.9	182.5	1.30962
9-ULS	4	0.7	0.7	13	452.9	187.6	1.34621
10-ULS	4	0.7	0.7	13	452.9	177.1	1.27087
11-ULS	4	0.7	0.9	13	452.9	141.6	1.30644
12-FLS	4	0.7	1	13	452.9	115.5	3.3153
13-FLS	4	0.7	1	13	452.9	117.4	3.36984

FOUR-LANE BRIDGE : 14 Girders, 17.276m Width, 32m Length

Load Cases	n	RL	RL'	N	VT	Vmax	Fv
1-ULS	4	0.7	1	14	452.9	152.6	1.68470
2-ULS	4	0.7	0.9	14	452.9	149.2	1.48245
3-ULS	4	0.7	0.8	14	452.9	144.3	1.27445
4-ULS	4	0.7	0.7	14	452.9	148.7	1.14915
5-ULS	4	0.7	0.9	14	452.9	166.8	1.65732
6-ULS	4	0.7	0.9	14	452.9	163.1	1.62056
7-ULS	4	0.7	0.8	14	452.9	174.7	1.54295
8-ULS	4	0.7	0.7	14	452.9	181.7	1.40417
9-ULS	4	0.7	0.7	14	452.9	183.1	1.41499
10-ULS	4	0.7	0.7	14	452.9	176.2	1.36167
11-ULS	4	0.7	0.9	14	452.9	136.4	1.35527
12-FLS	4	0.7	1	14	452.9	112.5	3.47759
13-FLS	4	0.7	1	14	452.9	105.4	3.25811

TABLE A.116: Fd VALUES FOR B700 FOUR-LANE BRIDGE 16m LENGTH

FOUR-LANE BRIDGE : 12 Girders, 14.806m Width, 16m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
12-FLS	4	0.7	1	12	24.09	3.5	1.74346

FOUR-LANE BRIDGE : 13 Girders, 16.041m Width, 16m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
12-FLS	4	0.7	1	13	24.09	3.4	1.83479

FOUR-LANE BRIDGE : 14 Girders, 17.276m Width, 16m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
12-FLS	4	0.7	1	14	24.09	3.1	1.80158

TABLE A.117: Fd VALUES FOR B700 FOUR-LANE BRIDGE 24m LENGTH

FOUR-LANE BRIDGE : 12 Girders, 14.806m Width, 24m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
12-FLS	4	0.7	1	12	104.25	12.7	1.46187

FOUR-LANE BRIDGE : 13 Girders, 16.041m Width, 24m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
12-FLS	4	0.7	1	13	104.25	11.9	1.48393

FOUR-LANE BRIDGE : 14 Girders, 17.276m Width, 24m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
12-FLS	4	0.7	1	14	104.25	11.3	1.51751

TABLE A.118: Fd VALUES FOR B800 FOUR-LANE BRIDGE 20m LENGTH

FOUR-LANE BRIDGE : 12 Girders, 14.806m Width, 20m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
12-FLS	4	0.7	1	12	38.97	5.3	1.63202

FOUR-LANE BRIDGE : 13 Girders, 16.041m Width, 20m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
12-FLS	4	0.7	1	13	38.97	5.2	1.73467

FOUR-LANE BRIDGE : 14 Girders, 17.276m Width, 20m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
12-FLS	4	0.7	1	14	38.97	4.7	1.68848

TABLE A.119: Fd VALUES FOR B800 FOUR-LANE BRIDGE 26m LENGTH

FOUR-LANE BRIDGE : 12 Girders, 14.806m Width, 26m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
12-FLS	4	0.7	1	12	101.96	12.3	1.44763

FOUR-LANE BRIDGE : 13 Girders, 16.041m Width, 26m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
12-FLS	4	0.7	1	13	101.96	11.9	1.51726

FOUR-LANE BRIDGE : 14 Girders, 17.276m Width, 26m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
12-FLS	4	0.7	1	14	101.96	10.8	1.48293

TABLE A.120: Fd VALUES FOR B900 FOUR-LANE BRIDGE 24m LENGTH

FOUR-LANE BRIDGE : 12 Girders, 14.806m Width, 24m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
12-FLS	4	0.7	1	12	57.51	7.3	1.52321

FOUR-LANE BRIDGE : 13 Girders, 16.041m Width, 24m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
12-FLS	4	0.7	1	13	57.51	7.1	1.60494

FOUR-LANE BRIDGE : 14 Girders, 17.276m Width, 24m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
12-FLS	4	0.7	1	14	57.51	6.4	1.55799

TABLE A.121: Fd VALUES FOR B900 FOUR-LANE BRIDGE 30m LENGTH

FOUR-LANE BRIDGE : 12 Girders, 14.806m Width, 30m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
12-FLS	4	0.7	1	12	129.7	14.9	1.37857

FOUR-LANE BRIDGE : 13 Girders, 16.041m Width, 30m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
12-FLS	4	0.7	1	13	129.7	14.4	1.44333

FOUR-LANE BRIDGE : 14 Girders, 17.276m Width, 30m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
12-FLS	4	0.7	1	14	129.7	13.2	1.42483

TABLE A.122: Fd VALUES FOR B1000 FOUR-LANE BRIDGE 26m LENGTH

FOUR-LANE BRIDGE : 12 Girders, 14.806m Width, 26m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
12-FLS	4	0.7	1	12	60.5	7.5	1.4876

FOUR-LANE BRIDGE : 13 Girders, 16.041m Width, 26m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
12-FLS	4	0.7	1	13	60.5	7.3	1.5686

FOUR-LANE BRIDGE : 14 Girders, 17.276m Width, 26m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
12-FLS	4	0.7	1	14	60.5	6.7	1.55041

TABLE A.123: Fd VALUES FOR B1000 FOUR-LANE BRIDGE 32m LENGTH

FOUR-LANE BRIDGE : 12 Girders, 14.806m Width, 32m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
12-FLS	4	0.7	1	12	126.75	14.4	1.36331

FOUR-LANE BRIDGE : 13 Girders, 16.041m Width, 32m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
12-FLS	4	0.7	1	13	126.75	14.0	1.4359

FOUR-LANE BRIDGE : 14 Girders, 17.276m Width, 32m Length

Load Cases	n	RL	RL'	N	DT	Dmax	Fd
12-FLS	4	0.7	1	14	126.75	12.8	1.41381

APPENDEX (C)
SAP 2000 INPUT FILE
FOR
BOX GIRDER BRIDGE

```
:CASE  L=16/STRAIGHT NB=3  NXBS=2  BS=2m  # OF ELEMENTS=32
SYSTEM
DOF=ALL     LENGTH=M    FORCE=KN

JOINTS
1     X=0.0625    Y=0      Z=0
33    X=0.0625    Y=16     Z=0
133   X=1.1575    Y=0      Z=0
165   X=1.1575    Y=16     Z=0           ; Top Flange 1
 Lgen=1,133,33,33,1
201   X=1.2975    Y=0      Z=0
233   X=1.2975    Y=16     Z=0
333   X=2.3925    Y=0      Z=0
365   X=2.3925    Y=16     Z=0           ; Top Flange 2
 Lgen=201,333,33,233,1
401   X=2.5325    Y=0      Z=0
433   X=2.5325    Y=16     Z=0
533   X=3.6275    Y=0      Z=0
565   X=3.6275    Y=16     Z=0           ; Top Flange 3
 Lgen=401,533,33,433,1
601   X=3.7675    Y=0      Z=0
633   X=3.7675    Y=16     Z=0
733   X=4.8625    Y=0      Z=0
765   X=4.8625    Y=16     Z=0           ; Top Flange 4
 Lgen=601,733,33,633,1
801   X=5.0025    Y=0      Z=0
833   X=5.0025    Y=16     Z=0
933   X=6.0975    Y=0      Z=0
965   X=6.0975    Y=16     Z=0           ; Top Flange 5
 Lgen=801,933,33,833,1
1001  X=6.2375    Y=0      Z=0
1033  X=6.2375    Y=16     Z=0
1133  X=7.3325    Y=0      Z=0
1165  X=7.3325    Y=16     Z=0           ; Top Flange 6
 Lgen=1001,1133,33,1033,1
1201  X=0.0625    Y=0      Z=-0.8025
1233  X=0.0625    Y=16     Z=-0.8025
1333  X=1.1575    Y=0      Z=-0.8025
1365  X=1.1575    Y=16     Z=-0.8025     ;Bot Flange 1
 Lgen=1201,1333,33,1233,1
1401  X=1.2975    Y=0      Z=-0.8025
1433  X=1.2975    Y=16     Z=-0.8025
1533  X=2.3925    Y=0      Z=-0.8025
1565  X=2.3925    Y=16     Z=-0.8025     ;Bot Flange 2
 Lgen=1401,1533,33,1433,1
1601  X=2.5325    Y=0      Z=-0.8025
1633  X=2.5325    Y=16     Z=-0.8025
1733  X=3.6275    Y=0      Z=-0.8025
1765  X=3.6275    Y=16     Z=-0.8025     ;Bot Flange 3
 Lgen=1601,1733,33,1633,1
1801  X=3.7675    Y=0      Z=-0.8025
1833  X=3.7675    Y=16     Z=-0.8025
1933  X=4.8625    Y=0      Z=-0.8025
1965  X=4.8625    Y=16     Z=-0.8025     ;Bot Flange 4
```

```
 Lgen=1801,1933,33,1833,1
2001  X=5.0025    Y=0      Z=-0.8025
2033  X=5.0025    Y=16     Z=-0.8025
2133  X=6.0975    Y=0      Z=-0.8025
2165  X=6.0975    Y=16     Z=-0.8025     ;Bot Flange 5
 Lgen=2001,2133,33,2033,1
2201  X=6.2375    Y=0      Z=-0.8025
2233  X=6.2375    Y=16     Z=-0.8025
2333  X=7.3325    Y=0      Z=-0.8025
2365  X=7.3325    Y=16     Z=-0.8025     ;Bot Flange 6
 Lgen=2201,2333,33,2233,1
2401  X=0.0625    Y=0      Z=-0.2675
2433  X=0.0625    Y=16     Z=-0.2675
2434  X=0.0625    Y=0      Z=-0.535
2466  X=0.0625    Y=16     Z=-0.535     ;Web 1
 Lgen=2401,2434,33,2433,1
2501  X=1.1575    Y=0      Z=-0.2675
2533  X=1.1575    Y=16     Z=-0.2675
2534  X=1.1575    Y=0      Z=-0.535
2566  X=1.1575    Y=16     Z=-0.535      ;Web 2
 Lgen=2501,2534,33,2533,1
2601  X=1.2975    Y=0      Z=-0.2675
2633  X=1.2975    Y=16     Z=-0.2675
2634  X=1.2975    Y=0      Z=-0.535
2666  X=1.2975    Y=16     Z=-0.535  ;Web 3
 Lgen=2601,2634,33,2633,1
2701  X=2.3925    Y=0      Z=-0.2675
2733  X=2.3925    Y=16     Z=-0.2675
2734  X=2.3925    Y=0      Z=-0.535
2766  X=2.3925    Y=16     Z=-0.535 ;Web 4
 Lgen=2701,2734,33,2733,1
2801  X=2.5325    Y=0      Z=-0.2675
2833  X=2.5325    Y=16     Z=-0.2675
2834  X=2.5325    Y=0      Z=-0.535
2866  X=2.5325    Y=16     Z=-0.535 ;Web 5
 Lgen=2801,2834,33,2833,1
2901  X=3.6275    Y=0      Z=-0.2675
2933  X=3.6275    Y=16     Z=-0.2675
2934  X=3.6275    Y=0      Z=-0.535
2966  X=3.6275    Y=16     Z=-0.535 ;Web 6
 Lgen=2901,2934,33,2933,1
3001  X=3.7675    Y=0      Z=-0.2675
3033  X=3.7675    Y=16     Z=-0.2675
3034  X=3.7675    Y=0      Z=-0.535
3066  X=3.7675    Y=16     Z=-0.535 ;Web 7
 Lgen=3001,3034,33,3033,1
3101  X=4.8625    Y=0      Z=-0.2675
3133  X=4.8625    Y=16     Z=-0.2675
3134  X=4.8625    Y=0      Z=-0.535
3166  X=4.8625    Y=16     Z=-0.535 ;Web 8
 Lgen=3101,3134,33,3133,1
3201  X=5.0025    Y=0      Z=-0.2675
3233  X=5.0025    Y=16     Z=-0.2675
3234  X=5.0025    Y=0      Z=-0.535
```

```
3266  X=5.0025    Y=16      Z=-0.535 ;Web 9
 Lgen=3201,3234,33,3233,1
3301  X=6.0975    Y=0       Z=-0.2675
3333  X=6.0975    Y=16      Z=-0.2675
3334  X=6.0975    Y=0       Z=-0.535
3366  X=6.0975    Y=16      Z=-0.535 ;Web 10
 Lgen=3301,3334,33,3333,1
3401  X=6.2375    Y=0       Z=-0.2675
3433  X=6.2375    Y=16      Z=-0.2675
3434  X=6.2375    Y=0       Z=-0.535
3466  X=6.2375    Y=16      Z=-0.535 ;Web 11
 Lgen=3401,3434,33,3433,1
3501  X=7.3325    Y=0       Z=-0.2675
3533  X=7.3325    Y=16      Z=-0.2675
3534  X=7.3325    Y=0       Z=-0.535
3566  X=7.3325    Y=16      Z=-0.535 ;Web 12
 Lgen=3501,3534,33,3533,1
3601  X=0.33625   Y=0       Z=-0.2675     ;diapharm

Pattern
 Name=Default

RESTRAINTS
 Add=1201        Dof=Ux,Uy,Uz,
 Add=1233        Dof=Ux,Uy,Uz,
 Add=1333        Dof=Ux,Uy,Uz,
 Add=1365        Dof=Ux,Uy,Uz,
 Add=1401        Dof=Ux,Uy,Uz,
 Add=1433        Dof=Ux,Uy,Uz,
 Add=1533        Dof=Ux,Uy,Uz,
 Add=1565        Dof=Ux,Uy,Uz,
 Add=1601        Dof=Ux,Uy,Uz,
 Add=1633        Dof=Ux,Uy,Uz,
 Add=1733        Dof=Ux,Uy,Uz,
 Add=1765        Dof=Ux,Uy,Uz,
 Add=1801        Dof=Ux,Uy,Uz,
 Add=1833        Dof=Ux,Uy,Uz,
 Add=1933        Dof=Ux,Uy,Uz,
 Add=1965        Dof=Ux,Uy,Uz,
 Add=2001        Dof=Ux,Uy,Uz,
 Add=2033        Dof=Ux,Uy,Uz,
 Add=2133        Dof=Ux,Uy,Uz,
 Add=2165        Dof=Ux,Uy,Uz,
 Add=2201        Dof=Ux,Uy,Uz,
 Add=2233        Dof=Ux,Uy,Uz,
 Add=2333        Dof=Ux,Uy,Uz,
 Add=2365        Dof=Ux,Uy,Uz,


Material
Name=concrete    W=24
      E=28000E3  U=0.2

Shell Section
```

```
 Name=slab       Type=Shell  Mat=concrete     Th=0.225
 Name=flange     Type=Shell  Mat=concrete     Th=0.140
 Name=web        Type=Shell  Mat=concrete     Th=0.125
 Name=diapharm   Type=Shell  Mat=concrete     Th=0.300

SHELL
  Local=31  Pldir=0
1     J=1,2,34,35               Sec=slab ;Top flange 1
 Gen=1 32 1 97 32          Jinc=1 33
129   J=201,202,234,235        Sec=slab ;Top flange 2
 Gen=129 160 1 225 32      Jinc=1 33
257   J=401,402,434,435        Sec=slab ;Top flange 3
 Gen=257 288 1 353 32      Jinc=1 33
385   J=601,602,634,635        Sec=slab ;Top flange 4
 Gen=385 416 1 481 32      Jinc=1 33
513   J=801,802,834,835        Sec=slab ;Top flange 5
 Gen=513 544 1 609 32        Jinc=1 33
641   J=1001,1002,1034,1035    Sec=slab ;Top flange 6
 Gen=641 672 1 737 32      Jinc=1 33
769   J=133,134,201,202         Sec=slab ;Connection 1
 Gen=769 800 1
801   J=333,334,401,402         Sec=slab ;Connection 2
 Gen=801 832 1
833   J=533,534,601,602         Sec=slab ;Connection 3
 Gen=833 864 1
865   J=733,734,801,802         Sec=slab ;Connection 4
 Gen=865 896 1
897   J=933,934,1001,1002      Sec=slab ;Connection 5
 Gen=897 928 1
961   J=1201,1202,1234,1235   Sec=flange ;Bot flange 1
 Gen=961 992 1 1057 32  Jinc=1 33
1089  J=1401,1402,1434,1435   Sec=flange ;Bot flange 2
 Gen=1089 1120 1 1185 32  Jinc=1 33
1217  J=1601,1602,1634,1635   Sec=flange ;Bot flange 3
 Gen=1217 1248 1 1313 32  Jinc=1 33
1345  J=1801,1802,1834,1835   Sec=flange ;Bot flange 4
 Gen=1345 1376 1 1441 32  Jinc=1 33
1473  J=2001,2002,2034,2035   Sec=flange ;Bot flange 5
 Gen=1473 1504 1 1569 32  Jinc=1 33
1601  J=2201,2202,2234,2235   Sec=flange ;Bot flange 6
 Gen=1601 1632 1 1697 32  Jinc=1 33
1729  J=1,2,2401,2402         Sec=web    ;Web 1 - Top
 Gen=1729 1760 1
1761  J=2401,2402,2434,2435   Sec=web    ;Web 1 - Mid
 Gen=1761 1792 1
1793  J=2434,2435,1201,1202   Sec=web    ;Web 1 - Bot
 Gen=1793 1824 1
1825  J=133,134,2501,2502     Sec=web    ;Web 2 - Top
 Gen=1825 1856 1
1857  J=2501,2502,2534,2535   Sec=web    ;Web 2 - Mid
 Gen=1857 1888 1
1889  J=2534,2535,1333,1334   Sec=web    ;Web 2 - Bot
 Gen=1889 1920 1
```

```
1921  J=201,202,2601,2602      Sec=web    ;Web 3 - Top
 Gen=1921 1952 1
1953  J=2601,2602,2634,2635   Sec=web    ;Web 3 - Mid
 Gen=1953 1984 1
1985  J=2634,2635,1401,1402   Sec=web    ;Web 3 - Bot
 Gen=1985 2016 1
2017  J=333,334,2701,2702      Sec=web    ;Web 4 - Top
 Gen=2017 2048 1
2049  J=2701,2702,2734,2735   Sec=web    ;Web 4 - Mid
 Gen=2049 2080 1
2081  J=2734,2735,1533,1534   Sec=web    ;Web 4 - Bot
 Gen=2081 2112 1
2113  J=401,402,2801,2802      Sec=web    ;Web 5 - Top
 Gen=2113 2144 1
2145  J=2801,2802,2834,2835   Sec=web    ;Web 5 - Mid
 Gen=2145 2176 1
2177  J=2834,2835,1601,1602   Sec=web    ;Web 5 - Bot
 Gen=2177 2208 1
2209  J=533,534,2901,2902      Sec=web    ;Web 6 - Top
 Gen=2209 2240 1
2241  J=2901,2902,2934,2935   Sec=web    ;Web 6 - Mid
 Gen=2241 2272 1
2273  J=2934,2935,1733,1734   Sec=web    ;Web 6 - Bot
 Gen=2273 2304 1
2305  J=601,602,3001,3002      Sec=web    ;Web 7 - Top
 Gen=2305 2336 1
2337  J=3001,3002,3034,3035   Sec=web    ;Web 7 - Mid
 Gen=2337 2368 1
2369  J=3034,3035,1801,1802   Sec=web    ;Web 7 - Bot
 Gen=2369 2400 1
2401  J=733,734,3101,3102      Sec=web    ;Web 8 - Top
 Gen=2401 2432 1
2433  J=3101,3102,3134,3135   Sec=web    ;Web 8 - Mid
 Gen=2433 2464 1
2465  J=3134,3135,1933,1934   Sec=web    ;Web 8 - Bot
 Gen=2465 2496 1
2497  J=801,802,3201,3202      Sec=web    ;Web 9 - Top
 Gen=2497 2528 1
2529  J=3201,3202,3234,3235   Sec=web    ;Web 9 - Mid
 Gen=2529 2560 1
2561  J=3234,3235,2001,2002   Sec=web    ;Web 9 - Bot
 Gen=2561 2592 1
2593  J=933,934,3301,3302      Sec=web    ;Web 10 - Top
 Gen=2593 2624 1
2625  J=3301,3302,3334,3335   Sec=web    ;Web 10 - Mid
 Gen=2625 2656 1
2657  J=3334,3335,2133,2134   Sec=web    ;Web 10 - Bot
 Gen=2657 2688 1
2689  J=1001,1002,3401,3402   Sec=web    ;Web 11 - Top
 Gen=2689 2720 1
2721  J=3401,3402,3434,3435   Sec=web    ;Web 11 - Mid
 Gen=2721 2752 1
2753  J=3434,3435,2201,2202   Sec=web    ;Web 11 - Bot
 Gen=2753 2784 1
```

```
2785  J=1133,1134,3501,3502   Sec=web    ;Web 12 - Top
 Gen=2785 2816 1
2817  J=3501,3502,3534,3535   Sec=web    ;Web 12 - Mid
 Gen=2817 2848 1
2849  J=3534,3535,2333,2334   Sec=web    ;Web 12 - Bot
 Gen=2849 2880 1
2881  J=1,34,2401,3601        Sec=diapharm    ;diapharm

Load
 Name=ow
    Type=Gravity  Elem=Shell
   Add=*  Uz=-1

Output
ELEM=JOINT  TYPE=DISP,REAC LOAD=*
ELEM=SHELL TYPE=FORCE LOAD=*
ELEM=SHELL TYPE=STRESS LOAD=*

END
```