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# ESTIMATION OF BENDING MOMENTS IN BOX-BEAM BRIDGES USING CROSS-SECTIONAL DEFLECTIONS

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by

Shu-jin Fang Miguel A. Macías Rendón

David A. VanHorn

Fritz Engineering Laboratory Report No. 322.2

#### Project 322

#### A STRUCTURAL MODEL STUDY OF LOAD DISTRIBUTION IN HIGHWAY BRIDGES

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# ESTIMATION OF BENDING MOMENTS IN BOX-BEAM BRIDGES USING CROSS-SECTIONAL DEFLECTIONS

by

## Shu-jin Fang Miguel A. Macías Rendón David A. VanHorn

This work was conducted as part of the project "A Structural Model Study of Load Distribution in Highway Bridges", sponsored by the National Science Foundation. The opinions, findings, and conclusions expressed in this report are those of the writers and not necessarily those of the sponsors.

> Department of Civil Engineering Fritz Engineering Laboratory Lehigh University Bethlehem, Pennsylvania

> > June 1968

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#### ABSTRACT

This report describes part of the research work conducted under the Fritz Laboratory Project 322, entitled "A Structural Model Study of Load Distribution in Highway Bridges".

The purposes of this work were to:

- Find an analytical correlation between the transverse distributions of longitudinal bending moments and the cross-sectional deflections in box-beam bridges.
- Develop a practical method for the estimation of bending moments in box-beam bridges by the use of cross-sectional deflections.

To experimentally verify the proposed method, test results from seventeen small scale (1/16) Plexiglas box-beam bridge models are reported. Details of the fabrication, instrumentation and testing of the models can be found in Ref. 9. In particular, it should be noted that these seventeen Plexiglas models were tested under static vehicular loads, using the creep compensating technique.

An analysis of the experimental results and a proposed method for estimating bending moments are presented. The estimated values exhibit good agreement with the model test results. The contribution of curbs and parapets to the flexural stiffness of the bridge was taken into account in the analysis. The influences on the correlation between bending moments and cross-sectional deflections due to curbs, parapets, diaphragms, size and spacing of beams, and thickness of slab are discussed.

The proposed method was used to estimate bending moments in one existing bridge. The estimated values were found to be close to those obtained in the field test. As a result of this investigation, it is believed that the use of measured deflections, along with the geometric properties of the crosssection, may enable an economical and accurate estimation of the lateral load distribution in prestressed concrete box-beam bridges.

#### 1. INTRODUCTION

#### 1.1 Background

Bridge structures form one of the most important components of modern highway systems. Over the past fifteen years, many new concepts have been introduced in the area of bridge design. One of the more recent concepts was the design of beamslab bridges utilizing precast, prestressed concrete box beams, spread apart and equally spaced, along with a cast-in-place concrete slab. The curbs and parapets are also cast in place, using reinforcing bars in the connection with the slab. In bridges of this type constructed in Pennsylvania, the beams are designed according to the provisions set forth in the Pennsylvania Department of Highways Bridge Division Standards ST-200 through ST-208.13 These provisions closely parallel those covering the design of longitudinal beams as set forth in the A.A.S.H.O. Standard Specifications for Highway Bridges.<sup>1</sup>

#### 1.2 Object and Scope

Recently, the field tests of several in-service highway bridges have established the fact that the actual distribution of maximum vehicular loads to the beams is not in line with the distribution assumed in the design.<sup>5</sup> In these tests,

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strain gages attached to the superstructure at selected locations were used to evaluate the load distribution.

To approach the evaluation in a different way, this investigation is directed toward the possible correlation of the transverse distribution of bending moment in the longitudinal beams with the cross-sectional deflections. The principal advantage of using cross-sectional deflections to evaluate the bending moments is that there are considerably fewer problems associated with the installation and operation of deflection equipment than with strain gage recording equipment. Equally important is the fact that the deflections are a form of an integrated response of the entire structure; while the fiber strains are of a more local nature, and greatly affected by singularities in the immediate vicinity of the strain measurement. If a fine correlation between the bending moments and deflections can be found, the primary use of deflections in field studies and laboratory work could result in more economical and efficient testing methods.

The principal objectives of the study presented in this report are:

1. To find a theoretical correlation between the transverse distribution of

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bending moment in the longitudinal beams and the cross-sectional deflections, in prestressed concrete spread box-beam bridges, with or without curbs, parapets, and diaphragms.

2. To develop a practical method of estimating the individual bending moments by using the cross-sectional deflections. The deflection of each box beam can be either directly measured by dial gages or by deflectometers, or even calculated by one of the existing theories of analysis.<sup>10</sup>

The study presented in this report is a part of the research work conducted under the Fritz Laboratory Project 322, entitled "A Structural Model Study of Load Distribution in Highway Bridges". The primary objective of the overall project is the investigation of static live load distribution in prestressed concrete spread box-beam bridges.

In order to experimentally verify the analytical correlation and the proposed method, presented in Chapters 2 and 5, respectively, a systematic series of seventeen small scale (1/16) Plexiglas box-beam bridge models was designed and fabricated, assembled and tested. Comparisons of the distributions of experimental bending moments with experimental cross-sectional deflections and with estimated distributions of bending moments are given

-5-

in this report. In addition, the influence of curbs, parapets, size and spacing of beams, and thickness of slab, on the correlation between bending moments and cross-sectional deflections, is discussed in detail.

#### 1.3 Previous Research

A number of field investigations have been conducted on highway bridges of the beam-slab type. Most of the bridges tested were I-beam bridges with either steel or prestressed concrete beams. Only a limited number of studies have dealt with prestressed concrete box-beam bridges. In particular, relatively little experimental and theoretical work has been carried out in the study of simply-supported, spread box-beam bridges.

An extensive annotated bibliography on lateral distribution of loads in bridges, including slab bridges and beamslab bridges, is given in Ref. 14. Since the information presented herein is evaluated by model tests, some of the previous model studies on load distribution are included as Refs. 2, 3, 4, 6, 7, 8, 11, 15, 16, 18, and 19.

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#### 2. THEORETICAL ANALYSIS

#### 2.1 Statement of Problem

In the theoretical work presented in Ref. 17, a single distribution coefficient was established for the determination of both deflections and longitudinal bending moments in a beam-slab bridge. This single distribution coefficient was applied only to bridge cross-sections with equal stiffness in all of the beams, and curb and parapet were not considered.

Satisfactory agreement with the theory was found in tests reported in Refs. 7 and 8 where, after a careful comparison of the theoretical distribution coefficients for longitudinal bending moments with the experimental distribution coefficients, it was concluded that the agreement was acceptable. Furthermore, an excellent agreement was found in the comparisons between the theoretical and experimental distribution coefficients for deflections.

On the other hand, the previous conclusions were not agreed upon by other investigators. Comparison of the strains in the bottom flanges of I beams with the deflections in a beamslab bridge showed no consistent correlation.<sup>6</sup> The same problem

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was observed in Ref. 12, where it was concluded that the bending moments and the deflections in the beams are not proportional as determined from field test results. It was also pointed out in Ref. 11 that there is a considerable discrepancy between the experimental distribution of bending moments and the calculated distribution coefficients, based on a sinusoidal longitudinal distribution of a concentrated load. Thus, an approximate adjustment to the Guyon-Massonnet theory was proposed,<sup>11</sup> in order to take into account the effect of a concentrated load.

Confusion may arise from the fact that different conclusions were reached by several investigators. Therefore, some of the assumptions in the theory will be examined.

The Guyon-Massonnet method<sup>5</sup> is based on the following two main assumptions:

- That a constant stiffness exists in both the longitudinal and transverse directions. In other words, the effects of a stiffening edge member and beams of different size cannot be considered.
- 2. That the transverse distribution of actual concentrated loads is the same as the transverse distribution of loads which are distributed sinusoidally along the length of the bridge.

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It is a fact that most of the existing prestressed concrete bridges have curbs and parapets. Test results have shown that some composite action exists between curbs and beams, and between curbs and parapets.<sup>5</sup> Thus, the first assumption cannot be satisfied when the curbs and parapets are present. If the effects due to curbs and parapets are not accounted for, errors will be introduced.

In addition, there is a substantial difference between the actual single concentrated load and the assumed sinusoidal load varying along the bridge. This difference is one of the reasons for the disagreement between the theoretical distribution coefficients for bending moments and experimentally determined values. Finally, the assumption of Poisson's ratio equal to zero is another source of error in the method under discussion.

Furthermore, it is believed that it is not adequate to use the strains at the bottom face of beams as a direct indication of bending moments in beams.<sup>4, 7</sup> The evaluation of the true bending moment in the beams should take into account the contribution of the individual slabs, since equilibrium should exist in each beam-slab unit. To more accurately determine the bending moments in beam-slab units, the strains along the side faces of beams, top of slab, curbs, and parapets should be

-9-

measured carefully, as well as the strains on the bottom faces of beams.

In order to better understand the correlation between the transverse distributions of longitudinal bending moments and the cross-sectional deflections in a single span, simply-supported box-beam bridge in which curbs and parapets may or may not be present, a theoretical analysis is given in this chapter. Finally, a simplified method of estimating bending moments in the beams by using the cross-sectional deflections and geometrical configuration of the cross-section of the bridge is proposed in Chapter 5.

#### 2.2 Assumptions

Before the analysis can be developed, the following assumptions are made.

- The structure is homogeneous and isotropic before the occurrence of any cracking (both in longitudinal and transverse directions) or excessive deformation.
- The thickness of each plate component is assumed to be constant and uniform.
- 3. A linear relationship exists between forces and deflections. Only elastic

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behavior of the bridge is considered in the analysis.

- 4. A full composite action exists between beams, slab, curbs, and parapets. All connections insure that no relative displacements between components can occur.
- 5. The end supports provide no longitudinal restraint for each beam-slab unit.
- The bending moment diagrams of all beamslab units are assumed similar in geometry.
- 7. The secondary effects on the deflection of the beams due to twisting are negligible.
- 8. The transverse bending moments (with respect to a vertical axis) in beam-slab units are assumed to be small compared with the longitudinal bending moments (with respect to horizontal axis) and can be neglected.
- 9. The presence of diaphragms does not affect the analysis.

#### 2.3 Development

A simply-supported, box-beam bridge can be regarded as an assemblage of a set of beam-slab units. Each beam-slab unit is composed of a box beam and an individual width of slab. Curbs and parapets act in combination with the exterior beamslab units. By Assumption 9, midspan and end diaphragms, which

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are originally designed in order to improve the load distribution of the bridge, are not considered in this analysis. It is believed that the diaphragms will not substantially affect the correlation between the transverse distributions of longitudinal bending moments and distributions of cross-sectional deflections. This concept will be discussed in Chapter 5.

A typical cross-section of a box-beam bridge is given in Fig.la. When the deck of the bridge is subjected to a vehicular load, five internal forces and moments are produced in any cross-section of each beam-slab unit. These forces and moments are longitudinal bending moment  $M_x$ , transverse bending moment  $M_y$ , total vertical shear force  $S_y$ , total horizontal shear force  $S_x$ , and twisting moment  $M_{xy}$ , which is shown in Fig. 1b.

The vertical deflection at the centroid,  $\delta_y$ , of given beam-slab unit can be written as

$$\delta_{y} = (\delta_{y})_{\text{bending}} + (\delta_{y})_{\text{shear}} + (\delta_{y})_{\text{torsion}}$$
(1)

As a beam-slab unit has a box beam of rigid closed cross-section, it is reasonable to consider the unit as a solid beam insofar as its behavior under the combined flexure and torsion is concerned.

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Consequently, the cross-section of each beam-slab unit which is initially plane remains plane after deformation, and there is no extension or shearing strain in the plane of the cross-section. Saint Venant's principle is valid in this case. According to this principle and the adopted hypothesis, the internal forces acting on the cross-section lead to one resultant, which may be replaced by an equivalent system of forces without changing the state of strain of the mathematical model adopted for the solid beam. The beam-slab unit would undergo torsion according to the law of pure torsion. Since the effect of the vertical deflection due to pure torsion is neglected according to Assumption 7, and since the effect of shear force is very small, Eq. 1 can be simplified as

$$\delta_{y} \cong (\delta_{y})_{\text{bending}}$$

considering a beam-slab unit as simply supported at both ends, (Assumption 5), the vertical deflection at the centroid of a given section due to bending can be found from Fig. 1b as follows:

The deflection in the VV direction is

$$\delta_{\mathbf{vv}} = \mathbf{F}\left(\frac{\mathbf{M}_{uu}}{\mathbf{E} \mathbf{I}_{uu}}\right)$$

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and the deflection in the UU direction is

$$\delta_{uu} = F\left(\frac{M_{vv}}{E T_{vv}}\right)$$

where  $M_{uu}$  and  $M_{vv}$  are the bending moments with respect to Axes UU and VV, respectively,

 $I_{uu}$  and  $I_{vv}$  are the moments of inertia with respect to Axes UU and VV, respectively,

and F is a certain function depending on the bending moment diagram and on the position of the section.

Superimposing the vertical components of  $\delta_{\rm vv}$  and  $\delta_{\rm uu}$ , the total vertical deflection is

$$\delta_{\rm v} = \delta_{\rm vv} \, \sin \theta + \delta_{\rm vv} \, \cos \theta$$

$$= F\left(\frac{M_{VV}}{E I_{VV}}\right) \sin \theta + F\left(\frac{M_{uu}}{E I_{uu}}\right) \cos \theta \qquad (2)$$

By the law of transformation of coordinate axes, the moments of inertia  $I_{uu}$ ,  $I_{vv}$ , and  $I_{uv}$  are expressed in terms of  $I_{xx}$ ,  $I_{yy}$ , and  $I_{xv}$ .

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$$\begin{bmatrix} \mathbf{I}_{uu} & -\mathbf{I}_{uv} \\ -\mathbf{I}_{uv} & \mathbf{I}_{vv} \end{bmatrix} = \mathbb{R} \begin{bmatrix} \mathbf{I}_{xx} & -\mathbf{I}_{xy} \\ -\mathbf{I}_{xy} & \mathbf{I}_{yy} \end{bmatrix} \mathbb{R}^{\mathrm{T}}$$
(3)

wherein R is the rotation matrix and

$$R = \begin{bmatrix} \cos \theta & -\sin \theta \\ -\sin \theta & \cos \theta \end{bmatrix}$$

Substituting R into Eq. 3, we obtain

$$I_{uu} = I_{xx} \cos^2 \theta + I_{yy} \sin^2 \theta - 2I_{xy} \sin \theta \cdot \cos \theta$$

$$I_{yy} = I_{xx} \sin^2 \theta + I_{yy} \cos^2 \theta + 2I_{xy} \sin \theta \cdot \cos \theta \qquad (4)$$

$$I_{uv} = (I_{yy} - I_{xx}) \sin \theta \cos \theta - I_{xy} \cos (2\theta)$$

 ${}^{M}_{uu}$  and  ${}^{M}_{vv}$  can be expressed as

$$M_{uu} = M_{x} \cos \theta + M_{y} \sin \theta$$

$$M_{vv} = -M_{x} \sin \theta + M_{y} \cos \theta$$
(5)

Substituting Eqs. 4 and 5 into Eq. 2

$$\delta_{y} = \frac{F}{E} \left( \frac{M_{x} \cos \theta + M_{y} \sin \theta}{I_{xx} \cos^{2} \theta + I_{yy} \sin^{2} \theta - 2I_{xy} \sin \theta \cos \theta} \right) \cos \theta$$
$$+ \frac{F}{E} \left( \frac{-M_{x} \sin \theta + M_{y} \cos \theta}{I_{xx} \sin^{2} \theta + I_{yy} \cos^{2} \theta + 2I_{xy} \sin \theta \cos \theta} \right) \sin \theta \quad (6)$$

According to Assumption 8, Eq. 6 can be simplified as

$$\delta_{y} = F \frac{M_{x}}{E} \left( \frac{Cos^{2} \theta}{I_{xx} Cos^{2} \theta + I_{yy} Sin^{2} \theta - 2I_{xy} Sin \theta Cos \theta} - \frac{Sin^{2} \theta}{I_{xx} Sin^{2} \theta + I_{yy} Cos^{2} \theta + 2I_{xy} Sin \theta Cos \theta} \right)$$
(7)

$$I_{eq} = \frac{1}{\frac{\cos^2 \theta}{I_{xx} \cos^2 \theta + I_{yy} \sin^2 \theta - I_{xy} \sin(2\theta)} - \frac{\sin^2 \theta}{I_{xx} \sin^2 \theta + I_{yy} \cos^2 \theta + I_{xy} \sin(2\theta)}}$$
(8)

wherein,  $I_{eq}$  is defined as "Equivalent Moment of Inertia" for each beam-slab unit. If  $\theta = 0$ ,  $I_{eq} = I_{xx}$ .

Substituting Eq. 8 into Eq. 7 and rearranging, we obtain

$$M_{x} = \frac{(E I_{eq}) \delta_{y}}{F}$$
(9)

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This is the expression for the longitudinal bending moment at a cross-section of a beam-slab unit.

Considering the equilibrium condition of longitudinal bending moments at any chosen cross-section of the bridge

$$(M_{x})_{EXT} = (M_{x})_{INT} = \sum_{i=1}^{i=m} (M_{x})_{i} = \sum_{i=1}^{i=m} \frac{E_{i} (I_{eq})_{i}}{F_{i}} (\delta_{y})_{i}$$
(10)

where  $(M_x)_{EXT}$  = total external bending moment

(M<sub>x</sub>)<sub>INT.</sub> = total internal resisting bending moment
m = number of beams
i = subscript used to identify beam-slab units

By definition, the moment percentage (M.P.) is

$$(M.P.)_{i} = \frac{(M_{X})_{i}}{\sum_{i=1}^{i=m} (M_{X})_{i}} \times 100$$

Using Eq. 10

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$$(M.P.)_{i} = \frac{\frac{E_{i} (I_{eq})_{i}}{F_{i}} (\delta_{y})_{i}}{\sum_{i=1}^{I=m} \frac{E_{i} (I_{eq})_{i}}{F_{i}} (\delta_{y})_{i}}$$

$$(M.P.)_{i} = \frac{E_{i} (I_{eq})_{i}}{\sum_{i=1}^{I} (F_{i})} (\delta_{y})_{i}$$

According to Assumptions 1 and 6,  $E_i$  and  $F_i$  are the same for all beam-slab units; therefore, a correlation between the transverse distribution of longitudinal bending moments in beam-slab units and the cross-sectional deflections is found as follows:

$$(M.P.)_{i} = \frac{(I_{eq})_{i} (\delta_{y})_{i}}{\sum_{i=1}^{i=m}}$$
(11)

For the special case when  $(I_{eq})_i$  is the same for all beam-slab units, Eq. 11 becomes

$$(M.P.)_{i} = \frac{(\delta_{y})_{i}}{\sum_{i=1}^{i=m}} = (D.P.)_{i}$$
(12)

In other words, the moment percentages (M.P.) will be equal to the deflection percentages (D.P.), if the bridge has identical equivalent moments of inertia for all beam-slab units.

#### 3. EXPERIMENTAL STUDY

#### 3.1 General Consideration

In this chapter, brief descriptions of the test program and tested models used in this study are presented. Details concerning the construction, instrumentation, fabrication, and modeling techniques of the models, as well as the similitude requirements considered, can be found in Ref. 9.

#### 3.2 Test Program

The test program for the models was designed with the objectives mentioned in Section 1.2.

In the experimental model investigation, a series of seventeen 1/16-scale Plexiglas models was fabricated and tested. All of the bridges were simply supported over a span of 48.94 inches.

According to the method of fabrication, the models can be classified into two categories: (1) Glued model, in which all of the components were cemented together using Ethylene Dichloride, and (2) Bolted model, in which pre-fabricated beams, slab, curbs, parapets, and diaphragms were connected together by screws or tie-rods. A brief description of all models is shown in Table 1.

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According to the geometry of the cross-section, the models can be separated into two groups: one group of models without curbs and parapets, and the other with curbs and parapets. Within each group, bridges can again be divided into two sub-groups: (1) bridges with diaphragms, and (2) bridges without diaphragms. For the convenience of simple use in later chapters, it might be helpful to classify the bridges as follows:

- Case (0,0,0) represents bridges without curbs, parapets, and diaphragms, such as models B1, B5, B9, B15, and B16.
- Case (0,0,1) represents bridges without curbs and parapets, but with diaphragms, such as models B2, B6, and B10.
- Case (1,1,0) represents bridges without diaphragms, but with curbs and parapets, such as models B3, B7, and B11.
- 4. Case (1,1,1) represents bridges with all elements. Most real bridges belong to this category. Models Al, B4, B8, B12, B13, and B14 are in this case.

Bridge model B4 was chosen as the typical bridge in this study. The cross-sectional dimensions are shown in Fig. la. The five loading lanes covering the entire clear width of 20.88 inches of the roadway, are numbered 1 through 5 from the east edge, westward. Four identical box beams, representing prototype

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beams 4 feet wide and 39 inches deep. A longitudinal view of a bolted model is given in Fig. 2, and the arrangement of all basic cross-sections of models is shown in Fig. 3.

Electrical wire-resistance strain gages were mounted at each of three sections. Vertical dial gages were placed under the box beams at the first and at the second sections gaged, which are 28.22 inches and 17.72 inches from the south support, respectively.

A typical test setup is shown in Figs. 3 and 4.9

#### 4. TEST RESULTS

#### 4.1 Presentation of Test Results

4.1.1 Experimental Moment Percentages

In this study, the moment percentage for a specific beam is defined as the bending moment in that beam divided by the sum of the bending moments in all of the beams at a given section. The experimental bending moments were calculated from stress blocks obtained from the measured strains in each beam.

The exterior beams were analyzed as acting compositely with the slab, curbs, and parapets whenever they were present. Thus, the bending moments contributed by the individual slab, curbs, and parapets were taken into account in the calculations of the experimental moment percentages for all of the beams. Through the use of a GE 225 digital computer with a rather complicated, but comprehensive program, these calculations were performed on the same day of the test. The synthetic description of this computer program can be found in Ref. 9.

The experimental moment percentages for all beams with the load on lanes 1, 2, and 3 are presented in table form. Tables 3, 4, 5, 6, 15, and 16 contain experimental moment percentages at Section 1 (nominal maximum moment) for the models

~22=

with four 4 ft. x 39 in.  $(4 \times 39)$  box beams; Tables 7, 8, 9, and 10 present similar values for models with four 4 x 30 box beams; and Tables 11, 12, 13, and 14 correspond to the bridge models with four 3 x 42 box beams. Furthermore, the results for the bridge models A1, B15, and B16 are presented in Tables 2, 17, and 18.

4.1.2 Deflection Percentages and Rotation Percentages

Section 2 (nominal third point of the span), in addition to Section 1, was gaged in order to measure cross-sectional deflections and beam rotations. As deflections were measured at the east and west faces of each beam, the average of these two values was used to represent the mid-width deflection of each beam.

The deflection percentage of a particular beam is defined as the deflection of that beam divided by the sum of the deflections of all of the beams at a given section. The rotation percentage of a particular beam is the rotation of that beam divided by the sum of the absolute values of the rotations of all of the beams at a given section.

Values of deflection percentages and rotation percentages at Section 1 in the model tests are listed in Tables 2 through 18.

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#### 4.2 Analysis of Test Results

#### 4.2.1 Cross-Sectional Strain Distribution

The experimental strains from two model tests are plotted along the faces of an exterior beam in Figs. 4 and 5. In most instances, a linear relationship existed in the slab and box beams. In the glued model Al, in which the curbs and parapets were cemented together, this linear variation extended with full interaction into the curbs, and with approximately 60% interaction into the parapets. In the bolted models, in which curbs and parapet pieces were bolted to the slab and to the curb, respectively, the measured strains at the top surface of the parapets were only 20% to 30% of the strains that would correspond to full linear strain variation. A possible reason for this deviation is mainly that the connection between curbs and parapets was not strong enough to develop full composite action. Another cause is that the strain gages at the top surface of the parapets were not in vertical alignment with those in the box beams and curbs. However, the experimental strain distribution obtained from model tests demonstrated that full composite action was developed in the interior beam-slab units, and in the exterior beams between the beam-slab unit and the curb.

Several strain readings were taken to investigate the strain distribution in the top surface of the slab. The

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longitudinal slab strains, although found to be in the same vertical linear variation with the strains in the corresponding beams, were found to depart somewhat from the linear variation in the transverse direction.

4.2.2 Location of Neutral Axes

The computation of the neutral axis location was based on linear strain distribution. The distances, in inches, from the top fiber of the box beam to the neutral axis on the east and west faces of the beams in models Al and Bl are presented in Table 19. Based on these values, the locations of neutral axes were plotted in Figs. 6 and 7. The rotations of the neutral axes with respect to horizontal axes were also calculated and tabulated in these figures.

The test results shown indicate that the neutral axes in the exterior beams were inclined for the load on any lane, while appreciable inclination of interior beam neutral axes occurred only when the load was on the side of the bridge opposite to the beam under consideration. The inclination of the neutral axes, which was less than  $15^{\circ}$  in all cases, did not produce an appreciable effect in the calculation of the bending moment  $M_{\chi}$ , if  $\theta$  was assumed equal to  $0^{\circ}$  in Eqs. 8 and 9.

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4.2.3 Correlation Between Rotation and Moment Percentages

From the test results presented, it can be seen that the transverse rotation of the beams was very small, and that the range of absolute rotations under vehicular load varied from 0 to 800 millionths of a radian, depending on the rigidity of the cross-section of the bridge.

In order to study the correlation between rotations of the beams and bending moment distribution, four typical plots of  $\lambda$  (the ratio of experimental moment percentage to deflection percentage) against rotation percentages are shown in Figs. 20, 21, 22, and 23. Each plot was chosen, from the test results of seventeen models, to represent a typical case. Figures 20 through 23 show results of model B1 for Case (0,0,0); model B6 for Case (0,0,1); model B11 for Case (1,1,0) and model A1 for Case (1,1,1), respectively.

A common characteristic was observed. In each figure,  $\lambda$  - rotation percentage relationships were plotted for both exterior and interior beams with the truck on the five different loading lanes. These figures indicate that the values of  $\lambda$  were insensitive to rotation of the beams when the load was on the same half of the roadway. The variation of  $\lambda$  increased considerably when the load was on the other half of the roadway. It

**∞**26**∝** 

was also observed that the rotation percentages decreased appreciably when the load was moved from lane 4 to lane 5.

As a consequence of these observations, it is believed that the rotations of the beam cross-sections do not bear any primary relationship with the bending moment distributions. In other words, no simple correlation was found between moment percentages and rotation percentages. On the other hand, it is believed that the rotations of the beams should play a more important role in torsional moment distribution. No attempt has been made to establish a correlation between torsional moment distribution and rotation percentages.

4.2.4 Correlation Between Moment and Deflection Percentages

The experimental moment percentages in all beams at test Section 1 are compared with the deflection percentages in Figs. 8 through 19. Four model test results were chosen to represent the comparisons in four typical cases, as mentioned in Section 4.2.3. In each case, comparisons are made in three figures corresponding to the load in lanes 1, 2, and 3, respectively.

Figures 8, 9, and 10 show a typical comparison of the experimental moment percentages and deflection percentages for Case (0,0,0). It can be easily seen that the ratios of moment

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percentages to deflection percentages are very close to a value of one, with a maximum relative deviation of 10.5% in interior beams and of 7.1% in exterior beams. In addition, these figures show that the exterior beams had slightly smaller moment percentages than deflection percentages.

Using the data from model B6, the effect of midspan and end diaphragms on the moment distributions and deflection distributions is illustrated in Figs. 11, 12, and 13. It can be observed that the experimental moment percentages in the exterior beams are slightly larger than the deflection percentages when the load is placed on lane 1 or lane 2. Furthermore, Fig. 13 shows that moment percentages are almost identical to deflection percentages when the load is on lane 3.

In addition, the effect due to diaphragms is obtained by a comparison of the data from models Bl and B2. The most noticeable consequence of adding diaphragms is that the load is distributed more uniformly across the bridge. However, the corresponding changes introduced in the moment percentages and in the deflection percentages of exterior beams are essentially the same. In other words, the presence of diaphragms did not produce any significant change on the correlation between bending moment percentages and deflection percentages.

-28- .

For the bridges with curbs and parapets, Case (1,1,0) and Case (1,1,1), the comparisons of experimental moment and deflection percentages are given in Figs. 14 through 19. In these two cases, there is an appreciable discrepancy between the bending moment distributions and deflection distributions. In general, for exterior beams, the moment percentages are substantially higher than the corresponding deflection percentages. but the opposite situation occurs for interior beams. The values of ratios of moment percentages to deflection percentages range between 0.91 to 1.27 for exterior beams, and between 0.65 to 0.91 for interior beams. This discrepancy is especially obvious when the load is on lane 1. Therefore, in these two cases, the deflection distribution cannot be used as a direct indication of the bending moment distribution. As a result, the difference in the flexural stiffness of the exterior and interior beam-slab units should be taken into consideration.

#### **4.2.5** Effects of Vehicular Loading

The close agreement between moment and deflection percentages in the bridges without curbs and parapets indicates that it may be reasonable to conclude that the moment-deflection relationship is quite similar for all of the beams when the bridge is subjected to vehicular loading. Therefore, there is no need

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to make a correction to take into account the effects due to each individual concentrated wheel load, as suggested in Ref. 4.

4.2.6 Effects Due to Other Parameters

Comparison of test results from model B4 with those from models B13 and B14, shows the effect of different thickness of slab on the correlation between moment and deflection percentages. Although a thicker slab produced a somewhat more uniform lateral load distribution than a thinner slab, the ratios of moment percentages to deflection percentages were nearly identical in these three cases. Hence, the correlation between bending moment distributions will remain the same for the box-beam bridges with different thicknesses of slab.

In addition, Table 35 shows that the experimental moment percentages for model B15 are in close agreement with the deflection percentages. The lateral load distributions obtained are very close to those in model B1. The same agreement may be found in Table 36 for the bridge with seven smaller identical  $(3 \times 24)$  box beams. All of the above observations indicate that the number, size, and spacing of box beams do not significantly affect the correlation between moment percentages and deflection percentages.

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## 5. PROPOSED METHOD FOR ESTIMATING BENDING MOMENT

### 5.1 Development of the Proposed Method

As discussed in Chapter 2, the elastic structural behavior of box-beam bridges under vehicular loads is extremely complicated, and no exact method of analysis has been reached. The analysis is further complicated by the presence of curbs, parapets, and diaphragms. Therefore, drastic simplifications and assumptions are essential in a reasonably approximate theoretical solution.

The assumptions made in Chapter 2 led to a simplified correlation between distributions of longitudinal bending moments and of cross-sectional deflections, as shown in Eqs. 11 and 12. It is apparent that the computations for  $I_{eq}$ , equivalent moments of inertia of individual beam-slab units, are still rather lengthy and cumbersome. In order to simplify the practical application, one further assumption should be made: the neutral axes in box beams are assumed to be horizontal and passing through the centroid of each beam-slab unit.

Based on this assumption,  $I_{eq}$ , shown in Eq. 8, can be simplified to  $I_{xx}$ . This results in a much simpler correlation, which is given as follows:

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$$(M.P.)_{i} = \frac{(I_{xx})_{i} (\delta_{y})_{i}}{\sum_{i=1}^{m} (I_{xx})_{i} (\delta_{y})_{i}}$$
(13)

By dividing  $(I_{xx})_i$  by  $I_o$  and  $(\delta_y)_i$  by  $\Sigma$   $(\delta_y)_i$ , this equation can be non-dimensionalized to

$$(M.P.)_{i} = \frac{(F.M.I.)_{i} (D.P.)_{i}}{m}$$
(14)  
$$\sum_{i=1}^{m} (F.M.I.)_{i} (D.P.)_{i}$$

where I is the moment of inertia of a reference box beam with respect to its horizontal centroidal axis,

F.M.I. is the factor of moment of inertia, defined as the ratio of  $I_{xx}/I_o$ , and

D.P. is the deflection percentage of an individual beam-slab unit.

The only undefined variable in computing  $I_{\chi\chi}$  is the individual slab width. Although a slab width varies appreciably when the load is on different lanes, its effect on the magnitude of  $I_{\chi\chi}$  and on F.M.I. was found to be small. (See Figs. 24 and 25.)

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Therefore, the center-to-center spacing of box beams is used as the individual slab width for interior beams, and edge-of-slab to the first mid-spacing as the individual slab width for exterior beams. According to this simplification, the values of the so-called "Hypothetic Factor of Moment of Inertia" for the bridges with three different sizes of box beams were calculated and presented in Table 20. In each case, the hypothetic F.M.I. were computed based on three different thicknesses of slab and four different percentages of effectiveness of parapets: 0%, 30%, 60%, and 100%.

To study the validity of the hypothetic F.M.I., a comparison of experimental and hypothetic values was made and is presented in Table 21. The experimental F.M.I. values were based on the experimental individual slab widths.

In Table 21, it is seen that the values of hypothetic F.M.I. are nearly equal to the corresponding values of average experimental F.M.I. for exterior beams, and approximately 4 - 10% smaller in interior beams. Therefore, a complete set of suggested values of Factor of Moment of Inertia is presented in Table 22. For convenience, these tabulated values are also presented in Figs. 26 through 28. In these figures, the required values of F.M.I. can be read directly or by interpolation for different combinations of slab thickness and effectiveness of parapets.

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The moment percentages based on the experimental F.M.I. are tabulated in Tables 2 through 18 under the title of "computed moment percentages". The influence of using suggested F.M.I. can be found by comparing these computed moment percentages with estimated moment percentages based on the following proposed method:

- Step 1. Compute the deflection percentages
   (D.P.) for each box beam by using
   the cross-sectional deflections (\$ y),
   which would be obtained by direct
   measurements.
- Step 2. Adopt a value for the percentages of effectiveness of parapets in accordance with the nature of the connection, and then determine the values of Factor of Moment of Inertia for all beams by the use of the provided charts. If the thickness is not available in the charts, the required values can be found by interpolation.
- Step 3. Compute the coefficients of moment of inertia (C.M.I.) for all beams by dividing the F.M.I. of each beam by the summation of F.M.I.'s of all of the beams.
- Step 4. Calculate the estimated moment percentages (E.M.P.) using the following formula.

$$(E.M.P.)_{i} = \frac{(C.M.I.)_{i} (D.P.)_{i}}{\sum_{i=1}^{m} (C.M.I.)_{i} (D.P.)_{i}}$$
(15)

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# 

## 5.2 Illustrated Example

An example to illustrate the proposed method is presented as follows:

The problem is to find the moment percentages at Section 1 in Bridge Model B4 when the load is on lane 1 by using the following information:

- The cross-sectional deflections
   (in 10<sup>-5</sup> in.) are 489 for beam 1;
   379 for beam 2; 229 for beam 3; and
   120 for beam 4.
- The bridge has four 4 x 39 box beams, slab 8 in. in thickness, curbs, parapets, and diaphragms.

Solution:

Step 1. Deflection Percentages (D.P.)

 $(D.P.)_1 = \frac{489}{(489 + 379 + 229 + 120)} (100) = 40.18$ 

Similarly

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$$(D.P.)_2 = 31.13$$
  
 $(D.P.)_3 = 18.82$   
 $(D.P.)_4 = 9.86$ 

# <u>Step 2</u>.

Thirty percent of parapet effectiveness can be considered as contributing to the flexural stiffness of this bridge, based on Fig. 5.

The suggested values of F.M.I. are taken from the charts in Fig. 26.

 $(F.M.I.)_{1,4} = 3.74$  $(F.M.I.)_{2,3} = 2.75$ 

<u>Step 3</u>. Coefficients of Moment of Inertia:

$$(C.M.I.)_{1,4} = \frac{3.74}{(3.74 + 2.75)} = 1.12$$

$$(C.M.I.)_{2,3} = \frac{2.75}{(3.74 + 2.75)(2)} = 0.88$$

Step 4. Estimated Moment Percentages from Eq. 15

$$(E.M.P.)_{1} = \frac{(1.12) (40.18)}{(1.12) (40.18 + 9.86) + (0.88) (31.14 + 18.82)} = 44.96$$

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Similarly

$$(E.M.P.)_2 = 27.43$$
  
 $(E.M.P.)_3 = 16.58$   
 $(E.M.P.)_4 = 11.03$ 

### 5.3 Comparisons of Experimental and Estimated Moment Percentages

Using the proposed method, values of estimated moment percentages were calculated and compared with experimental moment percentages for the Berwick Bridge and eight bridge models. The results are presented in Tables 23 through 31. As mentioned in Section 4.2.1, a 60% effectiveness of the parapets was assumed in model A1 and the Berwick Bridge, and a 30% effectiveness of the parapets in models B3, B4, B7, B8, B12, B13, and B14.

Satisfactory agreement was found in all cases between the experimental and estimated moment percentages. In particular, the differences were minimal for all models when the load was on lane 3.

For the bridge models with curbs, parapets, and with or without diaphragms, the maximum difference in the comparison is within 3% of the total resisting bending moment at Section 1. In most instances, this occurred in beam 1 when the load was on lane 1. The reason is possibly due to the fact that the assumed

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percentages of effectiveness of the parapets were not entirely valid when the load was on lane 1. On the other hand, virtually identical results were obtained when the load was on lane 3. This can be explained by the fact that the neutral axes in the box beams with the load on lane 3 are almost horizontal, and thus, the assumption ( $I_{eq} = I_{xx}$  or  $\theta = 0^{\circ}$ ) can be better satisfied.

For the bridges without curbs and parapets, the equivalent moments of inertia of individual beam-slab units are nearly equal. It is reasonable to assume that the  $I_{eq}$ 's are the same in all beam-slab units. Therefore, by Eq. 12, the estimated moment percentages can be taken as equal to the deflection percentages; and the comparison of estimated and experimental moment percentages and deflection percentages as discussed in Section 4.2.4. For convenience, this comparison is given in Tables 32 through 36.

The comparison for the Berwick Bridge is shown in Table 23. The differences between the experimental and the estimated moment percentages are slightly larger than in the models. However, for practical purposes, the estimated values are still acceptable. The deflections used in the Berwick Bridge were based on the crawl-speed field tests.

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### 5.4 Validity and Limitations of the Proposed Method

Since the proposed method was developed by using the theoretical correlation between the bending moment distribution and the cross-sectional deflections, all of the assumptions made in Sections 2.2 and 5.1 should be satisfied. It may be noted that most of these assumptions and simplifications have already been discussed and evaluated in Sections 4.2 and 5.1. In this section, more attention is given to the discussion of the assumptions which are not always valid, and to the limitations of this method. This discussion can be summarized as follows:

- 1. The linear longitudinal slab strain
   distribution in the transverse direction
   is a simplifying assumption which produces
   some error in the computation of the ex perimental moment percentages.<sup>9</sup>
- 2. It was assumed in this method that the bridge is homogeneous. Actually, the modulus of elasticity for the cast-inplace slab, curbs, parapets, and diaphragms is lower than that of the box beams. This again, introduces certain errors in estimating bending moments by the proposed method.
- 3. The neutral axes were assumed to be horizontal and passing through the centroid of each beam-slab unit. This condition was found to exist in all model tests,

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only when the load was on lane 3.

- 4. This method can be used to estimate the longitudinal bending moments in box-beam bridges within the elastic range only. The transverse bending moments and inelastic structural behavior are not to be determined by this method.
- 5. The charts provided in Figs. 26, 27, and 28 are applicable to bridges constructed according to bridge standards similar to those of the Pennsylvania Department of Highways.<sup>2</sup> For a bridge with different design of curb and parapet, the provided charts cannot be used. The true factors of moment of inertia should be calculated by adequate consideration of the reserve strength in curbs and parapets.

#### 6. CONCLUSIONS

The lateral distribution of static vehicular loads in prestressed concrete box-beam bridges, within the elastic range, has been successfully estimated for eighteen different crosssections. Within the scope of this report, the following conclusions were reached:

- In box-beam bridges without curbs and parapets, the moment percentages were found to be essentially the same as the deflection percentages under vehicular loads. Both the theoretical analysis and the test results confirmed this conclusion.
- 2. The test results consistently indicated full composite action between the slab and the curb sections, and some degree of composite action between curb and parapet sections. This degree of composite action is believed to be one of the primary reasons for the difference between the distributions of longi-tudinal bending moments and that of cross-sectional deflections. Thus, the reserve strength contributed by curbs and parapets should be accounted for in the analysis and design.
- 3. Since a reasonable agreement was found in the comparison of the experimental moment percentages and the estimated moment percentages by

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the proposed method, the lateral distribution of longitudinal bending moments may be estimated within acceptable accuracy using the proposed method for the bridges with curbs and parapets.

- 4. It appears that the presence of midspan and end diaphragms has little effect on the correlation between the distributions of longitudinal bending moments and the cross-sectional deflections.
- 5. The plots of the ratios of moment percentages to deflection percentages against rotation percentages indicate that there is no simple relationship between the lateral distribution of bending moments and the transverse individual rotations in box-beam bridges.
- 6. In a box-beam bridge under vehicular loading, the moment-deflection relationship is quite similar for all beams, regardless of vehicle location. This is due to the fact that the effects on the non-proportionality between strains and deflections is greatly reduced when multiple wheel loads are used instead of a single concentrated load.

7. The proposed method has been primarily evaluated by the test results of four-beam bridges. It is believed that further study of load distribution for three-beam and five-beam bridges might be helpful in establishing a better

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understanding of the reliability of this method.

8. Every step of the proposed method can be carried out by means of a system of electronic circuits built into instrument modules. The circuits can be readily set in accordance with the bridge cross-section characteristics. It would be possible to devise a testing system in order to measure beam deflections by the use of deflectometers. The cross-sectional deflections could then be fed to a set of inter-connected instrument modules, and the moment percentages could be read directly in digital counters. Through this idea, a more efficient and more economical method can be used for both field and laboratory investigations.

### 7. ACKNOWLEDGMENTS

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Model No.	Number of Beam <b>s</b>	Size of Beams	Slab Thick. (in.)	Curbs*	Parapets*	Dia- phragms*	File Comp. Output
Al	4	4x39	0.5	1	1	1	I23
Bl	4	4x39	0.5	0	0	0	a
B2	4	4x39	0.5	0	0	1	n
B3	4	4x39	0.5	1	l	0	m
.B4	<u>ц</u>	4x39	0.5	1	.1	1	е
B5	4	4x30	0.5	0	0	0	k
B6	4	4x30	0.5	0	0	1	1
B7	4	4x30	0.5	Ĺ	1	0	j
В <b>8</b>	4	4x30	0.5	1	l	1	i
В <b>9</b>	4	3x42	0.5	0	0	0	ο
B10	4	3x42	0.5	0	0	1	r
B11	4	3x42	0.5	1	1	0	р
B12	4	3x42	0.5	1	1	1	q
B13	4	4x39	0.375	1	1	1	g
B14	4	4x39	0.625	l	1	1	f
B15	4 <sup>2</sup> 4 2	-3x42 -4x30	0.5	0	0	0	s
B16	7	3x24	0.5	0	0	0	t

Table 1 Models Tested

\*Code: A zero means NO and a one means YES.

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	LANE	3	22,74	27,26	27,26	22,74
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	LANE	3	29,44	20,56	-20,56	-29,44
			COMPUTE	D MOMENT PERC	ENTAGES	
		w	42 85	24 73	17.70	14 70
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LOAD POSITION 1 SECTION NUMBER 1 BEAM 1 BEAM 2 BEAM 3 BEAM 4 EXPERIMENTAL MOMENT PERCENTAGES LANE 1 44.80 32.45 15.11 7.64 LANE 2 30.20 34.81 22.32 12.67 LANE 3 19.32 30.68 30.68 19.32 BEAM DEFLECTION PERCENTAGES LANE 1 44.78 30.42 16.87 7.93 LANE 2 30.92 32.99 2.87 13.22 LANE 3 20.78 29.22 20.22 20.78 RATIO OF MOMENT PER, / DEFLECTION PER, LANE 1 1.00 1.07 0.90 0.96 LANE 2 0.98 1.06 0.98 0.96 LANE 3 0.93 1.05 1.05 0.93 BEAM ROTATION PERCENTAGES LANE 1 1.972 *10.74 *41.55 *27.99 LANE 3 26.03 23.97 *23.97 *26.03 COMPUTED MOMENT PERCENTAGES LANE 1 49.46 26.59 16.50 7.43 LANE 2 0.928 1.06 0.96 LANE 3 20.33 29.67 20.57 20.33 COMPUTED MOMENT PERCENTAGES LANE 1 49.46 26.59 16.50 7.43 LANE 1 3.06 2.42 2.71 2.59 LANE 3 20.33 29.67 20.57 20.33 MOMENT OF INERTIA ID= 2.106 IN**3 LANE 1 3.06 2.42 2.71 2.59 LANE 3 20.33 29.67 20.57 20.33 LANE 3 20.67 2.77 2.77 2.67 COEFFICIENTS OF MOMENT OF INERTIA LANE 1 1.10 0.96 1.00 0.96 LANE 2 0.99 1.00 1.00 0.96 LANE 3 2.67 2.77 2.77 2.67 COEFFICIENTS OF MOMENT OF INERTIA				BRIDGE M	ODEL NUMBER E	9 <b>1</b> :·	
BEAM 1         BEAM 2         BEAM 3         BEAM 4           EXPERIMENTAL MOMENT PERCENTAGES           LANE 1         44,80         32,49         15,11         7,64           LANE 2         30,20         34,81         22,32         12,67           LANE 3         19,32         30,66         37,56         19,32           BEAM DEFLECTION PERCENTAGES           LANE 1         44,78         30,42         16,87         7,93           LANE 2         30,92         32,99         22,87         13,22           LANE 3         20,78         29,22         29,22         20,78           LANE 4         1,00         1,07         0,90         0,96           LANE 5         0,98         1,06         0,98         0,96           LANE 1         1,00         1,07         0,90         0,96           LANE 1         1,06         0,93         1,05         0,93           BEAM ROTATION PERCENTAGES         1         1,05         41,55         +27,99           LANE 1         1,02         1,9,72         +10,74         +41,55         +27,99           LANE 2         19,72         +10,74         +41,55         +27,99		LOAD	POSITIO	IN 1 SECT	ION NUMBER 1		and the second of the second
EXPERIMENTAL MOMENT PERCENTAGES           LANE         1         44,80         32,45         15,11         7,64           LANE         3         30,20         34,81         22,32         12,67           LANE         3         19,32         30,68         30,68         19,32           BEAM DEFLECTION PERCENTAGES           LANE         1         44,78         30,42         16,87         7,93           LANE         2         30,92         32,99         21,97         14,22           LANE         3         20,78         29,22         29,12         20,78           RATIO OF MOMENT PER, / DEFLECTION PER,           LANE         1         1,00         1,07         0,90         0,96           LANE         1         1,00         1,07         0,90         0,96           LANE         1         1,00         1,07         0,90         0,96           LANE         1         1,00         1,07         0,96         0,96           LANE         1         1,00         1,07         0,96         0,96           LANE         1         1,00         1,04         1,96         0,96				BEAM 1	BEAM 2	BEAM 3	REAM 4
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LANE       3       17,32       30,03       30708       17,32         BEAM DEFLECTION PERCENTAGES         LANE       1       44,78       30,42       16,67       7,93         LANE       2       30,92       32,99       22,87       13,22         LANE       3       20,78       29,22       29,22       20,78         RATIO OF MOMENT PER, / DEFLECTION PER,         LANE       1       1,00       1,07       0,90       0,96         LANE       2       0,98       1,06       0,93       0,96         LANE       3       0,93       1,05       1,05       0,93         BEAM ROTATION PERCENTAGES         LANE       1       -15,54       -39,62       -29,42       +15,42         LANE       2       19,72       +10,74       +41,55       +27,99         LANE       3       26,03       23,97       +23,97       +26,03         COMPUTED MOMENT PERCENTAGES         LANE       1       49,48       26,59       16,50       7,43         LANE       1       49,48       26,59       16,50       7,43         LANE       3 <td< td=""><td>en en e</td><td></td><td></td><td>40 72</td><td>30,64</td><td>70 60</td><td>16,07</td></td<>	en e			40 72	30,64	70 60	16,07
BEAM DEFLECTION PERCENTAGES           LANE         1         44,78         30,42         16,87         7,93           LANE         2         30,92         32,99         22,87         13,22           LANE         3         20,78         29,22         29,22         20,78           RATIO OF MOMENT PER,         DEFLECTION PER,         NERATIO OF MOMENT PER,         DEFLECTION PER,           LANE         1         1.00         1.07         0.90         0.96           LANE         2         0.98         1.06         0.98         0.96           LANE         3         0.93         1.05         1.05         0.93           BEAM ROTATION PERCENTAGES         BEAM ROTATION PERCENTAGES         20,92         *15,42         *27,99           LANE         1         *15,54         *39,62         *29,42         *15,42           LANE         2         19,72         *10,74         *41,55         *27,99           LANE         2         19,72         *10,74         *41,55         *27,99           LANE         3         0,22         33,85         23,94         12,00           LANE         1         49,48         26,59         16,50		CANE		+7,9×6	<b>VV, V</b> 0	<b>JU10</b>	17,34
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RATIO OF MOMENT PER, / DEFLECTION PER,         LANE 1       1,00       1,07       0,90       0,96         LANE 2       0,98       1,06       0,98       0,96         LANE 3       0,93       1,05       1,05       0,93         BEAM ROTATION PERCENTAGES         LANE 1       *15,54       *39.62       *29,42       *15,42         LANE 2       19,72       *10,74       *41,55       *27,99         LANE 3       26,03       23,97       *28,97       *26,03         COMPUTED MOMENT PERCENTAGES         LANE 3       26,03       23,97       *26,03         COMPUTED MOMENT PERCENTAGES         LANE 1       49,48       26,59       16,50       7,43         LANE 3       20,33       29,67       29,57       20,33         MOMENT OF INERTIA       10=       2,106       1N**3         LANE 1       3,06       2,42       2,71       2,59         LANE 1       3,06       2,42       2,71       2,53       2,53         LANE 2       2,67       2,77       2,67       2,53         LANE 3       2,67       2,77       2,6	ingen ing	LANE	3	20,78	29,22	29,22	20,78
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BEAM ROTATION PERCENTAGES           LANE         1         *15,54         *39,62         *29,42         *15,42           LANE         2         19,72         *10,74         -41,55         *27,99           LANE         3         26,03         23,97         *23,97         *26,03           COMPUTED MOMENT PERCENTAGES           LANE         1         49,48         26,59         16,50         7,43           LANE         2         30,22         33,85         23,94         12,00           LANE         3         20,33         29,67         29,67         20,33           MOMENT OF INERTIA         10=         2,106         1N**3           LANE         1         3,06         2,42         2,71         2,59           LANE         1         3,06         2,42         2,71         2,59           LANE         3         2,67         2,77         2,77         2,67           COEFFICIENTS OF MOMENT OF INERTIA           LANE         1,13         0,90         1,00         0,96           LANE         1         1,13         0,90         1,00         0,96           LANE<	an a	LANE	3	0,93	1,05	1.05	0,93
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COMPUTED MOMENT PERCENTAGES         LANE       1       49.48       26.59       16.50       7.43         LANE       2       30.22       33.85       23.94       12.00         LANE       3       20.33       29.67       29.67       20.33         MOMENT OF INERTIA       IO=       2.106       1N**3         LANE       1       3.06       2.42       2.71       2.59         LANE       2       2.72       2.86       2.91       2.53         LANE       3       2.67       2.77       2.67         COEFFICIENTS OF MOMENT OF INERTIA         LANE       1       1.13       0.90       1.00       0.96         LANE       1       1.13       0.90       1.06       0.92         LANE       2       0.99       1.04       1.02       0.98	an a	LANE	3	26,03	23,97	-23,97	⇒26,03
LANE       1       49,48       26,59       16,50       7,43         LANE       2       30,22       33,85       23,94       12,00         LANE       3       20,33       29,67       29,67       20,33         MOMENT OF INERTIA       IO=       2,106       IN**3         LANE       1       3,06       2,42       2.71       2,59         LANE       2       2.72       2.86       2.91       2,53         LANE       3       2.67       2.77       2.77       2.67         COEFFICIENTS OF MOMENT OF INERTIA         LANE       1,13       0,90       1.00       0,96         LANE       1,13       0,90       1.06       0,92         LANE       0,98       1,02       0,98	a and are and also been as a second	an a	- a sector and sector and sector and sector a	COMPUTE	D MOMENT PERCE	INTAGES	an san ang pang pang pang pang pang pang pan
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LANE         2         0         1         0         1         0         1 <th1< th=""> <th1< th=""> <th1< th=""> <th1< th=""></th1<></th1<></th1<></th1<>			2	30 22	33 85	23.94	12.00
MOMENT OF INERTIA       IO=       2,106       IN**3         LANE       1       3,06       2,42       2.71       2,59         LANE       2       2,72       2,86       2.91       2,53         LANE       3       2.67       2.77       2,77       2,67         COEFFICIENTS OF MOMENT OF INERTIA         LANE       1,13       0.90       1.00       0,96         LANE       2       0.99       1.04       1.06       0.92         LANE       3       0.98       1.02       0.98	alle en 1995 ander an	LANE	3	20,33	29,67	29,67	20,33
LANE 1       3,06       2,42       2,71       2,59         LANE 2       2,72       2,86       2,91       2,53         LANE 3       2,67       2,77       2,77       2,67         COEFFICIENTS OF MOMENT OF INERTIA         LANE 1       1,13       0,90       1,00       0,96         LANE 1       1,13       0,90       1,00       0,96         LANE 2       0,99       1,04       1,06       0,92         LANE 3       0,98       1,02       1,02       0,98	- the state of the		a para tanàna ara ina mandri aratra dia mandri dia	MOMENT	OF INERTIA	10= 2.1	L06 1N==3
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LANE         2         2,72         2,86         2,91         2,53           LANE         3         2,67         2,77         2,77         2,67           COEFFICIENTS OF MOMENT OF INERTIA           LANE         1         1,13         0,90         1,00         0,96           LANE         2         0,99         1,04         1,06         0,92           LANE         3         0,98         1,02         1,02         0,98		LANE	1	3,06	2,42	2.71	2,59
LANE 3 2.07 2.77 2.67 COEFFICIENTS OF MOMENT OF INERTIA LANE 1 1.13 0.90 1.00 0.96 LANE 2 0.99 1.04 1.06 0.92 LANE 3 0.98 1.02 1.02 0.98	e (1929) în la construction de position autoritation de la construction de la constru La construction de la construction de	LANE	2	2,72	2,86	2191	2,53
COEFFICIENTS OF MOMENT OF INERTIA           LANE 1         1,13         0,90         1,00         0,96           LANE 2         0,99         1,04         1,06         0,92           LANE 3         0,98         1,02         1,02         0,98		LANE		2,07	2,72	2,17	6,67
LANE         1,13         0,90         1,00         0,96           LANE         2         0,99         1,04         1,06         0,92           LANE         3         0,98         1,02         1,02         0,98		an a	e vere uzte kon tellt ertik eine som	COEFFIC	IENTS OF MOMEN	NT OF INERTIA	a na se a la ser a na ala ala dan wake
LANE 2 0.99 1.04 1.06 0.92 LANE 3 0.98 1.02 1.02 0.98	the man man part your died and a	LANE	1	1,13	0,90	1,00	0,96
LANE 3 0,98 1,02 1,02 0,98	an a	LANE	5	0,99	1,04		0,92
		LANE	3	0,98	1,02	1.02	0,98

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BRIDGE MODEL NUMBER B 2.           LOAD POSITION 1         SECTION NUMBER 1           DEAM 1         DEAM 2         DEAM 3           EXPERIMENTAL MOMENT PERCENTAGES         DANE 3         22,71         27,29         21,51           LANE 1         42,65         29,76         16,52         151           LANE 2         31,50         31,09         21,51           LANE 3         22,71         27,29         27,29           BEAM DEFLECTION PERCENTAGES         DEAM 2         30,74         18,68           LANE 2         30,98         30,74         18,68           LANE 2         20,98         30,74         18,68           LANE 3         22,55         27,45         27,45           RATIO OF MOMENT PERCENTAGES         RATIO OF MOMENT PER, / DEFLECTION         DEFLECTION           LANE 1         1,04         0,97         0,88           LANE 3         1,01         0,99         0,79           BEAM ROTATION PERCENTAGES         COMPUTED MOMENT PERCENTAGES           LANE 3         24,02         25,98         -29,12           LANE 4         *17,45         *35,96         -29,12           LANE 3         24,02         25,98         -25,98	
LOAD POSITION 1 SECTION NUMBER 1 BEAM 1 BEAM 2 BEAM 3 EXPERIMENTAL MOMENT PERCENTAGES LANE 1 42.65 29.76 16.52 LANE 2 31.50 31.09 21.31 LANE 3 22.71 27.29 27.29 BEAM DEFLECTION PERCENTAGES LANE 1 40.90 30.74 18.68 LANE 1 40.90 30.74 18.68 LANE 2 30.98 30.78 22.78 LANE 3 22.55 27.45 27.45 RATIO OF MOMENT PER, / DEFLECTION LANE 1 1.04 0.97 0.88 LANE 2 1.02 1.01 0.99 BEAM ROTATION PERCENTAGES LANE 1 1.04 0.97 0.88 LANE 2 1.02 1.01 0.99 BEAM ROTATION PERCENTAGES LANE 1 1.7.45 *35.96 -29.12 LANE 2 5.45 *20.05 *48.76 LANE 2 5.45 *20.05 *48.76 LANE 3 24.02 25.98 *25.98 COMPUTED MOMENT PERCENTAGES LANE 1 44.08 28.83 17.40 LANE 3 22.61 27.39 MOMENT OF INERTIA 10: 2.11 LANE 3 22.61 27.39 27.39 MOMENT OF INERTIA 10: 2.11 LANE 1 2.98 2.59 2.58 LANE 3 27.3 2.71 2.71 COEFFICIENTS OF MOMENT OF INERTIA	
BEAM 1       BEAM 2       BEAM 3         EVPERIMENTAL MOMENT PERCENTAGES         LANE 1       42.65       29.76       16.52         LANE 1       42.65       29.76       16.52         LANE 2       31.50       31.09       21.31         LANE 3       22.71       27.29       27.29         BEAM DEFLECTION PERCENTAGES       LANE 3       22.55       27.45       27.45         LANE 1       40.90       30.74       18.58       LANE 3       22.75         LANE 2       30.98       30.74       18.58       LANE 3       22.75         LANE 3       1.01       0.97       0.58       LANE 3       1.01       0.97         LANE 1       1.04       0.97       0.58       LANE 3       1.01       0.99       0.79         BEAM ROTATION PERCENTAGES       BEAM ROTATION PERCENTAGES       25.98       -29.12       LANE 3       24.02       25.98       -25.98         LANE 1       -17.45       -35.96       -29.12       -48.76       -24.02       -25.98       -25.98       -25.98       -25.98       -25.98       -25.98       -25.98       -25.98       -25.98       -25.98       -25.10       -27.39       27.39       -2	
BEAM 1       BEAM 2       BEAM 3         EXPERIMENTAL MOMENT PERCENTAGES         LANE 1       42.65       29.76       16.52         LANE 2       31.50       31.09       21.51         LANE 3       22.71       27.29       27.29         BEAM DEFLECTION PERCENTAGES       BEAM DEFLECTION PERCENTAGES         LANE 1       40.90       30.74       18.56         LANE 2       30.98       30.78       22.78         LANE 3       22.55       27.45       27.45         RATIO OF MOMENT PER, / DEFLECTION       DEFLECTION       DEFLECTION         LANE 1       1.04       0.97       0.86         LANE 2       1.02       1.01       0.94         LANE 3       1.01       0.99       0.99         BEAM ROTATION PERCENTAGES       BEAM ROTATION PERCENTAGES         LANE 1       *17.45       *35.98       -29.12         LANE 3       24.02       25.98       -29.92         LANE 3       24.02       25.98       -25.98         COMPUTED MOMENT PERCENTAGES       LANE 3       22.61       27.39         LANE 3       22.61       27.39       27.39         MOMENT OF INERTIA       IO= 2.10	
EXPERIMENTAL MOMENT PERCENTAGES           LANE         1         42.65         29.76         16.52           LANE         3         22.71         27.29         27.29           BEAM DEFLECTION PERCENTAGES           LANE         1         40.90         30.74         18.68           LANE         1         40.90         30.74         18.68           LANE         2.98         30.78         22.78           LANE         3         22.55         27.45         27.45           LANE         3         22.55         27.45         27.45           LANE         1         1.04         0.97         0.86           LANE         1         1.02         1.01         0.94           LANE         1         1.02         1.01         0.99           LANE         1         17.45         -35.96         -29.12           LANE         1         17.45         -35.96         -29.12           LANE         2         5.45         -20.05         -48.76           LANE         2         5.45         -20.05         -48.76           LANE         2         5.45         31.11         22.84	BEAM 4
LANE 1 42.65 29.76 16.52 LANE 2 31.50 31.09 21.31 LANE 3 22.71 27.29 27.29 BEAM DEFLECTION PERCENTAGES LANE 1 40.90 30.74 18.68 LANE 2 30.98 30.78 22.78 LANE 3 22.55 27.45 27.45 RATIO OF MOMENT PER. / DEFLECTION LANE 1 1.04 0.97 0.58 LANE 2 1.02 1.01 0.99 LANE 3 1.01 0.99 0.99 BEAM ROTATION PERCENTAGES LANE 1 -17.45 -35.98 -29.12 LANE 2 5.45 +20.05 -448.76 LANE 3 24.02 25.98 -25.98 COMPUTED MOMENT PERCENTAGES LANE 1 44.08 28.83 17.40 LANE 3 22.61 27.39 27.39 MOMENT OF INERTIA 10= 2.10 LANE 1 2.98 2.59 2.58 LANE 1 2.98 2.59 2.58 LANE 1 2.98 2.59 2.58 LANE 3 22.61 27.39 27.39 MOMENT OF INERTIA 10= 2.10 LANE 3 2.73 2.71 2.71 COEFFICIENTS OF MOMENT OF INERTIA	alah singa dipan dan serai dan serai san serai dan serai serai dan serai dan serai dan serai dan serai dan sera
LANE 2 31.50 31.09 21.51 LANE 3 22.71 27.29 27.29 BEAM DEFLECTION PERCENTAGES LANE 1 40.90 30.74 18.58 LANE 2 30.98 30.78 22.78 LANE 3 22.55 27.45 27.45 RATIO OF MOMENT PER, / DEFLECTION LANE 1 1.04 0.97 0.88 LANE 2 1.02 1.01 0.94 LANE 3 1.01 0.99 0.99 BEAM ROTATION PERCENTAGES LANE 1 -17.45 -35.98 -29.12 LANE 3 24.02 25.98 -25.98 COMPUTED MOMENT PERCENTAGES LANE 1 44.08 28.83 17.40 LANE 3 22.61 27.39 27.39 MOMENT OF INERTIA 10= 2.10 LANE 1 2.98 2.59 2.58 LANE 2 2.69 2.75 2.73 LANE 3 2.73 2.71 2.71 COEFFICIENTS OF MOMENT OF INERTIA	11,07
LANE 3 22,71 27,29 27,29 BEAM DEFLECTION PERCENTAGES LANE 1 40,90 30,74 18,58 LANE 2 30,98 30,78 22,78 LANE 3 22,55 27,45 27,45 RATIO OF MOMENT PER, / DEFLECTION LANE 1 1,04 0,97 0,88 LANE 2 1,02 1,01 0,94 LANE 3 1,01 0,99 0,99 BEAM ROTATION PERCENTAGES LANE 1 *17,45 *35,98 -29,12 LANE 2 5,45 +20,05 +48,76 LANE 3 24,02 25,98 +25,98 COMPUTED MOMENT PERCENTAGES LANE 1 44,08 28,83 17,40 LANE 3 22,61 27,39 27,39 MOMENT OF INERTIA 10 = 2,10 LANE 1 2,98 2,59 2,58 LANE 2 2,69 2,75 2,73 LANE 3 2,73 2,71 2,71 COEFFICIENTS OF MOMENT OF INERTIA	15,90
BEAM DEFLECTION PERCENTAGES           LANE         1         40,90         30,74         18,68           LANE         2         30,98         30,74         18,68           LANE         2         30,98         30,74         18,68           LANE         2         30,98         30,74         18,68           LANE         2         2,55         27,45         27,45           RATIO OF MOMENT PER, /         DEFLECTION         DEFLECTION           LANE         1,04         0,97         0,88           LANE         1,02         1,01         0,94           LANE         1,01         0,99         0,99           BEAM ROTATION PERCENTAGES         BEAM ROTATION PERCENTAGES           LANE         1         *17,45         *35,98         -29,12           LANE         2         5,45         #20,05         -48,76           LANE         2         0,65         31,11         22,84           LANE         3         22,61         27,39         27,39           MOMENT OF INERTIA         10=         2,10           LANE         2,98         2,59         2,58           LANE         2,98	22,71
LANE 1 40,90 30,74 18,58 LANE 2 30,98 30,78 22,78 LANE 3 22,55 27,45 27,45 RATIO OF MOMENT PER, / DEFLECTION LANE 1 1,04 0,97 0.88 LANE 2 1,02 1.01 0.94 LANE 3 1,01 0.99 0.99 BEAM ROTATION PERCENTAGES LANE 1 *17,45 *35,98 -29,12 LANE 2 5,45 *20,05 +48,76 LANE 3 24,02 25,98 -25,98 COMPUTED MOMENT PERCENTAGES LANE 1 44,08 28,83 17,40 LANE 3 22,61 27,39 27,39 MOMENT OF INERTIA 10= 2,10 LANE 1 2,98 2,59 2,58 LANE 2 2,69 2,75 2,73 LANE 3 2,73 2,71 2,71 COEFFICIENTS OF MOMENT OF INERTIA	
LANE 2 30,98 30,78 22,78 LANE 3 22,55 27,45 27,45 RATIO OF MOMENT PER, / DEFLECTION LANE 1 1,04 0,97 0,88 LANE 2 1,02 1,01 0,94 LANE 3 1,01 0,99 0,99 BEAM ROTATION PERCENTAGES LANE 1 "17,45 =35,98 -29,12 LANE 3 24,02 25,98 -25,98 COMPUTED MOMENT PERCENTAGES LANE 1 44,08 28,83 17,40 LANE 3 22,61 27,39 27,39 MOMENT OF INERTIA 10= 2,10 LANE 1 2,98 2,59 2,58 LANE 3 2,73 2,71 2,71 COEFFICIENTS OF MOMENT OF INERTIA	9.68
LANE 3 22,55 27,45 27,45 RATIO OF MOMENT PER, / DEFLECTION LANE 1 1,04 0,97 0,88 LANE 2 1,02 1,01 0,94 LANE 3 1,01 0,99 0,99 BEAM ROTATION PERCENTAGES LANE 1 "17,45 "35,98 -29,12 LANE 2 5,45 "20,05 "48,76 LANE 3 24,02 25,98 -25,98 COMPUTED MOMENT PERCENTAGES LANE 1 44,08 28,83 17,40 LANE 3 22,61 27,39 27,39 MOMENT OF INERTIA 10= 2,10 LANE 1 2,98 2,59 2,58 LANE 1 2,98 2,59 2,58 LANE 1 2,98 2,59 2,58 LANE 1 2,98 2,59 2,58 LANE 1 2,98 2,59 2,73 LANE 3 2,73 2,71 2,71 COEFFICIENTS OF MOMENT OF INERTIA	15,46
RATIO OF MOMENT PER, / DEFLECTION         LANE       1       1,04       0,97       0.88         LANE       2       1,02       1,01       0.94         LANE       3       1,01       0.99       0.99         BEAM ROTATION PERCENTAGES         LANE       1       -17.45       -35.98       -29.12         LANE       2       5.45       -20.05       -48.76         LANE       3       24.02       25.98       -25.98         COMPUTED MOMENT PERCENTAGES       COMPUTED MOMENT PERCENTAGES         LANE       1       44.08       28.63       17.40         LANE       2       30.65       31.11       22.84         LANE       3       22.61       27.39       27.39         MOMENT OF INERTIA       10=       2.10         LANE       2.98       2.59       2.58         LANE       2.69       2.75       2.73         LANE       2.73       2.71       2.71         COEFFICIENTS OF MOMENT OF INERTIA       0.9       2.71	22,55
LANE 1 1,04 0,97 0,88 LANE 2 1,02 1,01 0,94 LANE 3 1,01 0,99 0,99 BEAM ROTATION PERCENTAGES LANE 1 -17,45 -35,98 -29,12 LANE 2 5,45 -20,05 -48,76 LANE 3 24,02 25,98 -25,98 COMPUTED MOMENT PERCENTAGES LANE 1 44,08 28,83 17,40 LANE 2 30,65 31,11 22,84 LANE 3 22,61 27,39 27,39 MOMENT OF INERTIA 10= 2,10 LANE 1 2,98 2,59 2,58 LANE 2 2,69 2,75 2,73 LANE 3 2,73 2,71 2,71 COEFFICIENTS OF MOMENT OF INERTIA	N PER,
LANE 2 1,02 1,01 0,94 LANE 3 1,01 0,99 0,99 BEAM ROTATION PERCENTAGES LANE 1 =17,45 =35,98 -29,12 LANE 2 5,45 =20,05 -48,76 LANE 3 24,02 25,98 -25,98 COMPUTED MOMENT PERCENTAGES LANE 1 44,08 28,83 17,40 LANE 2 30,65 31,11 22,84 LANE 3 22,61 27,39 27,39 MOMENT OF INERTIA ID= 2,10 LANE 1 2,98 2,59 2,58 LANE 2 2,69 2,75 2,73 LANE 3 2,73 2,71 2,71 COEFFICIENTS OF MOMENT OF INERTIA	1.14
LANE 3 1,01 0,99 0,99 BEAM ROTATION PERCENTAGES LANE 1 =17,45 =35,98 -29,12 LANE 2 5,45 =20,05 -48,76 LANE 3 24,02 25,98 -25,98 COMPUTED MOMENT PERCENTAGES LANE 1 44,08 28,83 17,40 LANE 2 30,65 31,11 22,84 LANE 3 22,61 27,39 27,39 MOMENT OF INERTIA 10= 2,10 LANE 1 2,98 2,59 2,58 LANE 2 2,69 2,75 2,73 LANE 3 2,73 2,71 2,71 COEFFICIENTS OF MOMENT OF INERTIA	1,03
BEAM ROTATION PERCENTAGES         LANE       1       =17,45       =35,98       -29,12         LANE       2       5,45       =20,05       =48,76         LANE       3       24,02       25,98       =25,98         COMPUTED       MOMENT       PERCENTAGES         LANE       1       44,08       28,83       17,40         LANE       2       30,65       31,11       22,84         LANE       3       22,61       27,39       27,39         MOMENT OF INERTIA       IO=       2,10         LANE       1       2,98       2,59       2,58         LANE       2       2,69       2,75       2,73         LANE       2       2,69       2,75       2,73         LANE       3       2,73       2,71       2,71         COEFFICIENTS OF MOMENT OF INERTIA       0       0       0	1,01
LANE 1 = 17,45 = 35,98 -29,12 LANE 2 5,45 = 20,05 = 48,76 LANE 3 24,02 25,98 = 25,98 COMPUTED MOMENT PERCENTAGES LANE 1 44,08 28,83 17,40 LANE 2 30,65 31,11 22,84 LANE 3 22,61 27,39 27,39 MOMENT OF INERTIA IO = 2,10 LANE 1 2,98 2,59 2,58 LANE 2 2,69 2,75 2,73 LANE 3 2,73 2,71 2,71 COEFFICIENTS OF MOMENT OF INERTIA	
LANE 2 5.45 =20.05 =48.76 LANE 3 24.02 25.98 =25.98 COMPUTED MOMENT PERCENTAGES LANE 1 44.08 28.83 17.40 LANE 2 30.65 31.11 22.84 LANE 3 22.61 27.39 27.39 MOMENT OF INERTIA ID= 2.10 LANE 1 2.98 2.59 2.58 LANE 2 2.69 2.75 2.73 LANE 3 2.73 2.71 2.71 COEFFICIENTS OF MOMENT OF INERTIA	•17,45
LANE 3 24.02 25.98 -25.98 COMPUTED MOMENT PERCENTAGES LANE 1 44.08 28.83 17.40 LANE 2 30.65 31.11 22.84 LANE 3 22.61 27.39 27.39 MOMENT OF INERTIA IO= 2.10 LANE 1 2.98 2.59 2.58 LANE 2 2.69 2.75 2.73 LANE 3 2.73 2.71 2.71 COEFFICIENTS OF MOMENT OF INERTIA	=25 <b>,7</b> 4
COMPUTED MOMENT PERCENTAGES         LANE 1       44.08       28.83       17.40         LANE 2       30.65       31.11       22.84         LANE 3       22.61       27.39       27.39         MOMENT OF INERTIA       IO=       2.10         LANE 1       2.98       2.59       2.58         LANE 2       2.69       2.75       2.73         LANE 3       2.73       2.71       2.71         COEFFICIENTS OF MOMENT OF INERTIA       COEFFICIENTS OF MOMENT OF INERTIA	•24,02
LANE 1 44,08 28,83 17.40 LANE 2 30,65 31,11 22.84 LANE 3 22,61 27.39 27.39 MOMENT OF INERTIA IO= 2,10 LANE 1 2,98 2,59 2.58 LANE 2 2,69 2.75 2.73 LANE 3 2,73 2,71 2.71 COEFFICIENTS OF MOMENT OF INERTIA	
LANE 2 30,65 31,11 22,84 LANE 3 22,61 27,39 27,39 MOMENT OF INERTIA IO= 2,10 LANE 1 2,98 2,59 2,58 LANE 2 2,69 2,75 2,73 LANE 3 2,73 2,71 2,71 COEFFICIENTS OF MOMENT OF INERTIA	9,68
LANE 3 22,61 27,39 27,39 MOMENT OF INERTIA IO= 2,10 LANE 1 2,98 2,59 2,58 LANE 2 2,69 2,75 2,73 LANE 3 2,73 2,71 2,71 COEFFICIENTS OF MOMENT OF INERTIA	15,40
MOMENT OF INERTIA       IO=       2,10         LANE       1       2,98       2,59       2,58         LANE       2       2,69       2,75       2,73         LANE       3       2,73       2,71       2,71         COEFFICIENTS OF MOMENT OF INERTIA	22,61
LANE 1 2,98 2,59 2,58 LANE 2 2,69 2.75 2,73 LANE 3 2,73 2,71 2,71 COEFFICIENTS OF MOMENT OF INERTIA	96 IN**3
LANE 2 2,69 2.75 2.73 LANE 3 2.73 2.71 2.71 COEFFICIENTS OF MOMENT OF INERTIA	2,77
LANE 3 2,73 2,71 2,71 COEFFICIENTS OF MOMENT OF INERTIA	2,71
COEFFICIENTS OF MOMENT OF INERTIA	2,73
n na na sana ang kana na	بر <sub>ما</sub> ر به این به این <sub>ک</sub> ی بر استان را ا
LANE 1	1,01
LANE 2 0,99 1.01 1.00	1,00
LANE 3 1,00 1,00 1,00	1,00
je se	
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Table 5 Summary of Test Results (Model B3)

LO	AD P	OSITION	1 SEC	TION NUMBER 1		
annunganna innernistinna da starefotori peren fritori perit informationi perita		entre-montheline entresente a fisientemologi	BEAM 1	BEAM 2	BEAM 3	BEAM 4
and the new new the new off the set of the s	و جنب تحمر حمد		EXPERI	MENTAL MOMENT	PERCENTAGE	<b>S</b>
, erst 11=30 −000 ersz higt dune osna tan, egye ala zona jege IAN	F 1	a and the start press length sheet anyone	49.02	29 88		7.79
LAN	Ē 2		34.44	32 34	10.91	13.31
LAN	E 3	and a comparison of the second se	22,71	27,79	27,79	22,21
are out of the radiation ${\rm M}(t)$ the matrix ${\rm M}(t)$ and		n ana dari 1994 nak kawa dan nyy i	BEAM C	DEFLECTION PERC	ENTAGES	Aptimation of addition working the state of pro-
LAN	E 1	e more en part part and and	42,43	33.33	17.54	6.71
LAN	E 2		29,81	34.65	23.51	12.04
LAN	E 3		19,46	30,54	30,54	19,46
an an '' '' '' ''' ''''''''''''''''''''	-,, <sub>44</sub>	the second to the second second	RATIO	OF MOMENT PER.	/ DEFLE	CTION PER,
LAN	5 1	and the star of the second	1.16	0.90	0.76	1.16
LAN	E 2		1.16	0.93	0.85	1.11
LAN	ž 3	$\label{eq:product} p_{i} = 0  \text{adding} \left\{ p_{i} (p_{i}) (p$	1,17	0,91	0,91	1,14
man solar vala dari anan man man man man man	alar man nan ang	and the second	BEAM R	TATION PERCEN	TAGES	and the second
Line and the are not the transformed to the state of the	E 1	and who have been as a set of	·8,50	*39.38	=33.74	-18.41
LANI	E 2		25,64	-10,26	-38,80	-25,30
LAN	Ë 3	real scraw our designed and development in a scraw of the	28,48	21,52	-21, 52	>28,48
	wall while sine was	- and even and good terms have prove a	COMPUT	ED MOMENT PERC	ENTAGES	
the state and goal the and and the test and the state of	5 1	and and the good and have been a	47,93	29,05	15,65	7,36
LANI	= 2		33,74	31,09	21,95	13,22
LANI	: 3	KITALUKUH KITU LELI KARANAN (MENJERAKA ANA KARUKU)	21,60	28,40	28,40	21,60
en and an and an are an are an are		and a second	MOMENT	OF INERTIA	10=	2,106 IN**3
	: 1	inter part about facts and acts attail at	3.81	2.94	3.04	3.71
LAN	: 2		3,77	2,99	3.11	3.66
LANI	<u> </u>		3,67	3,08	3,08	3,67
	en erd bei och	and and the state way for any	COEFFI	CIENTS OF MOME	NT OF INER	TIA
LANI	E 1.	Bernstein auf der Bernstein	1,13	0,87	0,89	1.10
LANI	; 2		1,11	0,88	0,92	1,08
LANI	: 3		1,09	0,91	0,91	1,09
and annual free wars guilt from which they says a set		alan dari neger berte alam seri dari da				

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LANE 1 1,15 0,90 0,80 1,01 LANE 1 44,52 7,40 16,18 1,10 LANE 1 1,17 0,90 0,80 1,01 LANE 2 1,16 0,88 0,88 1,16 BEAM ROTATION PERCENTAGES LANE 1 44,52 -32,10 -36,29 -17,10 LANE 3 17,96 32,04 -32,04 -417,96 COMPUTED MOMENT PERCENTAGES LANE 1 45,52 27,40 16,18 10,90 LANE 3 24,94 25,06 25,06 24,94 MOMENT OF INERTIA 10= 2,106 IN+*3 LANE 1 3,85 2,99 2,93 3,76 LANE 1 3,85 2,99 2,93 3,76 LANE 3 3,80 2,67 2,67 3,80 COEFFICIENTS OF MOMENT OF INERTIA	19 Teorettel	LANE LANE LANE	2. 5. 1	1,14 1,12 1,14	0,88 0,85 0,86	0 • 86 0 • 90 0 • 86	1,11 1,12 1,14
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ere ang en an an an ar	LANE	1 ,	19,53	35,28	-28,50	-16,6
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	• • • • • • • • •		COMPUTED MO	MENT PERCEN	ITAGES	
	LANE	L	41,00	31,14	18,11	9.7
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	LANE	1	1,19	0,87	0,76	1,11
and general contraction of the	LANE	3	1,10	0,89	0,89	1,17
an anna 17 de de ann an an an an an an			BEAM ROT	ATION PERCEN	TAGES	
· · · · · · · · · · · · · · · · · · ·	LANE	1	-11,95	<b>36</b> ,55	-31.18	-20,32
		2	23,31	=7,52 20.87	-37,07	-32,10
	800 <b>/ 1 / 1 600</b>	••••	COMPLITE	MOMENT PERCE	ENTAGES	. ⊷س و هطب ⊂
1966 - J. Harrison (1975) - Lan	·····	<b>.</b>				
		1	4/,48	25,56	16,37	10,58
	LANE	3	24,02	25,98	25,98	24,02
		-, m <sub>a</sub>	MOMENT C	)F INERTIA	i () =	1,123 IN**3
	المراجع المراجع المراجع المراجع	<u> </u>	4,65	3,16	3,43	4,54
e maa aa ee maa ahaa ka ka dhaa	LANE	1344		0004	···· A .	4 65
n maa aa ahaa maa ahaa ahaa dhaa ahaa ahaa baya yaa ka muuruya shahayayadaan	LANE	We complete the second se	4,61	3,16	3,44	
	LANE LANE LANE	3	4,61 4,55	3,16 3,39	3 + 4 4 3 + 3 9	4,55
<ul> <li>In the second sec</li></ul>	LANE LANE LANE	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	4,61 4,55 COEFFICI	3,16 3,39 Ents of Momen	3,44 3,39 NT OF INERT	4,55
<ul> <li></li></ul>	LANE LANE LANE	2 2 3 4 4 4 4 4 4 4 4 4 4 4 4 4	4,61 4,55 COEFFICI	3,16 3,39 ENTS OF MOMEI 0,80	3,44 3,39 NT OF INERT 0,87	4,55 IA 1,15

	· · · · · · · · ·		BRIL	GE MODEL N	UMBER B (	3		• • •
lay and an over not any second a	LOAD	POSITION	int our our popular :	SECTION NU	MBER 1			men Antonio (k. 1914), provident
annandele feler fan Frislânsker frei ferste frislânse felferer of felferer of felferer of felferer of felferer	utilalaa oo lahii oo lahiilayi (tiibheer naliyoo oo li	we call the solution of the second transmission of the second se	BEAM	1 BE	AM 5	ØEA	M 3	BEAM
n mana pana ang mga ng ang ang ang ang ang ang ang ang an		$m_{\rm H}$ , and the spectrum spectrum with the	EXF	PERIMENTAL	MOMENT PER	RCENT	AGES	lana ber tanı dağı tanı tara
	LANE	• •	46,77	25	, 92. · · · · · · · · · · · · · · · · · · ·	14,	80	12,51
	LANE	3	35,04	27	,55 ,82	19,	82	18,30
			RE/	M DEFLECTI	ON PERCEN	AGES		· · · · · · · · · · · ·
	1 A NUT		30 00		ст. <b>4</b>	0.8	na managan yan manangin na basa basa basa Manangin	44.44
	LANE	1 2	29.67	s 30 7 30	, 23 , 79	20	66	11,18
	LANE	3	22,12	27	,88	27,	88	22,12
and New The CHI Const Cont Co			RAI	IO OF MOME	NT PER. /	DE	FLECTION	PER,
the same set over 11 and an a	LANE	1	1,23	0	,85	0,	73	1,12
	LANE LANE	2 3	1,18	8 0 8 0	,89 ,85	0 , 0 ,	8 <u>1</u> 85	1,19
			0 E A	M ROTATION	PERCENTA	SES		
<ul> <li>An the set for an of the</li> </ul>	LANE	1.	-16,38	- 31	,99	-28	16	-23,20
and Phone Market Science (1997) Address (1997) Market Science (1997)		2	10,93	s =13 s = 25	,58 ,27	~41, ~25.	80	-33,69
The second s	n an	<del>с</del>	COM	PUTED MOME	NT PERCEN	AGES	5	· · · · · · · · · · · ·
an and the way out to be to be	A KIE	4	AA 06	24	67	4 9	30	12 04
	LANE	5	35.02	25	,67	50.	96	18.35
	LANE	ala an	26,43	23	,57	23,	57	26,43
alor half office only lower half many parts of	Re red in the same time	$\label{eq:product} T_{\rm eq} = 100^{-1} - 1$	MOM	IENT OF INE	RTJA	j C	= 1,12	3 [N**]
tan can mar wije die die die sega w	LANE		4,64	3	,18	3,	38	4,50
	LANE	ar seguna ser trismumerromo and a	4,60	) 3	,25	3,	45 52	9,5(
to all we are all our		wa wa wa see any bits and the	101	FETCIENTS	NE MOMENT	OF 1	NERTIA	.,0.
ente este sue testendo manufacio	n ten fill mit em eine mit mit	and the state and the state and	a may a	na na ku ku na na ku ku ku ku na ku				
•		1 9	1,18	3 Q	,81 82	0,	86	1,10
an a	LANE	a ling a manufat in an	1,17	Ő	,83	0 :	83	1,1
, e cha cell call net der bler star st	ng that and and and and and an		andia pranta da tana tangka a	in nga nga nga nga nga nga nga nga nga nga			· · · · · · · · · · · · · · · · · · ·	
$1.5$ $\times$ . The solution was solve while while while while while $2.00$	en anne sens geer (eer tod) herr gega taas	ngiết with "Spip III activ thing which noise noise	د (معد الحور وطب وسع معد) .	<b>الحد الحد (1</b> 2) من الحد (12) من الح		· ' · · · · · · · · · · ·		na shekara a sa
$= - \alpha_{1} \alpha_{1} \alpha_{2} \alpha_{3} \alpha_{4} \alpha_{5} $	alingundad figer ladded ei allan ei d	le nome de mais en ministre contra de la ministre de la secon	1-1-1				e ser <b>X</b> exa els gradas en els	

	•		RUII	NGE MODEI	- NUMBEI	Я В 9 ;•				
	LOAD	POSITION	1	SECTION	NUMBER	1			ing of the	
99 - 199 - 199 - 199 - 199 - 199 - 199 - 199 - 199 - 199 - 199 - 199 - 199 - 199 - 199 - 199 - 199 - 199 - 199	9 2019 - 9 2019 - 9 2019 - 201	III ) CULTURE - CULTURE	BEAM	1	BEAM 2	<b>B</b> I	AM 3		BEI	۱M.
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neer over over were one offer over whee	LANE	and our for it's time two line with with with	48,15	5	32,10	1.3	5 . 44		6,	31
an 1977 - Tanin Marine Marine and Antonio Antonio Antonio Antonio Antonio Antonio Antonio Antonio Antonio Anton	LANE	2 ····································	31,19	erenden betreventinkoningenter in oorder	36,55	21	. , 89		10,	37
	LANE	3	18,14		31,80	31	156		10,	14
ann waa too noo noo noo ah ann ann ann ann ann ann ann ann ann		' . ~ ''') web (∞ ())	BEI	AM DEFLE	TION P	ERCENTAGE	S			
$\label{eq:constraint} J$ where $P$ and $P$ and $P$ and $P$ and $P$	LANE	1	46,72	2	32,97	1 militaria da las estas de 19 19	,84		4,	46
a star (1) - a staff - a new paper of the second states of the second st	LANE	2	32,02	2	34,31	23	1,12		10,	55
	LANE	3	19,49	<b>y</b>	30,51	30	1.21		19,	49
n na sa na	48 995 min − 11 1999 311		RAT	TTO OF MO	DMENT PE	ER, / 0	EFLE	CTION	PER	en lande. Fort
n ann 19. com con Ran aide poil s	LANE	1	1,03	3	0,97	C	.85		1,	41
nar is parte and inchestic sympositic process piec	LANE	2	0,97	7	1,07	6	,95		0,	98
	LANE	3	0,93	3	1,04	1	<b>,04</b>		Ο,	93
2000 - Ann - 1989, 2006 - Ann - Ann - 2007 - 2007 - 2007	n and silve apply been deal data and i from		BEA	AM ROTAT	ION PER	CENTAGES				
a area sear and and an er see are	LANE		<b>*18,5</b> 5	ō ,	35,78	-26	,24		-17,	43
	LANE	2	16,85	5	12,40	-43	,18		-27,	58
	LANE	. د	24,19	1	25,21	- 65	• • • 1		≈24ı	19
in and more allowed HBBA follows and provide and a set of the second secon	na Perge relationaria dalla suora della dalla dalla Anna dalla dalla Anna dalla	and for out many out of the second	CON	PUTED MO	MENT PE	ERCENTAGE	S			
a baa haa ahaa ahaa ahaa ahaa ahaa ahaa	LANE	the first and the set form and the	47,94	na ann an sao an an	33,26	13	.92		4,	88
	LANE	2	30,51	angertas compositiva feore e como e a	35,71	23	. 50		10,	18
	LANE	3	18,29	9	31,71	31	*/1		18,	29
- eren alder oder over open maar w	en senn den ninn sjist den som mer	ang man nga gap man pan spa da kan	MON	IENT OF	NERTIA	Ĩ	0 =	2,057	1 V *	* * 3
	LANE	the other and and other and the	2,83	5	2,78	2	,43		3,	02
	LANE	2	2,72	Janes al antes e transmissione	2,97	2	,92		2,	75
	LANE	3	2,70	)	2,99	2	,99		2,	70
		and the owner data time and show	COE	FFICIEN	S OF MO	DMENT OF	INER	TIA		
	LANE	and and and and and and any and	1,02	2	1,01		.88		1,	09
	LANE		0,96	Renfilment of all the states of the second states o	1,05		,03	ana	0,	97
		•	U , 75	•	1,02		.05		Υ,	93
and the state and the state and	an anna muise na suis ann an suis ann an suis anna	and real time the set of the set	nyeewinaado kalko onee meso p		187 - 1994 - 1994 - Arim, Serger - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994					

Îs un es qui a construir a actua	na na san kata mana ma	a sugaran su the historic sense see and	. من مع بعن مع مع مع شق شد منه .	an the state and and state state and the state of the state A state of the state o	and the second	
			BRIDGE MC	DEL NUMBER	810	144
Na kana asa na na kana sa salikati ata i	LOAD	POSITION	1 SECTI	ION NUMBER 1		and and the second s
$\hat{b}$ is the constraint of the transmission of transmission of the transmission of trans	,	kina a nikalini any ara kaomo na manda any any any aliani aliani	BEAM 1	BEAM 2	BEAM 3	BEAM 4
For the second second second second second	nne Marin State ander ogen voorde boert door	 In the second	EXPERIME	NTAL MOMENT	PERCENTAGES	n ook soon noon wate sins oom in in ook in indige soon.
The same spine and they have some when we are and	LANE	an min outs with row the star way the shore	46,25	31,10	14,93	7,72
d An early a state of the state of a surger by a surgery	LANE	2	33,06	32,43	20,22	14,28
	LANE	3	22,03	27,97	27,97	55,03
til, it in at in an or por por pi			BEAM DEF	LECTION PERC	ENTAGES	· · · · ·
	LANE	 1	44.64	31,99	17.18	6.18
· · ·	LANE	S	32.61	31.48	22.04	13.87
None processing and processing and the second se	LANE	3	22,37	27,63	27.63	22,37
			RATIO OF	MOMENT PER,	/ DEFLECTI	ON PER,
1	LANE	1	1.04	0.97	0.87	1.25
	LANE	2	1.01	1.03	0.92	1.03
	LANE	3	0,98	1,01	1 0 1	0,98
Kanala ang pananana ang	**************************************		BEAM ROT	ATION PERCEN	TAGES	
$\tilde{f}_{1}$ , we associate the same set of the set of t	LANE	1	22.66	-30.12	-27.44	+19.78
	LANE	2	0,00	· · · 20, 22	-54,35	-25.43
an a	LANE	3	14,97	35,03	-35,03	-14,97
land and the second and the second	No transmission and the Anna South of the	· · · ·	COMPUTED	MOMENT PERC	ENTAGES	· · · · · · · · · · ·
9	LANE	1	45.38	32.22	15.85	6.56
	LANE	2	32.32	32,51	21.32	13.85
, with the matrix ${\bf r}_{\rm end} = {\bf r}_{\rm end} = {\bf r}_{\rm end}$ in the second state of the second state	LANE	n - Carlor Contraction - Statistical and a second sec	21,84	28,16	28,16	21,84
ν Υ΄ του τους , τ. το τημητικής τους που δουος το	s dist fille son end way ongo one		MOMENT	OF INERTIA	10= 2,	057 IN**3
First may provide the many rank rank rank and	LANE	e calle pada nota man arma arma dima cang karma.	2,84	2.8 <u>6</u>	2.57	2,96
	LANE	2	2,83	2,95	2.76	2.85
, $\label{eq:eq:constraint} ,$	LANE	americani antiporta presidente de la construcción de la construcción de la construcción de la construcción de l Construcción de la construcción de la constru	2,78	ан у 1 2 <b>у 2 1</b> 2 <b>у 2 1</b>	non and the second s	2,78
e e compressione any selle and one pour part National	s they draw only sub-a series made appa	. May wike of a sum over over two .	COEFFICI	ENTS OF MOME	NT OF INERTIA	
n an man bar bar yan ya ka ka ka ka ka	LANE	t man from the state of the source of the state	1,01	1,01	0,92	1,06
19 <sup>19</sup> Staning subsequences (Staning Staning stations and stations	LANE	2	0,99	1,04	0,97	1,00
,	LANE		0,98	1,02	. 1,02	0,98
if me any and an one or out and and by	, and only not the line of only	. Main relation work more from Your 2000 relation of the "from "	in - 21 12 wet wet blik her lich the Univ St	13 un dans deur 713 dies with och um hun died die ser	nden han han han an a	gan an a
$\beta_{\rm c}$ for adaption to the loss that the time and an	t proceeding and and one, and	will ear and and dark they was been been been	with party which that make the same targe filled all	na ann ann ann ann ann ann ann ann ann		e mate hat some some som en er en som av er som er e

Summary of Test Results (Model B11) Table 13 811 BRIDGE MODEL NUMBER LOAD POSITION 1 SECTION NUMBER 1 BEAM 1 BEAM 2 BEAM 3 BEAM 4 EXPERIMENTAL MOMENT PERCENTAGES 52,81 30,37 LANE 12,18 4,64 1 34,58 10,75 2 34,09 20,58 LANE LANE 3 19,72 30,28 30,28 19,72 BEAM DEFLECTION PERCENTAGES 45,12 33,61 16,18 5.09 LANE 1 35,33 2 30,00 24,26 LANE 10,41 18,22 31.78 LANE 3 31,78 18.22 RATIO OF MOMENT PER. / DEFLECTION PER, 0,90 0,75 LANE 1 1,17 0,91 1,14 0,98 LANE 2 0,85 1,03 3 1,08 0,95 LANE 0.95 1,08 REAM ROTATION PERCENTAGES =10,50 .37,27 -19.03 LANE 1 =33,20 24,96 -26,38 LANE 2 •7,62 -41,04 LANE 3 26,13 23,87 -23,87 -26,13 COMPUTED MOMENT PERCENTAGES 52,61 LANE 27,83 5.81 1 13,75 34,32 LANE 2 31,69 22,48 11,51 LANE 3 20.39 29,61 20,39 29,61 MOMENT OF INERTIA 2.057 1N\*#3 10= 4,05 2,95 3,96 LANE 1 2,87 3,98 LANE 2 3,12 3.22 3,85 LANE 3 3,88 3,23 3,88 3,23 CDEFFICIENTS OF MOMENT OF INERTIA LANE 0.83 0,85 1 1,17 1,15 LANE 2 1,12 0,88 0,91 1.09 LANE 1,09 0,91 3 0.91 1,09 -58-

1977 Jun 2 Part, Come II 1922 of Byrdonia		Table 14	Summary of	Test Results	(Model B12)	
, Sala las dala dala d'al mar	enne neme acce acce nece évoir acce nace	a and ware draw and 1000 and 1000 and	BRIDGE MO	DEL NUMBER I	B12	and the set of the set of the set of the set of the
a i na shine ka a ana	LOAD	POSITION	1 SECTI	ON NUMBER 1	the state and the second second second second second second	
	en: tall-alling-activity-alling-powers and powersed	a (non mellon das provinsi kon das provinsi	BEAM 1	BEAM 2	BEAM 3	BEAM 4
pan	ganga ngang mengi pena ment teruk ang p	a fore case were now used role wave field for	EXPERIME	NTAL MOMENT I	PERCENTAGES	
an a	LANE	a pag and one may well and could and the	50,80	28,76	13,18	7,26
	LANE	2	36,70	30,43	1.8.1.8. 1.8	14,69
	LANE	3	24,32	25,68	25,68	24:32
	aan Mali da laa laa keessaa ka	a anay inter may only the tool only only but boy	BEAM DEF	LECTION PERCI	ENTAGES	Anna ann ann an a a a lan a dù bar ann an dù
	LANE	o and word over the first seek even over the	43,45	32,40	17,01	7.14
	LANE	2	31,59	32,67	22.03	13,72
	LANE	3	21,48	28,52	28,52	21,48
ang ang ang ang ang ang as .		a ana aon gan ann emr an an an an	RATIO OF	MOMENT PER,	/ DEFLECTI	ON PER,
	LANE	n verse your your wave some work verse verse	1,17	0.89	0,77	1,02
	LANE	2	1,16	0,93	0,83	1,07
1	LANE	3:	1,13	0,90	0 : 90	1,13
nar an ann far far shir i	till i like word geen geen week ge	n nan waa waa kan ana kan istis ini ku	BEAM ROT	ATION PERCEN	TAGES	in statistical and the second se
the and the set are set i	LANE	A light page and the wet over over ever over	-18.02	·32.98 ·	-29.37	-19.63
	LANE	2	8,90	-14,08	-57,76	-19,25
	LANE	3.	17,84	32,16	-32,16	=17,84
	sir issa ann susa sant ytän dage Guij An	n diget kanne didet littig tikall omet ockom port prod	COMPUTED	MOMENT PERCI	ENTAGES	
the law Till had you with a	LANE	• • • • • • • • • • • • • • • • • • •	50,67	27.25	13.76	8.31
	LANE	2	36,07	29,28	19,28	15,36
ny ny fahita dia kaominina dia mandritra amin'ny fahitana	LANE	3	24,24	25,76	25.76	24,24
			MOMENT O	FINERTIA	10= 2,	057 1N**3
	LANE		4,01	2.89	2.78	4.00
	LANE	2	3,99	3,13	3,06	3,91
	LANE	3 3	3,92	3,14	3,14	3,92
	n - new our, and this day had not wa	9797 - 004 - 0046 - 4141 - 9468 - 42717 - 724 - 646	COEFFICI	ENTS OF MOME	NT OF INERTIA	
an an an an an an an a	LANE	- Out finded and some many string booth shirt man	1.17	0.85	A . 84	1.1-
	LANE	2	1.13	0.89	0.87	1.1.
$\cdots \rightarrow \cdots , or an even being (0.001) and (0.$	LANE		The function of a second secon	0,89	0.89	1,11
	المراجع	terrer wards when the state over some some some	a shife and stars with some shift with the set of the set of	•		
en en sem ben en man b	and similar districtions and the	e benefit detter dette dimet dimet ander aller ander	e and such the conclust one per perious and	2007 Stat Adi mari ani ani kati ti ta sa sa sa s		
		and said a de said		-59-		N

an gener o wee all a state of second second	a sa ang ang ang ang ang ang ang ang ang an	Table 19	5 Summary o:	f Test Results	(Model B13)	
an gan gan ta ta ta gina na na sa	nat one tet na <sup>rt</sup> ena das como país c	an a	BRIDGE MI	DDEL NUMBER B	11.3	
	LOAD	POSITIC	IN 1 SECT	ION NUMBER 1		
a a sa anangina na mangina na sa	Bey awai malifit figibalikina ara gabrenda haka	HINNENITI E PUELON NY VERY IENNE ANTIPANINA IMPERIMENT	BEAM 1	BEAM 2	BEAM 3	BEAM 4
	and an and an and an	n i na ma jula ma jun ana d	EXPERIM	INTAL MOMENT P	ERCENTAGE	
en a de la companya de la del della del	LANE		49,16	28,46	13,80	8,58
er men er er er bestregten sovermanstmenden.	LANE		34,58	31, 15	19,38	14,89
	LANE	3	20 g 94	20,00	20,46	20,94
			BEAM DE	LECTION PERCE	NTAGES	
<ul> <li>Also also and accession may make</li> </ul>	LANE	1	42,85	32,10	17,87	7,19
e e e e e e e e e e e e e e e e e e e	LANE	2	29,97	32,77	22,75	14,51
	LANE	3	20,90	29,10	29,10	20,90
A way from our care we are not			RATIO OF	MOMENT PER,	1 DEFLEC	TION PER.
a state of the state way for the state of	LANE	1	1.15	0.89	0.77	1.10
	LANE	2	1,15	0,95	0,85	1,03
· ·	LANE	3	1,15	0,90	0,90	1,15
Bar are not the yes, but not a	NAA adam waxee weege week linnina. a.ia		BEAM ROI	ATION PERCENT	AGES	
b 0009 Note way give page and ways a	IANE			- 37 05	- 34 75	45 74
	LANE	2	19.08	*15.35	-44.96	~20.61
ninininin yang mang mang mang mang mang mang mang m	LANE	3	17,14	32,86	-32,86	017,14
	nant bada dada. Mara alam mener anan mener ana		COMPUTEI	MOMENT PERCE	VTAGES	
t was not and that was tone of		ry file dan ers gin ger ber som er	- AG & 7	26 70	15 00	7 67
	LANE	5	34.36	28.75	20.97	15.92
personal and a support of the second s	LANE		24,10	25,90	25,90	24,10
	nne son son anna son anna sean acas ac	an and Dell year area for a dire in the - i	MOMENT	OF INERTIA	10=	2,100 IN**3
and all the last more and a		na nanga anan anan singa anan sanas nana a	a 1928 they are the first first from the time of a			
	LANE	<b>1</b> <b>2</b>	3 43	2,20	20/9	3 28
t Rayweddan ond a'r arllen gryfery, ewn aldell	LANE	3	3,38	2,61	2,61	3,38
ena era era mor alla Ella han el	ann anna daog prìos anna 1986 ANN ANN ANN	na nana nazz nazd kajal kajal kajal kajal kajal	COFFEC	ENTS OF MOMEN	T OF INERI	
	~ mal =0, =0 ↓ IIIs yes viz wire cu	a waa ahaa ahaa ahaa ahaa ahaa ahaa aha	na se	Kanadari (san ang ang ang ang ang ang ang ang ang a		en na sena en la seconda de la seconda de La seconda de la seconda de La seconda de la seconda de
л. С. С. С	LANE	1	1,17	0,84	0,91	1,07
adalah ang sa Panganan ang sa	LANE		1,13		0171	1,09
and prove states basis with the	то сток одо 5256 жил 2019. тер ок.2 -100	*	e alement a		Hand Hand Hand Hand Hand Hand Hand Hand	na n
find the to $1-\delta$ the key $M^{2}R$ $M$		ین میشد ساید برای دران برای برای این این این این این این این این این ا	. Hende beins john hims lande wird www. eens derd bieds word i	zer maa waa ada waa maa ugur tata tata ada ada ada ada ada ada ada		
•		-		-60-	· •	

	Remains and Along street is a paint of	Tab <b>le 1</b> 6	Summary of	Test Results	(Model B14)	an a
anna mar gan ma gan mah an ada da sa ak	e enere alle dans mare overge overge	n 2 martin group and and and and and and	BRIDGE MO	DEL NUMBER E	<b>314</b>	
and may the other star can be seen again white the	LOAD	POSITION	1 SECTI	ON NUMBER 1		<ul> <li>Path and the start and the star</li></ul>
a 19 Mal Alwani Mali Magan Jamili Tangke anu ata'u ang munung anu ng malan tanin.			BEAM 1	BEAM 2	BEAM 3	BEAM 4
مالية (مَعْلَمُ طَالَةً) (1/2 1/2) مَالَة عَالَةًا مَالَةًا مَالَةًا مَالَةًا مَالًا مَالًا مَالًا م	e man web wate som aller slave	anya upa mene mene anya ngin mela (1999) 1999.	EXPERIME	NTAL MOMENT P	PERCENTAGES	
	LANE	1	47,35	27,97	14,65	1.0,03
	LANE	2	35,59	28,89	19,38	18,14
i na amin'ny faritr'i Alamai Samai Yana Manadol Alaminana ila amin'ny faritr'i Alamai N	LANE	3	24,52	25,48	25,48	24,52
دهم اومه الاسل معل محل محل معلوم معلوم العالي . الم	and the star the Asso share	and and also also and and also also also also also also also also	BEAM DEF	LECTION PERCE	ENTAGES	
$(1,2,\cdots, n) = (2,2,1,\cdots, n)$ with this with $(1,2,\cdots, 1,2,\cdots, n)$			40 84	31 11	18.80	
	LANE	2	30,87	30.78	23.20	15.15
$\label{eq:constraint} \ensuremath{S}(w) (w) (w) (w) (w) (w) (w) (w) (w) (w) $	LANE	3	22,05	27,95	27,95	22,05
ande stelle fande solde filselik filselike sjolet filse oan ee			RATIO OF	MOMENT PER,	/ DEFLECT	ION PER.
an wave but you will be out one was in the	a sterio	A.L. 1994. 1	A A 2	0 0 0	<b>A 7</b>	
	LANE	1	1,10	0,90	0,18	1,09
en en fisteren in en	LANE		1,15	0,94	0,54	1,20
	LANC	3	1,11	U, 91	0,91	4,11
ann aigen aithe dhe litht can aine ann ann ann ann			BEAM ROT	ATION PERCENT	AGES	
with order which note that with a set of the set of $\frac{1}{2}$ , we have $\frac{1}{2}$	LANE	1,	16,53	-30,11	-32,24	-21,11
	LANE	2	4,97	-11,18	-56,83	<u>-27,02</u>
	LANE	3	18,93	31,07	-31,07	≈18,93
the sub-level has well this had any ne	e lande som målt ogsår som for e		COMPUTED	MOMENT PERCE	ENTAGES	
na nan wa, wa nan wa kuta ilala dila ilali. Ilali	LANE	ten de las ser est est est est.	46.35	26,67	17.28	9,70
	LANE	2	34.49	27.95	21.34	16,22
n 111 - Print II. Anthony and a land and a second contract-positioned	LANE		.24,32	25,68	25,58	24,32
		the belo that even must allow over the state	MOMENT O	FINERTIA	10= 2	,106 IN**3
. د. سب می سی می است .	IANE	andt john illige jähle Klass beitet sitten hete namm.	Δ	3 22	7.47	3 07
	LANE		4 18	3 40	3.44	<u>4.00</u>
16.16 w. 6.45 / 16.1 - 12 w.1 w.1 w.1 famos frigwind an gradient of the state of	LANE		4.08	3.40	3.40	4,08
					₩73 ₩4	, ji de c.
an an an in the second second second and a second		bind when did give non-	COEFFICI	ENTS OF MOMEN	NT OF INERTI	<b>A</b>
the state of the same way made 1990 Mar 444	LANE	new new other there and over the state of the	1,14	0,86	0,92	1,07
-	LANE	2	1,11	0,90	0,92	1,07
	LANE	3 c	1,09	0,91	0,91	1,09
,	NBM here your work 1267 days	ويعتهز مردية متلقة إصفية لمحتل المحتر المردي المردي	and with first over over the prime of the second second second	(b) (0); Was Asia Asian must part dome upper over sets area.		an tanan sa
ar in the second s	. End that some going even system	, we may not the life which for had	razne desk svezi proje iska ugljor vjeti sveše dilita ubive svih	а так ша аж аж ан так ша до ул так ша. 	······································	· · · · · · · · · · · · · · · · · · ·
<ul> <li></li></ul>		SINTER	oo waxaa			• • • • • • • • • • • • • • • • • • • •

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			RBINGE W	UDEL NUMBER I	812	
a na ana ana ana ana amin'ny kaodim-paositra.	LOAD	POSITION	1 SECT	ION NUMBER 1		
e na		- 1911 P.B. William Streams P.A. Handley Michael M. Bardara	BEAM 1	BEAM 2	BEAM 3	BEAM 4
المراجعة (مراجع وريم محموم وريم م مراجع مراجع مراج	cles in risk loss with each	nati mener anal kenin mener dalar halar dalar	EXPERIM	ENTAL MOMENT	PERCENTAGES	the second second second second second
ala ala en ca an co	LANE	and and load way ways load when also is	44,95	32,16	14,71	8,16
e-main et al e - e - e - e - e - e - e - e - e -	LANE	2	29,67	34,98	23,26	12,10
	LANE	<b>3</b>	18,70	31,30	31,30	10,70
	teris and "den van inter-van-	and they folly to it does not that and it	BÉAM DE	FLECTION PERCI	ENTAGES	- new (mai, 1999) (Mile man, 1999) (Mile) (Mile) (Mile)
	LANE		43,57	32,31	17.37	5.74
	LANE	2	30,77	33,48	23,50	12,25
	LANE	3	19,97	30,03	30,03	19,97
and new light over over over poor new	ngap appy aper and a second		RATIO O	F MOMENT PER,	/ DEFLECTI	ON PER.
	LANE	4	1 03	1.00	0.85	1.21
	LANF	2	0,96	1.04	0.90	0.99
	LANE	3	0,94	1,04	1:04	0,94
			BEAM RO	TATION PERCEN	TÁGES	
	LANE	1	-15,71		-28,14	-18,76
	LANE	5	18,95	-10,54	-41:58	⇒28,83
	LANE	3	26,16	23,84	-23,84	-26,16
			COMPUTE	D MOMENT PERCI	ENTAGES	
	LANE	<u> </u>	44,60	31,71	16,13	7,55
an a	LANE	2	29,90	33,88	24,38	11,83
	LANE	3	19,22	30,78	30,78	19,22
		nag spile over det all spin vers line -	MOMENT	OF INERTIA	10= 2,	057 IN**3
	LANE	1	2,77	2,66	2,51	3,03
	LANE	2	2,74	2,86	2,93	2,73
	LANE	<b>3</b> 	2,72	2,90	2,90	2,72
the over one and had by optimized		nd pol one and and one bod not a	COEFFIC	IENTS OF MOMEI	NT OF INERTIA	
and the second of the second second	LANE	1	1,01	0,97	0,92	1,11
an a	LANE	2	0,97	1,02	1,04	0,97
	LANE	3	U,97	1,03	1 • V 3	U,97
			a an			ng ng pang banang pangang ang pang pang pang ang pang pang pang pang pang pang pang p

<b>D</b>	anno an	New of the second s	n - Half en 1999 en 1997 en 19 Transforment de la companya de la comp	ing and provide a set of the set		en e	and an	an ar fan in a anne maaroonnerste standaker gad getregt fan gebregt fan stad
			BRIDGE	MODEL NUMBER	816			1. The set of the latter and the set of t
D	LOAD POS	ITION 1 SEC	TION NUMBER 1		n na shan na a T		a an	er til er men skal men som var som en statiske som en skal som en so I som en som e
	nitera de 1969 (Altidore II) (portative a una esperatura de portantesse	BEAN 1	BEAN 2	неля з	PEAN 5.	BEAM 5	BEAN 6	BEAM 7
	to for some til the second provide second to be set of the	a na kina ma na	EXPER	IMENTAL MOMENT	PERCENTAGE		$\tau$ , in the second second $\lambda_{i}^{2}$ ,	n ser en son son give the any ser son and many how we have
D	LANE	25,85	21,59	16.37	12,69	8:83	7.57	- 19 fed het fel fed for Vel ste de zoe we en gezege oor je K 🖓 👔
) Antina selepetational	al New York and a second s	ana ana ana ang sana ang satu pang sa	18,27	17.24	15.07	11:94	10.31	9 4 9 m m m m m m m m m m m m m m m m m
D			7.4.1.63	72.01	10.02	12:01	14.03	12.65
			HEAM	DEFLECTION PER	CENTAGES		<ul> <li>The set of the set o</li></ul>	er men han start here eren start forst spin van eren start som her start som eren som eren som eren som eren s Te start som eren som
	LANE	23,50	19,84	17.31	13,43	10:85	8,28	
Sec. Harris and a second	Norman and Article Statistics	in the second	17,13	17.10	14,92	13:10	10.69	9,42
	し為保護してきた。	18.94	1.5.75	15.62	15,43	15;62	13.71	12,94
	e en la seconda de la companya de la seconda de la seco	y da tani na kati na kati na na na na na na na na na na Na na	RATIC	OF MOMENT PER		CTION PER.	n an	and an
<b>D</b>	LAVE	1,10	1.00000	0.96	6,94	Ü,81	0.91	1.02
in a state of the	ana ana ana ang ang ang ang ang ang ang	energia en la la la la company	1 . 0 7 minimum and a constraint of the second se	1.01	1.01	0.91	0.56	1.00
D	LAUR 3	U * 949	1.02	0+98	1,04	0.98	1,02	0.98
in the second	under na verse andre and en uit na multiple and en ser and en	ele al al dela de angene de ser en	6EAM	ROTATION PERCE	NTAGES	a da anti-		<ul> <li>The second se</li></ul>
D	LANE 1	-10,21	-16.77	-19,80	-1r.94	-12:80	-10.22	-7.25
1. The support same	AND A REAL PROPERTY AND A	ning in the second s		-15,14	-22,29	-22:17	-20,84	-12.41
D	L.X.912 - 3	1/.10	20,46	11,56	1.15	-11.86	*80.46	-17.10
	n an in the second s		CÚMPU	ITED MOMENT PER	CENTAGES	and the second	na da an	
<b>D</b>	LAILE 1	24,74	22.73	16.44	16.54	8161	(1)11111111111111111111111111111111111	7 23
The second second	1 ANS - 2	16,37	17,72	16.06	12,15	11,54	10.46	0.01
<b>a</b>	CANE 3	10,75	14,50	14.40	10,54	14,40	14.25	13,95
	and an an an an art of the second	no na manana ang kanang na sanang na sanang sa sa	NUNEN	I OF INERIIA	10=	0.501 10**3		an te conservation de la conservat
•	Tang 1	8,28	3.57	2.96	6.91	2:47	2.90	3,30
	and a CANE - A	santing partition of the states of the	, 21	3.06	3,13	2:73	3.04	3.26
	LANE S	9,50	3.1ª	2.52	3.08	2,82	3.18	3.50
	i Men (Mortan Regionale Altonomous) and and an and a second second second second second second second second s	ni in sin fan de stat de de ser en se geren en en Ne	CUFFF	ICIENTS OF MON	ENT OF ÍNÉR	TIA		- et alegier, can ber ver ber av en ar ar an alegier and ar and
<ul> <li>Bene series</li> </ul>	and the second sec	1,07	1.17	n - 97	0,95	0.81	0,95	1.09
	Statis I Ally P	1,04	1,64	0.44	1,02	0188	0.98	i.05
	LARE 3	1,04	1,04	p. +2	1,00	0,92	1.04	1,04

 Table 18
 Summary of Test Results (Model B16)

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Table 19 Distances (in inches) From the Top Fiber of the Beam to the Neutral Axis in the Beams

At Section 1, Bridge Model Al

Load	Bea	m 1	Beam 2			
on Lane	East Face	West Face	East Face	West Face		
1	0.1931	0.1134	0,4102	0.2095		
2	0.2680	0.3000	0.4384	0.3539		
3	0.1823	0.4517	0.3415	0.2842		
4	0.0613	0.4789	0.2765	0.4297		
5	0.3745	0.5841	0.4039	0.6517		

At Section 1, Bridge Model B1

Bea	m l	Beam 2			
East Face	West Face	East Face	West Face		
0,5279	0.3103	0.6395	0.2786		
0.5460	0.4231	0.5224	0.3547		
0.4670	0.5333	0.4210	0.4917		
0.3097	0.8347	0.1725	0.6353		
0.1348	0.8565	0.2854	0.8509		
	Bea East Face 0.5279 0.5460 0.4670 0.3097 0.1348	Beam 1East FaceWest Face0,52790.31030.54600.42310.46700.53330.30970.83470.13480.8565	Beam 1         Beam           East Face         West Face         East Face           0,5279         0.3103         0.6395           0.5460         0.4231         0.5224           0.4670         0.5333         0.4210           0.3097         0.8347         0.1725           0.1348         0.8565         0.2854		

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Table 20

Hypothetic Factors of Moment of Inertia (F.M.I.)

Beam	Slab		Hypothetic	F.M.I.	
Size (Prototype)	Thickness (in.)	P*	Exterior Beam Use	Interior Beam Use	$I_{0}^{**}(in^{4})$
÷.	6	0 30 60 100	2.99 3.38 3.74 4.18	2.39	
4 x 39	8	0 30 60 100	3.34 3.74 4.11 4.56	2.75	2.106
	10	0 30 60 100	3.70 4.12 4.50 4.97	3.11	
	6	0 30 60 100	3.4 <u>1</u> 4.01 4.57 5.23	2.61	
4 x 39	8	0 30 60 100	3.88 4.50 5.08 5.78	3.06	1.123
	10	0 30 60 100	4.38 5.03 5.64 6.38	3.52	
	6	0 30 60 100	3.12 3.52 3.89 4.33	2.51	
4 х 39 \	8	0 30 60 100	3.48 3.88 4.26 4.72	2.88	2.052
	10	0 30 60 100	3.85 4.26 4.65 5.13	3.24	

Note: \* P - Percentages of Effectiveness of Parapets \*\* I - Base Moment of Inertia of Box Beam

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	Тэ		nicon of Evr				
		are sr compa	of Moment	of Inertia at	Section 1	actors	
	(1) (2)		(3)	•	(4)	(5)	(6)
I	Brg. Beam	E: Lane 1 Ion	xperimental	F.M.I.	Avera	ge Hypoth.	∆* (%)
		Danc I. Dall	c ralle 3	pane 4 ba	ane o F.M.	L. F.M.I.	

	A-1	1 2	4.20 2.96	4.07 2.83	4.01 3.08	4.10 2.99	3.83 3.05	4.04 2.98	4.11 2.75	-1.71 +7.72
<b>-</b> 66 <b>-</b>	B-4	1 2	3.84 2.99	3.74 2.86	3.78 2.87	3.73 3.02	3.74 2.93	3.76 2.93	3.74 2.75	+0.54 +6.56
	B-13	1 2	3.50 2.53	3.41 2.62	3.36 2.61	3.26 2.75	3.20 2.71	3.35 2.64	3.38 2.39	-0.89 +10.05
	B-14	1 2	4.24 3.22	4.16 3.40	4.06 3.40	3.98 3.44	3.95 3.43	4.08 3.38	4.12 3.11	-0.97 +8.69
	B-8	1 2	4.61 3.18	4.57 3.25	4.57 3.26	4.47 3.45	4.53 3.38	4.55 3.30	4.50 3.06	+1.11 +7.84
	B-12	1 2	3.99 2.89	3.97 3.13	3.90 3.14	3.89 3.06	3.98 2.78	3.95 3.00	3.88 2.88	+1.80 +3.82

Note:  $* \Delta$  : Difference =  $\frac{(4) - (5)}{(5)} \times 100$ 

-
Beam	Slab		Suggested F	.M.I.
Size (Prototype)	Thickness (in.)	P*	Exterior Beam Use	Interior Beam Use
	6	0 50 100	2.99 3.59 4.18	2.57
4 X 39	8	0 50 100	3.34 3.95 4.56	2.96
	10	0 50 100	3.70 4.33 4.97	3.34
	6	0 50 100	3.41 4.32 5.23	2.80
4 X 39	8	0 50 100	3.88 4.83 5.78	3.29
	10	0 50 100	4.38 5.38 6.38	3.78
	6	0 50 100	3.12 3.73 4.33	2.70
4 × 39	8	0 50 100	3.48 4.10 4.72	3.10
	10	0 50 100	3.85 4.49 5.13	3.48

Table 22 Suggested Factors of Moment of Inertia (F.M.I.)

Note: \* P - Percentages of Effectiveness of Parapets

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(1)	.(2)	(3)	(4)	(5)	(6)	(7)	(8)
Test Bridge	Load on Lane	Beam No.	Experimental Moment Percentages	Deflection Percentages	Coeff. of Moment of Inertia	Estimated Moment Percentages	Difference (7) - (4)
		1	43.82	34.99	1.15	40.78	-3.04
	-	2	30.95	31.03	0.85	26.50	-4.45
	1.	3	15.02	22.02	0.85	18.80	+3.78
		4	10.21	11.95	1.15	13.93	+3.72
Powertok		l	33.00	28.47	1.15	33.69	+0.69
DELATCK	n	2	31.06	33.39	0.85	28.95	-2.11
Bridge	2	3	20.85	24.59	0.85	21.32	+0.47
(Prototype)	)	4	15.09	13.55	1.15	16.03	+0.94
		1	21.12	19.91	1.15	23.75	+2.63
	2	2	29.00	29.48	0.85	25.76	-2.76
	5	3	28.88	30.92	0.85	27.02	-1.86
		4	21.12	19.68	1.15	23,47	+2.35

Comparison of Experimental and Estimated Moment Percentages at Section 1, Northbound, Berwick Bridge Table 23

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## e 24 Comparison of Experimental and Estimated Moment Percentages at Section 1, Load on Position 1

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bridge Model No.	Load on Lane	Beam No.	Experimental Moment Percentages	Deflection Percentages	Coeff. of Moment of Inertia	Estimated Moment Percentages	Difference (7) - (4)
·.							
		1	44.57	36.20	1.15	41.81	-2.76
	7	2	27.02	29.62	0.85	25.06	-1.96
	Ŧ	3	15.43	20.59	0.85	17.43	+2.00
		4	12.98	13.59	1.15	15.69	+2.71
		l	33.32	29.03	1.15	33.89	+0.57
7 <b>7</b>	n	2	26.61	29.77	0.85	25.46	-1.15
A-1	2	3	20.33	23.86	0.85	20.41	+0.08
		4	19.74	17.34	1.15	20.25	+0.51
		1	25.50	22.74	1.15	26.62	+1.12
	ъ.	2	24.50	27.26	0.85	23.38	-1.12
•	2	3	24.50	27.26	0.85	23.38	-1.12
		4	25.50	22.74	1.15	26.62	+1.12

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(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bridge Model No.	Load on Lane	Beam No.	Experimental Moment Percentages	Deflection Percentages	Coeff. of Moment of Inertia	Estimated Moment Percentages	Difference (7) - (4)
	1	1 2 3 4	47.01 28.10 14.97 9.92	40.18 31.14 18.82 9.86	1.12 0.88 0.88 1.12	44.96 27.43 16.58 11.03	-2.05 -0.67 +1.61 +1.11
B <b>-4</b>	2	1 2 3 4	35.13 29.30 19.31 16.26	30.48 31.70 22.98 14.83	1.12 0.88 0.88 1.12	34.49 28.24 20.48 16.79	-0.64 -1.06 +1.17 +0.53
	3	1 2 3 4	24.82 25.18 25.18 24.82	21.46 28.54 28.54 21.46	1.12 0.88 0.88 1.12	24.43 25.57 25.57 24.43	-0.39 +0.39 +0.39 -0.39

# Table 25 Comparison of Experimental and Estimated Moment Percentages at Section 1, Load on Position 1

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(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bridge Model No.	Load on Lane	Beam No.	Experimental Moment Percentages	Deflection Percentages	Coeff. of Moment of Inertia	Estimated Moment Percentages	Difference (7) - (4)
		1	46.77	38.08	1.16	44.31	-2.46
	1	23	25.92 14 80	20.23	0.84 0.84	25.08	-0.24 +2 21
		_4	12.51	11.18	1.16	13.01	+0.50
		1	35.04	29.67	1.16	34.94	-0.10
B-8	2	2	27.55	30.79	0.84	26.22	-1.33
D-0	2	3	<b>1</b> 9.11	23.66	0.84	20.15	+1.04
		4	18.30	15.88	1.16	18.70	+0.40
		1	26.18	22.12	1.16	26.16	-0.02
	З	2	23.82	27.88	0.84	23.84	+0.02
	5	3	23.82	27.88	0.84	23.84	+0.02
н. На селото се		4	26.18	22.12	1.16	26.16	-0.02

Table 26	Comparison	of	Experime	enta	l and	Es	stimated	Moment	Percentages
	-	at	Section	1,	Load	on	Position	1 <b>1</b>	_

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Table 27	Comparison	of	Experime	enta	al and	Es	stimated	Moment	Percentages
		at	Section	1,	Load	on	Positior	1 <b>1</b>	-

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(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bridge Model No.	Load on Lane	Beam No.	Experimental Mome <sup>i</sup> nt Percentages	Deflection Percentages	Coeff. of Moment of Inertia	Estimated Moment Percentages	Difference (7) - (4)
		1	50.80	43.45	1.12	48.62	-2.18
	7	2	28.76	32.40	0.88	28.45	-0.31
	Ŧ	3	13.18	17.01	0.88	14.93	+1.75
		4	7.26	7.14	1.12	7.99	+0.64
		1	36.70	31.59	1.12	35.80	-0.90
n 10	2	2	30.43	32.67	0.88	29.06	-1.37
B-12	2	3	18.18	22.03	0.88	19.59	+1.41
		4	14.69	13.72	1.12	15.55	+0.86
		1	24.32	21.48	1.12	24.48	+0.16
		2	25.68	28.52	0.88	25.52	-0.16
	3	3	25.68	28.52	0.88	25.52	-0.16
		4	24.32	21.48	1.12	24.48	+0.16

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(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bridge Model No.	Load on Lane	Beam No.	Experimental Moment Percentages	Deflection Percentages	Coeff. of Moment of Inertia	Estimated Moment Percentages	Difference (7) - (4)
	l	1 2 3 4	49.16 28.46 13.80 8.58	42.85 32.10 17.87 7.19	1.13 0.87 0.87 1.13	48.49 27.86 15.51 8.14	-0.67 -0.60 +1.71 -0.44
B-13	2	1 2 3 4	34.58 31.15 19.38 14.89	29.97 32.77 22.75 14.51	1.13 0.87 0.87 1.13	34.42 28.87 20.05 16.66	-0.16 -2.28 +0.67 +1.77
	3	1 2 3 4	23.94 26.06 26.06 23.94	20.90 29.10 29.10 29.90	1.13 0.87 0.87 1.13	24.17 25.83 25.83 24.17	+0.23 -0.23 -0.23 +0.23

Table 28 Comparison of Experimental and Estimated Moment Percentages at Section 1, Load on Position 1

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(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bridge Model No.	Load on Lane	Beam No.	Experimental Moment Percentages	Deflection Percentages	Coeff. of Moment of Inertia	Estimated Moment Percentages	Difference (7) - (4)
	1	1 2 3	47.35 27.97 14.65	40.84 31.11 18.89	1.10 0.90 0.90	44.91 28.00 17.01	-2.44 +0.03 +2.36
		. 4	10.03	9.16	1.10	10.07	+0.04
B <b>-1</b> 4	2.	1 2 3 4	35.59 28.89 19.38 16.14	30.87 30.78 23.20 15.15	1.10 0.90 0.90 1.10	34.22 27.93 21.05 16.80	-1.37 -0.96 +1.67 +0.64
	3	1. 2 3 4	24.52 25.48 25.48 24.52	22.05 27.95 27.95 22.05	1.10 0.90 0.90 1.10	24.53 25.47 25.47 24.53	+0.01 -0.01 -0.01 +0.01

Table 29 Comparison of Experimental and Estimated Moment Percentages at Section 1, Load on Position 1

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Table	30	

30 Comparison of Experimental and Estimated Moment Percentages at Section 1, Load on Position 1

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bridge Model No.	Load on Lane	Beam No.	Experimental Moment Percentages	Deflection Percentages	Coeff. of Moment of Inertia	Estimated Moment Percentages	Difference (7) - (4)
		1	49.02	42.43	1.15	48.90	-0.12
	٦	2	29.88	33.33	0.85	28.40	-1.44
	7	3	13.33	17.54	0.85	14.96	1.63
		4	7.77	6.70	1.15	7.74	-0.03
		1	34.44	29.81	1.15	35.15	0.71
р Э	2	2	32.34	34.65	0.85	30.20	-2.14
c-a	2	3	19.91	23.51	0.85	20.45	0.54
		4	13.31	12.04	1.15	14.20	0.89
		1	22.21	19.46	<b>1.</b> 15	23.18	0.97
	2	2	27.79	30.34	0.85	26.82	-0.97
	5	3	27.79	30.54	0.85	26.82	-0.97
		4	22.21	19.46	1.15	23.18	0.97

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(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bridge Model No.	Load on Lane	Beam No.	Experimental Moment Percentages	Deflection Percentages	Coeff. of Moment of Inertia	Estimated Moment Percentages	Difference (7) - (4)
		1	47.90	<u>ЦП 19</u>	1 16	116 20	1 70
	1 2	2	27.60	31 85	<u>л яц</u>	26 50	-1.0
		3	14,29	18.78	0.84	15 56	1 27
		4	10.21	9.18	1.16	11.74	1.53
		1	34.86	29.59	1.16	35.15	0.29
B <b>-7</b>	2	2	29.35	32.94	0.84	28.25	-1.10
D-1	2	3	19.96	23.89	0.84	20.55	0.59
		4	15.82	13.57	1.16	16.05	0.23
		1	23.72	20.40	1.16	24.42	0.70
	3	2	26.28	29.60	0.84	25.58	-0.70
	5	3	26.28	29.60	0.84	25.58	-0.70
		4	23.72	20.40	1.16	24.42	0.70

Comparison of Experimental and Estimated Moment Percentages at Section 1, Load on Position 1

Table 31

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(1)	(2)	(3)	(4)	(5)	(6)
Bridge Model No.	Load on Lane	Beam No.	Experimental Moment Percentages	Estimated Moment Percentages	Difference (5) - (4)
	ı I	1 2 3 4	42.65 29.76 16.52 11.07	40.90 30.74 18.68 9.68	-1.75 0.98 2.16 -1.39
B-2	2	1 2 3 4	31.50 31.09 21.51 15.90	30.98 30.78 22.78 15.46	-0.52 -0.31 1.27 -0.44
	3	1 2 3 4	22.71 27.29 27.29 22.71	22.55 27.45 27.45 22.55	-0.16 0.16 0.16 -0.16

(1)	(2)	(3)	(4)	(5)	(6)
Bridge Model No.	Load on Lane	Beam No.	Experimental Moment Percentages	Estimated Moment Percentages	Difference (5) - (4)
	1	1 2 3 4	39.80 29.25 17.93 13.02	38.52 29.97 19.95 1 <b>1.</b> 56	-1.28 0.72 2.02 -1.46
B-6	2	1 2 3 4	30.75 29.93 21.95 17.37	30.29 29.58 23.42 16.71	-0.46 -0.35 1.47 -0.66
	3	1 2 3 4	23.01 26.99 26.99 23.01	22.89 27.11 27.11 22.89	-0.12 0.12 0.12 -0.12

(1)	(2)	(3)	(4)	(5)	(6)
Bridge Model No.	Load on Lane	Beam No.	Experimental Moment Percentages	Estimated Moment Percentages	Difference (5) - (4)
	1	1 2 3 4	44.80 32.45 15.11 7.64	44.78 30.42 16.87 7.93	-0.02 -2.03 1.76 0.29
B-1	2	1 2 3 4	30.20 34.81 22.32 12.67	30.92 32.99 22.87 13.22	0.72 -1.82 0.55 0.55
	3	1. 2 3 4	19.32 30.68 30.68 19.32	20.78 29.22 29.22 20.78	1.46 -1.46 -1.46 1.46

(1)	(2)	(3)	(4)	(5)	(6)
Bridge Model No.	Load on Lane	Beam No.	Experimental Moment Percentages	Estimated Moment Percentages	Difference (5) - (4)
	1	1 2 3 4	44,95 32.16 14.71 8.16	43.57 32.31 17.37 6.74	-1.38 0.15 2.66 -1.42
B <b>-1</b> 5	2	1 2 3 4	29.67 34.98 23.26 12.10	30.77 33.48 23.50 12.25	1.10 -1.50 0.24 0.15
	3	1 2 3 4	18.70 31.30 31.30 18.70	19.97 30.03 30.03 19.97	1.27 -1.27 -1.27 1.27

Table	36	Comparison of Experimental and Estimated
		Moment Percentages at Section 1,
		Load on Position 1

(1)	(2)	(3)	(4)	(5)	(6)
Bridge Model No.	Load on Lane	Beam No.	Experimental Moment Percentages	Estimated Moment Percentages	Difference (5) - (4)
	1	1 2 3 4 5 6 7	25.85 21.59 16.57 12.69 8.83 7.57 6.90	23.50 19.84 17.31 13.43 10.85 8.28 6.78	-2.35 -1.75 0.74 0.74 2.02 0.71 -0.12
B <b>-1</b> 6	2	1 2 3 4 5 6 7	17.73 18.27 17.24 15.07 11.94 10.31 9.45	17.64 17.13 17.10 14.92 13.10 10.69 9.42	-0.09 -1.14 -0.14 -0.15 1.16 0.38 -0.03
	3	1 2 3 4 5 6 7	12.65 14.03 15.31 16.02 15.31 14.03 12.65	12.94 13.73 15.62 15.43 15.62 13.73 12.94	0.29 -0.30 0.31 -0.59 0.31 -0.30 0.29

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9. <u>FIGURES</u>

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ι 83 Ι



Note:

θ

XX,YY - Horizontal and Vertical Centroidal Axes

UU, VV - Neutral Axes

Angle Between Axis UU
and Axis XX

Fig. 1b Beam-Slab Unit

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#### Fig. 2 Longitudinal View of a Bolted Model



Fig. 3 Basic Cross-Sections Tested

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Fig. 4 Strains in Exterior Beam, Model Al

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Fig. 5 Strains in Exterior Beam, Model B4

LOAD	ROTATION OF NEUTRAL AXIS (RADIANS)					
ON LANE	θι	θ2	θз	θ4		
I	0.0268	0.0669	0.0836	0.0698		
2	-0.0106	0.0282	0.0511	0.1392		
3	-0.0892	0.0124	-0.0124	0.0898		









LOAD	ROTATION OF NEUTRAL AXIS (RADIANS)					
ON LANE	θι	θ2	θз	θ4		
l	0.0725	0.1203	0.1885	0.2408		
2	0.0409	0.0559	0.1549	0.1750		
3	-0.0221	0.0236	0.0236	0.0221		







Fig. 7 Neutral Axes, Model Bl

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Fig. 8 Model Bl, Lane 1

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Fig. 9 Model Bl, Lane 2





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Fig. 11 Model B6, Lane 1

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Fig. 12 Model B6, Lane 2

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Fig. 13 Model B6, Lane 3

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Fig. 14 Model Bll, Lane 1

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Fig. 15 Model Bll, Lane 2

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Fig. 16 Model Bll, Lane 3

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Fig. 17 Model Al, Lane 1

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Fig. 18 Model Al, Lane 2

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Fig. 19 Model Al, Lane 3

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Fig. 24 Moments of Inertia, Model Al

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Fig. 25 Moments of Inertia, Model Bl2

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Fig. 26 F.M.I. Chart, 4 ft. x 39 in. Box Beam

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Fig. 28 F.M.I. Chart, 3 ft. x 42 in. Box Beam

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