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Aziz Saber, Ph.D., P.E., Joseph Toups, Leslie Guice, Ph.D., P.E., and Abdelkader Tayebi, Ph.D.

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Louisiana Tech University
Civil Engineering
600 W. Arizona Street
Ruston, LA 71272

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16. Abstract
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Note: Due to their size, all appendices are provided on the accompanying CD.

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Continuity Diaphragm, skew angle, continuous span, precast, prestressed, concrete, girders, bridges, experiment, load, tensile stress, compressive stress, load distribution, axial loads, truckloads, deflection, FEM Analysis, LRFD, AASHTO

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Continuity Diaphragm for Skewed Continuous Span Precast Prestressed Concrete Girder Bridges

by

Aziz Saber, Ph.D., P.E.

Joseph Toups

Leslie Guice, Ph.D., P.E.

Abdelkader Tayebi, Ph.D.

Louisiana Tech University

Civil Engineering

600 W. Arizona Street

Ruston, LA 71272

LTRC Project No. 01-1ST

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ABSTRACT

Continuity diaphragms used on skewed bents in prestressed girder bridges cause difficulties in detailing and construction. Details for bridges with large diaphragm skew angles (>30°) have not been a problem for LA DOTD. However, as the skew angle decreases[1] or when the girder spacing decreases, the connection and the construction become more difficult. Even the effectiveness of the diaphragms is questionable at these high skews. Thus, the need for continuity diaphragms for skewed continuous span precast prestressed concrete girder bridges is investigated. The bridge parameters considered in this study are based on results of a survey sent to other states' bridge engineers and design of experiment techniques. The parameters include girder type, bridge skew angle, girder spacing, span length, and diaphragm skew angle. The effects of continuity diaphragms on stresses and deflections from truck and lane loading on continuous skewed bridges are evaluated and results provide a fundamental understanding of the load transfer mechanism in diaphragms of skewed bridges. The effectiveness of continuity diaphragms for skewed continuous bridges is limited. The outcome of the research will reduce the construction and maintenance costs of bridges in the state of Louisiana and the nation.

[1] The skew angle of the diaphragm is the angle between the centerline of the diaphragm and the roadway centerline, shown as a in figure 4.

ACKNOWLEDGMENTS

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IMPLEMENTATION STATEMENT

This study dealt with the first and second parts of the objective: determining the need of continuity diaphragms and studying the load transfer mechanism through the diaphragm. However, the findings did not warrant addressing the third and fourth parts of the objective: determining when a full depth diaphragm is required and determining the minimum skew angle at which a diaphragm becomes ineffective.

The results may not be conclusive and implementable since the study encompassed only the theoretical aspect. Laboratory tests and field measurements will be initiated in the next fiscal year. If those results do not confirm the findings from this study, the third and fourth parts of the objective will then be addressed.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The majority of highway bridges are built as cast-in-place reinforced concrete slabs and prestressed concrete girders. Composite action between the slabs and girders is assured by the shear connectors on the top of the girders. The design guidelines for bridges in AASHTO section 8.12 indicate that diaphragms should be installed for T-girder spans and may be omitted where structural analysis shows adequate strength. Furthermore, the effects of diaphragms are not accounted for in the proportioning of the girders. Therefore, the use of diaphragms should be investigated.

Continuity diaphragms used in prestressed girder bridges on skewed bents cause difficulties in detailing and construction. Details for bridges with small skew angles (>30° from perpendicular) have not been a problem for LA DOTD. However, as the skew angle decreases or the girder spacing decreases, the connection and the construction become more difficult. Even the effectiveness of the diaphragms is questionable at these high skews. The study is divided into five different tasks. This report summarizes the activities of all tasks performed to accomplish the objectives of this research.

Description of Diaphragms

In the 1996 Standard Specifications for Highway Bridges, of the *American Association of State Highway and Transportation Officials* (AASHTO), a diaphragm is defined as a transverse stiffener, which is provided between girders in order to maintain section geometry. For many years, diaphragms have been thought to contribute to the overall distribution of live loads in bridges. Consequently, most bridges constructed have intuitively included diaphragms. Depending on the type of bridge, the diaphragms may take different forms. Cast-in-place concrete diaphragms are most common in prestressed concrete I-girder bridge construction. A diaphragm terminated at the end of the sloping portion of the bottom flange is called "full-depth". Generally, the diaphragm is integral with the deck through continuous reinforcement, tied to the I-girder through anchor bars [2].

Continuity diaphragms are used to achieve continuity over the supports. The continuity is achieved during the construction phase. In stage one, the girders are placed as simply supported girders as shown in figure 1. In stage two, the bridge deck slab and diaphragms cast in place to form the continuous girder as shown in figure 2.

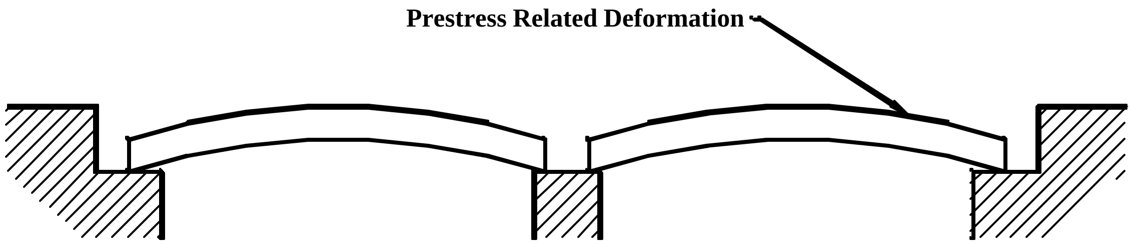

Figure 1
Simply supported girders stage one of construction

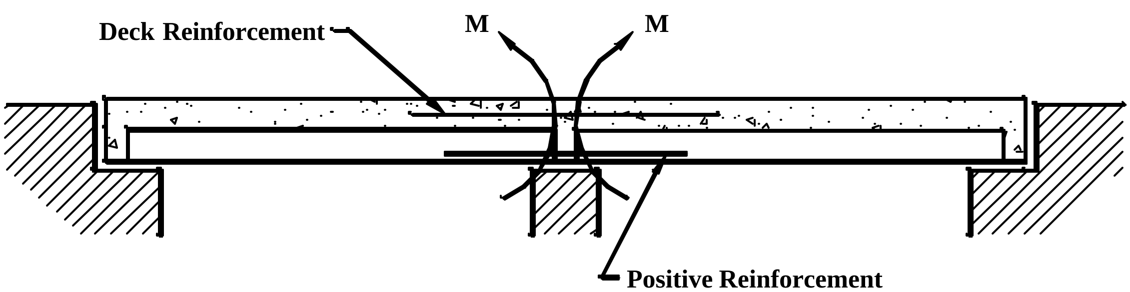

Figure 2
Casting of deck slab and diaphragm for continuity: stage two of construction

The skew angle of the bridge is the angle between the centerline of a support and a line normal to the roadway centerline, shown as ß in figure 3. The skew angle of the diaphragm is the angle between the centerline of the diaphragm and the roadway centerline, shown as a in figure 4.

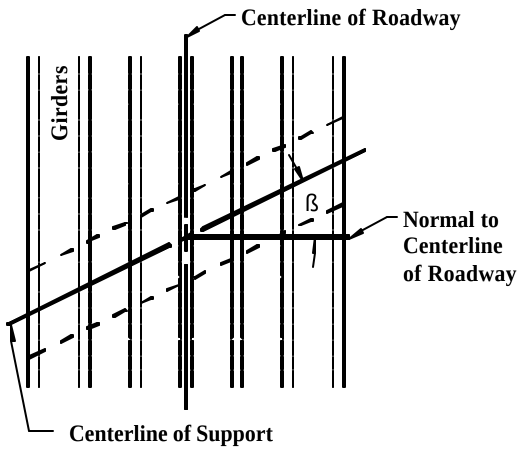

Figure 3
Bridge skew angle

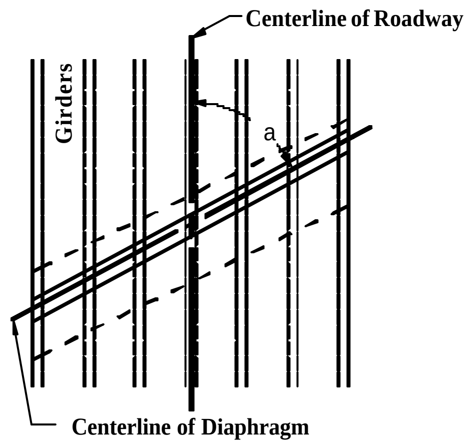

Figure 4
Diaphragm skew angle

Code Requirements

The American Association of State Highway and Transportation Officials (AASHTO) require the use of diaphragms in both of its design codes. Section 9.1.0 of the Standard Specifications for Highway Bridges (AASHTO 1996) requires the inclusion of diaphragms in prestressed concrete bridge design. Furthermore, Section 9.10.2 requires intermediate diaphragms to be placed between the girders at the points where maximum moments occur in spans in excess of 12.20-m (40-ft) [2]. Where tests or structural analysis show adequate strength, though, diaphragms may be omitted. Similar recommendations are made in the Load Resistance Factor Design (LRFD) Bridge Design Code (AASHTO 1994). Article 5.13.2.2 requires the use of intermediate diaphragms to provide assistance in the distribution of live loads between the girders and to resist torsional forces. However, AASHTO does not incorporate the presence of intermediate diaphragms into the design equations for distribution of live load, despite the fact that their inclusion is more or less mandated [1].

OBJECTIVE

The objectives of this research are to (1) determine the need of continuity diaphragms, (2) study the load transfer mechanism through diaphragms, (3) determine when a full depth diaphragm is required, and (4) determine the minimum skew angle at which a diaphragm becomes ineffective.

SCOPE

This report summarizes the literature review, the questionnaire survey sent to out-of-state bridge engineers, the method of analysis, and the findings of this investigation. The literature search included previous research and on-going studies on continuity diaphragms for precast prestressed bridge girders. The survey questionnaire focused on design procedures, construction practices, maintenance, and limit of practice of other states. The analysis concentrated on the effects of the following parameters: girder type, bridge skew angle, girder spacing, span length, and diaphragm condition. The findings of this investigation are limited to these parameters.

METHODOLOGY

Literature Review

The literature search showed that the number of investigations into the effect of continuity diaphragms on the response of prestressed concrete bridges was rather limited. The extensive literature review was conducted to investigate all aspects of the work that would be required to complete this study. The following four topics were identified as major areas where previous research information could be beneficial: (1) diaphragms, (2) load distribution and design of highway bridges, (3) analytical modeling, and (4) experimental testing of bridges.

Various analytical methods have been used to analyze load distributions in highway bridges. Assumptions are made to simplify the problem and postulate a manageable solution. The slab and girder bridges can be considered as a plate structure stiffened by the girders. The orthotropic plate theory can be used for bridges with close girder spacing. While it has been very popular in analyzing slab on girder bridges, there are limitations of the orthotropic plate theory for the case of continuous and skew bridges and bridges with diaphragms, hence the need for more elaborate methods in such cases. Gustafson performed the analysis of slab and girder bridges using the finite element method in 1966. The investigation by Sithichaikasem in 1972 included the effects of the torsional stiffness and warping stiffness of the girders and the effects of in-plane forces in the slab. The study recommended that interior diaphragms be eliminated from most prestressed I-beam bridges unless they are required for erection purposes. The results of the study by Wong and Gamble (1973) on the effects of diaphragms on load distribution of continuous, straight, right slab and girder highway bridges reported the following. Although the diaphragms may improve the load distribution characteristics of some bridges that have a large beam spacing to span ratio, their usefulness is minimal and they are harmful in most cases. Based on cost effectiveness, the authors recommended that diaphragms be omitted in highway bridges. The study recommended that interior diaphragms be eliminated from most prestressed I-beam bridges unless they are required for erection purposes [46]. One of the arguments that have been raised for using diaphragms in bridges is that diaphragms help limit damage to an overpass structure that is struck transversely from below by an oversized load. There appears to be conflicting evidence as to whether the diaphragms are damage limiting or damage-spreading members. However, no analyses were reported relevant to such a claim, and the analyses mentioned above were all performed on simply supported bridges.

Sengupta and Breen (1973) studied the effect of diaphragms in prestressed concrete girder and slab bridges by varying span length, skew angle, stiffness, location, and number of diaphragms. It was found that interior diaphragms were effective only in distributing the load more evenly while never significantly reducing the governing design moment. The conclusion reached was that it is more economical to provide increased girder strength than to rely on improved distribution of load due to provision of diaphragms. Furthermore, the distribution factors for live loads in the 1969 specifications of the *American Association of State Highway Officials* (AASHO) were found to be conservative even without diaphragms. In addition, interior diaphragms made the girders more vulnerable to damages from lateral impacts. It was recommended that interior diaphragms should not be provided in simply supported prestressed concrete girder and slab bridges, and that provision of exterior diaphragms should be considered necessary for reliable serviceability [39].

Much of the present design criteria on load distribution are based on the results of simply supported bridges. The provisions for the design of negative moment regions are inferred from the behavior of the positive moments. Because of the effective span length resulting from the negative moment at the interior support, it is difficult to make a direct comparison between the results of an analysis of a simply supported bridge and continuous bridge. Since most highway bridges are continuous bridges, analyses of the effects of diaphragms on continuous bridges will undoubtedly provide new data and supplement the data on the design of slab and girder bridges.

In 1986, Marx, Khachaturiian, and Gamble developed wheel load distribution equations using the finite element analysis of 108 simply supported skew slab-and-girder bridges. The research included models for bridge concrete deck and prestressed girders as eccentrically stiffened shell assembly [50]. In 1983, Kennedy and Grace studied the effects of diaphragms in skew bridges subjected to concentrated loads. They concluded that diaphragms enhance the distribution of point loads specifically in bridges with large skew angles [31]. During this time, El-Ali (1986) used the SAP-IV finite element program to study the wheel load distribution characteristics of simply supported skew bridges using the discretization scheme of Bishara (1986), in which each I-beam girder was divided into two T-shaped beam elements and elastic properties of these elements lumped at the centroid of the flanges. Truss systems were used to connect the two beam elements and the top beam element to the deck plate element. Such a procedure was very lengthy, and because of limited scope of the study, no expressions were developed [12], [24]. Amiri (1988) did a finite element study on continuous composite skew bridges with prestressed girders and proposed some distribution equations based on linear elastic theory with a limited range of parameters specific to girder spacing [6].

Effects of Diaphragms on Load Distribution

The National Cooperative Highway Research program (NCHRP) Project No. 12-26, which produced the truckload distribution factors for the AASHTO LRFD Specifications (AASHTO 1994), assumed diaphragms and cross-frames had an insignificant effect on load distribution. Despite this acknowledgment, AASHTO still requires the inclusion of diaphragms at points of maximum moment for spans over 12.20-m (40-ft) [1].

Cheung et al. (1986) reported on the apparent lack of previous research to deal with the actual increases or decreases of longitudinal moments due to diaphragms [17]. For example, most published papers concentrated on the alleged effectiveness, or lack of a particular arrangement of diaphragms. Kennedy and Soliman (1982) had reached similar conclusions four years earlier. Based on experimental findings and parametric studies using the finite element method, it was observed that the effective moments of resistance along failure yield lines in the positive and negative moment regions depended on the position of the load and on the nature of the connection between the transverse steel diaphragms and the longitudinal steel beams or girders [30].

Load Distribution and Design

Background information on the development of wheel load distribution factors can be found in Hays et al. (1986) [27], Sanders and Elleby (1970) [38], and Stanton and Manock (1986) [42]. Chen (1995a, 1995b and 1995c) studied load distribution in bridges with unequally spaced girders [13], [14], and [15]. AASHTO empirical formulas for estimating live load distribution factors were compared to results from the refined method. Parametric studies were conducted with a number of field bridge examples that were simply supported, non-skewed, and had no diaphragms. Refined load distribution equations were proposed. Subsequent work by Chen and Aswad (1996) sought to review the accuracy of the formulas for live load distribution for flexure contained in the LRFD Specifications (AASHTO 1994) for prestressed concrete I-girder bridges. It was concluded that the use of a finite element analysis leads to a reduction of the lateral load distribution factor in I-beams when compared to the simplified LRFD guidelines [16].

Further revisions to load distribution equations were presented by Tarhini and Frederick (1995). Contrary to AASHTO assumptions, the finite element analysis revealed that the entire bridge superstructure acts as one unit rather than a collection of individual structural elements. The effect of diaphragms on the wheel load distribution factor was found to be negligible. The research correlated distribution factor results obtained from published field test data with the proposed formulae as well as the AASHTO method [43].

Analytical Modeling

Chen and Aswad (1994) investigated the differences between AASHTO, LRFD, and refined methods such as finite element method, the grillage analogy method, and the harmonic [series] methods for bridge analysis. Bridge models were constructed using standard shell and beam finite elements. The researchers concluded that the refined methods yielded substantially smaller values for distribution factors than the two code procedures [16].

Bakht (1988) reported on a simplified procedure in which skewed bridges could be analyzed to acceptable design accuracy using methods originally developed for the analysis of straight bridges. The study concluded that beam spacing, in addition to skew angle, is an important criterion when analyzing a skew bridge as right. Results from an error analysis using experimental data indicated that the process of analyzing a skew bridge as an equivalent straight bridge is conservative for longitudinal moments but is not conservative when dealing with longitudinal shears [51].

Jaeger and Bakht (1982) initially discussed the use of grillage analogy to conduct bridge analyses [52]. A very detailed explanation of the theory and application was included. Wilson (1996) also examined the use of finite element models in conducting three-dimensional dynamic analyses of structures. Special emphasis was placed on dynamic analysis for Earthquake Engineering [53].

Nassif and Nowak (1995) attempted to quantify the Dynamic Load Factor (DLF) associated with the current inventory of trucks using the results from previously published experiments. The study concluded that the DLF decreases as the static stress in each girder increases [54]. In other words, the DLF decreases for heavier trucks.

The lateral stability of prestressed girders was investigated by Saber (1998). The analyses were for long span simply supported non-skew bridges. The results indicated that the AASHTO 1996 recommendation for T-girder construction, of one intermediate diaphragm at the point of maximum positive moment of spans in excess of 40 feet, is conservative [37].

Barth and Bowman (1999) studied the effect of diaphragm details on the service life of bridges and found that even though some fatigue cracking might have occurred in certain locations it did not reduce the service life of the bridge [10].

Barr et al. (2000) evaluated live-load distribution factors by testing a series of three-span, prestressed concrete girder bridges and comparing to AASHTO and finite element analysis. It was found that lifts, end diaphragms, skew angle and load type significantly decreased the distribution factors, while continuity and intermediate diaphragms had the least effect [11].

Yazdani and Green (2000) studied the performance of elastomeric bearing pads in precast concrete bridge girders using a parametric study on the interaction of support boundary conditions and bridge girders. It was found that intermediate diaphragms have the positive effect of reducing the overall midpoint deflections and maximum stresses for the bridge system but the reductions in deflections and stresses were smaller for increasing skew angles [47].

Experimental Testing

Aktan el al. (1992) reported on the use of known weight trucks to obtain static bridge response as a basis for nondestructive bridge evaluation (NDE). Experimental data taken from the static and dynamic testing of the bridge were used to calibrate a finite element model [5]. A prestressed flat slab bridge was tested by Cook el at. (1993). The experimental and analytical research was conducted with the primary objectives of: testing the bridge for service, fatigue, and ultimate loads; developing analytical models to predict the performance of the system, and verifying the analytical results by comparing them with those obtained from experimental data [18]. In Helba and Kennedy (1995), equations for the design and analysis of skew bridges were developed from the analysis of a prototype composite bridge subjected to Ontario-Highway Bridge Design Code (OHBDC) truck loading. One conclusion drawn from the study was that rigidly connected diaphragms produce a significant increase in the ultimate load capacity of the bridge [28]. Law et al. (1995a) studied the effect of local damage in the diaphragm on the first modal frequency. Three types of damage were studied that constituted a reduction in the stiffness of the diaphragm(s). The study concluded that there was no noticeable change in the first modal frequency in all three cases [34]. Law et al. (1995b) furthered the work with model tests and measurements of 13 full-scale bridges [35]. Similarly, Paultre et al. (1995) initiated a study with the following main objectives: 1) evaluating the dynamic amplification factor for different highway bridges, 2) calibrating finite element models of the bridges being tested, and 3) examining the effects of changes in the stiffness of structural elements and the influence of secondary structural elements on the dynamic response. Data from the tests demonstrated that the dynamic amplification factor could be influenced by variables such as the vehicle speed and the ratio of the vehicle weight to the total weight of the structure.

Summary of Survey

A questionnaire survey (see Appendix A) was sent to all 49 states' Departments of Transportation on November 13, 2001. The 22 states that submitted a response are shown in table 1. The table indicates the states that have owned, designed, or constructed skew continuous precast prestressed concrete bridges as well as the states that have included diaphragm connection details that are used with the continuous concrete skew bridges. Of the 22 respondents, 17 have owned, designed, or constructed skew continuous precast prestressed concrete girder bridges. Of those, 16 states submitted details of their diaphragm connection details.

Although no state provided any short-term or long-term field data (deflection, strain measurements) of skewed continuous precast prestressed concrete bridges with continuity diaphragms, Connecticut and Tennessee are in the process of obtaining the strain monitoring devices. Connecticut already included them the plans for a project, but the data will not be available until 2003.

Table 1
Survey respondents

	Respondent	Question 1	Details Included
1	Arkansas	Yes	Yes
2	Colorado	Yes	Yes
3	Connecticut	Yes	Yes
4	Florida	No	NA
5	Georgia	No	NA
6	Hawaii	Yes	Yes
7	Idaho	Yes	Yes
8	Illinois	Yes	Yes
9	Kentucky	Yes	Yes
10	Maryland	Yes	Yes
11	Mississippi	Yes	Yes
12	Missouri	Yes	Yes
13	Nevada	No	NA
14	New Hampshire	No	NA
15	New Jersey	Yes	Yes
16	New York	Yes	Yes
17	Ohio	Yes	Yes
18	Pennsylvania	Yes	No
19	South Carolina	Yes	Yes
20	Tennessee	Yes	Yes
21	Texas	No	NA
22	Washington State	Yes	Yes

Design Procedures

Item 9 of the survey (see Appendix A) discussed the design guidelines for continuity diaphragms. Eleven states use code methods, eleven use simple beam theory, and Pennsylvania, South Carolina, and Tennessee did not specify their additional design approach. Item 10 of the survey covers the connection of continuity diaphragm used in skew bridges. Eight respondents indicated that they used mild reinforcement extending from bottom flange of the girder. Seven respondents used mild reinforcement bent 90 degrees up into the diaphragm. Hawaii, Pennsylvania, and South Carolina included hairpin reinforcement with both legs embedded in the girder. Connecticut and Ohio used mechanical bar sensor and Mississippi and New York used a welded bar connection. Seven states used a strand extension bent up into the diaphragm and Washington State used a mechanical strand connector. Typical properties specified for skewed bridges and diaphragms were given in Item 3 of the survey. Table 2 shows the range of values given in the responses to the listed material properties along with their arithmetic mean and standard deviation. Bridge configuration parameters identified by the 22 states that responded to the survey are listed in table 3.

Table 2
Typical material properties for skewed bridges and diaphragms

	Minimum	Maximum	Average	Standard Deviation
Release Strength (f_{ci}'), psi	4000	7500	5184	1052
Final Strength (f_c'), psi	5000	10150	6733	1579
Strength of deck concrete, psi	4000	4000	4000	0
Concrete strength of slab, psi	3000	5000	4050	394
Concrete strength of intermediate/end diaphragm, psi	3000	5500	4012	464
Concrete strength of continuous diaphragm, psi	3000	7000	4148	782

Table 3
Bridge configuration parameters

Girder Type	Span Length (ft)		Span Width (ft)		Slab Thickness (in)		Girder Spacing (ft)		Girder Height (in)		Bridge Skew Angle
	min	max	min	max	min	max	min	max	min	max	max
AASTHO Type I	40	45	22	120	7.75	9	5	12			20°
AASTHO Type II	40	60	22	120	7.75	9	5	12			20°
AASTHO Type III	50	90	22	120	7.75	9	5	12			20°
AASTHO Type IV	60	110	22	120	7.75	9	5	12			6°
AASTHO Type V	70	120	26	44	8	8.5	7.5	9.75			22°
AASTHO Type VI	85	140	26	44	8	8.5	7.5	9.75			45°
Box Type Girders	17	130	22	200	6	9	5.5	15	17	72	20°

A common approach for the use of additional bars extending into the continuity diaphragm is to use holes in the web of bridge girders. Few states limit the use of such approaches at abutments or cases where there is collision potential. Connecticut responded that interior girders have rigid metal sleeves cast into the webs of the bulb tees to accommodate number 8 dowels. The dowels are connected to the reinforcement in the diaphragms by mechanical bar connectors.

Construction Practices

Item 5 in the survey discussed the construction sequence of the bridges. Nine states replied that they cast the continuity diaphragms first and then the deck while ten other states indicated that the two are cast at the same time. Hawaii gives the contractor the option of which to cast first because they have not yet specified one or the other. Idaho cast the mid-span region first and then cast the ends of the deck last, at the same time as the pier diaphragm. In Illinois, the diaphragms are poured over continuous piers about forty-five minutes to an hour before the deck. Washington State casts the deck first and then the diaphragm.

Specific Problems

Special issues and problems with skewed continuity diaphragms used are listed in Item 6 of the survey. These include the following: box girders do not sit flat on seat, girder clips front of seat when on grade and skew, hooked positive moment reinforcement conflicts spatially, no consistency between bridges with diaphragm details, cracking girder originating at girder-diaphragm interface, achieving required concrete cover due to rebar placement, and cracking of diaphragm and deck concrete. The problems appear to occur with a skew angle between 20 and 84 degrees.

Only three of the seventeen respondents have considered or used post-tensioning to prevent cracking at the continuity connection. Colorado used post-tensioning and splicing to extend the span capabilities and considered post-tensioning but did not use it to control deck cracking. Pennsylvania tried post-tensioning but did not need it.

Five states reported that they have experienced specific problems with the negative moment diaphragm connections including cracking and spalling of the front seat edge. Colorado noted that early bridges before 1972 sometimes spalled in the front seat edge. New Jersey mentioned a problem achieving the required concrete cover due to the rebar placement. Tennessee acknowledged some cracking but thought it was of no structural consequences and added that most cracking can be eliminated by requiring 90 days before making continuous. New York experienced cracking in the closure pour between the beam segments.

Item 15 provided techniques to overcome some of the problems encountered with continuity diaphragms. Seat spalling was eliminated by expansion joint material between girder and the front of the seat. In Colorado, difficulty with girder clipping the front of seat on skewed bridges on grade was resolved by checking clearance and sloping seat or thickening the leveling pad. Missouri indicated the use of P/C and P/S panels on the majority of their bridges. M-steel in slab therefore has to be placed in one layer. It sometimes limits the achievable span of bridge.

A Design of Experiment Approach for Determining the Effects of Continuity Diaphragms

Introduction to Design of Experiments

A *designed experiment* is a test or series of tests in which purposeful changes are made to the input variables of a process or system so that we may observe and identify the reasons for changes in the output response.

The objectives of experiments often include determining the following:

- Which variables are most influential on the response,“y”
- Where to set the influential “x” variables so that “y” is almost always near the desired nominal value
- Where to set the influential x’s so that variability in y is small
- Where to set the influential x's so that the effects of the uncontrollable “z”variables are minimized

Any system or production process may be viewed as a system of inputs/outputs as illustrated in figure 5.

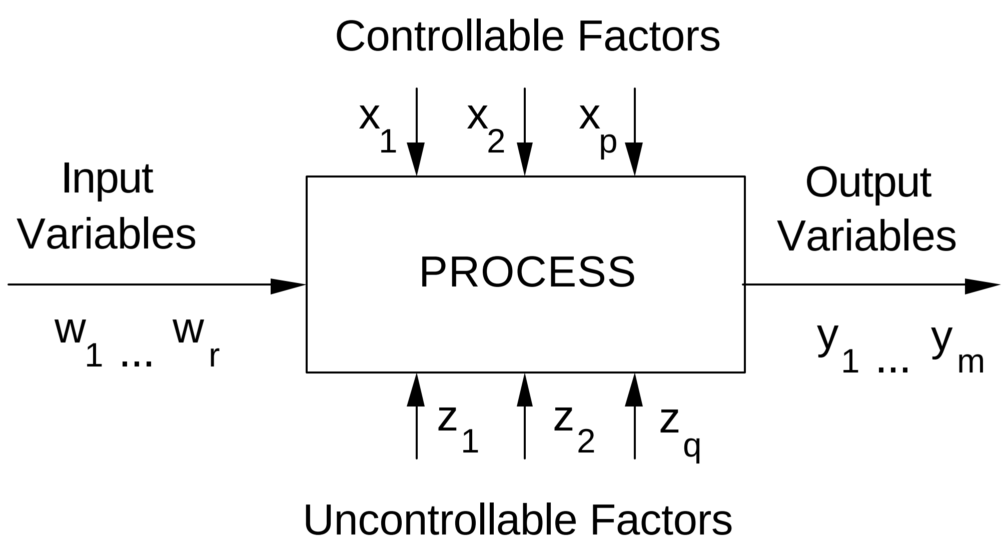

Figure 5
Schematic of system/process design

Experimental Design is a systematic approach to understanding interrelationships in order to understand main factors affecting a given system and optimize the design of the system for highest performance.

Application of Experimental Design to the Continuity Diaphragm Problem

In the case of the continuity diaphragm problem, we used the Design of Experiment method in a reverse fashion to isolate the contribution of continuity diaphragms to bridge system performance. Two major questions are posed for this problem. Is a continuity diaphragm necessary for bridge performance? If so, under what conditions, and what design details should it have?

Relating our problem to figure 5, we assume our bridge system is under controllable factors only, where the input variables are the design variables in terms of material properties and geometry and the output variables are the performance variables. In what follows, we define our input/design and output/performance variables:

Design Variables

Eight design factors were considered. The presence of the diaphragm was added as a factor to identify if the diaphragm has any contribution to performance and to identify possible interaction effects of other design factors with the diaphragm. These factors are:

- Bridge Width
- Concrete Strength
- Slab thickness
- Girder Type
- Bridge Skew Angle
- Girder Spacing
- Span Length
- Diaphragm Condition (30° Skew, 65° Skew, None Used)

The first three factors were fixed for a typical bridge and the remaining five were allowed to vary between a minimum value (-) and a maximum value (+).

- Bridge Width fixed at 30-ft
- Concrete Strength fixed at 5-ksi (for girders and deck)
- Slab thickness fixed at 8-in

Girder types followed AASHTO standards and min/max spans were related to girder type per AASHTO standards. A summary of min/max values for each factor is presented in table 4.

Table 4
Bridge parameters for investigation

Bridge Group	Model No.	AASHTO Girder	Bridge Skew Angle	Girder Spacing (m)	Span Length (m)	Diaphragm Condition
A	101	Type II	10°	1.52	22.8	30°
	102	Type II	10°	1.52	22.8	65°
	103	Type II	10°	1.52	22.8	Not used
B	104	Type II	10°	2.75	16.8	30°
	105	Type II	10°	2.75	16.8	65°
	106	Type II	10°	2.75	16.8	Not used
C	107	Type II	20°	1.52	22.8	30°
	108	Type II	20°	1.52	22.8	65°
	109	Type II	20°	1.52	22.8	Not used
D	110	Type II	20°	2.75	16.8	30°
	111	Type II	20°	2.75	16.8	65°
	112	Type II	20°	2.75	16.8	Not used
E	113	Type IV	10°	1.52	34.0	30°
	114	Type IV	10°	1.52	34.0	65°
	115	Type IV	10°	1.52	34.0	Not used
F	116	Type IV	10°	2.75	28.0	30°
	117	Type IV	10°	2.75	28.0	65°
	118	Type IV	10°	2.75	28.0	Not used
G	119	Type IV	20°	1.52	34.0	30°
	120	Type IV	20°	1.52	34.0	65°
	121	Type IV	20°	1.52	34.0	Not used
H	122	Type IV	20°	2.75	28.0	30°
	123	Type IV	20°	2.75	28.0	65°
	124	Type IV	20°	2.75	28.0	Not used

Eleven bridge response factors were selected to represent bridge performance. These factors are:

- Max normal stress in the deck (x direction) [Sdxmax]
- Max normal stress in the deck (y direction) [Sdymax]
- Max shear stress in the deck xy [Sdxymax]
- Max shear stress in the deck xz [Sdxzmax]
- Max normal stress in the beam (x direction) [Sbxmax]
- Max shear stress in the beam xy [Sbxymax]
- Max Deflection (Dmax)
- Max Torsional Rotation of beams (Omax)
- Max Axial Force in Diaphragm (Mafd)

Screening Fractional Factorial DOE

Methods of experimental design are numerous, ranging from trial and error methods to sophisticated ones. What always matters is the relationship between the degree of sophistication and the nature of the problem being solved. We selected to use one-quarter screening fractional factorial DOE in our study, which resulted in 24 experiments to be conducted. In what follows, we briefly explain our methodology.

Four main strategies are followed to conduct parametric analyses to identify the effects of design factors on system behavior:

Trial and error: As its name indicates, this method is based on random trials of values of design factors, within a given range. The analyst is not guided by any systematic procedure. This method rarely gives any insight into the problem and is mainly used to find a solution and not to map a concept or identify system behavior.

Best guess approach: This method is an evolved version of the first one. The only difference is that the analyst is an expert in the field and is guided by some technical intuition in proceeding with the trial and error method. Success in this method hinges on the expertise of the analyst. Here again, the main usage of the method is to find a point solution (optimum or alike). There are, however, at least two major disadvantages to this method. First, suppose the initial best guess does not produce the desired results. Now the experimenter has to take another guess at the correct combination of factor levels. This could continue for a long time, without any guarantee of success. Second, suppose the initial best guess produces an acceptable result. Second, if the initial guess produces acceptable results, the analyst is tempted to stop testing, although there is no guarantee that the best solution has been found or that a comprehensive understanding of the system has been achieved.

One factor at a time approach: This method is a version of what is called systematic parametric analysis. We start with a baseline of levels for each factor, and then successively vary each factor over its range with the other factors held constant at the baseline level. In a statistical analysis with an industrial engineering setting, a series of graphs are usually constructed showing how response variables are affected by varying each factor with all other factors held constant. This method is efficient in mapping a whole system and identifying main effect variables. However, it does not help identify interaction effects between combined variables, hence the need for factorial experiments.

Factorial experiments: In the case of the bridge system, there are several bridge components and their dimensions and material properties that we call design/input factors, which influence the response of the system. Since we are in a situation in which we want to identify the continuity diaphragms level of contribution to bridge performance, and a possible conclusion could be the complete elimination of diaphragm, we need not miss any main or combined effect of diaphragms. That is, even if we find that diaphragms do not have main effects, we need to go further to see if they have any combined effect with any other factor.

Factorial experiments are an experimental strategy in which factors are varied together instead of one at a time. If there are k factors each at two levels (min/max of an interval range), the factorial design will require 2^k. Factorial design has the advantage of capturing all possible combinations of the levels of the factors. However, the larger the number of factors (k) are included, the larger and more prohibitive the testing.

Fractional Factorial Experiments

In our case, we have six factors; a full factorial design would require 64 tests to be performed, which is prohibitive. However, if we look closely at the available degrees of freedom in the design, we find that only 6 of the 63 degrees of freedom (DOFS) correspond to main effects, and only 15 DOFS correspond to two-factor interactions. The remaining 42 DOFS are associated with three-factor and higher interaction effects. In practical engineering applications, it is extremely rare to have more than two-factor interaction on a system or a process; as such, it is a valid assumption to ignore three-factor and higher interaction effects. Running, only a fraction of the full factorial design is called fractional factorial design. One-half, one-quarter, one-eighth, … etc. are possible depending on the case in hand and the resolution required.

Screening Experiments

In this type of experiment (analytical, numerical, physical), many factors are considered and the objective is to identify those factors that have large effects. It is these factors that we will need to pay more attention to and optimize. Screening experiments are usually performed in the early stages of a project when it is likely that many of the factors initially considered have little or no effect on the response. The factors that are identified as important are often investigated more thoroughly in subsequent experiments. Three major concepts govern screening experiments using fractional factorial designs:

- ♦ The Sparsity of Effects Principle: When a number of design variables serve as input to a system, the latter is likely to be primarily driven by some of the main effects and low-order interactions.
- ♦ The projection property: Fractional factorial designs can be projected into larger designs in the subset of significant factors (that is the initial screening effort is reusable).

- Sequential experimentation: Two or more fractional factorial designs can be combined to sequentially assemble a larger design to estimate the factor effects and interactions of interest.

In our study, we selected to use a one-half fractional factorial experiment, which results in the highest resolution. How do we determine the influence of diaphragms and how to proceed?

The presence or absence not of continuity diaphragms is considered as an independent design factor that will be tested if it is a main effect or main interaction effect through an initial screening DOE. If and only if this factor shows up as a possible effect, we shall go further in the detailing. The screening experiments are shown in table 5.

Method of Approach for Analysis

The use of finite element modeling is among the most popular methods of analysis. Significant advances in computer technology allow for construction and analysis of complicated models. The finite element model used in this investigation simulates the behavior of skewed continuous span bridges. The girders are modeled using Type-IPSL Tridimensional Elements available in GTSTRUDL. Type-SBCR Plate Elements are used for the bridge deck. Prismatic Space Truss Members are used to model the continuity diaphragms and the connection between the deck plate elements and the girder elements.

Girder Element Type-IPSL

Properties of Type Tridimensional Finite Elements are explained in the GTSTRUDL User Guide. They are used to model the behavior of general three-dimensional solid bodies. Three translational degrees of freedom in the global X, Y, and Z directions are considered per node. Only force type loads may be applied to these tri-dimensional elements.

The Type-IPSL Tridimensional Finite Element is an eight-node element capable of carrying both joint loads and element loads. The joint loads may define concentrated loads or temperature changes, while the element, loads may define edge loads, surface loads, or body loads. GTSTRUDL is capable of listing the output for stress, strain, and element forces for Type-IPSL Tridimensional Elements at each node. The average stress, average strain, average principal stress, average principal strain, and average Von Mises at each node may be calculated.

Plate Element Type-SBCR

Properties of Type Plate Finite Elements are explained in the GTSTRUDL User Guide. Type Plate Finite Elements are used to model problems that involve both stretching and bending behavior. Although the element is a two-dimensional flat plate element, it is commonly used to model thin-walled, curved structures. The Type Plate Finite Elements are formulated as a superposition of Type Plane Stress and Type Plate Bending finite elements. For flat plate structures, the stretching and bending behavior is uncoupled, but for structures where the elements do not lie in the same plane, the stretching and bending behavior is coupled.

The Type-SBCR Plate Finite Element is a four-node element capable of carrying both joint loads and element loads. The joint loads may define concentrated loads, temperature change loads, or temperature gradients, while the element loads may define surface loads or body loads. GTSTRUDL is capable of listing the output for in-plane stresses at the centroid and moment resultants, the shear resultant, and element forces at each node for Type-SBCR Plate Elements. The average stresses, average principal stresses, average resultants, average principal membrane, principal bending, and average Von Mises at each node may be calculated.

Prismatic Space Truss Members

Properties of Space Truss Members are explained in the GTSTRUDL User Guide. Space Truss Members are used when a member experiences only axial forces and is ideally pin connected to each joint that it is incident upon. No force or moment loads may be applied to a Space Truss Member. Only constant axial temperature changes or constant initial strain type loads may be applied. These type loads cause axial loads in the members. The self-weight of these members is generated as joint loads, which the member is incident upon.

When the Prismatic Member Property option is used, the section properties are assumed constant over the entire length of the member. Up to 14 prismatic section properties may be directly specified and may be directly specified or stored in tables. If not specified, the values may be assumed according to the material specified. All 14- member cross-section properties are assumed to be with respect to the member cross-section's principle axis (local y- and z- axes) which have their origin on the centroidal axis (local x- axis) of the member.

Concrete Girder Bridges

Slab and girder bridges are used frequently in highway construction. Advantages of using reinforced concrete in slab and girder bridges include economy, durability, and low maintenance costs. These structures consist of a slab and stiffeners. The slab represents the roadway, while the stiffeners provide flexible supports for the roadway. A continuous span bridge is held up by rigid supports. The continuity is adequately achieved with the casting of the deck. Composite action, between the slab and the girders, is obtained by the use of shear connectors.

Geometry of Bridge

The geometry of the bridge is dependent on the width of the roadway, girder type and quantity, number of spans, span length, girder spacing, the bridge skew angle, and the diaphragm skew angle. The span length is measured from the center of one support to the center of an adjacent support. The girder spacing is measured from the center of one girder to the center of an adjacent girder that is identical and parallel to the previous girder. The bridge skew angle is defined by AASHTO as the angle between the centerline of the support and a line normal to the centerline of the roadway. The diaphragm skew angle is defined by AASHTO as the angle between the centerline of the diaphragm and the centerline of the roadway. The structures analyzed in this investigation are 9.14-meter wide, three-span, continuous bridges. The bridges in which the girders are spaced at 1.52 meters on center contain seven girders, as shown in figure 6, while bridges in which the girders are spaced at 2.75 meters on center contain only five girders, as shown in figure 7. Note that the symbol '#' is contingent upon whether the diaphragms are located over the first or the second intermediate support.

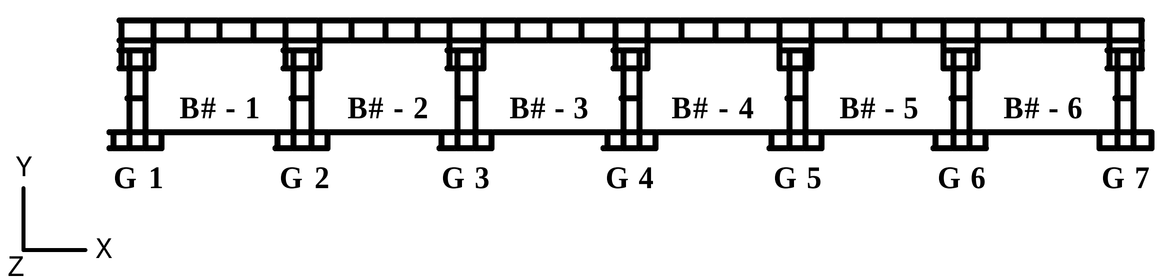

Figure 6
Cross section of bridge models with 1.52-meter girder spacing

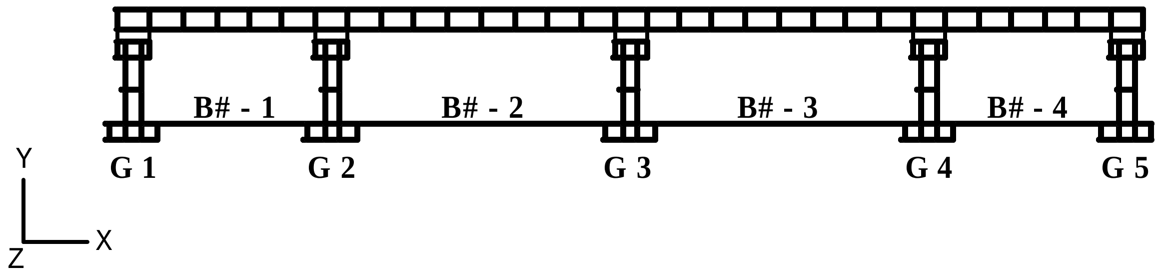

Figure 7
Cross section of bridge models with 2.75-meter girder spacing

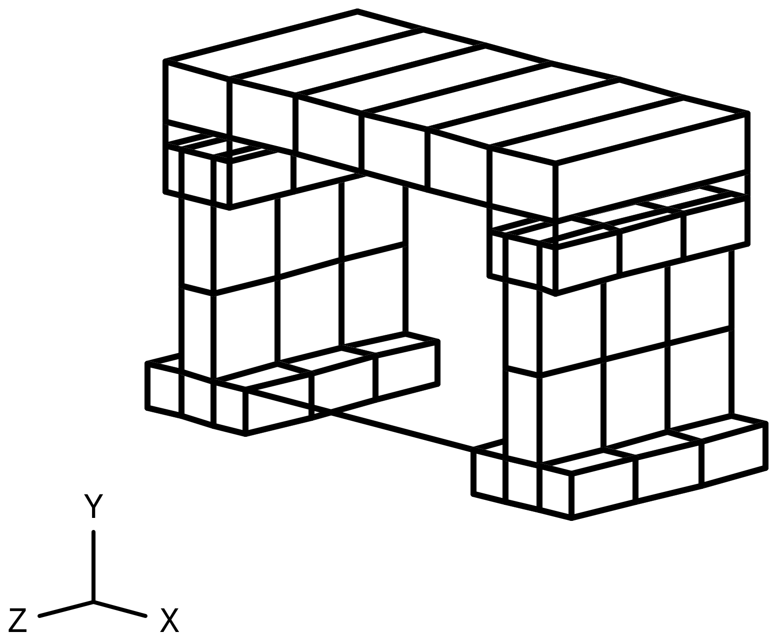

Figure 8
Typical plate and girder elements

Bridge Properties

The girders are considered continuous with continuity being achieved during the casting of the deck and the continuity diaphragms. The properties of the bridge girders are defined by certain parameters dependent on the geometry of the bridge. The behavior of the structure is complex and depends on a wide range of parameters. The design of experiments (DOE described earlier) identified the number of combinations of parameters to twenty-four models as shown here in table 4.

Table 4
Bridge parameters for investigation (repeated)

Bridge Group	Model No.	AASHTO Girder	Bridge Skew Angle	Girder Spacing (m)	Span Length (m)	Diaphragm Condition
A	101	Type II	10°	1.52	22.8	30°
	102	Type II	10°	1.52	22.8	65°
	103	Type II	10°	1.52	22.8	Not used
B	104	Type II	10°	2.75	16.8	30°
	105	Type II	10°	2.75	16.8	65°
	106	Type II	10°	2.75	16.8	Not used
C	107	Type II	20°	1.52	22.8	30°
	108	Type II	20°	1.52	22.8	65°
	109	Type II	20°	1.52	22.8	Not used
D	110	Type II	20°	2.75	16.8	30°
	111	Type II	20°	2.75	16.8	65°
	112	Type II	20°	2.75	16.8	Not used
E	113	Type IV	10°	1.52	34.0	30°
	114	Type IV	10°	1.52	34.0	65°
	115	Type IV	10°	1.52	34.0	Not used
F	116	Type IV	10°	2.75	28.0	30°
	117	Type IV	10°	2.75	28.0	65°
	118	Type IV	10°	2.75	28.0	Not used
G	119	Type IV	20°	1.52	34.0	30°
	120	Type IV	20°	1.52	34.0	65°
	121	Type IV	20°	1.52	34.0	Not used
H	122	Type IV	20°	2.75	28.0	30°
	123	Type IV	20°	2.75	28.0	65°
	124	Type IV	20°	2.75	28.0	Not used

Seven girders are used in models with 1.52-meter girder spacing. Five girders are used in models with 2.75-meter girder spacing; however, the exterior girders on the models are spaced at 1.83 meters in order to maintain a 9.14-meter bridge width. The following assumptions are made in the formulation of the bridges in this investigation:

- The slab has a constant thickness of 200-mm and width of 9.14 meter.
- All girders in the model are identical and parallel to each other. The girders in this investigation based on the DOE are AASHTO Type II or AASHTO Type IV.
- The bridges consist of three span continuous girders.
- Full composite action is assumed between the girder and the slab.
- The outer girders are placed at the edge of the slab.

Models Under Investigation

The maximum aspect ratio for girder and plate elements of bridge configurations consisting of AASHTO Type II girders is 4.00. The maximum aspect ratio for girder and plate elements of bridge configurations consisting of AASHTO Type IV girders is 3.23. See Appendix C for sketches of the bridge configuration models Appendix D for the GTSTRUDL input files of the bridge configuration models used for this analysis.

Boundary Conditions. The restraints for all models consist of four joints across the width at the base of the girder, at the end and intermediate supports, and at the two joints that connect the plate elements to the rigid members at the end supports as pins.

AASHTO Loading. A uniform volumetric dead load of 23.6-KN/m^3 was applied to all elements and all members to account for the self-weight of the concrete. The truck loading on the bridge was represented by the HS20 truck loading, based on AASHTO 3.6.1.2.2. The truck loading includes two 145-KN axles spaced 4 meters apart to produce maximum moment plus one 35-KN axle spaced 4 meters from the first 145-KN axle (see figure 20). In addition to the dead and truckloads, a future wearing surface loading of 4-KPa was placed on the deck to account for future overlays. A wind load of 2.4-KPa, based on AASHTO 3.8.1.2, was applied perpendicular to the windward exterior girder. The loading conditions used in this investigation are required by the AASHTO LRFD Bridge Design Manual and shown in table 5.

Table 5
AASHTO LRFD bridge design loading conditions

#	Loading	Dead Load (DL)	Vehicular Live Load (LL)	Live Load Surcharge (LS)	Wind Load (WL)
10	Strength I Min	0.90	1.75	1.75	0.00
11	Strength I Max	1.25	1.75	1.75	0.00
12	Strength II Min	0.90	1.35	1.35	0.00
13	Strength II Max	1.25	1.35	1.35	0.00
14	Strength III Min	0.90	0.00	0.00	1.40
15	Strength III Max	1.25	0.00	0.00	1.40
16	Strength V Min	0.90	1.35	1.35	0.40
17	Strength V Max	1.25	1.35	1.35	0.40
18	Service I	1.00	1.00	1.00	0.30
19	Service II	1.00	1.30	1.30	0.00
20	Fatigue	0.00	0.75	0.75	0.00

Finite Element Modeling of the Girder Connections

Continuity diaphragms provide continuity between two consecutive girders. When the diaphragm condition called for the omission of the diaphragm, the girder was modeled as a continuous girder without a diaphragm, as shown in figure 9. Omitting the diaphragm in the construction of the bridge creates a space between the two girders over the interior supports. Since the diaphragm does not provide continuity in this case, the girder may require a 50-mm gap between the girders, as shown in figure 11, and the results are compared to the results of the initial model. In order to determine which modeling technique most accurately reflects true conditions, two models were analyzed with GTSTRUDL and results were compared. Both models contained AASHTO Type IV girders, a 10° bridge skew angle, and a girder spacing of 1.52-m. One bridge configuration consisted of continuous span girders with a span length of 34.0-m and the second bridge configuration consisted of 50-mm gaps separating two adjoining girders with a span length of 33-m. In graphing the two bridges, the span lengths are scaled to percentages of the span length in order to graph two unequal length spans on the same set of coordinate axes.

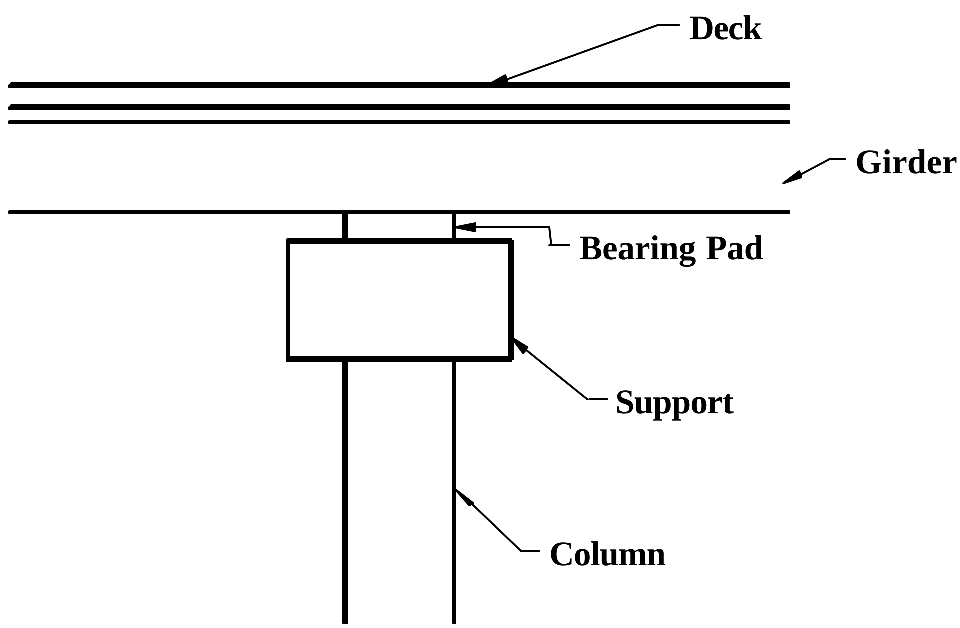

Figure 9
Elevation view of the no diaphragm condition with continuity over the support

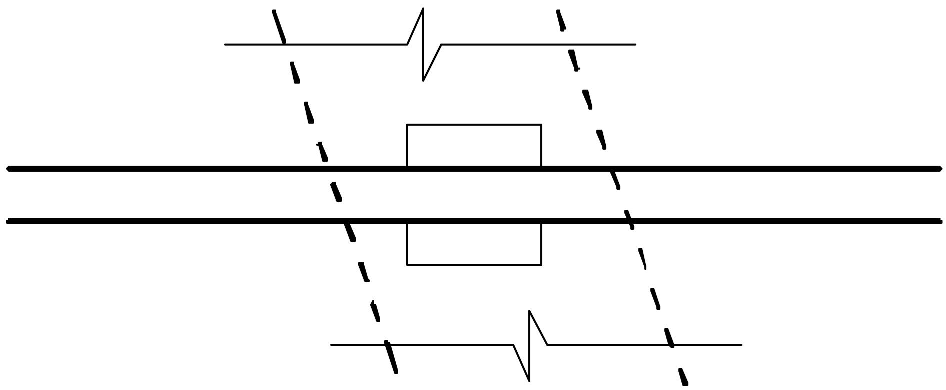

Figure 10
Plan view of the no diaphragm condition with continuity over the support

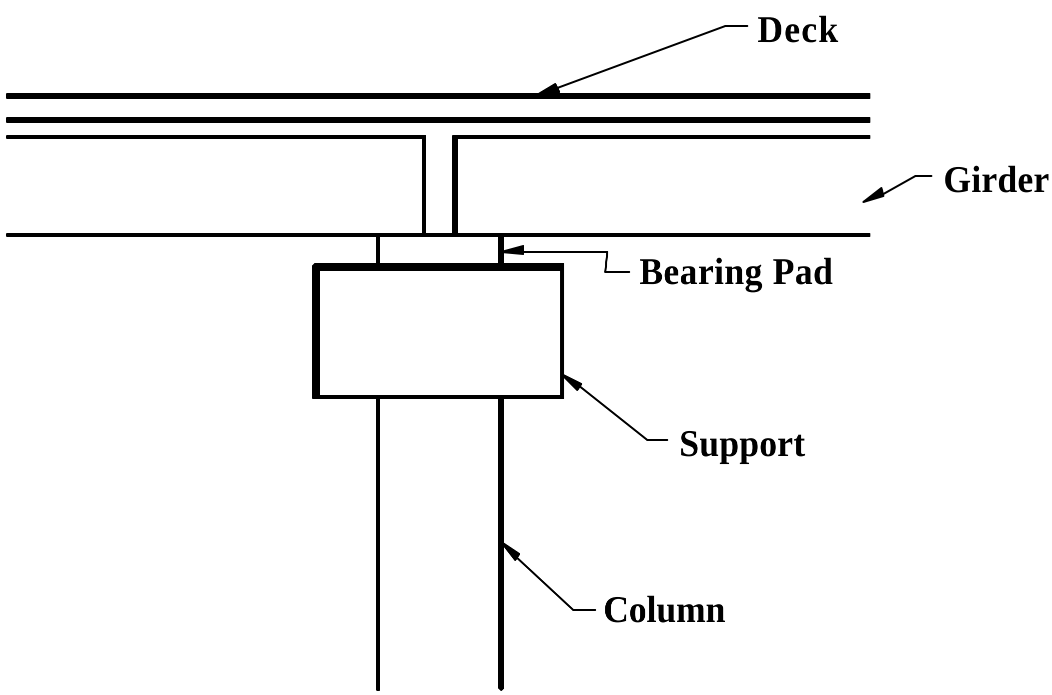

Figure 11
Elevation view of no diaphragm condition without continuity over the support

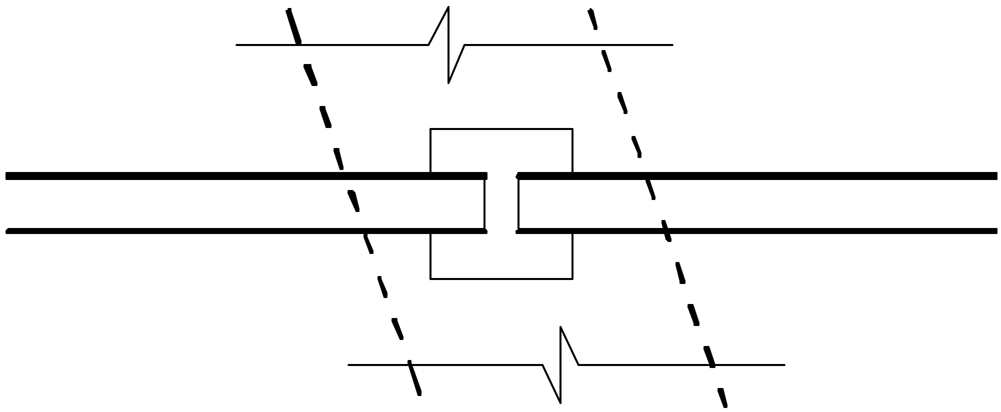

Figure 12
Plan view of no diaphragm condition without continuity over the support

Bridge decks contain longitudinal reinforcing, which carries the tensile stresses induced by the negative moment over the support. In construction, the combination of the deck and the bearing pad restricts the rotation of the girder over the support. Although the girders, when constructed without a continuity diaphragm, are not joined end to end, the girder is not completely free to act as a truly simply supported beam. In modeling the connection with a 50-mm gap between adjoining girders, the girders are free to rotate and act as a simply supported beam because the beam is supported by points at the end of the girder and not resting on the pad. Due to the restricted rotation of the girders, tensile and compressive stresses may still exist at the girder ends. When modeling the connection as a continuous beam, the tendency to rotate is reduced. Figure 13 compares the stresses in the top fiber of Girder 5 along the longitudinal distance of the bridge configurations with and without continuity over the support. Figure 14 compares the stress distribution of both models at the cross section of Girder 5 located over the first intermediate support.

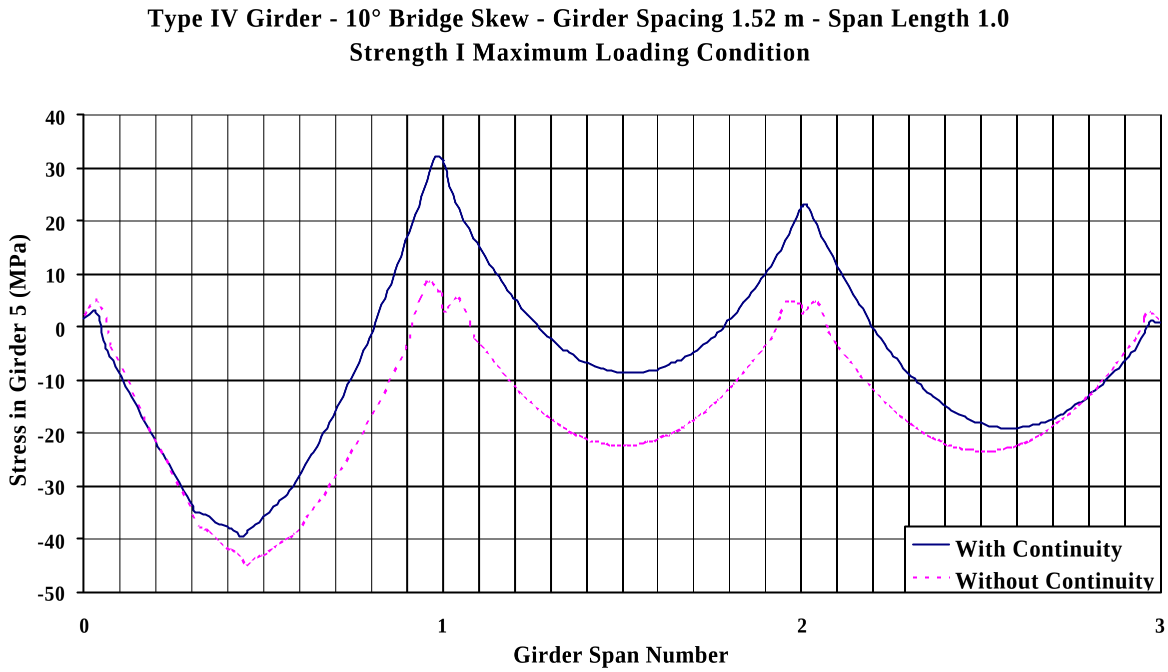

Figure 13
Stress distribution along the bridge (with and without continuity)

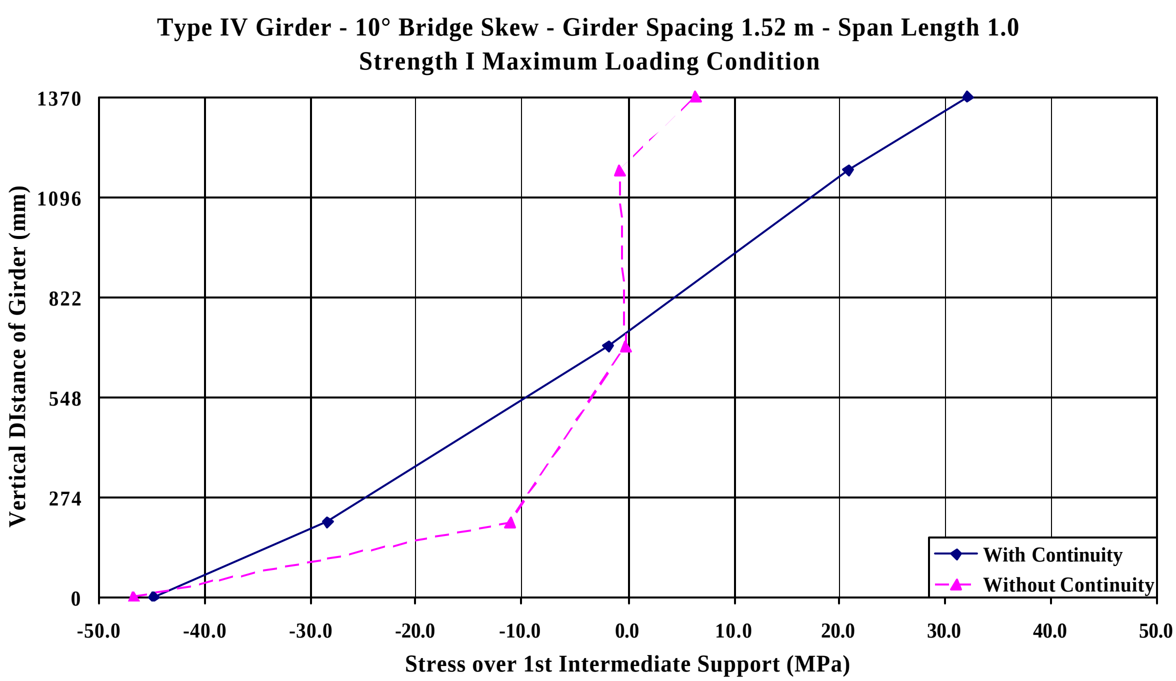

Figure 14
Stress distribution of Girder 5 at 1st interior support

Figure 13 compares the stress distribution of the two models along the bridge length in Girder 5. The tensile stress is reduced in the negative moment region over the first intermediate support when the 50-mm gap eliminates continuity. However, compressive stress near midspan is increased. With more rotation allowed at the end, higher bending is expected at midspan. The 50-mm gap allowed the girders to rotate freely and behave as simply supported beams. When the continuity was omitted in the modeling, the tensile stress over the first support was reduced by 25 MPa. In doing so, the stress in the deck is expected to increase substantially to maintain equilibrium.

Figure 14 compares the stress distribution of the cross section of Girder 5 at the first intermediate support of the two models. The bridge configuration modeled with continuous spans shows a linear stress distribution through the depth of the girder. A linear stress distribution for the continuous-span bridge configuration ranges from about 45-MPa in compression at the base of the girder to about 33 MPa in tension at the top of the girder. The bridge configuration modeled with a 50-mm gap between the girders show areas of low stress in the girder. A non-linear stress distribution in for the simply-supported bridge configuration includes a compressive stress of about 46 MPa in compression at the base of the girder, 10 MPa in compression at the top of the bottom flange, 0 MPa at the center, and 7 MPa at the top of the girder.

In modeling the girders with a 50-mm gap between adjoining girders, the girders behave as simply supported beams, but the geometry of the connection details restricts the girder rotation. Although the actual construction of the bridge contains a gap between the adjoining girders, the girders behave more like continuous beams. A tensile stress in the negative moment region over the support of 10-MPa, given by the bridge configuration with a gap between the girders, may not give an adequate reflection of how the girder behaves. In order to obtain more conservative results for stresses in the negative moment region over the supports, the bridge configuration with the continuous girders shall be used.

Verification of the Model

In order to verify the modeling steps and assumptions for the skewed continuous span concrete girder bridges, two 14.5-m long, simply-supported beams were defined, loaded, and analyzed using GTSTRUDL. The GTSTRUDL input files and hand calculations are located in the Appendix B. All the results were compared as shown in table 6. The beams defined represented AASHTO Type II girders compiled by defining the cross-sectional dimensions of the girder cross-section using a series of “GENERATE m JOINTS” commands. Three Type “IPSL” Tridimensional elements in the top and bottom flanges and two in the web are defined using the “GENERATE n ELEMENTS” command. The elements are repeated down the entire length of the bridge using the “OBJECT COPY” command. Two models and two loading conditions were considered in this analysis.

Model 1. The first model is a 14.5-m long, AASHTO Type II girder modeled using Type “IPSL” Tridimensional elements.

Model 2. The second model is a 14.5-m long, AASHTO Type II girder modeled using Type “IPSL” Tridimensional elements with a series of plate elements modeled using Type “SBCR” Plate elements to represent the deck of the bridge. The transition between girder elements and the deck elements is accomplished by using 1-mm long rigid members.

Boundary Conditions. The restraints for all models consist of four joints across the width of the girder at the end supports (beginning and end of the span) are modeled as a pin and roller, respectively.

Loading Conditions. The loads applied to the models include a dead load of the girder applied in the vertical direction and a concentrated load of 200 kN applied at the center of the beam and distributed over the width of the girder.

Results. The bending moments and stresses at the top and bottom of the beam at midspan were calculated due to the concentrated load only, self weight of the beam only, and the concentrated load plus the self weight. The stresses from hand calculations, as well as the stresses obtained using GTSTRUDL, are summarized in table 7.

Table 6
Comparison of Stresses for Model Verification

Model		Load	Source	Bottom of Girder Stress (Mpa)	Bottom of Girder Stress (ksi)	Bottom of Girder Percent Difference	Top of Girder Stress (Mpa)	Top of Girder Stress (ksi)	Top of Girder Percent Difference
Model 1	Girder Only	Self Weight	Calculated	2.7	0.4	1.6%	-3.3	-0.5	1.8%
			gtstrudl	2.7	0.4		-3.2	-0.5	
		Concentrated Load	Calculated	15.4	2.2	3.0%	-18.6	-2.7	-3.7%
			gtstrudl	15.0	2.2		-19.3	-2.8	
		Concentrated Load plus Self Weight	Calculated	18.1	2.6	2.8%	-21.9	-3.2	-2.9%
			gtstrudl	17.6	2.6		-22.6	-3.3	
Model 2	Girder Plus Deck	Self Weight	Calculated	3.5	0.5	3.8%	-4.2	-0.6	4.0%
			gtstrudl	3.4	0.5		-4.1	-0.6	
		Concentrated Load	Calculated	15.4	2.2	5.1%	-18.6	-2.7	0.8%
			gtstrudl	14.6	2.1		-18.5	-2.7	
		Concentrated Load plus Self Weight	Calculated	18.9	2.7	4.9%	-22.9	-3.3	1.4%
			gtstrudl	18.0	2.6		-22.6	-3.3	

The largest variation between the output and hand calculations was only 3.7 percent, or 0.686-MPa (0.100-ksi), for Model 1. While the largest variation between the output and the hand calculations for Model 2 was 5.1 percent, or 0.788 MPa (0.114-ksi). Thus, the modeling steps used in this report are acceptable. See Appendix B for the hand calculations used to compare and verify the results of GTSTRUDL.

Influence Line Analysis

To obtain the maximum moment, the truck must travel along the bridge. Axle loads provided in LRFD AASHTO chapter 3 are applied to the bridges. GTSTRUDL is used to generate the influence lines used to determine the position of the axle loads for maximum moment.

Modeling in GTSTRUDL

The influence lines were computed along the length of the bridge and across the width of the bridge to determine the most critical location of the truck on the bridge. The spacing of the truck wheel loads were followed in accordance with AASHTO specifications, taking the minimum wheel spacing to produce the maximum moment.

After constructing the models in GTSTRUDL, the unit loadings are applied to the bridge. With these unit loadings, GTSTRUDL is able to draw the displaced structure due to those loadings and list the ordinates (deflections) to use to determine the absolute maximum moment. The results were used to calculate the moment due to each possible truck loading for each unit load applied.

Determination of the Maximum Moment

For the generated influence line ordinate at each joint, the maximum moment at that point is found by shifting the concentrated loads over in one-meter intervals. The moments due to the placement of the wheel loads are computed by taking the sum of the ordinates multiplied by the magnitudes of the loads. The maximum value obtained dictates wheel load placement to produce the maximum moment. The locations of the wheel loadings that yielded the maximum moment are given in figures 15 and 16 on the next page.

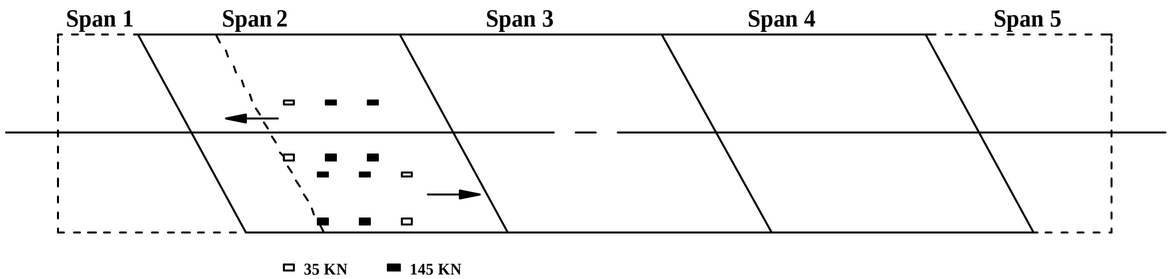

Figure 15
Location of the truck position on the three span continuous bridge models

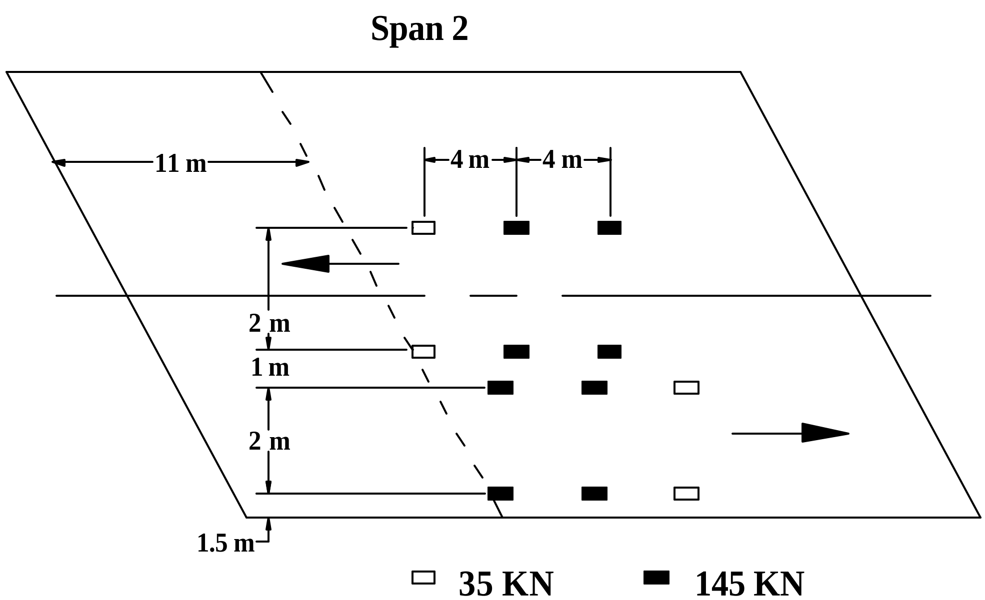

Figure 16
Dimensions of the wheel loads on span 2 of the bridge

DISCUSSION OF RESULTS

General Discussion

The objectives of this research are to determine the need of continuity diaphragms, study the load transfer mechanism through diaphragms, determine when a full depth diaphragm is required, and determine the minimum skew angle at which a diaphragm becomes ineffective. In pursuit of these objectives, the effects of continuity diaphragms for skewed continuous precast prestressed concrete girder bridges are investigated. The effects of continuity diaphragms over internal supports are studied under different loading conditions and varying bridge parameters.

Bridges are grouped based on the diaphragm conditions (i.e., 30° skew angle, 65° skew angle, and no diaphragm) to evaluate the stresses and deflections in the girders along the length of the bridge. Also, the axial loads in the diaphragms are investigated. The results of all bridge configurations listed in table 4 are compared to determine the effects of continuity diaphragms on skewed continuous bridges.

Effects of Diaphragm Skew Angle on Stress Distribution in the Girder

Figures 17 through 32 present the stress distribution in the critical girders of the bridge configurations listed in table 4 due to the critical loading condition (Strength I Maximum). See Appendix E for additional results of stress distribution in the bridge girders.

Bridges consisting of AASHTO Type II girders, 10°-bridge skew, 1.52-meter girder spacing, and 22.8-meter span length (Group A)

Figure 17 compares the results of the bridge configuration in Group A. The stress over the first intermediate support, a negative moment region, decreases around 3.1 percent as the diaphragm skew angle increases, as shown in figure 18. There is about a 0.4 percent increase in tensile stress at the first intermediate support between the 65° diaphragm skew angle condition and the no continuity diaphragm condition. The compressive stress near the truck loading, a positive moment region, increases around 0.7 percent as the diaphragm skew angle increases and increases about 0.1 percent when the diaphragm condition changes from 65° skew to no diaphragm.

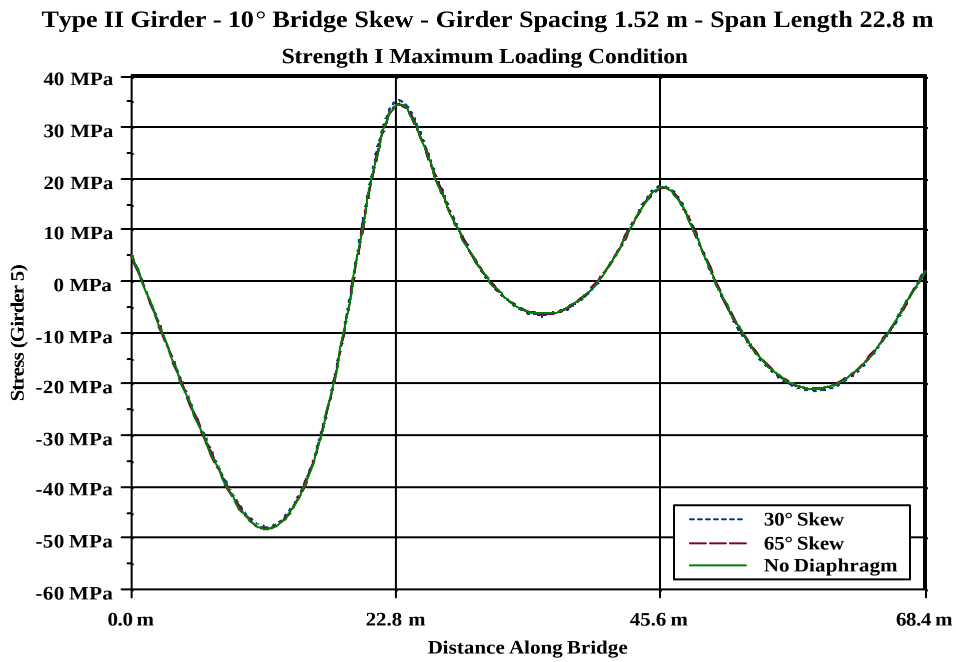

Figure 17
Effects of skew angle on stress distribution (Group A)

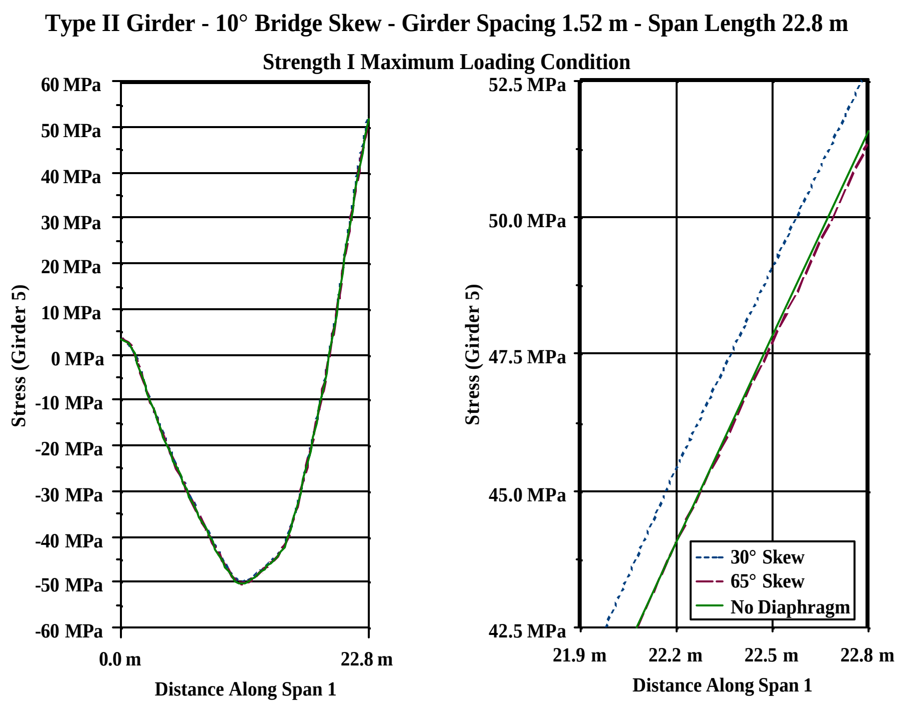

Figure 18
Effects of skew angle on stress distribution (Group A) for first span

Bridges consisting of AASHTO Type II girders, 10°-bridge skew, 2.75-meter girder spacing, and 16.8-meter span length (Group B)

Figure 19 compares the results of the bridge configuration in Group B. The stress over the first intermediate support, a negative moment region, decreases around 3.6 percent as the diaphragm skew angle increases, as shown in figure 20. There is about a 1.0 percent increase in tensile stress at the first intermediate support between the 65° diaphragm skew angle condition and the no continuity diaphragm condition. The compressive stress near the truck loading, a positive moment region, increases around 0.9 percent as the diaphragm skew angle decreases, and, it decreases about 0.2 percent when the diaphragm condition changes from 65° skew to no diaphragm.

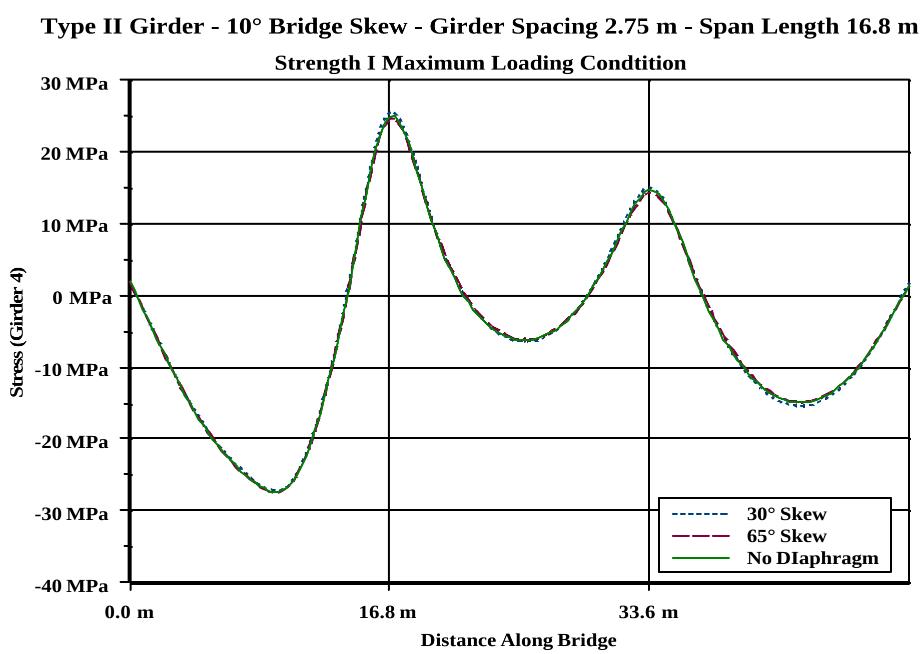

Figure 19
Effects of skew angle on stress distribution (Group B)

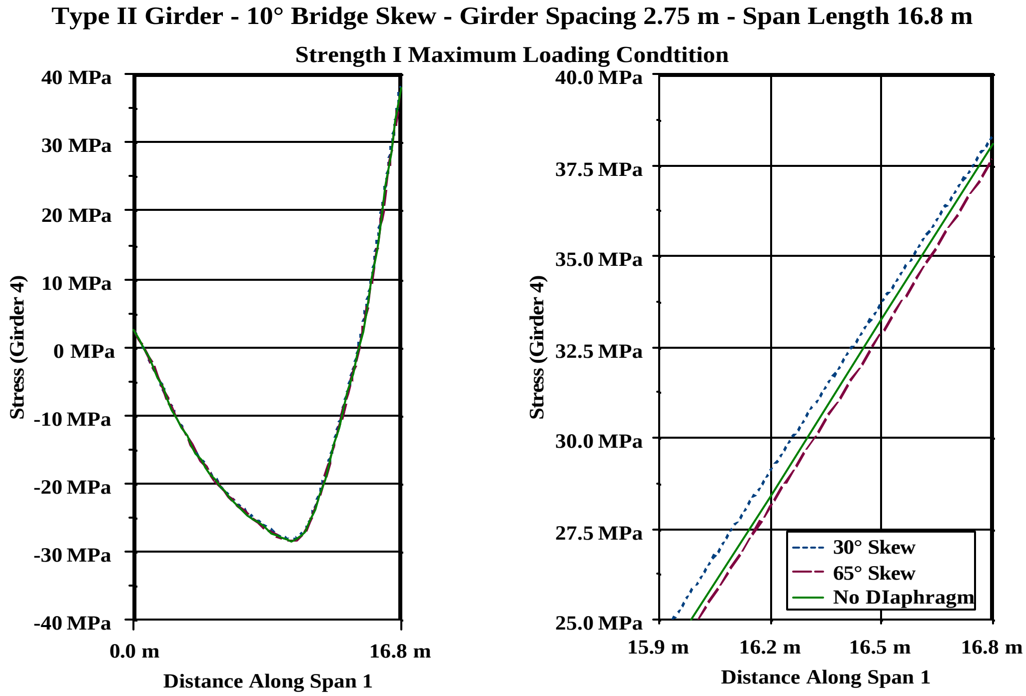

Figure 20
Effects of skew angle on stress distribution (Group B) for first span

Bridges consisting of AASHTO Type II girders, 20°-bridge skew, 1.52-meter girder spacing, and 22.8-meter span length (Group C)

Figure 21 compares the results of the bridge configuration in Group C. The stress over the first intermediate support, a negative moment region, decreases around 2.1 percent as the diaphragm skew angle increases as shown in figure 22. There is about a 0.5 percent increase in tensile stress at the first intermediate support between the 65° diaphragm skew angle condition and the no continuity diaphragm condition. The compressive stress near the truck loading, a positive moment region, increases around 0.9 percent as the diaphragm skew angle decreases, and it increases less than 0.1 percent when the diaphragm condition changes from 65° skew to no diaphragm.

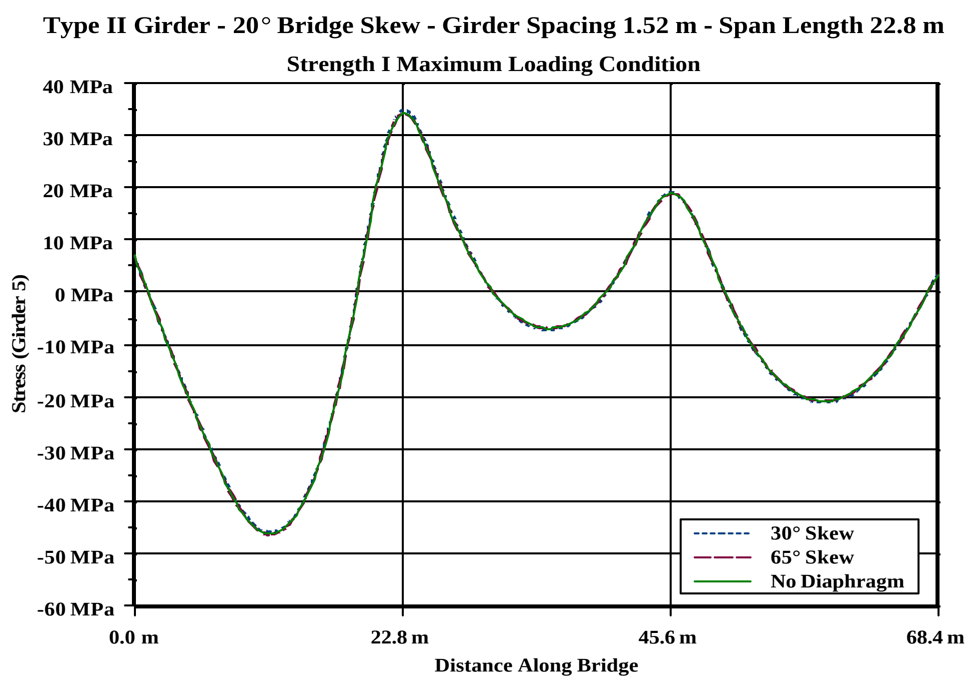

Figure 21
Effects of skew angle on stress distribution (Group C)

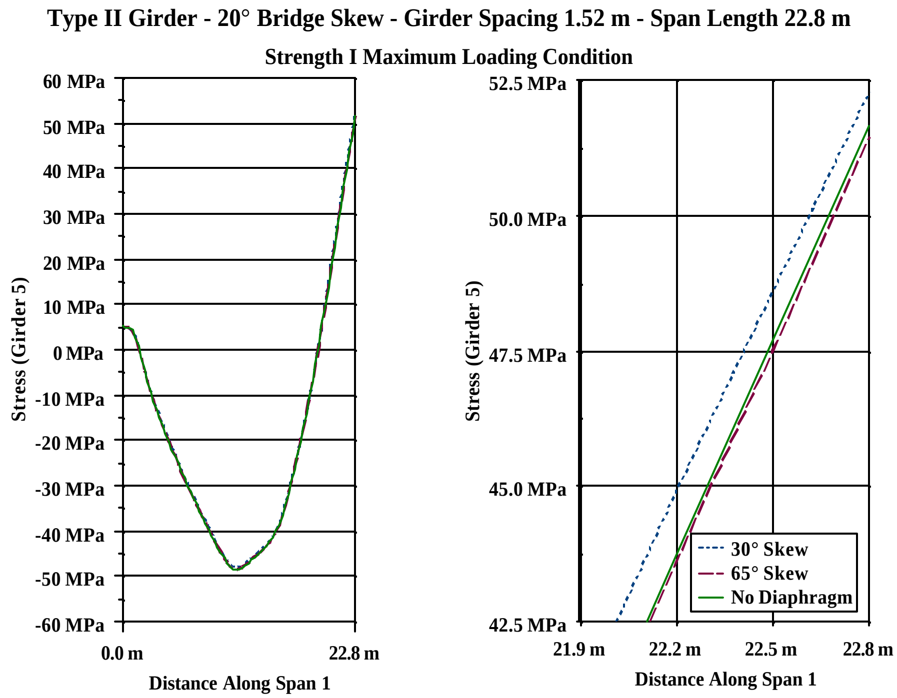

Figure 22
Effects of skew angle on stress distribution (Group C) for first span

Bridges consisting of AASHTO Type II girders, 20°-bridge skew, 2.75-meter girder spacing, and 16.8-meter span length (Group D)

Figure 23 compares the results of the bridge configuration in Group D. The stress over the first intermediate support, a negative moment region, decreases around 4.2 percent as the diaphragm skew angle increases, as shown in figure 24. There is about a 1.2 percent increase in tensile stress at the first intermediate support between the 65° diaphragm skew angle condition and the no continuity diaphragm condition. The compressive stress near the truck loading, a positive moment region, increases around 1.0 percent as the diaphragm skew angle decreases, and, it decreases about 0.2 percent when the diaphragm condition changes from 65° skew to no diaphragm.

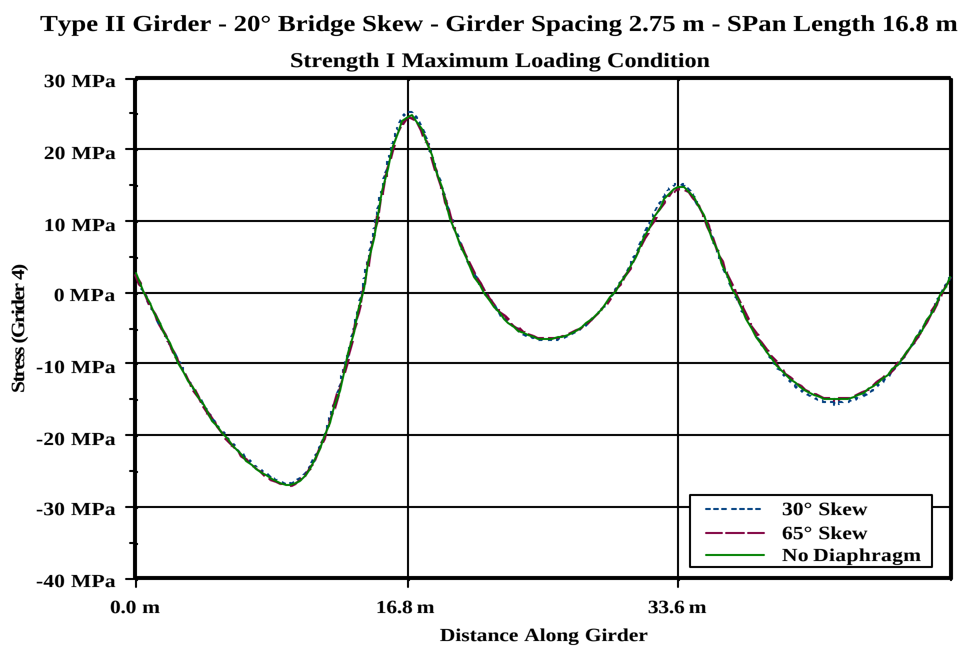

Figure 23
Effects of skew angle on stress distribution (Group D)

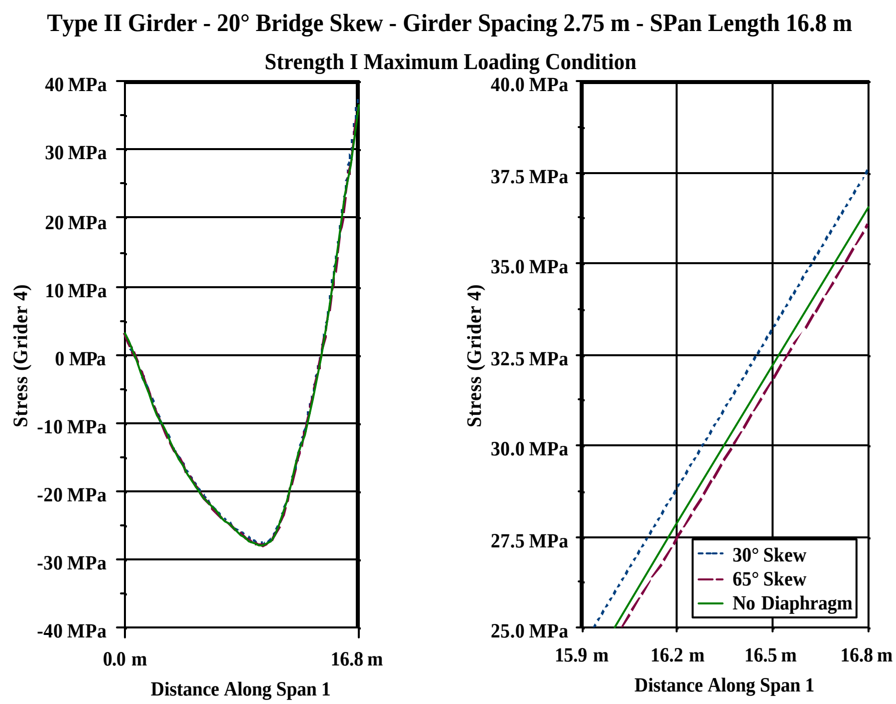

Figure 24
Effects of skew angle on stress distribution (Group D) for first span

Bridges consisting of AASHTO Type IV girders, 10°-bridge skew, 1.52-meter girder spacing, and 34.0-meter span length (Group E)

Figure 25 compares the results of the bridge configuration in Group E. The stress over the first intermediate support, a negative moment region, decreases around 2.9 percent as the diaphragm skew angle increases, as shown in figure 26. There is about a 0.3 percent increase in tensile stress at the first intermediate support between the 65° diaphragm skew angle condition and the no continuity diaphragm condition. The compressive stress near the truck loading, a positive moment region, increases around 0.5 percent as the diaphragm skew angle decreases, and, it increases less than 0.1 percent when the diaphragm condition changes from 65° skew to no diaphragm.

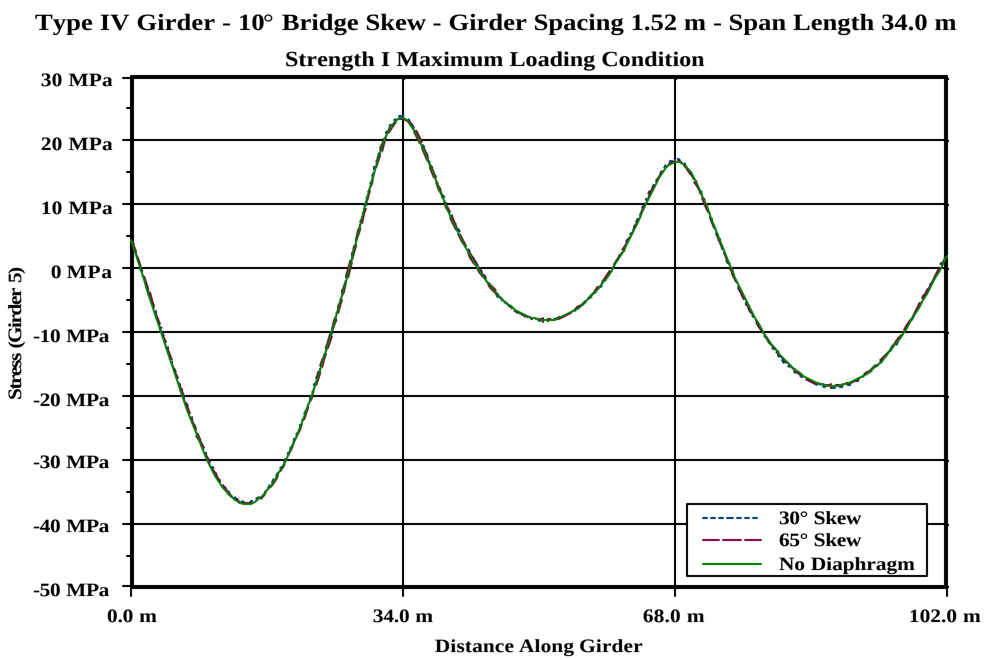

Figure 25
Effects of skew angle on stress distribution (Group E)

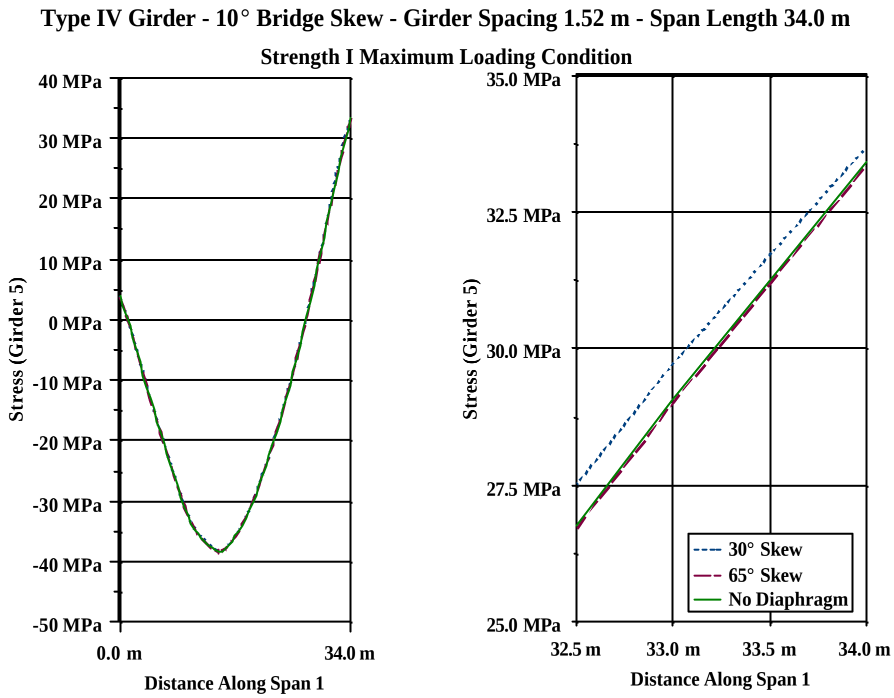

Figure 26
Effects of skew angle on stress distribution (Group E) for first span

Bridges consisting of AASHTO Type IV girders, 10°-bridge skew, 2.75-meter girder spacing, and 28.0-meter span length (Group F)

Figure 27 compares the results of the bridge configuration in Group F. The stress over the first intermediate support, a negative moment region, decreases around 3.1 percent as the diaphragm skew angle increases, as shown in figure 28. There is about a 0.1 percent increase in tensile stress at the first intermediate support between the 65° diaphragm skew angle condition and the no continuity diaphragm condition. The compressive stress near the truck loading, a positive moment region, increases around 0.6 percent as the diaphragm skew angle decreases, and, it increases about 0.1 percent when the diaphragm condition changes from 65° skew to no diaphragm.

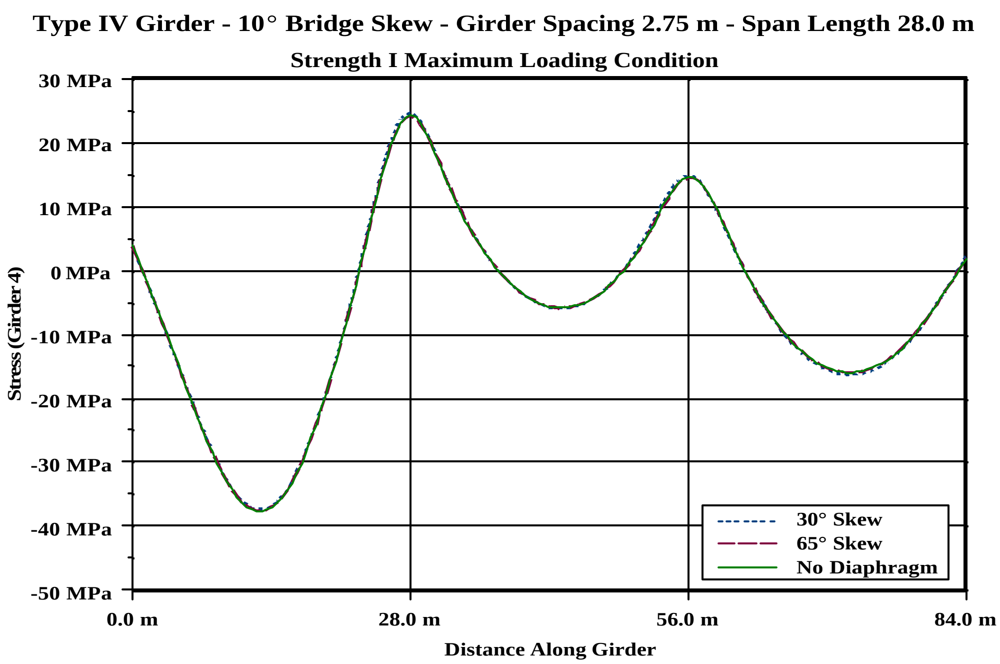

Figure 27
Effects of skew angle on stress distribution (Group F)

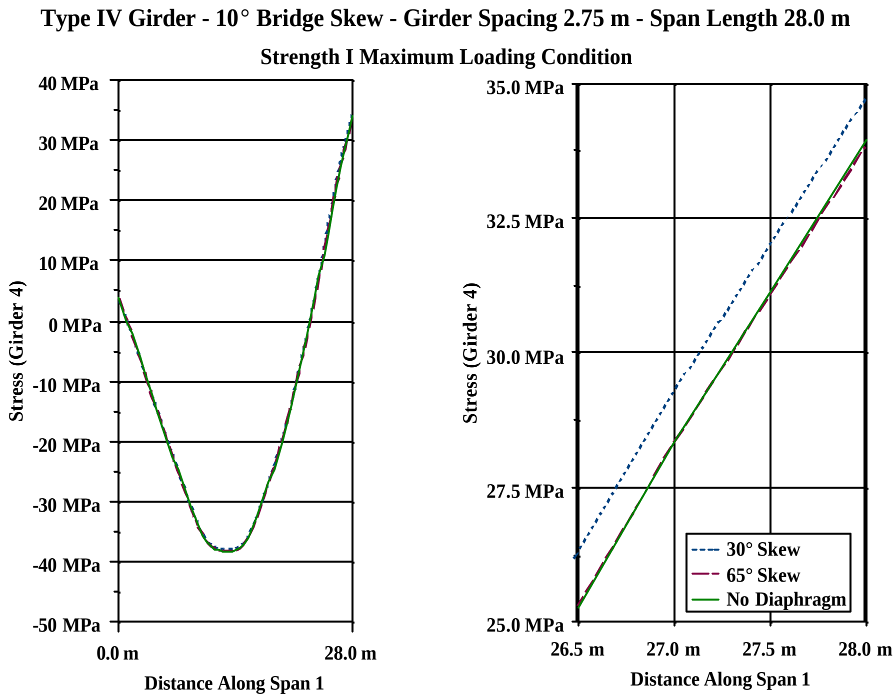

Figure 28
Effects of skew angle on stress distribution (Group F) for first span

Bridges consisting of AASHTO Type IV girders, a 20° bridge skew, 1.52-meter girder spacing, and 34.0-meter span length (Group G)

Figure 29 compares the results of the bridge configuration in Group G. The stress over the first intermediate support, a negative moment region, decreases around 2.3 percent as the diaphragm skew angle increases, as shown in figure 30. There is about a 0.3 percent increase in tensile stress at the first intermediate support between the 65° diaphragm skew angle condition and the no continuity diaphragm condition. The compressive stress near the truck loading, a positive moment region, increases around 0.5 percent as the diaphragm skew angle decreases, and, it decreases about 0.1 percent when the diaphragm condition changes from 65° skew to no diaphragm.

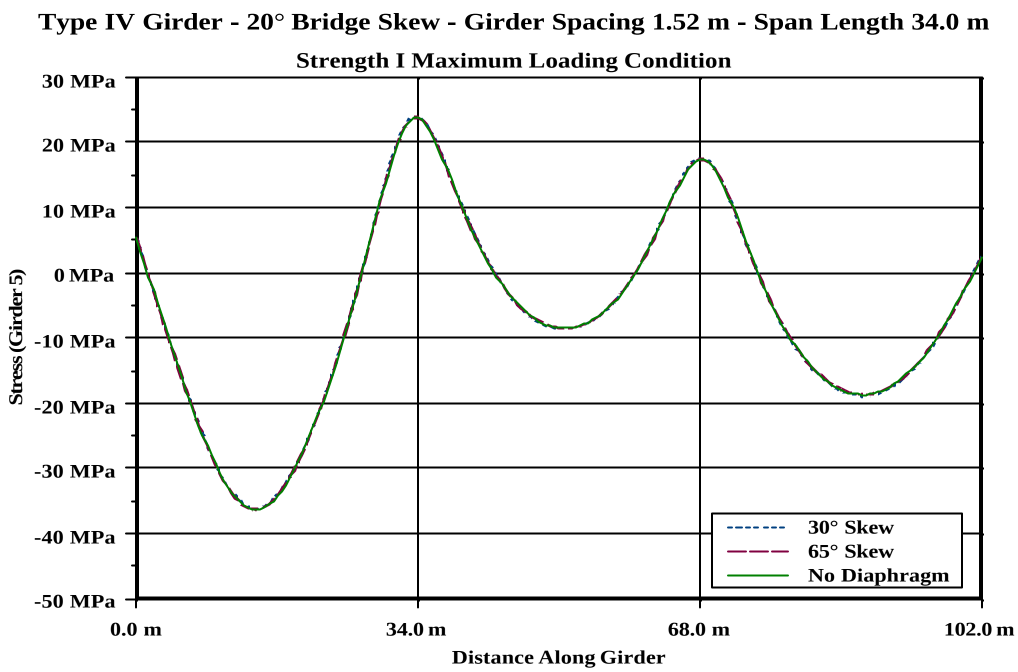

Figure 29
Effects of skew angle on stress distribution (Group G)

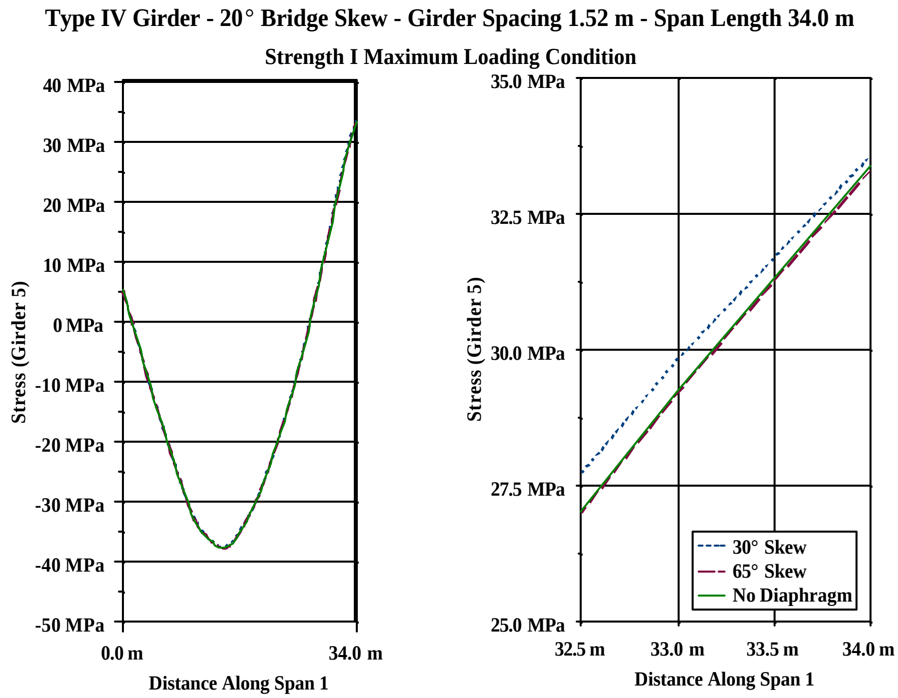

Figure 30
Effects of skew angle on stress distribution (Group G) for first span

Bridges consisting of AASHTO Type IV girders, 20°-bridge skew, 2.75-meter girder spacing, and 28.0-meter span length (Group H)

Figure 31 compares the results of the bridge configuration in Group H. The stress over the first intermediate support, a negative moment region, decreases around 3.3 percent as the diaphragm skew angle increases, as shown in figure 32. There is about a 0.6 percent increase in tensile stress at the first intermediate support between the 65° diaphragm skew angle condition and the no continuity diaphragm condition. The compressive stress near the truck loading, a positive moment region, increases around 0.7 percent as the diaphragm skew angle decreases, and, it increases less than 0.1 percent when the diaphragm condition changes from 65° skew to no diaphragm.

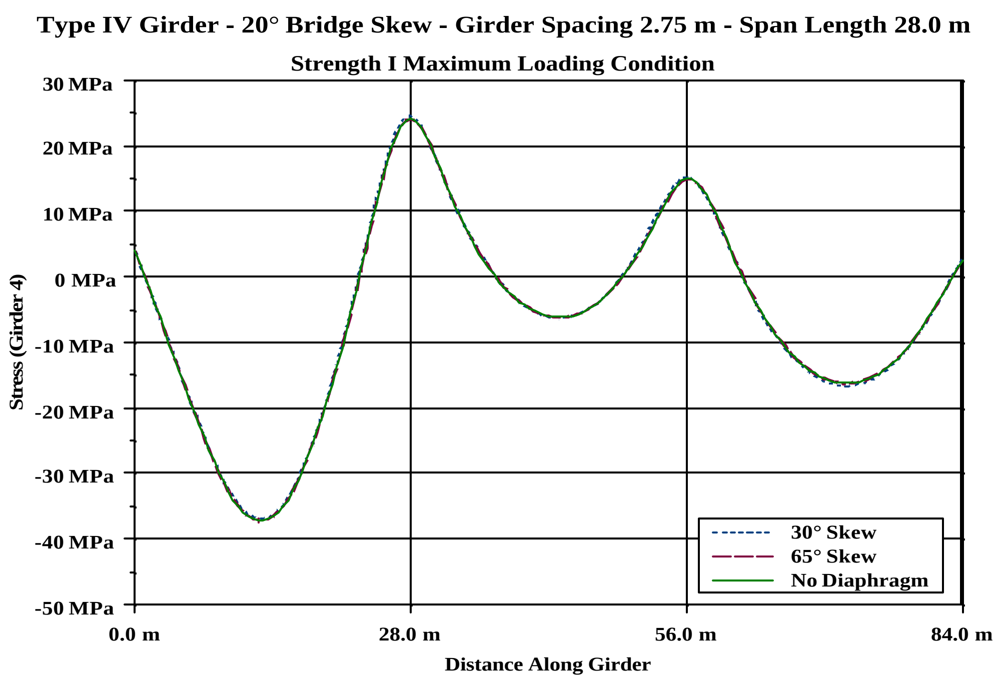

Figure 31
Effects of skew angle on stress distribution (Group H)

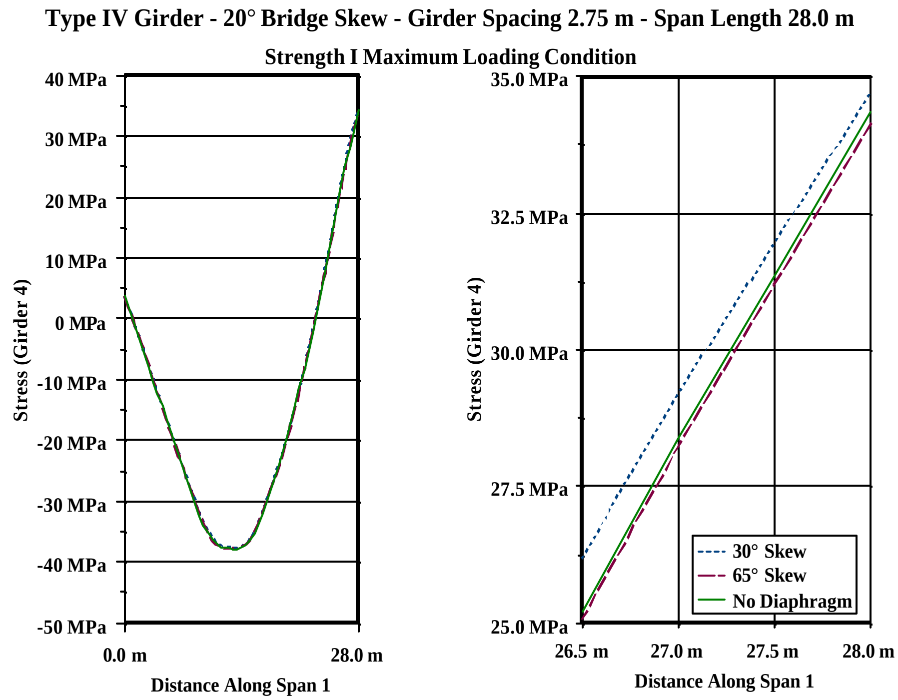

Figure 32
Effects of skew angle on stress distribution (Group H) for first span

Effects of Diaphragm Skew Angle on Maximum Tensile Stress (Girders' Top Fibers)

The effects of diaphragm skew angle on the maximum tensile stress (at top fiber of the girder) due to the critical loading condition (Strength I Maximum) for the bridge configurations listed in table 5 are presented in figures 33 through 40.

Bridges consisting of AASHTO Type II girders, 10°-bridge skew, 1.52-meter girder spacing, and 22.8-meter span length (Group A)

Figure 33 compares the maximum tensile stress in the negative moment region of the bridge configurations in Group A. The stress in Girder 4 and Girder 5 increases 2.0 percent and decreases 3.1 percent, respectively, as the diaphragm skew angle increases. There is a 0.5 percent increase and 0.4 percent increase in stress in Girder 4 and Girder 5, respectively, as the diaphragm condition changes from a 65° skew to the case with no diaphragm.

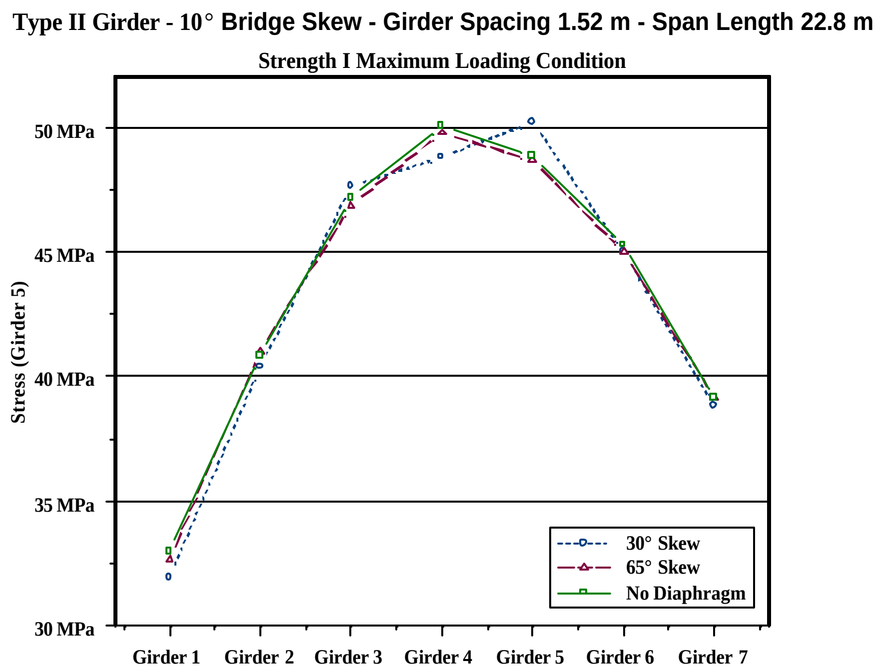

Figure 33
Effect of skew angle on maximum tensile stress in the negative moment region (Group A)

Bridges consisting of AASHTO Type II girders, 10°-bridge skew, 2.75-meter girder spacing, and 22.8-meter span length (Group B)

Figure 34 compares the maximum tensile stress in the negative moment region of the bridge configurations in Group B. The stress in Girder 3 and Girder 4 increases 0.4 percent and decreases 2.9 percent, respectively, as the diaphragm skew angle increases. There is a 0.7 percent increase and 1.3 percent increase in stress in Girder 3 and Girder 4, respectively, as the diaphragm condition changes from a 65° skew to the case with no diaphragm.

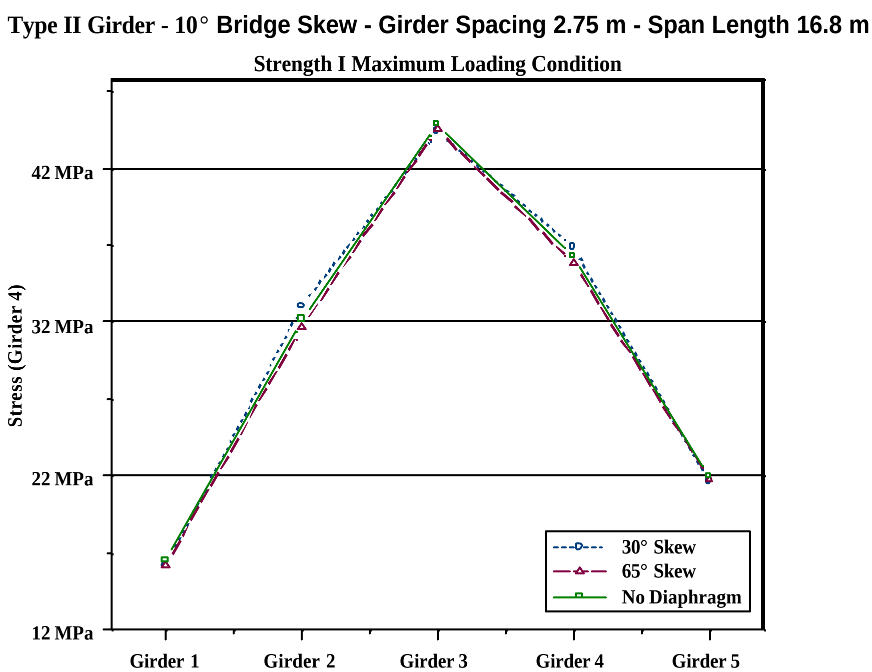

Figure 34
Effect of skew angle on maximum tensile stress in the negative moment region (Group B)

Bridges consisting of AASHTO Type II girders, 20°-bridge skew, 1.52-meter girder spacing, and 22.8-meter span length (Group C)

Figure 35 compares the maximum tensile stress in the negative moment region of the bridge configurations in Group C. The stress in Girder 4 and Girder 5 increases 3.3 percent and decreases 2.1 percent, respectively, as the diaphragm skew angle increases. There is a 0.3 percent increase and 0.5 percent increase in stress in Girder 4 and Girder 5, respectively, as the diaphragm condition changes from a 65° skew to the case with no diaphragm.

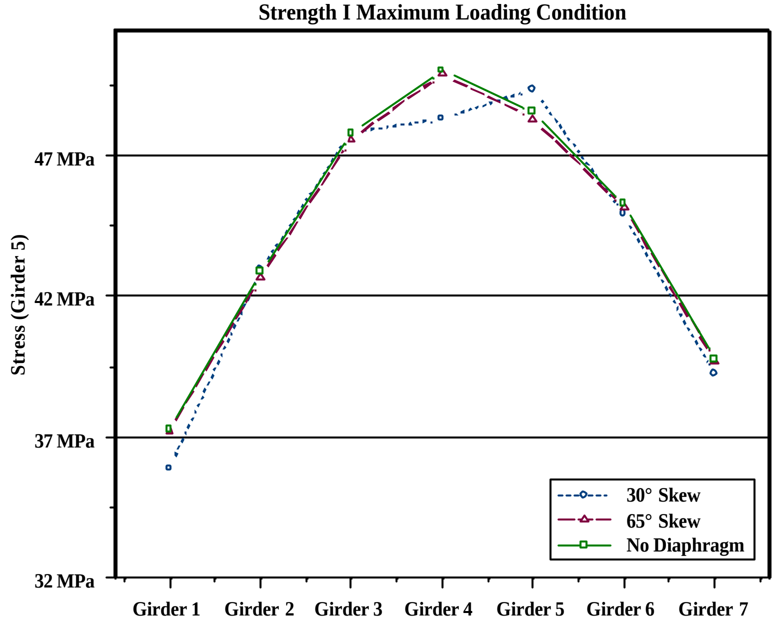

Figure 35
Effect of skew angle on maximum tensile stress in the negative moment region (Group C)

Bridges consisting of AASHTO Type II girders, 20°-bridge skew, 2.75-meter girder spacing, and 16.8-meter span length (Group D)

Figure 36 compares the maximum tensile stress in the negative moment region of the bridge configurations in Group D. The stress in Girder 3 and Girder 4 increases 0.6 percent and decreases 3.3 percent, respectively, as the diaphragm skew angle increases. There is a 0.5 percent increase and 1.3 percent increase in stress in Girder 3 and Girder 4, respectively, as the diaphragm condition changes from a 65° skew to the case with no diaphragm.

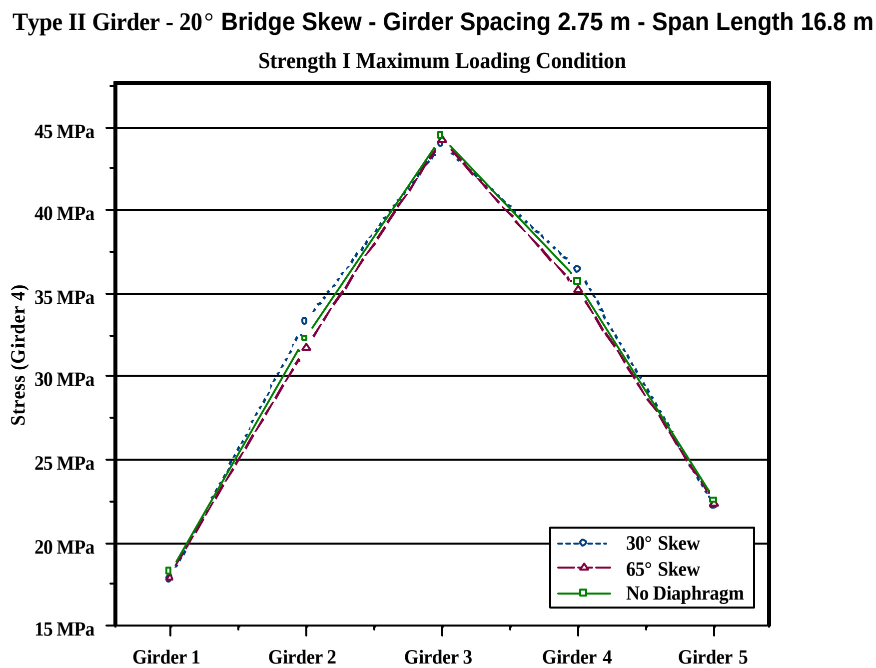

Figure 36
Effect of skew angle on maximum tensile stress in the negative moment region (Group D)

Bridges consisting of AASHTO Type IV girders, 10°-bridge skew, 1.52-meter girder spacing, and 34.0-meter span length (Group E)

Figure 37 compares the maximum tensile stress in the negative moment region of the bridge configurations in Group E. The stress in Girder 4 and Girder 5 increases 2.3 percent and decreases 2.9 percent, respectively, as the diaphragm skew angle increases. There is a 0.2 percent increase and 0.3 percent increase in stress in Girder 4 and Girder 5, respectively, as the diaphragm condition changes from a 65° skew to the case with no diaphragm.

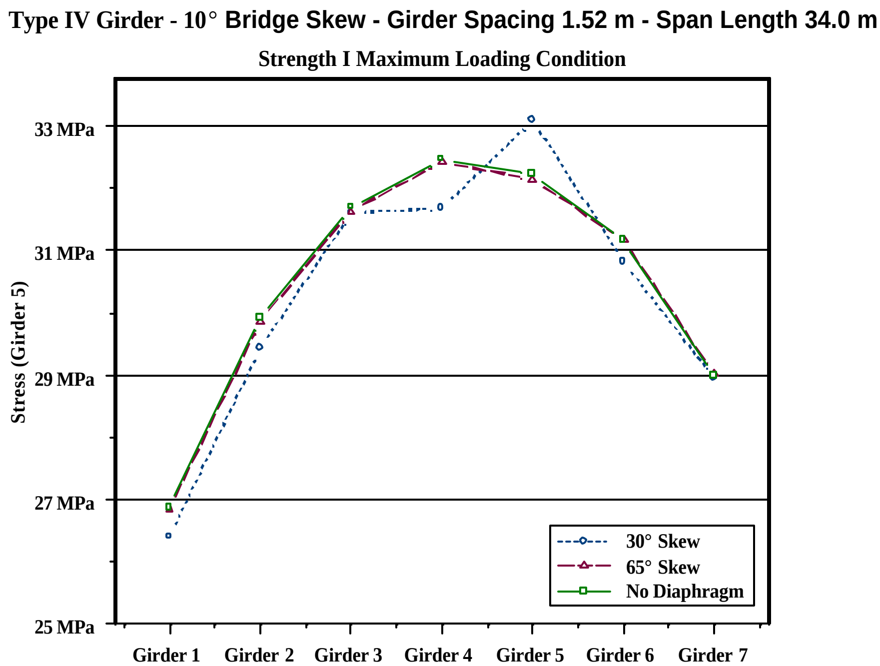

Figure 37
Effect of skew angle on maximum tensile stress in the negative moment region (Group E)

Bridges consisting of AASHTO Type IV girders, 10°-bridge skew, 2.75-meter girder spacing, and 28.0-meter span length (Group F)

Figure 38 compares the maximum tensile stress in the negative moment region of the bridge configurations in Group F. The stress in Girder 3 and Girder 4 increases 1.4 percent and decreases 3.1 percent, respectively, as the diaphragm skew angle increases. There is a 0.6 percent increase and 0.1 percent increase in stress in Girder 3 and Girder 4, respectively, as the diaphragm condition changes from a 65° skew to the case with no diaphragm.

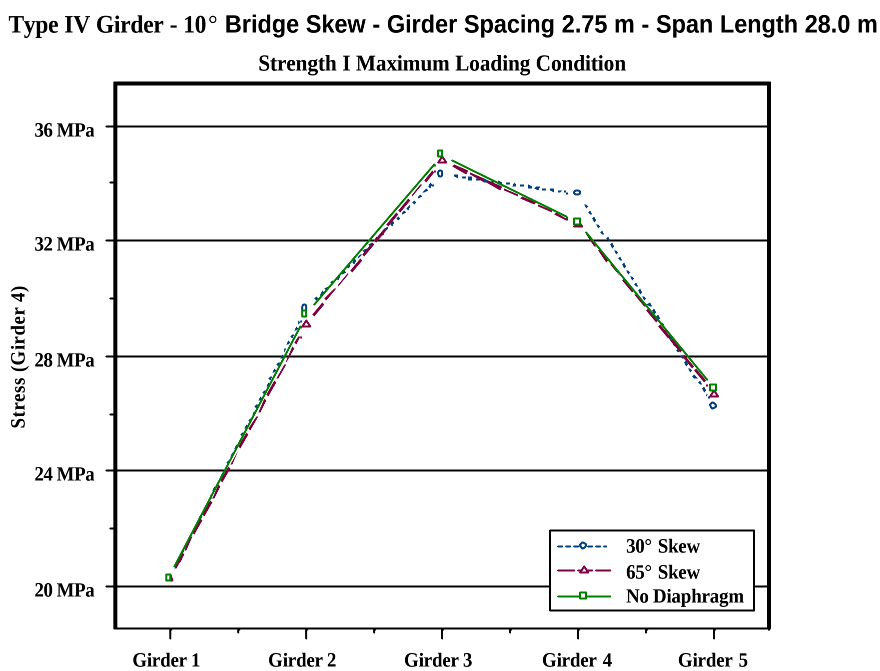

Figure 38
Effect of skew angle on maximum tensile stress in the negative moment region (Group F)

Bridges consisting of AASHTO Type IV girders, 20°-bridge skew, 1.52-meter girder spacing, and 34.0-meter span length (Group G)

Figure 39 compares the maximum tensile stress in the negative moment region of the bridge configurations in Group G. The stress in Girder 4 and Girder 5 increases 2.3 percent and decreases 2.3 percent, respectively, as the diaphragm skew angle increases. There is a 0.1 percent increase and 0.3 percent increase in stress in Girder 4 and Girder 5, respectively, as the diaphragm condition changes from a 65° skew to the case with no diaphragm.

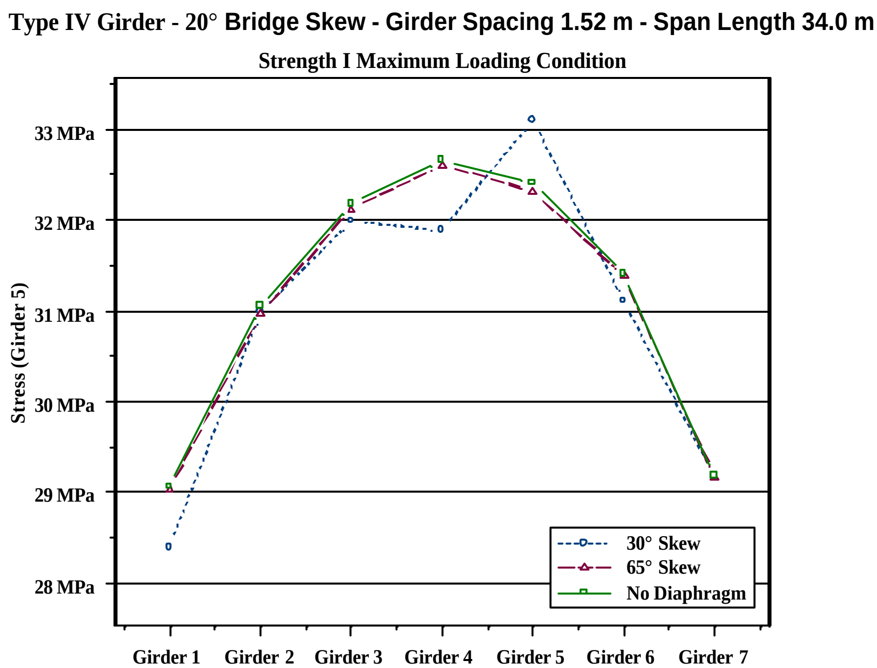

Figure 39
Effect of skew angle on maximum tensile stress in the negative moment region (Group G)

Bridges consisting of AASHTO Type IV girders, 20°-bridge skew, 2.75-meter girder spacing, and 28.0-meter span length (Group H)

Figure 40 compares the maximum tensile stress in the negative moment region of the bridge configurations in Group H. The stress in Girder 3 and Girder 4 increases 1.6 percent and decreases 3.3 percent, respectively, as the diaphragm skew angle increases. There is a 0.3 percent increase and 0.6 percent increase in stress in Girder 3 and Girder 4, respectively, as the diaphragm condition changes from a 65° skew to the case with no diaphragm.

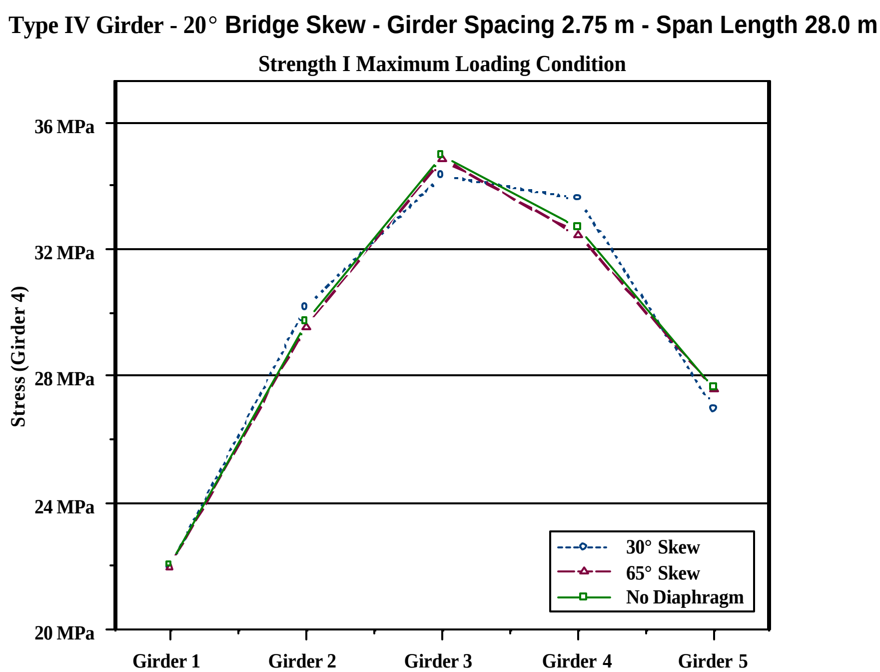

Figure 40
Effect of skew angle on maximum tensile stress in the negative moment region (Group H)

Effects of Diaphragm Skew Angle on Girders Deflections

The effects of the skew angle of continuity diaphragms on the deflections of skewed continuous span bridge girders are investigated in this study. Figures 41 through 56 present the maximum deflections in the critical girders of the bridge configurations listed in table 4 due to the critical loading condition (Strength I Maximum). Since the deflection is derived as a function of the stress, the behavior of the deflection in the girders will be similar to the behavior of the stress in the girders, except that the deflections at the supports are zero because the supports were assumed to be rigid and non-yielding. See Appendix Ffor additional graphs on the effects of diaphragm skew angle on girder deflections.

Bridges consisting of AASHTO Type II girders, 10°-bridge skew, 1.52-meter girder spacing, and 22.8-meter span length (Group A)

Figure 41 compares the results of the bridge configuration in Group A. There is a 0.5 percent increase in deflection as the skew angle increases and a 0.1 percent increase when the diaphragm condition changes from a 65° skew to the case with no diaphragm. Figure 42 illustrates the changes in girder 5 deflections as the diaphragm conditions change.

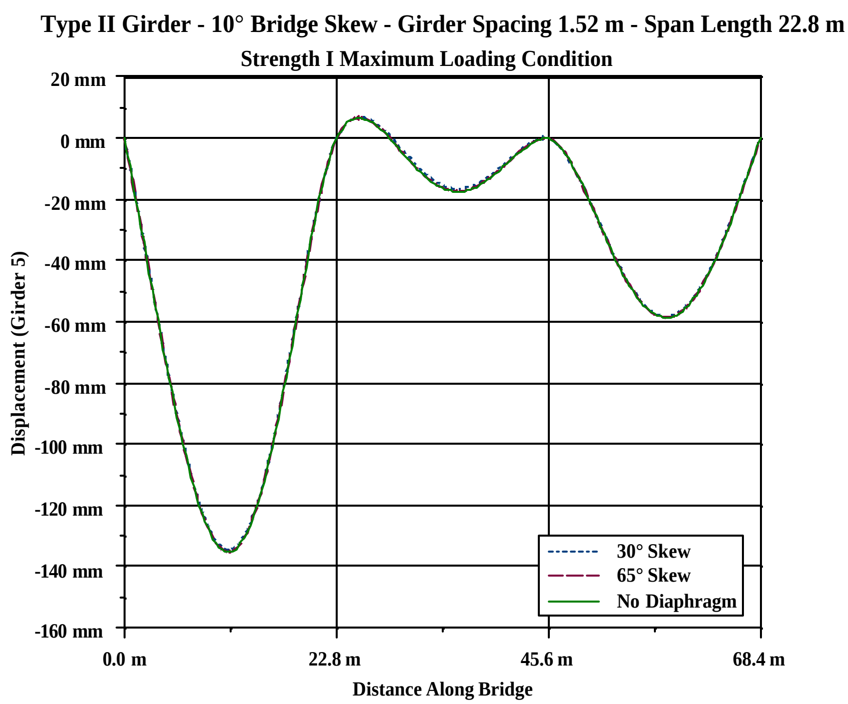

Figure 41
Effects of diaphragm skew angle on deflection in girder G5 (Group A)

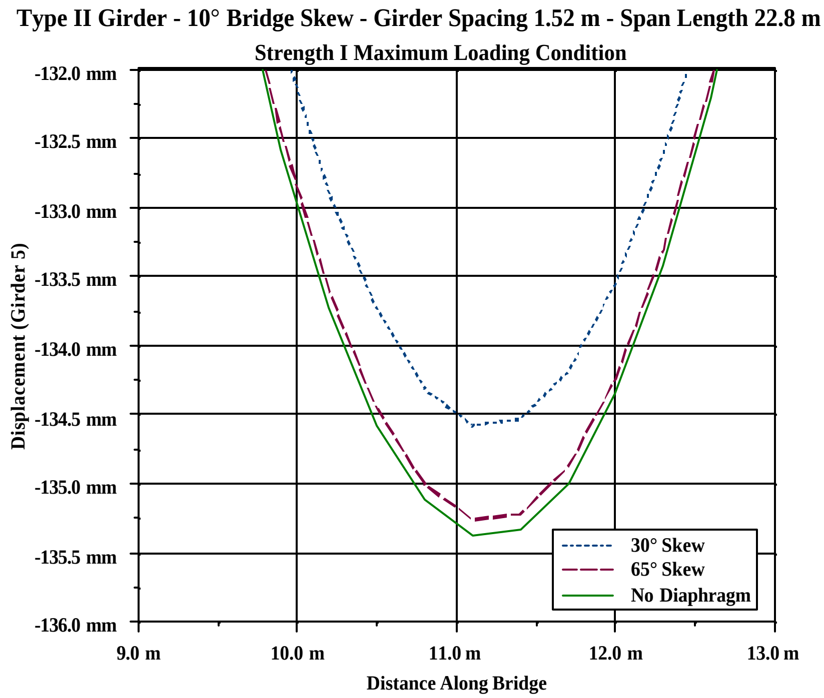

Figure 42
Effects of diaphragm skew angle on deflection at midspan girder G5 (Group A)

Bridges consisting of AASHTO Type II girders, 10°-bridge skew, 2.75-meter girder spacing, and 16.8-meter span length (Group B)

Figure 43 compares the results of the bridge configuration in Group B. There is a 0.7 percent increase in deflection as the skew angle increases and less than a 0.1 percent decrease when the diaphragm condition changes from a 65° skew to the case with no diaphragm. Figure 44 illustrates the changes in girder 4 deflections as the diaphragm conditions change.

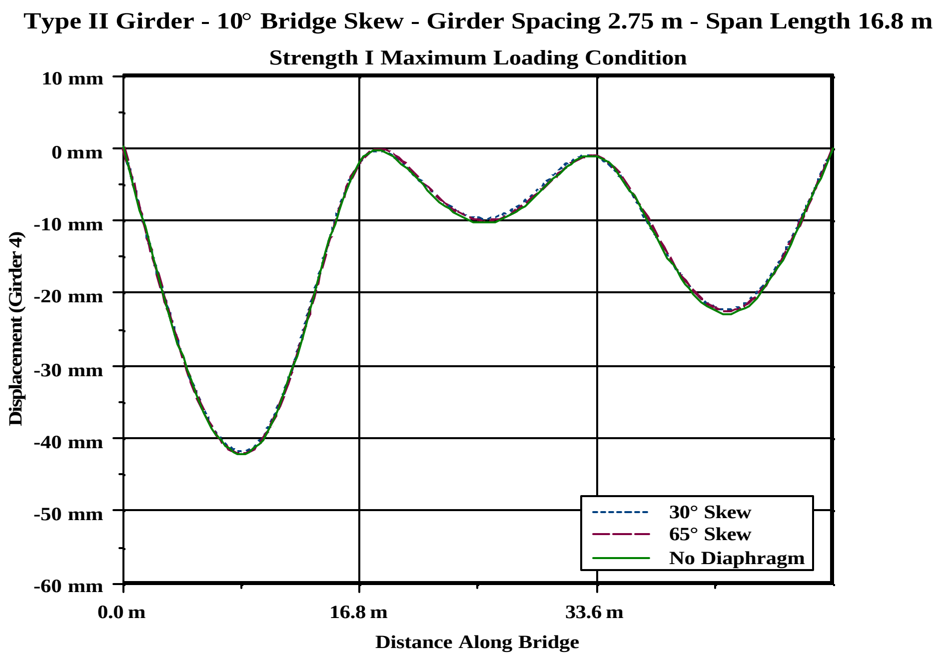

Figure 43
Effects of diaphragm skew angle on deflection in girder G4 (Group B)

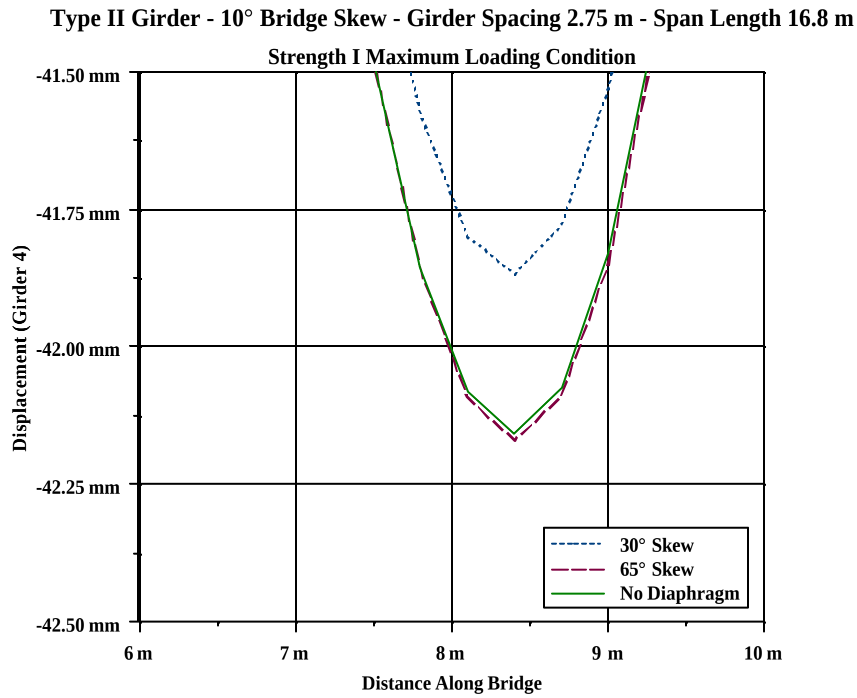

Figure 44
Effects of diaphragm skew angle on deflection at midspan girder G4 (Group B)

Bridges consisting of AASHTO Type II girders, 20°-bridge skew, 1.52-meter girder spacing, and 22.8-meter span length (Group C)

Figure 45 compares the results of the bridge configuration in Group C. There is a 0.6 percent increase in deflection as the skew angle increases and less than 0.1 percent increase when the diaphragm condition changes from a 65° skew to the case with no diaphragm. Figure 46 illustrates the changes in girder 5 deflections as the diaphragm conditions change.

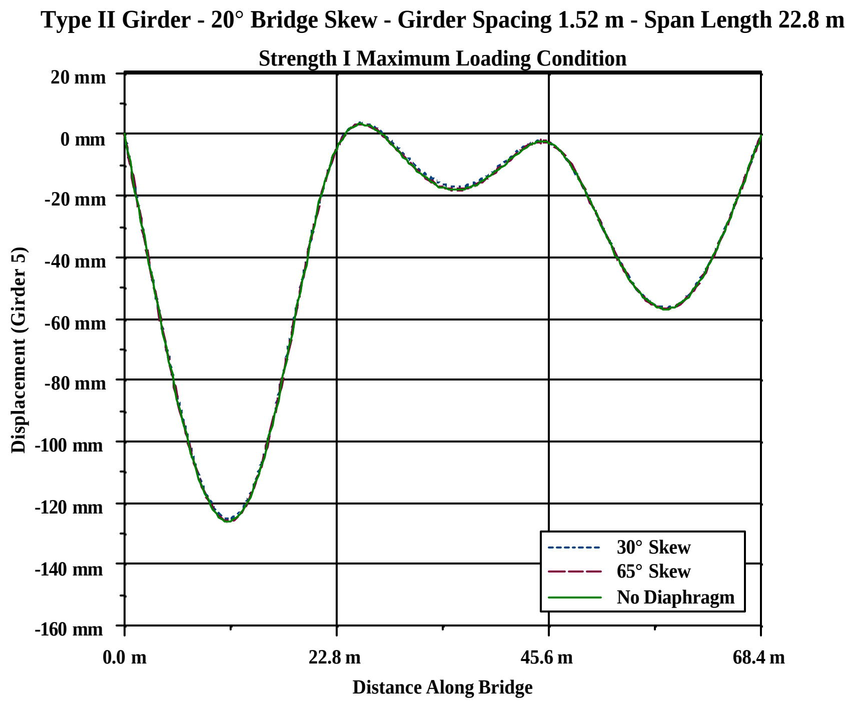

Figure 45
Effects of diaphragm skew angle on deflection in girder G5 (Group C)

Type II Girder - 20° Bridge Skew - Girder Spacing 1.52 m - Span Length 22.8 m

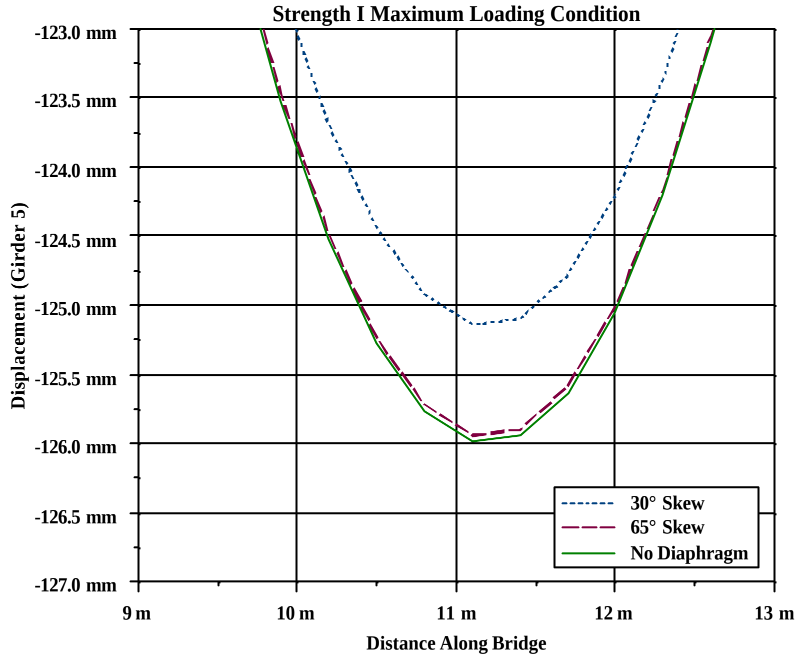

Figure 46
Effects of diaphragm skew angle on deflection at midspan girder G5 (Group C)

Bridges consisting of AASHTO Type II girders, 20°-bridge skew, 2.75-meter girder spacing, and 16.8-meter span length (Group D)

Figure 47 compares the results of the bridge configuration in Group D. There is a 0.8 percent increase in deflection as the skew angle increases and a 0.1 percent decrease when the diaphragm condition changes from a 65° skew to the case with no diaphragm. Figure 48 illustrates the changes in girder 4 deflections as the diaphragm conditions change.

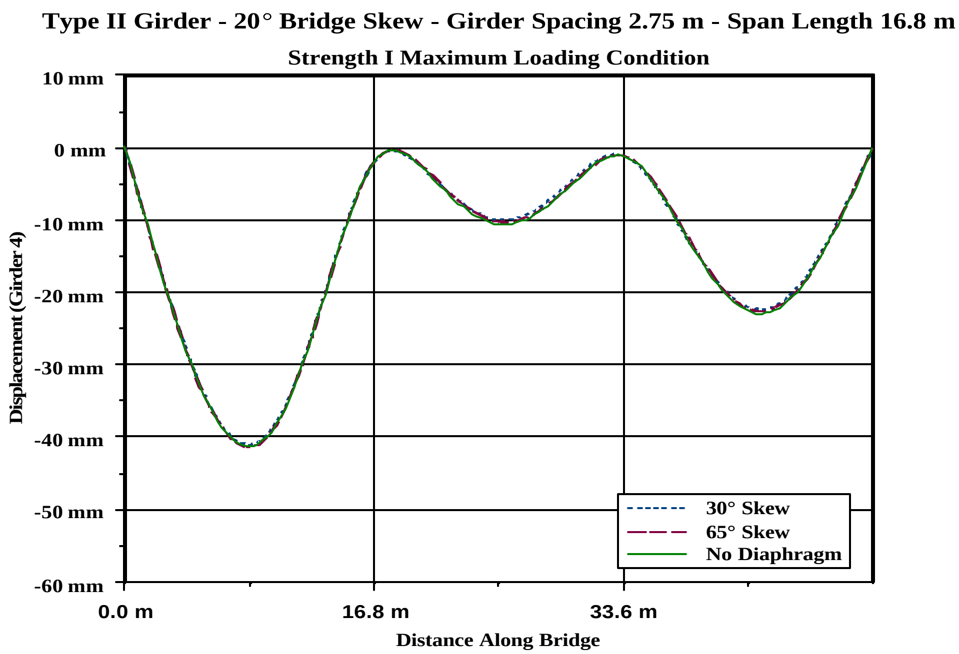

Figure 47
Effects of diaphragm skew angle on deflection in girder G4 (Group D)

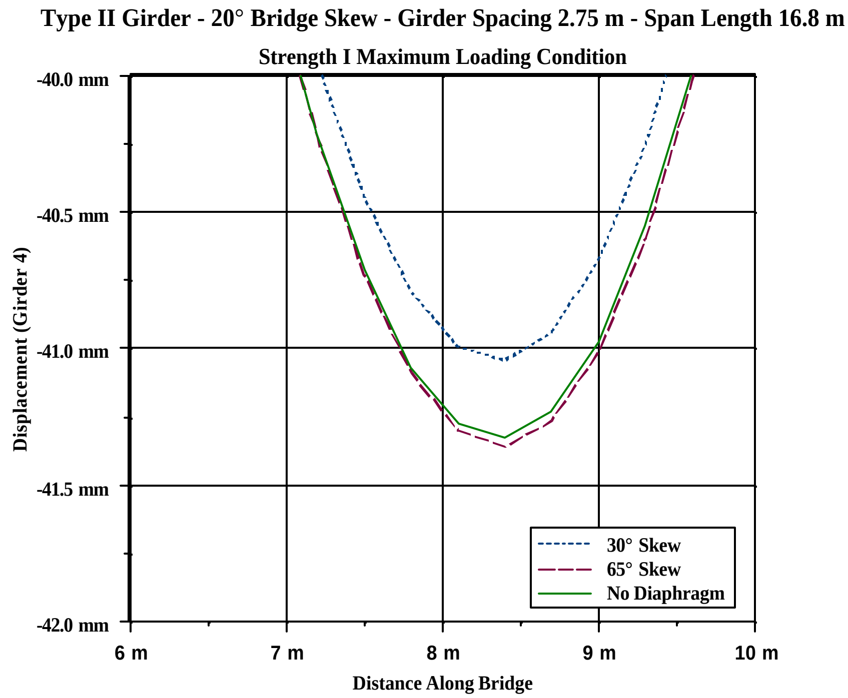

Figure 48
Effects of diaphragm skew angle on deflection at midspan girder G4 (Group D)

Bridges consisting of AASHTO Type IV girders, 10°-bridge skew, 1.52-meter girder spacing, and 34.0-meter span length (Group E)

Figure 49 compares the results of the bridge configuration in Group E. There is a 0.4 percent increase in deflection as the skew angle increases and less than less than a 0.1 percent increase when the diaphragm condition changes from a 65° skew to the case with no diaphragm. Figure 50 illustrates the changes in girder 4 deflections as the diaphragm conditions changes.

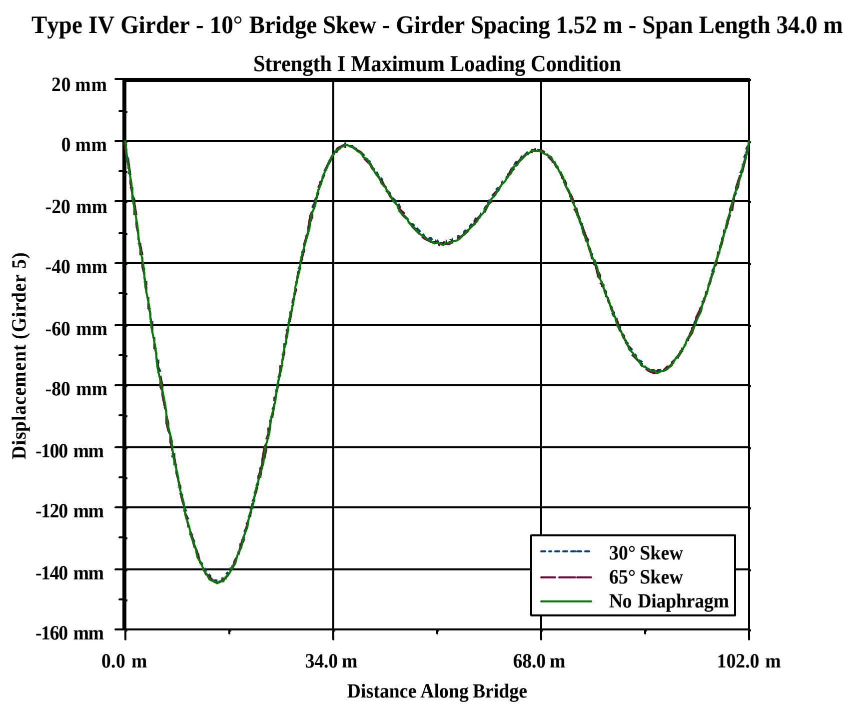

Figure 49
Effects of diaphragm skew angle on deflection in girder G5 (Group E)

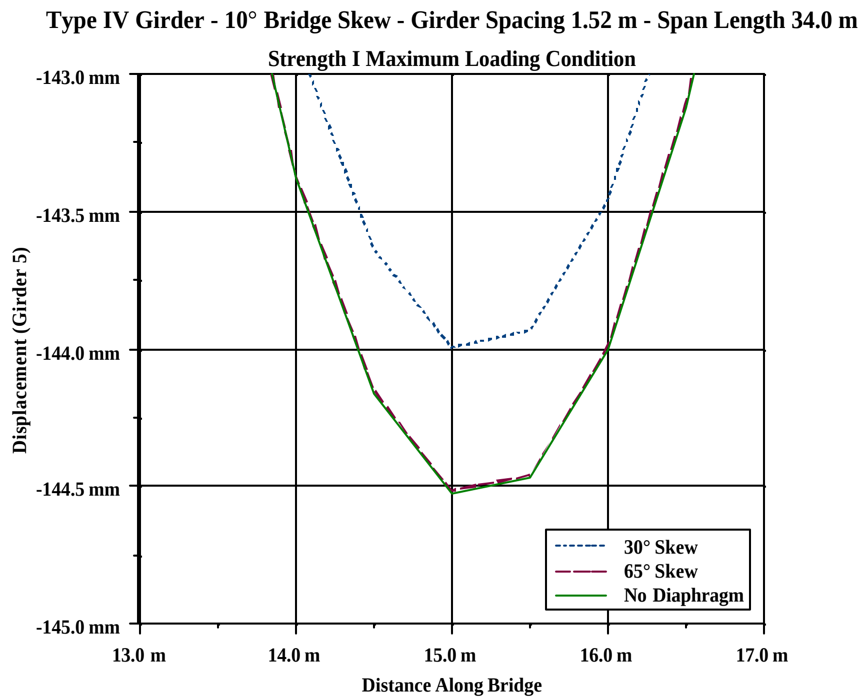

Figure 50
Effects of diaphragm skew angle on deflection at midspan girder G5 (Group E)

Bridges consisting of AASHTO Type IV girders, 10°-bridge skew, 2.75-meter girder spacing, and a 28.0-meter span length (Group F)

Figure 51 compares the results of the bridge configuration in Group F. There is a 0.5 percent increase in deflection as the skew angle increases and less than a 0.1 percent increase when the diaphragm condition changes from a 65° skew to the case with no diaphragm. Figure 52 illustrates how the changes in girder 4 deflections as the diaphragm conditions change.

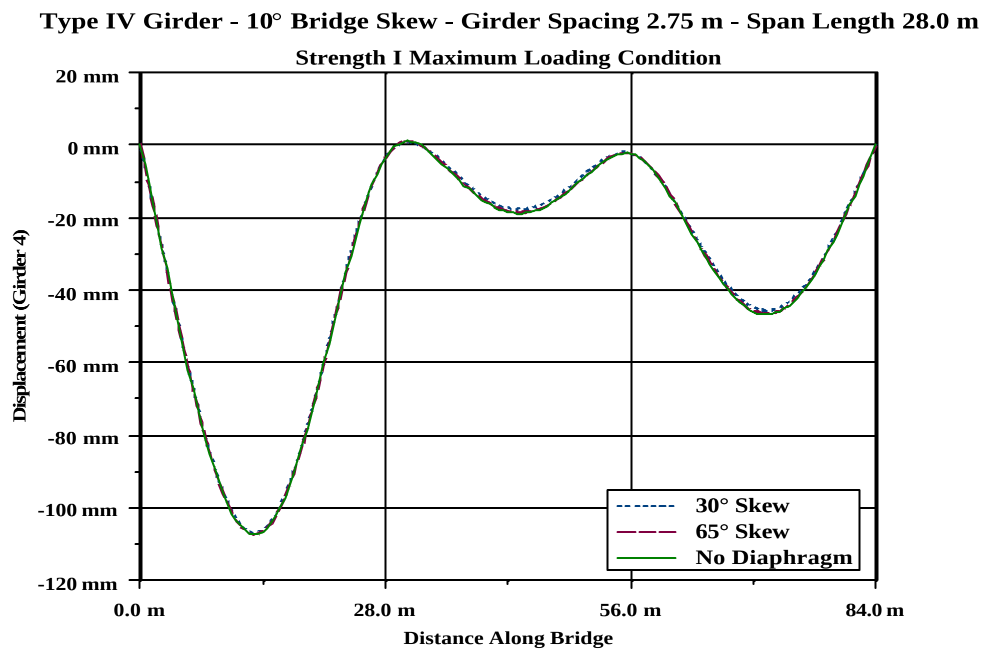

Figure 51
Effects of diaphragm skew angle on deflection in girder G4 (Group F)

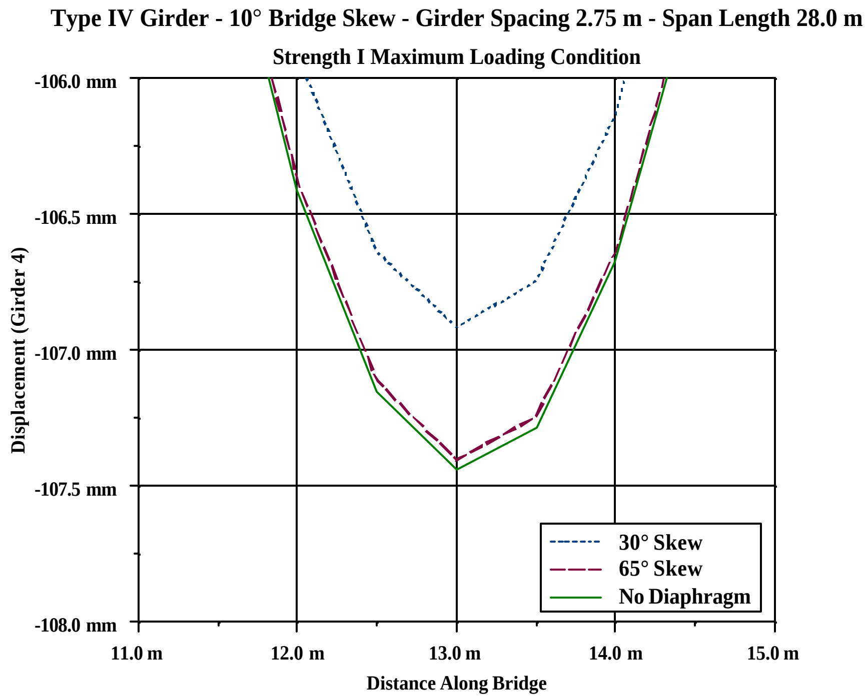

Figure 52
Effects of diaphragm skew angle on deflection at midspan girder G4 (Group F)

Bridges consisting of AASHTO Type IV girders, 20°-bridge skew, 1.52-meter girder spacing, and 34.0-meter span length (Group G)

Figure 53 compares the results of the bridge configuration in Group G. There is a 0.3 percent increase in deflection as the skew angle increases and less than a 0.1 percent increase when the diaphragm condition changes from a 65° skew to the case with no diaphragm. Figure 54 illustrates the changes in girder 5 deflections as the diaphragm conditions change.

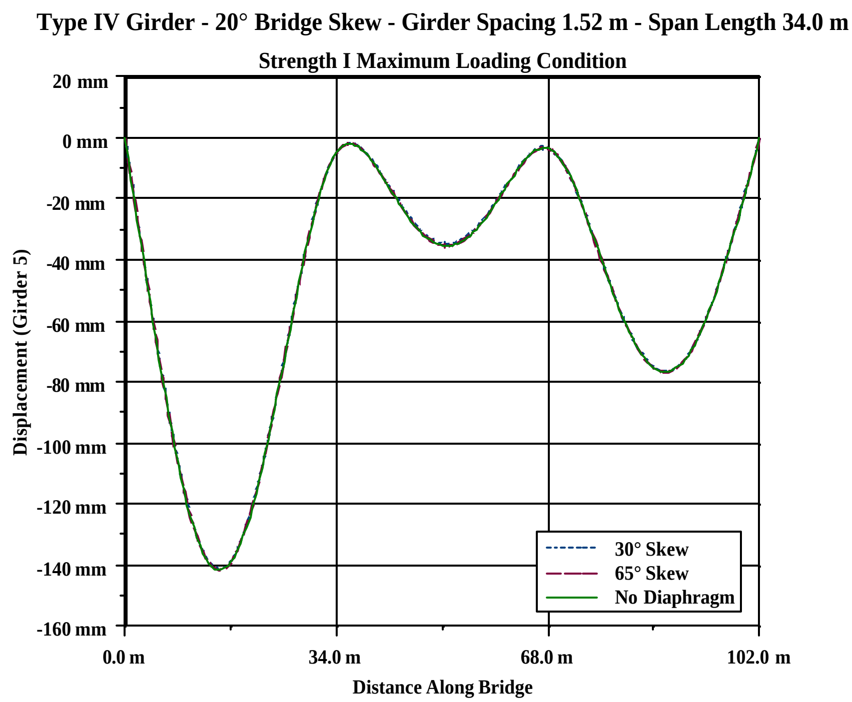

Figure 53
Effects of diaphragm skew angle on deflection in girder G5 (Group G)

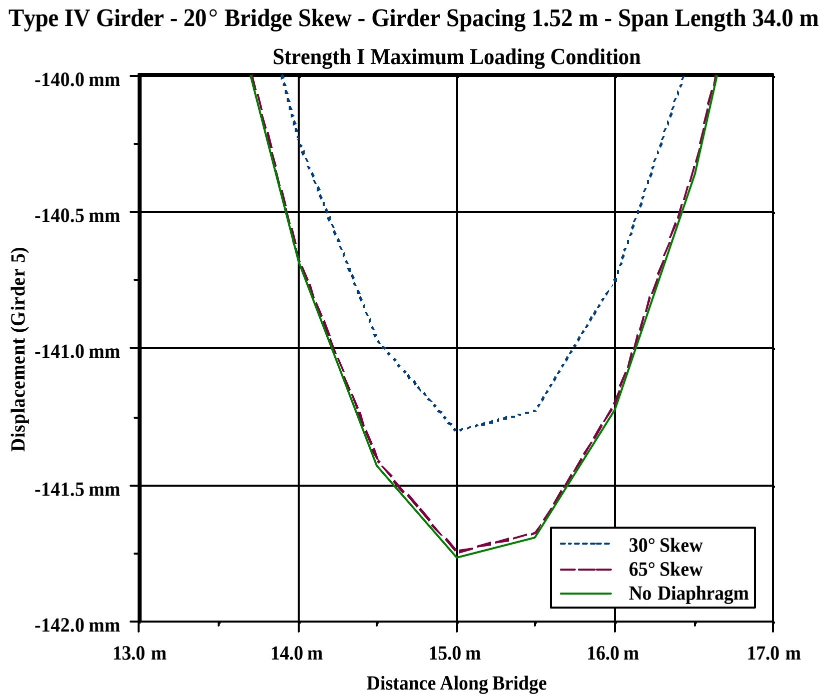

Figure 54
Effects of diaphragm skew angle on deflection at midspan girder G5 (Group G)

Bridges consisting of AASHTO Type IV girders, 20°-bridge skew, 2.75-meter girder spacing, and 28.0-meter span length (Group H)

Figure 55 compares the results of the bridge configuration in Group H. There is a 0.5 percent increase in deflection as the skew angle increases and less than a 0.1 percent increase when the diaphragm condition changes from a 65° skew to the case with no diaphragm. Figure 56 illustrates how the changes in girder 4 deflections as the diaphragm conditions change.

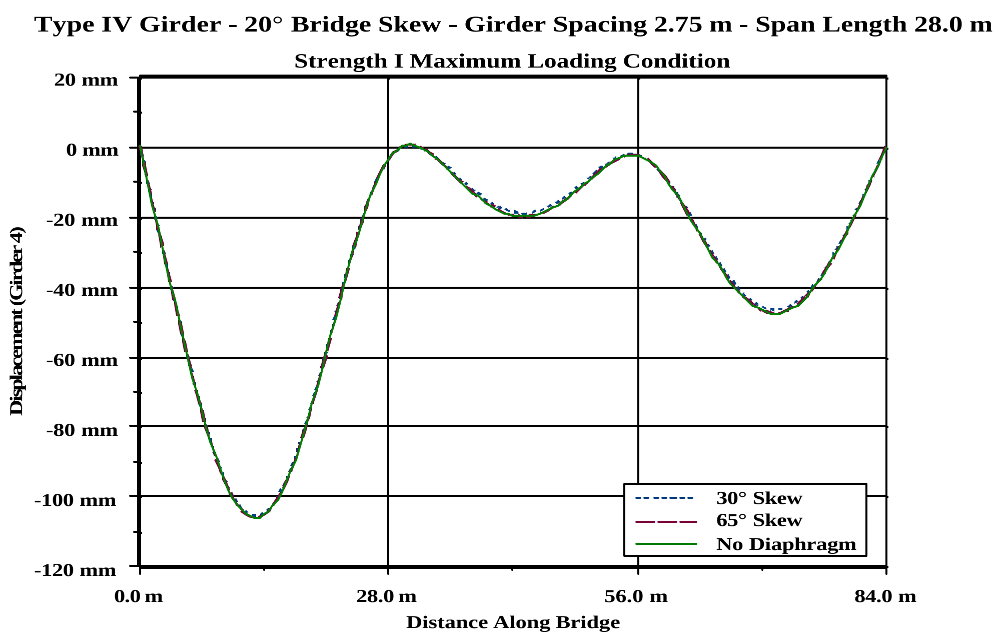

Figure 55
Effects of diaphragm skew angle on deflection in girder G4 (Group H)

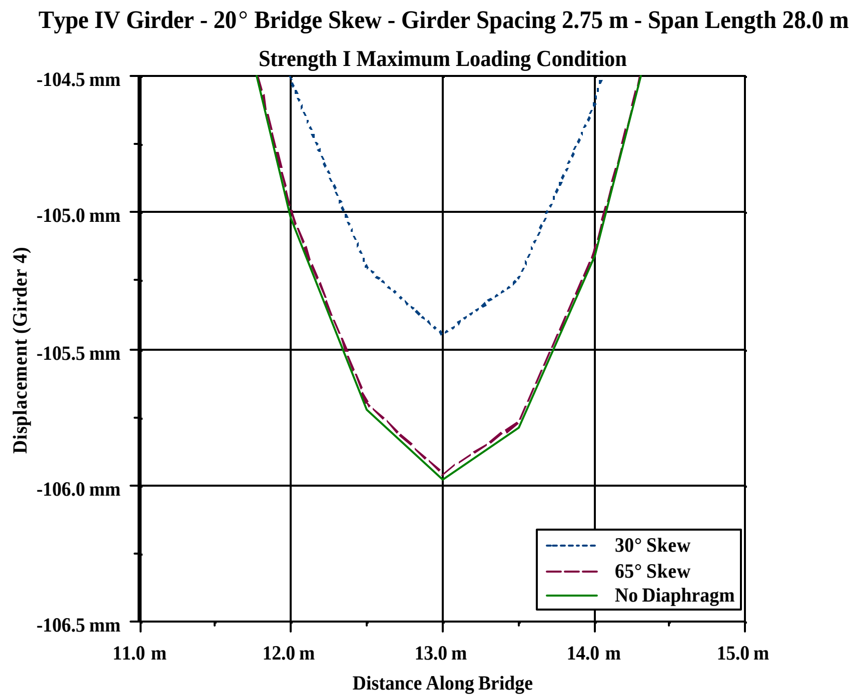

Figure 56
Effects of diaphragm skew angle on deflection at midspan girder G4 (Group H)

Axial Force in Diaphragms

The effects of the diaphragm skew angle on their axial load are investigated in this study. The results of the bridge configurations listed in table 5 due to the Strength I Maximum (1.25 DL+ 1.75 LL + 1.75 LS) and Strength III Maximum (1.25 DL +1.40 WL) loading conditions are presented in figure 57 through 72.

Bridges consisting of AASHTO Type II girders, 10° bridge skew, 1.52-meter girder spacing, and 22.8-meter span length (Group A)

Figure 57 presents the results of the axial load in the diaphragms of the bridge configuration in Group A for the Strength III Maximum loading condition. The axial load in the diaphragms decreases as the diaphragm skew angle increases. Although the Strength III Maximum loading condition carries dead load plus the wind load, the critical loading condition was the Strength I maximum loading condition. Figure 58 compares the results of the bridge configuration in Group A due to the Strength I Maximum loading condition. The axial force in the diaphragms decreases as the diaphragm skew angle increases.

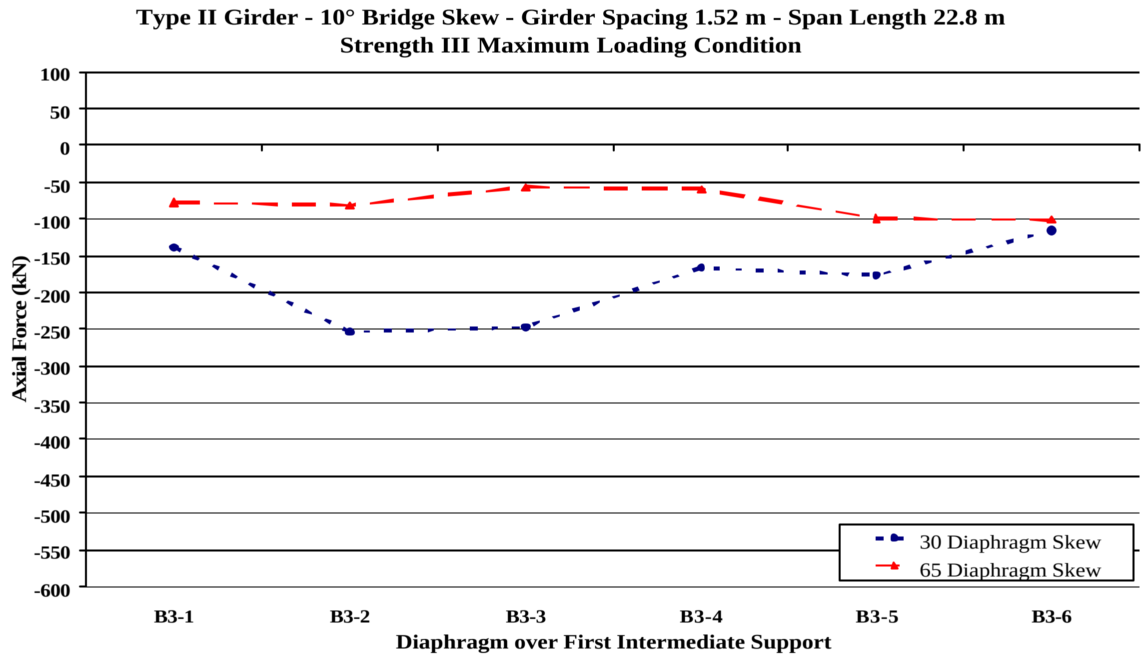

Figure 57
Effects of skew angle on axial load in diaphragm (Group A) for Strength III max

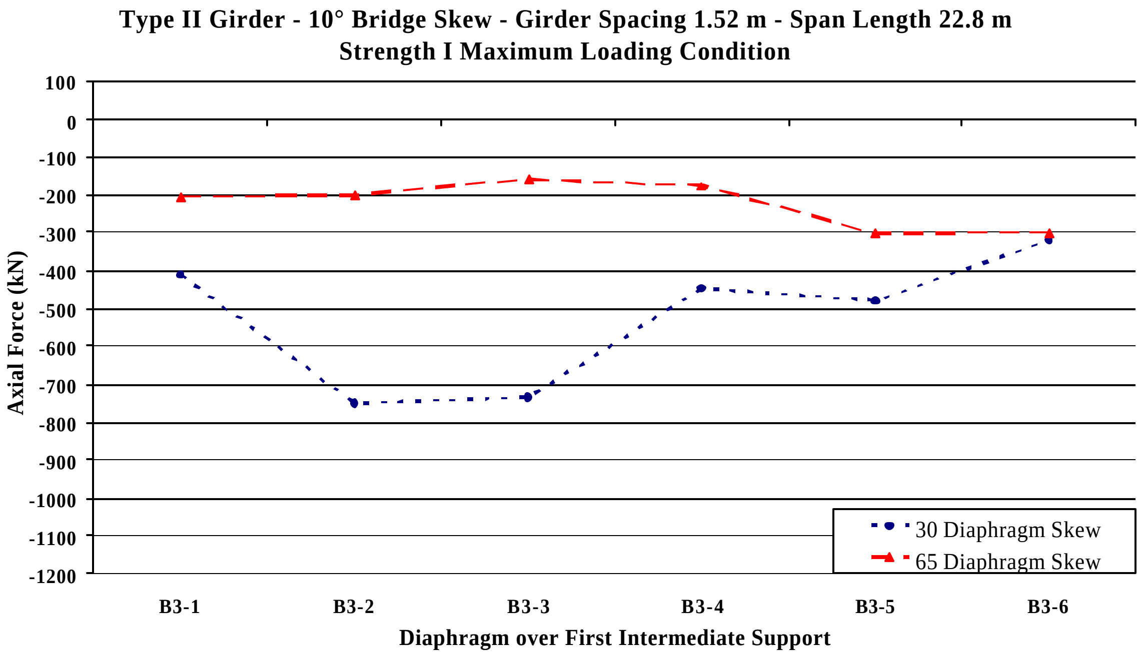

Figure 58
Effects of skew angle on axial load in diaphragm (Group A) for critical load (Strength I max)

Bridges consisting of AASHTO Type II girders, 10°-bridge skew, 2.75-meter girder spacing, and 16.8-meter span length (Group B)

Figure 59 presents the results of the axial load in the diaphragms of the bridge configuration in Group B for the Strength III Maximum loading condition. The axial load in the diaphragms decreases as the diaphragm skew angle increases. Although the Strength III Maximum loading condition carries dead load plus the wind load, the critical loading condition was the Strength I maximum loading condition. Figure 60 compares the results of the bridge configuration in Group B due to the Strength I Maximum loading condition. The axial force in the diaphragms decreases as the diaphragm skew angle increases.

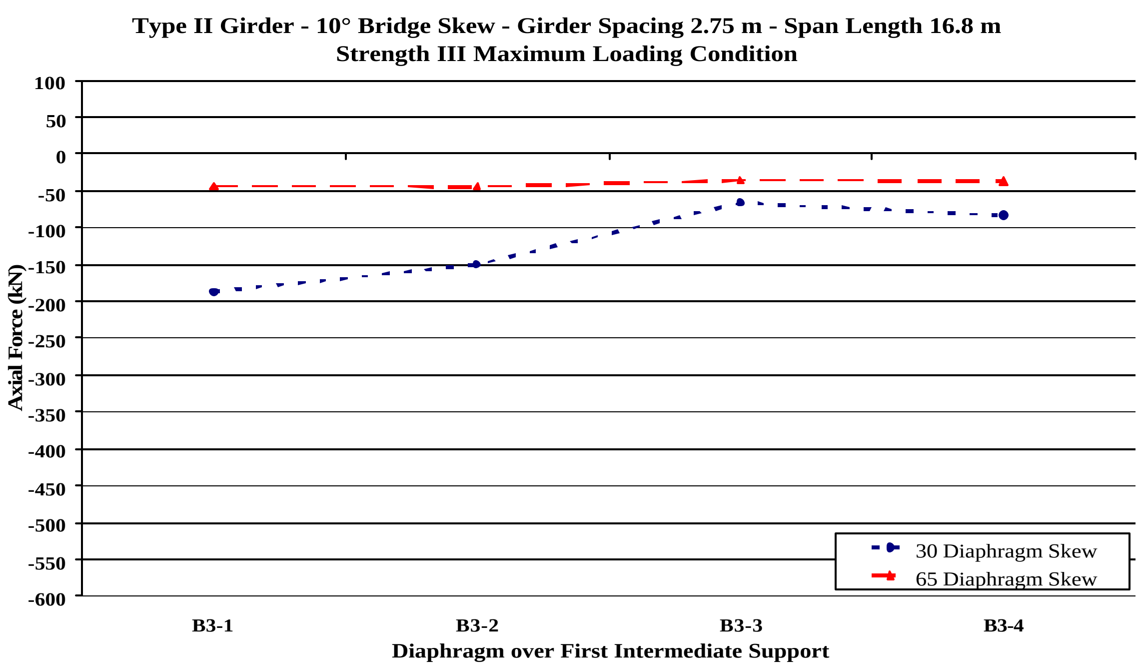

Figure 59
Effects of skew angle on axial load in diaphragm (Group B) for Strength III max

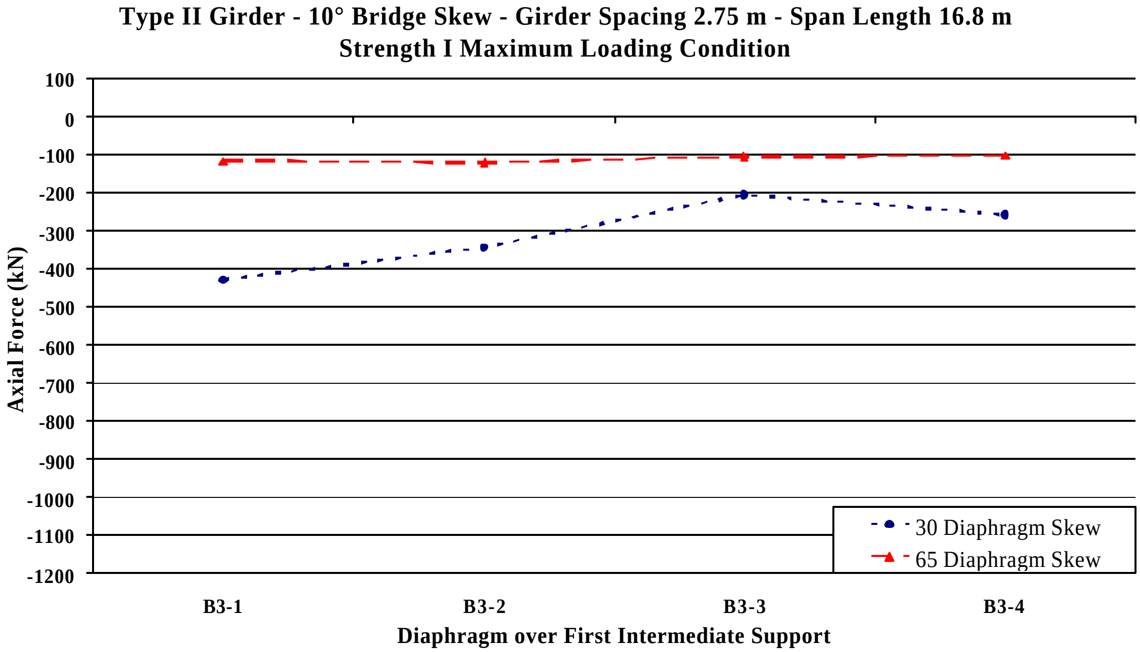

Figure 60
Effects of skew angle on axial load in diaphragm (Group B) for critical load (Strength I max)

Bridges consisting of AASHTO Type II girders, 20°-bridge skew, 1.52-meter girder spacing, and 22.8-meter span length (Group C)

Figure 61 presents the results of the axial load in the diaphragms of the bridge configuration in Group C for the Strength III Maximum loading condition. The axial load in the diaphragms decreases as the diaphragm skew angle increases. Although the Strength III Maximum loading condition carries dead load plus the wind load, the critical loading condition was the Strength I maximum loading condition. Figure 62 compares the results of the bridge configuration in Group C due to the Strength I Maximum loading condition. The axial force in the diaphragms decreases as the diaphragm skew angle increases.

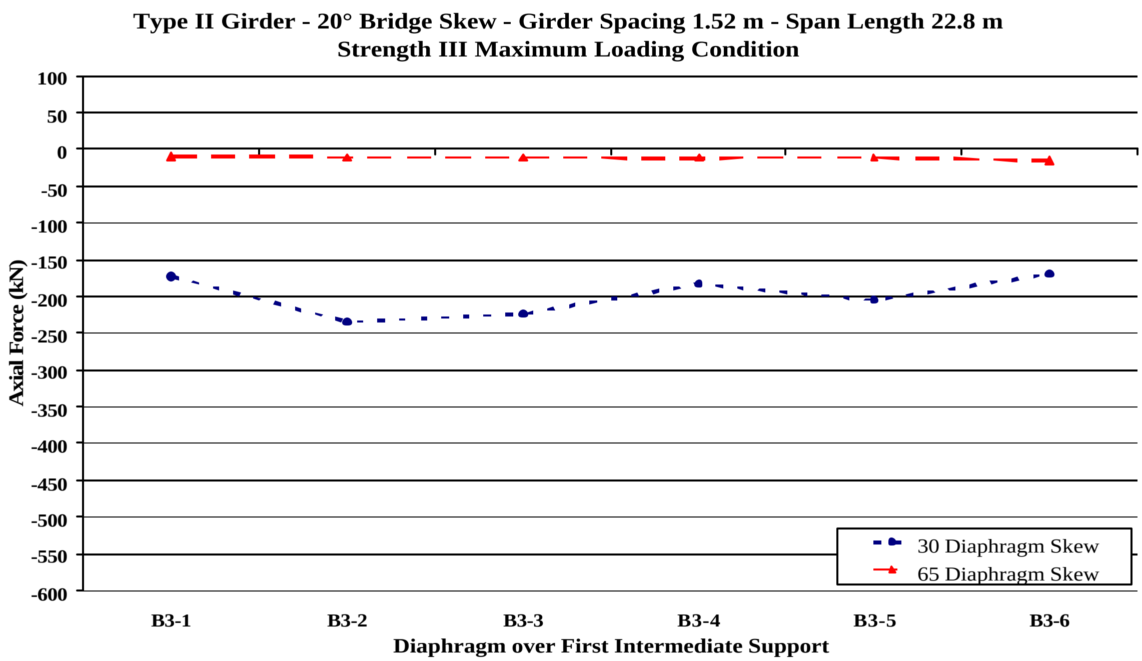

Figure 61
Effects of skew angle on axial load in diaphragm (Group C) for Strength III max

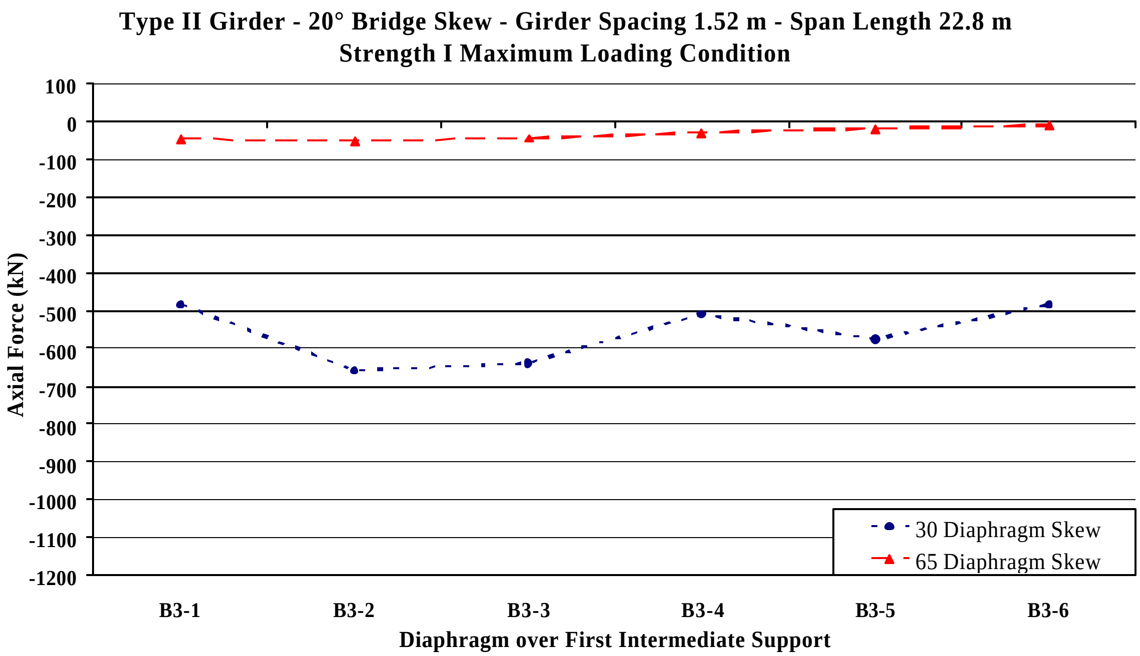

Figure 62
Effects of skew angle on axial load in diaphragm (Group C) for critical load (Strength I max)

Bridges consisting of AASHTO Type II girders, 20°-bridge skew, 2.75-meter girder spacing, and 16.8-meter span length (Group D)

Figure 63 presents the results of the axial load in the diaphragms of the bridge configuration in Group D for the Strength III Maximum loading condition. The axial load in the diaphragms decreases as the diaphragm skew angle increases. Although the Strength III Maximum loading condition carries dead load plus the wind load, the critical loading condition was the Strength I maximum loading condition. Figure 64 compares the results of the bridge configuration in Group D due to the Strength I Maximum loading condition. The axial force in the diaphragms decreases as the diaphragm skew angle increases.

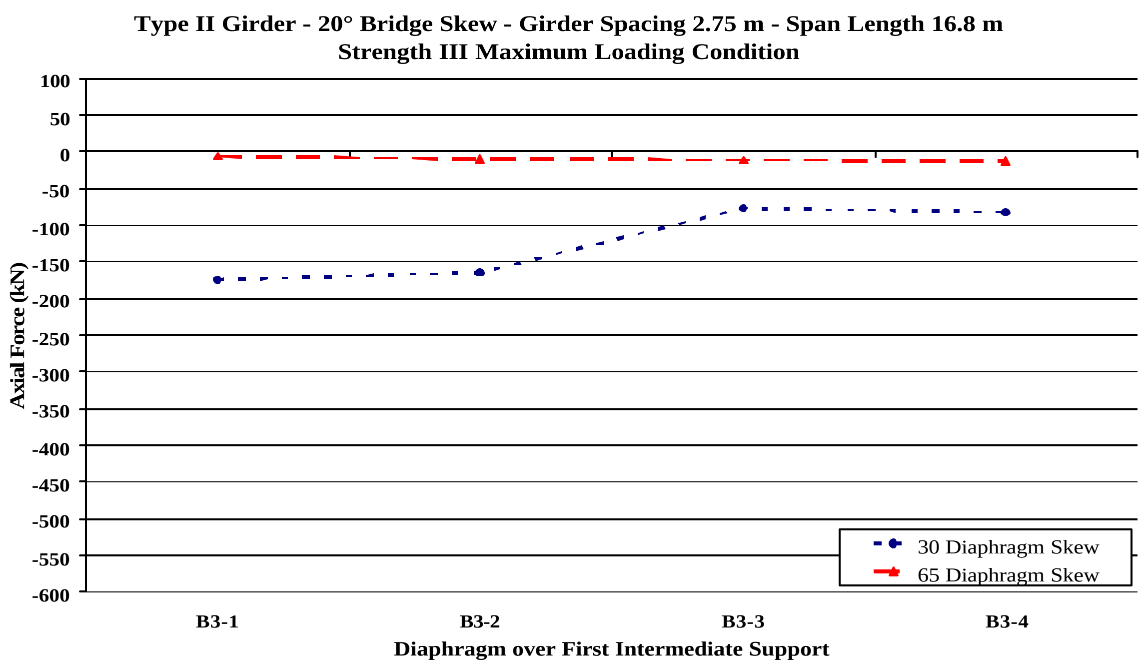

Figure 63
Effects of skew angle on axial load in diaphragm (Group D) for Strength III max

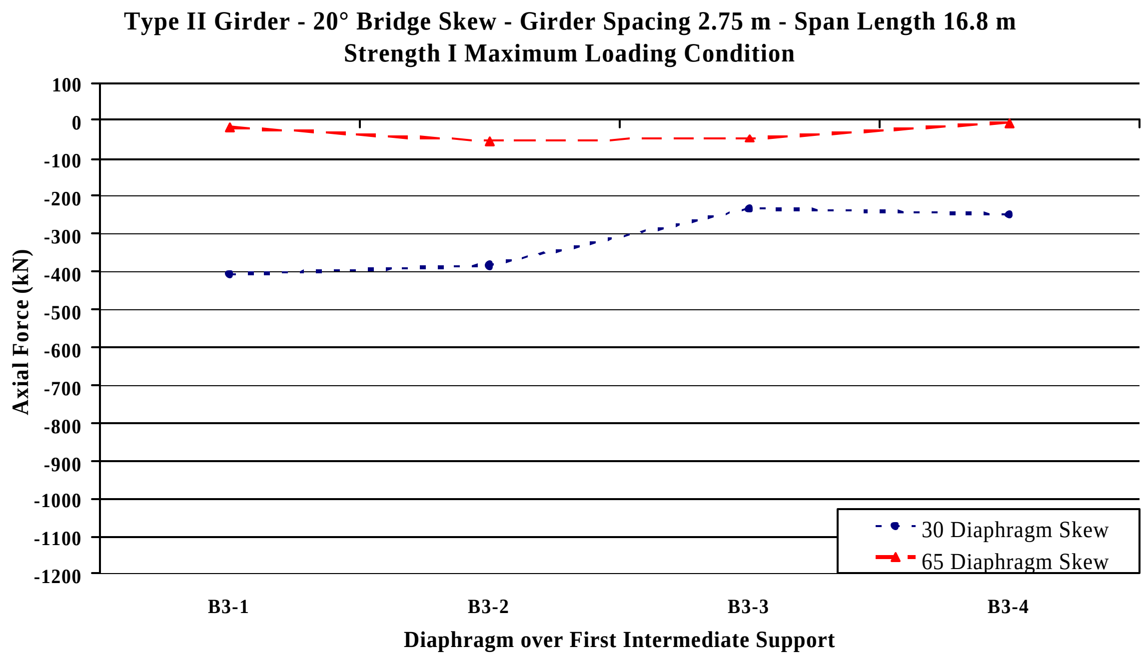

Figure 64
Effects of skew angle on axial load in diaphragm (Group D) for critical load (Strength I max)

Bridges consisting of AASHTO Type IV girders, 10°-bridge skew, 1.52-meter girder spacing, and 34.0-meter span length (Group E)

Figure 65 presents the results of the axial load in the diaphragms of the bridge configuration in Group E for the Strength III Maximum loading condition. The axial load in the diaphragms decreases as the diaphragm skew angle increases. Although the Strength III Maximum loading condition carries dead load plus the wind load, the critical loading condition was the Strength I maximum loading condition. Figure 66 compares the results of the bridge configuration in Group E due to the Strength I Maximum loading condition. The axial force in the diaphragms decreases as the diaphragm skew angle increases.

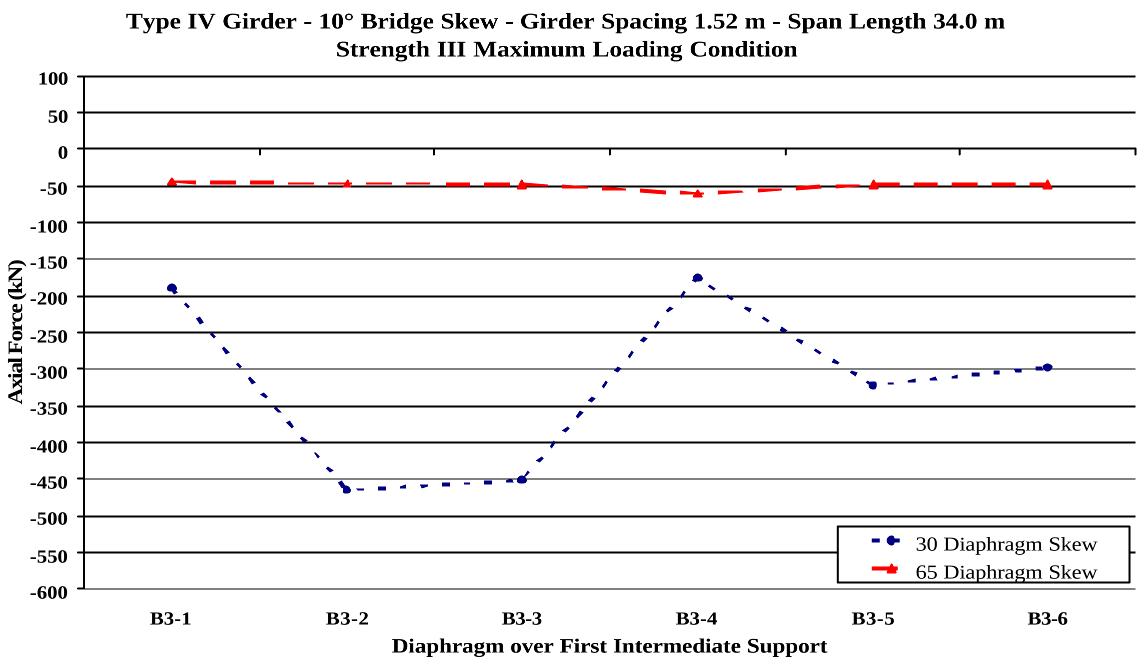

Figure 65
Effects of skew angle on axial load in diaphragm (Group E) for Strength III max

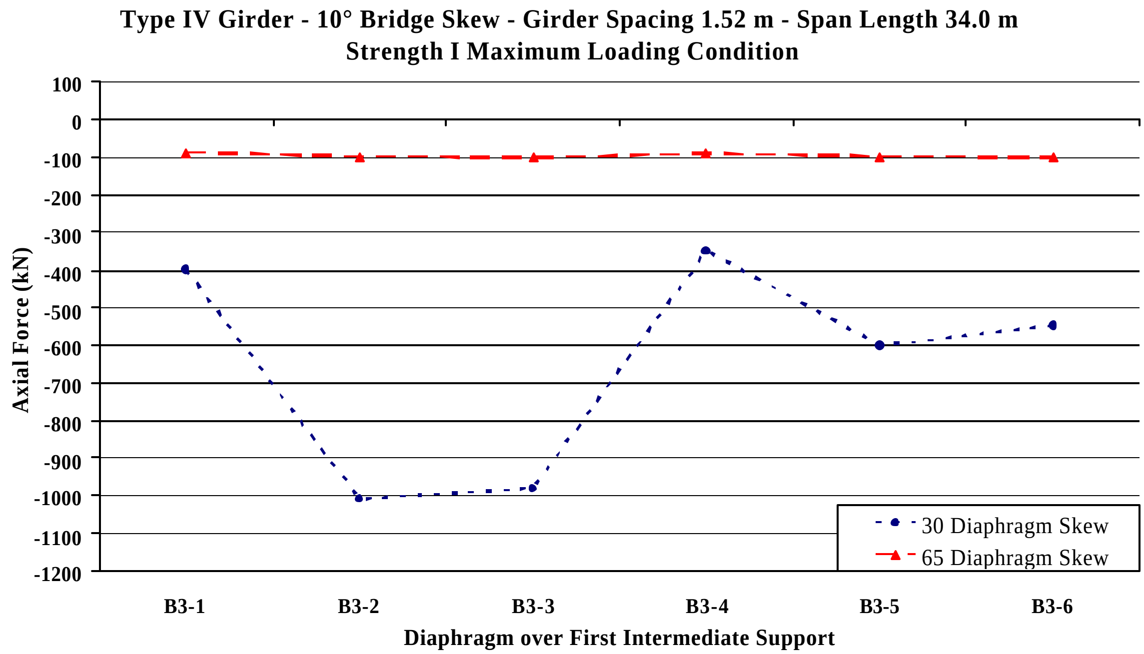

Figure 66
Effects of skew angle on axial load in diaphragm (Group E) for critical load (Strength I max)

Bridges consisting of AASHTO Type IV girders, 10°-bridge skew, 2.75-meter girder spacing, and 28.0-meter span length (Group F)

Figure 67 presents the results of the axial load in the diaphragms of the bridge configuration in Group F for the Strength III Maximum loading condition. The axial load in the diaphragms decreases as the diaphragm skew angle increases. Although the Strength III Maximum loading condition carries dead load plus the wind load, the critical loading condition was the Strength I maximum loading condition. Figure 68 compares the results of the bridge configuration in Group F due to the Strength I Maximum loading condition. The axial force in the diaphragms decreases as the diaphragm skew angle increases.

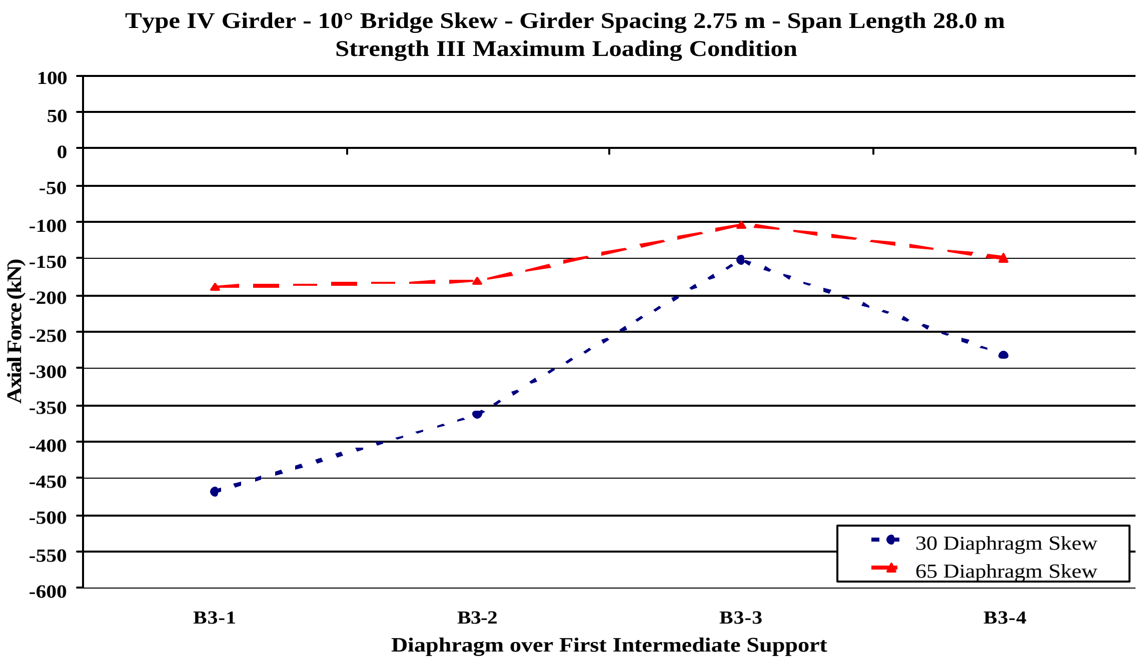

Figure 67
Effects of skew angle on axial load in diaphragm (Group F) for Strength III max

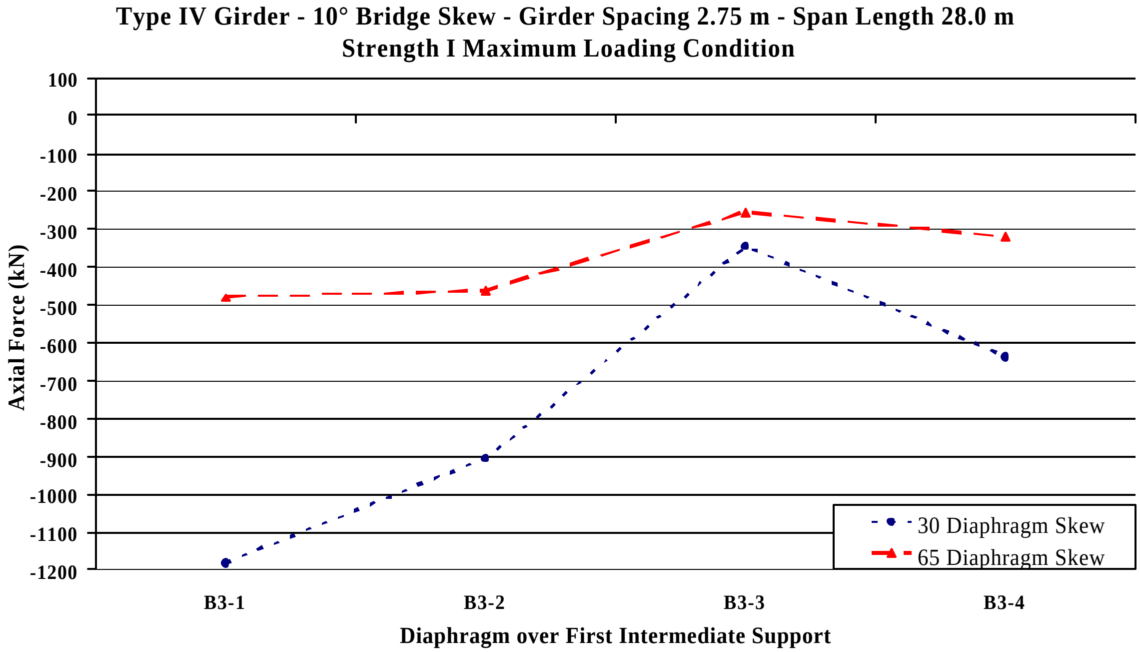

Figure 68
Effects of skew angle on axial load in diaphragm (Group F) for critical load (Strength I max)

Bridges consisting of AASHTO Type IV girders, 20°-bridge skew, 1.52-meter girder spacing, and 34.0-meter span length (Group G)

Figure 69 presents the results of the axial load in the diaphragms of the bridge configuration in Group G for the Strength III Maximum loading condition. The axial load in the diaphragms decreases as the diaphragm skew angle increases. Although the Strength III Maximum loading condition carries dead load plus the wind load, the critical loading condition was the Strength I maximum loading condition. Figure 70 compares the results of the bridge configuration in Group G due to the Strength I Maximum loading condition. The axial force in the diaphragms decreases as the diaphragm skew angle increases.

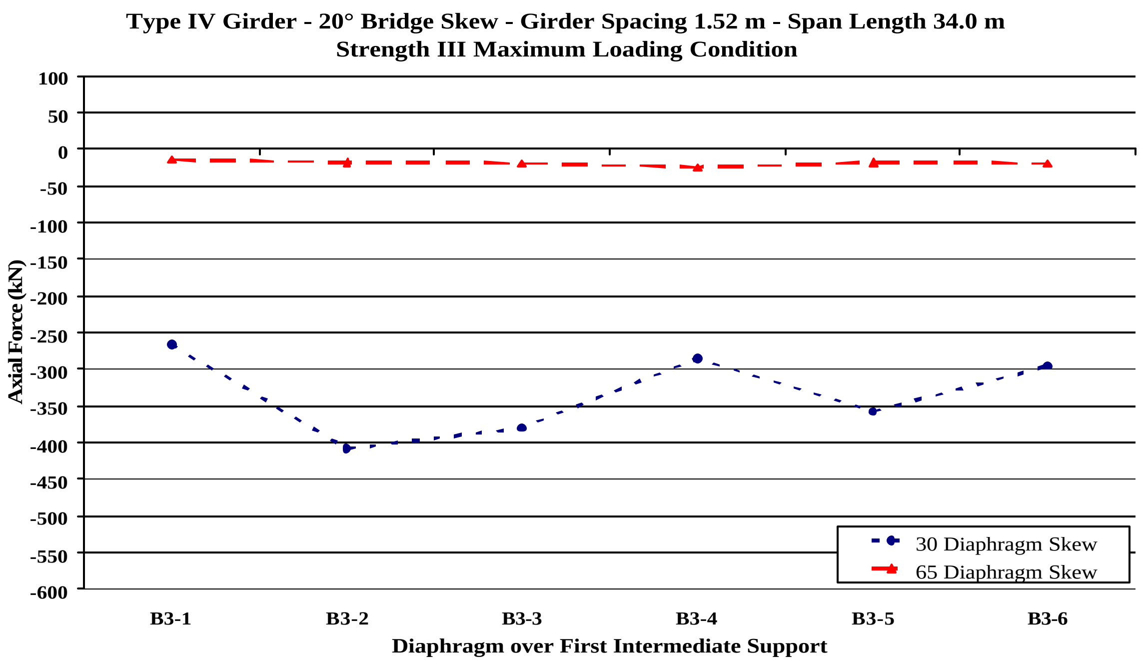

Figure 69
Effects of skew angle on axial load in diaphragm (Group G) for Strength III max

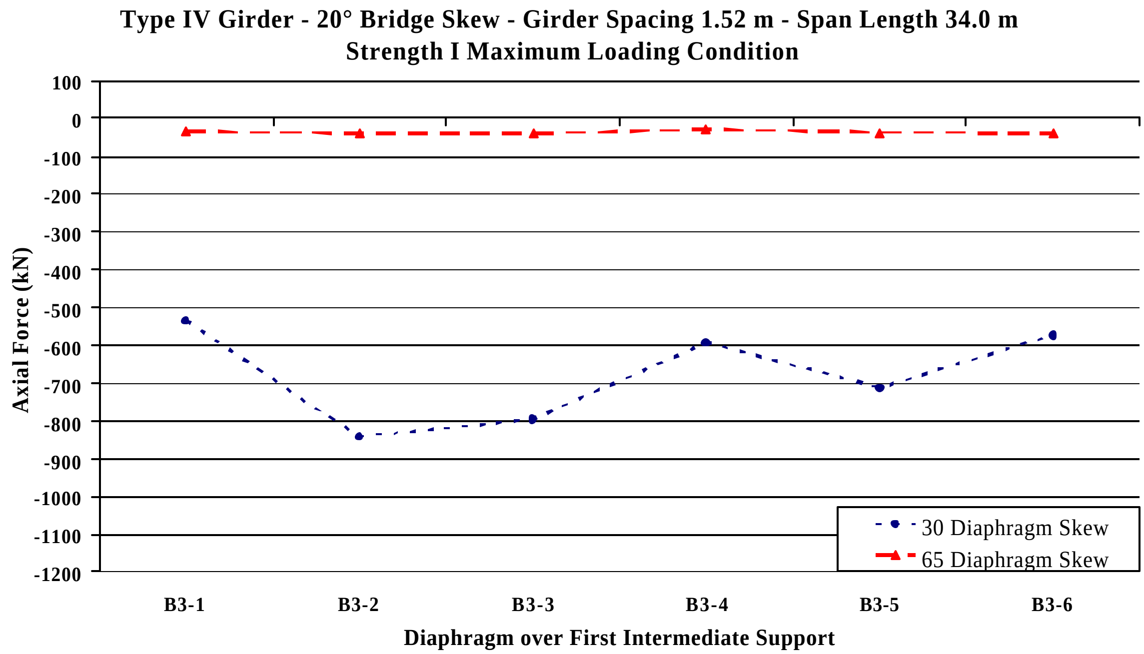

Figure 70
Effects of skew angle on axial load in diaphragm (Group G) for critical load (Strength I max)

Bridges consisting of AASHTO Type IV girders, 20°-bridge skew, 2.75-meter girder spacing, and 28.0-meter span length (Group H)

Figure 71 presents the results of the axial load in the diaphragms of the bridge configuration in Group H for the Strength III Maximum loading condition. The axial load in the diaphragms decreases as the diaphragm skew angle increases. Although the Strength III Maximum loading condition carries dead load plus a large wind load, the critical loading condition was the Strength I maximum loading condition. Figure 72 compares the results of the bridge configuration in Group H due to the Strength I Maximum loading condition. The axial force in the diaphragms decreases as the diaphragm skew angle increases.

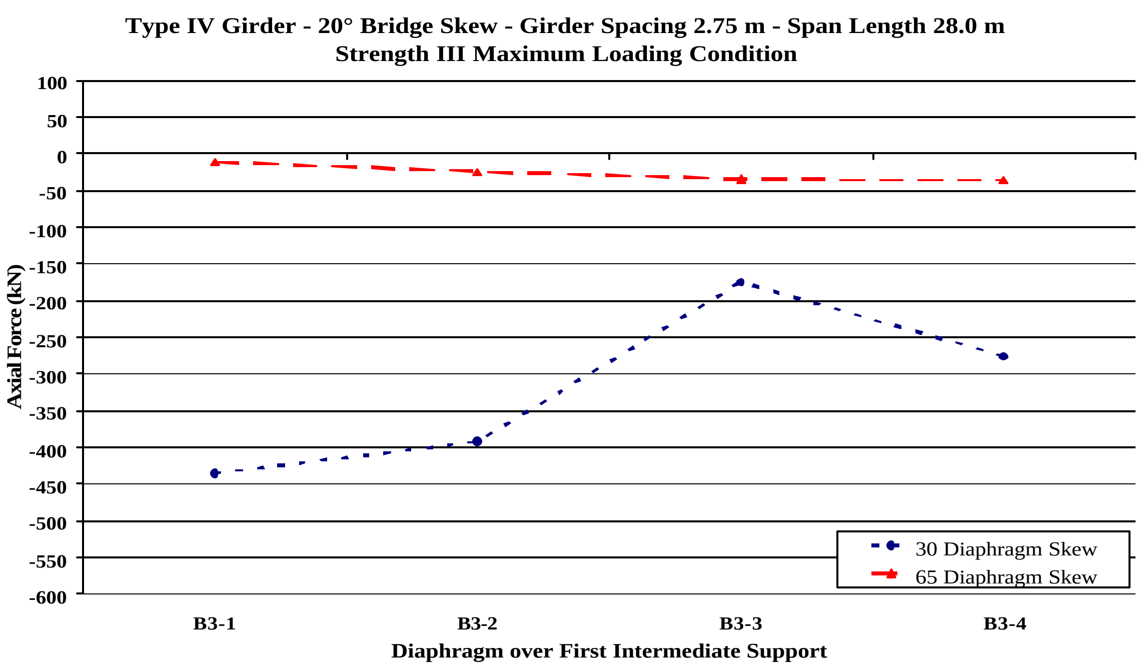

Figure 71
Effects of skew angle on axial load in diaphragm (Group H) for Strength III max

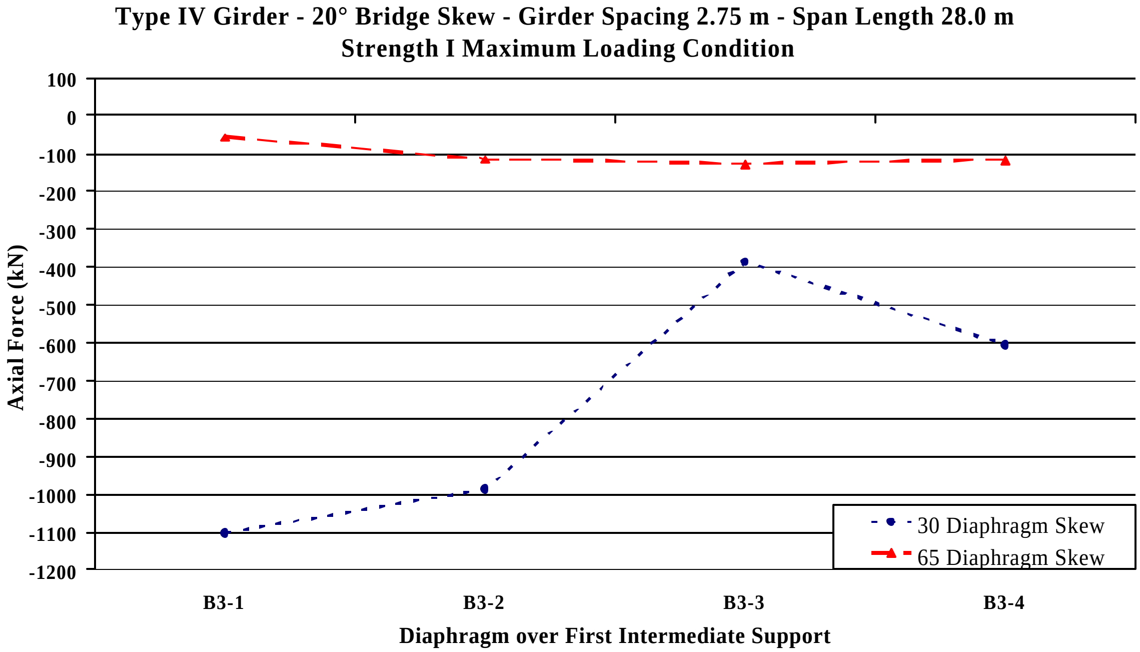

Figure 72
Effects of skew angle on axial load in diaphragm (Group H) for critical load (Strength I max)

Summary of Results

Bridges were grouped based on bridge parameters (girder type, bridge skew angle, girder spacing, span length, and diaphragm condition) to evaluate the stresses and deflections in the girders along the length of the bridge. Also, the axial loads in the diaphragms were investigated. The results of all bridge configurations listed in table 4 are compared to determine the effects of continuity diaphragms on skewed continuous bridges.

Effects of Diaphragm Skew Angle on Stress Distribution in the Girder

Table 7 presents a summary of the maximum stresses in the critical girders and table 8 shows the changes in the stresses among the models within each bridge configuration group. The stress distribution in the critical girders of the bridge configurations listed in table 4 due to the critical loading condition (Strength I Maximum) conforms to the same behavior. The results indicate that, overall, the stress over the first intermediate support, a negative moment region, decreases as the diaphragm skew angle increases. The stress near the truck loading, a positive moment region, increases as the diaphragm skew angle increases. The change in stress between the cases with a 65° diaphragm skew angle and the case without a continuity diaphragm is insignificant.

Table 7
Stresses in critical girder

Model No.	AASHTO Girder	Bridge Skew Angle	Girder Spacing (m)	Span Length (m)	Diaphragm Condition	Stress in Critical Girder Over 1st Intermediate Support (MPa)	Stress in Critical Girder Near Truck Loading (MPa)
101	Type II	10°	1.52	22.8	30° Skew	50.2	-51.8
102	Type II	10°	1.52	22.8	65° Skew	48.7	-52.1
103	Type II	10°	1.52	22.8	No Diaphragm	48.8	-52.2
104	Type II	10°	2.75	16.8	30° Skew	35.9	-29.2
105	Type II	10°	2.75	16.8	65° Skew	34.6	-29.4
106	Type II	10°	2.75	16.8	No Diaphragm	34.9	-29.4
107	Type II	20°	1.52	22.8	30° Skew	49.4	-49.8
108	Type II	20°	1.52	22.8	65° Skew	48.3	-50.3
109	Type II	20°	1.52	22.8	No Diaphragm	48.5	-50.3
110	Type II	20°	2.75	16.8	30° Skew	35.7	-28.6
111	Type II	20°	2.75	16.8	65° Skew	34.2	-28.9
112	Type II	20°	2.75	16.8	No Diaphragm	34.6	-28.9
113	Type IV	10°	1.52	34.0	30° Skew	33.1	-35.0
114	Type IV	10°	1.52	34.0	65° Skew	32.1	-35.2
115	Type IV	10°	1.52	34.0	No Diaphragm	32.2	-35.2
116	Type IV	10°	2.75	28.0	30° Skew	33.6	-37.7
117	Type IV	10°	2.75	28.0	65° Skew	32.6	-38.0
118	Type IV	10°	2.75	28.0	No Diaphragm	32.6	-38.0
119	Type IV	20°	1.52	34.0	30° Skew	33.1	-34.5
120	Type IV	20°	1.52	34.0	65° Skew	32.3	-34.7
121	Type IV	20°	1.52	34.0	No Diaphragm	32.4	-34.7
122	Type IV	20°	2.75	28.0	30° Skew	33.6	-37.4
123	Type IV	20°	2.75	28.0	65° Skew	32.5	-37.6
124	Type IV	20°	2.75	28.0	No Diaphragm	32.7	-37.6

Table 8
Changes in stress between models in the bridge configuration groups

Models Compared	Change in Stress at 1st Intermediate Support	Change in Stress Near Truck Loading
101 to 102	-3.1%	0.7%
102 to 103	0.4%	0.1%
101 to 103	-2.7%	0.8%
104 to 105	-3.6%	0.9%
105 to 106	1.0%	-0.2%
104 to 106	-2.7%	0.7%
107 to 108	-2.1%	0.9%
108 to 109	0.5%	0.0%
107 to 109	-1.6%	0.9%
110 to 111	-4.2%	1.0%
111 to 112	1.2%	-0.2%
110 to 112	-3.0%	0.8%
113 to 114	-2.9%	0.5%
114 to 115	0.3%	0.0%
113 to 115	-2.6%	0.5%
116 to 117	-3.1%	0.6%
117 to 118	0.1%	0.1%
116 to 118	-3.0%	0.7%
119 to 120	-2.3%	0.5%
120 to 121	0.3%	-0.1%
119 to 121	-2.1%	0.4%
122 to 123	-3.3%	0.7%
123 to 124	0.6%	0.0%
122 to 124	-2.7%	0.7%

Effects of Diaphragm Skew Angle on Maximum Tensile Stress in the Top Fiber of the Girder

Tables 9 through 12 present a summary of the stresses in the negative moment regions of the girders. Tables 13 and 14 show the changes in the stresses in the negative moment region between the models within each bridge configuration group. The diaphragm skew angle has the same effect on the maximum tensile stress (at top fiber of the girder) due to the critical loading condition (Strength I Maximum) for the bridge configurations listed in table 4. The results indicate that, overall, the stress for the case of 30° diaphragm skew is lower at the center girder but higher at the adjacent girders. Also, the change in stresses over the support, a negative moment region, for the cases of 65° diaphragm skew and without a continuity diaphragm is insignificant.

Table 9
Stresses in negative moment region for models 101 to 106

Model No.	AASHTO Girder	Bridge Skew Angle	Girder Spacing (m)	Span Length (m)	Diaphragm Condition	Girder No.	Stress in Negative Moment Region (MPa)
101	Type II	10°	1.52	22.8	30° Skew	1	31.9
						2	40.4
						3	47.6
						4	48.8
						5	50.2
						6	45.0
						7	38.8
102	Type II	10°	1.52	22.8	65° Skew	1	32.7
						2	41.0
						3	46.9
						4	49.8
						5	48.7
						6	45.0
						7	39.1
103	Type II	10°	1.52	22.8	No Diaphragm	1	33.0
						2	40.8
						3	47.1
						4	50.0
						5	48.8
						6	45.3
						7	39.1
104	Type II	10°	2.75	16.8	30° Skew	1	16.1
						2	33.0
						3	44.4
						4	36.9
						5	21.6
105	Type II	10°	2.75	16.8	65° Skew	1	16.2
						2	31.6
						3	44.5
						4	35.8
						5	21.8
106	Type II	10°	2.75	16.8	No Diaphragm	1	16.5
						2	32.2
						3	44.9
						4	36.3
						5	22.0

Table 10
Stresses in negative moment region for models 107 to 112

Model No.	AASHTO Girder	Bridge Skew Angle	Girder Spacing (m)	Span Length (m)	Diaphragm Condition	Girder No.	Stress in Negative Moment Region (MPa)
107	Type II	20°	1.52	22.8	30° Skew	1	35.9
						2	42.9
						3	47.8
						4	48.3
						5	49.4
						6	44.9
						7	39.2
108	Type II	20°	1.52	22.8	65° Skew	1	37.2
						2	42.7
						3	47.6
						4	49.9
						5	48.3
						6	45.1
						7	39.7
109	Type II	20°	1.52	22.8	No Diaphragm	1	37.3
						2	42.9
						3	47.8
						4	50.0
						5	48.5
						6	45.3
						7	39.8
110	Type II	20°	2.75	16.8	30° Skew	1	17.8
						2	33.3
						3	44.0
						4	36.4
						5	22.1
111	Type II	20°	2.75	16.8	65° Skew	1	17.9
						2	31.7
						3	44.2
						4	35.2
						5	22.4
112	Type II	20°	2.75	16.8	No Diaphragm	1	18.2
						2	32.2
						3	44.5
						4	35.7
						5	22.5

Table 11
Stresses in negative moment region for models 113 to 118

Model No.	AASHTO Girder	Bridge Skew Angle	Girder Spacing (m)	Span Length (m)	Diaphragm Condition	Girder No.	Stress in Negative Moment Region (MPa)
113	Type IV	10°	1.52	34.0	30° Skew	1	26.4
						2	29.4
						3	31.6
						4	31.7
						5	33.1
						6	30.8
						7	28.9
114	Type IV	10°	1.52	34.0	65° Skew	1	26.8
						2	29.9
						3	31.6
						4	32.4
						5	32.1
						6	31.2
						7	29.0
115	Type IV	10°	1.52	34.0	No Diaphragm	1	26.9
						2	29.9
						3	31.7
						4	32.5
						5	32.2
						6	31.2
						7	29.0
116	Type IV	10°	2.75	28.0	30° Skew	1	20.2
						2	29.6
						3	34.3
						4	33.6
						5	26.2
117	Type IV	10°	2.75	28.0	65° Skew	1	20.2
						2	29.1
						3	34.8
						4	32.6
						5	26.7
118	Type IV	10°	2.75	28.0	No Diaphragm	1	20.3
						2	29.4
						3	35.0
						4	32.6
						5	26.9

Table 12
Stresses in negative moment region for models 119 to 124

Model No.	AASHTO Girder	Bridge Skew Angle	Girder Spacing (m)	Span Length (m)	Diaphragm Condition	Girder No.	Stress in Negative Moment Region (MPa)
119	Type IV	20°	1.52	34.0	30° Skew	1	28.4
						2	31.0
						3	32.0
						4	31.9
						5	33.1
						6	31.1
						7	29.2
120	Type IV	20°	1.52	34.0	65° Skew	1	29.0
						2	31.0
						3	32.1
						4	32.6
						5	32.3
						6	31.4
						7	29.2
121	Type IV	20°	1.52	34.0	No Diaphra	1	29.1
						2	31.0
						3	32.2
						4	32.7
						5	32.4
						6	31.4
						7	29.2
122	Type IV	20°	2.75	28.0	30° Skew	1	22.0
						2	30.2
						3	34.3
						4	33.6
						5	27.0
123	Type IV	20°	2.75	28.0	65° Skew	1	22.0
						2	29.5
						3	34.8
						4	32.5
						5	27.6
124	Type IV	20°	2.75	28.0	No Diaphra	1	22.1
						2	29.7
						3	34.9
						4	32.7
						5	27.6

Table 13
Changes in stress in negative moment region for models 101 to 112

Models Compared	Girder No.	Percent Change	Models Compared	Girder No.	Percent Change
101 to 102	1	2.2%	107 to 108	1	3.6%
	2	1.6%		2	-0.6%
	3	-1.6%		3	-0.5%
	4	2.0%		4	3.3%
	5	-3.1%		5	-2.1%
	6	0.0%		6	0.4%
	7	0.8%		7	1.2%
102 to 103	1	0.9%	108 to 109	1	0.2%
	2	-0.4%		2	0.5%
	3	0.6%		3	0.4%
	4	0.5%		4	0.3%
	5	0.4%		5	0.5%
	6	0.7%		6	0.3%
	7	0.0%		7	0.1%
101 to 103	1	3.2%	107 to 109	1	3.9%
	2	1.1%		2	-0.1%
	3	-1.0%		3	-0.1%
	4	2.6%		4	3.6%
	5	-2.7%		5	-1.6%
	6	0.6%		6	0.8%
	7	0.8%		7	1.4%
104 to 105	1	0.4%	110 to 111	1	0.9%
	2	-4.2%		2	-4.7%
	3	0.4%		3	0.6%
	4	-2.9%		4	-3.3%
	5	0.7%		5	1.1%
105 to 106	1	1.9%	111 to 112	1	1.5%
	2	1.8%		2	1.6%
	3	0.7%		3	0.5%
	4	1.3%		4	1.3%
	5	0.8%		5	0.6%
104 to 106	1	2.3%	110 to 112	1	2.4%
	2	-2.5%		2	-3.1%
	3	1.1%		3	1.1%
	4	-1.6%		4	-2.1%
	5	1.5%		5	1.7%

Table 14
Changes in stress in negative moment region for models 113 to 124

Models Compared	Girder No.	Percent Change	Models Compared	Girder No.	Percent Change
113 to 114	1	1.7%	119 to 120	1	2.2%
	2	1.5%		2	-0.1%
	3	0.1%		3	0.4%
	4	2.3%		4	2.3%
	5	-2.9%		5	-2.3%
	6	1.1%		6	0.9%
	7	0.2%		7	0.0%
114 to 115	1	0.1%	120 to 121	1	0.1%
	2	0.2%		2	0.3%
	3	0.2%		3	0.2%
	4	0.2%		4	0.1%
	5	0.3%		5	0.3%
	6	0.0%		6	0.1%
	7	0.0%		7	0.0%
113 to 115	1	1.8%	119 to 121	1	2.3%
	2	1.7%		2	0.2%
	3	0.3%		3	0.6%
	4	2.5%		4	2.4%
	5	-2.6%		5	-2.1%
	6	1.1%		6	1.0%
	7	0.2%		7	0.1%
116 to 117	1	0.1%	122 to 123	1	-0.1%
	2	-1.9%		2	-2.1%
	3	1.4%		3	1.6%
	4	-3.1%		4	-3.3%
	5	1.7%		5	2.3%
117 to 118	1	0.1%	123 to 124	1	0.4%
	2	1.2%		2	0.7%
	3	0.6%		3	0.3%
	4	0.1%		4	0.6%
	5	0.6%		5	0.1%
116 to 118	1	0.2%	122 to 124	1	0.4%
	2	-0.6%		2	-1.5%
	3	2.0%		3	1.8%
	4	-3.0%		4	-2.7%
	5	2.4%		5	2.4%

Effects of Diaphragm Skew Angle on Girder Deflections

Table 15 presents a summary of the deflections in the critical girders and table 16 shows the changes in the deflections among the models within each bridge configuration group. The diaphragm skew angle has the same effect on the deflections of skewed continuous span bridge girders due to the critical loading condition (Strength I Maximum) for bridge configurations listed in table 4. The maximum changes in the deflection of the critical girders of continuous bridges with a 65° continuity diaphragm and without a diaphragm are insignificant. Also, the deflection decreases with a decrease in the diaphragm skew angle.

Table 15
Maximum deflections in critical girder

Model No.	AASHTO Girder	Bridge Skew Angle	Girder Spacing (m)	Span Length (m)	Diaphragm Condition	Deflection in Critical Girder (mm)
101	Type II	10°	1.52	22.8	30° Skew	-134.5
102	Type II	10°	1.52	22.8	65° Skew	-135.2
103	Type II	10°	1.52	22.8	No Diaphragm	-135.3
104	Type II	10°	2.75	16.8	30° Skew	-42.9
105	Type II	10°	2.75	16.8	65° Skew	-43.2
106	Type II	10°	2.75	16.8	No Diaphragm	-43.2
107	Type II	20°	1.52	22.8	30° Skew	-128.9
108	Type II	20°	1.52	22.8	65° Skew	-129.7
109	Type II	20°	1.52	22.8	No Diaphragm	-129.8
110	Type II	20°	2.75	16.8	30° Skew	-42.1
111	Type II	20°	2.75	16.8	65° Skew	-42.4
112	Type II	20°	2.75	16.8	No Diaphragm	-42.4
113	Type IV	10°	1.52	34.0	30° Skew	-148.4
114	Type IV	10°	1.52	34.0	65° Skew	-148.9
115	Type IV	10°	1.52	34.0	No Diaphragm	-148.9
116	Type IV	10°	2.75	28.0	30° Skew	-110.0
117	Type IV	10°	2.75	28.0	65° Skew	-110.5
118	Type IV	10°	2.75	28.0	No Diaphragm	-110.5
119	Type IV	20°	1.52	34.0	30° Skew	-145.5
120	Type IV	20°	1.52	34.0	65° Skew	-146.0
121	Type IV	20°	1.52	34.0	No Diaphragm	-146.0
122	Type IV	20°	2.75	28.0	30° Skew	-108.5
123	Type IV	20°	2.75	28.0	65° Skew	-109.0
124	Type IV	20°	2.75	28.0	No Diaphragm	-109.0

Table 16
Changes in deflection between models in the bridge configuration groups

Models Compared	Change in Deflection Near Truck Loading
101 to 102	0.5%
102 to 103	0.1%
101 to 103	0.6%
104 to 105	0.7%
105 to 106	0.0%
104 to 106	0.7%
107 to 108	0.6%
108 to 109	0.0%
107 to 109	0.7%
110 to 111	0.8%
111 to 112	-0.1%
110 to 112	0.7%
113 to 114	0.4%
114 to 115	0.0%
113 to 115	0.4%
116 to 117	0.5%
117 to 118	0.0%
116 to 118	0.5%
119 to 120	0.3%
120 to 121	0.0%
119 to 121	0.3%
122 to 123	0.5%
123 to 124	0.0%
122 to 124	0.5%

Axial Force in Diaphragms

Table 17 presents a summary of the maximum axial load in the diaphragms and table 18 shows the changes in the maximum axial load among the models within each bridge configuration group. The effects of diaphragm skew angle on their axial load are investigated in this study. Results indicate that for the critical load condition (strength I maximum), the axial force in the diaphragm decreases as the skew angle increases for all groups of bridge configurations.

Table 17
Maximum axial load in diaphragms

Model No.	AASHTO Girder	Bridge Skew Angle	Girder Spacing (m)	Span Length (m)	Diaphragm Condition	Axial Load in Diaphragm (kN)
101	Type II	10°	1.52	22.8	30° Skew	-751.5
102	Type II	10°	1.52	22.8	65° Skew	-304.9
103	Type II	10°	1.52	22.8	No Diaphragm	
104	Type II	10°	2.75	16.8	30° Skew	-431.7
105	Type II	10°	2.75	16.8	65° Skew	-123.6
106	Type II	10°	2.75	16.8	No Diaphragm	
107	Type II	20°	1.52	22.8	30° Skew	-661.4
108	Type II	20°	1.52	22.8	65° Skew	-53.0
109	Type II	20°	1.52	22.8	No Diaphragm	
110	Type II	20°	2.75	16.8	30° Skew	-406.3
111	Type II	20°	2.75	16.8	65° Skew	-54.7
112	Type II	20°	2.75	16.8	No Diaphragm	
113	Type IV	10°	1.52	34.0	30° Skew	-1008.9
114	Type IV	10°	1.52	34.0	65° Skew	-100.9
115	Type IV	10°	1.52	34.0	No Diaphragm	
116	Type IV	10°	2.75	28.0	30° Skew	-1183.4
117	Type IV	10°	2.75	28.0	65° Skew	-480.4
118	Type IV	10°	2.75	28.0	No Diaphragm	
119	Type IV	20°	1.52	34.0	30° Skew	-842.6
120	Type IV	20°	1.52	34.0	65° Skew	-40.0
121	Type IV	20°	1.52	34.0	No Diaphragm	
122	Type IV	20°	2.75	28.0	30° Skew	-1104.1
123	Type IV	20°	2.75	28.0	65° Skew	-129.3
124	Type IV	20°	2.75	28.0	No Diaphragm	

Table 18
Changes in maximum axial load in diaphragm between models

Models Compared	Percent Change
101 to 102	-59.4%
102 to 103	
101 to 103	
104 to 105	-71.4%
105 to 106	
104 to 106	
107 to 108	-92.0%
108 to 109	
107 to 109	
110 to 111	-86.5%
111 to 112	
110 to 112	
113 to 114	-90.0%
114 to 115	
113 to 115	
116 to 117	-59.4%
117 to 118	
116 to 118	
119 to 120	-95.3%
120 to 121	
119 to 121	
122 to 123	-88.3%
123 to 124	
122 to 124	

CONCLUSIONS

General Summary

The effects of diaphragm skew angle on the behavior of continuous span precast prestressed concrete girder bridges have been investigated using finite element analysis based on information gathered from questionnaires sent to other states' departments of transportation. Structures considered in this study are 9.14-meter wide, three span, continuous concrete girder bridges. All bridges had a uniform deck thickness of 200 millimeters. In addition to the diaphragm condition (i.e., 30° skew, 65° skew, and no diaphragm), other bridge parameters investigated include: AASHTO Type II and Type IV girders, 10° and 20° bridge skew angles, 1.52 meter girder spacing with 22.8 meter and 34.0 meter span lengths, and 2.75 meter girder spacing with 16.8 meter and 28.0 meter span lengths.

The skew angle of the bridge is the angle between the centerline of a support and a line normal to the roadway centerline. The skew angle of the diaphragm is the angle between its centerline and the roadway centerline.

All of the bridge configurations were analyzed using GTSTRUDL version 25 and subjected to their own dead load, a truck loading on the bridge that was represented by the HS20 truck loading, a live load surcharge applied to the bridge deck, and a wind load applied to the exterior girder.

Conclusions

The objectives of this investigation are to (1) determine the need of continuity diaphragms, (2) study the load transfer mechanism through diaphragms, (3) determine when a full depth diaphragm is required, and (4) determine the minimum skew angle at which a diaphragm becomes ineffective. The effects of continuity diaphragms for skewed continuous span precast prestressed concrete girder bridges are investigated in this study. Based on the results of the different bridge models used in the finite element analyses considered in this study, it is concluded that the continuity diaphragms may improve the load distribution characteristics, but their effectiveness for skewed continuous bridges is limited.

RECOMMENDATIONS

The results of the study presented in this investigation were based on finite element analysis to determine the effects of continuity diaphragms for skewed continuous span precast prestressed concrete girder bridges. The parameters that were considered in this study were bridge configurations with varying girder types, bridge skew angles, girder spacing, span length, and diaphragm skew angles. Based on the analytical results, it is recommended that continuity diaphragms for skewed continuous bridges are not used; however, it is recommended that laboratory tests and field measurements be considered to verify the theoretical results. Further research is needed to perform field load tests on similar bridges and compare measured strains and deflections with those determined through the theoretical approaches presented in this research.

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APPENDICES

Note: Due to the their size, all appendices are provided on the accompanying CD.

APPENDIX A

Survey Questionnaire

In order to design the survey to be mailed to Out-Of-State bridge engineers, the results of the literature search was combined with the following bridge parameters: material properties, relative dimensions of girders and slabs, bridge geometry, skew angle, girder spacing, span length, number of spans, type of loading, location and stiffness of diaphragms and location of supports. The design of the survey was based on modern methodologies of surveying and sensing (Spunt 1999, Peterson, 1999).

In the process of formulating the questionnaire, we implemented recommendations for modern surveys and questionnaires (Spunt 1999, Peterson, 1999). We emphasized the following points:

- Questionnaire Objectives
- Questionnaire Layout
- Questionnaire Content
- Questionnaire Flow
- Question Structure
- Question Wording
- Questionnaire Reliability and Validity

The proposed questionnaire was designed such as it would give us basic information that would guide us in narrowing the parameters of analysis to those that are of practical implication. The questionnaire assumes familiarity of the surveyed people with bridge terminology. As such, lengthy descriptions were omitted.

Continuity Diaphragm For Skewed Continuous Span Precast Prestressed Concrete Girder Bridges

STATE Project No. 736-99-0914

QUESTIONNAIRE SURVEY

November 13, 2001

PROJECT TEAM

Dr. Aziz Saber, P.E., Assistant Professor

Dr. Leslie Guice, P.E., Professor

Dr. Abdelkader Tayebi, Assistant Professor

Civil Engineering Program, 600 W. Arizona, Louisiana Tech University
Ruston, LA 71270. Phone: (318) 257-3744; Fax: (318) 257-2306
E-mail address: saber@coes.latech.edu

PROJECT MANAGER
Mr. Walid Alaywan, P.E.

Louisiana Transportation Research Center (LTRC)
4101 Gourrier Avenue
Baton Rouge, La 70808
Phone: (225) 767-9106 Fax: (225) 767-9108

E-mail address: **walaywan@dotd.state.la.us**

Purpose and Definition

This survey concerns the use of continuity diaphragms for skewed continuous span precast prestressed girder bridges on skewed bents. These diaphragms are posing some difficulties in detailing and construction for skew angles larger than 30 degrees, especially when the girder spacing decreases, the connection and the construction become more difficult. Even the effectiveness of the diaphragms is questionable at these high skews.

The design guidelines for bridges in AASHTO indicate that diaphragms should be installed for T-girder spans and may be omitted where structural analysis show adequate strength. Furthermore, the effects of diaphragms are not accounted for in the proportioning of the girders.

The Louisiana Transportation Research Center has contracted with the Louisiana Tech University to study the effectiveness of such diaphragms and when needed to provide practical construction details.

The objectives of this research are to (1) determine the need of continuity diaphragms, (2) study the load transfer mechanism through diaphragms, (3) determine when a full depth diaphragms is required, and (4) to determine the minimum skew angle at which a diaphragm becomes ineffective.

The purpose of this survey is to gather the information needed to complete the study on the basis of practical information that will be integrated with theoretical analysis. Please take a few minutes to complete the survey. Where numerical data is requested, reasonable estimates and/or ranges are acceptable. Please return the survey, by Friday, December 14, 2001, via fax or E-mail to:

Dr. Aziz Saber
Louisiana Tech University
Fax: 318.257.2306
E-mail address: saber@coes.latech.edu

Thanking you in advance.

Aziz Saber, Leslie Guice, Abdelkader Tayebi

General Information

Organization's name:

Respondent's name:

Position/Title:

Address:

1. Do/Did you own, design or construct skew continuous precast concrete bridges?

   __ Yes ____ No (If no, please stop here)

2. Please estimate the number of skewed continuous precast prestressed concrete bridges with or without continuity diaphragms in each of the following categories: (Please answer those which apply to your organization)

	Last 5 Years		Total	
	With Diaph.	Without	With Diaph.	Without
Do you own or have in service?	_________	_______	________	_______
Have you designed in your office?	_________	_______	_________	_______

3. Typical material properties specified for skewed bridges and diaphragms (Normal & High Performance/Strength Concrete mix):

Release strength (f'_{ci})	_________	_________
Final strength ($f'c$)	_________	_________
Strand size, grade, type	_________	_________
Strength of deck concrete (Lightweight)	_________	_________
Shear connectors type/strength	_________	_________
Concrete strength of slab	_________	_________
Concrete strength of intermediate/end diaphragm	_________	_________
Concrete strength of continuous diaphragm	_________	_________

4. What type of girders do you use in skew continuous precast prestressed concrete bridges?

Type of Girder	Span Length	Span Width	Slab Thickness	Girder Spacing	Girder Height	Bridge skew angle	Diaphragm skew angle	Diaphragm Dimensions
AASHTO Type I								
AASHTO Type II								
AASHTO Type III								
AASHTO Type IV								
AASHTO Type V								
AASHTO Type VI								
Box Type Girders								
Other								

5. What construction sequence do you follow? (check all which apply)

___ Continuity diaphragm cast first then deck.
___ Continuity diaphragm and deck cast at the same time.
____ Other

Please specify____

____

____

6. What are some of the issues/problems with regards to skewed continuity diaphragms you use or have used in the past? (check all which apply)

Type of Problem	Bridge Skew Angle Range at which problems occur	Diaphragm skew angle range at which problems occur
none		
none		

7. Would you consider or have you used post-tensioning to prevent cracking at the continuity connection?

____ Yes ____ No

8. Have you experienced specific problems with the negative moment diaphragm connections?

____ Yes ____ No

Please specify____

____

9. When you design a continuity diaphragm what method of analysis do you use? (Check all which apply)

____ Code Methods
____ Simple beam theory
____ Finite Element Method (what type of elements)
____ Finite Strip Method
____ Other-please specify

10. Please indicate the type of continuity diaphragm connection used in skew bridges you dealt with: (Check all that apply)

___ None
____ Mild reinforcement extending from bottom flange of girder
    ____ Straight
    ____ 90^0 bent up into diaphragm
    ____ 180^0 (Hairpin) with both legs embedded in girder
____ Some form of mechanical bar connector
____ Welded bar connection
____ Strand extension bent up into diaphragm
____ Some form of mechanical strand connector
____ Other

Please specify____

11. Are their any additional bars extending into the continuity diaphragm such as bars passing through holes in web?

Please specify:

____

____

____

12. How much of the girder is embedded into the diaphragm? (check all which apply)

Check what applies	Embedded length	Bridge Skew Angle	Diaphragm Skew Angle	Special Conditions?
	0” to < 2”			
	2” to < 4”			
	4” to < 6”			
	6” to < 8”			
	8” to < 10”			
	10” to < 12”			
	12” and up			

If more than one box is checked, please comment on factors causing the use of different embedment distances.

____

____

____

13. Can you share with us the diaphragm connection details that you used for your continuous concrete skew bridges? If yes, please provide a photocopy of the details.

____

____

____

____

14. Do you have any short-term or long-term field data (deflection, strain measurements) of skewed continuous precast prestressed concrete bridges with continuity diaphragms that can be made available to our Project Team? If yes can you give a brief description / data.

____

____

____

____

15. Please share with us any general comments on difficulties faced with skewed continuity diaphragms and solutions adopted

____

____

____

We would appreciate the name of a contact person in your organization to discuss some of these issues in more detail.

Name:

Position:

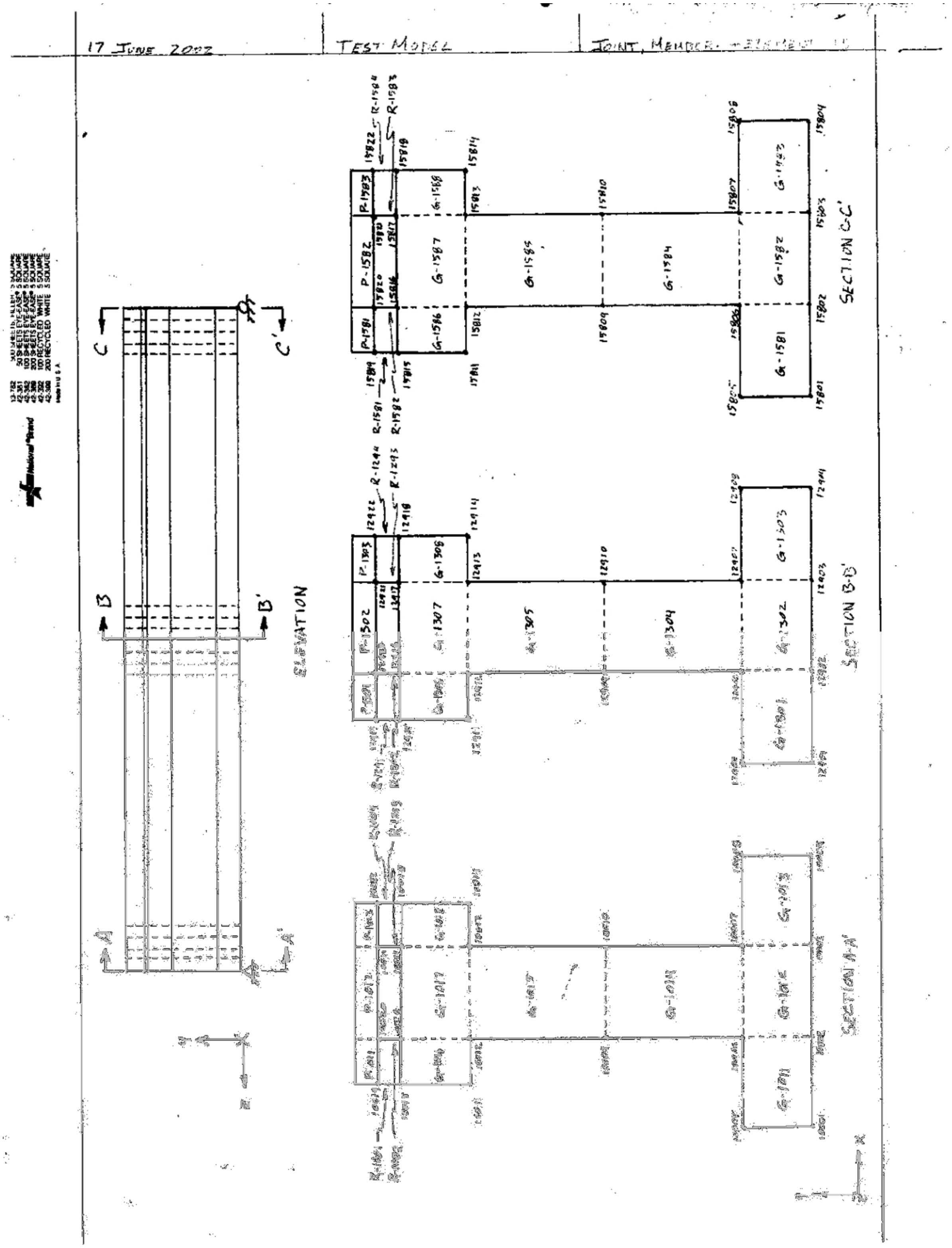
Telephone:

Fax:

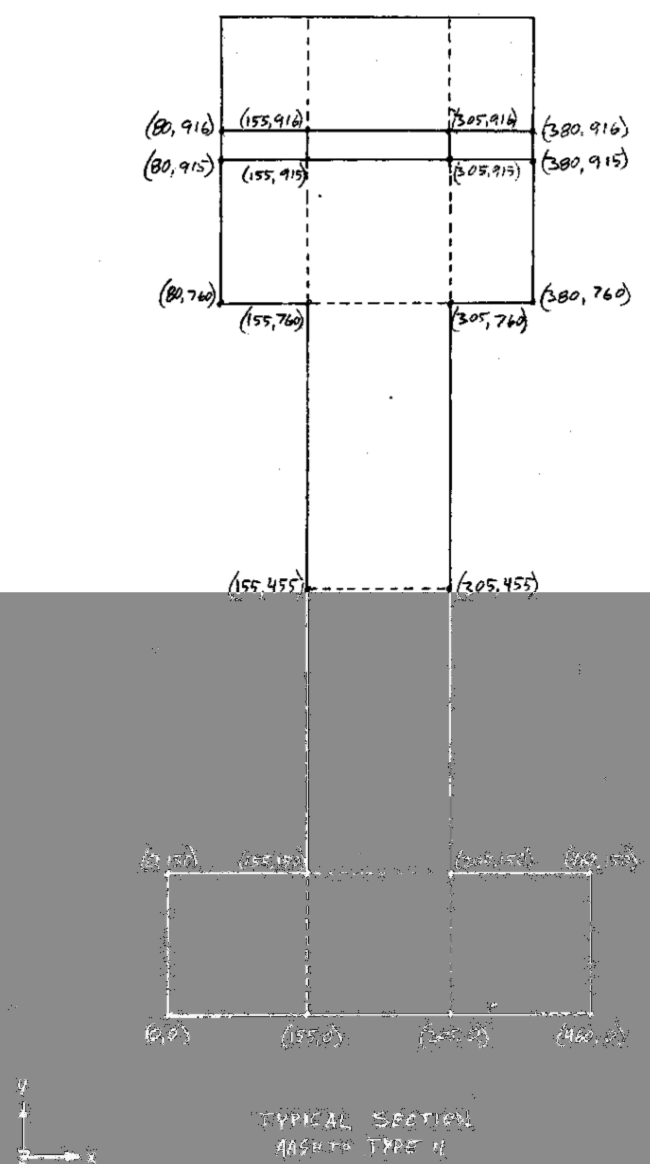
Email:

THANK YOU FOR TAKING THE TIME TO COMPLETE THIS SURVEY

APPENDIX B
HAND CALCULATIONS FOR MODEL VERIFICATION


17 JUNE 2002
TEST MODEL
ELEVATION
SECTION A-A'
SECTION B-B'
SECTION C-C'

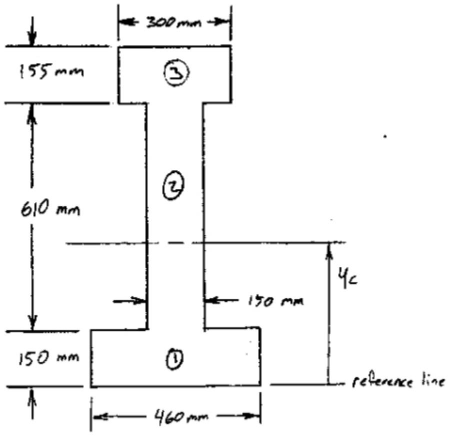
TEST MODEL | JOINT COORDINATES | D.2



TYPICAL SECTION
AASHTO TYPE IV

Girder Without Decking

AASHTO TYPE II



$A_1 = (.460\,m)(.150\,m) = 0.0690\ m^2$

$A_2 = (.150\,m)(.610\,m) = 0.0915\ m^2$

$A_3 = (.300\,m)(.155\,m) = 0.0465\ m^2$

$\Sigma A_n = 0.207\ m^2$

CENTER OF MASS

$$y_c = \frac{\Sigma A_n \bar{z}_n}{\Sigma A_n}$$

$$y_c = \frac{(.0690\,m^2)(.075\,m) + (.0915\,m^2)(.455\,m) + (.0465\,m^2)(.8375\,m)}{(.207\,m^2)}$$

$y_c = 0.4143\ m$

MOMENT OF INERTIA

$$I_x' = \tfrac{1}{12} b h^3 + A d^2$$

$$I_x' = \tfrac{1}{12}(.460\,m)(.150\,m)^3 + (.0690\,m^2)(.075\,m - y_c)^2 + \tfrac{1}{12}(.150\,m)(.610\,m)^3 + (.0915\,m^2)(.455\,m - y_c)^2 + \tfrac{1}{12}(.300\,m)(.155\,m)^3 + (.0465\,m^2)(.8375\,m - y_c)^2$$

$I_x' = 0.0195\ m^4$

J-2

13 JUNE 2002 | TEST MODEL VERIFICATION | STRESS DUE TO SELF WIEGHT

GIRDER WITHOUT DECKING

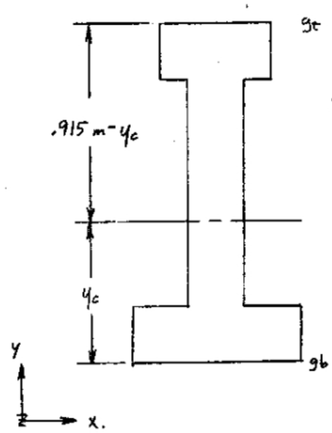
AASHTO TYPE II

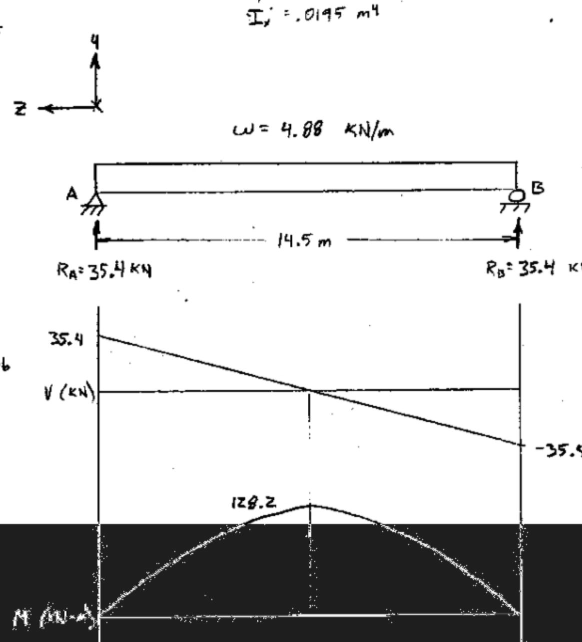
GIRDER SELF WEIGHT

$\omega = \rho A = (23.5616\ kN/m^3)(.207\ m^2) = 4.8773\ kN/m$

$y_c = .4143\ m$

$I_x' = .0195\ m^4$





STRESS

$$\sigma = -\frac{My}{I}$$

$$\sigma_{gb} = -\frac{(128.2\ kN\text{-}m)(-y_c)}{I_x'}$$

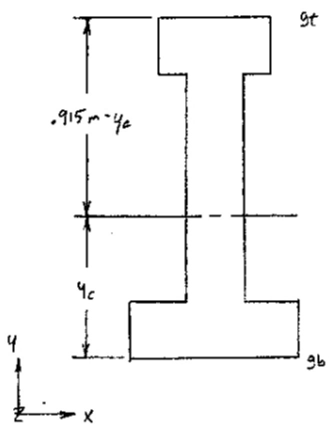
$$\sigma_{gt} = -\frac{(128.2\ kN\text{-}m)(.915m - y_c)}{I_x'}$$

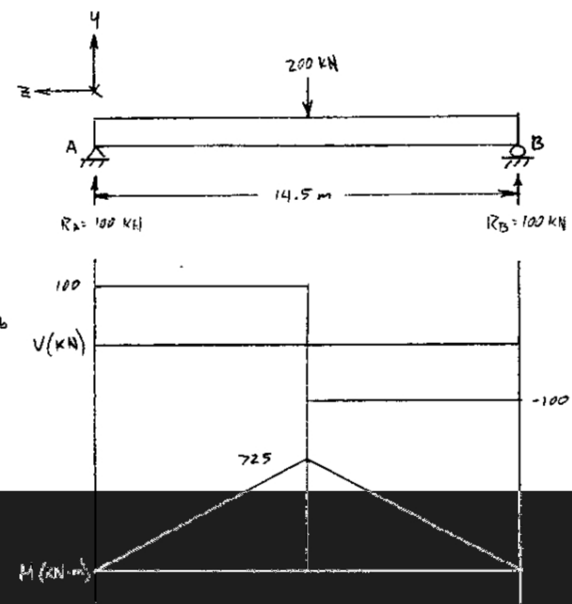
$\sigma_{gb} = 2.725\ kN/m^2$ T

$\sigma_{gt} = 3.294\ kN/m^2$ C

AASHTO TYPE II

$y_c = .4143$ m
$I_x' = .0195$ m^4





STRESS

$$\sigma = -\frac{My}{I}$$

$$\sigma_{gb} = -\frac{(725 \text{ kN·m})(-y_c)}{I_x'}$$

$$\sigma_{gt} = -\frac{(725 \text{ kN·m})(.915 - y_c)}{I_x'}$$

σ_{gb} = 15 415 kN/m^2 T

σ_{gt} = 18 634 kN/m^2 C

18 JUNE 2002 | TEST MODEL VERIFICATION | STRESS DUE TO SELF WIEGHT | T-4

GIRDER PLUS DECK

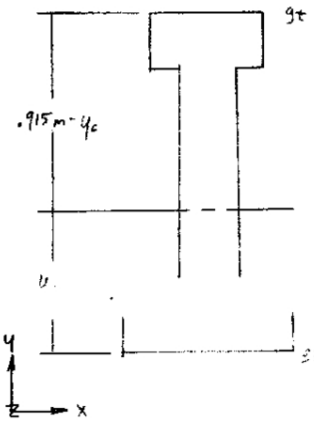
AASHTO TYPE II

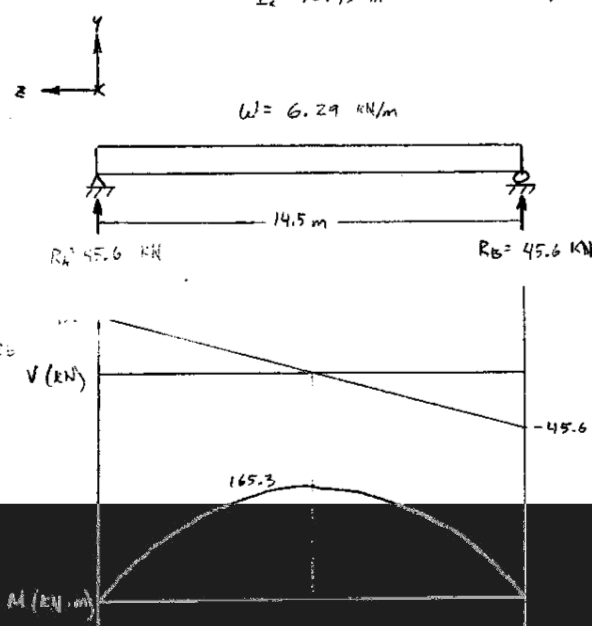
GIRDER PLUS DECK SELF WIEGHT

$\omega = \rho A = (23.5616\ kN/m^3)(.267 m^2) = 6.2909\ kN/m$

$y_c = .4143\ m$

$I_c = .0195\ m^4$





STRESS

$\sigma = -\frac{My}{I}$

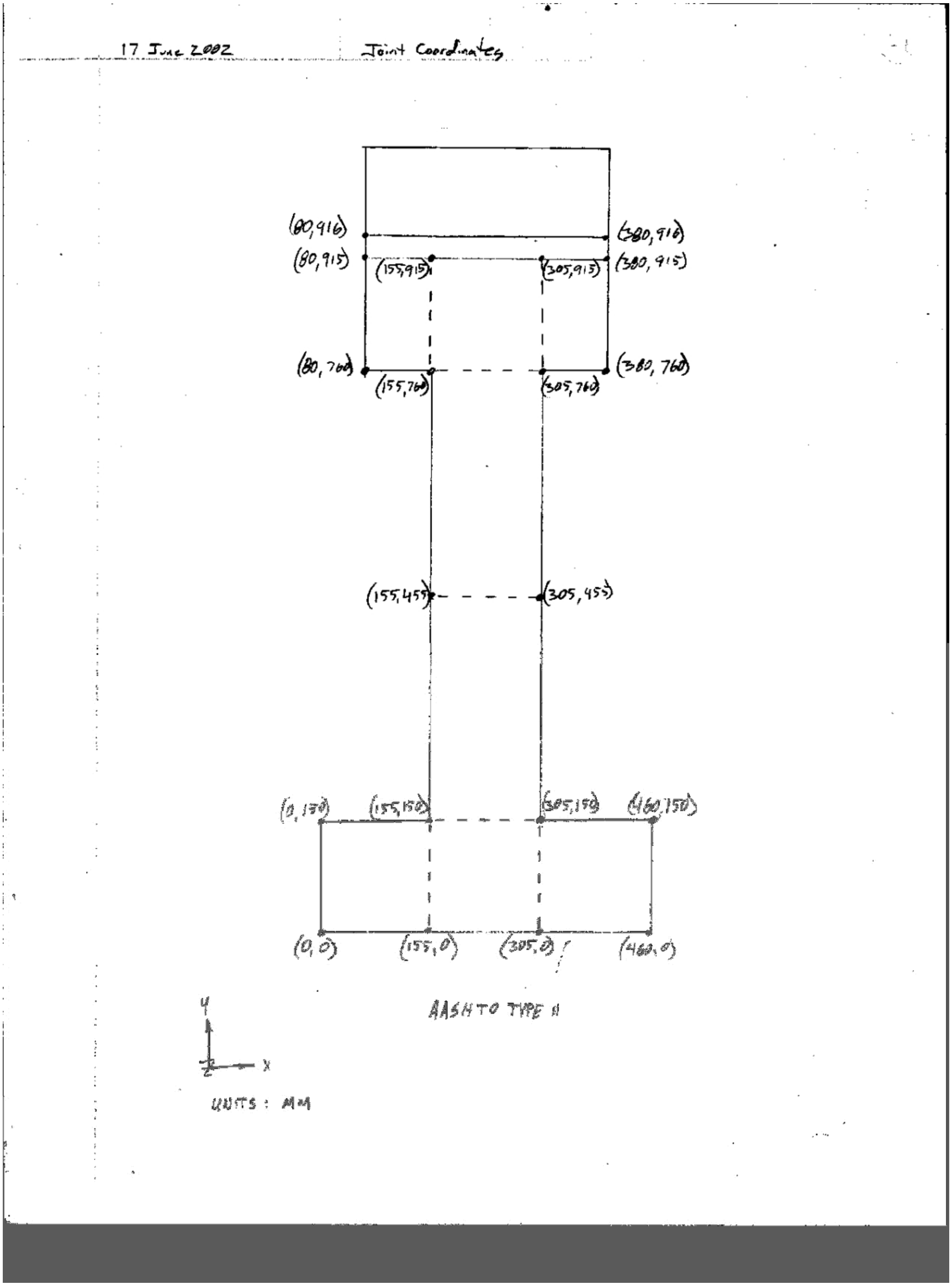
$\sigma_{gb} = -\frac{(165.3\ kN\cdot m)(-y_c)}{I_c}$

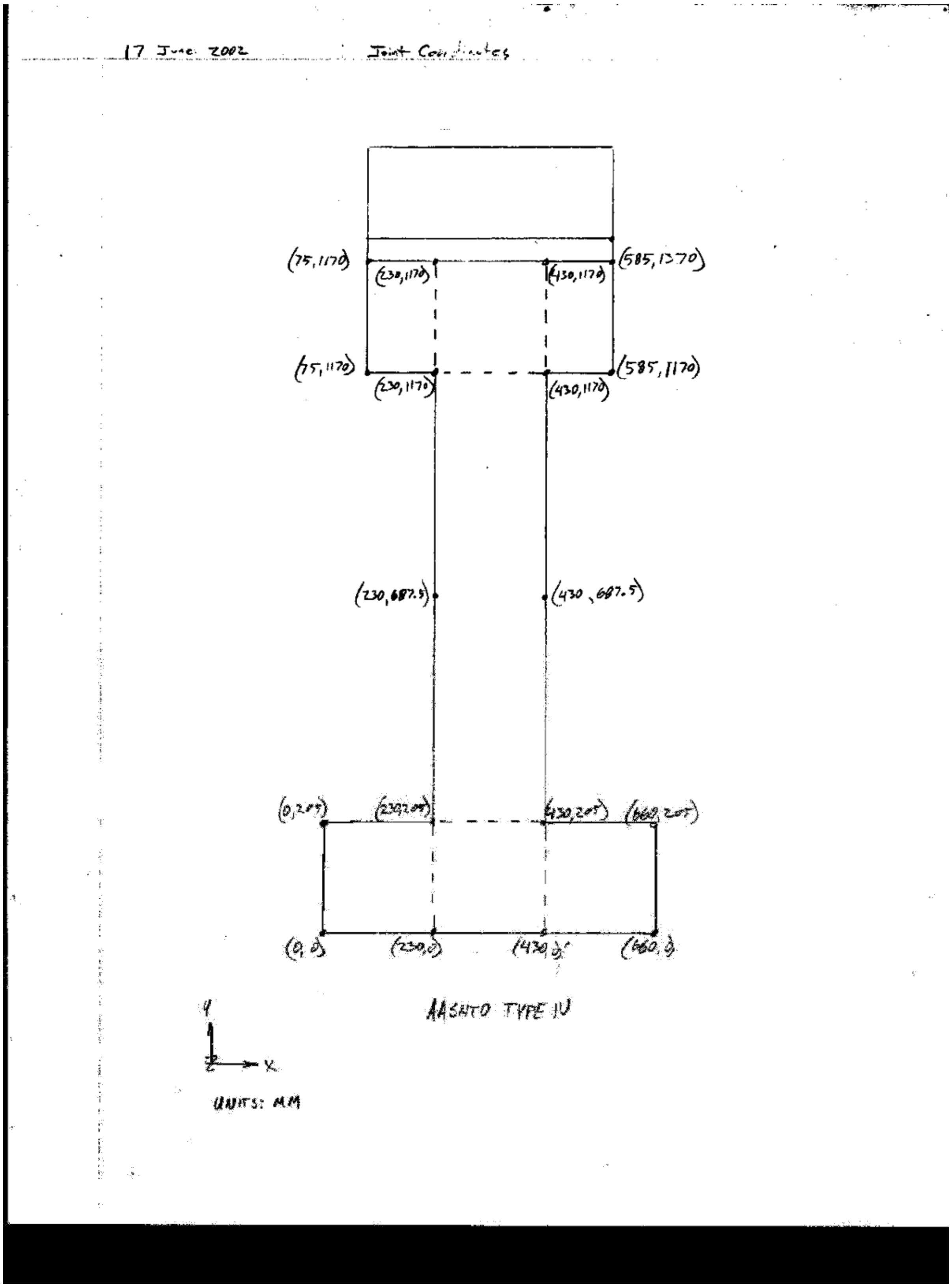
$\sigma_{gt} = -\frac{(165.3\ kN\cdot m)(.915 m - y_c)}{I_c}$

$\sigma_{gb} = 3515\ kN/m^2$ T

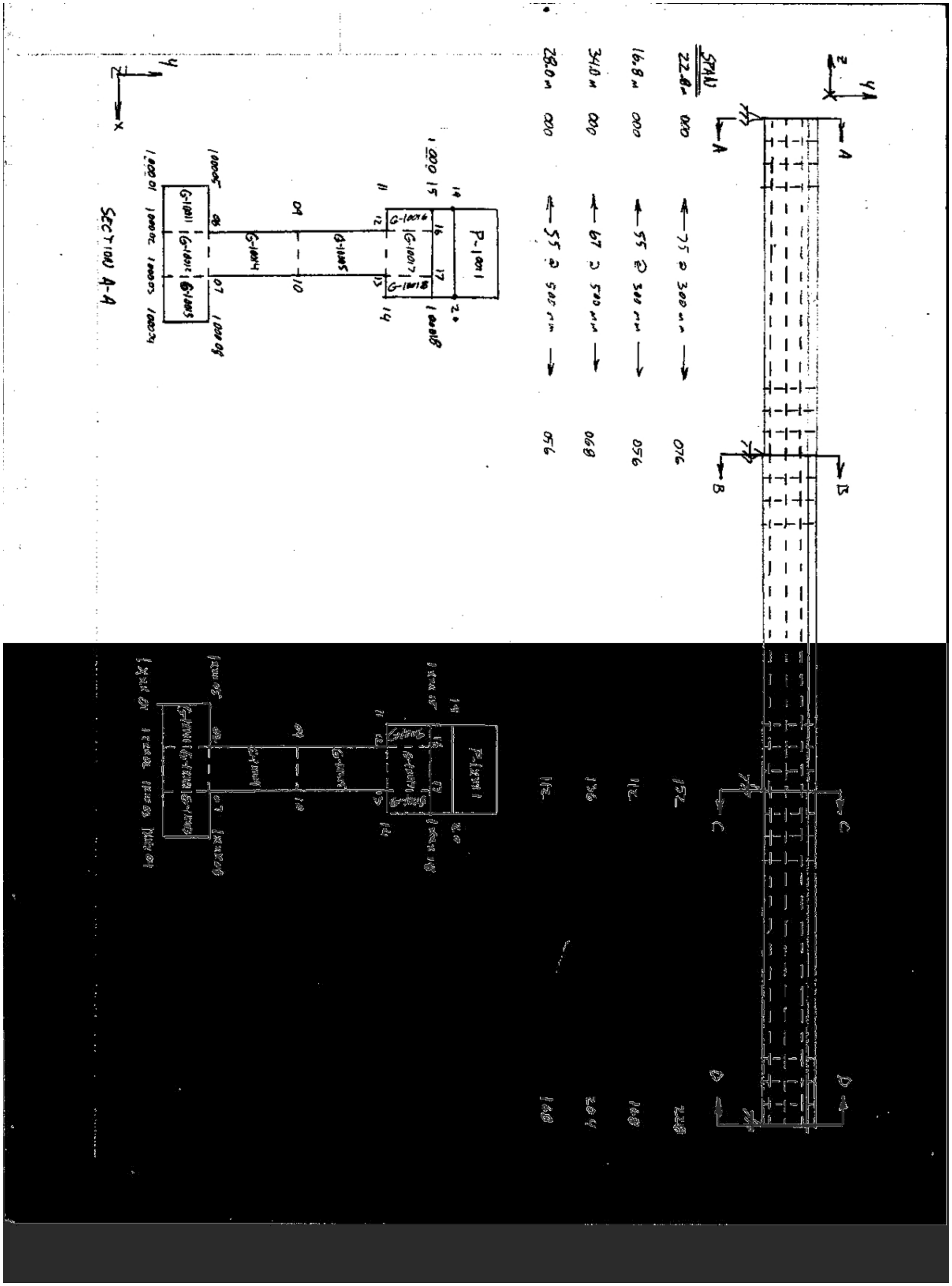
$\sigma_{gt} = 4244\ kN/m^2$ C

APPENDIX C
BRIDGE CONFIGURATION SKETCHES


17 June 2002
Joint Coordinates
(80,916)
(380,916)
(80,915)
(155,915)
(305,915)
(380,915)
(80,760)
(155,760)
(305,760)
(380,760)
(155,455)
(305,455)
(0,150)
(155,150)
(305,150)
(460,150)
(0,0)
(155,0)
(305,0)
(460,0)
AASHTO TYPE II
y
x
z
UNITS : MM

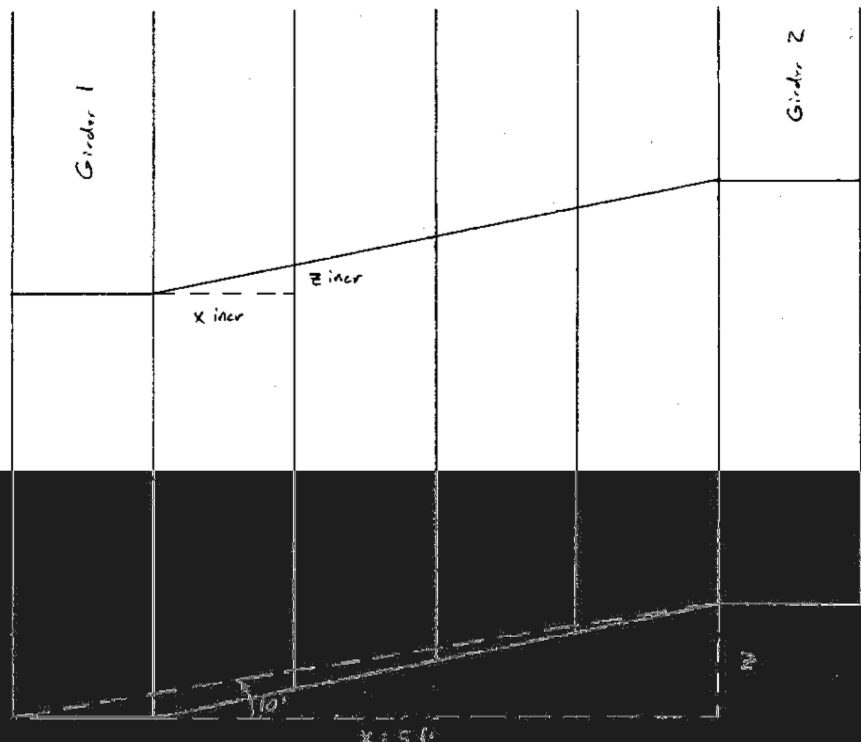


17 June 2002
Joint Coordinates
(75,1170)
(230,1170)
(430,1170)
(585,1370)
(75,1170)
(230,1170)
(430,1170)
(585,1170)
(230,687.5)
(430,687.5)
(0,205)
(230,205)
(430,205)
(660,205)
(0,0)
(230,0)
(430,0)
(660,0)
AASHTO TYPE IV
y
z
x
UNITS: MM


SECTION A-A

1.52m Girder Spacing
10° Bridge Skew

GROUP A

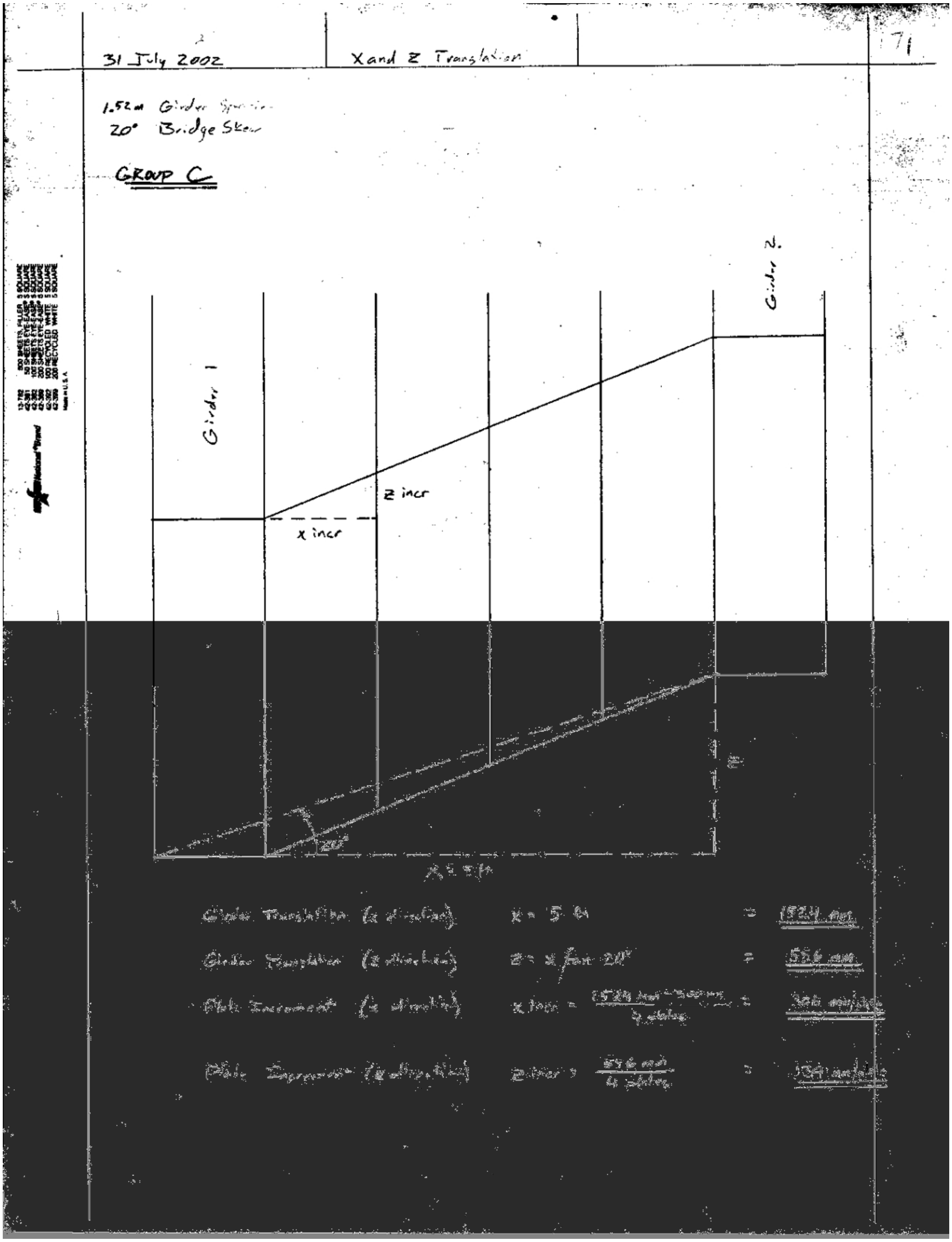


Girder Translation (x direction) $x = 5\text{ ft}$ = **1524 mm**

Girder Translation (z direction) $z = x \tan 10°$ = **268 mm**

Plate Increment (x direction) $x\text{ incr} = \frac{1524\text{ mm} - 304\text{ mm}}{4\text{ plates}}$ = **305 mm/plate**

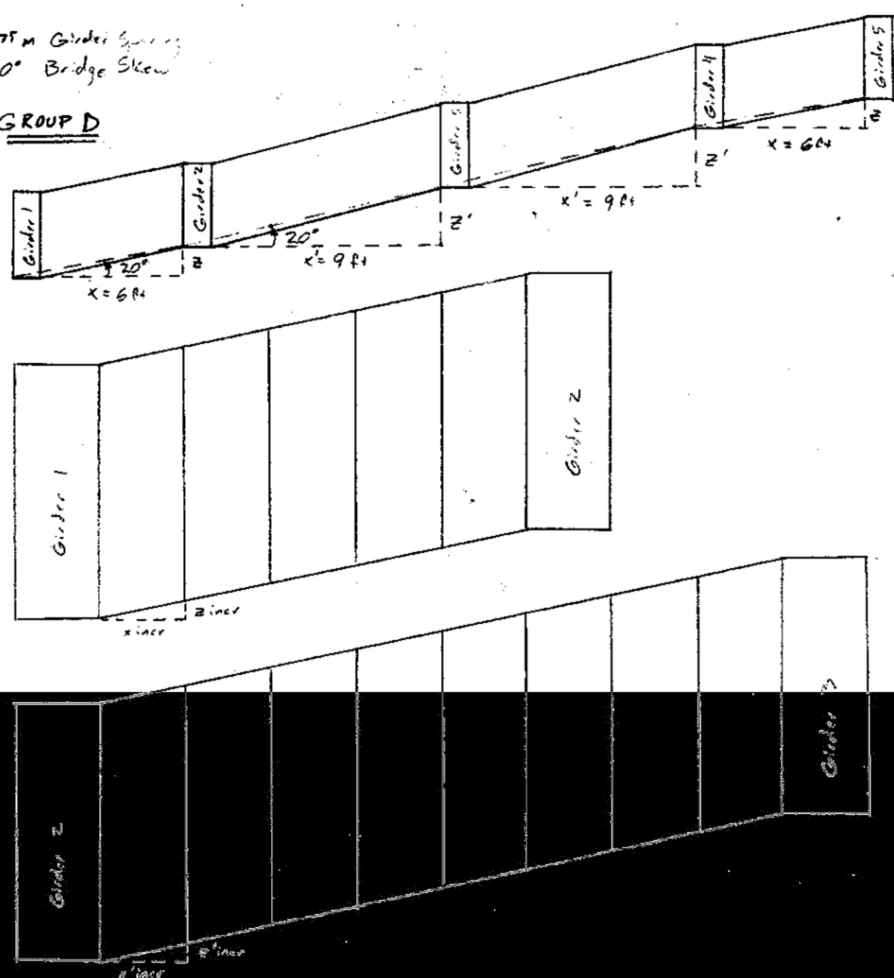
Plate Increment (z direction) $z\text{ incr} = \frac{268\text{ mm}}{4\text{ plates}}$ = **67 mm/plate**


31 July 2002
X and Z Translation
171
20° Bridge Skew
GROUP C
Girder 1
Girder 2
z incr
x incr
20°
x = 5 ft
z = x tan 20°
1524 mm
556 mm

31 July 2002 | X + Z Translation

2.75 m Girder Spacing
20° Bridge Skew

GROUP D



Girder Translation (x direction on 6ft Spacing) x = 6 ft = 1830 mm
(x direction on 9ft Spacing) x' = 9 ft = 2748 mm

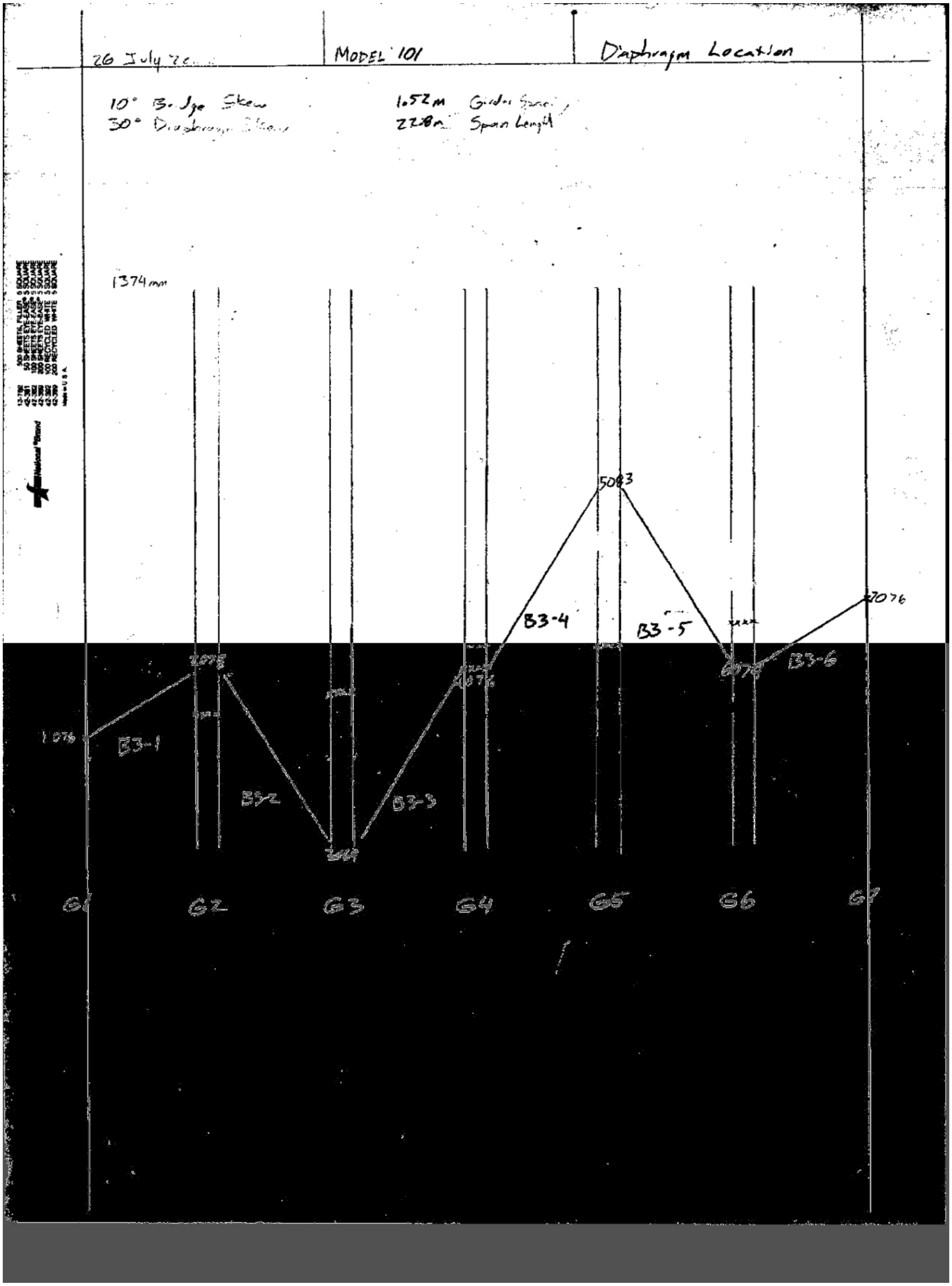
Girder Translation (z direction on 6 ft Spacing) z = x tan 20° = 665 mm
(z direction on 9 ft Spacing) z' = x' tan 20° = 1000 mm

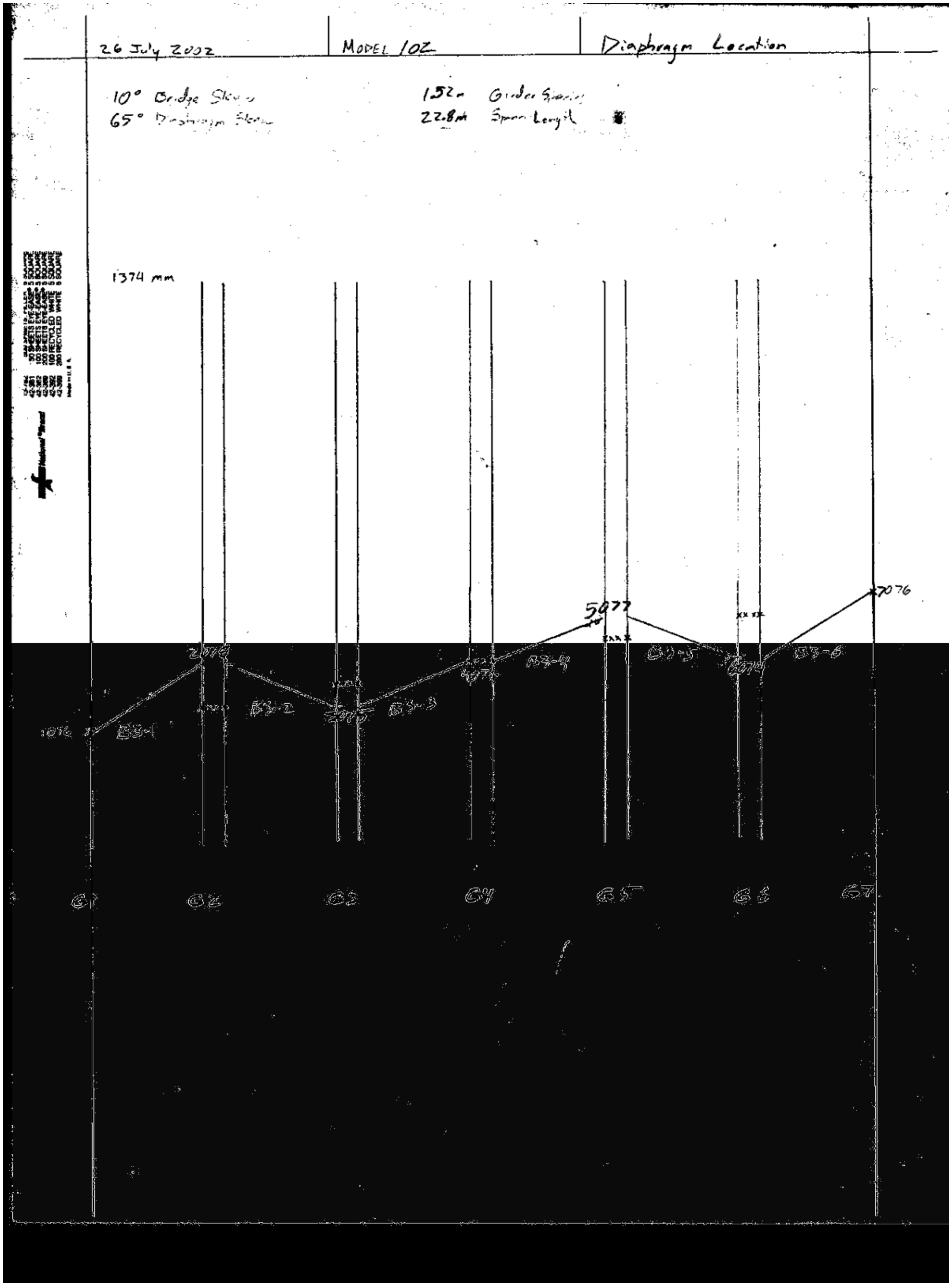
Plate Increment (x direction on 6ft Spacing) x incr = (1830 mm − 300 mm) / 5 plates = 306 mm/plate

(x direction on 9 ft Spacing) x' incr = (2748 mm − 300 mm) / 8 plates = 306 mm/plate

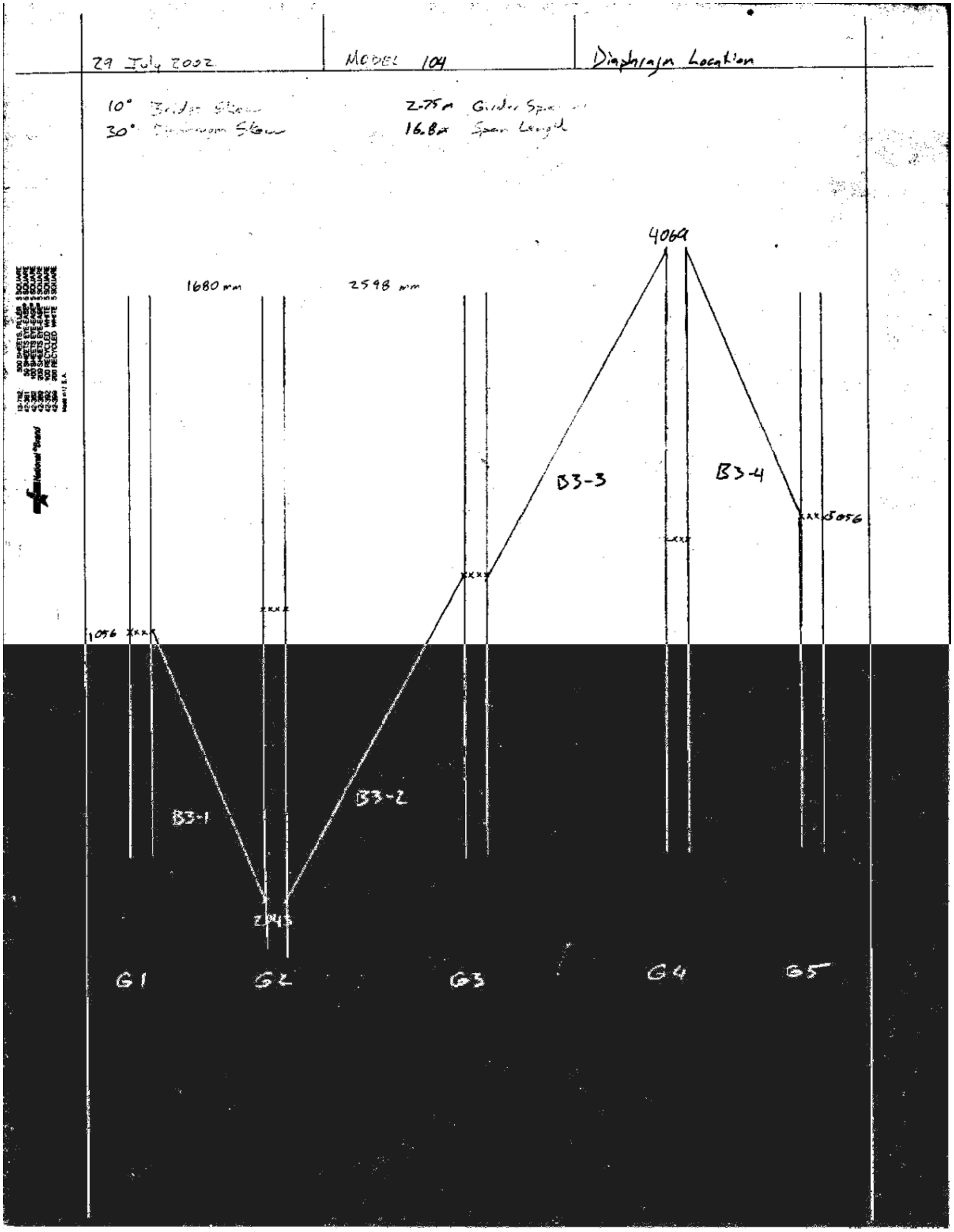
Plate Increment (z direction on 6ft Spacing) z incr = 665 mm / 5 plates = 133 mm/plate

(z direction on 9 ft Spacing) z' incr = 1000 mm / 8 plates = 125 mm/plate


MODEL 101
Diaphragm Location
10° Bridge Skew
1.52m
22.8m Span Length
1374mm
5083
B3-4
B3-5
2076
B3-6
B3-1
B3-2
B3-3
G1
G2
G3
G4
G5
G6
G7



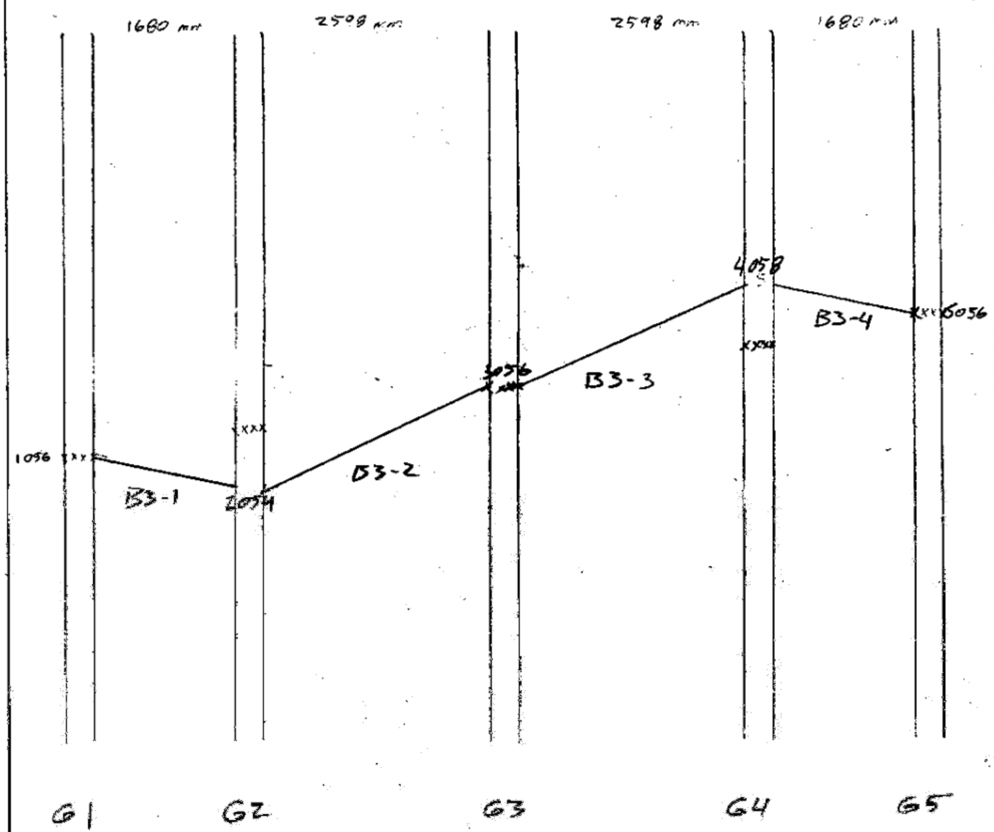
26 July 2002
Model 102
Diaphragm Location
10° Bridge Skew
65° Diaphragm Skew
1.52m Girder Spacing
22.8m Span Length
1374 mm
5077
7076
G1
G2
G3
G4
G5
G6
G7

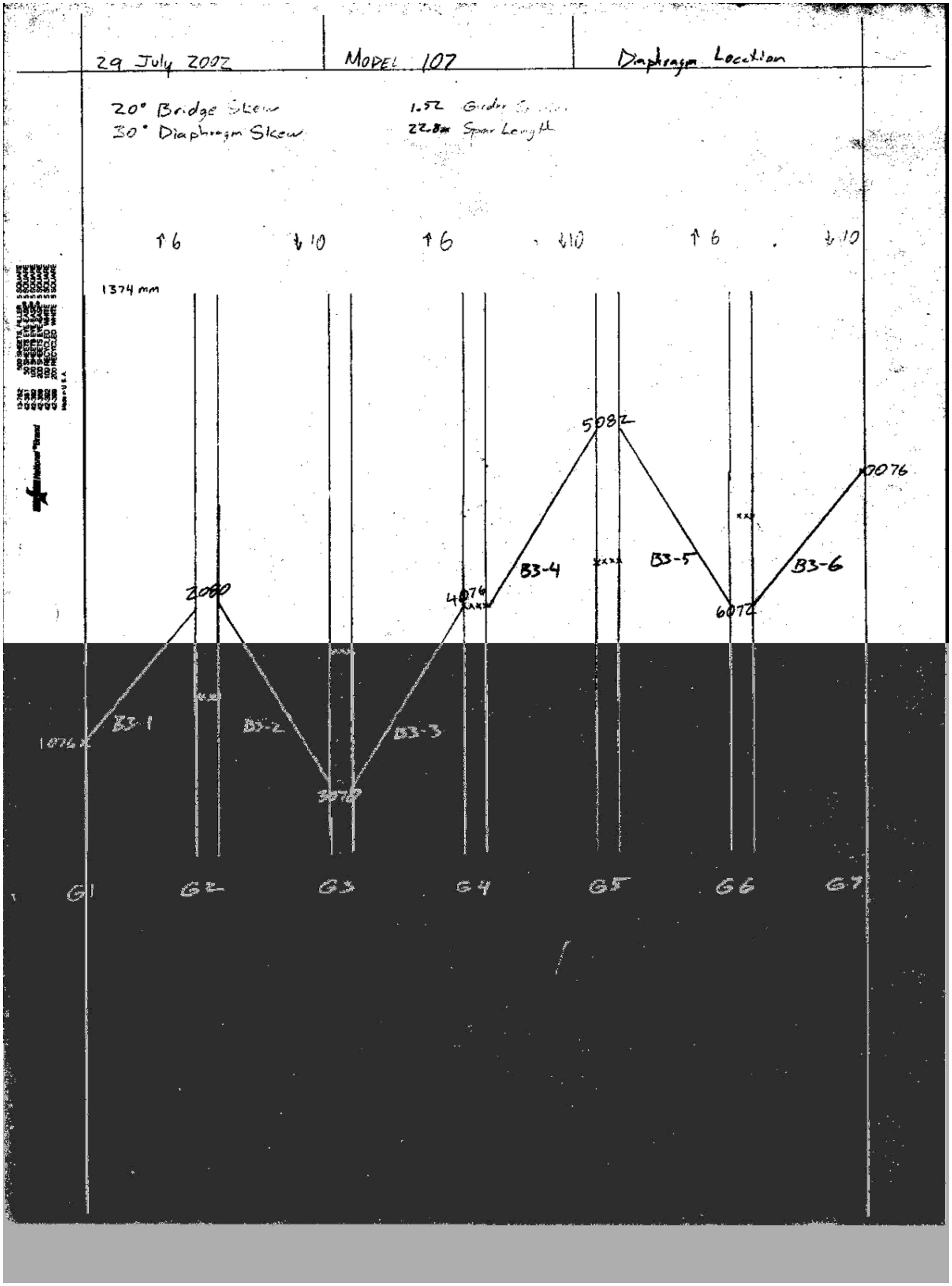

29 July 2002
MODEL 104
Diaphragm Location
10°
30°
2.75 m
16.8 m Span Length
4069
1680 mm
2598 mm
B3-3
B3-4
5056
1056
B3-1
B3-2
2943
G1
G2
G3
G4
G5

30 July 2002 | Model 105 | Diaphragm Location

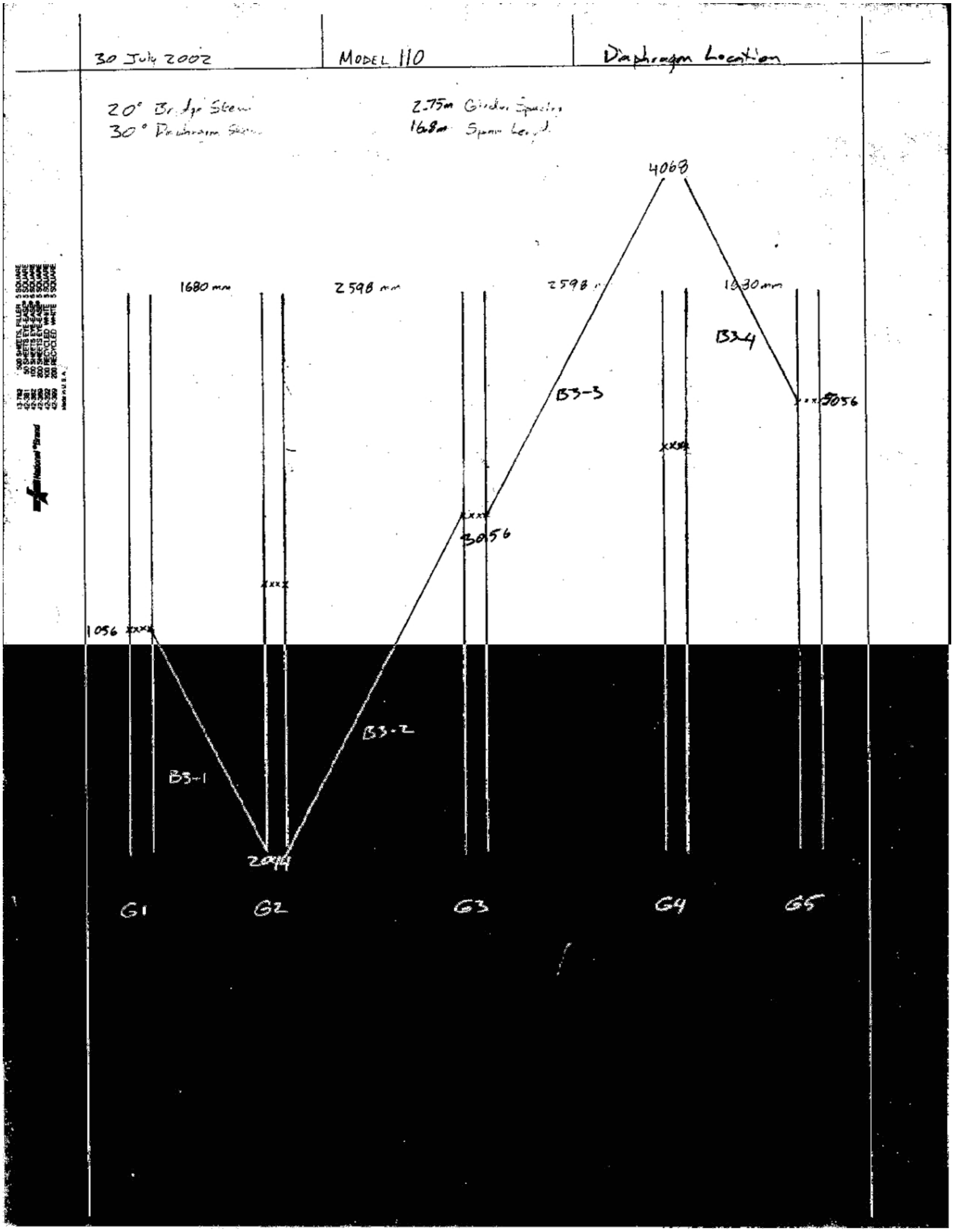
10° Bridge Skew
85° Diaphragm Skew

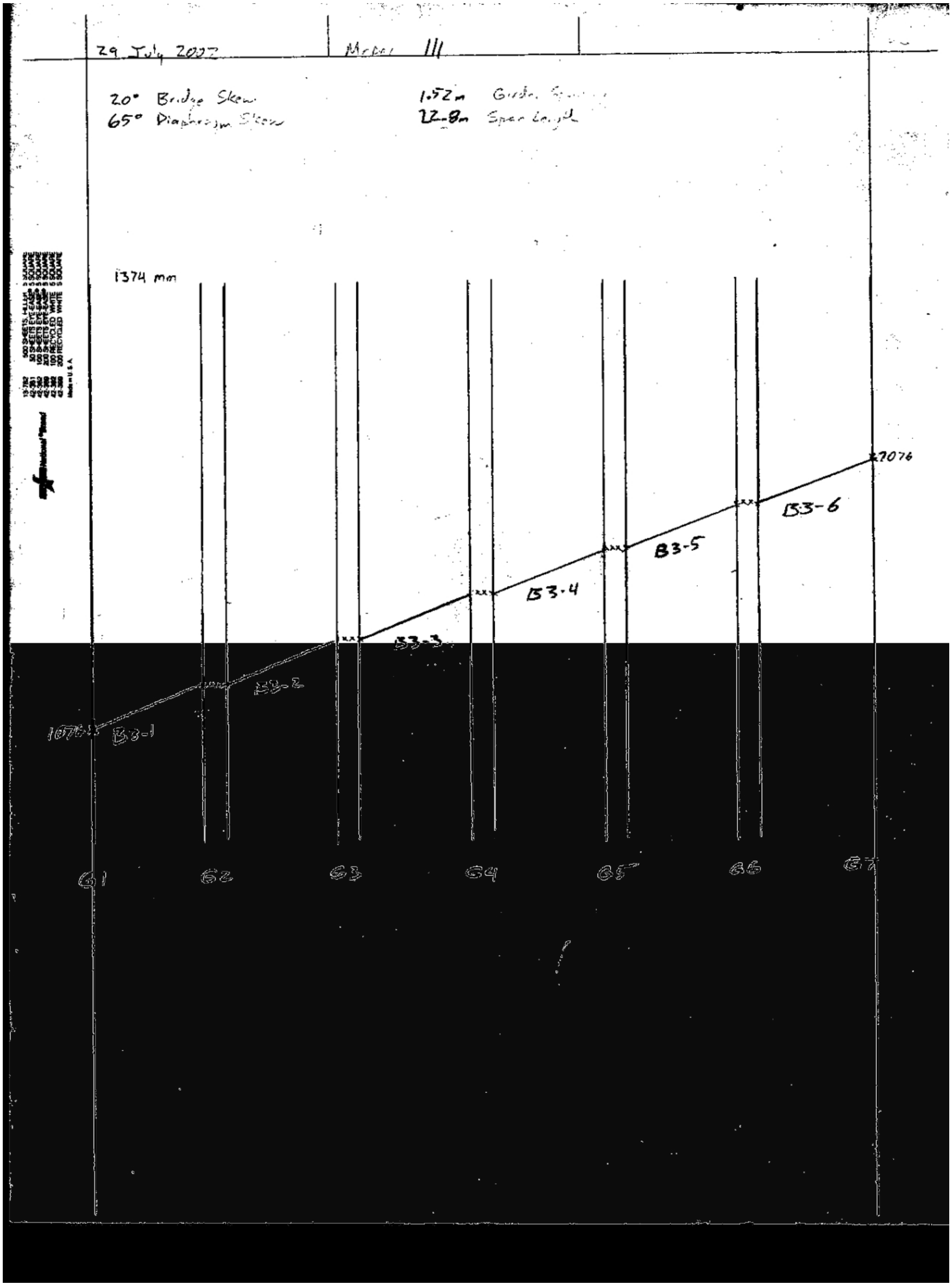
2.75m Girder Spacing
16.8m Span Length





29 July 2002
Model 107
Diaphragm Location
20° Bridge Skew
30° Diaphragm Skew
22.8m Span Length
↑6
↓10
↑6
↓10
↑6
↓10
1374 mm
5082
4076
2080
6072
B3-1
B3-2
B3-3
B3-4
B3-5
B3-6
G1
G2
G3
G4
G5
G6
G7


30 July 2002
MODEL 110
Diaphragm Location
4068
1680 mm
2598 mm
B3-4
B3-3
3056
1056
B3-2
B3-1
G1
G2
G3
G4
G5


20° Bridge Skew
65° Diaphragm Skew
1.52m Girder Spacing
22.8m Span Length
1374 mm
2076
B3-1
B3-2
B3-3
B3-4
B3-5
B3-6
G1
G2
G3
G4
G5
G6
G7

APPENDIX D
GTSTRUDL INPUT FILES

STRUDL 'Model 101' ‘Type II Girder, 10° Bridge Skew, Girder Spacing 1.52 m, Span Length 22.8 m, 30° Diaphragm Skew’

```
UNITS MM
PRINT GENERATE OFF

$====================================================================================================
$ Generate Joints to Connect Girder Brick Elements
$====================================================================================================
GENERATE 4 JOINTS ID 100001 1 X LIST 0 155 305 460 Z 0
REPEAT 1 ID 4 Y 150
REPEAT 1 ID 100 Z -300

GENERATE 2 JOINTS ID 100009 1 X 155 150 Y 455 Z 0
REPEAT 1 ID 100 Z -300

GENERATE 4 JOINTS ID 100011 1 X LIST 80 155 305 380 Y 760 Z 0
REPEAT 1 ID 4 Y 155
REPEAT 1 ID 100 Z -300

$====================================================================================================
$ Generate Girder Brick Elements
$====================================================================================================
TYPE TRIDEMINSIONAL
GENERATE 3 ELEMENTS ID 'G-10011' 1 FROM 100001 1 TO 100002 1 TO 100006 1 TO 100005 1 TO 100101 1 TO 100102 1 TO 100106 1 TO
100105 1
GENERATE 2 ELEMENTS ID 'G-10014' 1 FROM 100006 3 TO 100007 3 TO 100010 3 TO 100009 3 TO 100106 3 TO 100107 3 TO 100110 3 TO
100109 3
GENERATE 3 ELEMENTS ID 'G-10016' 1 FROM 100011 1 TO 100012 1 TO 100016 1 TO 100015 1 TO 100111 1 TO 100112 1 TO 100116 1 TO
100115 1

$====================================================================================================
$ Copy Generated Girder Section and Copy it Down Entire Length of Bridge
$====================================================================================================
DEFINE OBJECT 'SECTION' JOINTS 100001 TO 100018 100101 TO 100118, ELEMENTS 'G-10011' TO 'G-10018'
COPY OBJECT 'SECTION' REPEAT 227 TIMES JOINT INCR 100 ELEMENT INCR 10 TRANSLATE Z -300

$====================================================================================================
$ Copy Generated Girder and Copy it Across The Entire Width of Bridge
$====================================================================================================
DEFINE OBJECT 'GIRDER A' JOINTS EXISTING 100001 TO 122818, ELEMENTS EXISTING 'G-10011' TO 'G-12288'
COPY OBJECT 'GIRDER A' REPEAT 6 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1524 Z -268

$====================================================================================================
$ Generate Joints to Connect Deck Plate Elements
$====================================================================================================
GENERATE 2 JOINTS ID 100019 1 X LIST 80 380 Y 916 Z 0
REPEAT 6 ID 100000 X 1524 Z -268
REPEAT 76 ID 300 Z -900

GENERATE 3 JOINTS ID 100021 1 X 686 306 Y 916 0 Z -67 -67
REPEAT 5 ID 100000 X 1524 Z -268
REPEAT 76 ID 300 Z -900

$====================================================================================================
$ Generate Deck Plate Elements
$====================================================================================================
TYPE PLATE

GENERATE 4 ELEMENTS ID 'P-1011' 1 FROM 100019 1 TO 100020 1 TO 100320 1 TO 100319 1
REPEAT 5 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 75 ID 10 FROM INCR 300 TO INCR 300

GENERATE 6 ELEMENTS ID 'P-1015' 1000 FROM 100023 100000 TO 200019 100000 TO 200319 100000 TO 100323 100000
REPEAT 75 ID 10 FROM INCR 300 TO INCR 300

GENERATE 76 ELEMENTS ID 'P-7011' 10 FROM 700019 300 TO 700020 300 TO 700320 300 TO 700319 300

$====================================================================================================
$ Generate Rigid Members to Connect Girder Elements to Plate Elements
$====================================================================================================
TYPE SPACE TRUSS

GENERATE 2 MEMBERS ID 'R-1001' 1 FROM 100015 3 TO 100019 1
REPEAT 6 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 76 ID 10 FROM INCR 300 TO INCR 300

$====================================================================================================
$ Generate Diaphragm Members at Top of Bottom Flange
$====================================================================================================
$ END DIAPHRAGMS
GENERATE 6 MEMBERS ID 'B2-1' 1 FROM 100008 100000 TO 200005 100000
GENERATE 6 MEMBERS ID 'B5-1' 1 FROM 122808 100000 TO 222805 100000

$ INTERMEDIATE DIAPHRAGMS
GENERATE 2 MEMBERS ID 'B3-1' 5 FROM 107608 499800 TO 207805 499800
GENERATE 2 MEMBERS ID 'B3-2' 3 FROM 207808 300500 TO 306905 300500
GENERATE 2 MEMBERS ID 'B3-3' 1 FROM 306908 100700 TO 407605 100700

GENERATE 2 MEMBERS ID 'B4-1' 5 FROM 115208 499800 TO 215405 499800
GENERATE 2 MEMBERS ID 'B4-2' 3 FROM 215408 300500 TO 314505 300500
GENERATE 2 MEMBERS ID 'B4-3' 1 FROM 314508 100700 TO 415205 100700

$====================================================================================================
```

```
$ Define Element Properties
$===================================================================================================
MATERIAL CONCRETE ALL ELEMENTS
ELEMENT PROPERTIES
 EXISTING 'G-10011' TO 'G-12768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-20011' TO 'G-22768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-30011' TO 'G-32768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-40011' TO 'G-42768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-50011' TO 'G-52768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-60011' TO 'G-62768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-70011' TO 'G-72768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'P-1011' TO 'P-1765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-2011' TO 'P-2765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-3011' TO 'P-3765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-4011' TO 'P-4765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-5011' TO 'P-5765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-6011' TO 'P-6765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-7011' TO 'P-7761' TYPE 'SBCR' THICKNESS 200

$===================================================================================================
$ Define Member Properties
$===================================================================================================
MATERIAL CONCRETE ALL MEMBERS
MEMBER PROPERTIES PRISMATIC
 'R-1001' TO 'R-1761' BY 10 'R-1002' TO 'R-1762' BY 10 AX 5000
 'R-2001' TO 'R-2761' BY 10 'R-2002' TO 'R-2762' BY 10 AX 5000
 'R-3001' TO 'R-3761' BY 10 'R-3002' TO 'R-3762' BY 10 AX 5000
 'R-4001' TO 'R-4761' BY 10 'R-4002' TO 'R-4762' BY 10 AX 5000
 'R-5001' TO 'R-5761' BY 10 'R-5002' TO 'R-5762' BY 10 AX 5000
 'R-6001' TO 'R-6761' BY 10 'R-6002' TO 'R-6762' BY 10 AX 5000
 'R-7001' TO 'R-7761' BY 10 'R-7002' TO 'R-7762' BY 10 AX 5000
MEMBER PROPERTIES PRISMATIC
 'B2-1' TO 'B2-6' AX 219600
 'B3-1' TO 'B3-6' AX 219600
 'B4-1' TO 'B4-6' AX 219600
 'B5-1' TO 'B5-6' AX 219600

$===================================================================================================
$ Define Supports
$===================================================================================================
STATUS SUPPORT JOINTS -
 100001 TO 700001 BY 100000 100002 TO 700002 BY 100000 100003 TO 700003 BY 100000 100004 TO 700004 BY 100000 -
 107601 TO 707601 BY 100000 107602 TO 707602 BY 100000 107603 TO 707603 BY 100000 107604 TO 707604 BY 100000 -
 115201 TO 715201 BY 100000 115202 TO 715202 BY 100000 115203 TO 715203 BY 100000 115204 TO 715204 BY 100000 -
 122801 TO 722801 BY 100000 122802 TO 722802 BY 100000 122803 TO 722803 BY 100000 122804 TO 722804 BY 100000 -

 100019 TO 700019 BY 100000 100020 TO 700020 BY 100000 -
 122819 TO 722819 BY 100000 122820 TO 722820 BY 100000

$===================================================================================================
$ Set Boundary Conditions
$===================================================================================================
JOINT RELEASES

$ GIRDER BASE
$  END PIN CONDITIONS
 100001 TO 100004 200001 TO 200004 300001 TO 300004 400001 TO 400004 500001 TO 500004 600001 TO 600004 700001 TO 700004
MOMENT X Y
 122801 TO 122804 222801 TO 222804 322801 TO 322804 422801 TO 422804 522801 TO 522804 622801 TO 622804 722801 TO 722804
MOMENT X Y

$  INTERMEDIATE PIN CONDITIONS
 107601 TO 107604 207601 TO 207604 307601 TO 307604 407601 TO 407604 507601 TO 507604 607601 TO 607604 707601 TO 707604
MOMENT X Y Z
 115201 TO 115204 215201 TO 215204 315201 TO 315204 415201 TO 415204 515201 TO 515204 615201 TO 615204 715201 TO 715204
MOMENT X Y Z


$ DECK BASE
$  END CONDITIONS
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 600019 TO 600020 700019 TO 700020
FORCE Y
 122819 TO 122820 222819 TO 222820 322819 TO 322820 422819 TO 422820 522819 TO 522820 622819 TO 622820 722819 TO 722820
FORCE Y
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 600019 TO 600020 700019 TO 700020
MOMENT X Y
 122819 TO 122820 222819 TO 222820 322819 TO 322820 422819 TO 422820 522819 TO 522820 622819 TO 622820 722819 TO 722820
MOMENT X Y

$===================================================================================================
$ Define Loading
$===================================================================================================
UNITS KN M
LOADING 'DC1' 'DEAD LOAD STRUCTURAL COMPONENTS OF ELEMENTS'
 ELEMENT LOADS
  EXISTING 'G-10011' TO 'G-12288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-20011' TO 'G-22288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-30011' TO 'G-32288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-40011' TO 'G-42288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-50011' TO 'G-52288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-60011' TO 'G-62288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-70011' TO 'G-72288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-1011' TO 'P-1765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-2011' TO 'P-2765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-3011' TO 'P-3765' BODY FORCES GLOBAL BY -23.5616
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  EXISTING 'P-4011' TO 'P-4765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-5011' TO 'P-5765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-6011' TO 'P-6765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-7011' TO 'P-7761' BODY FORCES GLOBAL BY -23.5616
DEAD LOAD 'DC2' 'DEAD LOAD STRUCTURAL COMPONENTS OF MEMBERS' DIRECTION -Y -
  MEMBERS 'B2-1' TO 'B2-6' 'B3-1' TO 'B3-6' 'B4-1' TO 'B4-6' 'B5-1' TO 'B5-6'
LOADING 'LL' 'VEHICULAR LIVE LOAD'
 JOINT LOADS
$ Truck 1
  203623 403620 FORCE Y -45.5
  205123 405120 FORCE Y -188.5
  206323 406320 FORCE Y -188.5
$ Truck 2
  403623 603620 FORCE Y -188.5
  405123 605120 FORCE Y -188.5
  406323 606320 FORCE Y -45.5
LOADING 'LS' 'LIVE LOAD SURCHARGE'
 ELEMENT LOADS
  EXISTING 'P-1011' TO 'P-1765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-2011' TO 'P-2765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-3011' TO 'P-3765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-4011' TO 'P-4765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-5011' TO 'P-5765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-6011' TO 'P-6765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-7011' TO 'P-7761' SURFACE FORCES GLOBAL PY -3.9269
LOADING 'WS' 'WIND LOAD ON STRUCTURE'
 ELEMENT LOADS
  'G-70013' TO 'G-72283' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70014' TO 'G-72284' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70015' TO 'G-72285' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70018' TO 'G-72288' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4


$====================================================================================================
$ Factored Loads
$====================================================================================================
$LOADING COMBINATION 10 'STRENGTH I MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.75 'LS' 1.75 'WS' 0.0
LOADING COMBINATION 11 'STRENGTH I MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.75 'LS' 1.75 'WS' 0.0
$LOADING COMBINATION 12 'STRENGTH II MINIMUM'  SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 13 'STRENGTH II MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 14 'STRENGTH III MINIMUM' SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 0.0  'LS' 0.0  'WS' 1.4
LOADING COMBINATION 15 'STRENGTH III MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 0.0  'LS' 0.0  'WS' 1.4
$LOADING COMBINATION 16 'STRENGTH V MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.4
LOADING COMBINATION 17 'STRENGTH V MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.4
$LOADING COMBINATION 18 'SERVICE I'            SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.0  'LS' 1.0  'WS' 0.3
$LOADING COMBINATION 19 'SERVICE II'           SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.3  'LS' 1.3  'WS' 0.0
$LOADING COMBINATION 20 'FATIGUE'              SPECS 'DC1' 0.0  'DC2' 0.0  'LL' 0.75 'LS' 0.75 'WS' 0.0

$====================================================================================================
$ Prepare and Generate Output
$====================================================================================================
QUERY
STIFFNESS ANALYSIS

LIST SUMMATION OF REACTIONS
LIST REACTIONS

CALCULATE AVERAGE STRESS AT TOP SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-7765'
CALCULATE AVERAGE STRESS AT BOTTOM SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-7765'

CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-10011' TO 'G-12288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-20011' TO 'G-22288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-30011' TO 'G-32288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-40011' TO 'G-42288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-50011' TO 'G-52288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-60011' TO 'G-62288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-70011' TO 'G-72288'

LIST FORCES MEMBERS 'B2-1' TO 'B2-6' 'B3-1' TO 'B3-6' 'B4-1' TO 'B4-6' 'B5-1' TO 'B5-6'
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STRUDL 'Model 102' 'Type II Girder, 10° Bridge Skew, Girder Spacing 1.52 m, Span Length 22.8 m, 65° Diaphragm Skew'

```
UNITS MM
PRINT GENERATE OFF

$=====================================================================================================
$ Generate Joints to Connect Girder Brick Elements
$=====================================================================================================
GENERATE 4 JOINTS ID 100001 1 X LIST 0 155 305 460 Z 0
REPEAT 1 ID 4 Y 150
REPEAT 1 ID 100 Z -300

GENERATE 2 JOINTS ID 100009 1 X 155 150 Y 455 Z 0
REPEAT 1 ID 100 Z -300

GENERATE 4 JOINTS ID 100011 1 X LIST 80 155 305 380 Y 760 Z 0
REPEAT 1 ID 4 Y 155
REPEAT 1 ID 100 Z -300

$=====================================================================================================
$ Generate Girder Brick Elements
$=====================================================================================================
TYPE TRIDEMINSIONAL
GENERATE 3 ELEMENTS ID 'G-10011' 1 FROM 100001 1 TO 100002 1 TO 100006 1 TO 100005 1 TO 100101 1 TO 100102 1 TO 100106 1 TO
100105 1
GENERATE 2 ELEMENTS ID 'G-10014' 1 FROM 100006 3 TO 100007 3 TO 100010 3 TO 100009 3 TO 100106 3 TO 100107 3 TO 100110 3 TO
100109 3
GENERATE 3 ELEMENTS ID 'G-10016' 1 FROM 100011 1 TO 100012 1 TO 100016 1 TO 100015 1 TO 100111 1 TO 100112 1 TO 100116 1 TO
100115 1

$=====================================================================================================
$ Copy Generated Girder Section and Copy it Down Entire Length of Bridge
$=====================================================================================================
DEFINE OBJECT 'SECTION' JOINTS 100001 TO 100018 100101 TO 100118, ELEMENTS 'G-10011' TO 'G-10018'
COPY OBJECT 'SECTION' REPEAT 227 TIMES JOINT INCR 100 ELEMENT INCR 10 TRANSLATE Z -300


$=====================================================================================================
$ Copy Generated Girder and Copy it Across The Entire Width of Bridge
$=====================================================================================================
DEFINE OBJECT 'GIRDER A' JOINTS EXISTING 100001 TO 122818, ELEMENTS EXISTING 'G-10011' TO 'G-12288'
COPY OBJECT 'GIRDER A' REPEAT 6 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1524 Z -268

$=====================================================================================================
$ Generate Joints to Connect Deck Plate Elements
$=====================================================================================================
GENERATE 2 JOINTS ID 100019 1 X LIST 80 380 Y 916 Z 0
REPEAT 6 ID 100000 X 1524 Z -268
REPEAT 76 ID 300 Z -900

GENERATE 3 JOINTS ID 100021 1 X 686 306 Y 916 0 Z -67 -67
REPEAT 5 ID 100000 X 1524 Z -268
REPEAT 76 ID 300 Z -900

$=====================================================================================================
$ Generate Deck Plate Elements
$=====================================================================================================
TYPE PLATE

GENERATE 4 ELEMENTS ID 'P-1011' 1 FROM 100019 1 TO 100020 1 TO 100320 1 TO 100319 1
REPEAT 5 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 75 ID 10 FROM INCR 300 TO INCR 300

GENERATE 6 ELEMENTS ID 'P-1015' 1000 FROM 100023 100000 TO 200019 100000 TO 200319 100000 TO 100323 100000
REPEAT 75 ID 10 FROM INCR 300 TO INCR 300

GENERATE 76 ELEMENTS ID 'P-7011' 10 FROM 700019 300 TO 700020 300 TO 700320 300 TO 700319 300

$=====================================================================================================
$ Generate Rigid Members to Connect Girder Elements to Plate Elements
$=====================================================================================================
TYPE SPACE TRUSS

GENERATE 2 MEMBERS ID 'R-1001' 1 FROM 100015 3 TO 100019 1
REPEAT 6 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 76 ID 10 FROM INCR 300 TO INCR 300

$=====================================================================================================
$ Generate Diaphragm Members at Top of Bottom Flange
$=====================================================================================================
$ END DIAPHRAGMS
GENERATE 6 MEMBERS ID 'B2-1' 1 FROM 100008 100000 TO 200005 100000
GENERATE 6 MEMBERS ID 'B5-1' 1 FROM 122808 100000 TO 222805 100000

$ INTERMEDIATE DIAPHRAGMS
GENERATE 2 MEMBERS ID 'B3-1' 5 FROM 107608 499800 TO 207805 499800
GENERATE 2 MEMBERS ID 'B3-2' 3 FROM 207808 299900 TO 307505 299900
GENERATE 2 MEMBERS ID 'B3-3' 1 FROM 307508 100100 TO 407605 100100

GENERATE 2 MEMBERS ID 'B4-1' 5 FROM 115208 499800 TO 215405 499800
GENERATE 2 MEMBERS ID 'B4-2' 3 FROM 215408 299900 TO 315105 299900
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GENERATE 2 MEMBERS ID 'B4-3' 1 FROM 315108 100100 TO 415205 100100

$====================================================================================================
$ Define Element Properties
$====================================================================================================
MATERIAL CONCRETE ALL ELEMENTS
ELEMENT PROPERTIES
 EXISTING 'G-10011' TO 'G-12768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-20011' TO 'G-22768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-30011' TO 'G-32768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-40011' TO 'G-42768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-50011' TO 'G-52768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-60011' TO 'G-62768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-70011' TO 'G-72768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'P-1011' TO 'P-1765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-2011' TO 'P-2765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-3011' TO 'P-3765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-4011' TO 'P-4765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-5011' TO 'P-5765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-6011' TO 'P-6765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-7011' TO 'P-7761' TYPE 'SBCR' THICKNESS 200

$====================================================================================================
$ Define Member Properties
$====================================================================================================
MATERIAL CONCRETE ALL MEMBERS
MEMBER PROPERTIES PRISMATIC
 'R-1001' TO 'R-1761' BY 10 'R-1002' TO 'R-1762' BY 10 AX 5000
 'R-2001' TO 'R-2761' BY 10 'R-2002' TO 'R-2762' BY 10 AX 5000
 'R-3001' TO 'R-3761' BY 10 'R-3002' TO 'R-3762' BY 10 AX 5000
 'R-4001' TO 'R-4761' BY 10 'R-4002' TO 'R-4762' BY 10 AX 5000
 'R-5001' TO 'R-5761' BY 10 'R-5002' TO 'R-5762' BY 10 AX 5000
 'R-6001' TO 'R-6761' BY 10 'R-6002' TO 'R-6762' BY 10 AX 5000
 'R-7001' TO 'R-7761' BY 10 'R-7002' TO 'R-7762' BY 10 AX 5000
MEMBER PROPERTIES PRISMATIC
 'B2-1' TO 'B2-6' AX 219600
 'B3-1' TO 'B3-6' AX 219600
 'B4-1' TO 'B4-6' AX 219600
 'B5-1' TO 'B5-6' AX 219600

$====================================================================================================
$ Define Supports
$====================================================================================================
STATUS SUPPORT JOINTS -
 100001 TO 700001 BY 100000 100002 TO 700002 BY 100000 100003 TO 700003 BY 100000 100004 TO 700004 BY 100000 -
 107601 TO 707601 BY 100000 107602 TO 707602 BY 100000 107603 TO 707603 BY 100000 107604 TO 707604 BY 100000 -
 115201 TO 715201 BY 100000 115202 TO 715202 BY 100000 115203 TO 715203 BY 100000 115204 TO 715204 BY 100000 -
 122801 TO 722801 BY 100000 122802 TO 722802 BY 100000 122803 TO 722803 BY 100000 122804 TO 722804 BY 100000 -

 100019 TO 700019 BY 100000 100020 TO 700020 BY 100000 -
 122819 TO 722819 BY 100000 122820 TO 722820 BY 100000

$====================================================================================================
$ Set Boundary Conditions
$====================================================================================================
JOINT RELEASES

$ GIRDER BASE
$  END PIN CONDITIONS
 100001 TO 100004 200001 TO 200004 300001 TO 300004 400001 TO 400004 500001 TO 500004 600001 TO 600004 700001 TO 700004
MOMENT X Y
 122801 TO 122804 222801 TO 222804 322801 TO 322804 422801 TO 422804 522801 TO 522804 622801 TO 622804 722801 TO 722804
MOMENT X Y

$  INTERMEDIATE PIN CONDITIONS
 107601 TO 107604 207601 TO 207604 307601 TO 307604 407601 TO 407604 507601 TO 507604 607601 TO 607604 707601 TO 707604
MOMENT X Y Z
 115201 TO 115204 215201 TO 215204 315201 TO 315204 415201 TO 415204 515201 TO 515204 615201 TO 615204 715201 TO 715204
MOMENT X Y Z


$ DECK BASE
$  END CONDITIONS
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 600019 TO 600020 700019 TO 700020
FORCE Y
 122819 TO 122820 222819 TO 222820 322819 TO 322820 422819 TO 422820 522819 TO 522820 622819 TO 622820 722819 TO 722820
FORCE Y
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 600019 TO 600020 700019 TO 700020
MOMENT X Y
 122819 TO 122820 222819 TO 222820 322819 TO 322820 422819 TO 422820 522819 TO 522820 622819 TO 622820 722819 TO 722820
MOMENT X Y

$====================================================================================================
$ Define Loading
$====================================================================================================
UNITS KN M
LOADING 'DC1' 'DEAD LOAD STRUCTURAL COMPONENTS OF ELEMENTS'
 ELEMENT LOADS
  EXISTING 'G-10011' TO 'G-12288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-20011' TO 'G-22288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-30011' TO 'G-32288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-40011' TO 'G-42288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-50011' TO 'G-52288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-60011' TO 'G-62288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-70011' TO 'G-72288' BODY FORCES GLOBAL BY -23.5616
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  EXISTING 'P-1011' TO 'P-1765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-2011' TO 'P-2765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-3011' TO 'P-3765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-4011' TO 'P-4765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-5011' TO 'P-5765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-6011' TO 'P-6765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-7011' TO 'P-7761' BODY FORCES GLOBAL BY -23.5616
DEAD LOAD 'DC2' 'DEAD LOAD STRUCTURAL COMPONENTS OF MEMBERS' DIRECTION -Y -
  MEMBERS 'B2-1' TO 'B2-6' 'B3-1' TO 'B3-6' 'B4-1' TO 'B4-6' 'B5-1' TO 'B5-6'
LOADING 'LL' 'VEHICULAR LIVE LOAD'
 JOINT LOADS
$ Truck 1
  203623 403620 FORCE Y -45.5
  205123 405120 FORCE Y -188.5
  206323 406320 FORCE Y -188.5
$ Truck 2
  403623 603620 FORCE Y -188.5
  405123 605120 FORCE Y -188.5
  406323 606320 FORCE Y -45.5
LOADING 'LS' 'LIVE LOAD SURCHARGE'
 ELEMENT LOADS
  EXISTING 'P-1011' TO 'P-1765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-2011' TO 'P-2765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-3011' TO 'P-3765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-4011' TO 'P-4765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-5011' TO 'P-5765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-6011' TO 'P-6765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-7011' TO 'P-7761' SURFACE FORCES GLOBAL PY -3.9269
LOADING 'WS' 'WIND LOAD ON STRUCTURE'
 ELEMENT LOADS
  'G-70013' TO 'G-72283' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70014' TO 'G-72284' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70015' TO 'G-72285' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70018' TO 'G-72288' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4


$====================================================================================================
$ Factored Loads
$====================================================================================================
$LOADING COMBINATION 10 'STRENGTH I MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.75 'LS' 1.75 'WS' 0.0
LOADING COMBINATION 11 'STRENGTH I MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.75 'LS' 1.75 'WS' 0.0
$LOADING COMBINATION 12 'STRENGTH II MINIMUM'  SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 13 'STRENGTH II MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 14 'STRENGTH III MINIMUM' SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 0.0  'LS' 0.0  'WS' 1.4
LOADING COMBINATION 15 'STRENGTH III MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 0.0  'LS' 0.0  'WS' 1.4
$LOADING COMBINATION 16 'STRENGTH V MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.4
LOADING COMBINATION 17 'STRENGTH V MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.4
$LOADING COMBINATION 18 'SERVICE I'            SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.0  'LS' 1.0  'WS' 0.3
$LOADING COMBINATION 19 'SERVICE II'           SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.3  'LS' 1.3  'WS' 0.0
$LOADING COMBINATION 20 'FATIGUE'              SPECS 'DC1' 0.0  'DC2' 0.0  'LL' 0.75 'LS' 0.75 'WS' 0.0

$====================================================================================================
$ Prepare and Generate Output
$====================================================================================================
QUERY
STIFFNESS ANALYSIS

LIST SUMMATION OF REACTIONS
LIST REACTIONS

CALCULATE AVERAGE STRESS AT TOP SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-7765'
CALCULATE AVERAGE STRESS AT BOTTOM SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-7765'

CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-10011' TO 'G-12288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-20011' TO 'G-22288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-30011' TO 'G-32288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-40011' TO 'G-42288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-50011' TO 'G-52288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-60011' TO 'G-62288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-70011' TO 'G-72288'

LIST FORCES MEMBERS 'B2-1' TO 'B2-6' 'B3-1' TO 'B3-6' 'B4-1' TO 'B4-6' 'B5-1' TO 'B5-6'
```

STRUDL 'Model 103' 'Type II Girder, 10° Bridge Skew, Girder Spacing 1.52 m, Span Length 22.8 m, No Diaphragm'

```
UNITS MM
PRINT GENERATE OFF

$====================================================================================================
$ Generate Joints to Connect Girder Brick Elements
$====================================================================================================
GENERATE 4 JOINTS ID 100001 1 X LIST 0 155 305 460 Z 0
REPEAT 1 ID 4 Y 150
REPEAT 1 ID 100 Z -300

GENERATE 2 JOINTS ID 100009 1 X 155 150 Y 455 Z 0
REPEAT 1 ID 100 Z -300

GENERATE 4 JOINTS ID 100011 1 X LIST 80 155 305 380 Y 760 Z 0
REPEAT 1 ID 4 Y 155
REPEAT 1 ID 100 Z -300

$====================================================================================================
$ Generate Girder Brick Elements
$====================================================================================================
TYPE TRIDEMINSIONAL
GENERATE 3 ELEMENTS ID 'G-10011' 1 FROM 100001 1 TO 100002 1 TO 100006 1 TO 100005 1 TO 100101 1 TO 100102 1 TO 100106 1 TO
100105 1
GENERATE 2 ELEMENTS ID 'G-10014' 1 FROM 100006 3 TO 100007 3 TO 100010 3 TO 100009 3 TO 100106 3 TO 100107 3 TO 100110 3 TO
100109 3
GENERATE 3 ELEMENTS ID 'G-10016' 1 FROM 100011 1 TO 100012 1 TO 100016 1 TO 100015 1 TO 100111 1 TO 100112 1 TO 100116 1 TO
100115 1

$====================================================================================================
$ Copy Generated Girder Section and Copy it Down Entire Length of Bridge
$====================================================================================================
DEFINE OBJECT 'SECTION' JOINTS 100001 TO 100018 100101 TO 100118, ELEMENTS 'G-10011' TO 'G-10018'
COPY OBJECT 'SECTION' REPEAT 227 TIMES JOINT INCR 100 ELEMENT INCR 10 TRANSLATE Z -300

$====================================================================================================
$ Copy Generated Girder and Copy it Across The Entire Width of Bridge
$====================================================================================================
DEFINE OBJECT 'GIRDER A' JOINTS EXISTING 100001 TO 122818, ELEMENTS EXISTING 'G-10011' TO 'G-12288'
COPY OBJECT 'GIRDER A' REPEAT 6 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1524 Z -268

$====================================================================================================
$ Generate Joints to Connect Deck Plate Elements
$====================================================================================================
GENERATE 2 JOINTS ID 100019 1 X LIST 80 380 Y 916 Z 0
REPEAT 6 ID 100000 X 1524 Z -268
REPEAT 76 ID 300 Z -900

GENERATE 3 JOINTS ID 100021 1 X 686 306 Y 916 0 Z -67 -67
REPEAT 5 ID 100000 X 1524 Z -268
REPEAT 76 ID 300 Z -900

$====================================================================================================
$ Generate Deck Plate Elements
$====================================================================================================
TYPE PLATE

GENERATE 4 ELEMENTS ID 'P-1011' 1 FROM 100019 1 TO 100020 1 TO 100320 1 TO 100319 1
REPEAT 5 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 75 ID 10 FROM INCR 300 TO INCR 300

GENERATE 6 ELEMENTS ID 'P-1015' 1000 FROM 100023 100000 TO 200019 100000 TO 200319 100000 TO 100323 100000
REPEAT 75 ID 10 FROM INCR 300 TO INCR 300

GENERATE 76 ELEMENTS ID 'P-7011' 10 FROM 700019 300 TO 700020 300 TO 700320 300 TO 700319 300

$====================================================================================================
$ Generate Rigid Members to Connect Girder Elements to Plate Elements
$====================================================================================================
TYPE SPACE TRUSS

GENERATE 2 MEMBERS ID 'R-1001' 1 FROM 100015 3 TO 100019 1
REPEAT 6 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 76 ID 10 FROM INCR 300 TO INCR 300

$====================================================================================================
$ Generate Diaphragm Members at Mid Height of Web
$====================================================================================================
$ END DIAPHRAGMS
GENERATE 6 MEMBERS ID 'B2-1' 1 FROM 100010 100000 TO 200009 100000
GENERATE 6 MEMBERS ID 'B5-1' 1 FROM 122810 100000 TO 222809 100000

$ INTERMEDIATE DIAPHRAGMS
GENERATE 2 MEMBERS ID 'B3-1' 5 FROM 107610 499800 TO 207809 499800
GENERATE 2 MEMBERS ID 'B3-2' 3 FROM 207810 300500 TO 306909 300500
GENERATE 2 MEMBERS ID 'B3-3' 1 FROM 306910 100700 TO 407609 100700

GENERATE 2 MEMBERS ID 'B4-1' 5 FROM 115210 499800 TO 215409 499800
GENERATE 2 MEMBERS ID 'B4-2' 3 FROM 215410 300500 TO 314509 300500
GENERATE 2 MEMBERS ID 'B4-3' 1 FROM 314510 100700 TO 415209 100700

$====================================================================================================
```

```
$ Define Element Properties
$===================================================================================================
MATERIAL CONCRETE ALL ELEMENTS
ELEMENT PROPERTIES
 EXISTING 'G-10011' TO 'G-12768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-20011' TO 'G-22768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-30011' TO 'G-32768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-40011' TO 'G-42768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-50011' TO 'G-52768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-60011' TO 'G-62768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-70011' TO 'G-72768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'P-1011' TO 'P-1765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-2011' TO 'P-2765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-3011' TO 'P-3765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-4011' TO 'P-4765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-5011' TO 'P-5765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-6011' TO 'P-6765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-7011' TO 'P-7761' TYPE 'SBCR' THICKNESS 200

$===================================================================================================
$ Define Member Properties
$===================================================================================================
MATERIAL CONCRETE ALL MEMBERS
MEMBER PROPERTIES PRISMATIC
 'R-1001' TO 'R-1761' BY 10 'R-1002' TO 'R-1762' BY 10 AX 5000
 'R-2001' TO 'R-2761' BY 10 'R-2002' TO 'R-2762' BY 10 AX 5000
 'R-3001' TO 'R-3761' BY 10 'R-3002' TO 'R-3762' BY 10 AX 5000
 'R-4001' TO 'R-4761' BY 10 'R-4002' TO 'R-4762' BY 10 AX 5000
 'R-5001' TO 'R-5761' BY 10 'R-5002' TO 'R-5762' BY 10 AX 5000
 'R-6001' TO 'R-6761' BY 10 'R-6002' TO 'R-6762' BY 10 AX 5000
 'R-7001' TO 'R-7761' BY 10 'R-7002' TO 'R-7762' BY 10 AX 5000
MEMBER PROPERTIES PRISMATIC
 'B2-1' TO 'B2-6' AX 219600
 'B3-1' TO 'B3-6' AX 219600
 'B4-1' TO 'B4-6' AX 219600
 'B5-1' TO 'B5-6' AX 219600

$===================================================================================================
$ Define Supports
$===================================================================================================
STATUS SUPPORT JOINTS -
 100001 TO 700001 BY 100000 100002 TO 700002 BY 100000 100003 TO 700003 BY 100000 100004 TO 700004 BY 100000 -
 107601 TO 707601 BY 100000 107602 TO 707602 BY 100000 107603 TO 707603 BY 100000 107604 TO 707604 BY 100000 -
 115201 TO 715201 BY 100000 115202 TO 715202 BY 100000 115203 TO 715203 BY 100000 115204 TO 715204 BY 100000 -
 122801 TO 722801 BY 100000 122802 TO 722802 BY 100000 122803 TO 722803 BY 100000 122804 TO 722804 BY 100000 -

 100019 TO 700019 BY 100000 100020 TO 700020 BY 100000 -
 122819 TO 722819 BY 100000 122820 TO 722820 BY 100000

$===================================================================================================
$ Set Boundary Conditions
$===================================================================================================
JOINT RELEASES

$ GIRDER BASE
$  END PIN CONDITIONS
 100001 TO 100004 200001 TO 200004 300001 TO 300004 400001 TO 400004 500001 TO 500004 600001 TO 600004 700001 TO 700004
MOMENT X Y
 122801 TO 122804 222801 TO 222804 322801 TO 322804 422801 TO 422804 522801 TO 522804 622801 TO 622804 722801 TO 722804
MOMENT X Y

$  INTERMEDIATE PIN CONDITIONS
 107601 TO 107604 207601 TO 207604 307601 TO 307604 407601 TO 407604 507601 TO 507604 607601 TO 607604 707601 TO 707604
MOMENT X Y Z
 115201 TO 115204 215201 TO 215204 315201 TO 315204 415201 TO 415204 515201 TO 515204 615201 TO 615204 715201 TO 715204
MOMENT X Y Z


$ DECK BASE
$  END CONDITIONS
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 600019 TO 600020 700019 TO 700020
FORCE Y
 122819 TO 122820 222819 TO 222820 322819 TO 322820 422819 TO 422820 522819 TO 522820 622819 TO 622820 722819 TO 722820
FORCE Y
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 600019 TO 600020 700019 TO 700020
MOMENT X Y
 122819 TO 122820 222819 TO 222820 322819 TO 322820 422819 TO 422820 522819 TO 522820 622819 TO 622820 722819 TO 722820
MOMENT X Y

$===================================================================================================
$ Define Loading
$===================================================================================================
UNITS KN M
LOADING 'DC1' 'DEAD LOAD STRUCTURAL COMPONENTS OF ELEMENTS'
 ELEMENT LOADS
  EXISTING 'G-10011' TO 'G-12288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-20011' TO 'G-22288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-30011' TO 'G-32288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-40011' TO 'G-42288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-50011' TO 'G-52288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-60011' TO 'G-62288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-70011' TO 'G-72288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-1011' TO 'P-1765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-2011' TO 'P-2765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-3011' TO 'P-3765' BODY FORCES GLOBAL BY -23.5616
```

```
  EXISTING 'P-4011' TO 'P-4765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-5011' TO 'P-5765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-6011' TO 'P-6765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-7011' TO 'P-7761' BODY FORCES GLOBAL BY -23.5616
DEAD LOAD 'DC2' 'DEAD LOAD STRUCTURAL COMPONENTS OF MEMBERS' DIRECTION -Y -
  MEMBERS 'B2-1' TO 'B2-6' 'B3-1' TO 'B3-6' 'B4-1' TO 'B4-6' 'B5-1' TO 'B5-6'
LOADING 'LL' 'VEHICULAR LIVE LOAD'
 JOINT LOADS
$ Truck 1
  203623 403620 FORCE Y -45.5
  205123 405120 FORCE Y -188.5
  206323 406320 FORCE Y -188.5
$ Truck 2
  403623 603620 FORCE Y -188.5
  405123 605120 FORCE Y -188.5
  406323 606320 FORCE Y -45.5
LOADING 'LS' 'LIVE LOAD SURCHARGE'
 ELEMENT LOADS
  EXISTING 'P-1011' TO 'P-1765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-2011' TO 'P-2765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-3011' TO 'P-3765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-4011' TO 'P-4765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-5011' TO 'P-5765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-6011' TO 'P-6765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-7011' TO 'P-7761' SURFACE FORCES GLOBAL PY -3.9269
LOADING 'WS' 'WIND LOAD ON STRUCTURE'
 ELEMENT LOADS
  'G-70013' TO 'G-72283' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70014' TO 'G-72284' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70015' TO 'G-72285' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70018' TO 'G-72288' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4


$====================================================================================================
$ Factored Loads
$====================================================================================================
$LOADING COMBINATION 10 'STRENGTH I MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.75 'LS' 1.75 'WS' 0.0
LOADING COMBINATION 11 'STRENGTH I MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.75 'LS' 1.75 'WS' 0.0
$LOADING COMBINATION 12 'STRENGTH II MINIMUM'  SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 13 'STRENGTH II MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 14 'STRENGTH III MINIMUM' SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 0.0  'LS' 0.0  'WS' 1.4
LOADING COMBINATION 15 'STRENGTH III MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 0.0  'LS' 0.0  'WS' 1.4
$LOADING COMBINATION 16 'STRENGTH V MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.4
LOADING COMBINATION 17 'STRENGTH V MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.4
$LOADING COMBINATION 18 'SERVICE I'            SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.0  'LS' 1.0  'WS' 0.3
$LOADING COMBINATION 19 'SERVICE II'           SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.3  'LS' 1.3  'WS' 0.0
$LOADING COMBINATION 20 'FATIGUE'              SPECS 'DC1' 0.0  'DC2' 0.0  'LL' 0.75 'LS' 0.75 'WS' 0.0

$====================================================================================================
$ Delete Diaphragms
$====================================================================================================
DELETIONS
MEMBERS 'B2-1' TO 'B2-6' 'B3-1' TO 'B3-6' 'B4-1' TO 'B4-6' 'B5-1' TO 'B5-6'
ADDITIONS

$====================================================================================================
$ Prepare and Generate Output
$====================================================================================================
QUERY
STIFFNESS ANALYSIS

LIST SUMMATION OF REACTIONS
LIST REACTIONS

CALCULATE AVERAGE STRESS AT TOP SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-7765'
CALCULATE AVERAGE STRESS AT BOTTOM SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-7765'

CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-10011' TO 'G-12288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-20011' TO 'G-22288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-30011' TO 'G-32288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-40011' TO 'G-42288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-50011' TO 'G-52288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-60011' TO 'G-62288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-70011' TO 'G-72288'

$LIST FORCES MEMBERS 'B2-1' TO 'B2-6' 'B3-1' TO 'B3-6' 'B4-1' TO 'B4-6' 'B5-1' TO 'B5-6'
```

STRUDL 'Model 104' 'Type II Girder, 10° Bridge Skew, Girder Spacing 2.75 m, Span Length 16.8 m, 30° Diaphragm Skew'

```
UNITS MM
PRINT GENERATE OFF

$====================================================================================================
$ Generate Joints to Connect Girder Brick Elements
$====================================================================================================
GENERATE 4 JOINTS ID 100001 1 X LIST 0 155 305 460 Z 0
REPEAT 1 ID 4 Y 150
REPEAT 1 ID 100 Z -300

GENERATE 2 JOINTS ID 100009 1 X 155 150 Y 455 Z 0
REPEAT 1 ID 100 Z -300

GENERATE 4 JOINTS ID 100011 1 X LIST 80 155 305 380 Y 760 Z 0
REPEAT 1 ID 4 Y 155
REPEAT 1 ID 100 Z -300

$====================================================================================================
$ Generate Girder Brick Elements
$====================================================================================================
TYPE TRIDEMINSIONAL
GENERATE 3 ELEMENTS ID 'G-10011' 1 FROM 100001 1 TO 100002 1 TO 100006 1 TO 100005 1 TO 100101 1 TO 100102 1 TO 100106 1 TO
100105 1
GENERATE 2 ELEMENTS ID 'G-10014' 1 FROM 100006 3 TO 100007 3 TO 100010 3 TO 100009 3 TO 100106 3 TO 100107 3 TO 100110 3 TO
100109 3
GENERATE 3 ELEMENTS ID 'G-10016' 1 FROM 100011 1 TO 100012 1 TO 100016 1 TO 100015 1 TO 100111 1 TO 100112 1 TO 100116 1 TO
100115 1

$====================================================================================================
$ Copy Generated Girder Section and Copy it Down Entire Length of Bridge
$====================================================================================================
DEFINE OBJECT 'SECTION' JOINTS 100001 TO 100018 100101 TO 100118, ELEMENTS 'G-10011' TO 'G-10018'
COPY OBJECT 'SECTION' REPEAT 167 TIMES JOINT INCR 100 ELEMENT INCR 10 TRANSLATE Z -300


$====================================================================================================
$ Copy Generated Girder and Copy it Across The Entire Width of Bridge
$====================================================================================================
DEFINE OBJECT 'GIRDER A' JOINTS EXISTING 100001 TO 116818, ELEMENTS EXISTING 'G-10011' TO 'G-11688'
COPY OBJECT 'GIRDER A' REPEAT 1 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1830 Z -325

DEFINE OBJECT 'GIRDER B' JOINTS EXISTING 200001 TO 216818, ELEMENTS EXISTING 'G-20011' TO 'G-21688'
COPY OBJECT 'GIRDER B' REPEAT 2 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 2748 Z -488

DEFINE OBJECT 'GIRDER D' JOINTS EXISTING 400001 TO 416818, ELEMENTS EXISTING 'G-40011' TO 'G-41688'
COPY OBJECT 'GIRDER D' REPEAT 1 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1830 Z -325

$====================================================================================================
$ Generate Joints to Connect Deck Plate Elements
$====================================================================================================
GENERATE 2 JOINTS ID 100019 1 X LIST 80 380 Y 916 Z 0
REPEAT 56 ID 300 Z -900
GENERATE 2 JOINTS ID 200019 1 X LIST 1910 2210 Y 916 Z -325
REPEAT 56 ID 300 Z -900
GENERATE 2 JOINTS ID 300019 1 X LIST 4658 4958 Y 916 Z -813
REPEAT 56 ID 300 Z -900
GENERATE 2 JOINTS ID 400019 1 X LIST 7406 7706 Y 916 Z -1301
REPEAT 56 ID 300 Z -900
GENERATE 2 JOINTS ID 500019 1 X LIST 9236 9536 Y 916 Z -1626
REPEAT 56 ID 300 Z -900

GENERATE 4 JOINTS ID 100021 1 X 686 306 Y 916 0 Z -65 -65
REPEAT 1 ID 300000 X 7326 Z -1301
REPEAT 56 ID 300 Z -900

GENERATE 7 JOINTS ID 200021 1 X 2516 306 Y 916 0 Z -386 -61
REPEAT 1 ID 100000 X 2748 Z -488
REPEAT 56 ID 300 Z -900

$====================================================================================================
$ Generate Deck Plate Elements
$====================================================================================================
TYPE PLATE

GENERATE 5 ELEMENTS ID 'P-1011' 1 FROM 100019 1 TO 100020 1 TO 100320 1 TO 100319 1
REPEAT 1 ID 3000 FROM INCR 300000 TO INCR 300000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 2 ELEMENTS ID 'P-1016' 3000 FROM 100024 300000 TO 200019 300000 TO 200319 300000 TO 100324 300000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 8 ELEMENTS ID 'P-2011' 1 FROM 200019 1 TO 200020 1 TO 200320 1 TO 200319 1
REPEAT 1 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 2 ELEMENTS ID 'P-2019' 1000 FROM 200027 100000 TO 300019 100000 TO 300319 100000 TO 200327 100000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 56 ELEMENTS ID 'P-5011' 10 FROM 500019 300 TO 500020 300 TO 500320 300 TO 500319 300
```

```
$==================================================================================================
$ Generate Rigid Members to Connect Girder Elements to Plate Elements
$==================================================================================================
TYPE SPACE TRUSS

GENERATE 2 MEMBERS ID 'R-1001' 1 FROM 100015 3 TO 100019 1
REPEAT 4 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 56 ID 10 FROM INCR 300 TO INCR 300

$==================================================================================================
$ Generate Diaphragm Members at Top of Bottom Flange
$==================================================================================================
$ END DIAPHRAGMS
GENERATE 4 MEMBERS ID 'B2-1' 1 FROM 100008 100000 TO 200005 100000
GENERATE 4 MEMBERS ID 'B5-1' 1 FROM 116808 100000 TO 216805 100000

$ INTERMEDIATE DIAPHRAGMS
GENERATE 2 MEMBERS ID 'B3-1' 3 FROM 105608 301300 TO 204305 301300
GENERATE 2 MEMBERS ID 'B3-2' 1 FROM 204308 101300 TO 305605 101300

GENERATE 2 MEMBERS ID 'B4-1' 3 FROM 111208 301300 TO 209905 301300
GENERATE 2 MEMBERS ID 'B4-2' 1 FROM 209908 101300 TO 311205 101300

$==================================================================================================
$ Define Element Properties
$==================================================================================================
MATERIAL CONCRETE ALL ELEMENTS
ELEMENT PROPERTIES
 EXISTING 'G-10011' TO 'G-11688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-20011' TO 'G-21688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-30011' TO 'G-31688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-40011' TO 'G-41688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-50011' TO 'G-51688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'P-1011' TO 'P-1566' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-2011' TO 'P-2569' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-3011' TO 'P-3569' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-4011' TO 'P-4566' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-5011' TO 'P-5561' TYPE 'SBCR' THICKNESS 200

$==================================================================================================
$ Define Member Properties
$==================================================================================================
MATERIAL CONCRETE ALL MEMBERS
MEMBER PROPERTIES PRISMATIC
 'R-1001' TO 'R-1561' BY 10 'R-1002' TO 'R-1562' BY 10 AX 5000
 'R-2001' TO 'R-2561' BY 10 'R-2002' TO 'R-2562' BY 10 AX 5000
 'R-3001' TO 'R-3561' BY 10 'R-3002' TO 'R-3562' BY 10 AX 5000
 'R-4001' TO 'R-4561' BY 10 'R-4002' TO 'R-4562' BY 10 AX 5000
 'R-5001' TO 'R-5561' BY 10 'R-5002' TO 'R-5562' BY 10 AX 5000
MEMBER PROPERTIES PRISMATIC
 'B2-1' TO 'B2-4' AX 219600
 'B3-1' TO 'B3-4' AX 219600
 'B4-1' TO 'B4-4' AX 219600
 'B5-1' TO 'B5-4' AX 219600

$==================================================================================================
$ Define Supports
$==================================================================================================
STATUS SUPPORT JOINTS -
 100001 TO 500001 BY 100000 100002 TO 500002 BY 100000 100003 TO 500003 BY 100000 100004 TO 500004 BY 100000 -
 105601 TO 505601 BY 100000 105602 TO 505602 BY 100000 105603 TO 505603 BY 100000 105604 TO 505604 BY 100000 -
 111201 TO 511201 BY 100000 111202 TO 511202 BY 100000 111203 TO 511203 BY 100000 111204 TO 511204 BY 100000 -
 116801 TO 516801 BY 100000 116802 TO 516802 BY 100000 116803 TO 516803 BY 100000 116804 TO 516804 BY 100000 -

 100019 TO 500019 BY 100000 100020 TO 500020 BY 100000 -
 116819 TO 516819 BY 100000 116820 TO 516820 BY 100000

$==================================================================================================
$ Set Boundary Conditions
$==================================================================================================
JOINT RELEASES

$ GIRDER BASE
$  END PIN CONDITIONS
 100001 TO 100004 200001 TO 200004 300001 TO 300004 400001 TO 400004 500001 TO 500004 MOMENT X Y
 116801 TO 116804 216801 TO 216804 316801 TO 316804 416801 TO 416804 516801 TO 516804 MOMENT X Y

$  INTERMEDIATE PIN CONDITIONS
 105601 TO 105604 205601 TO 205604 305601 TO 305604 405601 TO 405604 505601 TO 505604 MOMENT X Y Z
 111201 TO 111204 211201 TO 211204 311201 TO 311204 411201 TO 411204 511201 TO 511204 MOMENT X Y Z


$ DECK BASE
$  END CONDITIONS
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 FORCE Y
 116819 TO 116820 216819 TO 216820 316819 TO 316820 416819 TO 416820 516819 TO 516820 FORCE Y
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 MOMENT X Y
 116819 TO 116820 216819 TO 216820 316819 TO 316820 416819 TO 416820 516819 TO 516820 MOMENT X Y

$==================================================================================================
$ Define Loading
$==================================================================================================
UNITS KN M
LOADING 'DC1' 'DEAD LOAD STRUCTURAL COMPONENTS OF ELEMENTS'
```

```
 ELEMENT LOADS
  EXISTING 'G-10011' TO 'G-11688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-20011' TO 'G-21688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-30011' TO 'G-31688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-40011' TO 'G-41688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-50011' TO 'G-51688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-1011' TO 'P-1566' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-2011' TO 'P-2569' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-3011' TO 'P-3569' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-4011' TO 'P-4566' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-5011' TO 'P-5561' BODY FORCES GLOBAL BY -23.5616
DEAD LOAD 'DC2' 'DEAD LOAD STRUCTURAL COMPONENTS OF MEMBERS' DIRECTION -Y -
  MEMBERS 'B2-1' TO 'B2-4' 'B3-1' TO 'B3-4' 'B4-1' TO 'B4-4' 'B5-1' TO 'B5-4'
LOADING 'LL' 'VEHICULAR LIVE LOAD'
 JOINT LOADS
$ Truck 1
  203622 303620 FORCE Y -45.5
  205122 305120 FORCE Y -188.5
  206322 306320 FORCE Y -188.5
$ Truck 2
  303623 403621 FORCE Y -188.5
  305123 405121 FORCE Y -188.5
  306323 406321 FORCE Y -45.5
LOADING 'LS' 'LIVE LOAD SURCHARGE'
 ELEMENT LOADS
  EXISTING 'P-1011' TO 'P-1566' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-2011' TO 'P-2569' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-3011' TO 'P-3569' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-4011' TO 'P-4566' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-5011' TO 'P-5561' SURFACE FORCES GLOBAL PY -3.9269
LOADING 'WS' 'WIND LOAD ON STRUCTURE'
 ELEMENT LOADS
  'G-50013' TO 'G-51683' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50014' TO 'G-51684' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50015' TO 'G-51685' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50018' TO 'G-51688' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4

$====================================================================================================
$ Factored Loads
$====================================================================================================
$LOADING COMBINATION 10 'STRENGTH I MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.75 'LS' 1.75 'WS' 0.0
LOADING COMBINATION 11 'STRENGTH I MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.75 'LS' 1.75 'WS' 0.0
$LOADING COMBINATION 12 'STRENGTH II MINIMUM'  SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 13 'STRENGTH II MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 14 'STRENGTH III MINIMUM' SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 0.0  'LS' 0.0  'WS' 1.4
LOADING COMBINATION 15 'STRENGTH III MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 0.0  'LS' 0.0  'WS' 1.4
$LOADING COMBINATION 16 'STRENGTH V MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.4
LOADING COMBINATION 17 'STRENGTH V MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.4
$LOADING COMBINATION 18 'SERVICE I'            SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.0  'LS' 1.0  'WS' 0.3
$LOADING COMBINATION 19 'SERVICE II'           SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.3  'LS' 1.3  'WS' 0.0
$LOADING COMBINATION 20 'FATIGUE'              SPECS 'DC1' 0.0  'DC2' 0.0  'LL' 0.75 'LS' 0.75 'WS' 0.0

$====================================================================================================
$ Prepare and Generate Output
$====================================================================================================
QUERY
STIFFNESS ANALYSIS

LIST SUMMATION OF REACTIONS
LIST REACTIONS

CALCULATE AVERAGE STRESS AT TOP SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-5565'
CALCULATE AVERAGE STRESS AT BOTTOM SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-5565'

CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-10011' TO 'G-11688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-20011' TO 'G-21688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-30011' TO 'G-31688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-40011' TO 'G-41688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-50011' TO 'G-51688'

LIST FORCES MEMBERS 'B2-1' TO 'B2-4' 'B3-1' TO 'B3-4' 'B4-1' TO 'B4-4' 'B5-1' TO 'B5-4'
```

STRUDL 'Model 105' ‘Type II Girder, 10° Bridge Skew, Girder Spacing 2.75 m, Span Length 16.8 m, 65° Diaphragm Skew’

```
UNITS MM
PRINT GENERATE OFF

$==================================================================================================
$ Generate Joints to Connect Girder Brick Elements
$==================================================================================================
GENERATE 4 JOINTS ID 100001 1 X LIST 0 155 305 460 Z 0
REPEAT 1 ID 4 Y 150
REPEAT 1 ID 100 Z -300

GENERATE 2 JOINTS ID 100009 1 X 155 150 Y 455 Z 0
REPEAT 1 ID 100 Z -300

GENERATE 4 JOINTS ID 100011 1 X LIST 80 155 305 380 Y 760 Z 0
REPEAT 1 ID 4 Y 155
REPEAT 1 ID 100 Z -300

$==================================================================================================
$ Generate Girder Brick Elements
$==================================================================================================
TYPE TRIDEMINSIONAL
GENERATE 3 ELEMENTS ID 'G-10011' 1 FROM 100001 1 TO 100002 1 TO 100006 1 TO 100005 1 TO 100101 1 TO 100102 1 TO 100106 1 TO
100105 1
GENERATE 2 ELEMENTS ID 'G-10014' 1 FROM 100006 3 TO 100007 3 TO 100010 3 TO 100009 3 TO 100106 3 TO 100107 3 TO 100110 3 TO
100109 3
GENERATE 3 ELEMENTS ID 'G-10016' 1 FROM 100011 1 TO 100012 1 TO 100016 1 TO 100015 1 TO 100111 1 TO 100112 1 TO 100116 1 TO
100115 1

$==================================================================================================
$ Copy Generated Girder Section and Copy it Down Entire Length of Bridge
$==================================================================================================
DEFINE OBJECT 'SECTION' JOINTS 100001 TO 100018 100101 TO 100118, ELEMENTS 'G-10011' TO 'G-10018'
COPY OBJECT 'SECTION' REPEAT 167 TIMES JOINT INCR 100 ELEMENT INCR 10 TRANSLATE Z -300


$==================================================================================================
$ Copy Generated Girder and Copy it Across The Entire Width of Bridge
$==================================================================================================
DEFINE OBJECT 'GIRDER A' JOINTS EXISTING 100001 TO 116818, ELEMENTS EXISTING 'G-10011' TO 'G-11688'
COPY OBJECT 'GIRDER A' REPEAT 1 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1830 Z -325

DEFINE OBJECT 'GIRDER B' JOINTS EXISTING 200001 TO 216818, ELEMENTS EXISTING 'G-20011' TO 'G-21688'
COPY OBJECT 'GIRDER B' REPEAT 2 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 2748 Z -488

DEFINE OBJECT 'GIRDER D' JOINTS EXISTING 400001 TO 416818, ELEMENTS EXISTING 'G-40011' TO 'G-41688'
COPY OBJECT 'GIRDER D' REPEAT 1 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1830 Z -325

$==================================================================================================
$ Generate Joints to Connect Deck Plate Elements
$==================================================================================================
GENERATE 2 JOINTS ID 100019 1 X LIST 80 380 Y 916 Z 0
REPEAT 56 ID 300 Z -900
GENERATE 2 JOINTS ID 200019 1 X LIST 1910 2210 Y 916 Z -325
REPEAT 56 ID 300 Z -900
GENERATE 2 JOINTS ID 300019 1 X LIST 4658 4958 Y 916 Z -813
REPEAT 56 ID 300 Z -900
GENERATE 2 JOINTS ID 400019 1 X LIST 7406 7706 Y 916 Z -1301
REPEAT 56 ID 300 Z -900
GENERATE 2 JOINTS ID 500019 1 X LIST 9236 9536 Y 916 Z -1626
REPEAT 56 ID 300 Z -900

GENERATE 4 JOINTS ID 100021 1 X 686 306 Y 916 0 Z -65 -65
REPEAT 1 ID 300000 X 7326 Z -1301
REPEAT 56 ID 300 Z -900

GENERATE 7 JOINTS ID 200021 1 X 2516 306 Y 916 0 Z -386 -61
REPEAT 1 ID 100000 X 2748 Z -488
REPEAT 56 ID 300 Z -900

$==================================================================================================
$ Generate Deck Plate Elements
$==================================================================================================
TYPE PLATE

GENERATE 5 ELEMENTS ID 'P-1011' 1 FROM 100019 1 TO 100020 1 TO 100320 1 TO 100319 1
REPEAT 1 ID 3000 FROM INCR 300000 TO INCR 300000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 2 ELEMENTS ID 'P-1016' 3000 FROM 100024 300000 TO 200019 300000 TO 200319 300000 TO 100324 300000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 8 ELEMENTS ID 'P-2011' 1 FROM 200019 1 TO 200020 1 TO 200320 1 TO 200319 1
REPEAT 1 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 2 ELEMENTS ID 'P-2019' 1000 FROM 200027 100000 TO 300019 100000 TO 300319 100000 TO 200327 100000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 56 ELEMENTS ID 'P-5011' 10 FROM 500019 300 TO 500020 300 TO 500320 300 TO 500319 300
```

```
$=====================================================================================================
$ Generate Rigid Members to Connect Girder Elements to Plate Elements
$=====================================================================================================
TYPE SPACE TRUSS

GENERATE 2 MEMBERS ID 'R-1001' 1 FROM 100015 3 TO 100019 1
REPEAT 4 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 56 ID 10 FROM INCR 300 TO INCR 300

$=====================================================================================================
$ Generate Diaphragm Members at Top of Bottom Flange
$=====================================================================================================
$ END DIAPHRAGMS
GENERATE 4 MEMBERS ID 'B2-1' 1 FROM 100008 100000 TO 200005 100000
GENERATE 4 MEMBERS ID 'B5-1' 1 FROM 116808 100000 TO 216805 100000

$ INTERMEDIATE DIAPHRAGMS
GENERATE 2 MEMBERS ID 'B3-1' 3 FROM 105608 300200 TO 205405 300200
GENERATE 2 MEMBERS ID 'B3-2' 1 FROM 205408 100200 TO 305605 100200

GENERATE 2 MEMBERS ID 'B4-1' 3 FROM 111208 300200 TO 211005 300200
GENERATE 2 MEMBERS ID 'B4-2' 1 FROM 211008 100200 TO 311205 100200

$=====================================================================================================
$ Define Element Properties
$=====================================================================================================
MATERIAL CONCRETE ALL ELEMENTS
ELEMENT PROPERTIES
 EXISTING 'G-10011' TO 'G-11688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-20011' TO 'G-21688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-30011' TO 'G-31688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-40011' TO 'G-41688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-50011' TO 'G-51688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'P-1011' TO 'P-1566' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-2011' TO 'P-2569' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-3011' TO 'P-3569' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-4011' TO 'P-4566' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-5011' TO 'P-5561' TYPE 'SBCR' THICKNESS 200

$=====================================================================================================
$ Define Member Properties
$=====================================================================================================
MATERIAL CONCRETE ALL MEMBERS
MEMBER PROPERTIES PRISMATIC
 'R-1001' TO 'R-1561' BY 10 'R-1002' TO 'R-1562' BY 10 AX 5000
 'R-2001' TO 'R-2561' BY 10 'R-2002' TO 'R-2562' BY 10 AX 5000
 'R-3001' TO 'R-3561' BY 10 'R-3002' TO 'R-3562' BY 10 AX 5000
 'R-4001' TO 'R-4561' BY 10 'R-4002' TO 'R-4562' BY 10 AX 5000
 'R-5001' TO 'R-5561' BY 10 'R-5002' TO 'R-5562' BY 10 AX 5000
MEMBER PROPERTIES PRISMATIC
 'B2-1' TO 'B2-4' AX 219600
 'B3-1' TO 'B3-4' AX 219600
 'B4-1' TO 'B4-4' AX 219600
 'B5-1' TO 'B5-4' AX 219600

$=====================================================================================================
$ Define Supports
$=====================================================================================================
STATUS SUPPORT JOINTS -
 100001 TO 500001 BY 100000 100002 TO 500002 BY 100000 100003 TO 500003 BY 100000 100004 TO 500004 BY 100000 -
 105601 TO 505601 BY 100000 105602 TO 505602 BY 100000 105603 TO 505603 BY 100000 105604 TO 505604 BY 100000 -
 111201 TO 511201 BY 100000 111202 TO 511202 BY 100000 111203 TO 511203 BY 100000 111204 TO 511204 BY 100000 -
 116801 TO 516801 BY 100000 116802 TO 516802 BY 100000 116803 TO 516803 BY 100000 116804 TO 516804 BY 100000 -

 100019 TO 500019 BY 100000 100020 TO 500020 BY 100000 -
 116819 TO 516819 BY 100000 116820 TO 516820 BY 100000

$=====================================================================================================
$ Set Boundary Conditions
$=====================================================================================================
JOINT RELEASES

$ GIRDER BASE
$  END PIN CONDITIONS
 100001 TO 100004 200001 TO 200004 300001 TO 300004 400001 TO 400004 500001 TO 500004 MOMENT X Y
 116801 TO 116804 216801 TO 216804 316801 TO 316804 416801 TO 416804 516801 TO 516804 MOMENT X Y

$  INTERMEDIATE PIN CONDITIONS
 105601 TO 105604 205601 TO 205604 305601 TO 305604 405601 TO 405604 505601 TO 505604 MOMENT X Y Z
 111201 TO 111204 211201 TO 211204 311201 TO 311204 411201 TO 411204 511201 TO 511204 MOMENT X Y Z


$ DECK BASE
$  END CONDITIONS
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 FORCE Y
 116819 TO 116820 216819 TO 216820 316819 TO 316820 416819 TO 416820 516819 TO 516820 FORCE Y
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 MOMENT X Y
 116819 TO 116820 216819 TO 216820 316819 TO 316820 416819 TO 416820 516819 TO 516820 MOMENT X Y

$=====================================================================================================
$ Define Loading
$=====================================================================================================
UNITS KN M
LOADING 'DC1' 'DEAD LOAD STRUCTURAL COMPONENTS OF ELEMENTS'
```

```
 ELEMENT LOADS
  EXISTING 'G-10011' TO 'G-11688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-20011' TO 'G-21688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-30011' TO 'G-31688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-40011' TO 'G-41688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-50011' TO 'G-51688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-1011' TO 'P-1566' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-2011' TO 'P-2569' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-3011' TO 'P-3569' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-4011' TO 'P-4566' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-5011' TO 'P-5561' BODY FORCES GLOBAL BY -23.5616
DEAD LOAD 'DC2' 'DEAD LOAD STRUCTURAL COMPONENTS OF MEMBERS' DIRECTION -Y -
  MEMBERS 'B2-1' TO 'B2-4' 'B3-1' TO 'B3-4' 'B4-1' TO 'B4-4' 'B5-1' TO 'B5-4'
LOADING 'LL' 'VEHICULAR LIVE LOAD'
 JOINT LOADS
$ Truck 1
  203622 303620 FORCE Y -45.5
  205122 305120 FORCE Y -188.5
  206322 306320 FORCE Y -188.5
$ Truck 2
  303623 403621 FORCE Y -188.5
  305123 405121 FORCE Y -188.5
  306323 406321 FORCE Y -45.5
LOADING 'LS' 'LIVE LOAD SURCHARGE'
 ELEMENT LOADS
  EXISTING 'P-1011' TO 'P-1566' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-2011' TO 'P-2569' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-3011' TO 'P-3569' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-4011' TO 'P-4566' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-5011' TO 'P-5561' SURFACE FORCES GLOBAL PY -3.9269
LOADING 'WS' 'WIND LOAD ON STRUCTURE'
 ELEMENT LOADS
  'G-50013' TO 'G-51683' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50014' TO 'G-51684' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50015' TO 'G-51685' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50018' TO 'G-51688' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4

$====================================================================================================
$ Factored Loads
$====================================================================================================
$LOADING COMBINATION 10 'STRENGTH I MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.75 'LS' 1.75 'WS' 0.0
LOADING COMBINATION 11 'STRENGTH I MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.75 'LS' 1.75 'WS' 0.0
$LOADING COMBINATION 12 'STRENGTH II MINIMUM'  SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 13 'STRENGTH II MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 14 'STRENGTH III MINIMUM' SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 0.0  'LS' 0.0  'WS' 1.4
LOADING COMBINATION 15 'STRENGTH III MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 0.0  'LS' 0.0  'WS' 1.4
$LOADING COMBINATION 16 'STRENGTH V MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.4
LOADING COMBINATION 17 'STRENGTH V MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.4
$LOADING COMBINATION 18 'SERVICE I'            SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.0  'LS' 1.0  'WS' 0.3
$LOADING COMBINATION 19 'SERVICE II'           SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.3  'LS' 1.3  'WS' 0.0
$LOADING COMBINATION 20 'FATIGUE'              SPECS 'DC1' 0.0  'DC2' 0.0  'LL' 0.75 'LS' 0.75 'WS' 0.0

$====================================================================================================
$ Prepare and Generate Output
$====================================================================================================
QUERY
STIFFNESS ANALYSIS

LIST SUMMATION OF REACTIONS
LIST REACTIONS

CALCULATE AVERAGE STRESS AT TOP SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-5565'
CALCULATE AVERAGE STRESS AT BOTTOM SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-5565'

CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-10011' TO 'G-11688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-20011' TO 'G-21688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-30011' TO 'G-31688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-40011' TO 'G-41688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-50011' TO 'G-51688'

LIST FORCES MEMBERS 'B2-1' TO 'B2-4' 'B3-1' TO 'B3-4' 'B4-1' TO 'B4-4' 'B5-1' TO 'B5-4'
```

STRUDL 'Model 106' 'Type II Girder, 10° Bridge Skew, Girder Spacing 2.75 m, Span Length 16.8 m, No Diaphragm'

```
UNITS MM
PRINT GENERATE OFF

$====================================================================================================
$ Generate Joints to Connect Girder Brick Elements
$====================================================================================================
GENERATE 4 JOINTS ID 100001 1 X LIST 0 155 305 460 Z 0
REPEAT 1 ID 4 Y 150
REPEAT 1 ID 100 Z -300

GENERATE 2 JOINTS ID 100009 1 X 155 150 Y 455 Z 0
REPEAT 1 ID 100 Z -300

GENERATE 4 JOINTS ID 100011 1 X LIST 80 155 305 380 Y 760 Z 0
REPEAT 1 ID 4 Y 155
REPEAT 1 ID 100 Z -300

$====================================================================================================
$ Generate Girder Brick Elements
$====================================================================================================
TYPE TRIDEMINSIONAL
GENERATE 3 ELEMENTS ID 'G-10011' 1 FROM 100001 1 TO 100002 1 TO 100006 1 TO 100005 1 TO 100101 1 TO 100102 1 TO 100106 1 TO
100105 1
GENERATE 2 ELEMENTS ID 'G-10014' 1 FROM 100006 3 TO 100007 3 TO 100010 3 TO 100009 3 TO 100106 3 TO 100107 3 TO 100110 3 TO
100109 3
GENERATE 3 ELEMENTS ID 'G-10016' 1 FROM 100011 1 TO 100012 1 TO 100016 1 TO 100015 1 TO 100111 1 TO 100112 1 TO 100116 1 TO
100115 1

$====================================================================================================
$ Copy Generated Girder Section and Copy it Down Entire Length of Bridge
$====================================================================================================
DEFINE OBJECT 'SECTION' JOINTS 100001 TO 100018 100101 TO 100118, ELEMENTS 'G-10011' TO 'G-10018'
COPY OBJECT 'SECTION' REPEAT 167 TIMES JOINT INCR 100 ELEMENT INCR 10 TRANSLATE Z -300

$====================================================================================================
$ Copy Generated Girder and Copy it Across The Entire Width of Bridge
$====================================================================================================
DEFINE OBJECT 'GIRDER A' JOINTS EXISTING 100001 TO 116818, ELEMENTS EXISTING 'G-10011' TO 'G-11688'
COPY OBJECT 'GIRDER A' REPEAT 1 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1830 Z -325

DEFINE OBJECT 'GIRDER B' JOINTS EXISTING 200001 TO 216818, ELEMENTS EXISTING 'G-20011' TO 'G-21688'
COPY OBJECT 'GIRDER B' REPEAT 2 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 2748 Z -488

DEFINE OBJECT 'GIRDER D' JOINTS EXISTING 400001 TO 416818, ELEMENTS EXISTING 'G-40011' TO 'G-41688'
COPY OBJECT 'GIRDER D' REPEAT 1 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1830 Z -325

$====================================================================================================
$ Generate Joints to Connect Deck Plate Elements
$====================================================================================================
GENERATE 2 JOINTS ID 100019 1 X LIST 80 380 Y 916 Z 0
REPEAT 56 ID 300 Z -900
GENERATE 2 JOINTS ID 200019 1 X LIST 1910 2210 Y 916 Z -325
REPEAT 56 ID 300 Z -900
GENERATE 2 JOINTS ID 300019 1 X LIST 4658 4958 Y 916 Z -813
REPEAT 56 ID 300 Z -900
GENERATE 2 JOINTS ID 400019 1 X LIST 7406 7706 Y 916 Z -1301
REPEAT 56 ID 300 Z -900
GENERATE 2 JOINTS ID 500019 1 X LIST 9236 9536 Y 916 Z -1626
REPEAT 56 ID 300 Z -900

GENERATE 4 JOINTS ID 100021 1 X 686 306 Y 916 0 Z -65 -65
REPEAT 1 ID 300000 X 7326 Z -1301
REPEAT 56 ID 300 Z -900

GENERATE 7 JOINTS ID 200021 1 X 2516 306 Y 916 0 Z -386 -61
REPEAT 1 ID 100000 X 2748 Z -488
REPEAT 56 ID 300 Z -900

$====================================================================================================
$ Generate Deck Plate Elements
$====================================================================================================
TYPE PLATE

GENERATE 5 ELEMENTS ID 'P-1011' 1 FROM 100019 1 TO 100020 1 TO 100320 1 TO 100319 1
REPEAT 1 ID 3000 FROM INCR 300000 TO INCR 300000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 2 ELEMENTS ID 'P-1016' 3000 FROM 100024 300000 TO 200019 300000 TO 200319 300000 TO 100324 300000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 8 ELEMENTS ID 'P-2011' 1 FROM 200019 1 TO 200020 1 TO 200320 1 TO 200319 1
REPEAT 1 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 2 ELEMENTS ID 'P-2019' 1000 FROM 200027 100000 TO 300019 100000 TO 300319 100000 TO 200327 100000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 56 ELEMENTS ID 'P-5011' 10 FROM 500019 300 TO 500020 300 TO 500320 300 TO 500319 300

$====================================================================================================
$ Generate Rigid Members to Connect Girder Elements to Plate Elements
```

```
$=====================================================================================================
TYPE SPACE TRUSS

GENERATE 2 MEMBERS ID 'R-1001' 1 FROM 100015 3 TO 100019 1
REPEAT 4 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 56 ID 10 FROM INCR 300 TO INCR 300

$=====================================================================================================
$ Generate Diaphragm Members at Mid Height of Web
$=====================================================================================================
$ END DIAPHRAGMS
GENERATE 4 MEMBERS ID 'B2-1' 1 FROM 100010 100000 TO 200009 100000
GENERATE 4 MEMBERS ID 'B5-1' 1 FROM 116810 100000 TO 216809 100000

$ INTERMEDIATE DIAPHRAGMS
GENERATE 2 MEMBERS ID 'B3-1' 3 FROM 105610 301300 TO 204309 301300
GENERATE 2 MEMBERS ID 'B3-2' 1 FROM 204310 101300 TO 305609 101300

GENERATE 2 MEMBERS ID 'B4-1' 3 FROM 111210 301300 TO 209909 301300
GENERATE 2 MEMBERS ID 'B4-2' 1 FROM 209910 101300 TO 311209 101300

$=====================================================================================================
$ Define Element Properties
$=====================================================================================================
MATERIAL CONCRETE ALL ELEMENTS
ELEMENT PROPERTIES
 EXISTING 'G-10011' TO 'G-11688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-20011' TO 'G-21688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-30011' TO 'G-31688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-40011' TO 'G-41688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-50011' TO 'G-51688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'P-1011' TO 'P-1566' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-2011' TO 'P-2569' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-3011' TO 'P-3569' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-4011' TO 'P-4566' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-5011' TO 'P-5561' TYPE 'SBCR' THICKNESS 200

$=====================================================================================================
$ Define Member Properties
$=====================================================================================================
MATERIAL CONCRETE ALL MEMBERS
MEMBER PROPERTIES PRISMATIC
 'R-1001' TO 'R-1561' BY 10 'R-1002' TO 'R-1562' BY 10 AX 5000
 'R-2001' TO 'R-2561' BY 10 'R-2002' TO 'R-2562' BY 10 AX 5000
 'R-3001' TO 'R-3561' BY 10 'R-3002' TO 'R-3562' BY 10 AX 5000
 'R-4001' TO 'R-4561' BY 10 'R-4002' TO 'R-4562' BY 10 AX 5000
 'R-5001' TO 'R-5561' BY 10 'R-5002' TO 'R-5562' BY 10 AX 5000
MEMBER PROPERTIES PRISMATIC
 'B2-1' TO 'B2-4' AX 219600
 'B3-1' TO 'B3-4' AX 219600
 'B4-1' TO 'B4-4' AX 219600
 'B5-1' TO 'B5-4' AX 219600

$=====================================================================================================
$ Define Supports
$=====================================================================================================
STATUS SUPPORT JOINTS -
 100001 TO 500001 BY 100000 100002 TO 500002 BY 100000 100003 TO 500003 BY 100000 100004 TO 500004 BY 100000 -
 105601 TO 505601 BY 100000 105602 TO 505602 BY 100000 105603 TO 505603 BY 100000 105604 TO 505604 BY 100000 -
 111201 TO 511201 BY 100000 111202 TO 511202 BY 100000 111203 TO 511203 BY 100000 111204 TO 511204 BY 100000 -
 116801 TO 516801 BY 100000 116802 TO 516802 BY 100000 116803 TO 516803 BY 100000 116804 TO 516804 BY 100000 -

 100019 TO 500019 BY 100000 100020 TO 500020 BY 100000 -
 116819 TO 516819 BY 100000 116820 TO 516820 BY 100000

$=====================================================================================================
$ Set Boundary Conditions
$=====================================================================================================
JOINT RELEASES

$ GIRDER BASE
$  END PIN CONDITIONS
 100001 TO 100004 200001 TO 200004 300001 TO 300004 400001 TO 400004 500001 TO 500004 MOMENT X Y
 116801 TO 116804 216801 TO 216804 316801 TO 316804 416801 TO 416804 516801 TO 516804 MOMENT X Y

$  INTERMEDIATE PIN CONDITIONS
 105601 TO 105604 205601 TO 205604 305601 TO 305604 405601 TO 405604 505601 TO 505604 MOMENT X Y Z
 111201 TO 111204 211201 TO 211204 311201 TO 311204 411201 TO 411204 511201 TO 511204 MOMENT X Y Z


$ DECK BASE
$  END CONDITIONS
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 FORCE Y
 116819 TO 116820 216819 TO 216820 316819 TO 316820 416819 TO 416820 516819 TO 516820 FORCE Y
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 MOMENT X Y
 116819 TO 116820 216819 TO 216820 316819 TO 316820 416819 TO 416820 516819 TO 516820 MOMENT X Y

$=====================================================================================================
$ Define Loading
$=====================================================================================================
UNITS KN M
LOADING 'DC1' 'DEAD LOAD STRUCTURAL COMPONENTS OF ELEMENTS'
 ELEMENT LOADS
  EXISTING 'G-10011' TO 'G-11688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-20011' TO 'G-21688' BODY FORCES GLOBAL BY -23.5616
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  EXISTING 'G-30011' TO 'G-31688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-40011' TO 'G-41688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-50011' TO 'G-51688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-1011' TO 'P-1566' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-2011' TO 'P-2569' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-3011' TO 'P-3569' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-4011' TO 'P-4566' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-5011' TO 'P-5561' BODY FORCES GLOBAL BY -23.5616
DEAD LOAD 'DC2' 'DEAD LOAD STRUCTURAL COMPONENTS OF MEMBERS' DIRECTION -Y -
  MEMBERS 'B2-1' TO 'B2-4' 'B3-1' TO 'B3-4' 'B4-1' TO 'B4-4' 'B5-1' TO 'B5-4'
LOADING 'LL' 'VEHICULAR LIVE LOAD'
 JOINT LOADS
$ Truck 1
  203622 303620 FORCE Y -45.5
  205122 305120 FORCE Y -188.5
  206322 306320 FORCE Y -188.5
$ Truck 2
  303623 403621 FORCE Y -188.5
  305123 405121 FORCE Y -188.5
  306323 406321 FORCE Y -45.5
LOADING 'LS' 'LIVE LOAD SURCHARGE'
 ELEMENT LOADS
  EXISTING 'P-1011' TO 'P-1566' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-2011' TO 'P-2569' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-3011' TO 'P-3569' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-4011' TO 'P-4566' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-5011' TO 'P-5561' SURFACE FORCES GLOBAL PY -3.9269
LOADING 'WS' 'WIND LOAD ON STRUCTURE'
 ELEMENT LOADS
  'G-50013' TO 'G-51683' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50014' TO 'G-51684' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50015' TO 'G-51685' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50018' TO 'G-51688' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4

$====================================================================================================
$ Factored Loads
$====================================================================================================
$LOADING COMBINATION 10 'STRENGTH I MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.75 'LS' 1.75 'WS' 0.0
LOADING COMBINATION 11 'STRENGTH I MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.75 'LS' 1.75 'WS' 0.0
$LOADING COMBINATION 12 'STRENGTH II MINIMUM'  SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 13 'STRENGTH II MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 14 'STRENGTH III MINIMUM' SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 0.0  'LS' 0.0  'WS' 1.4
LOADING COMBINATION 15 'STRENGTH III MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 0.0  'LS' 0.0  'WS' 1.4
$LOADING COMBINATION 16 'STRENGTH V MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.4
LOADING COMBINATION 17 'STRENGTH V MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.4
$LOADING COMBINATION 18 'SERVICE I'            SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.0  'LS' 1.0  'WS' 0.3
$LOADING COMBINATION 19 'SERVICE II'           SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.3  'LS' 1.3  'WS' 0.0
$LOADING COMBINATION 20 'FATIGUE'              SPECS 'DC1' 0.0  'DC2' 0.0  'LL' 0.75 'LS' 0.75 'WS' 0.0

$====================================================================================================
$ Delete Diaphragms
$====================================================================================================
DELETIONS
MEMBERS 'B2-1' TO 'B2-4' 'B3-1' TO 'B3-4' 'B4-1' TO 'B4-4' 'B5-1' TO 'B5-4'
ADDITIONS

$====================================================================================================
$ Prepare and Generate Output
$====================================================================================================
QUERY
STIFFNESS ANALYSIS

LIST SUMMATION OF REACTIONS
LIST REACTIONS

CALCULATE AVERAGE STRESS AT TOP SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-5565'
CALCULATE AVERAGE STRESS AT BOTTOM SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-5565'

CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-10011' TO 'G-11688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-20011' TO 'G-21688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-30011' TO 'G-31688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-40011' TO 'G-41688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-50011' TO 'G-51688'

$LIST FORCES MEMBERS 'B2-1' TO 'B2-4' 'B3-1' TO 'B3-4' 'B4-1' TO 'B4-4' 'B5-1' TO 'B5-4'
```

STRUDL 'Model 107' ‘Type II Girder, 20° Bridge Skew, Girder Spacing 1.52 m, Span Length 22.8 m, 30° Diaphragm Skew’

```
UNITS MM
PRINT GENERATE OFF

$====================================================================================================
$ Generate Joints to Connect Girder Brick Elements
$====================================================================================================
GENERATE 4 JOINTS ID 100001 1 X LIST 0 155 305 460 Z 0
REPEAT 1 ID 4 Y 150
REPEAT 1 ID 100 Z -300

GENERATE 2 JOINTS ID 100009 1 X 155 150 Y 455 Z 0
REPEAT 1 ID 100 Z -300

GENERATE 4 JOINTS ID 100011 1 X LIST 80 155 305 380 Y 760 Z 0
REPEAT 1 ID 4 Y 155
REPEAT 1 ID 100 Z -300

$====================================================================================================
$ Generate Girder Brick Elements
$====================================================================================================
TYPE TRIDEMINSIONAL
GENERATE 3 ELEMENTS ID 'G-10011' 1 FROM 100001 1 TO 100002 1 TO 100006 1 TO 100005 1 TO 100101 1 TO 100102 1 TO 100106 1 TO
100105 1
GENERATE 2 ELEMENTS ID 'G-10014' 1 FROM 100006 3 TO 100007 3 TO 100010 3 TO 100009 3 TO 100106 3 TO 100107 3 TO 100110 3 TO
100109 3
GENERATE 3 ELEMENTS ID 'G-10016' 1 FROM 100011 1 TO 100012 1 TO 100016 1 TO 100015 1 TO 100111 1 TO 100112 1 TO 100116 1 TO
100115 1

$====================================================================================================
$ Copy Generated Girder Section and Copy it Down Entire Length of Bridge
$====================================================================================================
DEFINE OBJECT 'SECTION' JOINTS 100001 TO 100018 100101 TO 100118, ELEMENTS 'G-10011' TO 'G-10018'
COPY OBJECT 'SECTION' REPEAT 227 TIMES JOINT INCR 100 ELEMENT INCR 10 TRANSLATE Z -300


$====================================================================================================
$ Copy Generated Girder and Copy it Across The Entire Width of Bridge
$====================================================================================================
DEFINE OBJECT 'GIRDER A' JOINTS EXISTING 100001 TO 122820, ELEMENTS EXISTING 'G-10011' TO 'G-12288'
COPY OBJECT 'GIRDER A' REPEAT 6 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1524 Z -556

$====================================================================================================
$ Generate Joints to Connect Deck Plate Elements
$====================================================================================================
GENERATE 2 JOINTS ID 100019 1 X LIST 80 380 Y 916 Z 0
REPEAT 6 ID 100000 X 1524 Z -556
REPEAT 76 ID 300 Z -900

GENERATE 3 JOINTS ID 100021 1 X 686 306 Y 916 0 Z -139 -139
REPEAT 5 ID 100000 X 1524 Z -556
REPEAT 76 ID 300 Z -900

$====================================================================================================
$ Generate Deck Plate Elements
$====================================================================================================
TYPE PLATE

GENERATE 4 ELEMENTS ID 'P-1011' 1 FROM 100019 1 TO 100020 1 TO 100320 1 TO 100319 1
REPEAT 5 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 75 ID 10 FROM INCR 300 TO INCR 300

GENERATE 6 ELEMENTS ID 'P-1015' 1000 FROM 100023 100000 TO 200019 100000 TO 200319 100000 TO 100323 100000
REPEAT 75 ID 10 FROM INCR 300 TO INCR 300

GENERATE 76 ELEMENTS ID 'P-7011' 10 FROM 700019 300 TO 700020 300 TO 700320 300 TO 700319 300

$====================================================================================================
$ Generate Rigid Members to Connect Girder Elements to Plate Elements
$====================================================================================================
TYPE SPACE TRUSS

GENERATE 2 MEMBERS ID 'R-1001' 1 FROM 100015 3 TO 100019 1
REPEAT 6 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 76 ID 10 FROM INCR 300 TO INCR 300

$====================================================================================================
$ Generate Diaphragm Members at Top of Bottom Flange
$====================================================================================================
$ END DIAPHRAGMS
GENERATE 6 MEMBERS ID 'B2-1' 1 FROM 100008 100000 TO 200005 100000
GENERATE 6 MEMBERS ID 'B5-1' 1 FROM 122808 100000 TO 222805 100000

$ INTERMEDIATE DIAPHRAGMS
GENERATE 2 MEMBERS ID 'B3-1' 5 FROM 107608 499600 TO 208005 499600
GENERATE 2 MEMBERS ID 'B3-2' 3 FROM 208008 300200 TO 307005 300200
GENERATE 2 MEMBERS ID 'B3-3' 1 FROM 307008 100600 TO 407605 100600

GENERATE 2 MEMBERS ID 'B4-1' 5 FROM 115208 499600 TO 215605 499600
GENERATE 2 MEMBERS ID 'B4-2' 3 FROM 215608 300200 TO 314605 300200
GENERATE 2 MEMBERS ID 'B4-3' 1 FROM 314608 100600 TO 415205 100600
```

```
$=================================================================================================
$ Define Element Properties
$=================================================================================================
MATERIAL CONCRETE ALL ELEMENTS
ELEMENT PROPERTIES
 EXISTING 'G-10011' TO 'G-12768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-20011' TO 'G-22768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-30011' TO 'G-32768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-40011' TO 'G-42768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-50011' TO 'G-52768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-60011' TO 'G-62768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-70011' TO 'G-72768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'P-1011' TO 'P-1765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-2011' TO 'P-2765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-3011' TO 'P-3765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-4011' TO 'P-4765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-5011' TO 'P-5765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-6011' TO 'P-6765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-7011' TO 'P-7761' TYPE 'SBCR' THICKNESS 200

$=================================================================================================
$ Define Member Properties
$=================================================================================================
MATERIAL CONCRETE ALL MEMBERS
MEMBER PROPERTIES PRISMATIC
 'R-1001' TO 'R-1761' BY 10 'R-1002' TO 'R-1762' BY 10 AX 5000
 'R-2001' TO 'R-2761' BY 10 'R-2002' TO 'R-2762' BY 10 AX 5000
 'R-3001' TO 'R-3761' BY 10 'R-3002' TO 'R-3762' BY 10 AX 5000

 'R-4001' TO 'R-4761' BY 10 'R-4002' TO 'R-4762' BY 10 AX 5000
 'R-5001' TO 'R-5761' BY 10 'R-5002' TO 'R-5762' BY 10 AX 5000
 'R-6001' TO 'R-6761' BY 10 'R-6002' TO 'R-6762' BY 10 AX 5000
 'R-7001' TO 'R-7761' BY 10 'R-7002' TO 'R-7762' BY 10 AX 5000

MEMBER PROPERTIES PRISMATIC
 'B2-1' TO 'B2-6' AX 219600
 'B3-1' TO 'B3-6' AX 219600
 'B4-1' TO 'B4-6' AX 219600
 'B5-1' TO 'B5-6' AX 219600

$=================================================================================================
$ Define Supports
$=================================================================================================
STATUS SUPPORT JOINTS -
 100001 TO 700001 BY 100000 100002 TO 700002 BY 100000 100003 TO 700003 BY 100000 100004 TO 700004 BY 100000 -
 107601 TO 707601 BY 100000 107602 TO 707602 BY 100000 107603 TO 707603 BY 100000 107604 TO 707604 BY 100000 -
 115201 TO 715201 BY 100000 115202 TO 715202 BY 100000 115203 TO 715203 BY 100000 115204 TO 715204 BY 100000 -
 122801 TO 722801 BY 100000 122802 TO 722802 BY 100000 122803 TO 722803 BY 100000 122804 TO 722804 BY 100000 -

 100019 TO 700019 BY 100000 100020 TO 700020 BY 100000 -
 122819 TO 722819 BY 100000 122820 TO 722820 BY 100000

$=================================================================================================
$ Set Boundary Conditions
$=================================================================================================
JOINT RELEASES

$ GIRDER BASE
$  END PIN CONDITIONS
 100001 TO 100004 200001 TO 200004 300001 TO 300004 400001 TO 400004 500001 TO 500004 600001 TO 600004 700001 TO 700004
MOMENT X Y
 122801 TO 122804 222801 TO 222804 322801 TO 322804 422801 TO 422804 522801 TO 522804 622801 TO 622804 722801 TO 722804
MOMENT X Y

$  INTERMEDIATE PIN CONDITIONS
 107601 TO 107604 207601 TO 207604 307601 TO 307604 407601 TO 407604 507601 TO 507604 607601 TO 607604 707601 TO 707604
MOMENT X Y Z
 115201 TO 115204 215201 TO 215204 315201 TO 315204 415201 TO 415204 515201 TO 515204 615201 TO 615204 715201 TO 715204
MOMENT X Y Z


$ DECK BASE
$  END CONDITIONS
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 600019 TO 600020 700019 TO 700020
FORCE Y
 122819 TO 122820 222819 TO 222820 322819 TO 322820 422819 TO 422820 522819 TO 522820 622819 TO 622820 722819 TO 722820
FORCE Y
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 600019 TO 600020 700019 TO 700020
MOMENT X Y
 122819 TO 122820 222819 TO 222820 322819 TO 322820 422819 TO 422820 522819 TO 522820 622819 TO 622820 722819 TO 722820
MOMENT X Y


$=================================================================================================
$ Define Loading
$=================================================================================================
UNITS KN M
LOADING 'DC1' 'DEAD LOAD STRUCTURAL COMPONENTS OF ELEMENTS'
 ELEMENT LOADS
  EXISTING 'G-10011' TO 'G-12288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-20011' TO 'G-22288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-30011' TO 'G-32288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-40011' TO 'G-42288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-50011' TO 'G-52288' BODY FORCES GLOBAL BY -23.5616
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  EXISTING 'G-60011' TO 'G-62288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-70011' TO 'G-72288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-1011' TO 'P-1765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-2011' TO 'P-2765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-3011' TO 'P-3765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-4011' TO 'P-4765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-5011' TO 'P-5765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-6011' TO 'P-6765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-7011' TO 'P-7761' BODY FORCES GLOBAL BY -23.5616
DEAD LOAD 'DC2' 'DEAD LOAD STRUCTURAL COMPONENTS OF MEMBERS' DIRECTION -Y -
  MEMBERS 'B2-1' TO 'B2-6' 'B3-1' TO 'B3-6' 'B4-1' TO 'B4-6' 'B5-1' TO 'B5-6'
LOADING 'LL' 'VEHICULAR LIVE LOAD'
 JOINT LOADS
$ Truck 1
  203623 403620 FORCE Y -45.5
  205123 405120 FORCE Y -188.5
  206323 406320 FORCE Y -188.5
$ Truck 2
  403623 603620 FORCE Y -188.5
  405123 605120 FORCE Y -188.5
  406323 606320 FORCE Y -45.5
LOADING 'LS' 'LIVE LOAD SURCHARGE'
 ELEMENT LOADS
  EXISTING 'P-1011' TO 'P-1765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-2011' TO 'P-2765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-3011' TO 'P-3765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-4011' TO 'P-4765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-5011' TO 'P-5765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-6011' TO 'P-6765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-7011' TO 'P-7761' SURFACE FORCES GLOBAL PY -3.9269
LOADING 'WS' 'WIND LOAD ON STRUCTURE'
 ELEMENT LOADS
  'G-70013' TO 'G-72283' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70014' TO 'G-72284' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70015' TO 'G-72285' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70018' TO 'G-72288' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4

$=====================================================================================================
$ Factored Loads
$=====================================================================================================
$LOADING COMBINATION 10 'STRENGTH I MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.75 'LS' 1.75 'WS' 0.0
LOADING COMBINATION 11 'STRENGTH I MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.75 'LS' 1.75 'WS' 0.0
$LOADING COMBINATION 12 'STRENGTH II MINIMUM'  SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 13 'STRENGTH II MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 14 'STRENGTH III MINIMUM' SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 0.0  'LS' 0.0  'WS' 1.4
LOADING COMBINATION 15 'STRENGTH III MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 0.0  'LS' 0.0  'WS' 1.4
$LOADING COMBINATION 16 'STRENGTH V MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.4
LOADING COMBINATION 17 'STRENGTH V MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.4
$LOADING COMBINATION 18 'SERVICE I'            SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.0  'LS' 1.0  'WS' 0.3
$LOADING COMBINATION 19 'SERVICE II'           SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.3  'LS' 1.3  'WS' 0.0
$LOADING COMBINATION 20 'FATIGUE'              SPECS 'DC1' 0.0  'DC2' 0.0  'LL' 0.75 'LS' 0.75 'WS' 0.0

$=====================================================================================================
$ Prepare and Generate Output
$=====================================================================================================
QUERY
STIFFNESS ANALYSIS

LIST SUMMATION OF REACTIONS
LIST REACTIONS

CALCULATE AVERAGE STRESS AT TOP SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-7765'
CALCULATE AVERAGE STRESS AT BOTTOM SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-7765'

CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-10011' TO 'G-12288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-20011' TO 'G-22288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-30011' TO 'G-32288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-40011' TO 'G-42288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-50011' TO 'G-52288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-60011' TO 'G-62288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-70011' TO 'G-72288'

LIST FORCES MEMBERS 'B2-1' TO 'B2-6' 'B3-1' TO 'B3-6' 'B4-1' TO 'B4-6' 'B5-1' TO 'B5-6'
```

STRUDL 'Model 108' 'Type II Girder, 20° Bridge Skew, Girder Spacing 1.52 m, Span Length 22.8 m, 65° Diaphragm Skew'

UNITS MM

```
PRINT GENERATE OFF

$====================================================================================================
$ Generate Joints to Connect Girder Brick Elements
$====================================================================================================
GENERATE 4 JOINTS ID 100001 1 X LIST 0 155 305 460 Z 0
REPEAT 1 ID 4 Y 150
REPEAT 1 ID 100 Z -300

GENERATE 2 JOINTS ID 100009 1 X 155 150 Y 455 Z 0
REPEAT 1 ID 100 Z -300

GENERATE 4 JOINTS ID 100011 1 X LIST 80 155 305 380 Y 760 Z 0
REPEAT 1 ID 4 Y 155
REPEAT 1 ID 100 Z -300

$====================================================================================================
$ Generate Girder Brick Elements
$====================================================================================================
TYPE TRIDEMINSIONAL
GENERATE 3 ELEMENTS ID 'G-10011' 1 FROM 100001 1 TO 100002 1 TO 100006 1 TO 100005 1 TO 100101 1 TO 100102 1 TO 100106 1 TO
100105 1
GENERATE 2 ELEMENTS ID 'G-10014' 1 FROM 100006 3 TO 100007 3 TO 100010 3 TO 100009 3 TO 100106 3 TO 100107 3 TO 100110 3 TO
100109 3
GENERATE 3 ELEMENTS ID 'G-10016' 1 FROM 100011 1 TO 100012 1 TO 100016 1 TO 100015 1 TO 100111 1 TO 100112 1 TO 100116 1 TO
100115 1

$====================================================================================================
$ Copy Generated Girder Section and Copy it Down Entire Length of Bridge
$====================================================================================================
DEFINE OBJECT 'SECTION' JOINTS 100001 TO 100018 100101 TO 100118, ELEMENTS 'G-10011' TO 'G-10018'
COPY OBJECT 'SECTION' REPEAT 227 TIMES JOINT INCR 100 ELEMENT INCR 10 TRANSLATE Z -300


$====================================================================================================
$ Copy Generated Girder and Copy it Across The Entire Width of Bridge
$====================================================================================================
DEFINE OBJECT 'GIRDER A' JOINTS EXISTING 100001 TO 122820, ELEMENTS EXISTING 'G-10011' TO 'G-12288'
COPY OBJECT 'GIRDER A' REPEAT 6 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1524 Z -556

$====================================================================================================
$ Generate Joints to Connect Deck Plate Elements
$====================================================================================================
GENERATE 2 JOINTS ID 100019 1 X LIST 80 380 Y 916 Z 0
REPEAT 6 ID 100000 X 1524 Z -556
REPEAT 76 ID 300 Z -900

GENERATE 3 JOINTS ID 100021 1 X 686 306 Y 916 0 Z -139 -139
REPEAT 5 ID 100000 X 1524 Z -556
REPEAT 76 ID 300 Z -900

$====================================================================================================
$ Generate Deck Plate Elements
$====================================================================================================
TYPE PLATE

GENERATE 4 ELEMENTS ID 'P-1011' 1 FROM 100019 1 TO 100020 1 TO 100320 1 TO 100319 1
REPEAT 5 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 75 ID 10 FROM INCR 300 TO INCR 300

GENERATE 6 ELEMENTS ID 'P-1015' 1000 FROM 100023 100000 TO 200019 100000 TO 200319 100000 TO 100323 100000
REPEAT 75 ID 10 FROM INCR 300 TO INCR 300

GENERATE 76 ELEMENTS ID 'P-7011' 10 FROM 700019 300 TO 700020 300 TO 700320 300 TO 700319 300

$====================================================================================================
$ Generate Rigid Members to Connect Girder Elements to Plate Elements
$====================================================================================================
TYPE SPACE TRUSS

GENERATE 2 MEMBERS ID 'R-1001' 1 FROM 100015 3 TO 100019 1
REPEAT 6 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 76 ID 10 FROM INCR 300 TO INCR 300

$====================================================================================================
$ Generate Diaphragm Members at Top of Bottom Flange
$====================================================================================================
$ END DIAPHRAGMS
GENERATE 6 MEMBERS ID 'B2-1' 1 FROM 100008 100000 TO 200005 100000
GENERATE 6 MEMBERS ID 'B5-1' 1 FROM 122808 100000 TO 222805 100000

$ INTERMEDIATE DIAPHRAGMS
GENERATE 6 MEMBERS ID 'B3-1' 1 FROM 107608 100000 TO 207605 100000

GENERATE 6 MEMBERS ID 'B4-1' 1 FROM 115208 100000 TO 215205 100000

$====================================================================================================
$ Define Element Properties
$====================================================================================================
```

```
MATERIAL CONCRETE ALL ELEMENTS
ELEMENT PROPERTIES
 EXISTING 'G-10011' TO 'G-12768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-20011' TO 'G-22768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-30011' TO 'G-32768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-40011' TO 'G-42768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-50011' TO 'G-52768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-60011' TO 'G-62768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-70011' TO 'G-72768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'P-1011' TO 'P-1765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-2011' TO 'P-2765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-3011' TO 'P-3765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-4011' TO 'P-4765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-5011' TO 'P-5765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-6011' TO 'P-6765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-7011' TO 'P-7761' TYPE 'SBCR' THICKNESS 200

$====================================================================================================
$ Define Member Properties
$====================================================================================================
MATERIAL CONCRETE ALL MEMBERS
MEMBER PROPERTIES PRISMATIC
 'R-1001' TO 'R-1761' BY 10 'R-1002' TO 'R-1762' BY 10 AX 5000
 'R-2001' TO 'R-2761' BY 10 'R-2002' TO 'R-2762' BY 10 AX 5000
 'R-3001' TO 'R-3761' BY 10 'R-3002' TO 'R-3762' BY 10 AX 5000
 'R-4001' TO 'R-4761' BY 10 'R-4002' TO 'R-4762' BY 10 AX 5000
 'R-5001' TO 'R-5761' BY 10 'R-5002' TO 'R-5762' BY 10 AX 5000
 'R-6001' TO 'R-6761' BY 10 'R-6002' TO 'R-6762' BY 10 AX 5000
 'R-7001' TO 'R-7761' BY 10 'R-7002' TO 'R-7762' BY 10 AX 5000
MEMBER PROPERTIES PRISMATIC
 'B2-1' TO 'B2-6' AX 219600
 'B3-1' TO 'B3-6' AX 219600
 'B4-1' TO 'B4-6' AX 219600
 'B5-1' TO 'B5-6' AX 219600

$====================================================================================================
$ Define Supports
$====================================================================================================
STATUS SUPPORT JOINTS -
 100001 TO 700001 BY 100000 100002 TO 700002 BY 100000 100003 TO 700003 BY 100000 100004 TO 700004 BY 100000 -
 107601 TO 707601 BY 100000 107602 TO 707602 BY 100000 107603 TO 707603 BY 100000 107604 TO 707604 BY 100000 -
 115201 TO 715201 BY 100000 115202 TO 715202 BY 100000 115203 TO 715203 BY 100000 115204 TO 715204 BY 100000 -
 122801 TO 722801 BY 100000 122802 TO 722802 BY 100000 122803 TO 722803 BY 100000 122804 TO 722804 BY 100000 -

 100019 TO 700019 BY 100000 100020 TO 700020 BY 100000 -
 122819 TO 722819 BY 100000 122820 TO 722820 BY 100000

$====================================================================================================
$ Set Boundary Conditions
$====================================================================================================
JOINT RELEASES

$ GIRDER BASE
$  END PIN CONDITIONS
 100001 TO 100004 200001 TO 200004 300001 TO 300004 400001 TO 400004 500001 TO 500004 600001 TO 600004 700001 TO 700004
MOMENT X Y
 122801 TO 122804 222801 TO 222804 322801 TO 322804 422801 TO 422804 522801 TO 522804 622801 TO 622804 722801 TO 722804
MOMENT X Y

$  INTERMEDIATE PIN CONDITIONS
 107601 TO 107604 207601 TO 207604 307601 TO 307604 407601 TO 407604 507601 TO 507604 607601 TO 607604 707601 TO 707604
MOMENT X Y Z
 115201 TO 115204 215201 TO 215204 315201 TO 315204 415201  TO 415204 515201 TO 515204 615201 TO 615204 715201 TO 715204
MOMENT X Y Z


$ DECK BASE
$  END CONDITIONS
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 600019 TO 600020 700019 TO 700020
FORCE Y
 122819 TO 122820 222819 TO 222820 322819 TO 322820 422819 TO 422820 522819 TO 522820 622819 TO 622820 722819 TO 722820
FORCE Y
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 600019 TO 600020 700019 TO 700020
MOMENT X Y
 122819 TO 122820 222819 TO 222820 322819 TO 322820 422819 TO 422820 522819 TO 522820 622819 TO 622820 722819 TO 722820
MOMENT X Y


$====================================================================================================
$ Define Loading
$====================================================================================================
UNITS KN M
LOADING 'DC1' 'DEAD LOAD STRUCTURAL COMPONENTS OF ELEMENTS'
 ELEMENT LOADS
  EXISTING 'G-10011' TO 'G-12288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-20011' TO 'G-22288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-30011' TO 'G-32288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-40011' TO 'G-42288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-50011' TO 'G-52288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-60011' TO 'G-62288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-70011' TO 'G-72288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-1011' TO 'P-1765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-2011' TO 'P-2765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-3011' TO 'P-3765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-4011' TO 'P-4765' BODY FORCES GLOBAL BY -23.5616
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  EXISTING 'P-5011' TO 'P-5765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-6011' TO 'P-6765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-7011' TO 'P-7761' BODY FORCES GLOBAL BY -23.5616
DEAD LOAD 'DC2' 'DEAD LOAD STRUCTURAL COMPONENTS OF MEMBERS' DIRECTION -Y -
  MEMBERS 'B2-1' TO 'B2-6' 'B3-1' TO 'B3-6' 'B4-1' TO 'B4-6' 'B5-1' TO 'B5-6'
LOADING 'LL' 'VEHICULAR LIVE LOAD'
 JOINT LOADS
$ Truck 1
  203623 403620 FORCE Y -45.5
  205123 405120 FORCE Y -188.5
  206323 406320 FORCE Y -188.5
$ Truck 2
  403623 603620 FORCE Y -188.5
  405123 605120 FORCE Y -188.5
  406323 606320 FORCE Y -45.5
LOADING 'LS' 'LIVE LOAD SURCHARGE'
 ELEMENT LOADS
  EXISTING 'P-1011' TO 'P-1765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-2011' TO 'P-2765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-3011' TO 'P-3765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-4011' TO 'P-4765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-5011' TO 'P-5765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-6011' TO 'P-6765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-7011' TO 'P-7761' SURFACE FORCES GLOBAL PY -3.9269
LOADING 'WS' 'WIND LOAD ON STRUCTURE'
 ELEMENT LOADS
  'G-70013' TO 'G-72283' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70014' TO 'G-72284' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70015' TO 'G-72285' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70018' TO 'G-72288' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4

$====================================================================================================
$ Factored Loads
$====================================================================================================
$LOADING COMBINATION 10 'STRENGTH I MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.75 'LS' 1.75 'WS' 0.0
LOADING COMBINATION 11 'STRENGTH I MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.75 'LS' 1.75 'WS' 0.0
$LOADING COMBINATION 12 'STRENGTH II MINIMUM'  SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 13 'STRENGTH II MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 14 'STRENGTH III MINIMUM' SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 0.0  'LS' 0.0  'WS' 1.4
LOADING COMBINATION 15 'STRENGTH III MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 0.0  'LS' 0.0  'WS' 1.4
$LOADING COMBINATION 16 'STRENGTH V MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.4
LOADING COMBINATION 17 'STRENGTH V MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.4
$LOADING COMBINATION 18 'SERVICE I'            SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.0  'LS' 1.0  'WS' 0.3
$LOADING COMBINATION 19 'SERVICE II'           SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.3  'LS' 1.3  'WS' 0.0
$LOADING COMBINATION 20 'FATIGUE'              SPECS 'DC1' 0.0  'DC2' 0.0  'LL' 0.75 'LS' 0.75 'WS' 0.0

$====================================================================================================
$ Prepare and Generate Output
$====================================================================================================
QUERY
STIFFNESS ANALYSIS

LIST SUMMATION OF REACTIONS
LIST REACTIONS

CALCULATE AVERAGE STRESS AT TOP SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-7765'
CALCULATE AVERAGE STRESS AT BOTTOM SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-7765'

CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-10011' TO 'G-12288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-20011' TO 'G-22288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-30011' TO 'G-32288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-40011' TO 'G-42288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-50011' TO 'G-52288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-60011' TO 'G-62288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-70011' TO 'G-72288'

LIST FORCES MEMBERS 'B2-1' TO 'B2-6' 'B3-1' TO 'B3-6' 'B4-1' TO 'B4-6' 'B5-1' TO 'B5-6'
```

STRUDL 'Model 109' 'Type II Girder, 20° Bridge Skew, Girder Spacing 1.52 m, Span Length 22.8 m, No Diaphragm'

```
UNITS MM
PRINT GENERATE OFF

$==================================================================================================
$ Generate Joints to Connect Girder Brick Elements
$==================================================================================================
GENERATE 4 JOINTS ID 100001 1 X LIST 0 155 305 460 Z 0
REPEAT 1 ID 4 Y 150
REPEAT 1 ID 100 Z -300

GENERATE 2 JOINTS ID 100009 1 X 155 150 Y 455 Z 0
REPEAT 1 ID 100 Z -300

GENERATE 4 JOINTS ID 100011 1 X LIST 80 155 305 380 Y 760 Z 0
REPEAT 1 ID 4 Y 155
REPEAT 1 ID 100 Z -300

$==================================================================================================
$ Generate Girder Brick Elements
$==================================================================================================
TYPE TRIDEMINSIONAL
GENERATE 3 ELEMENTS ID 'G-10011' 1 FROM 100001 1 TO 100002 1 TO 100006 1 TO 100005 1 TO 100101 1 TO 100102 1 TO 100106 1 TO
100105 1
GENERATE 2 ELEMENTS ID 'G-10014' 1 FROM 100006 3 TO 100007 3 TO 100010 3 TO 100009 3 TO 100106 3 TO 100107 3 TO 100110 3 TO
100109 3
GENERATE 3 ELEMENTS ID 'G-10016' 1 FROM 100011 1 TO 100012 1 TO 100016 1 TO 100015 1 TO 100111 1 TO 100112 1 TO 100116 1 TO
100115 1

$==================================================================================================
$ Copy Generated Girder Section and Copy it Down Entire Length of Bridge
$==================================================================================================
DEFINE OBJECT 'SECTION' JOINTS 100001 TO 100018 100101 TO 100118, ELEMENTS 'G-10011' TO 'G-10018'
COPY OBJECT 'SECTION' REPEAT 227 TIMES JOINT INCR 100 ELEMENT INCR 10 TRANSLATE Z -300

$==================================================================================================
$ Copy Generated Girder and Copy it Across The Entire Width of Bridge
$==================================================================================================
DEFINE OBJECT 'GIRDER A' JOINTS EXISTING 100001 TO 122820, ELEMENTS EXISTING 'G-10011' TO 'G-12288'
COPY OBJECT 'GIRDER A' REPEAT 6 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1524 Z -556

$==================================================================================================
$ Generate Joints to Connect Deck Plate Elements
$==================================================================================================
GENERATE 2 JOINTS ID 100019 1 X LIST 80 380 Y 916 Z 0
REPEAT 6 ID 100000 X 1524 Z -556
REPEAT 76 ID 300 Z -900

GENERATE 3 JOINTS ID 100021 1 X 686 306 Y 916 0 Z -139 -139
REPEAT 5 ID 100000 X 1524 Z -556
REPEAT 76 ID 300 Z -900

$==================================================================================================
$ Generate Deck Plate Elements
$==================================================================================================
TYPE PLATE

GENERATE 4 ELEMENTS ID 'P-1011' 1 FROM 100019 1 TO 100020 1 TO 100320 1 TO 100319 1
REPEAT 5 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 75 ID 10 FROM INCR 300 TO INCR 300

GENERATE 6 ELEMENTS ID 'P-1015' 1000 FROM 100023 100000 TO 200019 100000 TO 200319 100000 TO 100323 100000
REPEAT 75 ID 10 FROM INCR 300 TO INCR 300

GENERATE 76 ELEMENTS ID 'P-7011' 10 FROM 700019 300 TO 700020 300 TO 700320 300 TO 700319 300

$==================================================================================================
$ Generate Rigid Members to Connect Girder Elements to Plate Elements
$==================================================================================================
TYPE SPACE TRUSS

GENERATE 2 MEMBERS ID 'R-1001' 1 FROM 100015 3 TO 100019 1
REPEAT 6 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 76 ID 10 FROM INCR 300 TO INCR 300

$==================================================================================================
$ Generate Diaphragm Members at Mid Height of Web
$==================================================================================================
$ END DIAPHRAGMS
GENERATE 6 MEMBERS ID 'B2-1' 1 FROM 100010 100000 TO 200009 100000
GENERATE 6 MEMBERS ID 'B5-1' 1 FROM 122810 100000 TO 222809 100000

$ INTERMEDIATE DIAPHRAGMS
GENERATE 2 MEMBERS ID 'B3-1' 5 FROM 107610 499600 TO 208009 499600
GENERATE 2 MEMBERS ID 'B3-2' 3 FROM 208010 300200 TO 307009 300200
GENERATE 2 MEMBERS ID 'B3-3' 1 FROM 307010 100600 TO 407609 100600

GENERATE 2 MEMBERS ID 'B4-1' 5 FROM 115210 499600 TO 215609 499600
GENERATE 2 MEMBERS ID 'B4-2' 3 FROM 215610 300200 TO 314609 300200
GENERATE 2 MEMBERS ID 'B4-3' 1 FROM 314610 100600 TO 415209 100600

$==================================================================================================
```

```
$ Define Element Properties
$=====================================================================================================
MATERIAL CONCRETE ALL ELEMENTS
ELEMENT PROPERTIES
 EXISTING 'G-10011' TO 'G-12768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-20011' TO 'G-22768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-30011' TO 'G-32768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-40011' TO 'G-42768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-50011' TO 'G-52768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-60011' TO 'G-62768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-70011' TO 'G-72768' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'P-1011' TO 'P-1765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-2011' TO 'P-2765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-3011' TO 'P-3765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-4011' TO 'P-4765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-5011' TO 'P-5765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-6011' TO 'P-6765' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-7011' TO 'P-7761' TYPE 'SBCR' THICKNESS 200

$=====================================================================================================
$ Define Member Properties
$=====================================================================================================
MATERIAL CONCRETE ALL MEMBERS
MEMBER PROPERTIES PRISMATIC
 'R-1001' TO 'R-1761' BY 10 'R-1002' TO 'R-1762' BY 10 AX 5000
 'R-2001' TO 'R-2761' BY 10 'R-2002' TO 'R-2762' BY 10 AX 5000
 'R-3001' TO 'R-3761' BY 10 'R-3002' TO 'R-3762' BY 10 AX 5000

 'R-4001' TO 'R-4761' BY 10 'R-4002' TO 'R-4762' BY 10 AX 5000
 'R-5001' TO 'R-5761' BY 10 'R-5002' TO 'R-5762' BY 10 AX 5000
 'R-6001' TO 'R-6761' BY 10 'R-6002' TO 'R-6762' BY 10 AX 5000
 'R-7001' TO 'R-7761' BY 10 'R-7002' TO 'R-7762' BY 10 AX 5000

MEMBER PROPERTIES PRISMATIC
 'B2-1' TO 'B2-6' AX 219600
 'B3-1' TO 'B3-6' AX 219600
 'B4-1' TO 'B4-6' AX 219600
 'B5-1' TO 'B5-6' AX 219600

$=====================================================================================================
$ Define Supports
$=====================================================================================================
STATUS SUPPORT JOINTS -
 100001 TO 700001 BY 100000 100002 TO 700002 BY 100000 100003 TO 700003 BY 100000 100004 TO 700004 BY 100000 -
 107601 TO 707601 BY 100000 107602 TO 707602 BY 100000 107603 TO 707603 BY 100000 107604 TO 707604 BY 100000 -
 115201 TO 715201 BY 100000 115202 TO 715202 BY 100000 115203 TO 715203 BY 100000 115204 TO 715204 BY 100000 -
 122801 TO 722801 BY 100000 122802 TO 722802 BY 100000 122803 TO 722803 BY 100000 122804 TO 722804 BY 100000 -

 100019 TO 700019 BY 100000 100020 TO 700020 BY 100000 -
 122819 TO 722819 BY 100000 122820 TO 722820 BY 100000

$=====================================================================================================
$ Set Boundary Conditions
$=====================================================================================================
JOINT RELEASES

$ GIRDER BASE
$  END PIN CONDITIONS
 100001 TO 100004 200001 TO 200004 300001 TO 300004 400001 TO 400004 500001 TO 500004 600001 TO 600004 700001 TO 700004
MOMENT X Y
 122801 TO 122804 222801 TO 222804 322801 TO 322804 422801 TO 422804 522801 TO 522804 622801 TO 622804 722801 TO 722804
MOMENT X Y

$  INTERMEDIATE PIN CONDITIONS
 107601 TO 107604 207601 TO 207604 307601 TO 307604 407601 TO 407604 507601 TO 507604 607601 TO 607604 707601 TO 707604
MOMENT X Y Z
 115201 TO 115204 215201 TO 215204 315201 TO 315204 415201 TO 415204 515201 TO 515204 615201 TO 615204 715201 TO 715204
MOMENT X Y Z


$ DECK BASE
$  END CONDITIONS
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 600019 TO 600020 700019 TO 700020
FORCE Y
 122819 TO 122820 222819 TO 222820 322819 TO 322820 422819 TO 422820 522819 TO 522820 622819 TO 622820 722819 TO 722820
FORCE Y
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 600019 TO 600020 700019 TO 700020
MOMENT X Y
 122819 TO 122820 222819 TO 222820 322819 TO 322820 422819 TO 422820 522819 TO 522820 622819 TO 622820 722819 TO 722820
MOMENT X Y


$=====================================================================================================
$ Define Loading
$=====================================================================================================
UNITS KN M
LOADING 'DC1' 'DEAD LOAD STRUCTURAL COMPONENTS OF ELEMENTS'
 ELEMENT LOADS
  EXISTING 'G-10011' TO 'G-12288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-20011' TO 'G-22288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-30011' TO 'G-32288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-40011' TO 'G-42288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-50011' TO 'G-52288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-60011' TO 'G-62288' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-70011' TO 'G-72288' BODY FORCES GLOBAL BY -23.5616
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```
  EXISTING 'P-1011' TO 'P-1765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-2011' TO 'P-2765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-3011' TO 'P-3765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-4011' TO 'P-4765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-5011' TO 'P-5765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-6011' TO 'P-6765' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-7011' TO 'P-7761' BODY FORCES GLOBAL BY -23.5616
DEAD LOAD 'DC2' 'DEAD LOAD STRUCTURAL COMPONENTS OF MEMBERS' DIRECTION -Y -
  MEMBERS 'B2-1' TO 'B2-6' 'B3-1' TO 'B3-6' 'B4-1' TO 'B4-6' 'B5-1' TO 'B5-6'
LOADING 'LL' 'VEHICULAR LIVE LOAD'
 JOINT LOADS
$ Truck 1
  203623 403620 FORCE Y -45.5
  205123 405120 FORCE Y -188.5
  206323 406320 FORCE Y -188.5
$ Truck 2
  403623 603620 FORCE Y -188.5
  405123 605120 FORCE Y -188.5
  406323 606320 FORCE Y -45.5
LOADING 'LS' 'LIVE LOAD SURCHARGE'
 ELEMENT LOADS
  EXISTING 'P-1011' TO 'P-1765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-2011' TO 'P-2765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-3011' TO 'P-3765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-4011' TO 'P-4765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-5011' TO 'P-5765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-6011' TO 'P-6765' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-7011' TO 'P-7761' SURFACE FORCES GLOBAL PY -3.9269
LOADING 'WS' 'WIND LOAD ON STRUCTURE'
 ELEMENT LOADS
  'G-70013' TO 'G-72283' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70014' TO 'G-72284' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70015' TO 'G-72285' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70018' TO 'G-72288' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4

$====================================================================================================
$ Factored Loads
$====================================================================================================
$LOADING COMBINATION 10 'STRENGTH I MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.75 'LS' 1.75 'WS' 0.0
LOADING COMBINATION 11 'STRENGTH I MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.75 'LS' 1.75 'WS' 0.0
$LOADING COMBINATION 12 'STRENGTH II MINIMUM'  SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 13 'STRENGTH II MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 14 'STRENGTH III MINIMUM' SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 0.0  'LS' 0.0  'WS' 1.4
LOADING COMBINATION 15 'STRENGTH III MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 0.0  'LS' 0.0  'WS' 1.4
$LOADING COMBINATION 16 'STRENGTH V MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.4
LOADING COMBINATION 17 'STRENGTH V MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.4
$LOADING COMBINATION 18 'SERVICE I'            SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.0  'LS' 1.0  'WS' 0.3
$LOADING COMBINATION 19 'SERVICE II'           SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.3  'LS' 1.3  'WS' 0.0
$LOADING COMBINATION 20 'FATIGUE'              SPECS 'DC1' 0.0  'DC2' 0.0  'LL' 0.75 'LS' 0.75 'WS' 0.0

$====================================================================================================
$ Delete Diaphragms
$====================================================================================================
DELETIONS
MEMBERS 'B2-1' TO 'B2-6' 'B3-1' TO 'B3-6' 'B4-1' TO 'B4-6' 'B5-1' TO 'B5-6'
ADDITIONS

$====================================================================================================
$ Prepare and Generate Output
$====================================================================================================
QUERY
STIFFNESS ANALYSIS

LIST SUMMATION OF REACTIONS
LIST REACTIONS

CALCULATE AVERAGE STRESS AT TOP SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-7765'
CALCULATE AVERAGE STRESS AT BOTTOM SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-7765'

CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-10011' TO 'G-12288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-20011' TO 'G-22288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-30011' TO 'G-32288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-40011' TO 'G-42288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-50011' TO 'G-52288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-60011' TO 'G-62288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-70011' TO 'G-72288'

$LIST FORCES MEMBERS 'B2-1' TO 'B2-6' 'B3-1' TO 'B3-6' 'B4-1' TO 'B4-6' 'B5-1' TO 'B5-6'
```

STRUDL 'Model 110' ‘Type II Girder, 20° Bridge Skew, Girder Spacing 2.75 m, Span Length 16.8 m, 30° Diaphragm Skew’

```
UNITS MM
PRINT GENERATE OFF

$====================================================================================================
$ Generate Joints to Connect Girder Brick Elements
$====================================================================================================
GENERATE 4 JOINTS ID 100001 1 X LIST 0 155 305 460 Z 0
REPEAT 1 ID 4 Y 150
REPEAT 1 ID 100 Z -300

GENERATE 2 JOINTS ID 100009 1 X 155 150 Y 455 Z 0
REPEAT 1 ID 100 Z -300

GENERATE 4 JOINTS ID 100011 1 X LIST 80 155 305 380 Y 760 Z 0
REPEAT 1 ID 4 Y 155
REPEAT 1 ID 100 Z -300

$====================================================================================================
$ Generate Girder Brick Elements
$====================================================================================================
TYPE TRIDEMINSIONAL
GENERATE 3 ELEMENTS ID 'G-10011' 1 FROM 100001 1 TO 100002 1 TO 100006 1 TO 100005 1 TO 100101 1 TO 100102 1 TO 100106 1 TO
100105 1
GENERATE 2 ELEMENTS ID 'G-10014' 1 FROM 100006 3 TO 100007 3 TO 100010 3 TO 100009 3 TO 100106 3 TO 100107 3 TO 100110 3 TO
100109 3
GENERATE 3 ELEMENTS ID 'G-10016' 1 FROM 100011 1 TO 100012 1 TO 100016 1 TO 100015 1 TO 100111 1 TO 100112 1 TO 100116 1 TO
100115 1

$====================================================================================================
$ Copy Generated Girder Section and Copy it Down Entire Length of Bridge
$====================================================================================================
DEFINE OBJECT 'SECTION' JOINTS 100001 TO 100018 100101 TO 100118, ELEMENTS 'G-10011' TO 'G-10018'
COPY OBJECT 'SECTION' REPEAT 167 TIMES JOINT INCR 100 ELEMENT INCR 10 TRANSLATE Z -300


$====================================================================================================
$ Copy Generated Girder and Copy it Across The Entire Width of Bridge
$====================================================================================================
DEFINE OBJECT 'GIRDER A' JOINTS EXISTING 100001 TO 116818, ELEMENTS EXISTING 'G-10011' TO 'G-11688'
COPY OBJECT 'GIRDER A' REPEAT 1 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1830 Z -665

DEFINE OBJECT 'GIRDER B' JOINTS EXISTING 200001 TO 216818, ELEMENTS EXISTING 'G-20011' TO 'G-21688'
COPY OBJECT 'GIRDER B' REPEAT 2 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 2748 Z -1000

DEFINE OBJECT 'GIRDER D' JOINTS EXISTING 400001 TO 416818, ELEMENTS EXISTING 'G-40011' TO 'G-41688'
COPY OBJECT 'GIRDER D' REPEAT 1 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1830 Z -665

$====================================================================================================
$ Generate Joints to Connect Deck Plate Elements
$====================================================================================================
GENERATE 2 JOINTS ID 100019 1 X LIST 80 380 Y 916 Z 0
REPEAT 56 ID 300 Z -900
GENERATE 2 JOINTS ID 200019 1 X LIST 1910 2210 Y 916 Z -665
REPEAT 56 ID 300 Z -900
GENERATE 2 JOINTS ID 300019 1 X LIST 4658 4958 Y 916 Z -1665
REPEAT 56 ID 300 Z -900
GENERATE 2 JOINTS ID 400019 1 X LIST 7406 7706 Y 916 Z -2665
REPEAT 56 ID 300 Z -900
GENERATE 2 JOINTS ID 500019 1 X LIST 9236 9536 Y 916 Z -3330
REPEAT 56 ID 300 Z -900

GENERATE 4 JOINTS ID 100021 1 X 686 306 Y 916 0 Z -133 -133
REPEAT 1 ID 300000 X 7326 Z -2665
REPEAT 56 ID 300 Z -900

GENERATE 7 JOINTS ID 200021 1 X 2516 306 Y 916 0 Z -790 -125
REPEAT 1 ID 100000 X 2748 Z -1000
REPEAT 56 ID 300 Z -900

$====================================================================================================
$ Generate Deck Plate Elements
$====================================================================================================
TYPE PLATE

GENERATE 5 ELEMENTS ID 'P-1011' 1 FROM 100019 1 TO 100020 1 TO 100320 1 TO 100319 1
REPEAT 1 ID 3000 FROM INCR 300000 TO INCR 300000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 2 ELEMENTS ID 'P-1016' 3000 FROM 100024 300000 TO 200019 300000 TO 200319 300000 TO 100324 300000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 8 ELEMENTS ID 'P-2011' 1 FROM 200019 1 TO 200020 1 TO 200320 1 TO 200319 1
REPEAT 1 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 2 ELEMENTS ID 'P-2019' 1000 FROM 200027 100000 TO 300019 100000 TO 300319 100000 TO 200327 100000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 56 ELEMENTS ID 'P-5011' 10 FROM 500019 300 TO 500020 300 TO 500320 300 TO 500319 300

$====================================================================================================
```

```
$ Generate Rigid Members to Connect Girder Elements to Plate Elements
$=====================================================================================================
TYPE SPACE TRUSS

GENERATE 2 MEMBERS ID 'R-1001' 1 FROM 100015 3 TO 100019 1
REPEAT 4 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 56 ID 10 FROM INCR 300 TO INCR 300

$=====================================================================================================
$ Generate Diaphragm Members at Top of Bottom Flange
$=====================================================================================================
$ END DIAPHRAGMS
GENERATE 4 MEMBERS ID 'B2-1' 1 FROM 100008 100000 TO 200005 100000
GENERATE 4 MEMBERS ID 'B5-1' 1 FROM 116808 100000 TO 216805 100000

$ INTERMEDIATE DIAPHRAGMS
GENERATE 2 MEMBERS ID 'B3-1' 3 FROM 105608 301200 TO 204405 301200
GENERATE 2 MEMBERS ID 'B3-2' 1 FROM 204408 101200 TO 305605 101200

GENERATE 2 MEMBERS ID 'B4-1' 3 FROM 111208 301200 TO 210005 301200
GENERATE 2 MEMBERS ID 'B4-2' 1 FROM 210008 101200 TO 311205 101200

$=====================================================================================================
$ Define Element Properties
$=====================================================================================================
MATERIAL CONCRETE ALL ELEMENTS
ELEMENT PROPERTIES
 EXISTING 'G-10011' TO 'G-11688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-20011' TO 'G-21688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-30011' TO 'G-31688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-40011' TO 'G-41688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-50011' TO 'G-51688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'P-1011' TO 'P-1566' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-2011' TO 'P-2569' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-3011' TO 'P-3569' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-4011' TO 'P-4566' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-5011' TO 'P-5561' TYPE 'SBCR' THICKNESS 200

$=====================================================================================================
$ Define Member Properties
$=====================================================================================================
MATERIAL CONCRETE ALL MEMBERS
MEMBER PROPERTIES PRISMATIC
 'R-1001' TO 'R-1561' BY 10 'R-1002' TO 'R-1562' BY 10 AX 5000
 'R-2001' TO 'R-2561' BY 10 'R-2002' TO 'R-2562' BY 10 AX 5000
 'R-3001' TO 'R-3561' BY 10 'R-3002' TO 'R-3562' BY 10 AX 5000
 'R-4001' TO 'R-4561' BY 10 'R-4002' TO 'R-4562' BY 10 AX 5000
 'R-5001' TO 'R-5561' BY 10 'R-5002' TO 'R-5562' BY 10 AX 5000
MEMBER PROPERTIES PRISMATIC
 'B2-1' TO 'B2-4' AX 219600
 'B3-1' TO 'B3-4' AX 219600
 'B4-1' TO 'B4-4' AX 219600
 'B5-1' TO 'B5-4' AX 219600

$=====================================================================================================
$ Define Supports
$=====================================================================================================
STATUS SUPPORT JOINTS -
 100001 TO 500001 BY 100000 100002 TO 500002 BY 100000 100003 TO 500003 BY 100000 100004 TO 500004 BY 100000 -
 105601 TO 505601 BY 100000 105602 TO 505602 BY 100000 105603 TO 505603 BY 100000 105604 TO 505604 BY 100000 -
 111201 TO 511201 BY 100000 111202 TO 511202 BY 100000 111203 TO 511203 BY 100000 111204 TO 511204 BY 100000 -
 116801 TO 516801 BY 100000 116802 TO 516802 BY 100000 116803 TO 516803 BY 100000 116804 TO 516804 BY 100000 -

 100019 TO 500019 BY 100000 100020 TO 500020 BY 100000 -
 116819 TO 516819 BY 100000 116820 TO 516820 BY 100000

$=====================================================================================================
$ Set Boundary Conditions
$=====================================================================================================
JOINT RELEASES

$ GIRDER BASE
$  END PIN CONDITIONS
 100001 TO 100004 200001 TO 200004 300001 TO 300004 400001 TO 400004 500001 TO 500004 MOMENT X Y
 116801 TO 116804 216801 TO 216804 316801 TO 316804 416801 TO 416804 516801 TO 516804 MOMENT X Y

$  INTERMEDIATE PIN CONDITIONS
 105601 TO 105604 205601 TO 205604 305601 TO 305604 405601 TO 405604 505601 TO 505604 MOMENT X Y Z
 111201 TO 111204 211201 TO 211204 311201 TO 311204 411201 TO 411204 511201 TO 511204 MOMENT X Y Z


$ DECK BASE
$  END CONDITIONS
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 FORCE Y
 116819 TO 116820 216819 TO 216820 316819 TO 316820 416819 TO 416820 516819 TO 516820 FORCE Y
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 MOMENT X Y
 116819 TO 116820 216819 TO 216820 316819 TO 316820 416819 TO 416820 516819 TO 516820 MOMENT X Y

$=====================================================================================================
$ Define Loading
$=====================================================================================================
UNITS KN M
LOADING 'DC1' 'DEAD LOAD STRUCTURAL COMPONENTS OF ELEMENTS'
 ELEMENT LOADS
  EXISTING 'G-10011' TO 'G-11688' BODY FORCES GLOBAL BY -23.5616
```

```
  EXISTING 'G-20011' TO 'G-21688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-30011' TO 'G-31688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-40011' TO 'G-41688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-50011' TO 'G-51688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-1011' TO 'P-1566' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-2011' TO 'P-2569' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-3011' TO 'P-3569' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-4011' TO 'P-4566' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-5011' TO 'P-5561' BODY FORCES GLOBAL BY -23.5616
DEAD LOAD 'DC2' 'DEAD LOAD STRUCTURAL COMPONENTS OF MEMBERS' DIRECTION -Y -
  MEMBERS 'B2-1' TO 'B2-4' 'B3-1' TO 'B3-4' 'B4-1' TO 'B4-4' 'B5-1' TO 'B5-4'
LOADING 'LL' 'VEHICULAR LIVE LOAD'
 JOINT LOADS
$ Truck 1
  203622 303620 FORCE Y -45.5
  205122 305120 FORCE Y -188.5
  206322 306320 FORCE Y -188.5
$ Truck 2
  303623 403621 FORCE Y -188.5
  305123 405121 FORCE Y -188.5
  306323 406321 FORCE Y -45.5
LOADING 'LS' 'LIVE LOAD SURCHARGE'
 ELEMENT LOADS
  EXISTING 'P-1011' TO 'P-1566' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-2011' TO 'P-2569' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-3011' TO 'P-3569' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-4011' TO 'P-4566' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-5011' TO 'P-5561' SURFACE FORCES GLOBAL PY -3.9269
LOADING 'WS' 'WIND LOAD ON STRUCTURE'
 ELEMENT LOADS
  'G-50013' TO 'G-51683' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50014' TO 'G-51684' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50015' TO 'G-51685' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50018' TO 'G-51688' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4

$===================================================================================================
$ Factored Loads
$===================================================================================================
$LOADING COMBINATION 10 'STRENGTH I MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.75 'LS' 1.75 'WS' 0.0
LOADING COMBINATION 11 'STRENGTH I MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.75 'LS' 1.75 'WS' 0.0
$LOADING COMBINATION 12 'STRENGTH II MINIMUM'  SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 13 'STRENGTH II MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 14 'STRENGTH III MINIMUM' SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 0.0  'LS' 0.0  'WS' 1.4
LOADING COMBINATION 15 'STRENGTH III MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 0.0  'LS' 0.0  'WS' 1.4
$LOADING COMBINATION 16 'STRENGTH V MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.4
LOADING COMBINATION 17 'STRENGTH V MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.4
$LOADING COMBINATION 18 'SERVICE I'            SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.0  'LS' 1.0  'WS' 0.3
$LOADING COMBINATION 19 'SERVICE II'           SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.3  'LS' 1.3  'WS' 0.0
$LOADING COMBINATION 20 'FATIGUE'              SPECS 'DC1' 0.0  'DC2' 0.0  'LL' 0.75 'LS' 0.75 'WS' 0.0

$===================================================================================================
$ Prepare and Generate Output
$===================================================================================================
QUERY
STIFFNESS ANALYSIS

LIST SUMMATION OF REACTIONS
LIST REACTIONS

CALCULATE AVERAGE STRESS AT TOP SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-5565'
CALCULATE AVERAGE STRESS AT BOTTOM SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-5565'

CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-10011' TO 'G-11688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-20011' TO 'G-21688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-30011' TO 'G-31688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-40011' TO 'G-41688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-50011' TO 'G-51688'

LIST FORCES MEMBERS 'B2-1' TO 'B2-4' 'B3-1' TO 'B3-4' 'B4-1' TO 'B4-4' 'B5-1' TO 'B5-4'
```

STRUDL 'Model 111' ‘Type II Girder, 20° Bridge Skew, Girder Spacing 2.75 m, Span Length 16.8 m, 65° Diaphragm Skew’

```
UNITS MM
PRINT GENERATE OFF

$====================================================================================================
$ Generate Joints to Connect Girder Brick Elements
$====================================================================================================
GENERATE 4 JOINTS ID 100001 1 X LIST 0 155 305 460 Z 0
REPEAT 1 ID 4 Y 150
REPEAT 1 ID 100 Z -300

GENERATE 2 JOINTS ID 100009 1 X 155 150 Y 455 Z 0
REPEAT 1 ID 100 Z -300

GENERATE 4 JOINTS ID 100011 1 X LIST 80 155 305 380 Y 760 Z 0
REPEAT 1 ID 4 Y 155
REPEAT 1 ID 100 Z -300

$====================================================================================================
$ Generate Girder Brick Elements
$====================================================================================================
TYPE TRIDEMINSIONAL
GENERATE 3 ELEMENTS ID 'G-10011' 1 FROM 100001 1 TO 100002 1 TO 100006 1 TO 100005 1 TO 100101 1 TO 100102 1 TO 100106 1 TO
100105 1
GENERATE 2 ELEMENTS ID 'G-10014' 1 FROM 100006 3 TO 100007 3 TO 100010 3 TO 100009 3 TO 100106 3 TO 100107 3 TO 100110 3 TO
100109 3
GENERATE 3 ELEMENTS ID 'G-10016' 1 FROM 100011 1 TO 100012 1 TO 100016 1 TO 100015 1 TO 100111 1 TO 100112 1 TO 100116 1 TO
100115 1

$====================================================================================================
$ Copy Generated Girder Section and Copy it Down Entire Length of Bridge
$====================================================================================================
DEFINE OBJECT 'SECTION' JOINTS 100001 TO 100018 100101 TO 100118, ELEMENTS 'G-10011' TO 'G-10018'
COPY OBJECT 'SECTION' REPEAT 167 TIMES JOINT INCR 100 ELEMENT INCR 10 TRANSLATE Z -300


$====================================================================================================
$ Copy Generated Girder and Copy it Across The Entire Width of Bridge
$====================================================================================================
DEFINE OBJECT 'GIRDER A' JOINTS EXISTING 100001 TO 116818, ELEMENTS EXISTING 'G-10011' TO 'G-11688'
COPY OBJECT 'GIRDER A' REPEAT 1 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1830 Z -665

DEFINE OBJECT 'GIRDER B' JOINTS EXISTING 200001 TO 216818, ELEMENTS EXISTING 'G-20011' TO 'G-21688'
COPY OBJECT 'GIRDER B' REPEAT 2 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 2748 Z -1000

DEFINE OBJECT 'GIRDER D' JOINTS EXISTING 400001 TO 416818, ELEMENTS EXISTING 'G-40011' TO 'G-41688'
COPY OBJECT 'GIRDER D' REPEAT 1 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1830 Z -665

$====================================================================================================
$ Generate Joints to Connect Deck Plate Elements
$====================================================================================================
GENERATE 2 JOINTS ID 100019 1 X LIST 80 380 Y 916 Z 0
REPEAT 56 ID 300 Z -900
GENERATE 2 JOINTS ID 200019 1 X LIST 1910 2210 Y 916 Z -665
REPEAT 56 ID 300 Z -900
GENERATE 2 JOINTS ID 300019 1 X LIST 4658 4958 Y 916 Z -1665
REPEAT 56 ID 300 Z -900
GENERATE 2 JOINTS ID 400019 1 X LIST 7406 7706 Y 916 Z -2665
REPEAT 56 ID 300 Z -900
GENERATE 2 JOINTS ID 500019 1 X LIST 9236 9536 Y 916 Z -3330
REPEAT 56 ID 300 Z -900

GENERATE 4 JOINTS ID 100021 1 X 686 306 Y 916 0 Z -133 -133
REPEAT 1 ID 300000 X 7326 Z -2665
REPEAT 56 ID 300 Z -900

GENERATE 7 JOINTS ID 200021 1 X 2516 306 Y 916 0 Z -790 -125
REPEAT 1 ID 100000 X 2748 Z -1000
REPEAT 56 ID 300 Z -900

$====================================================================================================
$ Generate Deck Plate Elements
$====================================================================================================
TYPE PLATE

GENERATE 5 ELEMENTS ID 'P-1011' 1 FROM 100019 1 TO 100020 1 TO 100320 1 TO 100319 1
REPEAT 1 ID 3000 FROM INCR 300000 TO INCR 300000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 2 ELEMENTS ID 'P-1016' 3000 FROM 100024 300000 TO 200019 300000 TO 200319 300000 TO 100324 300000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 8 ELEMENTS ID 'P-2011' 1 FROM 200019 1 TO 200020 1 TO 200320 1 TO 200319 1
REPEAT 1 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 2 ELEMENTS ID 'P-2019' 1000 FROM 200027 100000 TO 300019 100000 TO 300319 100000 TO 200327 100000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 56 ELEMENTS ID 'P-5011' 10 FROM 500019 300 TO 500020 300 TO 500320 300 TO 500319 300

$====================================================================================================
```

```
$ Generate Rigid Members to Connect Girder Elements to Plate Elements
$=====================================================================================================
TYPE SPACE TRUSS

GENERATE 2 MEMBERS ID 'R-1001' 1 FROM 100015 3 TO 100019 1
REPEAT 4 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 56 ID 10 FROM INCR 300 TO INCR 300

$=====================================================================================================
$ Generate Diaphragm Members at Top of Bottom Flange
$=====================================================================================================
$ END DIAPHRAGMS
GENERATE 4 MEMBERS ID 'B2-1' 1 FROM 100008 100000 TO 200005 100000
GENERATE 4 MEMBERS ID 'B5-1' 1 FROM 116808 100000 TO 216805 100000

$ INTERMEDIATE DIAPHRAGMS
GENERATE 4 MEMBERS ID 'B3-1' 1 FROM 105608 100000 TO 205605 100000

GENERATE 4 MEMBERS ID 'B4-1' 1 FROM 111208 100000 TO 211205 100000

$=====================================================================================================
$ Define Element Properties
$=====================================================================================================
MATERIAL CONCRETE ALL ELEMENTS
ELEMENT PROPERTIES
 EXISTING 'G-10011' TO 'G-11688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-20011' TO 'G-21688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-30011' TO 'G-31688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-40011' TO 'G-41688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-50011' TO 'G-51688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'P-1011' TO 'P-1566' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-2011' TO 'P-2569' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-3011' TO 'P-3569' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-4011' TO 'P-4566' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-5011' TO 'P-5561' TYPE 'SBCR' THICKNESS 200

$=====================================================================================================
$ Define Member Properties
$=====================================================================================================
MATERIAL CONCRETE ALL MEMBERS
MEMBER PROPERTIES PRISMATIC
 'R-1001' TO 'R-1561' BY 10 'R-1002' TO 'R-1562' BY 10 AX 5000
 'R-2001' TO 'R-2561' BY 10 'R-2002' TO 'R-2562' BY 10 AX 5000
 'R-3001' TO 'R-3561' BY 10 'R-3002' TO 'R-3562' BY 10 AX 5000
 'R-4001' TO 'R-4561' BY 10 'R-4002' TO 'R-4562' BY 10 AX 5000
 'R-5001' TO 'R-5561' BY 10 'R-5002' TO 'R-5562' BY 10 AX 5000
MEMBER PROPERTIES PRISMATIC
 'B2-1' TO 'B2-4' AX 219600
 'B3-1' TO 'B3-4' AX 219600
 'B4-1' TO 'B4-4' AX 219600
 'B5-1' TO 'B5-4' AX 219600

$=====================================================================================================
$ Define Supports
$=====================================================================================================
STATUS SUPPORT JOINTS -
 100001 TO 500001 BY 100000 100002 TO 500002 BY 100000 100003 TO 500003 BY 100000 100004 TO 500004 BY 100000 -
 105601 TO 505601 BY 100000 105602 TO 505602 BY 100000 105603 TO 505603 BY 100000 105604 TO 505604 BY 100000 -
 111201 TO 511201 BY 100000 111202 TO 511202 BY 100000 111203 TO 511203 BY 100000 111204 TO 511204 BY 100000 -
 116801 TO 516801 BY 100000 116802 TO 516802 BY 100000 116803 TO 516803 BY 100000 116804 TO 516804 BY 100000 -

 100019 TO 500019 BY 100000 100020 TO 500020 BY 100000 -
 116819 TO 516819 BY 100000 116820 TO 516820 BY 100000

$=====================================================================================================
$ Set Boundary Conditions
$=====================================================================================================
JOINT RELEASES

$ GIRDER BASE
$  END PIN CONDITIONS
 100001 TO 100004 200001 TO 200004 300001 TO 300004 400001 TO 400004 500001 TO 500004 MOMENT X Y
 116801 TO 116804 216801 TO 216804 316801 TO 316804 416801 TO 416804 516801 TO 516804 MOMENT X Y

$  INTERMEDIATE PIN CONDITIONS
 105601 TO 105604 205601 TO 205604 305601 TO 305604 405601 TO 405604 505601 TO 505604 MOMENT X Y Z
 111201 TO 111204 211201 TO 211204 311201 TO 311204 411201 TO 411204 511201 TO 511204 MOMENT X Y Z


$ DECK BASE
$  END CONDITIONS
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 FORCE Y
 116819 TO 116820 216819 TO 216820 316819 TO 316820 416819 TO 416820 516819 TO 516820 FORCE Y
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 MOMENT X Y
 116819 TO 116820 216819 TO 216820 316819 TO 316820 416819 TO 416820 516819 TO 516820 MOMENT X Y

$=====================================================================================================
$ Define Loading
$=====================================================================================================
UNITS KN M
LOADING 'DC1' 'DEAD LOAD STRUCTURAL COMPONENTS OF ELEMENTS'
 ELEMENT LOADS
  EXISTING 'G-10011' TO 'G-11688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-20011' TO 'G-21688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-30011' TO 'G-31688' BODY FORCES GLOBAL BY -23.5616
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  EXISTING 'G-40011' TO 'G-41688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-50011' TO 'G-51688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-1011' TO 'P-1566' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-2011' TO 'P-2569' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-3011' TO 'P-3569' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-4011' TO 'P-4566' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-5011' TO 'P-5561' BODY FORCES GLOBAL BY -23.5616
DEAD LOAD 'DC2' 'DEAD LOAD STRUCTURAL COMPONENTS OF MEMBERS' DIRECTION -Y -
  MEMBERS 'B2-1' TO 'B2-4' 'B3-1' TO 'B3-4' 'B4-1' TO 'B4-4' 'B5-1' TO 'B5-4'
LOADING 'LL' 'VEHICULAR LIVE LOAD'
 JOINT LOADS
$ Truck 1
  203622 303620 FORCE Y -45.5
  205122 305120 FORCE Y -188.5
  206322 306320 FORCE Y -188.5
$ Truck 2
  303623 403621 FORCE Y -188.5
  305123 405121 FORCE Y -188.5
  306323 406321 FORCE Y -45.5
LOADING 'LS' 'LIVE LOAD SURCHARGE'
 ELEMENT LOADS
  EXISTING 'P-1011' TO 'P-1566' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-2011' TO 'P-2569' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-3011' TO 'P-3569' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-4011' TO 'P-4566' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-5011' TO 'P-5561' SURFACE FORCES GLOBAL PY -3.9269
LOADING 'WS' 'WIND LOAD ON STRUCTURE'
 ELEMENT LOADS
  'G-50013' TO 'G-51683' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50014' TO 'G-51684' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50015' TO 'G-51685' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50018' TO 'G-51688' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4

$=====================================================================================================
$ Factored Loads
$=====================================================================================================
$LOADING COMBINATION 10 'STRENGTH I MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.75 'LS' 1.75 'WS' 0.0
LOADING COMBINATION 11 'STRENGTH I MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.75 'LS' 1.75 'WS' 0.0
$LOADING COMBINATION 12 'STRENGTH II MINIMUM'  SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 13 'STRENGTH II MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.0

$LOADING COMBINATION 14 'STRENGTH III MINIMUM' SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 0.0  'LS' 0.0  'WS' 1.4
LOADING COMBINATION 15 'STRENGTH III MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 0.0  'LS' 0.0  'WS' 1.4
$LOADING COMBINATION 16 'STRENGTH V MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.4
LOADING COMBINATION 17 'STRENGTH V MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.4
$LOADING COMBINATION 18 'SERVICE I'            SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.0  'LS' 1.0  'WS' 0.3
$LOADING COMBINATION 19 'SERVICE II'           SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.3  'LS' 1.3  'WS' 0.0
$LOADING COMBINATION 20 'FATIGUE'             SPECS 'DC1' 0.0  'DC2' 0.0  'LL' 0.75 'LS' 0.75 'WS' 0.0

$=====================================================================================================
$ Prepare and Generate Output
$=====================================================================================================
QUERY
STIFFNESS ANALYSIS

LIST SUMMATION OF REACTIONS
LIST REACTIONS

CALCULATE AVERAGE STRESS AT TOP SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-7765'
CALCULATE AVERAGE STRESS AT BOTTOM SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-7765'

CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-10011' TO 'G-12288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-20011' TO 'G-22288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-30011' TO 'G-32288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-40011' TO 'G-42288'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-50011' TO 'G-52288'

LIST FORCES MEMBERS 'B2-1' TO 'B2-4' 'B3-1' TO 'B3-4' 'B4-1' TO 'B4-4' 'B5-1' TO 'B5-4'
```

STRUDL 'Model 112' 'Type II Girder, 20° Bridge Skew, Girder Spacing 2.75 m, Span Length 16.8 m, No Diaphragm'

```
UNITS MM
PRINT GENERATE OFF

$==================================================================================================
$ Generate Joints to Connect Girder Brick Elements
$==================================================================================================
GENERATE 4 JOINTS ID 100001 1 X LIST 0 155 305 460 Z 0
REPEAT 1 ID 4 Y 150
REPEAT 1 ID 100 Z -300

GENERATE 2 JOINTS ID 100009 1 X 155 150 Y 455 Z 0
REPEAT 1 ID 100 Z -300

GENERATE 4 JOINTS ID 100011 1 X LIST 80 155 305 380 Y 760 Z 0
REPEAT 1 ID 4 Y 155
REPEAT 1 ID 100 Z -300

$==================================================================================================
$ Generate Girder Brick Elements
$==================================================================================================
TYPE TRIDEMINSIONAL
GENERATE 3 ELEMENTS ID 'G-10011' 1 FROM 100001 1 TO 100002 1 TO 100006 1 TO 100005 1 TO 100101 1 TO 100102 1 TO 100106 1 TO
100105 1
GENERATE 2 ELEMENTS ID 'G-10014' 1 FROM 100006 3 TO 100007 3 TO 100010 3 TO 100009 3 TO 100106 3 TO 100107 3 TO 100110 3 TO
100109 3
GENERATE 3 ELEMENTS ID 'G-10016' 1 FROM 100011 1 TO 100012 1 TO 100016 1 TO 100015 1 TO 100111 1 TO 100112 1 TO 100116 1 TO
100115 1

$==================================================================================================
$ Copy Generated Girder Section and Copy it Down Entire Length of Bridge
$==================================================================================================
DEFINE OBJECT 'SECTION' JOINTS 100001 TO 100018 100101 TO 100118, ELEMENTS 'G-10011' TO 'G-10018'
COPY OBJECT 'SECTION' REPEAT 167 TIMES JOINT INCR 100 ELEMENT INCR 10 TRANSLATE Z -300

$==================================================================================================
$ Copy Generated Girder and Copy it Across The Entire Width of Bridge
$==================================================================================================
DEFINE OBJECT 'GIRDER A' JOINTS EXISTING 100001 TO 116818, ELEMENTS EXISTING 'G-10011' TO 'G-11688'
COPY OBJECT 'GIRDER A' REPEAT 1 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1830 Z -665

DEFINE OBJECT 'GIRDER B' JOINTS EXISTING 200001 TO 216818, ELEMENTS EXISTING 'G-20011' TO 'G-21688'
COPY OBJECT 'GIRDER B' REPEAT 2 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 2748 Z -1000

DEFINE OBJECT 'GIRDER D' JOINTS EXISTING 400001 TO 416818, ELEMENTS EXISTING 'G-40011' TO 'G-41688'
COPY OBJECT 'GIRDER D' REPEAT 1 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1830 Z -665

$==================================================================================================
$ Generate Joints to Connect Deck Plate Elements
$==================================================================================================
GENERATE 2 JOINTS ID 100019 1 X LIST 80 380 Y 916 Z 0
REPEAT 56 ID 300 Z -900
GENERATE 2 JOINTS ID 200019 1 X LIST 1910 2210 Y 916 Z -665
REPEAT 56 ID 300 Z -900
GENERATE 2 JOINTS ID 300019 1 X LIST 4658 4958 Y 916 Z -1665
REPEAT 56 ID 300 Z -900
GENERATE 2 JOINTS ID 400019 1 X LIST 7406 7706 Y 916 Z -2665
REPEAT 56 ID 300 Z -900
GENERATE 2 JOINTS ID 500019 1 X LIST 9236 9536 Y 916 Z -3330
REPEAT 56 ID 300 Z -900

GENERATE 4 JOINTS ID 100021 1 X 686 306 Y 916 0 Z -133 -133
REPEAT 1 ID 300000 X 7326 Z -2665
REPEAT 56 ID 300 Z -900

GENERATE 7 JOINTS ID 200021 1 X 2516 306 Y 916 0 Z -790 -125
REPEAT 1 ID 100000 X 2748 Z -1000
REPEAT 56 ID 300 Z -900

$==================================================================================================
$ Generate Deck Plate Elements
$==================================================================================================
TYPE PLATE

GENERATE 5 ELEMENTS ID 'P-1011' 1 FROM 100019 1 TO 100020 1 TO 100320 1 TO 100319 1
REPEAT 1 ID 3000 FROM INCR 300000 TO INCR 300000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 2 ELEMENTS ID 'P-1016' 3000 FROM 100024 300000 TO 200019 300000 TO 200319 300000 TO 100324 300000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 8 ELEMENTS ID 'P-2011' 1 FROM 200019 1 TO 200020 1 TO 200320 1 TO 200319 1
REPEAT 1 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 2 ELEMENTS ID 'P-2019' 1000 FROM 200027 100000 TO 300019 100000 TO 300319 100000 TO 200327 100000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 56 ELEMENTS ID 'P-5011' 10 FROM 500019 300 TO 500020 300 TO 500320 300 TO 500319 300

$==================================================================================================
$ Generate Rigid Members to Connect Girder Elements to Plate Elements
```

```
$=====================================================================================================
TYPE SPACE TRUSS

GENERATE 2 MEMBERS ID 'R-1001' 1 FROM 100015 3 TO 100019 1
REPEAT 4 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 56 ID 10 FROM INCR 300 TO INCR 300

$=====================================================================================================
$ Generate Diaphragm Members at Mid Height of Web
$=====================================================================================================
$ END DIAPHRAGMS
GENERATE 4 MEMBERS ID 'B2-1' 1 FROM 100010 100000 TO 200009 100000
GENERATE 4 MEMBERS ID 'B5-1' 1 FROM 116810 100000 TO 216809 100000

$ INTERMEDIATE DIAPHRAGMS
GENERATE 2 MEMBERS ID 'B3-1' 3 FROM 105610 301200 TO 204409 301200
GENERATE 2 MEMBERS ID 'B3-2' 1 FROM 204410 101200 TO 305609 101200

GENERATE 2 MEMBERS ID 'B4-1' 3 FROM 111210 301200 TO 210009 301200
GENERATE 2 MEMBERS ID 'B4-2' 1 FROM 210010 101200 TO 311209 101200

$=====================================================================================================
$ Define Element Properties
$=====================================================================================================
MATERIAL CONCRETE ALL ELEMENTS
ELEMENT PROPERTIES
 EXISTING 'G-10011' TO 'G-11688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-20011' TO 'G-21688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-30011' TO 'G-31688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-40011' TO 'G-41688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-50011' TO 'G-51688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'P-1011' TO 'P-1566' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-2011' TO 'P-2569' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-3011' TO 'P-3569' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-4011' TO 'P-4566' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-5011' TO 'P-5561' TYPE 'SBCR' THICKNESS 200

$=====================================================================================================
$ Define Member Properties
$=====================================================================================================
MATERIAL CONCRETE ALL MEMBERS
MEMBER PROPERTIES PRISMATIC
 'R-1001' TO 'R-1561' BY 10 'R-1002' TO 'R-1562' BY 10 AX 5000
 'R-2001' TO 'R-2561' BY 10 'R-2002' TO 'R-2562' BY 10 AX 5000
 'R-3001' TO 'R-3561' BY 10 'R-3002' TO 'R-3562' BY 10 AX 5000
 'R-4001' TO 'R-4561' BY 10 'R-4002' TO 'R-4562' BY 10 AX 5000
 'R-5001' TO 'R-5561' BY 10 'R-5002' TO 'R-5562' BY 10 AX 5000
MEMBER PROPERTIES PRISMATIC
 'B2-1' TO 'B2-4' AX 219600
 'B3-1' TO 'B3-4' AX 219600
 'B4-1' TO 'B4-4' AX 219600
 'B5-1' TO 'B5-4' AX 219600

$=====================================================================================================
$ Define Supports
$=====================================================================================================
STATUS SUPPORT JOINTS -
 100001 TO 500001 BY 100000 100002 TO 500002 BY 100000 100003 TO 500003 BY 100000 100004 TO 500004 BY 100000 -
 105601 TO 505601 BY 100000 105602 TO 505602 BY 100000 105603 TO 505603 BY 100000 105604 TO 505604 BY 100000 -
 111201 TO 511201 BY 100000 111202 TO 511202 BY 100000 111203 TO 511203 BY 100000 111204 TO 511204 BY 100000 -
 116801 TO 516801 BY 100000 116802 TO 516802 BY 100000 116803 TO 516803 BY 100000 116804 TO 516804 BY 100000 -

 100019 TO 500019 BY 100000 100020 TO 500020 BY 100000 -
 116819 TO 516819 BY 100000 116820 TO 516820 BY 100000

$=====================================================================================================
$ Set Boundary Conditions
$=====================================================================================================
JOINT RELEASES

$ GIRDER BASE
$  END PIN CONDITIONS
 100001 TO 100004 200001 TO 200004 300001 TO 300004 400001 TO 400004 500001 TO 500004 MOMENT X Y
 116801 TO 116804 216801 TO 216804 316801 TO 316804 416801 TO 416804 516801 TO 516804 MOMENT X Y

$  INTERMEDIATE PIN CONDITIONS
 105601 TO 105604 205601 TO 205604 305601 TO 305604 405601 TO 405604 505601 TO 505604 MOMENT X Y Z
 111201 TO 111204 211201 TO 211204 311201 TO 311204 411201 TO 411204 511201 TO 511204 MOMENT X Y Z


$ DECK BASE
$  END CONDITIONS
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 FORCE Y
 116819 TO 116820 216819 TO 216820 316819 TO 316820 416819 TO 416820 516819 TO 516820 FORCE Y
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 MOMENT X Y
 116819 TO 116820 216819 TO 216820 316819 TO 316820 416819 TO 416820 516819 TO 516820 MOMENT X Y

$=====================================================================================================
$ Define Loading
$=====================================================================================================
UNITS KN M
LOADING 'DC1' 'DEAD LOAD STRUCTURAL COMPONENTS OF ELEMENTS'
 ELEMENT LOADS
  EXISTING 'G-10011' TO 'G-11688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-20011' TO 'G-21688' BODY FORCES GLOBAL BY -23.5616
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  EXISTING 'G-30011' TO 'G-31688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-40011' TO 'G-41688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-50011' TO 'G-51688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-1011' TO 'P-1566' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-2011' TO 'P-2569' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-3011' TO 'P-3569' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-4011' TO 'P-4566' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-5011' TO 'P-5561' BODY FORCES GLOBAL BY -23.5616
DEAD LOAD 'DC2' 'DEAD LOAD STRUCTURAL COMPONENTS OF MEMBERS' DIRECTION -Y -
  MEMBERS 'B2-1' TO 'B2-4' 'B3-1' TO 'B3-4' 'B4-1' TO 'B4-4' 'B5-1' TO 'B5-4'
LOADING 'LL' 'VEHICULAR LIVE LOAD'
 JOINT LOADS
$ Truck 1
  203622 303620 FORCE Y -45.5
  205122 305120 FORCE Y -188.5
  206322 306320 FORCE Y -188.5
$ Truck 2
  303623 403621 FORCE Y -188.5
  305123 405121 FORCE Y -188.5
  306323 406321 FORCE Y -45.5
LOADING 'LS' 'LIVE LOAD SURCHARGE'
 ELEMENT LOADS
  EXISTING 'P-1011' TO 'P-1566' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-2011' TO 'P-2569' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-3011' TO 'P-3569' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-4011' TO 'P-4566' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-5011' TO 'P-5561' SURFACE FORCES GLOBAL PY -3.9269
LOADING 'WS' 'WIND LOAD ON STRUCTURE'
 ELEMENT LOADS
  'G-50013' TO 'G-51683' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50014' TO 'G-51684' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50015' TO 'G-51685' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50018' TO 'G-51688' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4

$====================================================================================================
$ Factored Loads
$====================================================================================================
$LOADING COMBINATION 10 'STRENGTH I MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.75 'LS' 1.75 'WS' 0.0
LOADING COMBINATION 11 'STRENGTH I MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.75 'LS' 1.75 'WS' 0.0
$LOADING COMBINATION 12 'STRENGTH II MINIMUM'  SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 13 'STRENGTH II MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 14 'STRENGTH III MINIMUM' SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 0.0  'LS' 0.0  'WS' 1.4
LOADING COMBINATION 15 'STRENGTH III MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 0.0  'LS' 0.0  'WS' 1.4
$LOADING COMBINATION 16 'STRENGTH V MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.4
LOADING COMBINATION 17 'STRENGTH V MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.4
$LOADING COMBINATION 18 'SERVICE I'            SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.0  'LS' 1.0  'WS' 0.3
$LOADING COMBINATION 19 'SERVICE II'           SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.3  'LS' 1.3  'WS' 0.0
$LOADING COMBINATION 20 'FATIGUE'              SPECS 'DC1' 0.0  'DC2' 0.0  'LL' 0.75 'LS' 0.75 'WS' 0.0

$====================================================================================================
$ Delete Diaphragms
$====================================================================================================
DELETIONS
MEMBERS 'B2-1' TO 'B2-4' 'B3-1' TO 'B3-4' 'B4-1' TO 'B4-4' 'B5-1' TO 'B5-4'
ADDITIONS

$====================================================================================================
$ Prepare and Generate Output
$====================================================================================================
QUERY
STIFFNESS ANALYSIS

LIST SUMMATION OF REACTIONS
LIST REACTIONS

CALCULATE AVERAGE STRESS AT TOP SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-5565'
CALCULATE AVERAGE STRESS AT BOTTOM SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-5565'

CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-10011' TO 'G-11688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-20011' TO 'G-21688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-30011' TO 'G-31688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-40011' TO 'G-41688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-50011' TO 'G-51688'

$LIST FORCES MEMBERS 'B2-1' TO 'B2-4' 'B3-1' TO 'B3-4' 'B4-1' TO 'B4-4' 'B5-1' TO 'B5-4'
```

STRUDL 'Model 113' 'Type IV Girder, 10° Bridge Skew, Girder Spacing 1.52 m, Span Length 34.0 m, 30° Diaphragm Skew'

```
UNITS MM
PRINT GENERATE OFF

$====================================================================================================
$ Generate Joints to Connect Girder Brick Elements
$====================================================================================================
GENERATE 4 JOINTS ID 100001 1 X LIST 0 230 430 660 Y 0 Z 0
REPEAT 1 ID 4 Y 205
REPEAT 1 ID 100 Z -500

GENERATE 2 JOINTS ID 100009 1 X LIST 230 430 Y 687.5 Z 0
REPEAT 1 ID 100 Z -500

GENERATE 4 JOINTS ID 100011 1 X LIST 75 230 430 585 Y 1170 Z 0
REPEAT 1 ID 4 Y 200
REPEAT 1 ID 100 Z -500

$====================================================================================================
$ Generate Girder Brick Elements
$====================================================================================================
TYPE TRIDEMINSIONAL
GENERATE 3 ELEMENTS ID 'G-10011' 1 FROM 100001 1 TO 100002 1 TO 100006 1 TO 100005 1 TO 100101 1 TO 100102 1 TO 100106 1 TO
100105 1
GENERATE 2 ELEMENTS ID 'G-10014' 1 FROM 100006 3 TO 100007 3 TO 100010 3 TO 100009 3 TO 100106 3 TO 100107 3 TO 100110 3 TO
100109 3
GENERATE 3 ELEMENTS ID 'G-10016' 1 FROM 100011 1 TO 100012 1 TO 100016 1 TO 100015 1 TO 100111 1 TO 100112 1 TO 100116 1 TO
100115 1

$====================================================================================================
$ Copy Generated Girder Section and Copy it Down Entire Length of Bridge
$====================================================================================================
DEFINE OBJECT 'SECTION' JOINTS 100001 TO 100018 100101 TO 100118, ELEMENTS 'G-10011' TO 'G-10018'
COPY OBJECT 'SECTION' REPEAT 203 TIMES JOINT INCR 100 ELEMENT INCR 10 TRANSLATE Z -500

$====================================================================================================
$ Copy Generated Girder and Copy it Across The Entire Width of Bridge
$====================================================================================================
DEFINE OBJECT 'GIRDER A' JOINTS EXISTING 100001 TO 120418, ELEMENTS EXISTING 'G-10011' TO 'G-12048'
COPY OBJECT 'GIRDER A' REPEAT 6 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1524 Z -268

$====================================================================================================
$ Generate Joints to Connect Deck Plate Elements
$====================================================================================================
GENERATE 2 JOINTS ID 100019 1 X LIST 75 585 Y 1371 Z 0
REPEAT 6 ID 100000 X 1524 Z -268
REPEAT 68 ID 300 Z -1500

GENERATE 6 JOINTS ID 100021 100000 X 1092 1524 Y 1371 0 Z -134 -268
REPEAT 68 ID 300 Z -1500

$====================================================================================================
$ Generate Deck Plate Elements
$====================================================================================================
TYPE PLATE

GENERATE 7 ELEMENTS ID 'P-1011' 1000 FROM 100019 100000 TO 100020 100000 TO 100320 100000 TO 100319 100000
REPEAT 67 ID 10 FROM INCR 300 TO INCR 300

GENERATE 6 ELEMENTS ID 'P-1012' 1000 FROM 100020 100000 TO 100021 100000 TO 100321 100000 TO 100320 100000
REPEAT 67 ID 10 FROM INCR 300 TO INCR 300

GENERATE 6 ELEMENTS ID 'P-1013' 1000 FROM 100021 100000 TO 200019 100000 TO 200319 100000 TO 100321 100000
REPEAT 67 ID 10 FROM INCR 300 TO INCR 300

$====================================================================================================
$ Generate Rigid Members to Connect Girder Elements to Plate Elements
$====================================================================================================
TYPE SPACE TRUSS

GENERATE 2 MEMBERS ID 'R-1001' 1 FROM 100015 3 TO 100019 1
REPEAT 6 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 68 ID 10 FROM INCR 300 TO INCR 300

$====================================================================================================
$ Generate Diaphragm Members at Top of Bottom Flange
$====================================================================================================
$ END DIAPHRAGMS
GENERATE 6 MEMBERS ID 'B2-1' 1 FROM 100008 100000 TO 200005 100000
GENERATE 6 MEMBERS ID 'B5-1' 1 FROM 120408 100000 TO 220405 100000

$ INTERMEDIATE DIAPHRAGMS
GENERATE 2 MEMBERS ID 'B3-1' 5 FROM 106808 300000 TO 206905 300300
GENERATE 2 MEMBERS ID 'B3-2' 3 FROM 206908 300300 TO 306405 300300
GENERATE 2 MEMBERS ID 'B3-3' 1 FROM 306408 300300 TO 406805 300000

GENERATE 2 MEMBERS ID 'B4-1' 5 FROM 113608 300000 TO 213705 300300
GENERATE 2 MEMBERS ID 'B4-2' 3 FROM 213708 300300 TO 313205 300300
GENERATE 2 MEMBERS ID 'B4-3' 1 FROM 313208 300300 TO 413605 300000

$====================================================================================================
$ Define Element Properties
```

```
$==================================================================================================
MATERIAL CONCRETE ALL ELEMENTS
ELEMENT PROPERTIES
 EXISTING 'G-10011' TO 'G-12048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-20011' TO 'G-22048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-30011' TO 'G-32048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-40011' TO 'G-42048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-50011' TO 'G-52048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-60011' TO 'G-62048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-70011' TO 'G-72048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'P-1011' TO 'P-1685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-2011' TO 'P-2685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-3011' TO 'P-3685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-4011' TO 'P-4685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-5011' TO 'P-5685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-6011' TO 'P-6685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-7011' TO 'P-7681' TYPE 'SBCR' THICKNESS 200

$==================================================================================================
$ Define Member Properties
$==================================================================================================
MATERIAL CONCRETE ALL MEMBERS
MEMBER PROPERTIES PRISMATIC
 'R-1001' TO 'R-1681' BY 10 'R-1002' TO 'R-1682' BY 10 AX 5000
 'R-2001' TO 'R-2681' BY 10 'R-2002' TO 'R-2682' BY 10 AX 5000
 'R-3001' TO 'R-3681' BY 10 'R-3002' TO 'R-3682' BY 10 AX 5000
 'R-4001' TO 'R-4681' BY 10 'R-4002' TO 'R-4682' BY 10 AX 5000
 'R-5001' TO 'R-5681' BY 10 'R-5002' TO 'R-5682' BY 10 AX 5000
 'R-6001' TO 'R-6681' BY 10 'R-6002' TO 'R-6682' BY 10 AX 5000
 'R-7001' TO 'R-7681' BY 10 'R-7002' TO 'R-7682' BY 10 AX 5000
MEMBER PROPERTIES PRISMATIC
 'B2-1' TO 'B2-6' AX 219600
 'B3-1' TO 'B3-6' AX 219600
 'B4-1' TO 'B4-6' AX 219600
 'B5-1' TO 'B5-6' AX 219600

$==================================================================================================
$ Define Supports
$==================================================================================================
STATUS SUPPORT JOINTS -
 100001 TO 700001 BY 100000 100002 TO 700002 BY 100000 100003 TO 700003 BY 100000 100004 TO 700004 BY 100000 -
 106801 TO 706801 BY 100000 106802 TO 706802 BY 100000 106803 TO 706803 BY 100000 106804 TO 706804 BY 100000 -
 113601 TO 713601 BY 100000 113602 TO 713602 BY 100000 113603 TO 713603 BY 100000 113604 TO 713604 BY 100000 -
 120401 TO 720401 BY 100000 120402 TO 720402 BY 100000 120403 TO 720403 BY 100000 120404 TO 720404 BY 100000 -

 100019 TO 700019 BY 100000 100020 TO 700020 BY 100000 -
 120419 TO 720419 BY 100000 120420 TO 720420 BY 100000

$==================================================================================================
$ Set Boundary Conditions
$==================================================================================================
JOINT RELEASES

$ GIRDER BASE
$  END PIN CONDITIONS
 100001 TO 100004 200001 TO 200004 300001 TO 300004 400001 TO 400004 500001 TO 500004 600001 TO 600004 700001 TO 700004
MOMENT X Y
 120401 TO 120404 220401 TO 220404 320401 TO 320404 420401 TO 420404 520401 TO 520404 620401 TO 620404 720401 TO 720404
MOMENT X Y

$  INTERMEDIATE PIN CONDITIONS
 106801 TO 106804 206801 TO 206804 306801 TO 306804 406801 TO 406804 506801 TO 506804 606801 TO 606804 706801 TO 706804
MOMENT X Y Z
 113601 TO 113604 213601 TO 213604 313601 TO 313604 413601 TO 413604 513601 TO 513604 613601 TO 613604 713601 TO 713604
MOMENT X Y Z


$ DECK BASE
$  END CONDITIONS
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 600019 TO 600020 700019 TO 700020
FORCE Y
 120419 TO 120420 220419 TO 220420 320419 TO 320420 420419 TO 420420 520419 TO 520420 620419 TO 620420 720419 TO 720420
FORCE Y
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 600019 TO 600020 700019 TO 700020
MOMENT X Y
 120419 TO 120420 220419 TO 220420 320419 TO 320420 420419 TO 420420 520419 TO 520420 620419 TO 620420 720419 TO 720420
MOMENT X Y

$==================================================================================================
$ Define Loading
$==================================================================================================
UNITS KN M
LOADING 'DC1' 'DEAD LOAD STRUCTURAL COMPONENTS OF ELEMENTS'
 ELEMENT LOADS
  EXISTING 'G-10011' TO 'G-12048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-20011' TO 'G-22048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-30011' TO 'G-32048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-40011' TO 'G-42048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-50011' TO 'G-52048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-60011' TO 'G-62048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-70011' TO 'G-72048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-1011' TO 'P-1685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-2011' TO 'P-2685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-3011' TO 'P-3685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-4011' TO 'P-4685' BODY FORCES GLOBAL BY -23.5616
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  EXISTING 'P-5011' TO 'P-5685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-6011' TO 'P-6685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-7011' TO 'P-7681' BODY FORCES GLOBAL BY -23.5616
DEAD LOAD 'DC2' 'DEAD LOAD STRUCTURAL COMPONENTS OF MEMBERS' DIRECTION -Y -
  MEMBERS 'B2-1' TO 'B2-6' 'B3-1' TO 'B3-6' 'B4-1' TO 'B4-6' 'B5-1' TO 'B5-6'
LOADING 'LL' 'VEHICULAR LIVE LOAD'
 JOINT LOADS
$ Truck 1
  302119 402120 FORCE Y -45.5
  303019 403020 FORCE Y -188.5
  303919 403920 FORCE Y -188.5
$ Truck 2
  502119 602120 FORCE Y -188.5
  503019 603020 FORCE Y -188.5
  503919 603920 FORCE Y -45.5
LOADING 'LS' 'LIVE LOAD SURCHARGE'
 ELEMENT LOADS
  EXISTING 'P-1011' TO 'P-1685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-2011' TO 'P-2685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-3011' TO 'P-3685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-4011' TO 'P-4685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-5011' TO 'P-5685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-6011' TO 'P-6685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-7011' TO 'P-7681' SURFACE FORCES GLOBAL PY -3.9269
LOADING 'WS' 'WIND LOAD ON STRUCTURE'
 ELEMENT LOADS
  'G-70013' TO 'G-72043' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70014' TO 'G-72044' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70015' TO 'G-72045' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70018' TO 'G-72048' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4

$====================================================================================================
$ Factored Loads
$====================================================================================================
$LOADING COMBINATION 10 'STRENGTH I MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.75 'LS' 1.75 'WS' 0.0
LOADING COMBINATION 11 'STRENGTH I MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.75 'LS' 1.75 'WS' 0.0
$LOADING COMBINATION 12 'STRENGTH II MINIMUM'  SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 13 'STRENGTH II MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 14 'STRENGTH III MINIMUM' SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 0.0  'LS' 0.0  'WS' 1.4
LOADING COMBINATION 15 'STRENGTH III MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 0.0  'LS' 0.0  'WS' 1.4
$LOADING COMBINATION 16 'STRENGTH V MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.4
LOADING COMBINATION 17 'STRENGTH V MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.4
$LOADING COMBINATION 18 'SERVICE I'            SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.0  'LS' 1.0  'WS' 0.3
$LOADING COMBINATION 19 'SERVICE II'           SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.3  'LS' 1.3  'WS' 0.0
$LOADING COMBINATION 20 'FATIGUE'              SPECS 'DC1' 0.0  'DC2' 0.0  'LL' 0.75 'LS' 0.75 'WS' 0.0

$====================================================================================================
$ Prepare and Generate Output
$====================================================================================================
QUERY
STIFFNESS ANALYSIS

LIST SUMMATION OF REACTIONS
LIST REACTIONS

CALCULATE AVERAGE STRESS AT TOP SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-7683'
CALCULATE AVERAGE STRESS AT BOTTOM SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-7683'

CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-10011' TO 'G-12048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-20011' TO 'G-22048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-30011' TO 'G-32048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-40011' TO 'G-42048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-50011' TO 'G-52048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-60011' TO 'G-62048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-70011' TO 'G-72048'

LIST FORCES MEMBERS 'B2-1' TO 'B2-6' 'B3-1' TO 'B3-6' 'B4-1' TO 'B4-6' 'B5-1' TO 'B5-6'
```

STRUDL 'Model 114' 'Type IV Girder, 10° Bridge Skew, Girder Spacing 1.52 m, Span Length 34.0 m, 65° Diaphragm Skew'

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UNITS MM
PRINT GENERATE OFF

$====================================================================================================
$ Generate Joints to Connect Girder Brick Elements
$====================================================================================================
GENERATE 4 JOINTS ID 100001 1 X LIST 0 230 430 660 Y 0 Z 0
REPEAT 1 ID 4 Y 205
REPEAT 1 ID 100 Z -500

GENERATE 2 JOINTS ID 100009 1 X LIST 230 430 Y 687.5 Z 0
REPEAT 1 ID 100 Z -500

GENERATE 4 JOINTS ID 100011 1 X LIST 75 230 430 585 Y 1170 Z 0
REPEAT 1 ID 4 Y 200
REPEAT 1 ID 100 Z -500

$====================================================================================================
$ Generate Girder Brick Elements
$====================================================================================================
TYPE TRIDEMINSIONAL
GENERATE 3 ELEMENTS ID 'G-10011' 1 FROM 100001 1 TO 100002 1 TO 100006 1 TO 100005 1 TO 100101 1 TO 100102 1 TO 100106 1 TO
100105 1
GENERATE 2 ELEMENTS ID 'G-10014' 1 FROM 100006 3 TO 100007 3 TO 100010 3 TO 100009 3 TO 100106 3 TO 100107 3 TO 100110 3 TO
100109 3
GENERATE 3 ELEMENTS ID 'G-10016' 1 FROM 100011 1 TO 100012 1 TO 100016 1 TO 100015 1 TO 100111 1 TO 100112 1 TO 100116 1 TO
100115 1

$====================================================================================================
$ Copy Generated Girder Section and Copy it Down Entire Length of Bridge
$====================================================================================================
DEFINE OBJECT 'SECTION' JOINTS 100001 TO 100018 100101 TO 100118, ELEMENTS 'G-10011' TO 'G-10018'
COPY OBJECT 'SECTION' REPEAT 203 TIMES JOINT INCR 100 ELEMENT INCR 10 TRANSLATE Z -500

$====================================================================================================
$ Copy Generated Girder and Copy it Across The Entire Width of Bridge
$====================================================================================================
DEFINE OBJECT 'GIRDER A' JOINTS EXISTING 100001 TO 120418, ELEMENTS EXISTING 'G-10011' TO 'G-12048'
COPY OBJECT 'GIRDER A' REPEAT 6 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1524 Z -268

$====================================================================================================
$ Generate Joints to Connect Deck Plate Elements
$====================================================================================================
GENERATE 2 JOINTS ID 100019 1 X LIST 75 585 Y 1371 Z 0
REPEAT 6 ID 100000 X 1524 Z -268
REPEAT 68 ID 300 Z -1500

GENERATE 6 JOINTS ID 100021 100000 X 1092 1524 Y 1371 0 Z -134 -268
REPEAT 68 ID 300 Z -1500

$====================================================================================================
$ Generate Deck Plate Elements
$====================================================================================================
TYPE PLATE

GENERATE 7 ELEMENTS ID 'P-1011' 1000 FROM 100019 100000 TO 100020 100000 TO 100320 100000 TO 100319 100000
REPEAT 67 ID 10 FROM INCR 300 TO INCR 300

GENERATE 6 ELEMENTS ID 'P-1012' 1000 FROM 100020 100000 TO 100021 100000 TO 100321 100000 TO 100320 100000
REPEAT 67 ID 10 FROM INCR 300 TO INCR 300

GENERATE 6 ELEMENTS ID 'P-1013' 1000 FROM 100021 100000 TO 200019 100000 TO 200319 100000 TO 100321 100000
REPEAT 67 ID 10 FROM INCR 300 TO INCR 300

$====================================================================================================
$ Generate Rigid Members to Connect Girder Elements to Plate Elements
$====================================================================================================
TYPE SPACE TRUSS

GENERATE 2 MEMBERS ID 'R-1001' 1 FROM 100015 3 TO 100019 1
REPEAT 6 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 68 ID 10 FROM INCR 300 TO INCR 300

$====================================================================================================
$ Generate Diaphragm Members at Top of Bottom Flange
$====================================================================================================
$ END DIAPHRAGMS
GENERATE 6 MEMBERS ID 'B2-1' 1 FROM 100008 100000 TO 200005 100000
GENERATE 6 MEMBERS ID 'B5-1' 1 FROM 120408 100000 TO 220405 100000

$ INTERMEDIATE DIAPHRAGMS
GENERATE 2 MEMBERS ID 'B3-1' 5 FROM 106808 300000 TO 206805 300000
GENERATE 2 MEMBERS ID 'B3-2' 3 FROM 206808 300000 TO 306805 300000
GENERATE 2 MEMBERS ID 'B3-3' 1 FROM 306808 300000 TO 406805 300000

GENERATE 2 MEMBERS ID 'B4-1' 5 FROM 113608 300000 TO 213605 300000
GENERATE 2 MEMBERS ID 'B4-2' 3 FROM 213608 300000 TO 313605 300000
GENERATE 2 MEMBERS ID 'B4-3' 1 FROM 313608 300000 TO 413605 300000

$====================================================================================================
$ Define Element Properties
```

```
$==================================================================================================
MATERIAL CONCRETE ALL ELEMENTS
ELEMENT PROPERTIES
 EXISTING 'G-10011' TO 'G-12048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-20011' TO 'G-22048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-30011' TO 'G-32048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-40011' TO 'G-42048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-50011' TO 'G-52048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-60011' TO 'G-62048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-70011' TO 'G-72048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'P-1011' TO 'P-1685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-2011' TO 'P-2685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-3011' TO 'P-3685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-4011' TO 'P-4685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-5011' TO 'P-5685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-6011' TO 'P-6685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-7011' TO 'P-7681' TYPE 'SBCR' THICKNESS 200

$==================================================================================================
$ Define Member Properties
$==================================================================================================
MATERIAL CONCRETE ALL MEMBERS
MEMBER PROPERTIES PRISMATIC
 'R-1001' TO 'R-1681' BY 10 'R-1002' TO 'R-1682' BY 10 AX 5000
 'R-2001' TO 'R-2681' BY 10 'R-2002' TO 'R-2682' BY 10 AX 5000
 'R-3001' TO 'R-3681' BY 10 'R-3002' TO 'R-3682' BY 10 AX 5000
 'R-4001' TO 'R-4681' BY 10 'R-4002' TO 'R-4682' BY 10 AX 5000
 'R-5001' TO 'R-5681' BY 10 'R-5002' TO 'R-5682' BY 10 AX 5000
 'R-6001' TO 'R-6681' BY 10 'R-6002' TO 'R-6682' BY 10 AX 5000
 'R-7001' TO 'R-7681' BY 10 'R-7002' TO 'R-7682' BY 10 AX 5000
MEMBER PROPERTIES PRISMATIC
 'B2-1' TO 'B2-6' AX 219600
 'B3-1' TO 'B3-6' AX 219600
 'B4-1' TO 'B4-6' AX 219600
 'B5-1' TO 'B5-6' AX 219600

$==================================================================================================
$ Define Supports
$==================================================================================================
STATUS SUPPORT JOINTS -
 100001 TO 700001 BY 100000 100002 TO 700002 BY 100000 100003 TO 700003 BY 100000 100004 TO 700004 BY 100000 -
 106801 TO 706801 BY 100000 106802 TO 706802 BY 100000 106803 TO 706803 BY 100000 106804 TO 706804 BY 100000 -
 113601 TO 713601 BY 100000 113602 TO 713602 BY 100000 113603 TO 713603 BY 100000 113604 TO 713604 BY 100000 -
 120401 TO 720401 BY 100000 120402 TO 720402 BY 100000 120403 TO 720403 BY 100000 120404 TO 720404 BY 100000 -

 100019 TO 700019 BY 100000 100020 TO 700020 BY 100000 -
 120419 TO 720419 BY 100000 120420 TO 720420 BY 100000

$==================================================================================================
$ Set Boundary Conditions
$==================================================================================================
JOINT RELEASES

$ GIRDER BASE
$  END PIN CONDITIONS
 100001 TO 100004 200001 TO 200004 300001 TO 300004 400001 TO 400004 500001 TO 500004 600001 TO 600004 700001 TO 700004
MOMENT X Y
 120401 TO 120404 220401 TO 220404 320401 TO 320404 420401 TO 420404 520401 TO 520404 620401 TO 620404 720401 TO 720404
MOMENT X Y

$  INTERMEDIATE PIN CONDITIONS
 106801 TO 106804 206801 TO 206804 306801 TO 306804 406801 TO 406804 506801 TO 506804 606801 TO 606804 706801 TO 706804
MOMENT X Y Z
 113601 TO 113604 213601 TO 213604 313601 TO 313604 413601 TO 413604 513601 TO 513604 613601 TO 613604 713601 TO 713604
MOMENT X Y Z


$ DECK BASE
$  END CONDITIONS
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 600019 TO 600020 700019 TO 700020
FORCE Y
 120419 TO 120420 220419 TO 220420 320419 TO 320420 420419 TO 420420 520419 TO 520420 620419 TO 620420 720419 TO 720420
FORCE Y
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 600019 TO 600020 700019 TO 700020
MOMENT X Y
 120419 TO 120420 220419 TO 220420 320419 TO 320420 420419 TO 420420 520419 TO 520420 620419 TO 620420 720419 TO 720420
MOMENT X Y

$==================================================================================================
$ Define Loading
$==================================================================================================
UNITS KN M
LOADING 'DC1' 'DEAD LOAD STRUCTURAL COMPONENTS OF ELEMENTS'
 ELEMENT LOADS
  EXISTING 'G-10011' TO 'G-12048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-20011' TO 'G-22048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-30011' TO 'G-32048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-40011' TO 'G-42048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-50011' TO 'G-52048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-60011' TO 'G-62048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-70011' TO 'G-72048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-1011' TO 'P-1685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-2011' TO 'P-2685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-3011' TO 'P-3685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-4011' TO 'P-4685' BODY FORCES GLOBAL BY -23.5616
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  EXISTING 'P-5011' TO 'P-5685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-6011' TO 'P-6685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-7011' TO 'P-7681' BODY FORCES GLOBAL BY -23.5616
DEAD LOAD 'DC2' 'DEAD LOAD STRUCTURAL COMPONENTS OF MEMBERS' DIRECTION -Y -
  MEMBERS 'B2-1' TO 'B2-6' 'B3-1' TO 'B3-6' 'B4-1' TO 'B4-6' 'B5-1' TO 'B5-6'
LOADING 'LL' 'VEHICULAR LIVE LOAD'
 JOINT LOADS
$ Truck 1
  302119 402120 FORCE Y -45.5
  303019 403020 FORCE Y -188.5
  303919 403920 FORCE Y -188.5
$ Truck 2
  502119 602120 FORCE Y -188.5
  503019 603020 FORCE Y -188.5
  503919 603920 FORCE Y -45.5
LOADING 'LS' 'LIVE LOAD SURCHARGE'
 ELEMENT LOADS
  EXISTING 'P-1011' TO 'P-1685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-2011' TO 'P-2685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-3011' TO 'P-3685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-4011' TO 'P-4685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-5011' TO 'P-5685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-6011' TO 'P-6685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-7011' TO 'P-7681' SURFACE FORCES GLOBAL PY -3.9269
LOADING 'WS' 'WIND LOAD ON STRUCTURE'
 ELEMENT LOADS
  'G-70013' TO 'G-72043' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70014' TO 'G-72044' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70015' TO 'G-72045' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70018' TO 'G-72048' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4

$====================================================================================================
$ Factored Loads
$====================================================================================================
$LOADING COMBINATION 10 'STRENGTH I MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.75 'LS' 1.75 'WS' 0.0
LOADING COMBINATION 11 'STRENGTH I MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.75 'LS' 1.75 'WS' 0.0
$LOADING COMBINATION 12 'STRENGTH II MINIMUM'  SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 13 'STRENGTH II MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 14 'STRENGTH III MINIMUM' SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 0.0  'LS' 0.0  'WS' 1.4
LOADING COMBINATION 15 'STRENGTH III MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 0.0  'LS' 0.0  'WS' 1.4
$LOADING COMBINATION 16 'STRENGTH V MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.4
LOADING COMBINATION 17 'STRENGTH V MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.4
$LOADING COMBINATION 18 'SERVICE I'            SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.0  'LS' 1.0  'WS' 0.3
$LOADING COMBINATION 19 'SERVICE II'           SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.3  'LS' 1.3  'WS' 0.0
$LOADING COMBINATION 20 'FATIGUE'              SPECS 'DC1' 0.0  'DC2' 0.0  'LL' 0.75 'LS' 0.75 'WS' 0.0

$====================================================================================================
$ Prepare and Generate Output
$====================================================================================================
QUERY
STIFFNESS ANALYSIS

LIST SUMMATION OF REACTIONS
LIST REACTIONS

CALCULATE AVERAGE STRESS AT TOP SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-7683'
CALCULATE AVERAGE STRESS AT BOTTOM SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-7683'

CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-10011' TO 'G-12048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-20011' TO 'G-22048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-30011' TO 'G-32048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-40011' TO 'G-42048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-50011' TO 'G-52048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-60011' TO 'G-62048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-70011' TO 'G-72048'

LIST FORCES MEMBERS 'B2-1' TO 'B2-6' 'B3-1' TO 'B3-6' 'B4-1' TO 'B4-6' 'B5-1' TO 'B5-6'
```

STRUDL 'Model 115' ‘Type IV Girder, 10° Bridge Skew, Girder Spacing 1.52 m, Span Length 34.0 m, No Diaphragm’

```
UNITS MM
PRINT GENERATE OFF

$====================================================================================================
$ Generate Joints to Connect Girder Brick Elements
$====================================================================================================
GENERATE 4 JOINTS ID 100001 1 X LIST 0 230 430 660 Y 0 Z 0
REPEAT 1 ID 4 Y 205
REPEAT 1 ID 100 Z -500

GENERATE 2 JOINTS ID 100009 1 X LIST 230 430 Y 687.5 Z 0
REPEAT 1 ID 100 Z -500

GENERATE 4 JOINTS ID 100011 1 X LIST 75 230 430 585 Y 1170 Z 0
REPEAT 1 ID 4 Y 200
REPEAT 1 ID 100 Z -500

$====================================================================================================
$ Generate Girder Brick Elements
$====================================================================================================
TYPE TRIDEMINSIONAL
GENERATE 3 ELEMENTS ID 'G-10011' 1 FROM 100001 1 TO 100002 1 TO 100006 1 TO 100005 1 TO 100101 1 TO 100102 1 TO 100106 1 TO
100105 1
GENERATE 2 ELEMENTS ID 'G-10014' 1 FROM 100006 3 TO 100007 3 TO 100010 3 TO 100009 3 TO 100106 3 TO 100107 3 TO 100110 3 TO
100109 3
GENERATE 3 ELEMENTS ID 'G-10016' 1 FROM 100011 1 TO 100012 1 TO 100016 1 TO 100015 1 TO 100111 1 TO 100112 1 TO 100116 1 TO
100115 1

$====================================================================================================
$ Copy Generated Girder Section and Copy it Down Entire Length of Bridge
$====================================================================================================
DEFINE OBJECT 'SECTION' JOINTS 100001 TO 100018 100101 TO 100118, ELEMENTS 'G-10011' TO 'G-10018'
COPY OBJECT 'SECTION' REPEAT 203 TIMES JOINT INCR 100 ELEMENT INCR 10 TRANSLATE Z -500

$====================================================================================================
$ Copy Generated Girder and Copy it Across The Entire Width of Bridge
$====================================================================================================
DEFINE OBJECT 'GIRDER A' JOINTS EXISTING 100001 TO 120418, ELEMENTS EXISTING 'G-10011' TO 'G-12048'
COPY OBJECT 'GIRDER A' REPEAT 6 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1524 Z -268

$====================================================================================================
$ Generate Joints to Connect Deck Plate Elements
$====================================================================================================
GENERATE 2 JOINTS ID 100019 1 X LIST 75 585 Y 1371 Z 0
REPEAT 6 ID 100000 X 1524 Z -268
REPEAT 68 ID 300 Z -1500

GENERATE 6 JOINTS ID 100021 100000 X 1092 1524 Y 1371 0 Z -134 -268
REPEAT 68 ID 300 Z -1500

$====================================================================================================
$ Generate Deck Plate Elements
$====================================================================================================
TYPE PLATE

GENERATE 7 ELEMENTS ID 'P-1011' 1000 FROM 100019 100000 TO 100020 100000 TO 100320 100000 TO 100319 100000
REPEAT 67 ID 10 FROM INCR 300 TO INCR 300

GENERATE 6 ELEMENTS ID 'P-1012' 1000 FROM 100020 100000 TO 100021 100000 TO 100321 100000 TO 100320 100000
REPEAT 67 ID 10 FROM INCR 300 TO INCR 300

GENERATE 6 ELEMENTS ID 'P-1013' 1000 FROM 100021 100000 TO 200019 100000 TO 200319 100000 TO 100321 100000
REPEAT 67 ID 10 FROM INCR 300 TO INCR 300

$====================================================================================================
$ Generate Rigid Members to Connect Girder Elements to Plate Elements
$====================================================================================================
TYPE SPACE TRUSS

GENERATE 2 MEMBERS ID 'R-1001' 1 FROM 100015 3 TO 100019 1
REPEAT 6 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 68 ID 10 FROM INCR 300 TO INCR 300

$====================================================================================================
$ Generate Diaphragm Members at Mid Height of Web
$====================================================================================================
$ END DIAPHRAGMS
GENERATE 6 MEMBERS ID 'B2-1' 1 FROM 100010 100000 TO 200009 100000
GENERATE 6 MEMBERS ID 'B5-1' 1 FROM 120410 100000 TO 220409 100000

$ INTERMEDIATE DIAPHRAGMS
GENERATE 2 MEMBERS ID 'B3-1' 5 FROM 106810 300000 TO 206909 300300
GENERATE 2 MEMBERS ID 'B3-2' 3 FROM 206910 300300 TO 306409 300300
GENERATE 2 MEMBERS ID 'B3-3' 1 FROM 306410 300300 TO 406809 300000

GENERATE 2 MEMBERS ID 'B4-1' 5 FROM 113610 300000 TO 213709 300300
GENERATE 2 MEMBERS ID 'B4-2' 3 FROM 213710 300300 TO 313209 300300
GENERATE 2 MEMBERS ID 'B4-3' 1 FROM 313210 300300 TO 413609 300000

$====================================================================================================
$ Define Element Properties
```

```
$===================================================================================================
MATERIAL CONCRETE ALL ELEMENTS
ELEMENT PROPERTIES
 EXISTING 'G-10011' TO 'G-12048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-20011' TO 'G-22048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-30011' TO 'G-32048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-40011' TO 'G-42048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-50011' TO 'G-52048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-60011' TO 'G-62048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-70011' TO 'G-72048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'P-1011' TO 'P-1685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-2011' TO 'P-2685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-3011' TO 'P-3685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-4011' TO 'P-4685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-5011' TO 'P-5685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-6011' TO 'P-6685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-7011' TO 'P-7681' TYPE 'SBCR' THICKNESS 200

$===================================================================================================
$ Define Member Properties
$===================================================================================================
MATERIAL CONCRETE ALL MEMBERS
MEMBER PROPERTIES PRISMATIC
 'R-1001' TO 'R-1681' BY 10 'R-1002' TO 'R-1682' BY 10 AX 5000
 'R-2001' TO 'R-2681' BY 10 'R-2002' TO 'R-2682' BY 10 AX 5000
 'R-3001' TO 'R-3681' BY 10 'R-3002' TO 'R-3682' BY 10 AX 5000
 'R-4001' TO 'R-4681' BY 10 'R-4002' TO 'R-4682' BY 10 AX 5000
 'R-5001' TO 'R-5681' BY 10 'R-5002' TO 'R-5682' BY 10 AX 5000
 'R-6001' TO 'R-6681' BY 10 'R-6002' TO 'R-6682' BY 10 AX 5000
 'R-7001' TO 'R-7681' BY 10 'R-7002' TO 'R-7682' BY 10 AX 5000
MEMBER PROPERTIES PRISMATIC
 'B2-1' TO 'B2-6' AX 219600
 'B3-1' TO 'B3-6' AX 219600
 'B4-1' TO 'B4-6' AX 219600
 'B5-1' TO 'B5-6' AX 219600

$===================================================================================================
$ Define Supports
$===================================================================================================
STATUS SUPPORT JOINTS -
 100001 TO 700001 BY 100000 100002 TO 700002 BY 100000 100003 TO 700003 BY 100000 100004 TO 700004 BY 100000 -
 106801 TO 706801 BY 100000 106802 TO 706802 BY 100000 106803 TO 706803 BY 100000 106804 TO 706804 BY 100000 -
 113601 TO 713601 BY 100000 113602 TO 713602 BY 100000 113603 TO 713603 BY 100000 113604 TO 713604 BY 100000 -
 120401 TO 720401 BY 100000 120402 TO 720402 BY 100000 120403 TO 720403 BY 100000 120404 TO 720404 BY 100000 -

 100019 TO 700019 BY 100000 100020 TO 700020 BY 100000 -
 120419 TO 720419 BY 100000 120420 TO 720420 BY 100000

$===================================================================================================
$ Set Boundary Conditions
$===================================================================================================
JOINT RELEASES

$ GIRDER BASE
$  END PIN CONDITIONS
 100001 TO 100004 200001 TO 200004 300001 TO 300004 400001 TO 400004 500001 TO 500004 600001 TO 600004 700001 TO 700004
MOMENT X Y
 120401 TO 120404 220401 TO 220404 320401 TO 320404 420401 TO 420404 520401 TO 520404 620401 TO 620404 720401 TO 720404
MOMENT X Y

$  INTERMEDIATE PIN CONDITIONS
 106801 TO 106804 206801 TO 206804 306801 TO 306804 406801 TO 406804 506801 TO 506804 606801 TO 606804 706801 TO 706804
MOMENT X Y Z
 113601 TO 113604 213601 TO 213604 313601 TO 313604 413601 TO 413604 513601 TO 513604 613601 TO 613604 713601 TO 713604
MOMENT X Y Z


$ DECK BASE
$  END CONDITIONS
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 600019 TO 600020 700019 TO 700020
FORCE Y
 120419 TO 120420 220419 TO 220420 320419 TO 320420 420419 TO 420420 520419 TO 520420 620419 TO 620420 720419 TO 720420
FORCE Y
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 600019 TO 600020 700019 TO 700020
MOMENT X Y
 120419 TO 120420 220419 TO 220420 320419 TO 320420 420419 TO 420420 520419 TO 520420 620419 TO 620420 720419 TO 720420
MOMENT X Y

$===================================================================================================
$ Define Loading
$===================================================================================================
UNITS KN M
LOADING 'DC1' 'DEAD LOAD STRUCTURAL COMPONENTS OF ELEMENTS'
 ELEMENT LOADS
  EXISTING 'G-10011' TO 'G-12048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-20011' TO 'G-22048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-30011' TO 'G-32048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-40011' TO 'G-42048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-50011' TO 'G-52048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-60011' TO 'G-62048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-70011' TO 'G-72048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-1011' TO 'P-1685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-2011' TO 'P-2685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-3011' TO 'P-3685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-4011' TO 'P-4685' BODY FORCES GLOBAL BY -23.5616
```

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  EXISTING 'P-5011' TO 'P-5685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-6011' TO 'P-6685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-7011' TO 'P-7681' BODY FORCES GLOBAL BY -23.5616
DEAD LOAD 'DC2' 'DEAD LOAD STRUCTURAL COMPONENTS OF MEMBERS' DIRECTION -Y -
  MEMBERS 'B2-1' TO 'B2-6' 'B3-1' TO 'B3-6' 'B4-1' TO 'B4-6' 'B5-1' TO 'B5-6'
LOADING 'LL' 'VEHICULAR LIVE LOAD'
 JOINT LOADS
$ Truck 1
  302119 402120 FORCE Y -45.5
  303019 403020 FORCE Y -188.5
  303919 403920 FORCE Y -188.5
$ Truck 2
  502119 602120 FORCE Y -188.5
  503019 603020 FORCE Y -188.5
  503919 603920 FORCE Y -45.5
LOADING 'LS' 'LIVE LOAD SURCHARGE'
 ELEMENT LOADS
  EXISTING 'P-1011' TO 'P-1685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-2011' TO 'P-2685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-3011' TO 'P-3685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-4011' TO 'P-4685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-5011' TO 'P-5685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-6011' TO 'P-6685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-7011' TO 'P-7681' SURFACE FORCES GLOBAL PY -3.9269
LOADING 'WS' 'WIND LOAD ON STRUCTURE'
 ELEMENT LOADS
  'G-70013' TO 'G-72043' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70014' TO 'G-72044' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70015' TO 'G-72045' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70018' TO 'G-72048' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4

$====================================================================================================
$ Factored Loads
$====================================================================================================
$LOADING COMBINATION 10 'STRENGTH I MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.75 'LS' 1.75 'WS' 0.0
LOADING COMBINATION 11 'STRENGTH I MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.75 'LS' 1.75 'WS' 0.0
$LOADING COMBINATION 12 'STRENGTH II MINIMUM'  SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 13 'STRENGTH II MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 14 'STRENGTH III MINIMUM' SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 0.0  'LS' 0.0  'WS' 1.4
LOADING COMBINATION 15 'STRENGTH III MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 0.0  'LS' 0.0  'WS' 1.4
$LOADING COMBINATION 16 'STRENGTH V MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.4
LOADING COMBINATION 17 'STRENGTH V MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.4
$LOADING COMBINATION 18 'SERVICE I'            SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.0  'LS' 1.0  'WS' 0.3
$LOADING COMBINATION 19 'SERVICE II'           SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.3  'LS' 1.3  'WS' 0.0
$LOADING COMBINATION 20 'FATIGUE'              SPECS 'DC1' 0.0  'DC2' 0.0  'LL' 0.75 'LS' 0.75 'WS' 0.0

$====================================================================================================
$ Delete Diaphragms
$====================================================================================================
DELETIONS
MEMBERS 'B2-1' TO 'B2-6' 'B3-1' TO 'B3-6' 'B4-1' TO 'B4-6' 'B5-1' TO 'B5-6'
ADDITIONS

$====================================================================================================
$ Prepare and Generate Output
$====================================================================================================
QUERY
STIFFNESS ANALYSIS

LIST SUMMATION OF REACTIONS
LIST REACTIONS

CALCULATE AVERAGE STRESS AT TOP SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-7683'
CALCULATE AVERAGE STRESS AT BOTTOM SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-7683'

CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-10011' TO 'G-12048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-20011' TO 'G-22048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-30011' TO 'G-32048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-40011' TO 'G-42048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-50011' TO 'G-52048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-60011' TO 'G-62048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-70011' TO 'G-72048'

$LIST FORCES MEMBERS 'B2-1' TO 'B2-6' 'B3-1' TO 'B3-6' 'B4-1' TO 'B4-6' 'B5-1' TO 'B5-6'
```

STRUDL 'Model 116' ‘Type IV Girder, 10° Bridge Skew, Girder Spacing 2.75 m, Span Length 28.0 m, 30° Diaphragm Skew’

```
UNITS MM
PRINT GENERATE OFF

$===================================================================================================
$ Generate Joints to Connect Girder Brick Elements
$===================================================================================================
GENERATE 4 JOINTS ID 100001 1 X LIST 0 230 430 660 Y 0 Z 0
REPEAT 1 ID 4 Y 205
REPEAT 1 ID 100 Z -500

GENERATE 2 JOINTS ID 100009 1 X LIST 230 430 Y 687.5 Z 0
REPEAT 1 ID 100 Z -500

GENERATE 4 JOINTS ID 100011 1 X LIST 75 230 430 585 Y 1170 Z 0
REPEAT 1 ID 4 Y 200
REPEAT 1 ID 100 Z -500

$===================================================================================================
$ Generate Girder Brick Elements
$===================================================================================================
TYPE TRIDEMINSIONAL
GENERATE 3 ELEMENTS ID 'G-10011' 1 FROM 100001 1 TO 100002 1 TO 100006 1 TO 100005 1 TO 100101 1 TO 100102 1 TO 100106 1 TO
100105 1
GENERATE 2 ELEMENTS ID 'G-10014' 1 FROM 100006 3 TO 100007 3 TO 100010 3 TO 100009 3 TO 100106 3 TO 100107 3 TO 100110 3 TO
100109 3
GENERATE 3 ELEMENTS ID 'G-10016' 1 FROM 100011 1 TO 100012 1 TO 100016 1 TO 100015 1 TO 100111 1 TO 100112 1 TO 100116 1 TO
100115 1

$===================================================================================================
$ Copy Generated Girder Section and Copy it Down Entire Length of Bridge
$===================================================================================================
DEFINE OBJECT 'SECTION' JOINTS 100001 TO 100018 100101 TO 100118, ELEMENTS 'G-10011' TO 'G-10018'
COPY OBJECT 'SECTION' REPEAT 167 TIMES JOINT INCR 100 ELEMENT INCR 10 TRANSLATE Z -500

$===================================================================================================
$ Copy Generated Girder and Copy it Across The Entire Width of Bridge
$===================================================================================================
DEFINE OBJECT 'GIRDER A' JOINTS EXISTING 100001 TO 116818, ELEMENTS EXISTING 'G-10011' TO 'G-11688'
COPY OBJECT 'GIRDER A' REPEAT 1 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1830 Z -324

DEFINE OBJECT 'GIRDER B' JOINTS EXISTING 200001 TO 216818, ELEMENTS EXISTING 'G-20011' TO 'G-21688'
COPY OBJECT 'GIRDER B' REPEAT 2 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 2750 Z -485

DEFINE OBJECT 'GIRDER D' JOINTS EXISTING 400001 TO 416818, ELEMENTS EXISTING 'G-40011' TO 'G-41688'
COPY OBJECT 'GIRDER D' REPEAT 1 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1830 Z -324

$===================================================================================================
$ Generate Joints to Connect Deck Plate Elements
$===================================================================================================
GENERATE 2 JOINTS ID 100019 1 X LIST 75 585 Y 1371 Z 0
REPEAT 56 ID 300 Z -1500
GENERATE 2 JOINTS ID 200019 1 X LIST 1905 2415 Y 1371 Z -324
REPEAT 56 ID 300 Z -1500
GENERATE 2 JOINTS ID 300019 1 X LIST 4655 5163 Y 1371 Z -809
REPEAT 56 ID 300 Z -1500
GENERATE 2 JOINTS ID 400019 1 X LIST 7405 7911 Y 1371 Z -1294
REPEAT 56 ID 300 Z -1500
GENERATE 2 JOINTS ID 500019 1 X LIST 9235 9741 Y 1371 Z -1618
REPEAT 56 ID 300 Z -1500

GENERATE 2 JOINTS ID 100021 1 X 1025 440 Y 1371 0 Z -108 -108
REPEAT 1 ID 300000 X 7330 Z -1294
REPEAT 56 ID 300 Z -1500

GENERATE 4 JOINTS ID 200021 1 X 2863 448 Y 1371 0 Z -421 -97
REPEAT 1 ID 100000 X 2750 Z -485
REPEAT 56 ID 300 Z -1500

$===================================================================================================
$ Generate Deck Plate Elements
$===================================================================================================
TYPE PLATE

GENERATE 3 ELEMENTS ID 'P-1011' 1 FROM 100019 1 TO 100020 1 TO 100320 1 TO 100319 1
REPEAT 1 ID 3000 FROM INCR 300000 TO INCR 300000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 2 ELEMENTS ID 'P-1014' 3000 FROM 100022 300000 TO 200019 300000 TO 200319 300000 TO 100322 300000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 5 ELEMENTS ID 'P-2011' 1 FROM 200019 1 TO 200020 1 TO 200320 1 TO 200319 1
REPEAT 1 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 2 ELEMENTS ID 'P-2016' 1000 FROM 200024 100000 TO 300019 100000 TO 300319 100000 TO 200324 100000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 56 ELEMENTS ID 'P-5011' 10 FROM 500019 300 TO 500020 300 TO 500320 300 TO 500319 300

$===================================================================================================
$ Generate Rigid Members to Connect Girder Elements to Plate Elements
```

```
$==================================================================================================
TYPE SPACE TRUSS

GENERATE 2 MEMBERS ID 'R-1001' 1 FROM 100015 3 TO 100019 1
REPEAT 4 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 56 ID 10 FROM INCR 300 TO INCR 300

$==================================================================================================
$ Generate Diaphragm Members at Top of Bottom Flange
$==================================================================================================
$ END DIAPHRAGMS
GENERATE 4 MEMBERS ID 'B2-1' 1 FROM 100008 100000 TO 200005 100000
GENERATE 4 MEMBERS ID 'B5-1' 1 FROM 116808 100000 TO 216805 100000

$ INTERMEDIATE DIAPHRAGMS
GENERATE 2 MEMBERS ID 'B3-1' 3 FROM 105608 300800 TO 204805 300800
GENERATE 2 MEMBERS ID 'B3-2' 1 FROM 204808 100800 TO 305605 100800

GENERATE 2 MEMBERS ID 'B4-1' 3 FROM 111208 300800 TO 210405 300800
GENERATE 2 MEMBERS ID 'B4-2' 1 FROM 210408 100800 TO 311205 100800

$==================================================================================================
$ Define Element Properties
$==================================================================================================
MATERIAL CONCRETE ALL ELEMENTS
ELEMENT PROPERTIES
 EXISTING 'G-10011' TO 'G-11688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-20011' TO 'G-21688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-30011' TO 'G-31688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-40011' TO 'G-41688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-50011' TO 'G-51688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'P-1011' TO 'P-1566' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-2011' TO 'P-2569' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-3011' TO 'P-3569' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-4011' TO 'P-4566' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-5011' TO 'P-5561' TYPE 'SBCR' THICKNESS 200

$==================================================================================================
$ Define Member Properties
$==================================================================================================
MATERIAL CONCRETE ALL MEMBERS
MEMBER PROPERTIES PRISMATIC
 'R-1001' TO 'R-1561' BY 10 'R-1002' TO 'R-1562' BY 10 AX 5000
 'R-2001' TO 'R-2561' BY 10 'R-2002' TO 'R-2562' BY 10 AX 5000
 'R-3001' TO 'R-3561' BY 10 'R-3002' TO 'R-3562' BY 10 AX 5000
 'R-4001' TO 'R-4561' BY 10 'R-4002' TO 'R-4562' BY 10 AX 5000
 'R-5001' TO 'R-5561' BY 10 'R-5002' TO 'R-5562' BY 10 AX 5000
MEMBER PROPERTIES PRISMATIC
 'B2-1' TO 'B2-4' AX 219600
 'B3-1' TO 'B3-4' AX 219600
 'B4-1' TO 'B4-4' AX 219600
 'B5-1' TO 'B5-4' AX 219600

$==================================================================================================
$ Define Supports
$==================================================================================================
STATUS SUPPORT JOINTS -
 100001 TO 500001 BY 100000 100002 TO 500002 BY 100000 100003 TO 500003 BY 100000 100004 TO 500004 BY 100000 -
 105601 TO 505601 BY 100000 105602 TO 505602 BY 100000 105603 TO 505603 BY 100000 105604 TO 505604 BY 100000 -
 111201 TO 511201 BY 100000 111202 TO 511202 BY 100000 111203 TO 511203 BY 100000 111204 TO 511204 BY 100000 -
 116801 TO 516801 BY 100000 116802 TO 516802 BY 100000 116803 TO 516803 BY 100000 116804 TO 516804 BY 100000 -


 100019 TO 500019 BY 100000 100020 TO 500020 BY 100000 -
 116819 TO 516819 BY 100000 116820 TO 516820 BY 100000

$==================================================================================================
$ Set Boundary Conditions
$==================================================================================================
JOINT RELEASES

$ GIRDER BASE
$  END PIN CONDITIONS
 100001 TO 100004 200001 TO 200004 300001 TO 300004 400001 TO 400004 500001 TO 500004 MOMENT X Y
 116801 TO 116804 216801 TO 216804 316801 TO 316804 416801 TO 416804 516801 TO 516804 MOMENT X Y

$  INTERMEDIATE PIN CONDITIONS
 105601 TO 105604 205601 TO 205604 305601 TO 305604 405601 TO 405604 505601 TO 505604 MOMENT X Y Z
 111201 TO 111204 211201 TO 211204 311201 TO 311204 411201 TO 411204 511201 TO 511204 MOMENT X Y Z


$ DECK BASE
$  END CONDITIONS
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 FORCE Y
 116819 TO 116820 216819 TO 216820 316819 TO 316820 416819 TO 416820 516819 TO 516820 FORCE Y
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 MOMENT X Y
 116819 TO 116820 216819 TO 216820 316819 TO 316820 416819 TO 416820 516819 TO 516820 MOMENT X Y

$==================================================================================================
$ Define Loading
$==================================================================================================
UNITS KN M
LOADING 'DC1' 'DEAD LOAD STRUCTURAL COMPONENTS OF ELEMENTS'
 ELEMENT LOADS
  EXISTING 'G-10011' TO 'G-11688' BODY FORCES GLOBAL BY -23.5616
```

```
  EXISTING 'G-20011' TO 'G-21688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-30011' TO 'G-31688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-40011' TO 'G-41688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-50011' TO 'G-51688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-1011' TO 'P-1566' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-2011' TO 'P-2569' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-3011' TO 'P-3569' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-4011' TO 'P-4566' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-5011' TO 'P-5561' BODY FORCES GLOBAL BY -23.5616
DEAD LOAD 'DC2' 'DEAD LOAD STRUCTURAL COMPONENTS OF MEMBERS' DIRECTION -Y -
  MEMBERS 'B2-1' TO 'B2-4' 'B3-1' TO 'B3-4' 'B4-1' TO 'B4-4' 'B5-1' TO 'B5-4'
LOADING 'LL' 'VEHICULAR LIVE LOAD'
 JOINT LOADS
$ Truck 1
  202122 302120 FORCE Y -45.5
  203022 303020 FORCE Y -188.5
  203922 303920 FORCE Y -188.5
$ Truck 2
  302123 402121 FORCE Y -188.5
  303023 403021 FORCE Y -188.5
  303923 403921 FORCE Y -45.5
LOADING 'LS' 'LIVE LOAD SURCHARGE'
 ELEMENT LOADS
  EXISTING 'P-1011' TO 'P-1566' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-2011' TO 'P-2569' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-3011' TO 'P-3569' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-4011' TO 'P-4566' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-5011' TO 'P-5561' SURFACE FORCES GLOBAL PY -3.9269
LOADING 'WS' 'WIND LOAD ON STRUCTURE'
 ELEMENT LOADS
  'G-50013' TO 'G-51683' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50014' TO 'G-51684' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50015' TO 'G-51685' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50018' TO 'G-51688' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4

$====================================================================================================
$ Factored Loads
$====================================================================================================
$LOADING COMBINATION 10 'STRENGTH I MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.75 'LS' 1.75 'WS' 0.0
LOADING COMBINATION 11 'STRENGTH I MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.75 'LS' 1.75 'WS' 0.0
$LOADING COMBINATION 12 'STRENGTH II MINIMUM'  SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 13 'STRENGTH II MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 14 'STRENGTH III MINIMUM' SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 0.0  'LS' 0.0  'WS' 1.4
LOADING COMBINATION 15 'STRENGTH III MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 0.0  'LS' 0.0  'WS' 1.4
$LOADING COMBINATION 16 'STRENGTH V MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.4
LOADING COMBINATION 17 'STRENGTH V MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.4
$LOADING COMBINATION 18 'SERVICE I'            SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.0  'LS' 1.0  'WS' 0.3
$LOADING COMBINATION 19 'SERVICE II'           SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.3  'LS' 1.3  'WS' 0.0
$LOADING COMBINATION 20 'FATIGUE'              SPECS 'DC1' 0.0  'DC2' 0.0  'LL' 0.75 'LS' 0.75 'WS' 0.0

$====================================================================================================
$ Prepare and Generate Output
$====================================================================================================
QUERY
STIFFNESS ANALYSIS

LIST SUMMATION OF REACTIONS
LIST REACTIONS

CALCULATE AVERAGE STRESS AT TOP SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-5565'
CALCULATE AVERAGE STRESS AT BOTTOM SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-5565'

CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-10011' TO 'G-11688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-20011' TO 'G-21688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-30011' TO 'G-31688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-40011' TO 'G-41688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-50011' TO 'G-51688'

LIST FORCES MEMBERS 'B2-1' TO 'B2-4' 'B3-1' TO 'B3-4' 'B4-1' TO 'B4-4' 'B5-1' TO 'B5-4'
```

STRUDL 'Model 117' ‘Type IV Girder, 10° Bridge Skew, Girder Spacing 2.75 m, Span Length 28.0 m, 65° Diaphragm Skew’

```
UNITS MM
PRINT GENERATE OFF

$===================================================================================================
$ Generate Joints to Connect Girder Brick Elements
$===================================================================================================
GENERATE 4 JOINTS ID 100001 1 X LIST 0 230 430 660 Y 0 Z 0
REPEAT 1 ID 4 Y 205
REPEAT 1 ID 100 Z -500

GENERATE 2 JOINTS ID 100009 1 X LIST 230 430 Y 687.5 Z 0
REPEAT 1 ID 100 Z -500

GENERATE 4 JOINTS ID 100011 1 X LIST 75 230 430 585 Y 1170 Z 0
REPEAT 1 ID 4 Y 200
REPEAT 1 ID 100 Z -500

$===================================================================================================
$ Generate Girder Brick Elements
$===================================================================================================
TYPE TRIDEMINSIONAL
GENERATE 3 ELEMENTS ID 'G-10011' 1 FROM 100001 1 TO 100002 1 TO 100006 1 TO 100005 1 TO 100101 1 TO 100102 1 TO 100106 1 TO
100105 1
GENERATE 2 ELEMENTS ID 'G-10014' 1 FROM 100006 3 TO 100007 3 TO 100010 3 TO 100009 3 TO 100106 3 TO 100107 3 TO 100110 3 TO
100109 3
GENERATE 3 ELEMENTS ID 'G-10016' 1 FROM 100011 1 TO 100012 1 TO 100016 1 TO 100015 1 TO 100111 1 TO 100112 1 TO 100116 1 TO
100115 1

$===================================================================================================
$ Copy Generated Girder Section and Copy it Down Entire Length of Bridge
$===================================================================================================
DEFINE OBJECT 'SECTION' JOINTS 100001 TO 100018 100101 TO 100118, ELEMENTS 'G-10011' TO 'G-10018'
COPY OBJECT 'SECTION' REPEAT 167 TIMES JOINT INCR 100 ELEMENT INCR 10 TRANSLATE Z -500

$===================================================================================================
$ Copy Generated Girder and Copy it Across The Entire Width of Bridge
$===================================================================================================
DEFINE OBJECT 'GIRDER A' JOINTS EXISTING 100001 TO 116818, ELEMENTS EXISTING 'G-10011' TO 'G-11688'
COPY OBJECT 'GIRDER A' REPEAT 1 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1830 Z -324

DEFINE OBJECT 'GIRDER B' JOINTS EXISTING 200001 TO 216818, ELEMENTS EXISTING 'G-20011' TO 'G-21688'
COPY OBJECT 'GIRDER B' REPEAT 2 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 2750 Z -485

DEFINE OBJECT 'GIRDER D' JOINTS EXISTING 400001 TO 416818, ELEMENTS EXISTING 'G-40011' TO 'G-41688'
COPY OBJECT 'GIRDER D' REPEAT 1 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1830 Z -324

$===================================================================================================
$ Generate Joints to Connect Deck Plate Elements
$===================================================================================================
GENERATE 2 JOINTS ID 100019 1 X LIST 75 585 Y 1371 Z 0
REPEAT 56 ID 300 Z -1500
GENERATE 2 JOINTS ID 200019 1 X LIST 1905 2415 Y 1371 Z -324
REPEAT 56 ID 300 Z -1500
GENERATE 2 JOINTS ID 300019 1 X LIST 4655 5163 Y 1371 Z -809
REPEAT 56 ID 300 Z -1500
GENERATE 2 JOINTS ID 400019 1 X LIST 7405 7911 Y 1371 Z -1294
REPEAT 56 ID 300 Z -1500
GENERATE 2 JOINTS ID 500019 1 X LIST 9235 9741 Y 1371 Z -1618
REPEAT 56 ID 300 Z -1500

GENERATE 2 JOINTS ID 100021 1 X 1025 440 Y 1371 0 Z -108 -108
REPEAT 1 ID 300000 X 7330 Z -1294
REPEAT 56 ID 300 Z -1500

GENERATE 4 JOINTS ID 200021 1 X 2863 448 Y 1371 0 Z -421 -97
REPEAT 1 ID 100000 X 2750 Z -485
REPEAT 56 ID 300 Z -1500

$===================================================================================================
$ Generate Deck Plate Elements
$===================================================================================================
TYPE PLATE

GENERATE 3 ELEMENTS ID 'P-1011' 1 FROM 100019 1 TO 100020 1 TO 100320 1 TO 100319 1
REPEAT 1 ID 3000 FROM INCR 300000 TO INCR 300000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 2 ELEMENTS ID 'P-1014' 3000 FROM 100022 300000 TO 200019 300000 TO 200319 300000 TO 100322 300000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 5 ELEMENTS ID 'P-2011' 1 FROM 200019 1 TO 200020 1 TO 200320 1 TO 200319 1
REPEAT 1 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 2 ELEMENTS ID 'P-2016' 1000 FROM 200024 100000 TO 300019 100000 TO 300319 100000 TO 200324 100000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 56 ELEMENTS ID 'P-5011' 10 FROM 500019 300 TO 500020 300 TO 500320 300 TO 500319 300

$===================================================================================================
$ Generate Rigid Members to Connect Girder Elements to Plate Elements
```

```
$==================================================================================================
TYPE SPACE TRUSS

GENERATE 2 MEMBERS ID 'R-1001' 1 FROM 100015 3 TO 100019 1
REPEAT 4 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 56 ID 10 FROM INCR 300 TO INCR 300

$==================================================================================================
$ Generate Diaphragm Members at Top of Bottom Flange
$==================================================================================================
$ END DIAPHRAGMS
GENERATE 4 MEMBERS ID 'B2-1' 1 FROM 100008 100000 TO 200005 100000
GENERATE 4 MEMBERS ID 'B5-1' 1 FROM 116808 100000 TO 216805 100000

$ INTERMEDIATE DIAPHRAGMS
GENERATE 2 MEMBERS ID 'B3-1' 3 FROM 105608 300200 TO 205405 300200
GENERATE 2 MEMBERS ID 'B3-2' 1 FROM 205408 100200 TO 305605 100200

GENERATE 2 MEMBERS ID 'B4-1' 3 FROM 111208 300200 TO 211005 300200
GENERATE 2 MEMBERS ID 'B4-2' 1 FROM 211008 100200 TO 311205 100200

$==================================================================================================
$ Define Element Properties
$==================================================================================================
MATERIAL CONCRETE ALL ELEMENTS
ELEMENT PROPERTIES
 EXISTING 'G-10011' TO 'G-11688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-20011' TO 'G-21688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-30011' TO 'G-31688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-40011' TO 'G-41688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-50011' TO 'G-51688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'P-1011' TO 'P-1566' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-2011' TO 'P-2569' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-3011' TO 'P-3569' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-4011' TO 'P-4566' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-5011' TO 'P-5561' TYPE 'SBCR' THICKNESS 200

$==================================================================================================
$ Define Member Properties
$==================================================================================================
MATERIAL CONCRETE ALL MEMBERS
MEMBER PROPERTIES PRISMATIC
 'R-1001' TO 'R-1561' BY 10 'R-1002' TO 'R-1562' BY 10 AX 5000
 'R-2001' TO 'R-2561' BY 10 'R-2002' TO 'R-2562' BY 10 AX 5000
 'R-3001' TO 'R-3561' BY 10 'R-3002' TO 'R-3562' BY 10 AX 5000
 'R-4001' TO 'R-4561' BY 10 'R-4002' TO 'R-4562' BY 10 AX 5000
 'R-5001' TO 'R-5561' BY 10 'R-5002' TO 'R-5562' BY 10 AX 5000
MEMBER PROPERTIES PRISMATIC
 'B2-1' TO 'B2-4' AX 219600
 'B3-1' TO 'B3-4' AX 219600
 'B4-1' TO 'B4-4' AX 219600
 'B5-1' TO 'B5-4' AX 219600

$==================================================================================================
$ Define Supports
$==================================================================================================
STATUS SUPPORT JOINTS -
 100001 TO 500001 BY 100000 100002 TO 500002 BY 100000 100003 TO 500003 BY 100000 100004 TO 500004 BY 100000 -
 105601 TO 505601 BY 100000 105602 TO 505602 BY 100000 105603 TO 505603 BY 100000 105604 TO 505604 BY 100000 -
 111201 TO 511201 BY 100000 111202 TO 511202 BY 100000 111203 TO 511203 BY 100000 111204 TO 511204 BY 100000 -
 116801 TO 516801 BY 100000 116802 TO 516802 BY 100000 116803 TO 516803 BY 100000 116804 TO 516804 BY 100000 -


 100019 TO 500019 BY 100000 100020 TO 500020 BY 100000 -
 116819 TO 516819 BY 100000 116820 TO 516820 BY 100000

$==================================================================================================
$ Set Boundary Conditions
$==================================================================================================
JOINT RELEASES

$ GIRDER BASE
$  END PIN CONDITIONS
 100001 TO 100004 200001 TO 200004 300001 TO 300004 400001 TO 400004 500001 TO 500004 MOMENT X Y
 116801 TO 116804 216801 TO 216804 316801 TO 316804 416801 TO 416804 516801 TO 516804 MOMENT X Y

$  INTERMEDIATE PIN CONDITIONS
 105601 TO 105604 205601 TO 205604 305601 TO 305604 405601 TO 405604 505601 TO 505604 MOMENT X Y Z
 111201 TO 111204 211201 TO 211204 311201 TO 311204 411201 TO 411204 511201 TO 511204 MOMENT X Y Z


$ DECK BASE
$  END CONDITIONS
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 FORCE Y
 116819 TO 116820 216819 TO 216820 316819 TO 316820 416819 TO 416820 516819 TO 516820 FORCE Y
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 MOMENT X Y
 116819 TO 116820 216819 TO 216820 316819 TO 316820 416819 TO 416820 516819 TO 516820 MOMENT X Y

$==================================================================================================
$ Define Loading
$==================================================================================================
UNITS KN M
LOADING 'DC1' 'DEAD LOAD STRUCTURAL COMPONENTS OF ELEMENTS'
 ELEMENT LOADS
  EXISTING 'G-10011' TO 'G-11688' BODY FORCES GLOBAL BY -23.5616
```

```
  EXISTING 'G-20011' TO 'G-21688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-30011' TO 'G-31688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-40011' TO 'G-41688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-50011' TO 'G-51688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-1011' TO 'P-1566' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-2011' TO 'P-2569' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-3011' TO 'P-3569' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-4011' TO 'P-4566' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-5011' TO 'P-5561' BODY FORCES GLOBAL BY -23.5616
DEAD LOAD 'DC2' 'DEAD LOAD STRUCTURAL COMPONENTS OF MEMBERS' DIRECTION -Y -
  MEMBERS 'B2-1' TO 'B2-4' 'B3-1' TO 'B3-4' 'B4-1' TO 'B4-4' 'B5-1' TO 'B5-4'
LOADING 'LL' 'VEHICULAR LIVE LOAD'
 JOINT LOADS
$ Truck 1
  202122 302120 FORCE Y -45.5
  203022 303020 FORCE Y -188.5
  203922 303920 FORCE Y -188.5
$ Truck 2
  302123 402121 FORCE Y -188.5
  303023 403021 FORCE Y -188.5
  303923 403921 FORCE Y -45.5
LOADING 'LS' 'LIVE LOAD SURCHARGE'
 ELEMENT LOADS
  EXISTING 'P-1011' TO 'P-1566' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-2011' TO 'P-2569' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-3011' TO 'P-3569' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-4011' TO 'P-4566' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-5011' TO 'P-5561' SURFACE FORCES GLOBAL PY -3.9269
LOADING 'WS' 'WIND LOAD ON STRUCTURE'
 ELEMENT LOADS
  'G-50013' TO 'G-51683' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50014' TO 'G-51684' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50015' TO 'G-51685' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50018' TO 'G-51688' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4

$====================================================================================================
$ Factored Loads
$====================================================================================================
$LOADING COMBINATION 10 'STRENGTH I MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.75 'LS' 1.75 'WS' 0.0
LOADING COMBINATION 11 'STRENGTH I MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.75 'LS' 1.75 'WS' 0.0
$LOADING COMBINATION 12 'STRENGTH II MINIMUM'  SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 13 'STRENGTH II MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 14 'STRENGTH III MINIMUM' SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 0.0  'LS' 0.0  'WS' 1.4
LOADING COMBINATION 15 'STRENGTH III MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 0.0  'LS' 0.0  'WS' 1.4
$LOADING COMBINATION 16 'STRENGTH V MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.4
LOADING COMBINATION 17 'STRENGTH V MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.4
$LOADING COMBINATION 18 'SERVICE I'            SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.0  'LS' 1.0  'WS' 0.3
$LOADING COMBINATION 19 'SERVICE II'           SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.3  'LS' 1.3  'WS' 0.0
$LOADING COMBINATION 20 'FATIGUE'              SPECS 'DC1' 0.0  'DC2' 0.0  'LL' 0.75 'LS' 0.75 'WS' 0.0

$====================================================================================================
$ Prepare and Generate Output
$====================================================================================================
QUERY
STIFFNESS ANALYSIS

LIST SUMMATION OF REACTIONS
LIST REACTIONS

CALCULATE AVERAGE STRESS AT TOP SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-5565'
CALCULATE AVERAGE STRESS AT BOTTOM SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-5565'

CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-10011' TO 'G-11688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-20011' TO 'G-21688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-30011' TO 'G-31688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-40011' TO 'G-41688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-50011' TO 'G-51688'

LIST FORCES MEMBERS 'B2-1' TO 'B2-4' 'B3-1' TO 'B3-4' 'B4-1' TO 'B4-4' 'B5-1' TO 'B5-4'
```

STRUDL 'Model 118' ‘Type IV Girder, 10° Bridge Skew, Girder Spacing 2.75 m, Span Length 28.0 m, No Diaphragm’

```
UNITS MM
PRINT GENERATE OFF

$====================================================================================================
$ Generate Joints to Connect Girder Brick Elements
$====================================================================================================
GENERATE 4 JOINTS ID 100001 1 X LIST 0 230 430 660 Y 0 Z 0
REPEAT 1 ID 4 Y 205
REPEAT 1 ID 100 Z -500

GENERATE 2 JOINTS ID 100009 1 X LIST 230 430 Y 687.5 Z 0
REPEAT 1 ID 100 Z -500

GENERATE 4 JOINTS ID 100011 1 X LIST 75 230 430 585 Y 1170 Z 0
REPEAT 1 ID 4 Y 200
REPEAT 1 ID 100 Z -500

$====================================================================================================
$ Generate Girder Brick Elements
$====================================================================================================
TYPE TRIDEMINSIONAL
GENERATE 3 ELEMENTS ID 'G-10011' 1 FROM 100001 1 TO 100002 1 TO 100006 1 TO 100005 1 TO 100101 1 TO 100102 1 TO 100106 1 TO
100105 1
GENERATE 2 ELEMENTS ID 'G-10014' 1 FROM 100006 3 TO 100007 3 TO 100010 3 TO 100009 3 TO 100106 3 TO 100107 3 TO 100110 3 TO
100109 3
GENERATE 3 ELEMENTS ID 'G-10016' 1 FROM 100011 1 TO 100012 1 TO 100016 1 TO 100015 1 TO 100111 1 TO 100112 1 TO 100116 1 TO
100115 1

$====================================================================================================
$ Copy Generated Girder Section and Copy it Down Entire Length of Bridge
$====================================================================================================
DEFINE OBJECT 'SECTION' JOINTS 100001 TO 100018 100101 TO 100118, ELEMENTS 'G-10011' TO 'G-10018'
COPY OBJECT 'SECTION' REPEAT 167 TIMES JOINT INCR 100 ELEMENT INCR 10 TRANSLATE Z -500

$====================================================================================================
$ Copy Generated Girder and Copy it Across The Entire Width of Bridge
$====================================================================================================
DEFINE OBJECT 'GIRDER A' JOINTS EXISTING 100001 TO 116818, ELEMENTS EXISTING 'G-10011' TO 'G-11688'
COPY OBJECT 'GIRDER A' REPEAT 1 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1830 Z -324

DEFINE OBJECT 'GIRDER B' JOINTS EXISTING 200001 TO 216818, ELEMENTS EXISTING 'G-20011' TO 'G-21688'
COPY OBJECT 'GIRDER B' REPEAT 2 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 2750 Z -485

DEFINE OBJECT 'GIRDER D' JOINTS EXISTING 400001 TO 416818, ELEMENTS EXISTING 'G-40011' TO 'G-41688'
COPY OBJECT 'GIRDER D' REPEAT 1 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1830 Z -324

$====================================================================================================
$ Generate Joints to Connect Deck Plate Elements
$====================================================================================================
GENERATE 2 JOINTS ID 100019 1 X LIST 75 585 Y 1371 Z 0
REPEAT 56 ID 300 Z -1500
GENERATE 2 JOINTS ID 200019 1 X LIST 1905 2415 Y 1371 Z -324
REPEAT 56 ID 300 Z -1500
GENERATE 2 JOINTS ID 300019 1 X LIST 4655 5163 Y 1371 Z -809
REPEAT 56 ID 300 Z -1500
GENERATE 2 JOINTS ID 400019 1 X LIST 7405 7911 Y 1371 Z -1294
REPEAT 56 ID 300 Z -1500
GENERATE 2 JOINTS ID 500019 1 X LIST 9235 9741 Y 1371 Z -1618
REPEAT 56 ID 300 Z -1500

GENERATE 2 JOINTS ID 100021 1 X 1025 440 Y 1371 0 Z -108 -108
REPEAT 1 ID 300000 X 7330 Z -1294
REPEAT 56 ID 300 Z -1500

GENERATE 4 JOINTS ID 200021 1 X 2863 448 Y 1371 0 Z -421 -97
REPEAT 1 ID 100000 X 2750 Z -485
REPEAT 56 ID 300 Z -1500

$====================================================================================================
$ Generate Deck Plate Elements
$====================================================================================================
TYPE PLATE

GENERATE 3 ELEMENTS ID 'P-1011' 1 FROM 100019 1 TO 100020 1 TO 100320 1 TO 100319 1
REPEAT 1 ID 3000 FROM INCR 300000 TO INCR 300000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 2 ELEMENTS ID 'P-1014' 3000 FROM 100022 300000 TO 200019 300000 TO 200319 300000 TO 100322 300000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 5 ELEMENTS ID 'P-2011' 1 FROM 200019 1 TO 200020 1 TO 200320 1 TO 200319 1
REPEAT 1 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 2 ELEMENTS ID 'P-2016' 1000 FROM 200024 100000 TO 300019 100000 TO 300319 100000 TO 200324 100000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 56 ELEMENTS ID 'P-5011' 10 FROM 500019 300 TO 500020 300 TO 500320 300 TO 500319 300

$====================================================================================================
$ Generate Rigid Members to Connect Girder Elements to Plate Elements
```

```
$===================================================================================================
TYPE SPACE TRUSS

GENERATE 2 MEMBERS ID 'R-1001' 1 FROM 100015 3 TO 100019 1
REPEAT 4 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 56 ID 10 FROM INCR 300 TO INCR 300

$===================================================================================================
$ Generate Diaphragm Members at Mid Height of Web
$===================================================================================================
$ END DIAPHRAGMS
GENERATE 4 MEMBERS ID 'B2-1' 1 FROM 100010 100000 TO 200009 100000
GENERATE 4 MEMBERS ID 'B5-1' 1 FROM 116810 100000 TO 216809 100000

$ INTERMEDIATE DIAPHRAGMS
GENERATE 2 MEMBERS ID 'B3-1' 3 FROM 105610 300800 TO 204809 300800
GENERATE 2 MEMBERS ID 'B3-2' 1 FROM 204810 100800 TO 305609 100800

GENERATE 2 MEMBERS ID 'B4-1' 3 FROM 111210 300800 TO 210409 300800
GENERATE 2 MEMBERS ID 'B4-2' 1 FROM 210410 100800 TO 311209 100800

$===================================================================================================
$ Define Element Properties
$===================================================================================================
MATERIAL CONCRETE ALL ELEMENTS
ELEMENT PROPERTIES
 EXISTING 'G-10011' TO 'G-11688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-20011' TO 'G-21688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-30011' TO 'G-31688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-40011' TO 'G-41688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-50011' TO 'G-51688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'P-1011' TO 'P-1566' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-2011' TO 'P-2569' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-3011' TO 'P-3569' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-4011' TO 'P-4566' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-5011' TO 'P-5561' TYPE 'SBCR' THICKNESS 200

$===================================================================================================
$ Define Member Properties
$===================================================================================================
MATERIAL CONCRETE ALL MEMBERS
MEMBER PROPERTIES PRISMATIC
 'R-1001' TO 'R-1561' BY 10 'R-1002' TO 'R-1562' BY 10 AX 5000
 'R-2001' TO 'R-2561' BY 10 'R-2002' TO 'R-2562' BY 10 AX 5000
 'R-3001' TO 'R-3561' BY 10 'R-3002' TO 'R-3562' BY 10 AX 5000
 'R-4001' TO 'R-4561' BY 10 'R-4002' TO 'R-4562' BY 10 AX 5000
 'R-5001' TO 'R-5561' BY 10 'R-5002' TO 'R-5562' BY 10 AX 5000
MEMBER PROPERTIES PRISMATIC
 'B2-1' TO 'B2-4' AX 219600
 'B3-1' TO 'B3-4' AX 219600
 'B4-1' TO 'B4-4' AX 219600
 'B5-1' TO 'B5-4' AX 219600

$===================================================================================================
$ Define Supports
$===================================================================================================
STATUS SUPPORT JOINTS -
 100001 TO 500001 BY 100000 100002 TO 500002 BY 100000 100003 TO 500003 BY 100000 100004 TO 500004 BY 100000 -
 105601 TO 505601 BY 100000 105602 TO 505602 BY 100000 105603 TO 505603 BY 100000 105604 TO 505604 BY 100000 -
 111201 TO 511201 BY 100000 111202 TO 511202 BY 100000 111203 TO 511203 BY 100000 111204 TO 511204 BY 100000 -
 116801 TO 516801 BY 100000 116802 TO 516802 BY 100000 116803 TO 516803 BY 100000 116804 TO 516804 BY 100000 -


 100019 TO 500019 BY 100000 100020 TO 500020 BY 100000 -
 116819 TO 516819 BY 100000 116820 TO 516820 BY 100000

$===================================================================================================
$ Set Boundary Conditions
$===================================================================================================
JOINT RELEASES

$ GIRDER BASE
$  END PIN CONDITIONS
 100001 TO 100004 200001 TO 200004 300001 TO 300004 400001 TO 400004 500001 TO 500004 MOMENT X Y
 116801 TO 116804 216801 TO 216804 316801 TO 316804 416801 TO 416804 516801 TO 516804 MOMENT X Y

$  INTERMEDIATE PIN CONDITIONS
 105601 TO 105604 205601 TO 205604 305601 TO 305604 405601 TO 405604 505601 TO 505604 MOMENT X Y Z
 111201 TO 111204 211201 TO 211204 311201 TO 311204 411201 TO 411204 511201 TO 511204 MOMENT X Y Z


$ DECK BASE
$  END CONDITIONS
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 FORCE Y
 116819 TO 116820 216819 TO 216820 316819 TO 316820 416819 TO 416820 516819 TO 516820 FORCE Y
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 MOMENT X Y
 116819 TO 116820 216819 TO 216820 316819 TO 316820 416819 TO 416820 516819 TO 516820 MOMENT X Y

$===================================================================================================
$ Define Loading
$===================================================================================================
UNITS KN M
LOADING 'DC1' 'DEAD LOAD STRUCTURAL COMPONENTS OF ELEMENTS'
 ELEMENT LOADS
  EXISTING 'G-10011' TO 'G-11688' BODY FORCES GLOBAL BY -23.5616
```

```
  EXISTING 'G-20011' TO 'G-21688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-30011' TO 'G-31688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-40011' TO 'G-41688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-50011' TO 'G-51688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-1011' TO 'P-1566' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-2011' TO 'P-2569' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-3011' TO 'P-3569' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-4011' TO 'P-4566' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-5011' TO 'P-5561' BODY FORCES GLOBAL BY -23.5616
DEAD LOAD 'DC2' 'DEAD LOAD STRUCTURAL COMPONENTS OF MEMBERS' DIRECTION -Y -
  MEMBERS 'B2-1' TO 'B2-4' 'B3-1' TO 'B3-4' 'B4-1' TO 'B4-4' 'B5-1' TO 'B5-4'
LOADING 'LL' 'VEHICULAR LIVE LOAD'
 JOINT LOADS
$ Truck 1
  202122 302120 FORCE Y -45.5
  203022 303020 FORCE Y -188.5
  203922 303920 FORCE Y -188.5
$ Truck 2
  302123 402121 FORCE Y -188.5
  303023 403021 FORCE Y -188.5
  303923 403921 FORCE Y -45.5
LOADING 'LS' 'LIVE LOAD SURCHARGE'
 ELEMENT LOADS
  EXISTING 'P-1011' TO 'P-1566' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-2011' TO 'P-2569' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-3011' TO 'P-3569' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-4011' TO 'P-4566' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-5011' TO 'P-5561' SURFACE FORCES GLOBAL PY -3.9269
LOADING 'WS' 'WIND LOAD ON STRUCTURE'
 ELEMENT LOADS
  'G-50013' TO 'G-51683' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50014' TO 'G-51684' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50015' TO 'G-51685' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50018' TO 'G-51688' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4

$====================================================================================================
$ Factored Loads
$====================================================================================================
$LOADING COMBINATION 10 'STRENGTH I MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.75 'LS' 1.75 'WS' 0.0
LOADING COMBINATION 11 'STRENGTH I MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.75 'LS' 1.75 'WS' 0.0
$LOADING COMBINATION 12 'STRENGTH II MINIMUM'  SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 13 'STRENGTH II MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 14 'STRENGTH III MINIMUM' SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 0.0  'LS' 0.0  'WS' 1.4
LOADING COMBINATION 15 'STRENGTH III MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 0.0  'LS' 0.0  'WS' 1.4
$LOADING COMBINATION 16 'STRENGTH V MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.4
LOADING COMBINATION 17 'STRENGTH V MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.4
$LOADING COMBINATION 18 'SERVICE I'            SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.0  'LS' 1.0  'WS' 0.3
$LOADING COMBINATION 19 'SERVICE II'           SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.3  'LS' 1.3  'WS' 0.0
$LOADING COMBINATION 20 'FATIGUE'              SPECS 'DC1' 0.0  'DC2' 0.0  'LL' 0.75 'LS' 0.75 'WS' 0.0

$====================================================================================================
$ Delete Diaphragms
$====================================================================================================
DELETIONS
MEMBERS 'B2-1' TO 'B2-4' 'B3-1' TO 'B3-4' 'B4-1' TO 'B4-4' 'B5-1' TO 'B5-4'
ADDITIONS

$====================================================================================================
$ Prepare and Generate Output
$====================================================================================================
QUERY
STIFFNESS ANALYSIS

LIST SUMMATION OF REACTIONS
LIST REACTIONS

CALCULATE AVERAGE STRESS AT TOP SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-5565'
CALCULATE AVERAGE STRESS AT BOTTOM SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-5565'

CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-10011' TO 'G-11688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-20011' TO 'G-21688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-30011' TO 'G-31688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-40011' TO 'G-41688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-50011' TO 'G-51688'

$LIST FORCES MEMBERS 'B2-1' TO 'B2-4' 'B3-1' TO 'B3-4' 'B4-1' TO 'B4-4' 'B5-1' TO 'B5-4'
```

STRUDL 'Model 119' 'Type IV Girder, 20° Bridge Skew, Girder Spacing 1.52 m, Span Length 34.0 m, 30° Diaphragm Skew'

```
UNITS MM
PRINT GENERATE OFF

$=====================================================================================================
$ Generate Joints to Connect Girder Brick Elements
$=====================================================================================================
GENERATE 4 JOINTS ID 100001 1 X LIST 0 230 430 660 Y 0 Z 0
REPEAT 1 ID 4 Y 205
REPEAT 1 ID 100 Z -500

GENERATE 2 JOINTS ID 100009 1 X LIST 230 430 Y 687.5 Z 0
REPEAT 1 ID 100 Z -500

GENERATE 4 JOINTS ID 100011 1 X LIST 75 230 430 585 Y 1170 Z 0
REPEAT 1 ID 4 Y 200
REPEAT 1 ID 100 Z -500

$=====================================================================================================
$ Generate Girder Brick Elements
$=====================================================================================================
TYPE TRIDEMINSIONAL
GENERATE 3 ELEMENTS ID 'G-10011' 1 FROM 100001 1 TO 100002 1 TO 100006 1 TO 100005 1 TO 100101 1 TO 100102 1 TO 100106 1 TO
100105 1
GENERATE 2 ELEMENTS ID 'G-10014' 1 FROM 100006 3 TO 100007 3 TO 100010 3 TO 100009 3 TO 100106 3 TO 100107 3 TO 100110 3 TO
100109 3
GENERATE 3 ELEMENTS ID 'G-10016' 1 FROM 100011 1 TO 100012 1 TO 100016 1 TO 100015 1 TO 100111 1 TO 100112 1 TO 100116 1 TO
100115 1

$=====================================================================================================
$ Copy Generated Girder Section and Copy it Down Entire Length of Bridge
$=====================================================================================================
DEFINE OBJECT 'SECTION' JOINTS 100001 TO 100018 100101 TO 100118, ELEMENTS 'G-10011' TO 'G-10018'
COPY OBJECT 'SECTION' REPEAT 203 TIMES JOINT INCR 100 ELEMENT INCR 10 TRANSLATE Z -500

$=====================================================================================================
$ Copy Generated Girder and Copy it Across The Entire Width of Bridge
$=====================================================================================================
DEFINE OBJECT 'GIRDER A' JOINTS EXISTING 100001 TO 120418, ELEMENTS EXISTING 'G-10011' TO 'G-12048'
COPY OBJECT 'GIRDER A' REPEAT 6 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1524 Z -556

$=====================================================================================================
$ Generate Joints to Connect Deck Plate Elements
$=====================================================================================================
GENERATE 2 JOINTS ID 100019 1 X LIST 75 585 Y 1371 Z 0
REPEAT 6 ID 100000 X 1524 Z -556
REPEAT 68 ID 300 Z -1500

GENERATE 6 JOINTS ID 100021 100000 X 1092 1524 Y 1371 0 Z -278 -556
REPEAT 68 ID 300 Z -1500

$=====================================================================================================
$ Generate Deck Plate Elements
$=====================================================================================================
TYPE PLATE

GENERATE 7 ELEMENTS ID 'P-1011' 1000 FROM 100019 100000 TO 100020 100000 TO 100320 100000 TO 100319 100000
REPEAT 67 ID 10 FROM INCR 300 TO INCR 300

GENERATE 6 ELEMENTS ID 'P-1012' 1000 FROM 100020 100000 TO 100021 100000 TO 100321 100000 TO 100320 100000
REPEAT 67 ID 10 FROM INCR 300 TO INCR 300

GENERATE 6 ELEMENTS ID 'P-1013' 1000 FROM 100021 100000 TO 200019 100000 TO 200319 100000 TO 100321 100000
REPEAT 67 ID 10 FROM INCR 300 TO INCR 300

$=====================================================================================================
$ Generate Rigid Members to Connect Girder Elements to Plate Elements
$=====================================================================================================
TYPE SPACE TRUSS

GENERATE 2 MEMBERS ID 'R-1001' 1 FROM 100015 3 TO 100019 1
REPEAT 6 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 68 ID 10 FROM INCR 300 TO INCR 300

$=====================================================================================================
$ Generate Diaphragm Members at Top of Bottom Flange
$=====================================================================================================
$ END DIAPHRAGMS
GENERATE 6 MEMBERS ID 'B2-1' 1 FROM 100008 100000 TO 200005 100000
GENERATE 6 MEMBERS ID 'B5-1' 1 FROM 120408 100000 TO 220405 100000

$ INTERMEDIATE DIAPHRAGMS
GENERATE 2 MEMBERS ID 'B3-1' 5 FROM 106808 300000 TO 207005 300100
GENERATE 2 MEMBERS ID 'B3-2' 3 FROM 207008 300100 TO 306505 300100
GENERATE 2 MEMBERS ID 'B3-3' 1 FROM 306508 300100 TO 406805 300000

GENERATE 2 MEMBERS ID 'B4-1' 5 FROM 113608 300000 TO 213805 300100
GENERATE 2 MEMBERS ID 'B4-2' 3 FROM 213808 300100 TO 313305 300100
GENERATE 2 MEMBERS ID 'B4-3' 1 FROM 313308 300100 TO 413605 300000

$=====================================================================================================
$ Define Element Properties
```

```
$===================================================================================================
MATERIAL CONCRETE ALL ELEMENTS
ELEMENT PROPERTIES
 EXISTING 'G-10011' TO 'G-12048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-20011' TO 'G-22048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-30011' TO 'G-32048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-40011' TO 'G-42048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-50011' TO 'G-52048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-60011' TO 'G-62048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-70011' TO 'G-72048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'P-1011' TO 'P-1685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-2011' TO 'P-2685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-3011' TO 'P-3685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-4011' TO 'P-4685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-5011' TO 'P-5685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-6011' TO 'P-6685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-7011' TO 'P-7681' TYPE 'SBCR' THICKNESS 200

$===================================================================================================
$ Define Member Properties
$===================================================================================================
MATERIAL CONCRETE ALL MEMBERS
MEMBER PROPERTIES PRISMATIC
 'R-1001' TO 'R-1681' BY 10 'R-1002' TO 'R-1682' BY 10 AX 5000
 'R-2001' TO 'R-2681' BY 10 'R-2002' TO 'R-2682' BY 10 AX 5000
 'R-3001' TO 'R-3681' BY 10 'R-3002' TO 'R-3682' BY 10 AX 5000
 'R-4001' TO 'R-4681' BY 10 'R-4002' TO 'R-4682' BY 10 AX 5000
 'R-5001' TO 'R-5681' BY 10 'R-5002' TO 'R-5682' BY 10 AX 5000
 'R-6001' TO 'R-6681' BY 10 'R-6002' TO 'R-6682' BY 10 AX 5000
 'R-7001' TO 'R-7681' BY 10 'R-7002' TO 'R-7682' BY 10 AX 5000
MEMBER PROPERTIES PRISMATIC
 'B2-1' TO 'B2-6' AX 219600
 'B3-1' TO 'B3-6' AX 219600
 'B4-1' TO 'B4-6' AX 219600
 'B5-1' TO 'B5-6' AX 219600

$===================================================================================================
$ Define Supports
$===================================================================================================
STATUS SUPPORT JOINTS -
 100001 TO 700001 BY 100000 100002 TO 700002 BY 100000 100003 TO 700003 BY 100000 100004 TO 700004 BY 100000 -
 106801 TO 706801 BY 100000 106802 TO 706802 BY 100000 106803 TO 706803 BY 100000 106804 TO 706804 BY 100000 -
 113601 TO 713601 BY 100000 113602 TO 713602 BY 100000 113603 TO 713603 BY 100000 113604 TO 713604 BY 100000 -
 120401 TO 720401 BY 100000 120402 TO 720402 BY 100000 120403 TO 720403 BY 100000 120404 TO 720404 BY 100000 -

 100019 TO 700019 BY 100000 100020 TO 700020 BY 100000 -
 120419 TO 720419 BY 100000 120420 TO 720420 BY 100000

$===================================================================================================
$ Set Boundary Conditions
$===================================================================================================
JOINT RELEASES

$ GIRDER BASE
$  END PIN CONDITIONS
 100001 TO 100004 200001 TO 200004 300001 TO 300004 400001 TO 400004 500001 TO 500004 600001 TO 600004 700001 TO 700004
MOMENT X Y
 120401 TO 120404 220401 TO 220404 320401 TO 320404 420401 TO 420404 520401 TO 520404 620401 TO 620404 720401 TO 720404
MOMENT X Y

$  INTERMEDIATE PIN CONDITIONS
 106801 TO 106804 206801 TO 206804 306801 TO 306804 406801 TO 406804 506801 TO 506804 606801 TO 606804 706801 TO 706804
MOMENT X Y Z
 113601 TO 113604 213601 TO 213604 313601 TO 313604 413601 TO 413604 513601 TO 513604 613601 TO 613604 713601 TO 713604
MOMENT X Y Z


$ DECK BASE
$  END CONDITIONS
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 600019 TO 600020 700019 TO 700020
FORCE Y
 120419 TO 120420 220419 TO 220420 320419 TO 320420 420419 TO 420420 520419 TO 520420 620419 TO 620420 720419 TO 720420
FORCE Y
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 600019 TO 600020 700019 TO 700020
MOMENT X Y
 120419 TO 120420 220419 TO 220420 320419 TO 320420 420419 TO 420420 520419 TO 520420 620419 TO 620420 720419 TO 720420
MOMENT X Y

$===================================================================================================
$ Define Loading
$===================================================================================================
UNITS KN M
LOADING 'DC1' 'DEAD LOAD STRUCTURAL COMPONENTS OF ELEMENTS'
 ELEMENT LOADS
  EXISTING 'G-10011' TO 'G-12048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-20011' TO 'G-22048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-30011' TO 'G-32048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-40011' TO 'G-42048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-50011' TO 'G-52048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-60011' TO 'G-62048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-70011' TO 'G-72048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-1011' TO 'P-1685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-2011' TO 'P-2685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-3011' TO 'P-3685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-4011' TO 'P-4685' BODY FORCES GLOBAL BY -23.5616
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  EXISTING 'P-5011' TO 'P-5685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-6011' TO 'P-6685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-7011' TO 'P-7681' BODY FORCES GLOBAL BY -23.5616
DEAD LOAD 'DC2' 'DEAD LOAD STRUCTURAL COMPONENTS OF MEMBERS' DIRECTION -Y -
  MEMBERS 'B2-1' TO 'B2-6' 'B3-1' TO 'B3-6' 'B4-1' TO 'B4-6' 'B5-1' TO 'B5-6'
LOADING 'LL' 'VEHICULAR LIVE LOAD'
 JOINT LOADS
$ Truck 1
  302119 402120 FORCE Y -45.5
  303019 403020 FORCE Y -188.5
  303919 403920 FORCE Y -188.5
$ Truck 2
  502119 602120 FORCE Y -188.5
  503019 603020 FORCE Y -188.5
  503919 603920 FORCE Y -45.5
LOADING 'LS' 'LIVE LOAD SURCHARGE'
 ELEMENT LOADS
  EXISTING 'P-1011' TO 'P-1685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-2011' TO 'P-2685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-3011' TO 'P-3685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-4011' TO 'P-4685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-5011' TO 'P-5685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-6011' TO 'P-6685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-7011' TO 'P-7681' SURFACE FORCES GLOBAL PY -3.9269
LOADING 'WS' 'WIND LOAD ON STRUCTURE'
 ELEMENT LOADS
  'G-70013' TO 'G-72043' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70014' TO 'G-72044' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70015' TO 'G-72045' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70018' TO 'G-72048' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4

$====================================================================================================
$ Factored Loads
$====================================================================================================
$LOADING COMBINATION 10 'STRENGTH I MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.75 'LS' 1.75 'WS' 0.0
LOADING COMBINATION 11 'STRENGTH I MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.75 'LS' 1.75 'WS' 0.0
$LOADING COMBINATION 12 'STRENGTH II MINIMUM'  SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 13 'STRENGTH II MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 14 'STRENGTH III MINIMUM' SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 0.0  'LS' 0.0  'WS' 1.4
LOADING COMBINATION 15 'STRENGTH III MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 0.0  'LS' 0.0  'WS' 1.4
$LOADING COMBINATION 16 'STRENGTH V MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.4
LOADING COMBINATION 17 'STRENGTH V MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.4
$LOADING COMBINATION 18 'SERVICE I'            SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.0  'LS' 1.0  'WS' 0.3
$LOADING COMBINATION 19 'SERVICE II'           SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.3  'LS' 1.3  'WS' 0.0
$LOADING COMBINATION 20 'FATIGUE'              SPECS 'DC1' 0.0  'DC2' 0.0  'LL' 0.75 'LS' 0.75 'WS' 0.0

$====================================================================================================
$ Prepare and Generate Output
$====================================================================================================
QUERY
STIFFNESS ANALYSIS

LIST SUMMATION OF REACTIONS
LIST REACTIONS

CALCULATE AVERAGE STRESS AT TOP SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-7683'
CALCULATE AVERAGE STRESS AT BOTTOM SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-7683'

CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-10011' TO 'G-12048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-20011' TO 'G-22048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-30011' TO 'G-32048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-40011' TO 'G-42048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-50011' TO 'G-52048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-60011' TO 'G-62048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-70011' TO 'G-72048'

LIST FORCES MEMBERS 'B2-1' TO 'B2-6' 'B3-1' TO 'B3-6' 'B4-1' TO 'B4-6' 'B5-1' TO 'B5-6'
```

STRUDL 'Model 120' 'Type IV Girder, 20° Bridge Skew, Girder Spacing 1.52 m, Span Length 34.0 m, 65° Diaphragm Skew'

```
UNITS MM
PRINT GENERATE OFF

$====================================================================================================
$ Generate Joints to Connect Girder Brick Elements
$====================================================================================================
GENERATE 4 JOINTS ID 100001 1 X LIST 0 230 430 660 Y 0 Z 0
REPEAT 1 ID 4 Y 205
REPEAT 1 ID 100 Z -500

GENERATE 2 JOINTS ID 100009 1 X LIST 230 430 Y 687.5 Z 0
REPEAT 1 ID 100 Z -500

GENERATE 4 JOINTS ID 100011 1 X LIST 75 230 430 585 Y 1170 Z 0
REPEAT 1 ID 4 Y 200
REPEAT 1 ID 100 Z -500

$====================================================================================================
$ Generate Girder Brick Elements
$====================================================================================================
TYPE TRIDEMINSIONAL
GENERATE 3 ELEMENTS ID 'G-10011' 1 FROM 100001 1 TO 100002 1 TO 100006 1 TO 100005 1 TO 100101 1 TO 100102 1 TO 100106 1 TO
100105 1
GENERATE 2 ELEMENTS ID 'G-10014' 1 FROM 100006 3 TO 100007 3 TO 100010 3 TO 100009 3 TO 100106 3 TO 100107 3 TO 100110 3 TO
100109 3
GENERATE 3 ELEMENTS ID 'G-10016' 1 FROM 100011 1 TO 100012 1 TO 100016 1 TO 100015 1 TO 100111 1 TO 100112 1 TO 100116 1 TO
100115 1

$====================================================================================================
$ Copy Generated Girder Section and Copy it Down Entire Length of Bridge
$====================================================================================================
DEFINE OBJECT 'SECTION' JOINTS 100001 TO 100018 100101 TO 100118, ELEMENTS 'G-10011' TO 'G-10018'
COPY OBJECT 'SECTION' REPEAT 203 TIMES JOINT INCR 100 ELEMENT INCR 10 TRANSLATE Z -500

$====================================================================================================
$ Copy Generated Girder and Copy it Across The Entire Width of Bridge
$====================================================================================================
DEFINE OBJECT 'GIRDER A' JOINTS EXISTING 100001 TO 120418, ELEMENTS EXISTING 'G-10011' TO 'G-12048'
COPY OBJECT 'GIRDER A' REPEAT 6 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1524 Z -556

$====================================================================================================
$ Generate Joints to Connect Deck Plate Elements
$====================================================================================================
GENERATE 2 JOINTS ID 100019 1 X LIST 75 585 Y 1371 Z 0
REPEAT 6 ID 100000 X 1524 Z -556
REPEAT 68 ID 300 Z -1500

GENERATE 6 JOINTS ID 100021 100000 X 1092 1524 Y 1371 0 Z -278 -556
REPEAT 68 ID 300 Z -1500

$====================================================================================================
$ Generate Deck Plate Elements
$====================================================================================================
TYPE PLATE

GENERATE 7 ELEMENTS ID 'P-1011' 1000 FROM 100019 100000 TO 100020 100000 TO 100320 100000 TO 100319 100000
REPEAT 67 ID 10 FROM INCR 300 TO INCR 300

GENERATE 6 ELEMENTS ID 'P-1012' 1000 FROM 100020 100000 TO 100021 100000 TO 100321 100000 TO 100320 100000
REPEAT 67 ID 10 FROM INCR 300 TO INCR 300

GENERATE 6 ELEMENTS ID 'P-1013' 1000 FROM 100021 100000 TO 200019 100000 TO 200319 100000 TO 100321 100000
REPEAT 67 ID 10 FROM INCR 300 TO INCR 300

$====================================================================================================
$ Generate Rigid Members to Connect Girder Elements to Plate Elements
$====================================================================================================
TYPE SPACE TRUSS

GENERATE 2 MEMBERS ID 'R-1001' 1 FROM 100015 3 TO 100019 1
REPEAT 6 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 68 ID 10 FROM INCR 300 TO INCR 300

$====================================================================================================
$ Generate Diaphragm Members at Top of Bottom Flange
$====================================================================================================
$ END DIAPHRAGMS
GENERATE 6 MEMBERS ID 'B2-1' 1 FROM 100008 100000 TO 200005 100000
GENERATE 6 MEMBERS ID 'B5-1' 1 FROM 120408 100000 TO 220405 100000

$ INTERMEDIATE DIAPHRAGMS
GENERATE 2 MEMBERS ID 'B3-1' 5 FROM 106808 300000 TO 206805 300000
GENERATE 2 MEMBERS ID 'B3-2' 3 FROM 206808 300000 TO 306805 300000
GENERATE 2 MEMBERS ID 'B3-3' 1 FROM 306808 300000 TO 406805 300000

GENERATE 2 MEMBERS ID 'B4-1' 5 FROM 113608 300000 TO 213605 300000
GENERATE 2 MEMBERS ID 'B4-2' 3 FROM 213608 300000 TO 313605 300000
GENERATE 2 MEMBERS ID 'B4-3' 1 FROM 313608 300000 TO 413605 300000

$====================================================================================================
$ Define Element Properties
```

```
$=====================================================================================================
MATERIAL CONCRETE ALL ELEMENTS
ELEMENT PROPERTIES
 EXISTING 'G-10011' TO 'G-12048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-20011' TO 'G-22048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-30011' TO 'G-32048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-40011' TO 'G-42048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-50011' TO 'G-52048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-60011' TO 'G-62048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-70011' TO 'G-72048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'P-1011' TO 'P-1685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-2011' TO 'P-2685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-3011' TO 'P-3685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-4011' TO 'P-4685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-5011' TO 'P-5685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-6011' TO 'P-6685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-7011' TO 'P-7681' TYPE 'SBCR' THICKNESS 200

$=====================================================================================================
$ Define Member Properties
$=====================================================================================================
MATERIAL CONCRETE ALL MEMBERS
MEMBER PROPERTIES PRISMATIC
 'R-1001' TO 'R-1681' BY 10 'R-1002' TO 'R-1682' BY 10 AX 5000
 'R-2001' TO 'R-2681' BY 10 'R-2002' TO 'R-2682' BY 10 AX 5000
 'R-3001' TO 'R-3681' BY 10 'R-3002' TO 'R-3682' BY 10 AX 5000
 'R-4001' TO 'R-4681' BY 10 'R-4002' TO 'R-4682' BY 10 AX 5000
 'R-5001' TO 'R-5681' BY 10 'R-5002' TO 'R-5682' BY 10 AX 5000
 'R-6001' TO 'R-6681' BY 10 'R-6002' TO 'R-6682' BY 10 AX 5000
 'R-7001' TO 'R-7681' BY 10 'R-7002' TO 'R-7682' BY 10 AX 5000
MEMBER PROPERTIES PRISMATIC
 'B2-1' TO 'B2-6' AX 219600
 'B3-1' TO 'B3-6' AX 219600
 'B4-1' TO 'B4-6' AX 219600
 'B5-1' TO 'B5-6' AX 219600

$=====================================================================================================
$ Define Supports
$=====================================================================================================
STATUS SUPPORT JOINTS -
 100001 TO 700001 BY 100000 100002 TO 700002 BY 100000 100003 TO 700003 BY 100000 100004 TO 700004 BY 100000 -
 106801 TO 706801 BY 100000 106802 TO 706802 BY 100000 106803 TO 706803 BY 100000 106804 TO 706804 BY 100000 -
 113601 TO 713601 BY 100000 113602 TO 713602 BY 100000 113603 TO 713603 BY 100000 113604 TO 713604 BY 100000 -
 120401 TO 720401 BY 100000 120402 TO 720402 BY 100000 120403 TO 720403 BY 100000 120404 TO 720404 BY 100000 -

 100019 TO 700019 BY 100000 100020 TO 700020 BY 100000 -
 120419 TO 720419 BY 100000 120420 TO 720420 BY 100000

$=====================================================================================================
$ Set Boundary Conditions
$=====================================================================================================
JOINT RELEASES

$ GIRDER BASE
$  END PIN CONDITIONS
 100001 TO 100004 200001 TO 200004 300001 TO 300004 400001 TO 400004 500001 TO 500004 600001 TO 600004 700001 TO 700004
MOMENT X Y
 120401 TO 120404 220401 TO 220404 320401 TO 320404 420401 TO 420404 520401 TO 520404 620401 TO 620404 720401 TO 720404
MOMENT X Y

$  INTERMEDIATE PIN CONDITIONS
 106801 TO 106804 206801 TO 206804 306801 TO 306804 406801 TO 406804 506801 TO 506804 606801 TO 606804 706801 TO 706804
MOMENT X Y Z
 113601 TO 113604 213601 TO 213604 313601 TO 313604 413601 TO 413604 513601 TO 513604 613601 TO 613604 713601 TO 713604
MOMENT X Y Z


$ DECK BASE
$  END CONDITIONS
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 600019 TO 600020 700019 TO 700020
FORCE Y
 120419 TO 120420 220419 TO 220420 320419 TO 320420 420419 TO 420420 520419 TO 520420 620419 TO 620420 720419 TO 720420
FORCE Y
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 600019 TO 600020 700019 TO 700020
MOMENT X Y
 120419 TO 120420 220419 TO 220420 320419 TO 320420 420419 TO 420420 520419 TO 520420 620419 TO 620420 720419 TO 720420
MOMENT X Y

$=====================================================================================================
$ Define Loading
$=====================================================================================================
UNITS KN M
LOADING 'DC1' 'DEAD LOAD STRUCTURAL COMPONENTS OF ELEMENTS'
 ELEMENT LOADS
  EXISTING 'G-10011' TO 'G-12048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-20011' TO 'G-22048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-30011' TO 'G-32048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-40011' TO 'G-42048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-50011' TO 'G-52048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-60011' TO 'G-62048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-70011' TO 'G-72048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-1011' TO 'P-1685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-2011' TO 'P-2685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-3011' TO 'P-3685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-4011' TO 'P-4685' BODY FORCES GLOBAL BY -23.5616
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  EXISTING 'P-5011' TO 'P-5685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-6011' TO 'P-6685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-7011' TO 'P-7681' BODY FORCES GLOBAL BY -23.5616
DEAD LOAD 'DC2' 'DEAD LOAD STRUCTURAL COMPONENTS OF MEMBERS' DIRECTION -Y -
  MEMBERS 'B2-1' TO 'B2-6' 'B3-1' TO 'B3-6' 'B4-1' TO 'B4-6' 'B5-1' TO 'B5-6'
LOADING 'LL' 'VEHICULAR LIVE LOAD'
 JOINT LOADS
$ Truck 1
  302119 402120 FORCE Y -45.5
  303019 403020 FORCE Y -188.5
  303919 403920 FORCE Y -188.5
$ Truck 2
  502119 602120 FORCE Y -188.5
  503019 603020 FORCE Y -188.5
  503919 603920 FORCE Y -45.5
LOADING 'LS' 'LIVE LOAD SURCHARGE'
 ELEMENT LOADS
  EXISTING 'P-1011' TO 'P-1685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-2011' TO 'P-2685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-3011' TO 'P-3685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-4011' TO 'P-4685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-5011' TO 'P-5685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-6011' TO 'P-6685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-7011' TO 'P-7681' SURFACE FORCES GLOBAL PY -3.9269
LOADING 'WS' 'WIND LOAD ON STRUCTURE'
 ELEMENT LOADS
  'G-70013' TO 'G-72043' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70014' TO 'G-72044' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70015' TO 'G-72045' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70018' TO 'G-72048' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4

$=====================================================================================================
$ Factored Loads
$=====================================================================================================
$LOADING COMBINATION 10 'STRENGTH I MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.75 'LS' 1.75 'WS' 0.0
LOADING COMBINATION 11 'STRENGTH I MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.75 'LS' 1.75 'WS' 0.0
$LOADING COMBINATION 12 'STRENGTH II MINIMUM'  SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 13 'STRENGTH II MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 14 'STRENGTH III MINIMUM' SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 0.0  'LS' 0.0  'WS' 1.4
LOADING COMBINATION 15 'STRENGTH III MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 0.0  'LS' 0.0  'WS' 1.4
$LOADING COMBINATION 16 'STRENGTH V MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.4
LOADING COMBINATION 17 'STRENGTH V MAXIMUM'     SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.4
$LOADING COMBINATION 18 'SERVICE I'            SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.0  'LS' 1.0  'WS' 0.3
$LOADING COMBINATION 19 'SERVICE II'           SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.3  'LS' 1.3  'WS' 0.0
$LOADING COMBINATION 20 'FATIGUE'              SPECS 'DC1' 0.0  'DC2' 0.0  'LL' 0.75 'LS' 0.75 'WS' 0.0

$=====================================================================================================
$ Prepare and Generate Output
$=====================================================================================================
QUERY
STIFFNESS ANALYSIS

LIST SUMMATION OF REACTIONS
LIST REACTIONS

CALCULATE AVERAGE STRESS AT TOP SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-7683'
CALCULATE AVERAGE STRESS AT BOTTOM SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-7683'

CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-10011' TO 'G-12048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-20011' TO 'G-22048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-30011' TO 'G-32048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-40011' TO 'G-42048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-50011' TO 'G-52048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-60011' TO 'G-62048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-70011' TO 'G-72048'

LIST FORCES MEMBERS 'B2-1' TO 'B2-6' 'B3-1' TO 'B3-6' 'B4-1' TO 'B4-6' 'B5-1' TO 'B5-6'
```

STRUDL 'Model 121' 'Type IV Girder, 20° Bridge Skew, Girder Spacing 1.52 m, Span Length 34.0 m, No Diaphragm'

```
UNITS MM
PRINT GENERATE OFF

$===================================================================================================
$ Generate Joints to Connect Girder Brick Elements
$===================================================================================================
GENERATE 4 JOINTS ID 100001 1 X LIST 0 230 430 660 Y 0 Z 0
REPEAT 1 ID 4 Y 205
REPEAT 1 ID 100 Z -500

GENERATE 2 JOINTS ID 100009 1 X LIST 230 430 Y 687.5 Z 0
REPEAT 1 ID 100 Z -500

GENERATE 4 JOINTS ID 100011 1 X LIST 75 230 430 585 Y 1170 Z 0
REPEAT 1 ID 4 Y 200
REPEAT 1 ID 100 Z -500

$===================================================================================================
$ Generate Girder Brick Elements
$===================================================================================================
TYPE TRIDEMINSIONAL
GENERATE 3 ELEMENTS ID 'G-10011' 1 FROM 100001 1 TO 100002 1 TO 100006 1 TO 100005 1 TO 100101 1 TO 100102 1 TO 100106 1 TO
100105 1
GENERATE 2 ELEMENTS ID 'G-10014' 1 FROM 100006 3 TO 100007 3 TO 100010 3 TO 100009 3 TO 100106 3 TO 100107 3 TO 100110 3 TO
100109 3
GENERATE 3 ELEMENTS ID 'G-10016' 1 FROM 100011 1 TO 100012 1 TO 100016 1 TO 100015 1 TO 100111 1 TO 100112 1 TO 100116 1 TO
100115 1

$===================================================================================================
$ Copy Generated Girder Section and Copy it Down Entire Length of Bridge
$===================================================================================================
DEFINE OBJECT 'SECTION' JOINTS 100001 TO 100018 100101 TO 100118, ELEMENTS 'G-10011' TO 'G-10018'
COPY OBJECT 'SECTION' REPEAT 203 TIMES JOINT INCR 100 ELEMENT INCR 10 TRANSLATE Z -500

$===================================================================================================
$ Copy Generated Girder and Copy it Across The Entire Width of Bridge
$===================================================================================================
DEFINE OBJECT 'GIRDER A' JOINTS EXISTING 100001 TO 120418, ELEMENTS EXISTING 'G-10011' TO 'G-12048'
COPY OBJECT 'GIRDER A' REPEAT 6 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1524 Z -556

$===================================================================================================
$ Generate Joints to Connect Deck Plate Elements
$===================================================================================================
GENERATE 2 JOINTS ID 100019 1 X LIST 75 585 Y 1371 Z 0
REPEAT 6 ID 100000 X 1524 Z -556
REPEAT 68 ID 300 Z -1500

GENERATE 6 JOINTS ID 100021 100000 X 1092 1524 Y 1371 0 Z -278 -556
REPEAT 68 ID 300 Z -1500

$===================================================================================================
$ Generate Deck Plate Elements
$===================================================================================================
TYPE PLATE

GENERATE 7 ELEMENTS ID 'P-1011' 1000 FROM 100019 100000 TO 100020 100000 TO 100320 100000 TO 100319 100000
REPEAT 67 ID 10 FROM INCR 300 TO INCR 300

GENERATE 6 ELEMENTS ID 'P-1012' 1000 FROM 100020 100000 TO 100021 100000 TO 100321 100000 TO 100320 100000
REPEAT 67 ID 10 FROM INCR 300 TO INCR 300

GENERATE 6 ELEMENTS ID 'P-1013' 1000 FROM 100021 100000 TO 200019 100000 TO 200319 100000 TO 100321 100000
REPEAT 67 ID 10 FROM INCR 300 TO INCR 300

$===================================================================================================
$ Generate Rigid Members to Connect Girder Elements to Plate Elements
$===================================================================================================
TYPE SPACE TRUSS

GENERATE 2 MEMBERS ID 'R-1001' 1 FROM 100015 3 TO 100019 1
REPEAT 6 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 68 ID 10 FROM INCR 300 TO INCR 300

$===================================================================================================
$ Generate Diaphragm Members at Mid Height of Web
$===================================================================================================
$ END DIAPHRAGMS
GENERATE 6 MEMBERS ID 'B2-1' 1 FROM 100010 100000 TO 200009 100000
GENERATE 6 MEMBERS ID 'B5-1' 1 FROM 120410 100000 TO 220409 100000

$ INTERMEDIATE DIAPHRAGMS
GENERATE 2 MEMBERS ID 'B3-1' 5 FROM 106810 300000 TO 207009 300100
GENERATE 2 MEMBERS ID 'B3-2' 3 FROM 207010 300100 TO 306509 300100
GENERATE 2 MEMBERS ID 'B3-3' 1 FROM 306510 300100 TO 406809 300000

GENERATE 2 MEMBERS ID 'B4-1' 5 FROM 113610 300000 TO 213809 300100
GENERATE 2 MEMBERS ID 'B4-2' 3 FROM 213810 300100 TO 313309 300100
GENERATE 2 MEMBERS ID 'B4-3' 1 FROM 313310 300100 TO 413609 300000

$===================================================================================================
$ Define Element Properties
```

```
$=====================================================================================================
MATERIAL CONCRETE ALL ELEMENTS
ELEMENT PROPERTIES
 EXISTING 'G-10011' TO 'G-12048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-20011' TO 'G-22048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-30011' TO 'G-32048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-40011' TO 'G-42048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-50011' TO 'G-52048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-60011' TO 'G-62048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-70011' TO 'G-72048' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'P-1011' TO 'P-1685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-2011' TO 'P-2685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-3011' TO 'P-3685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-4011' TO 'P-4685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-5011' TO 'P-5685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-6011' TO 'P-6685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-7011' TO 'P-7681' TYPE 'SBCR' THICKNESS 200

$=====================================================================================================
$ Define Member Properties
$=====================================================================================================
MATERIAL CONCRETE ALL MEMBERS
MEMBER PROPERTIES PRISMATIC
 'R-1001' TO 'R-1681' BY 10 'R-1002' TO 'R-1682' BY 10 AX 5000
 'R-2001' TO 'R-2681' BY 10 'R-2002' TO 'R-2682' BY 10 AX 5000
 'R-3001' TO 'R-3681' BY 10 'R-3002' TO 'R-3682' BY 10 AX 5000
 'R-4001' TO 'R-4681' BY 10 'R-4002' TO 'R-4682' BY 10 AX 5000
 'R-5001' TO 'R-5681' BY 10 'R-5002' TO 'R-5682' BY 10 AX 5000
 'R-6001' TO 'R-6681' BY 10 'R-6002' TO 'R-6682' BY 10 AX 5000
 'R-7001' TO 'R-7681' BY 10 'R-7002' TO 'R-7682' BY 10 AX 5000
MEMBER PROPERTIES PRISMATIC
 'B2-1' TO 'B2-6' AX 219600
 'B3-1' TO 'B3-6' AX 219600
 'B4-1' TO 'B4-6' AX 219600
 'B5-1' TO 'B5-6' AX 219600

$=====================================================================================================
$ Define Supports
$=====================================================================================================
STATUS SUPPORT JOINTS -
 100001 TO 700001 BY 100000 100002 TO 700002 BY 100000 100003 TO 700003 BY 100000 100004 TO 700004 BY 100000 -
 106801 TO 706801 BY 100000 106802 TO 706802 BY 100000 106803 TO 706803 BY 100000 106804 TO 706804 BY 100000 -
 113601 TO 713601 BY 100000 113602 TO 713602 BY 100000 113603 TO 713603 BY 100000 113604 TO 713604 BY 100000 -
 120401 TO 720401 BY 100000 120402 TO 720402 BY 100000 120403 TO 720403 BY 100000 120404 TO 720404 BY 100000 -

 100019 TO 700019 BY 100000 100020 TO 700020 BY 100000 -
 120419 TO 720419 BY 100000 120420 TO 720420 BY 100000

$=====================================================================================================
$ Set Boundary Conditions
$=====================================================================================================
JOINT RELEASES

$ GIRDER BASE
$  END PIN CONDITIONS
 100001 TO 100004 200001 TO 200004 300001 TO 300004 400001 TO 400004 500001 TO 500004 600001 TO 600004 700001 TO 700004
MOMENT X Y
 120401 TO 120404 220401 TO 220404 320401 TO 320404 420401 TO 420404 520401 TO 520404 620401 TO 620404 720401 TO 720404
MOMENT X Y

$  INTERMEDIATE PIN CONDITIONS
 106801 TO 106804 206801 TO 206804 306801 TO 306804 406801 TO 406804 506801 TO 506804 606801 TO 606804 706801 TO 706804
MOMENT X Y Z
 113601 TO 113604 213601 TO 213604 313601 TO 313604 413601 TO 413604 513601 TO 513604 613601 TO 613604 713601 TO 713604
MOMENT X Y Z


$ DECK BASE
$  END CONDITIONS
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 600019 TO 600020 700019 TO 700020
FORCE Y
 120419 TO 120420 220419 TO 220420 320419 TO 320420 420419 TO 420420 520419 TO 520420 620419 TO 620420 720419 TO 720420
FORCE Y
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 600019 TO 600020 700019 TO 700020
MOMENT X Y
 120419 TO 120420 220419 TO 220420 320419 TO 320420 420419 TO 420420 520419 TO 520420 620419 TO 620420 720419 TO 720420
MOMENT X Y

$=====================================================================================================
$ Define Loading
$=====================================================================================================
UNITS KN M
LOADING 'DC1' 'DEAD LOAD STRUCTURAL COMPONENTS OF ELEMENTS'
 ELEMENT LOADS
  EXISTING 'G-10011' TO 'G-12048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-20011' TO 'G-22048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-30011' TO 'G-32048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-40011' TO 'G-42048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-50011' TO 'G-52048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-60011' TO 'G-62048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-70011' TO 'G-72048' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-1011' TO 'P-1685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-2011' TO 'P-2685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-3011' TO 'P-3685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-4011' TO 'P-4685' BODY FORCES GLOBAL BY -23.5616
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  EXISTING 'P-5011' TO 'P-5685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-6011' TO 'P-6685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-7011' TO 'P-7681' BODY FORCES GLOBAL BY -23.5616
DEAD LOAD 'DC2' 'DEAD LOAD STRUCTURAL COMPONENTS OF MEMBERS' DIRECTION -Y -
  MEMBERS 'B2-1' TO 'B2-6' 'B3-1' TO 'B3-6' 'B4-1' TO 'B4-6' 'B5-1' TO 'B5-6'
LOADING 'LL' 'VEHICULAR LIVE LOAD'
 JOINT LOADS
$ Truck 1
  302119 402120 FORCE Y -45.5
  303019 403020 FORCE Y -188.5
  303919 403920 FORCE Y -188.5
$ Truck 2
  502119 602120 FORCE Y -188.5
  503019 603020 FORCE Y -188.5
  503919 603920 FORCE Y -45.5
LOADING 'LS' 'LIVE LOAD SURCHARGE'
 ELEMENT LOADS
  EXISTING 'P-1011' TO 'P-1685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-2011' TO 'P-2685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-3011' TO 'P-3685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-4011' TO 'P-4685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-5011' TO 'P-5685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-6011' TO 'P-6685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-7011' TO 'P-7681' SURFACE FORCES GLOBAL PY -3.9269
LOADING 'WS' 'WIND LOAD ON STRUCTURE'
 ELEMENT LOADS
  'G-70013' TO 'G-72043' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70014' TO 'G-72044' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70015' TO 'G-72045' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70018' TO 'G-72048' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4

$====================================================================================================
$ Factored Loads
$====================================================================================================
$LOADING COMBINATION 10 'STRENGTH I MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.75 'LS' 1.75 'WS' 0.0
LOADING COMBINATION 11 'STRENGTH I MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.75 'LS' 1.75 'WS' 0.0
$LOADING COMBINATION 12 'STRENGTH II MINIMUM'  SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 13 'STRENGTH II MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 14 'STRENGTH III MINIMUM' SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 0.0  'LS' 0.0  'WS' 1.4
LOADING COMBINATION 15 'STRENGTH III MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 0.0  'LS' 0.0  'WS' 1.4
$LOADING COMBINATION 16 'STRENGTH V MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.4
LOADING COMBINATION 17 'STRENGTH V MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.4
$LOADING COMBINATION 18 'SERVICE I'            SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.0  'LS' 1.0  'WS' 0.3
$LOADING COMBINATION 19 'SERVICE II'           SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.3  'LS' 1.3  'WS' 0.0
$LOADING COMBINATION 20 'FATIGUE'              SPECS 'DC1' 0.0  'DC2' 0.0  'LL' 0.75 'LS' 0.75 'WS' 0.0

$====================================================================================================
$ Delete Diaphragms
$====================================================================================================
DELETIONS
MEMBERS 'B2-1' TO 'B2-6' 'B3-1' TO 'B3-6' 'B4-1' TO 'B4-6' 'B5-1' TO 'B5-6'
ADDITIONS

$====================================================================================================
$ Prepare and Generate Output
$====================================================================================================
QUERY
STIFFNESS ANALYSIS

LIST SUMMATION OF REACTIONS
LIST REACTIONS

CALCULATE AVERAGE STRESS AT TOP SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-7683'
CALCULATE AVERAGE STRESS AT BOTTOM SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-7683'

CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-10011' TO 'G-12048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-20011' TO 'G-22048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-30011' TO 'G-32048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-40011' TO 'G-42048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-50011' TO 'G-52048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-60011' TO 'G-62048'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-70011' TO 'G-72048'

$LIST FORCES MEMBERS 'B2-1' TO 'B2-6' 'B3-1' TO 'B3-6' 'B4-1' TO 'B4-6' 'B5-1' TO 'B5-6'
```

STRUDL 'Model 122' 'Type IV Girder, 20° Bridge Skew, Girder Spacing 2.75 m, Span Length 28.0 m, 30° Diaphragm Skew'

```
UNITS MM
PRINT GENERATE OFF

$====================================================================================================
$ Generate Joints to Connect Girder Brick Elements
$====================================================================================================
GENERATE 4 JOINTS ID 100001 1 X LIST 0 230 430 660 Y 0 Z 0
REPEAT 1 ID 4 Y 205
REPEAT 1 ID 100 Z -500

GENERATE 2 JOINTS ID 100009 1 X LIST 230 430 Y 687.5 Z 0
REPEAT 1 ID 100 Z -500

GENERATE 4 JOINTS ID 100011 1 X LIST 75 230 430 585 Y 1170 Z 0
REPEAT 1 ID 4 Y 200
REPEAT 1 ID 100 Z -500

$====================================================================================================
$ Generate Girder Brick Elements
$====================================================================================================
TYPE TRIDEMINSIONAL
GENERATE 3 ELEMENTS ID 'G-10011' 1 FROM 100001 1 TO 100002 1 TO 100006 1 TO 100005 1 TO 100101 1 TO 100102 1 TO 100106 1 TO
100105 1
GENERATE 2 ELEMENTS ID 'G-10014' 1 FROM 100006 3 TO 100007 3 TO 100010 3 TO 100009 3 TO 100106 3 TO 100107 3 TO 100110 3 TO
100109 3
GENERATE 3 ELEMENTS ID 'G-10016' 1 FROM 100011 1 TO 100012 1 TO 100016 1 TO 100015 1 TO 100111 1 TO 100112 1 TO 100116 1 TO
100115 1

$====================================================================================================
$ Copy Generated Girder Section and Copy it Down Entire Length of Bridge
$====================================================================================================
DEFINE OBJECT 'SECTION' JOINTS 100001 TO 100018 100101 TO 100118, ELEMENTS 'G-10011' TO 'G-10018'
COPY OBJECT 'SECTION' REPEAT 167 TIMES JOINT INCR 100 ELEMENT INCR 10 TRANSLATE Z -500

$====================================================================================================
$ Copy Generated Girder and Copy it Across The Entire Width of Bridge
$====================================================================================================
DEFINE OBJECT 'GIRDER A' JOINTS EXISTING 100001 TO 116818, ELEMENTS EXISTING 'G-10011' TO 'G-11688'
COPY OBJECT 'GIRDER A' REPEAT 1 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1830 Z -666

DEFINE OBJECT 'GIRDER B' JOINTS EXISTING 200001 TO 216818, ELEMENTS EXISTING 'G-20011' TO 'G-21688'
COPY OBJECT 'GIRDER B' REPEAT 2 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 2750 Z -1000

DEFINE OBJECT 'GIRDER D' JOINTS EXISTING 400001 TO 416818, ELEMENTS EXISTING 'G-40011' TO 'G-41688'
COPY OBJECT 'GIRDER D' REPEAT 1 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1830 Z -666

$====================================================================================================
$ Generate Joints to Connect Deck Plate Elements
$====================================================================================================
GENERATE 2 JOINTS ID 100019 1 X LIST 75 585 Y 1371 Z 0
REPEAT 56 ID 300 Z -1500
GENERATE 2 JOINTS ID 200019 1 X LIST 1905 2415 Y 1371 Z -666
REPEAT 56 ID 300 Z -1500
GENERATE 2 JOINTS ID 300019 1 X LIST 4655 5163 Y 1371 Z -1666
REPEAT 56 ID 300 Z -1500
GENERATE 2 JOINTS ID 400019 1 X LIST 7405 7911 Y 1371 Z -2666
REPEAT 56 ID 300 Z -1500
GENERATE 2 JOINTS ID 500019 1 X LIST 9235 9741 Y 1371 Z -3332
REPEAT 56 ID 300 Z -1500

GENERATE 2 JOINTS ID 100021 1 X 1025 440 Y 1371 0 Z -222 -222
REPEAT 1 ID 300000 X 7330 Z -2666
REPEAT 56 ID 300 Z -1500

GENERATE 4 JOINTS ID 200021 1 X 2863 448 Y 1371 0 Z -866 -200
REPEAT 1 ID 100000 X 2750 Z -1000
REPEAT 56 ID 300 Z -1500

$====================================================================================================
$ Generate Deck Plate Elements
$====================================================================================================
TYPE PLATE

GENERATE 3 ELEMENTS ID 'P-1011' 1 FROM 100019 1 TO 100020 1 TO 100320 1 TO 100319 1
REPEAT 1 ID 3000 FROM INCR 300000 TO INCR 300000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 2 ELEMENTS ID 'P-1014' 3000 FROM 100022 300000 TO 200019 300000 TO 200319 300000 TO 100322 300000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 5 ELEMENTS ID 'P-2011' 1 FROM 200019 1 TO 200020 1 TO 200320 1 TO 200319 1
REPEAT 1 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 2 ELEMENTS ID 'P-2016' 1000 FROM 200024 100000 TO 300019 100000 TO 300319 100000 TO 200324 100000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 56 ELEMENTS ID 'P-5011' 10 FROM 500019 300 TO 500020 300 TO 500320 300 TO 500319 300

$====================================================================================================
$ Generate Rigid Members to Connect Girder Elements to Plate Elements
```

```
$=====================================================================================================
TYPE SPACE TRUSS

GENERATE 2 MEMBERS ID 'R-1001' 1 FROM 100015 3 TO 100019 1
REPEAT 4 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 56 ID 10 FROM INCR 300 TO INCR 300

$=====================================================================================================
$ Generate Diaphragm Members at Top of Bottom Flange
$=====================================================================================================
$ END DIAPHRAGMS
GENERATE 4 MEMBERS ID 'B2-1' 1 FROM 100008 100000 TO 200005 100000
GENERATE 4 MEMBERS ID 'B5-1' 1 FROM 116808 100000 TO 216805 100000

$ INTERMEDIATE DIAPHRAGMS
GENERATE 2 MEMBERS ID 'B3-1' 3 FROM 105608 300700 TO 204905 300700
GENERATE 2 MEMBERS ID 'B3-2' 1 FROM 204908 100700 TO 305605 100700

GENERATE 2 MEMBERS ID 'B4-1' 3 FROM 111208 300700 TO 210505 300700
GENERATE 2 MEMBERS ID 'B4-2' 1 FROM 210508 100700 TO 311205 100700

$=====================================================================================================
$ Define Element Properties
$=====================================================================================================
MATERIAL CONCRETE ALL ELEMENTS
ELEMENT PROPERTIES
 EXISTING 'G-10011' TO 'G-11688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-20011' TO 'G-21688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-30011' TO 'G-31688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-40011' TO 'G-41688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-50011' TO 'G-51688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'P-1011' TO 'P-1566' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-2011' TO 'P-2569' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-3011' TO 'P-3569' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-4011' TO 'P-4566' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-5011' TO 'P-5561' TYPE 'SBCR' THICKNESS 200

$=====================================================================================================
$ Define Member Properties
$=====================================================================================================
MATERIAL CONCRETE ALL MEMBERS
MEMBER PROPERTIES PRISMATIC
 'R-1001' TO 'R-1561' BY 10 'R-1002' TO 'R-1562' BY 10 AX 5000
 'R-2001' TO 'R-2561' BY 10 'R-2002' TO 'R-2562' BY 10 AX 5000
 'R-3001' TO 'R-3561' BY 10 'R-3002' TO 'R-3562' BY 10 AX 5000
 'R-4001' TO 'R-4561' BY 10 'R-4002' TO 'R-4562' BY 10 AX 5000
 'R-5001' TO 'R-5561' BY 10 'R-5002' TO 'R-5562' BY 10 AX 5000
MEMBER PROPERTIES PRISMATIC
 'B2-1' TO 'B2-4' AX 219600
 'B3-1' TO 'B3-4' AX 219600
 'B4-1' TO 'B4-4' AX 219600
 'B5-1' TO 'B5-4' AX 219600

$=====================================================================================================
$ Define Supports
$=====================================================================================================
STATUS SUPPORT JOINTS -
 100001 TO 500001 BY 100000 100002 TO 500002 BY 100000 100003 TO 500003 BY 100000 100004 TO 500004 BY 100000 -
 105601 TO 505601 BY 100000 105602 TO 505602 BY 100000 105603 TO 505603 BY 100000 105604 TO 505604 BY 100000 -
 111201 TO 511201 BY 100000 111202 TO 511202 BY 100000 111203 TO 511203 BY 100000 111204 TO 511204 BY 100000 -
 116801 TO 516801 BY 100000 116802 TO 516802 BY 100000 116803 TO 516803 BY 100000 116804 TO 516804 BY 100000 -

 100019 TO 500019 BY 100000 100020 TO 500020 BY 100000 -
 116819 TO 516819 BY 100000 116820 TO 516820 BY 100000

$=====================================================================================================
$ Set Boundary Conditions
$=====================================================================================================
JOINT RELEASES

$ GIRDER BASE
$  END PIN CONDITIONS
 100001 TO 100004 200001 TO 200004 300001 TO 300004 400001 TO 400004 500001 TO 500004 MOMENT X Y
 116801 TO 116804 216801 TO 216804 316801 TO 316804 416801 TO 416804 516801 TO 516804 MOMENT X Y

$  INTERMEDIATE PIN CONDITIONS
 105601 TO 105604 205601 TO 205604 305601 TO 305604 405601 TO 405604 505601 TO 505604 MOMENT X Y Z
 111201 TO 111204 211201 TO 211204 311201 TO 311204 411201 TO 411204 511201 TO 511204 MOMENT X Y Z


$ DECK BASE
$  END CONDITIONS
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 FORCE Y
 116819 TO 116820 216819 TO 216820 316819 TO 316820 416819 TO 416820 516819 TO 516820 FORCE Y
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 MOMENT X Y
 116819 TO 116820 216819 TO 216820 316819 TO 316820 416819 TO 416820 516819 TO 516820 MOMENT X Y

$=====================================================================================================
$ Define Loading
$=====================================================================================================
UNITS KN M
LOADING 'DC1' 'DEAD LOAD STRUCTURAL COMPONENTS OF ELEMENTS'
 ELEMENT LOADS
  EXISTING 'G-10011' TO 'G-11688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-20011' TO 'G-21688' BODY FORCES GLOBAL BY -23.5616
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  EXISTING 'G-30011' TO 'G-31688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-40011' TO 'G-41688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-50011' TO 'G-51688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-1011' TO 'P-1566' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-2011' TO 'P-2569' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-3011' TO 'P-3569' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-4011' TO 'P-4566' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-5011' TO 'P-5561' BODY FORCES GLOBAL BY -23.5616
DEAD LOAD 'DC2' 'DEAD LOAD STRUCTURAL COMPONENTS OF MEMBERS' DIRECTION -Y -
  MEMBERS 'B2-1' TO 'B2-4' 'B3-1' TO 'B3-4' 'B4-1' TO 'B4-4' 'B5-1' TO 'B5-4'
LOADING 'LL' 'VEHICULAR LIVE LOAD'
 JOINT LOADS
$ Truck 1
  202122 302120 FORCE Y -45.5
  203022 303020 FORCE Y -188.5
  203922 303920 FORCE Y -188.5
$ Truck 2
  302123 402121 FORCE Y -188.5
  303023 403021 FORCE Y -188.5
  303923 403921 FORCE Y -45.5
LOADING 'LS' 'LIVE LOAD SURCHARGE'
 ELEMENT LOADS
  EXISTING 'P-1011' TO 'P-1566' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-2011' TO 'P-2569' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-3011' TO 'P-3569' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-4011' TO 'P-4566' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-5011' TO 'P-5561' SURFACE FORCES GLOBAL PY -3.9269
LOADING 'WS' 'WIND LOAD ON STRUCTURE'
 ELEMENT LOADS
  'G-50013' TO 'G-51683' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50014' TO 'G-51684' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50015' TO 'G-51685' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50018' TO 'G-51688' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4

$====================================================================================================
$ Factored Loads
$====================================================================================================
$LOADING COMBINATION 10 'STRENGTH I MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.75 'LS' 1.75 'WS' 0.0
LOADING COMBINATION 11 'STRENGTH I MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.75 'LS' 1.75 'WS' 0.0
$LOADING COMBINATION 12 'STRENGTH II MINIMUM'  SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 13 'STRENGTH II MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 14 'STRENGTH III MINIMUM' SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 0.0  'LS' 0.0  'WS' 1.4
LOADING COMBINATION 15 'STRENGTH III MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 0.0  'LS' 0.0  'WS' 1.4
$LOADING COMBINATION 16 'STRENGTH V MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.4
LOADING COMBINATION 17 'STRENGTH V MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.4
$LOADING COMBINATION 18 'SERVICE I'            SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.0  'LS' 1.0  'WS' 0.3
$LOADING COMBINATION 19 'SERVICE II'           SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.3  'LS' 1.3  'WS' 0.0
$LOADING COMBINATION 20 'FATIGUE'              SPECS 'DC1' 0.0  'DC2' 0.0  'LL' 0.75 'LS' 0.75 'WS' 0.0

$====================================================================================================
$ Prepare and Generate Output
$====================================================================================================
QUERY
STIFFNESS ANALYSIS

LIST SUMMATION OF REACTIONS
LIST REACTIONS

CALCULATE AVERAGE STRESS AT TOP SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-5565'
CALCULATE AVERAGE STRESS AT BOTTOM SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-5565'

CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-10011' TO 'G-11688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-20011' TO 'G-21688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-30011' TO 'G-31688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-40011' TO 'G-41688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-50011' TO 'G-51688'

LIST FORCES MEMBERS 'B2-1' TO 'B2-4' 'B3-1' TO 'B3-4' 'B4-1' TO 'B4-4' 'B5-1' TO 'B5-4'
```

STRUDL 'Model 123' 'Type IV Girder, 20° Bridge Skew, Girder Spacing 2.75 m, Span Length 28.0 m, 65° Diaphragm Skew'

```
UNITS MM
PRINT GENERATE OFF

$====================================================================================================
$ Generate Joints to Connect Girder Brick Elements
$====================================================================================================
GENERATE 4 JOINTS ID 100001 1 X LIST 0 230 430 660 Y 0 Z 0
REPEAT 1 ID 4 Y 205
REPEAT 1 ID 100 Z -500

GENERATE 2 JOINTS ID 100009 1 X LIST 230 430 Y 687.5 Z 0
REPEAT 1 ID 100 Z -500

GENERATE 4 JOINTS ID 100011 1 X LIST 75 230 430 585 Y 1170 Z 0
REPEAT 1 ID 4 Y 200
REPEAT 1 ID 100 Z -500

$====================================================================================================
$ Generate Girder Brick Elements
$====================================================================================================
TYPE TRIDEMINSIONAL
GENERATE 3 ELEMENTS ID 'G-10011' 1 FROM 100001 1 TO 100002 1 TO 100006 1 TO 100005 1 TO 100101 1 TO 100102 1 TO 100106 1 TO
100105 1
GENERATE 2 ELEMENTS ID 'G-10014' 1 FROM 100006 3 TO 100007 3 TO 100010 3 TO 100009 3 TO 100106 3 TO 100107 3 TO 100110 3 TO
100109 3
GENERATE 3 ELEMENTS ID 'G-10016' 1 FROM 100011 1 TO 100012 1 TO 100016 1 TO 100015 1 TO 100111 1 TO 100112 1 TO 100116 1 TO
100115 1

$====================================================================================================
$ Copy Generated Girder Section and Copy it Down Entire Length of Bridge
$====================================================================================================
DEFINE OBJECT 'SECTION' JOINTS 100001 TO 100018 100101 TO 100118, ELEMENTS 'G-10011' TO 'G-10018'
COPY OBJECT 'SECTION' REPEAT 167 TIMES JOINT INCR 100 ELEMENT INCR 10 TRANSLATE Z -500

$====================================================================================================
$ Copy Generated Girder and Copy it Across The Entire Width of Bridge
$====================================================================================================
DEFINE OBJECT 'GIRDER A' JOINTS EXISTING 100001 TO 116818, ELEMENTS EXISTING 'G-10011' TO 'G-11688'
COPY OBJECT 'GIRDER A' REPEAT 1 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1830 Z -666

DEFINE OBJECT 'GIRDER B' JOINTS EXISTING 200001 TO 216818, ELEMENTS EXISTING 'G-20011' TO 'G-21688'
COPY OBJECT 'GIRDER B' REPEAT 2 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 2750 Z -1000

DEFINE OBJECT 'GIRDER D' JOINTS EXISTING 400001 TO 416818, ELEMENTS EXISTING 'G-40011' TO 'G-41688'
COPY OBJECT 'GIRDER D' REPEAT 1 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1830 Z -666

$====================================================================================================
$ Generate Joints to Connect Deck Plate Elements
$====================================================================================================
GENERATE 2 JOINTS ID 100019 1 X LIST 75 585 Y 1371 Z 0
REPEAT 56 ID 300 Z -1500
GENERATE 2 JOINTS ID 200019 1 X LIST 1905 2415 Y 1371 Z -666
REPEAT 56 ID 300 Z -1500
GENERATE 2 JOINTS ID 300019 1 X LIST 4655 5163 Y 1371 Z -1666
REPEAT 56 ID 300 Z -1500
GENERATE 2 JOINTS ID 400019 1 X LIST 7405 7911 Y 1371 Z -2666
REPEAT 56 ID 300 Z -1500
GENERATE 2 JOINTS ID 500019 1 X LIST 9235 9741 Y 1371 Z -3332
REPEAT 56 ID 300 Z -1500

GENERATE 2 JOINTS ID 100021 1 X 1025 440 Y 1371 0 Z -222 -222
REPEAT 1 ID 300000 X 7330 Z -2666
REPEAT 56 ID 300 Z -1500

GENERATE 4 JOINTS ID 200021 1 X 2863 448 Y 1371 0 Z -866 -200
REPEAT 1 ID 100000 X 2750 Z -1000
REPEAT 56 ID 300 Z -1500

$====================================================================================================
$ Generate Deck Plate Elements
$====================================================================================================
TYPE PLATE

GENERATE 3 ELEMENTS ID 'P-1011' 1 FROM 100019 1 TO 100020 1 TO 100320 1 TO 100319 1
REPEAT 1 ID 3000 FROM INCR 300000 TO INCR 300000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 2 ELEMENTS ID 'P-1014' 3000 FROM 100022 300000 TO 200019 300000 TO 200319 300000 TO 100322 300000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 5 ELEMENTS ID 'P-2011' 1 FROM 200019 1 TO 200020 1 TO 200320 1 TO 200319 1
REPEAT 1 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 2 ELEMENTS ID 'P-2016' 1000 FROM 200024 100000 TO 300019 100000 TO 300319 100000 TO 200324 100000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 56 ELEMENTS ID 'P-5011' 10 FROM 500019 300 TO 500020 300 TO 500320 300 TO 500319 300

$====================================================================================================
$ Generate Rigid Members to Connect Girder Elements to Plate Elements
```

```
$=========================================================================================================
TYPE SPACE TRUSS

GENERATE 2 MEMBERS ID 'R-1001' 1 FROM 100015 3 TO 100019 1
REPEAT 4 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 56 ID 10 FROM INCR 300 TO INCR 300

$=========================================================================================================
$ Generate Diaphragm Members at Top of Bottom Flange
$=========================================================================================================
$ END DIAPHRAGMS
GENERATE 4 MEMBERS ID 'B2-1' 1 FROM 100008 100000 TO 200005 100000
GENERATE 4 MEMBERS ID 'B5-1' 1 FROM 116808 100000 TO 216805 100000

$ INTERMEDIATE DIAPHRAGMS
GENERATE 2 MEMBERS ID 'B3-1' 3 FROM 105608 300000 TO 205605 300000
GENERATE 2 MEMBERS ID 'B3-2' 1 FROM 205608 100000 TO 305605 100000

GENERATE 2 MEMBERS ID 'B4-1' 3 FROM 111208 300000 TO 211205 300000
GENERATE 2 MEMBERS ID 'B4-2' 1 FROM 211208 100000 TO 311205 100000

$=========================================================================================================
$ Define Element Properties
$=========================================================================================================
MATERIAL CONCRETE ALL ELEMENTS
ELEMENT PROPERTIES
 EXISTING 'G-10011' TO 'G-11688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-20011' TO 'G-21688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-30011' TO 'G-31688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-40011' TO 'G-41688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-50011' TO 'G-51688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'P-1011' TO 'P-1566' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-2011' TO 'P-2569' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-3011' TO 'P-3569' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-4011' TO 'P-4566' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-5011' TO 'P-5561' TYPE 'SBCR' THICKNESS 200

$=========================================================================================================
$ Define Member Properties
$=========================================================================================================
MATERIAL CONCRETE ALL MEMBERS
MEMBER PROPERTIES PRISMATIC
 'R-1001' TO 'R-1561' BY 10 'R-1002' TO 'R-1562' BY 10 AX 5000
 'R-2001' TO 'R-2561' BY 10 'R-2002' TO 'R-2562' BY 10 AX 5000
 'R-3001' TO 'R-3561' BY 10 'R-3002' TO 'R-3562' BY 10 AX 5000
 'R-4001' TO 'R-4561' BY 10 'R-4002' TO 'R-4562' BY 10 AX 5000
 'R-5001' TO 'R-5561' BY 10 'R-5002' TO 'R-5562' BY 10 AX 5000
MEMBER PROPERTIES PRISMATIC
 'B2-1' TO 'B2-4' AX 219600
 'B3-1' TO 'B3-4' AX 219600
 'B4-1' TO 'B4-4' AX 219600
 'B5-1' TO 'B5-4' AX 219600

$=========================================================================================================
$ Define Supports
$=========================================================================================================
STATUS SUPPORT JOINTS -
 100001 TO 500001 BY 100000 100002 TO 500002 BY 100000 100003 TO 500003 BY 100000 100004 TO 500004 BY 100000 -
 105601 TO 505601 BY 100000 105602 TO 505602 BY 100000 105603 TO 505603 BY 100000 105604 TO 505604 BY 100000 -
 111201 TO 511201 BY 100000 111202 TO 511202 BY 100000 111203 TO 511203 BY 100000 111204 TO 511204 BY 100000 -
 116801 TO 516801 BY 100000 116802 TO 516802 BY 100000 116803 TO 516803 BY 100000 116804 TO 516804 BY 100000 -

 100019 TO 500019 BY 100000 100020 TO 500020 BY 100000 -
 116819 TO 516819 BY 100000 116820 TO 516820 BY 100000

$=========================================================================================================
$ Set Boundary Conditions
$=========================================================================================================
JOINT RELEASES

$ GIRDER BASE
$  END PIN CONDITIONS
 100001 TO 100004 200001 TO 200004 300001 TO 300004 400001 TO 400004 500001 TO 500004 MOMENT X Y
 116801 TO 116804 216801 TO 216804 316801 TO 316804 416801 TO 416804 516801 TO 516804 MOMENT X Y

$  INTERMEDIATE PIN CONDITIONS
 105601 TO 105604 205601 TO 205604 305601 TO 305604 405601 TO 405604 505601 TO 505604 MOMENT X Y Z
 111201 TO 111204 211201 TO 211204 311201 TO 311204 411201 TO 411204 511201 TO 511204 MOMENT X Y Z


$ DECK BASE
$  END CONDITIONS
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 FORCE Y
 116819 TO 116820 216819 TO 216820 316819 TO 316820 416819 TO 416820 516819 TO 516820 FORCE Y
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 MOMENT X Y
 116819 TO 116820 216819 TO 216820 316819 TO 316820 416819 TO 416820 516819 TO 516820 MOMENT X Y

$=========================================================================================================
$ Define Loading
$=========================================================================================================
UNITS KN M
LOADING 'DC1' 'DEAD LOAD STRUCTURAL COMPONENTS OF ELEMENTS'
 ELEMENT LOADS
  EXISTING 'G-10011' TO 'G-11688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-20011' TO 'G-21688' BODY FORCES GLOBAL BY -23.5616
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  EXISTING 'G-30011' TO 'G-31688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-40011' TO 'G-41688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-50011' TO 'G-51688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-1011' TO 'P-1566' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-2011' TO 'P-2569' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-3011' TO 'P-3569' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-4011' TO 'P-4566' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-5011' TO 'P-5561' BODY FORCES GLOBAL BY -23.5616
DEAD LOAD 'DC2' 'DEAD LOAD STRUCTURAL COMPONENTS OF MEMBERS' DIRECTION -Y -
  MEMBERS 'B2-1' TO 'B2-4' 'B3-1' TO 'B3-4' 'B4-1' TO 'B4-4' 'B5-1' TO 'B5-4'
LOADING 'LL' 'VEHICULAR LIVE LOAD'
 JOINT LOADS
$ Truck 1
  202122 302120 FORCE Y -45.5
  203022 303020 FORCE Y -188.5
  203922 303920 FORCE Y -188.5
$ Truck 2
  302123 402121 FORCE Y -188.5
  303023 403021 FORCE Y -188.5
  303923 403921 FORCE Y -45.5
LOADING 'LS' 'LIVE LOAD SURCHARGE'
 ELEMENT LOADS
  EXISTING 'P-1011' TO 'P-1566' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-2011' TO 'P-2569' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-3011' TO 'P-3569' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-4011' TO 'P-4566' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-5011' TO 'P-5561' SURFACE FORCES GLOBAL PY -3.9269
LOADING 'WS' 'WIND LOAD ON STRUCTURE'
 ELEMENT LOADS
  'G-50013' TO 'G-51683' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50014' TO 'G-51684' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50015' TO 'G-51685' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50018' TO 'G-51688' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4

$=====================================================================================================
$ Factored Loads
$=====================================================================================================
$LOADING COMBINATION 10 'STRENGTH I MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.75 'LS' 1.75 'WS' 0.0
LOADING COMBINATION 11 'STRENGTH I MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.75 'LS' 1.75 'WS' 0.0
$LOADING COMBINATION 12 'STRENGTH II MINIMUM'  SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 13 'STRENGTH II MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 14 'STRENGTH III MINIMUM' SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 0.0  'LS' 0.0  'WS' 1.4
LOADING COMBINATION 15 'STRENGTH III MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 0.0  'LS' 0.0  'WS' 1.4
$LOADING COMBINATION 16 'STRENGTH V MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.4
LOADING COMBINATION 17 'STRENGTH V MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.4
$LOADING COMBINATION 18 'SERVICE I'            SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.0  'LS' 1.0  'WS' 0.3
$LOADING COMBINATION 19 'SERVICE II'           SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.3  'LS' 1.3  'WS' 0.0
$LOADING COMBINATION 20 'FATIGUE'              SPECS 'DC1' 0.0  'DC2' 0.0  'LL' 0.75 'LS' 0.75 'WS' 0.0

$=====================================================================================================
$ Prepare and Generate Output
$=====================================================================================================
QUERY
STIFFNESS ANALYSIS

LIST SUMMATION OF REACTIONS
LIST REACTIONS

CALCULATE AVERAGE STRESS AT TOP SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-5565'
CALCULATE AVERAGE STRESS AT BOTTOM SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-5565'

CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-10011' TO 'G-11688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-20011' TO 'G-21688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-30011' TO 'G-31688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-40011' TO 'G-41688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-50011' TO 'G-51688'

LIST FORCES MEMBERS 'B2-1' TO 'B2-4' 'B3-1' TO 'B3-4' 'B4-1' TO 'B4-4' 'B5-1' TO 'B5-4'
```

STRUDL 'Model 124' 'Type IV Girder, 20° Bridge Skew, Girder Spacing 2.75 m, Span Length 28.0 m, No Diaphragm'

```
UNITS MM
PRINT GENERATE OFF

$====================================================================================================
$ Generate Joints to Connect Girder Brick Elements
$====================================================================================================
GENERATE 4 JOINTS ID 100001 1 X LIST 0 230 430 660 Y 0 Z 0
REPEAT 1 ID 4 Y 205
REPEAT 1 ID 100 Z -500

GENERATE 2 JOINTS ID 100009 1 X LIST 230 430 Y 687.5 Z 0
REPEAT 1 ID 100 Z -500

GENERATE 4 JOINTS ID 100011 1 X LIST 75 230 430 585 Y 1170 Z 0
REPEAT 1 ID 4 Y 200
REPEAT 1 ID 100 Z -500

$====================================================================================================
$ Generate Girder Brick Elements
$====================================================================================================
TYPE TRIDEMINSIONAL
GENERATE 3 ELEMENTS ID 'G-10011' 1 FROM 100001 1 TO 100002 1 TO 100006 1 TO 100005 1 TO 100101 1 TO 100102 1 TO 100106 1 TO
100105 1
GENERATE 2 ELEMENTS ID 'G-10014' 1 FROM 100006 3 TO 100007 3 TO 100010 3 TO 100009 3 TO 100106 3 TO 100107 3 TO 100110 3 TO
100109 3
GENERATE 3 ELEMENTS ID 'G-10016' 1 FROM 100011 1 TO 100012 1 TO 100016 1 TO 100015 1 TO 100111 1 TO 100112 1 TO 100116 1 TO
100115 1

$====================================================================================================
$ Copy Generated Girder Section and Copy it Down Entire Length of Bridge
$====================================================================================================
DEFINE OBJECT 'SECTION' JOINTS 100001 TO 100018 100101 TO 100118, ELEMENTS 'G-10011' TO 'G-10018'
COPY OBJECT 'SECTION' REPEAT 167 TIMES JOINT INCR 100 ELEMENT INCR 10 TRANSLATE Z -500

$====================================================================================================
$ Copy Generated Girder and Copy it Across The Entire Width of Bridge
$====================================================================================================
DEFINE OBJECT 'GIRDER A' JOINTS EXISTING 100001 TO 116818, ELEMENTS EXISTING 'G-10011' TO 'G-11688'
COPY OBJECT 'GIRDER A' REPEAT 1 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1830 Z -666

DEFINE OBJECT 'GIRDER B' JOINTS EXISTING 200001 TO 216818, ELEMENTS EXISTING 'G-20011' TO 'G-21688'
COPY OBJECT 'GIRDER B' REPEAT 2 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 2750 Z -1000

DEFINE OBJECT 'GIRDER D' JOINTS EXISTING 400001 TO 416818, ELEMENTS EXISTING 'G-40011' TO 'G-41688'
COPY OBJECT 'GIRDER D' REPEAT 1 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1830 Z -666

$====================================================================================================
$ Generate Joints to Connect Deck Plate Elements
$====================================================================================================
GENERATE 2 JOINTS ID 100019 1 X LIST 75 585 Y 1371 Z 0
REPEAT 56 ID 300 Z -1500
GENERATE 2 JOINTS ID 200019 1 X LIST 1905 2415 Y 1371 Z -666
REPEAT 56 ID 300 Z -1500
GENERATE 2 JOINTS ID 300019 1 X LIST 4655 5163 Y 1371 Z -1666
REPEAT 56 ID 300 Z -1500
GENERATE 2 JOINTS ID 400019 1 X LIST 7405 7911 Y 1371 Z -2666
REPEAT 56 ID 300 Z -1500
GENERATE 2 JOINTS ID 500019 1 X LIST 9235 9741 Y 1371 Z -3332
REPEAT 56 ID 300 Z -1500

GENERATE 2 JOINTS ID 100021 1 X 1025 440 Y 1371 0 Z -222 -222
REPEAT 1 ID 300000 X 7330 Z -2666
REPEAT 56 ID 300 Z -1500

GENERATE 4 JOINTS ID 200021 1 X 2863 448 Y 1371 0 Z -866 -200
REPEAT 1 ID 100000 X 2750 Z -1000
REPEAT 56 ID 300 Z -1500

$====================================================================================================
$ Generate Deck Plate Elements
$====================================================================================================
TYPE PLATE

GENERATE 3 ELEMENTS ID 'P-1011' 1 FROM 100019 1 TO 100020 1 TO 100320 1 TO 100319 1
REPEAT 1 ID 3000 FROM INCR 300000 TO INCR 300000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 2 ELEMENTS ID 'P-1014' 3000 FROM 100022 300000 TO 200019 300000 TO 200319 300000 TO 100322 300000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 5 ELEMENTS ID 'P-2011' 1 FROM 200019 1 TO 200020 1 TO 200320 1 TO 200319 1
REPEAT 1 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 2 ELEMENTS ID 'P-2016' 1000 FROM 200024 100000 TO 300019 100000 TO 300319 100000 TO 200324 100000
REPEAT 55 ID 10 FROM INCR 300 TO INCR 300

GENERATE 56 ELEMENTS ID 'P-5011' 10 FROM 500019 300 TO 500020 300 TO 500320 300 TO 500319 300

$====================================================================================================
$ Generate Rigid Members to Connect Girder Elements to Plate Elements
```

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$==================================================================================================
TYPE SPACE TRUSS

GENERATE 2 MEMBERS ID 'R-1001' 1 FROM 100015 3 TO 100019 1
REPEAT 4 ID 1000 FROM INCR 100000 TO INCR 100000
REPEAT 56 ID 10 FROM INCR 300 TO INCR 300

$==================================================================================================
$ Generate Diaphragm Members at Mid Height of Web
$==================================================================================================
$ END DIAPHRAGMS
GENERATE 4 MEMBERS ID 'B2-1' 1 FROM 100010 100000 TO 200009 100000
GENERATE 4 MEMBERS ID 'B5-1' 1 FROM 116810 100000 TO 216809 100000

$ INTERMEDIATE DIAPHRAGMS
GENERATE 2 MEMBERS ID 'B3-1' 3 FROM 105610 300700 TO 204909 300700
GENERATE 2 MEMBERS ID 'B3-2' 1 FROM 204910 100700 TO 305609 100700

GENERATE 2 MEMBERS ID 'B4-1' 3 FROM 111210 300700 TO 210509 300700
GENERATE 2 MEMBERS ID 'B4-2' 1 FROM 210510 100700 TO 311209 100700

$==================================================================================================
$ Define Element Properties
$==================================================================================================
MATERIAL CONCRETE ALL ELEMENTS
ELEMENT PROPERTIES
 EXISTING 'G-10011' TO 'G-11688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-20011' TO 'G-21688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-30011' TO 'G-31688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-40011' TO 'G-41688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-50011' TO 'G-51688' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'P-1011' TO 'P-1566' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-2011' TO 'P-2569' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-3011' TO 'P-3569' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-4011' TO 'P-4566' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-5011' TO 'P-5561' TYPE 'SBCR' THICKNESS 200

$==================================================================================================
$ Define Member Properties
$==================================================================================================
MATERIAL CONCRETE ALL MEMBERS
MEMBER PROPERTIES PRISMATIC
 'R-1001' TO 'R-1561' BY 10 'R-1002' TO 'R-1562' BY 10 AX 5000
 'R-2001' TO 'R-2561' BY 10 'R-2002' TO 'R-2562' BY 10 AX 5000
 'R-3001' TO 'R-3561' BY 10 'R-3002' TO 'R-3562' BY 10 AX 5000
 'R-4001' TO 'R-4561' BY 10 'R-4002' TO 'R-4562' BY 10 AX 5000
 'R-5001' TO 'R-5561' BY 10 'R-5002' TO 'R-5562' BY 10 AX 5000
MEMBER PROPERTIES PRISMATIC
 'B2-1' TO 'B2-4' AX 219600
 'B3-1' TO 'B3-4' AX 219600
 'B4-1' TO 'B4-4' AX 219600
 'B5-1' TO 'B5-4' AX 219600

$==================================================================================================
$ Define Supports
$==================================================================================================
STATUS SUPPORT JOINTS -
 100001 TO 500001 BY 100000 100002 TO 500002 BY 100000 100003 TO 500003 BY 100000 100004 TO 500004 BY 100000 -
 105601 TO 505601 BY 100000 105602 TO 505602 BY 100000 105603 TO 505603 BY 100000 105604 TO 505604 BY 100000 -
 111201 TO 511201 BY 100000 111202 TO 511202 BY 100000 111203 TO 511203 BY 100000 111204 TO 511204 BY 100000 -
 116801 TO 516801 BY 100000 116802 TO 516802 BY 100000 116803 TO 516803 BY 100000 116804 TO 516804 BY 100000 -

 100019 TO 500019 BY 100000 100020 TO 500020 BY 100000 -
 116819 TO 516819 BY 100000 116820 TO 516820 BY 100000

$==================================================================================================
$ Set Boundary Conditions
$==================================================================================================
JOINT RELEASES

$ GIRDER BASE
$  END PIN CONDITIONS
 100001 TO 100004 200001 TO 200004 300001 TO 300004 400001 TO 400004 500001 TO 500004 MOMENT X Y
 116801 TO 116804 216801 TO 216804 316801 TO 316804 416801 TO 416804 516801 TO 516804 MOMENT X Y

$  INTERMEDIATE PIN CONDITIONS
 105601 TO 105604 205601 TO 205604 305601 TO 305604 405601 TO 405604 505601 TO 505604 MOMENT X Y Z
 111201 TO 111204 211201 TO 211204 311201 TO 311204 411201 TO 411204 511201 TO 511204 MOMENT X Y Z


$ DECK BASE
$  END CONDITIONS
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 FORCE Y
 116819 TO 116820 216819 TO 216820 316819 TO 316820 416819 TO 416820 516819 TO 516820 FORCE Y
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 MOMENT X Y
 116819 TO 116820 216819 TO 216820 316819 TO 316820 416819 TO 416820 516819 TO 516820 MOMENT X Y

$==================================================================================================
$ Define Loading
$==================================================================================================
UNITS KN M
LOADING 'DC1' 'DEAD LOAD STRUCTURAL COMPONENTS OF ELEMENTS'
 ELEMENT LOADS
  EXISTING 'G-10011' TO 'G-11688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-20011' TO 'G-21688' BODY FORCES GLOBAL BY -23.5616
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  EXISTING 'G-30011' TO 'G-31688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-40011' TO 'G-41688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-50011' TO 'G-51688' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-1011' TO 'P-1566' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-2011' TO 'P-2569' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-3011' TO 'P-3569' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-4011' TO 'P-4566' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-5011' TO 'P-5561' BODY FORCES GLOBAL BY -23.5616
DEAD LOAD 'DC2' 'DEAD LOAD STRUCTURAL COMPONENTS OF MEMBERS' DIRECTION -Y -
  MEMBERS 'B2-1' TO 'B2-4' 'B3-1' TO 'B3-4' 'B4-1' TO 'B4-4' 'B5-1' TO 'B5-4'
LOADING 'LL' 'VEHICULAR LIVE LOAD'
 JOINT LOADS
$ Truck 1
  202122 302120 FORCE Y -45.5
  203022 303020 FORCE Y -188.5
  203922 303920 FORCE Y -188.5
$ Truck 2
  302123 402121 FORCE Y -188.5
  303023 403021 FORCE Y -188.5
  303923 403921 FORCE Y -45.5
LOADING 'LS' 'LIVE LOAD SURCHARGE'
 ELEMENT LOADS
  EXISTING 'P-1011' TO 'P-1566' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-2011' TO 'P-2569' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-3011' TO 'P-3569' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-4011' TO 'P-4566' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-5011' TO 'P-5561' SURFACE FORCES GLOBAL PY -3.9269
LOADING 'WS' 'WIND LOAD ON STRUCTURE'
 ELEMENT LOADS
  'G-50013' TO 'G-51683' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50014' TO 'G-51684' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50015' TO 'G-51685' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-50018' TO 'G-51688' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4

$=================================================================================================
$ Factored Loads
$=================================================================================================
$LOADING COMBINATION 10 'STRENGTH I MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.75 'LS' 1.75 'WS' 0.0
LOADING COMBINATION 11 'STRENGTH I MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.75 'LS' 1.75 'WS' 0.0
$LOADING COMBINATION 12 'STRENGTH II MINIMUM'  SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 13 'STRENGTH II MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 14 'STRENGTH III MINIMUM' SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 0.0  'LS' 0.0  'WS' 1.4
LOADING COMBINATION 15 'STRENGTH III MAXIMUM'  SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 0.0  'LS' 0.0  'WS' 1.4
$LOADING COMBINATION 16 'STRENGTH V MINIMUM'   SPECS 'DC1' 0.9  'DC2' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.4
LOADING COMBINATION 17 'STRENGTH V MAXIMUM'    SPECS 'DC1' 1.25 'DC2' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.4
$LOADING COMBINATION 18 'SERVICE I'            SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.0  'LS' 1.0  'WS' 0.3
$LOADING COMBINATION 19 'SERVICE II'           SPECS 'DC1' 1.0  'DC2' 1.0  'LL' 1.3  'LS' 1.3  'WS' 0.0
$LOADING COMBINATION 20 'FATIGUE'              SPECS 'DC1' 0.0  'DC2' 0.0  'LL' 0.75 'LS' 0.75 'WS' 0.0

$=================================================================================================
$ Delete Diaphragms
$=================================================================================================
DELETIONS
MEMBERS 'B2-1' TO 'B2-4' 'B3-1' TO 'B3-4' 'B4-1' TO 'B4-4' 'B5-1' TO 'B5-4'
ADDITIONS

$=================================================================================================
$ Prepare and Generate Output
$=================================================================================================
QUERY
STIFFNESS ANALYSIS

LIST SUMMATION OF REACTIONS
LIST REACTIONS

CALCULATE AVERAGE STRESS AT TOP SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-5565'
CALCULATE AVERAGE STRESS AT BOTTOM SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-5565'

CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-10011' TO 'G-11688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-20011' TO 'G-21688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-30011' TO 'G-31688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-40011' TO 'G-41688'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-50011' TO 'G-51688'

$LIST FORCES MEMBERS 'B2-1' TO 'B2-4' 'B3-1' TO 'B3-4' 'B4-1' TO 'B4-4' 'B5-1' TO 'B5-4'
```

STRUDL 'Model 125' 'Type IV Girder, 10° Bridge Skew, Girder Spacing 1.52 m, Span Length 34.0 m, No Diaphragm'

```
UNITS MM
PRINT GENERATE OFF

$====================================================================================================
$ Generate Joints to Connect Girder Brick Elements
$====================================================================================================
GENERATE 4 JOINTS ID 100001 1 X LIST 0 230 430 660 Y 0 Z 0
REPEAT 1 ID 4 Y 205
REPEAT 1 ID 100 Z -500

GENERATE 2 JOINTS ID 100009 1 X LIST 230 430 Y 687.5 Z 0
REPEAT 1 ID 100 Z -500

GENERATE 4 JOINTS ID 100011 1 X LIST 75 230 430 585 Y 1170 Z 0
REPEAT 1 ID 4 Y 200
REPEAT 1 ID 100 Z -500

$====================================================================================================
$ Generate Girder Brick Elements
$====================================================================================================
TYPE TRIDEMINSIONAL
GENERATE 3 ELEMENTS ID 'G-10011' 1 FROM 100001 1 TO 100002 1 TO 100006 1 TO 100005 1 TO 100101 1 TO 100102 1 TO 100106 1 TO
100105 1
GENERATE 2 ELEMENTS ID 'G-10014' 1 FROM 100006 3 TO 100007 3 TO 100010 3 TO 100009 3 TO 100106 3 TO 100107 3 TO 100110 3 TO
100109 3
GENERATE 3 ELEMENTS ID 'G-10016' 1 FROM 100011 1 TO 100012 1 TO 100016 1 TO 100015 1 TO 100111 1 TO 100112 1 TO 100116 1 TO
100115 1

$====================================================================================================
$ Copy Generated Girder Section and Copy it Down Entire Length of Bridge
$====================================================================================================
DEFINE OBJECT 'SECTION' JOINTS 100001 TO 100018 100101 TO 100118, ELEMENTS 'G-10011' TO 'G-10018'
COPY OBJECT 'SECTION' REPEAT 65 TIMES JOINT INCR 100 ELEMENT INCR 10 TRANSLATE Z -500

DEFINE OBJECT 'SPAN' JOINTS EXISTING 100001 TO 106618, ELEMENTS EXISTING 'G-10011' TO 'G-10668'
COPY OBJECT 'SPAN' REPEAT 2 TIMES JOINT INCR 6700 ELEMENT INCR 660 TRANSLATE Z -33050

$====================================================================================================
$ Copy Generated Girder and Copy it Across The Entire Width of Bridge
$====================================================================================================
DEFINE OBJECT 'GIRDER' JOINTS EXISTING 100001 TO 120018, ELEMENTS EXISTING 'G-10011' TO 'G-11988'
COPY OBJECT 'GIRDER' REPEAT 6 TIMES JOINT INCR 100000 ELEMENT INCR 10000 TRANSLATE X 1524 Z -268

$====================================================================================================
$ Generate Joints to Connect Deck Plate Elements
$====================================================================================================
GENERATE 2 JOINTS ID 100019 1 X LIST 75 585 Y 1371 Z 0
REPEAT 6 ID 100000 X 1524 Z -268
REPEAT 22 ID 300 Z -1500

GENERATE 2 JOINTS ID 106719 1 X LIST 75 585 Y 1371 Z -33050
REPEAT 6 ID 100000 X 1524 Z -268
REPEAT 22 ID 300 Z -1500

GENERATE 2 JOINTS ID 113419 1 X LIST 75 585 Y 1371 Z -66100
REPEAT 6 ID 100000 X 1524 Z -268
REPEAT 22 ID 300 Z -1500

GENERATE 6 JOINTS ID 100021 100000 X 1092 1524 Y 1371 0 Z -134 -268
REPEAT 22 ID 300 Z -1500
REPEAT 2 ID 6700 Z -33050

$====================================================================================================
$ Generate Deck Plate Elements
$====================================================================================================
TYPE PLATE

GENERATE 7 ELEMENTS ID 'P-1011' 1000 FROM 100019 100000 TO 100020 100000 TO 100320 100000 TO 100319 100000
REPEAT 21 ID 10 FROM 300 TO 300
REPEAT 2 ID 230 FROM 6700 TO 6700

GENERATE 6 ELEMENTS ID 'P-1012' 1000 FROM 100020 100000 TO 100021 100000 TO 100321 100000 TO 100320 100000
REPEAT 21 ID 10 FROM 300 TO 300
REPEAT 2 ID 230 FROM 6700 TO 6700

GENERATE 6 ELEMENTS ID 'P-1013' 1000 FROM 100021 100000 TO 200019 100000 TO 200319 100000 TO 100321 100000
REPEAT 21 ID 10 FROM 300 TO 300
REPEAT 2 ID 230 FROM 6700 TO 6700

GENERATE 7 ELEMENTS ID 'P-1231' 1000 FROM 106619 100000 TO 106620 100000 TO 106720 100000 TO 106719 100000
REPEAT 1 ID 230 FROM 6700 TO 6700

GENERATE 6 ELEMENTS ID 'P-1232' 1000 FROM 106620 100000 TO 106621 100000 TO 106721 100000 TO 106720 100000
REPEAT 1 ID 230 FROM 6700 TO 6700

GENERATE 6 ELEMENTS ID 'P-1233' 1000 FROM 106621 100000 TO 206619 100000 TO 206719 100000 TO 106721 100000
REPEAT 1 ID 230 FROM 6700 TO 6700

$====================================================================================================
$ Generate Rigid Members to Connect Girder Elements to Plate Elements
$====================================================================================================
```

```
TYPE SPACE TRUSS

GENERATE 7 MEMBERS ID 'R-1001' 1000 FROM 100015 100000 TO 100019 100000
REPEAT 22 ID 10 FROM INCR 300 TO INCR 300
REPEAT 2 ID 230 FROM INCR 6700 TO INCR 6700

GENERATE 7 MEMBERS ID 'R-1002' 1000 FROM 100018 100000 TO 100020 100000
REPEAT 22 ID 10 FROM INCR 300 TO INCR 300
REPEAT 2 ID 230 FROM INCR 6700 TO INCR 6700

$=====================================================================================================
$ Define Element Properties
$=====================================================================================================
MATERIAL CONCRETE ALL ELEMENTS
ELEMENT PROPERTIES
 EXISTING 'G-10011' TO 'G-11988' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-20011' TO 'G-21988' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-30011' TO 'G-31988' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-40011' TO 'G-41988' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-50011' TO 'G-51988' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-60011' TO 'G-61988' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'G-70011' TO 'G-71988' TYPE 'IPSL' INTEGRATION ORDER 3
 EXISTING 'P-1011' TO 'P-1685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-2011' TO 'P-2685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-3011' TO 'P-3685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-4011' TO 'P-4685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-5011' TO 'P-5685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-6011' TO 'P-6685' TYPE 'SBCR' THICKNESS 200
 EXISTING 'P-7011' TO 'P-7681' TYPE 'SBCR' THICKNESS 200

$=====================================================================================================
$ Define Member Properties
$=====================================================================================================
MATERIAL CONCRETE ALL MEMBERS
MEMBER PROPERTIES PRISMATIC
 'R-1001' TO 'R-1681' BY 10 'R-1002' TO 'R-1682' BY 10 AX 5000
 'R-2001' TO 'R-2681' BY 10 'R-2002' TO 'R-2682' BY 10 AX 5000
 'R-3001' TO 'R-3681' BY 10 'R-3002' TO 'R-3682' BY 10 AX 5000
 'R-4001' TO 'R-4681' BY 10 'R-4002' TO 'R-4682' BY 10 AX 5000
 'R-5001' TO 'R-5681' BY 10 'R-5002' TO 'R-5682' BY 10 AX 5000
 'R-6001' TO 'R-6681' BY 10 'R-6002' TO 'R-6682' BY 10 AX 5000
 'R-7001' TO 'R-7681' BY 10 'R-7002' TO 'R-7682' BY 10 AX 5000

$=====================================================================================================
$ Define Supports
$=====================================================================================================
STATUS SUPPORT JOINTS -
 100001 TO 700001 BY 100000 100002 TO 700002 BY 100000 100003 TO 700003 BY 100000 100004 TO 700004 BY 100000 -
 106601 TO 706601 BY 100000 106602 TO 706602 BY 100000 106603 TO 706603 BY 100000 106604 TO 706604 BY 100000 -
 106701 TO 706701 BY 100000 106702 TO 706702 BY 100000 106703 TO 706703 BY 100000 106704 TO 706704 BY 100000 -
 113301 TO 713301 BY 100000 113302 TO 713302 BY 100000 113303 TO 713303 BY 100000 113304 TO 713304 BY 100000 -
 113401 TO 713401 BY 100000 113402 TO 713402 BY 100000 113403 TO 713403 BY 100000 113404 TO 713404 BY 100000 -
 120001 TO 720001 BY 100000 120002 TO 720002 BY 100000 120003 TO 720003 BY 100000 120004 TO 720004 BY 100000 -

 100019 TO 700019 BY 100000 100020 TO 700020 BY 100000 -
 120019 TO 720019 BY 100000 120020 TO 720020 BY 100000

$=====================================================================================================
$ Set Boundary Conditions
$=====================================================================================================
JOINT RELEASES

$ GIRDER BASE
$  END PIN CONDITIONS
 100001 TO 100004 200001 TO 200004 300001 TO 300004 400001 TO 400004 500001 TO 500004 600001 TO 600004 700001 TO 700004
MOMENT X Y
 120001 TO 120004 220001 TO 220004 320001 TO 320004 420001 TO 420004 520001 TO 520004 620001 TO 620004 720001 TO 720004
MOMENT X Y

$  INTERMEDIATE PIN CONDITIONS
 106601 TO 106604 206601 TO 206604 306601 TO 306604 406601 TO 406604 506601 TO 506604 606601 TO 606604 706601 TO 706604
MOMENT X Y Z
 106701 TO 106704 206701 TO 206704 306701 TO 306704 406701 TO 406704 506701 TO 506704 606701 TO 606704 706701 TO 706704
MOMENT X Y Z
 113301 TO 113304 213301 TO 213304 313301 TO 313304 413301 TO 413304 513301 TO 513304 613301 TO 613304 713301 TO 713304
MOMENT X Y Z
 113401 TO 113404 213401 TO 213404 313401 TO 313404 413401 TO 413404 513401 TO 513404 613401 TO 613404 713401 TO 713404
MOMENT X Y Z

$ DECK BASE
$  END CONDITIONS
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 600019 TO 600020 700019 TO 700020
FORCE Y
 120019 TO 120020 220019 TO 220020 320019 TO 320020 420019 TO 420020 520019 TO 520020 620019 TO 620020 720019 TO 720020
FORCE Y
 100019 TO 100020 200019 TO 200020 300019 TO 300020 400019 TO 400020 500019 TO 500020 600019 TO 600020 700019 TO 700020
MOMENT X Y
 120019 TO 120020 220019 TO 220020 320019 TO 320020 420019 TO 420020 520019 TO 520020 620019 TO 620020 720019 TO 720020
MOMENT X Y

$=====================================================================================================
$ Define Loading
$=====================================================================================================
UNITS KN M
```

```
LOADING 'DC1' 'DEAD LOAD STRUCTURAL COMPONENTS OF ELEMENTS'

 ELEMENT LOADS
  EXISTING 'G-10011' TO 'G-11988' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-20011' TO 'G-21988' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-30011' TO 'G-31988' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-40011' TO 'G-41988' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-50011' TO 'G-51988' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-60011' TO 'G-61988' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'G-70011' TO 'G-71988' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-1011' TO 'P-1685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-2011' TO 'P-2685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-3011' TO 'P-3685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-4011' TO 'P-4685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-5011' TO 'P-5685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-6011' TO 'P-6685' BODY FORCES GLOBAL BY -23.5616
  EXISTING 'P-7011' TO 'P-7681' BODY FORCES GLOBAL BY -23.5616
LOADING 'LL' 'VEHICULAR LIVE LOAD'
 JOINT LOADS
$ Truck 1
  302119 402120 FORCE Y -45.5
  303019 403020 FORCE Y -188.5
  303919 403920 FORCE Y -188.5
$ Truck 2
  502119 602120 FORCE Y -188.5
  503019 603020 FORCE Y -188.5
  503919 603920 FORCE Y -45.5
LOADING 'LS' 'LIVE LOAD SURCHARGE'
 ELEMENT LOADS
  EXISTING 'P-1011' TO 'P-1685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-2011' TO 'P-2685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-3011' TO 'P-3685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-4011' TO 'P-4685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-5011' TO 'P-5685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-6011' TO 'P-6685' SURFACE FORCES GLOBAL PY -3.9269
  EXISTING 'P-7011' TO 'P-7681' SURFACE FORCES GLOBAL PY -3.9269
LOADING 'WS' 'WIND LOAD ON STRUCTURE'
 ELEMENT LOADS
  'G-70013' TO 'G-71983' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70014' TO 'G-71984' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70015' TO 'G-71985' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4
  'G-70018' TO 'G-71988' BY 10 SURFACE FORCES FACE 4 GLOBAL PX -2.4

$====================================================================================================
$ Factored Loads
$====================================================================================================
$LOADING COMBINATION 10 'STRENGTH I MINIMUM'   SPECS 'DC1' 0.9  'LL' 1.75 'LS' 1.75 'WS' 0.0
LOADING COMBINATION 11 'STRENGTH I MAXIMUM'    SPECS 'DC1' 1.25 'LL' 1.75 'LS' 1.75 'WS' 0.0
$LOADING COMBINATION 12 'STRENGTH II MINIMUM'  SPECS 'DC1' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 13 'STRENGTH II MAXIMUM'  SPECS 'DC1' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.0
$LOADING COMBINATION 14 'STRENGTH III MINIMUM' SPECS 'DC1' 0.9  'LL' 0.0  'LS' 0.0  'WS' 1.4
LOADING COMBINATION 15 'STRENGTH III MAXIMUM'  SPECS 'DC1' 1.25 'LL' 0.0  'LS' 0.0  'WS' 1.4
$LOADING COMBINATION 16 'STRENGTH V MINIMUM'   SPECS 'DC1' 0.9  'LL' 1.35 'LS' 1.35 'WS' 0.4
LOADING COMBINATION 17 'STRENGTH V MAXIMUM'    SPECS 'DC1' 1.25 'LL' 1.35 'LS' 1.35 'WS' 0.4
$LOADING COMBINATION 18 'SERVICE I'            SPECS 'DC1' 1.0  'LL' 1.0  'LS' 1.0  'WS' 0.3
$LOADING COMBINATION 19 'SERVICE II'           SPECS 'DC1' 1.0  'LL' 1.3  'LS' 1.3  'WS' 0.0
$LOADING COMBINATION 20 'FATIGUE'              SPECS 'DC1' 0.0  'LL' 0.75 'LS' 0.75 'WS' 0.0

$====================================================================================================
$ Prepare and Generate Output
$====================================================================================================
QUERY
STIFFNESS ANALYSIS

LIST SUMMATION OF REACTIONS
LIST REACTIONS

CALCULATE AVERAGE STRESS AT TOP SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-7683'
CALCULATE AVERAGE STRESS AT BOTTOM SURFACE FOR ELEMENTS EXISTING 'P-1011' TO 'P-7683'

CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-10011' TO 'G-11988'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-20011' TO 'G-21988'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-30011' TO 'G-31988'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-40011' TO 'G-41988'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-50011' TO 'G-51988'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-60011' TO 'G-61988'
CALCULATE AVERAGE STRESS AT MIDDLE SURFACE FOR ELEMENTS EXISTING 'G-70011' TO 'G-71988'
```

APPENDIX E
STRESS DISTRIBUTION IN BRIDGE GIRDERS

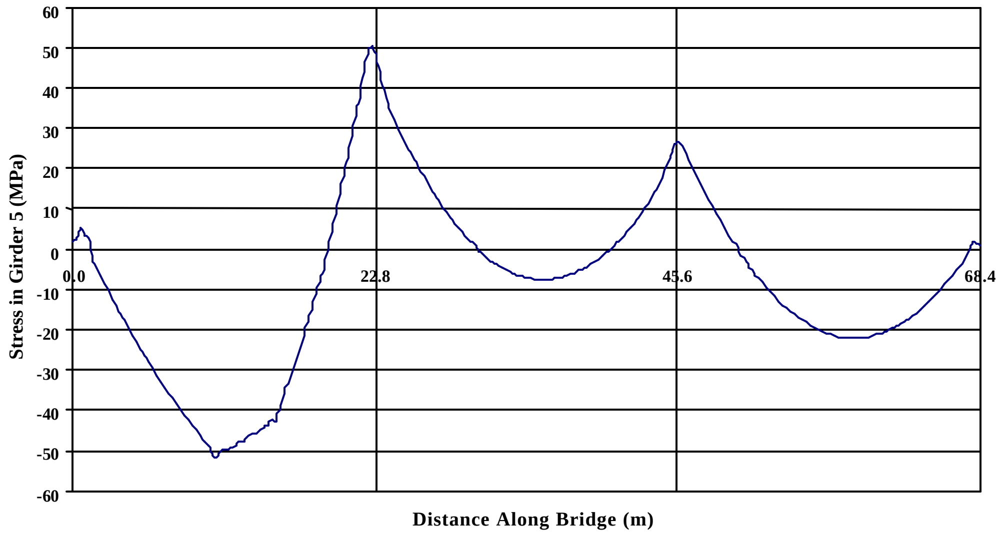

Figure 73
Type II Girder - 10º Bridge Skew – Girder spacing 1.52m – Span Length 22.8m - 30º Diaphragm Skew – Strength I Maximum Loading Condition

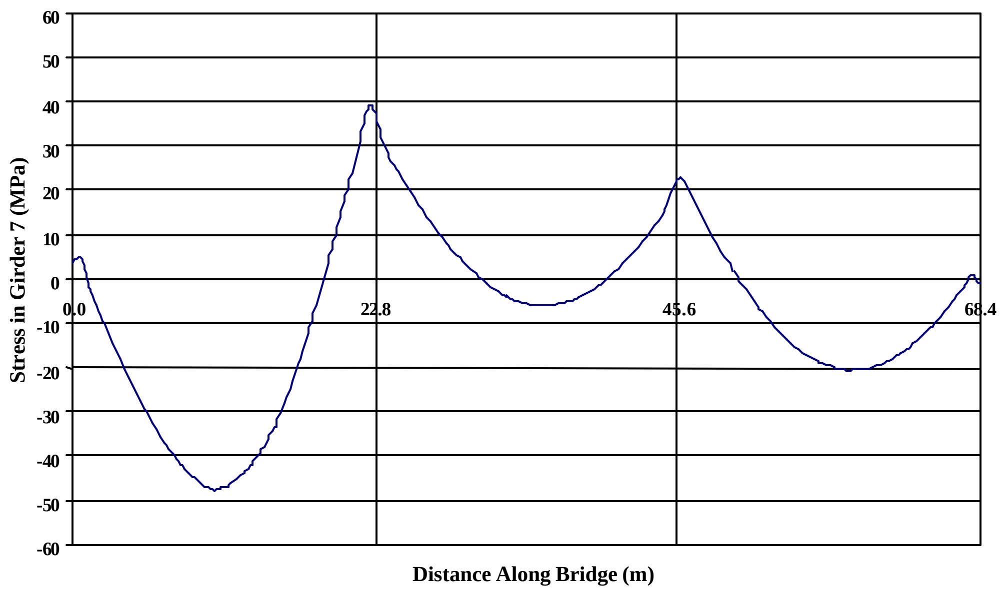

Figure 74
Type II Girder - 10º Bridge Skew – Girder spacing 1.52m – Span Length 22.8m - 30º Diaphragm Skew – Strength I Maximum Loading Condition

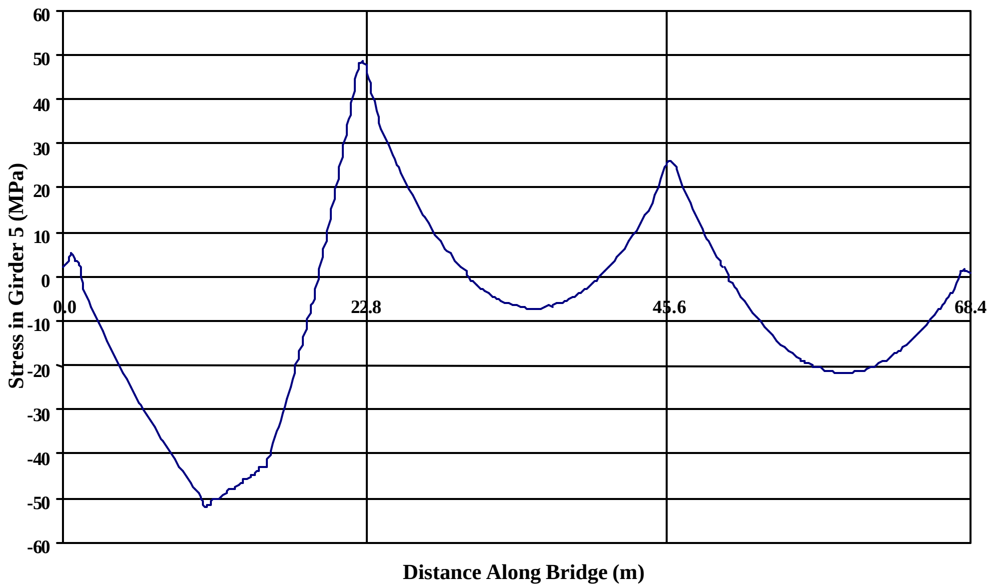

Figure 75
Type II Girder - 10º Bridge Skew – Girder spacing 1.52m – Span Length 22.8m - 65º Diaphragm Skew – Strength I Maximum Loading Condition

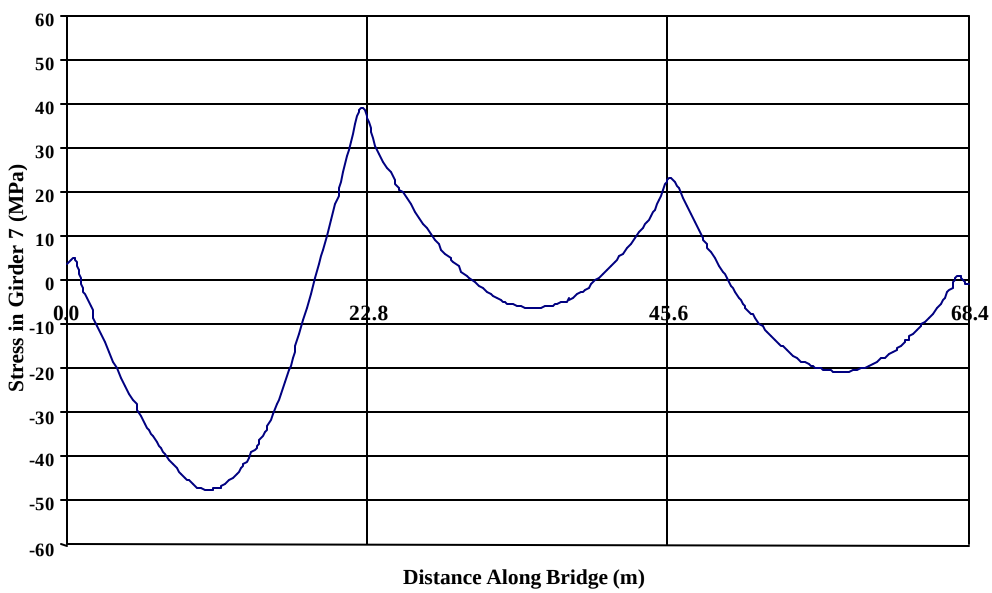

Figure 76
Type II Girder - 10º Bridge Skew – Girder spacing 1.52m – Span Length 22.8m - 65º Diaphragm Skew – Strength I Maximum Loading Condition

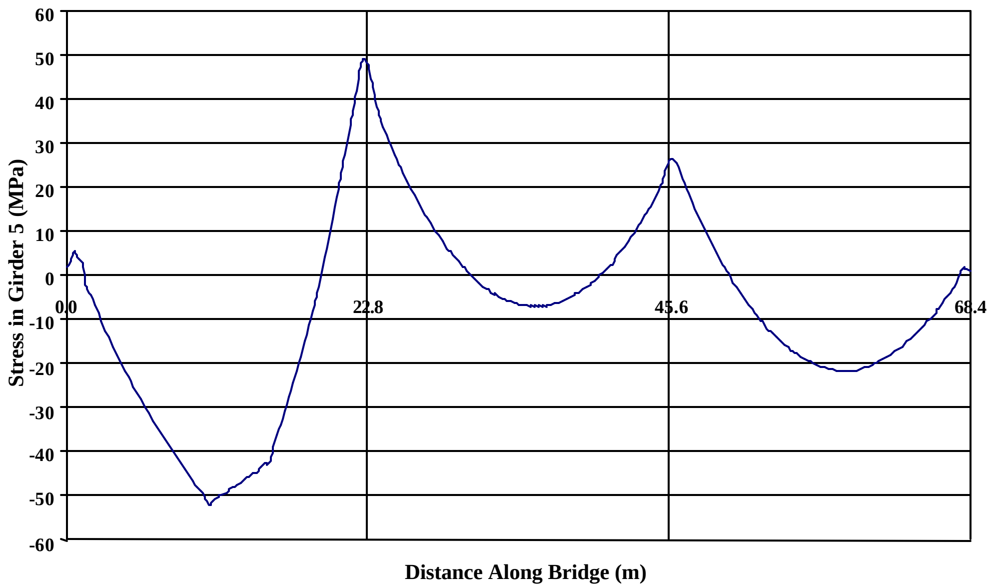

Figure 77
Type II Girder - 10º Bridge Skew – Girder spacing 1.52 – Span Length 22.8m - No Diaphragm – Strength I Maximum Loading Condition

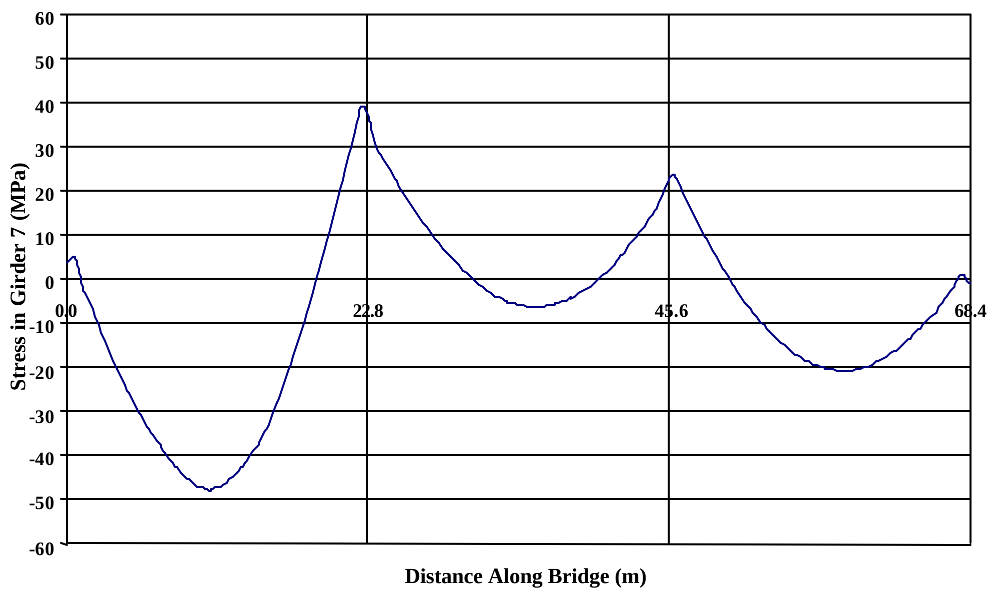

Figure 78
Type II Girder - 10º Bridge Skew – Girder spacing 1.52 – Span Length 22.8m - No Diaphragm – Strength I Maximum Loading Condition

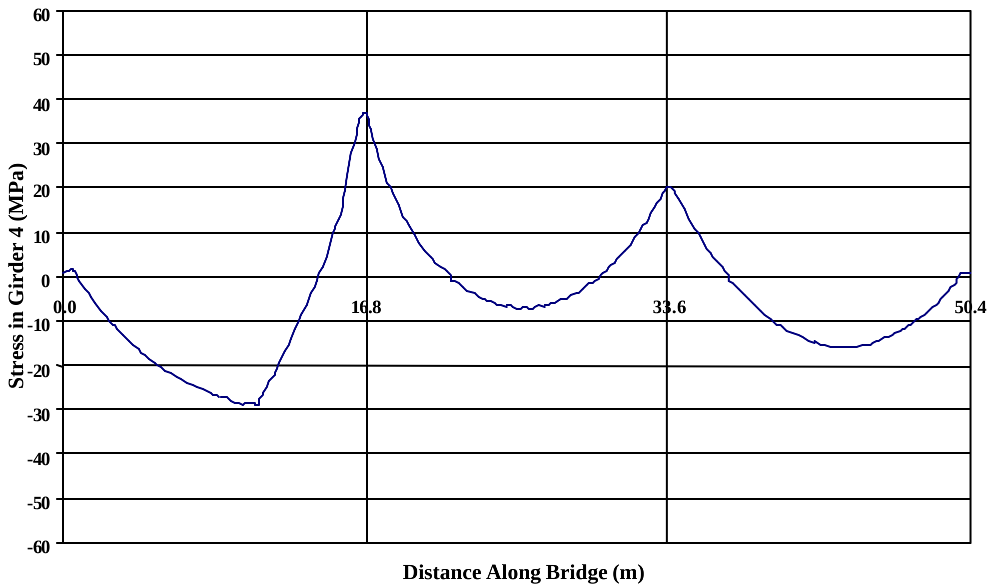

Figure 79
Type II Girder - 10º Bridge Skew – Girder spacing 2.75m – Span Length 16.8m - 30º Diaphragm Skew – Strength I Maximum Loading Condition

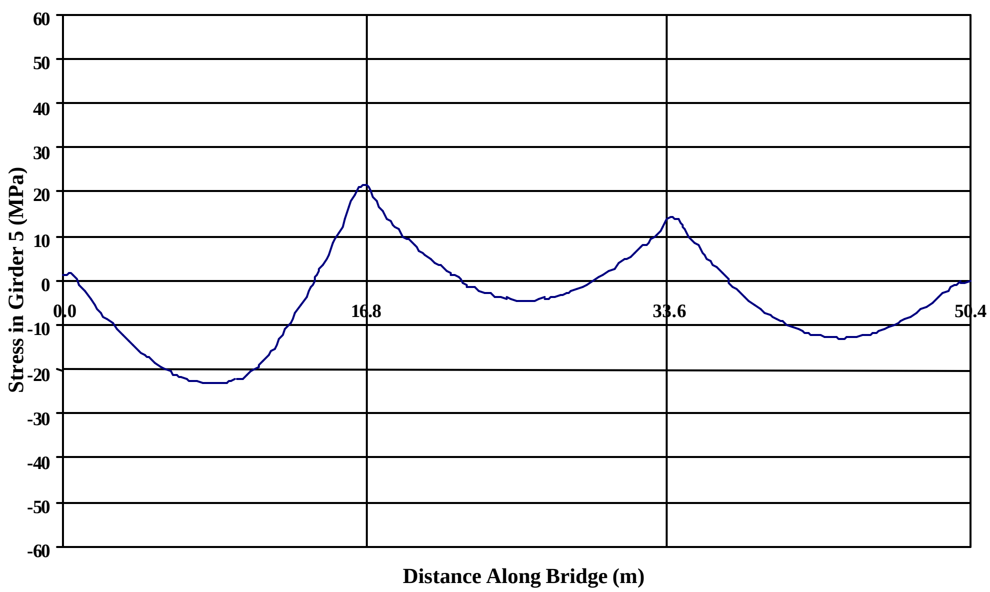

Figure 80
Type II Girder - 10º Bridge Skew – Girder spacing 2.75m – Span Length 16.8m - 30º Diaphragm Skew – Strength I Maximum Loading Condition

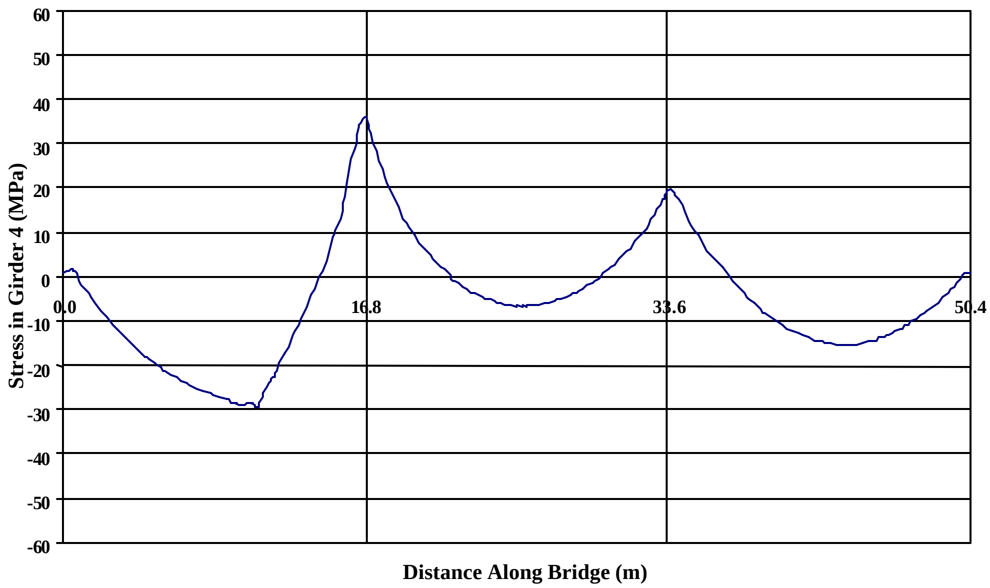

Figure 81
Type II Girder - 10º Bridge Skew – Girder spacing 2.75m – Span Length 16.8m - 65º Diaphragm Skew – Strength I Maximum Loading Condition

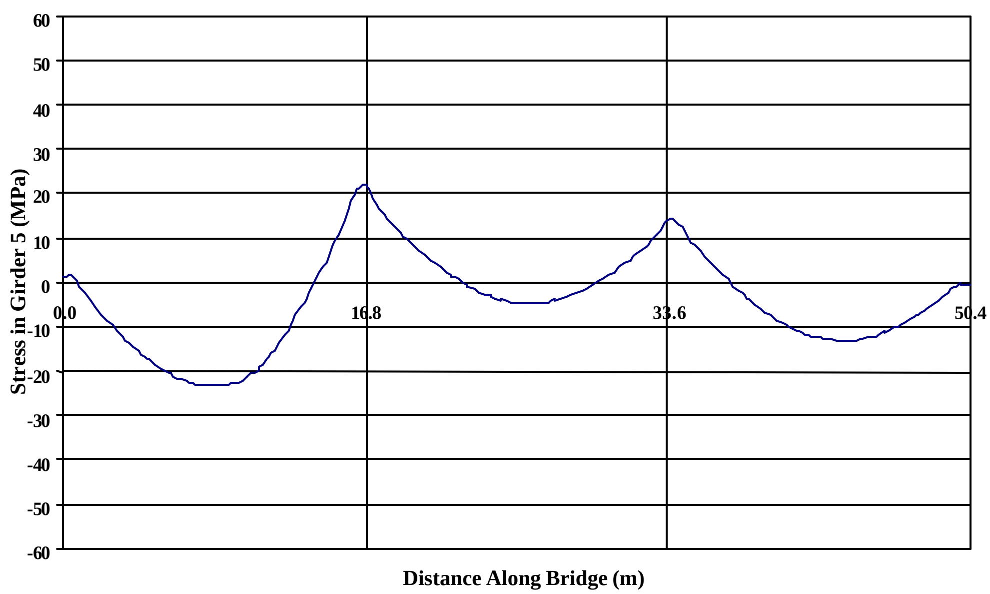

Figure 82
Type II Girder - 10º Bridge Skew – Girder spacing 2.75m – Span Length 16.8m - 65º Diaphragm Skew – Strength I Maximum Loading Condition

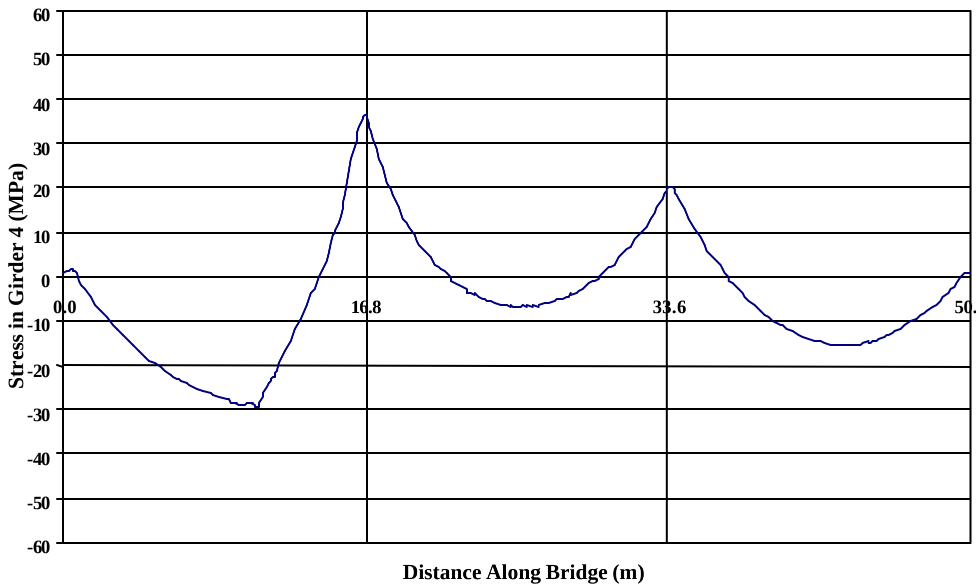

Figure 83
Type II Girder - 10º Bridge Skew – Girder spacing 2.75 – Span Length 16.8m - No Diaphragm – Strength I Maximum Loading Condition

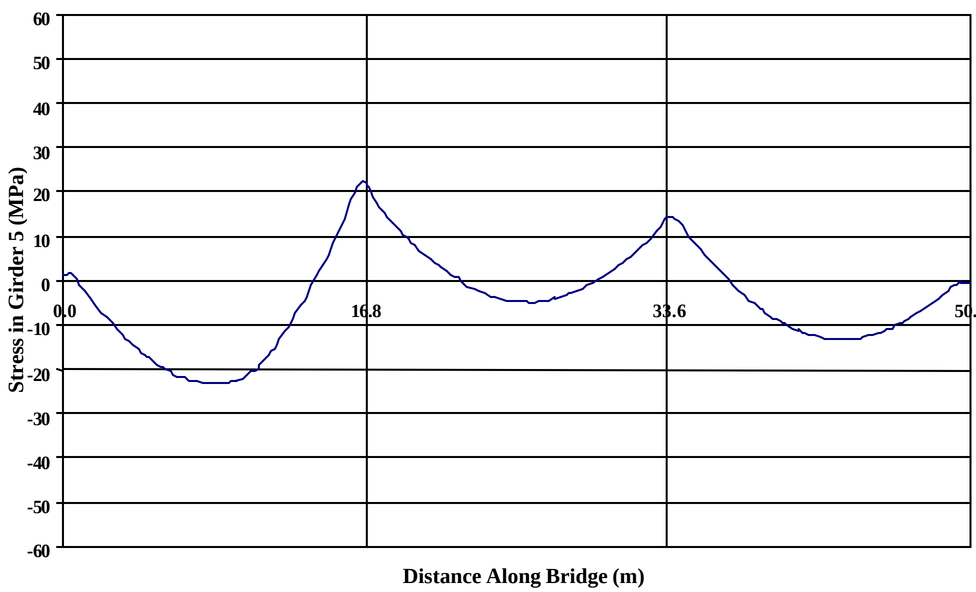

Figure 84
Type II Girder - 10º Bridge Skew – Girder spacing 2.75 – Span Length 16.8m - No Diaphragm – Strength I Maximum Loading Condition

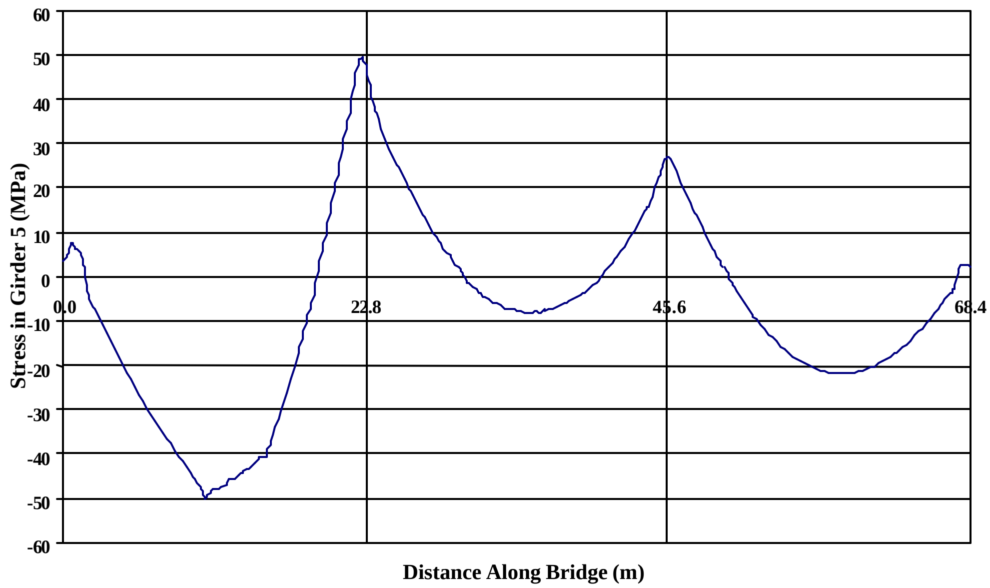

Figure 85
Type II Girder - 20º Bridge Skew – Girder spacing 1.52m – Span Length 22.8m - 30º Diaphragm Skew – Strength I Maximum Loading Condition

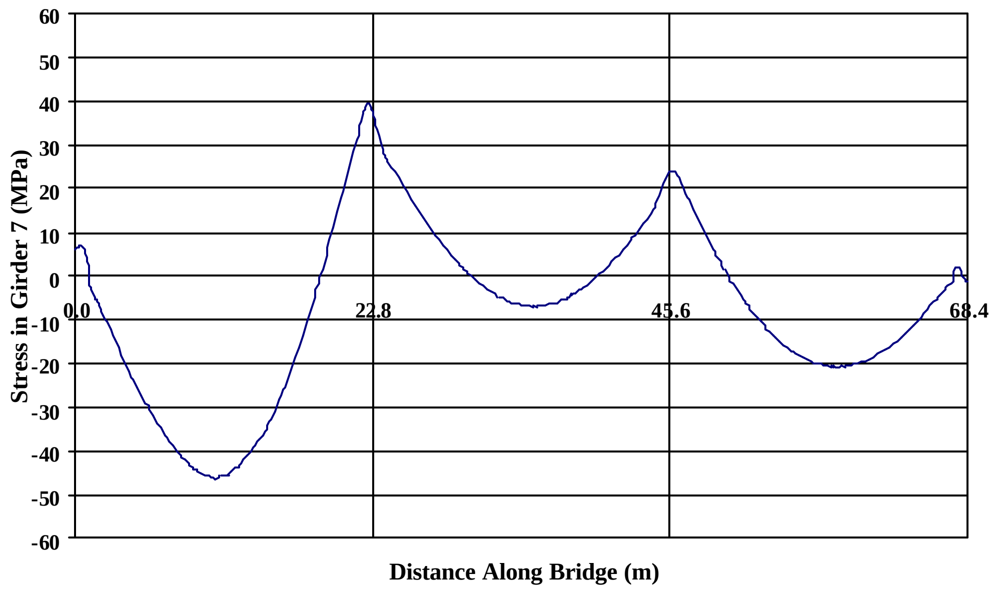

Figure 86
Type II Girder - 20º Bridge Skew – Girder spacing 1.52m – Span Length 22.8m - 30º Diaphragm Skew – Strength I Maximum Loading Condition

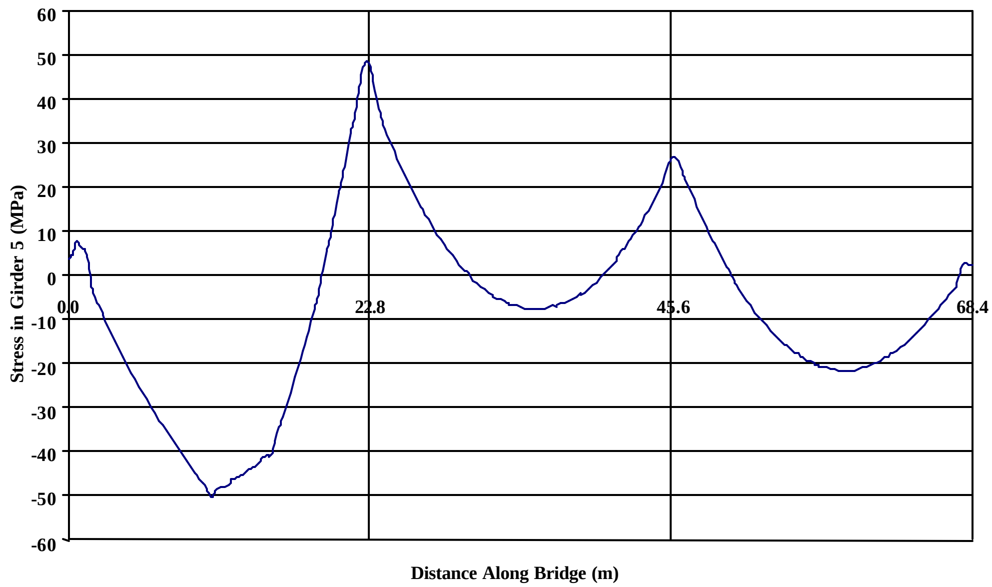

Figure 87
Type II Girder - 20º Bridge Skew – Girder spacing 1.52m – Span Length 22.8m - 65º Diaphragm Skew – Strength I Maximum Loading Condition

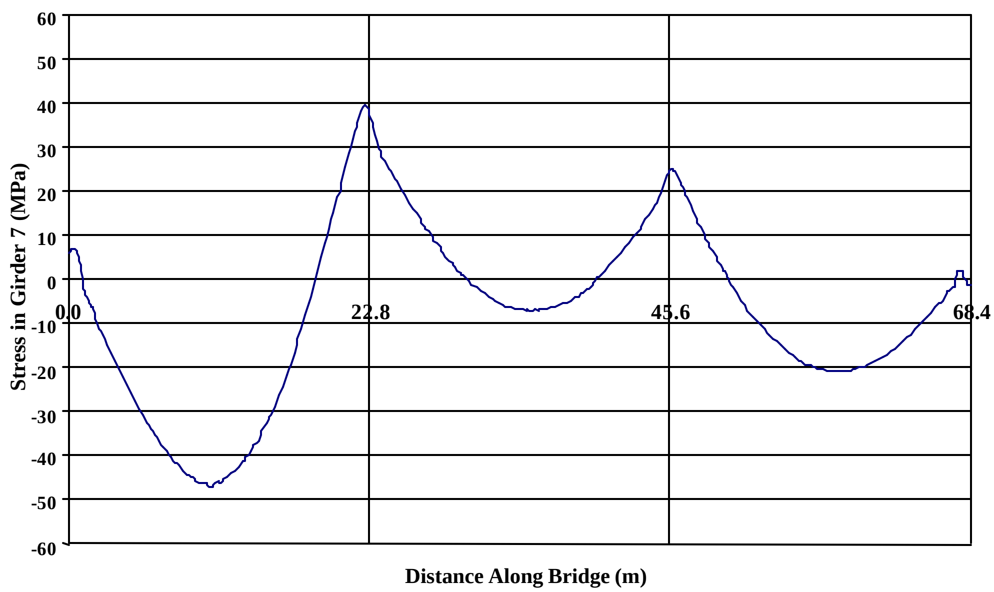

Figure 88
Type II Girder - 20º Bridge Skew – Girder spacing 1.52m – Span Length 22.8m - 65º Diaphragm Skew – Strength I Maximum Loading Condition

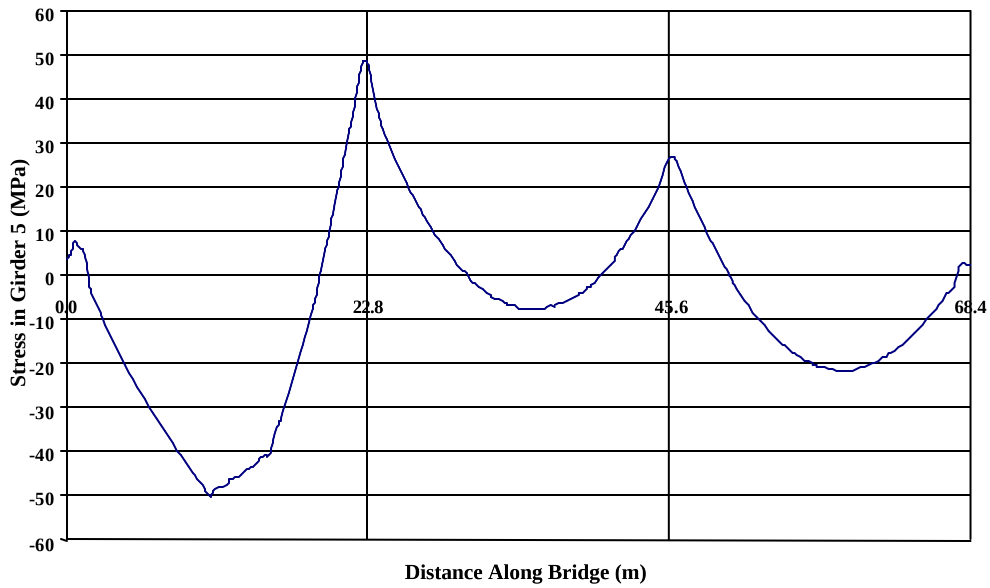

Figure 89
Type II Girder - 20º Bridge Skew – Girder spacing 1.52 – Span Length 22.8m - No Diaphragm – Strength I Maximum Loading Condition

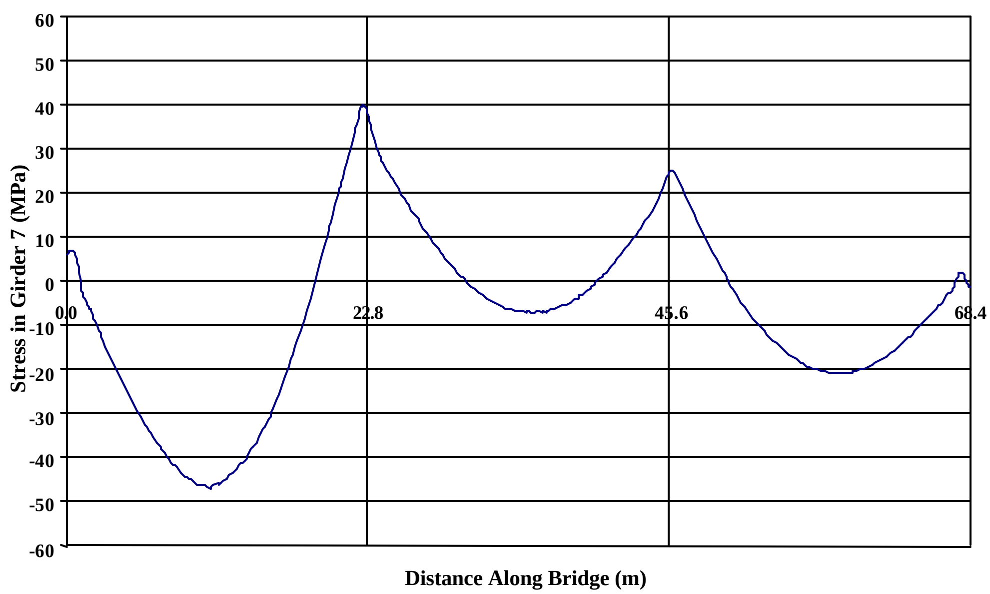

Figure 90
Type II Girder - 20º Bridge Skew – Girder spacing 1.52 – Span Length 22.8m - No Diaphragm – Strength I Maximum Loading Condition

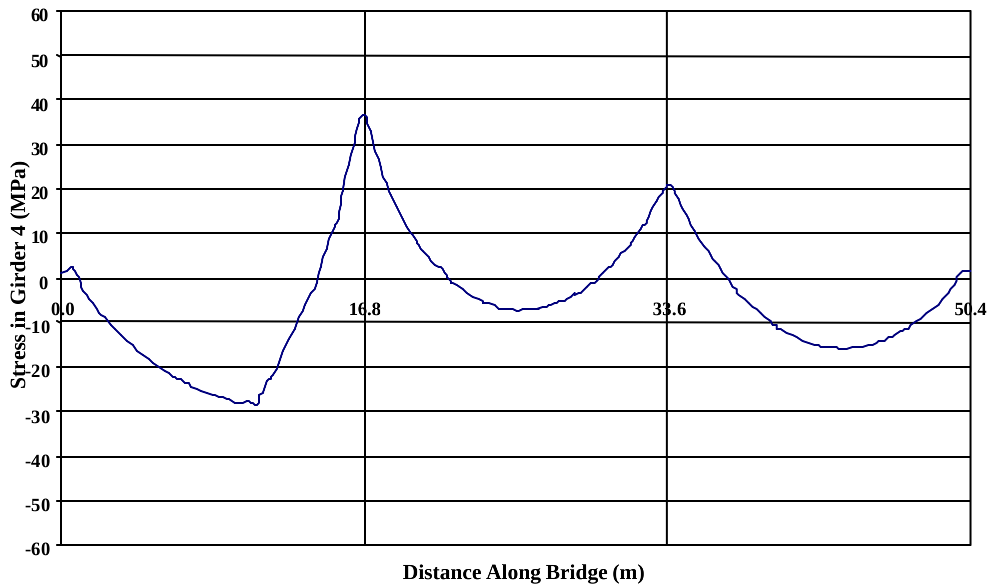

Figure 91
Type II Girder - 20º Bridge Skew – Girder spacing 2.75m – Span Length 16.8m - 30º Diaphragm Skew – Strength I Maximum Loading Condition

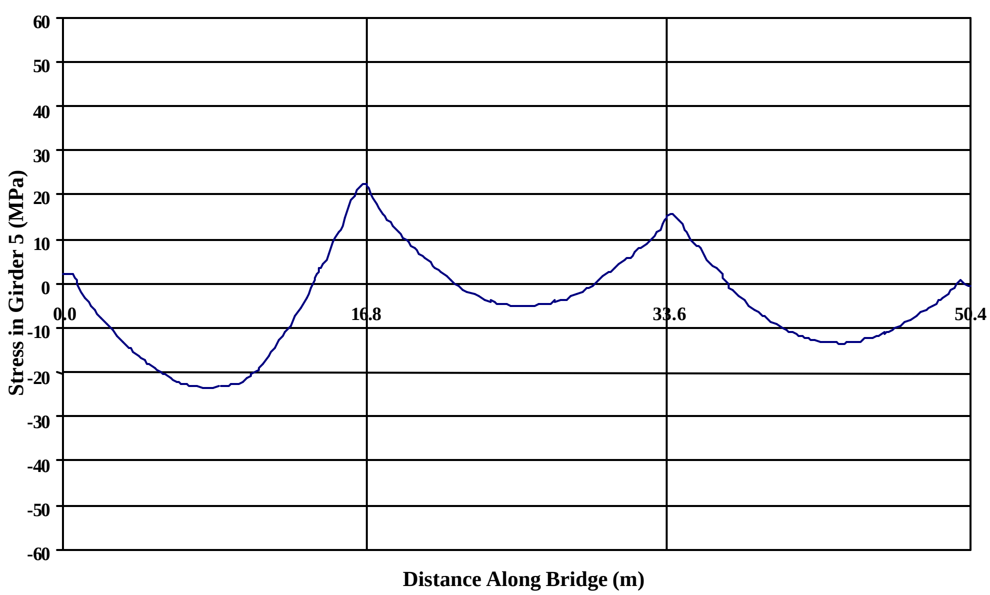

Figure 92
Type II Girder - 20º Bridge Skew – Girder spacing 2.75m – Span Length 16.8m - 30º Diaphragm Skew – Strength I Maximum Loading Condition

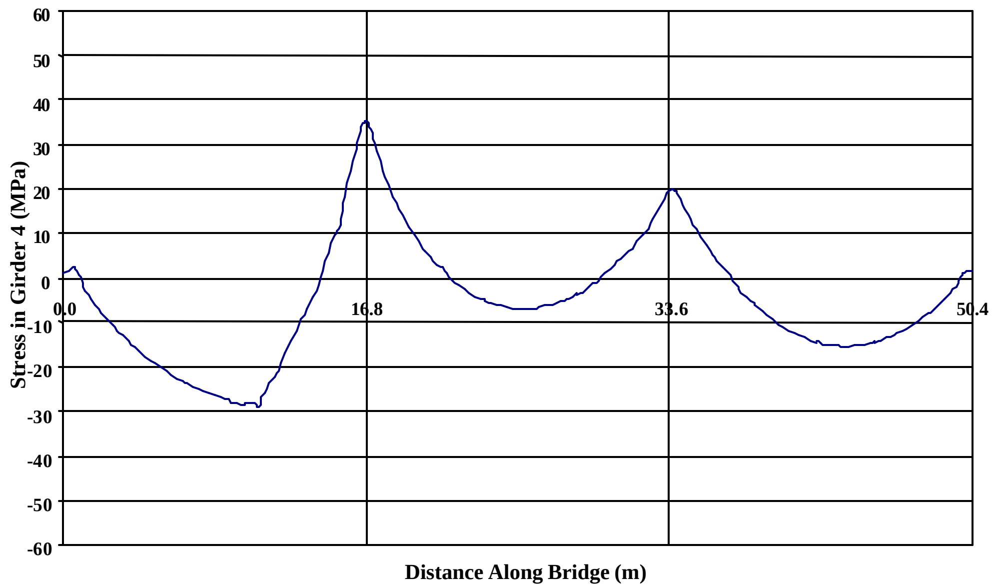

Figure 93
Type II Girder - 20º Bridge Skew – Girder spacing 2.75m – Span Length 16.8m - 65º Diaphragm Skew – Strength I Maximum Loading Condition

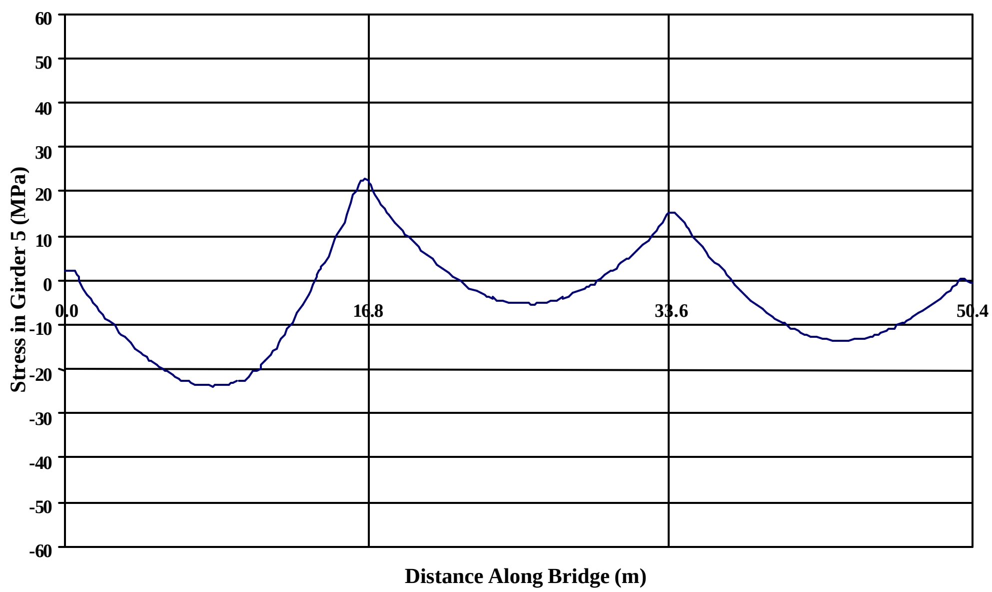

Figure 94
Type II Girder - 20º Bridge Skew – Girder spacing 2.75m – Span Length 16.8m - 65º Diaphragm Skew – Strength I Maximum Loading Condition

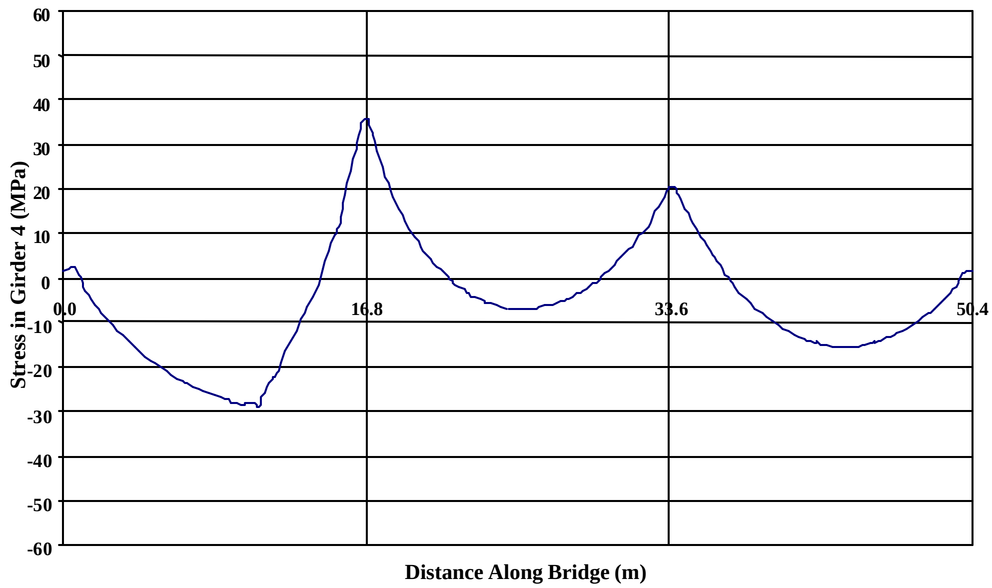

Figure 95
Type II Girder - 20º Bridge Skew – Girder spacing 2.75m – Span Length 16.8m - No Diaphragm – Strength I Maximum Loading Condition

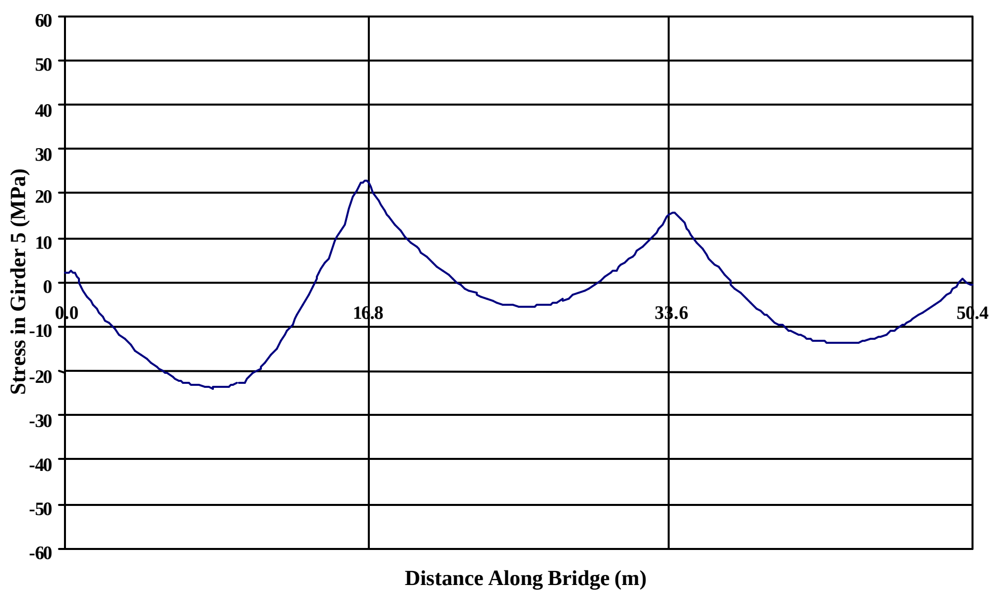

Figure 96
Type II Girder - 20º Bridge Skew – Girder spacing 2.75m – Span Length 16.8m - No Diaphragm – Strength I Maximum Loading Condition

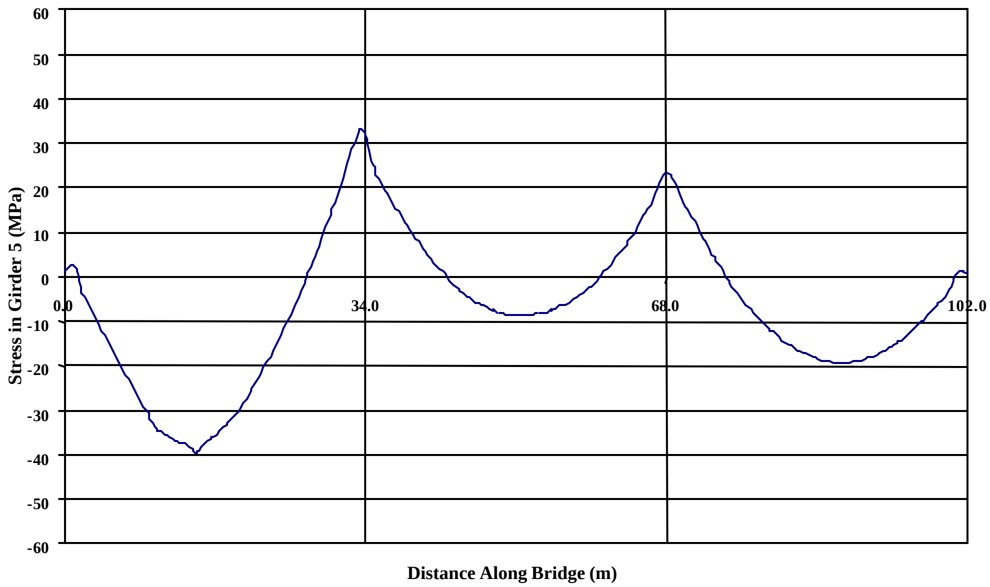

Figure 97
Type IV Girder - 10º Bridge Skew – Girder spacing 1.52m – Span Length 34.0m - 30º Diaphragm Skew – Strength I Maximum Loading Condition

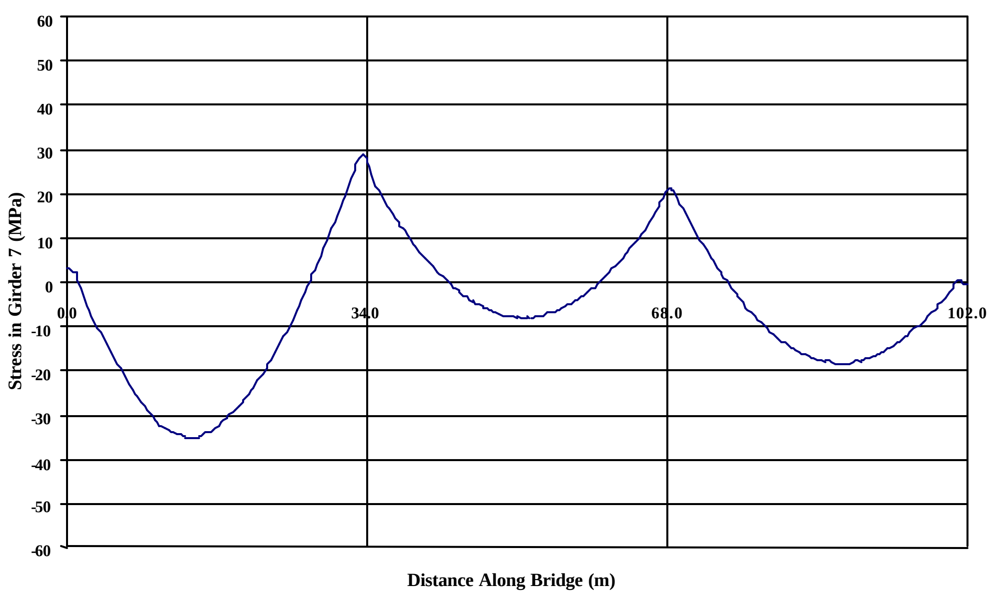

Figure 98
Type IV Girder - 10º Bridge Skew – Girder spacing 1.52m – Span Length 34.0m - 30º Diaphragm Skew – Strength I Maximum Loading Condition

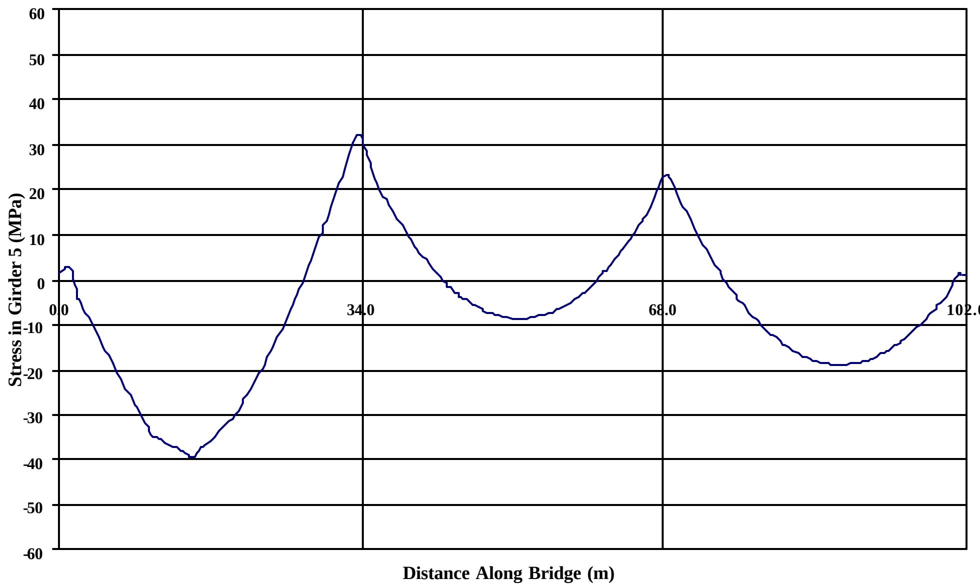

Figure 99
Type IV Girder - 10º Bridge Skew – Girder spacing 1.52m – Span Length 34.0m - 65º Diaphragm Skew – Strength I Maximum Loading Condition

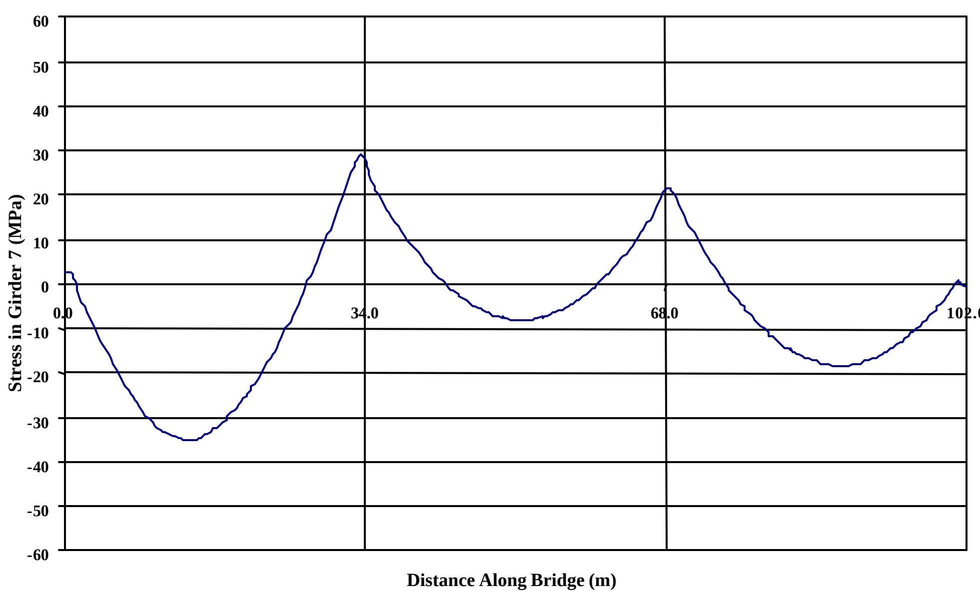

Figure 100
Type IV Girder - 10º Bridge Skew – Girder spacing 1.52m – Span Length 34.0m - 65º Diaphragm Skew – Strength I Maximum Loading Condition

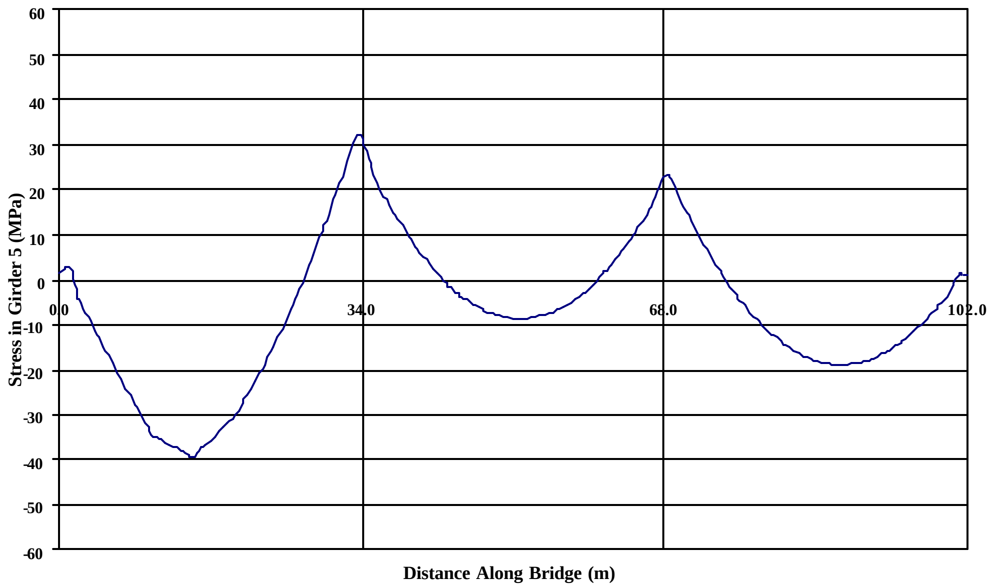

Figure 101
Type IV Girder - 10º Bridge Skew – Girder spacing 1.52m – Span Length 34.0m - No Diaphragm – Strength I Maximum Loading Condition

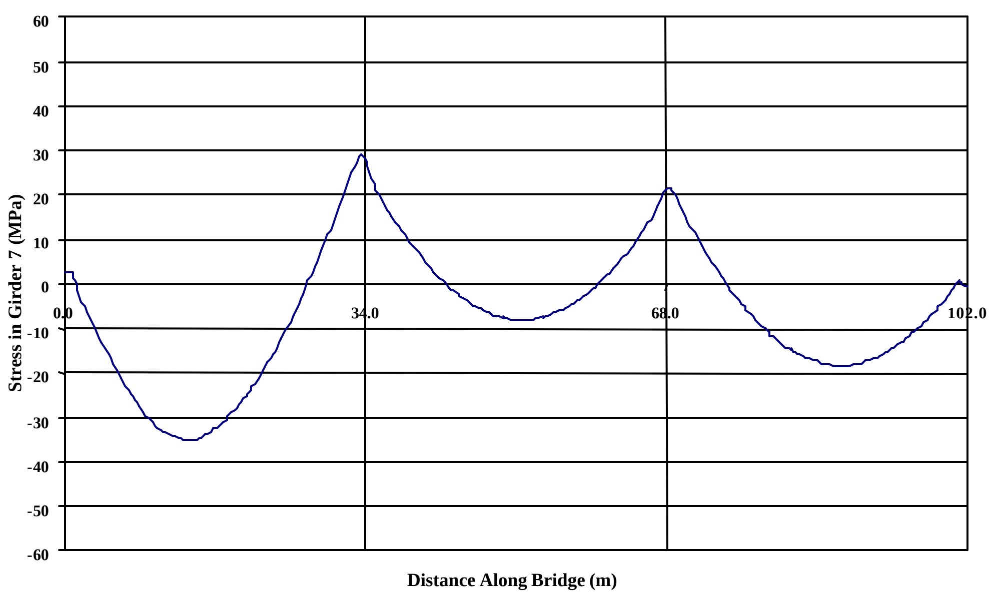

Figure 102
Type IV Girder - 10º Bridge Skew – Girder spacing 1.52m – Span Length 34.0m - No Diaphragm – Strength I Maximum Loading Condition

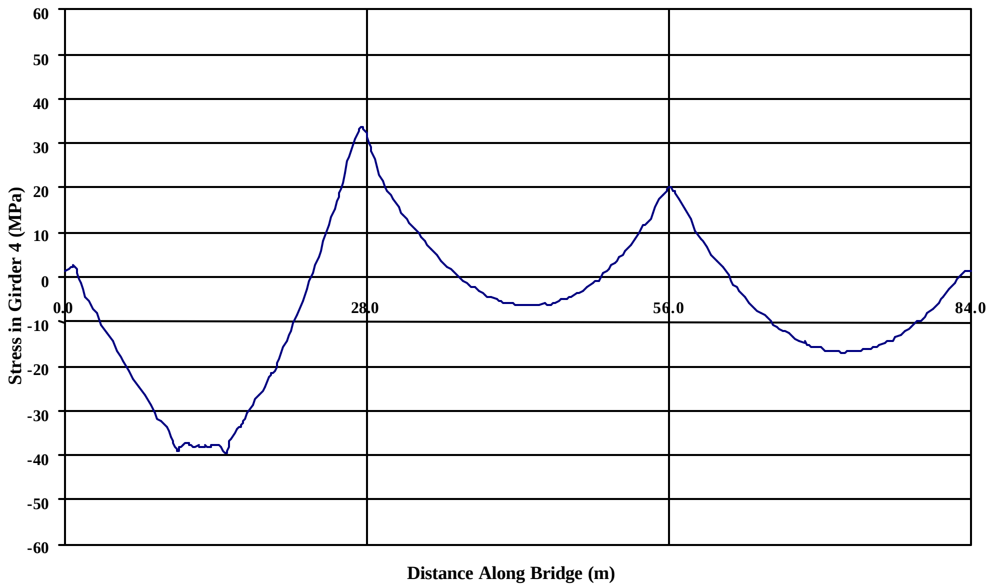

Figure 103
Type IV Girder - 10º Bridge Skew – Girder spacing 2.75m – Span Length 28.0m - 30º Diaphragm Skew – Strength I Maximum Loading Condition

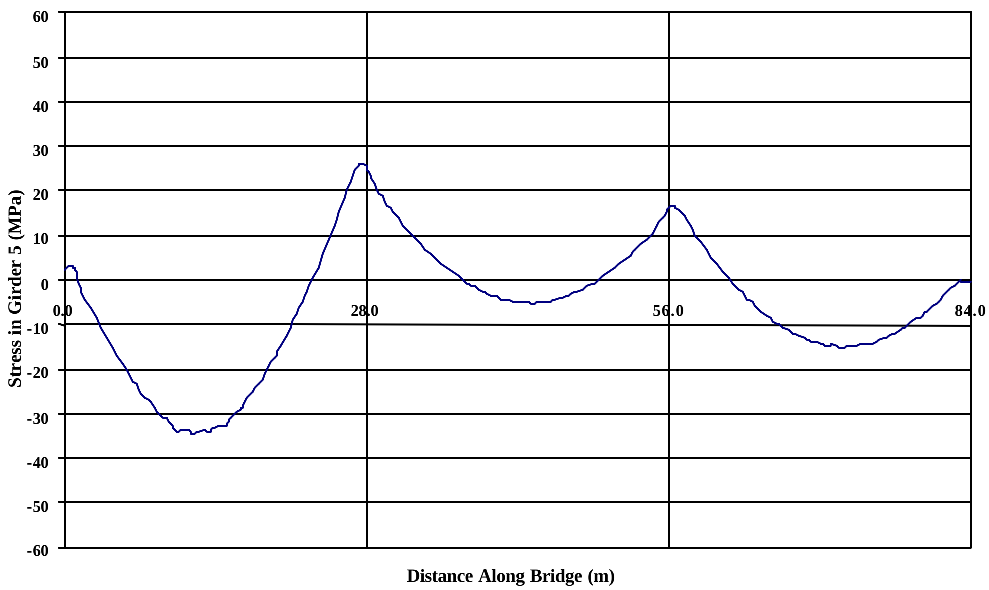

Figure 104
Type IV Girder - 10º Bridge Skew – Girder spacing 2.75m – Span Length 28.0m - 30º Diaphragm Skew – Strength I Maximum Loading Condition

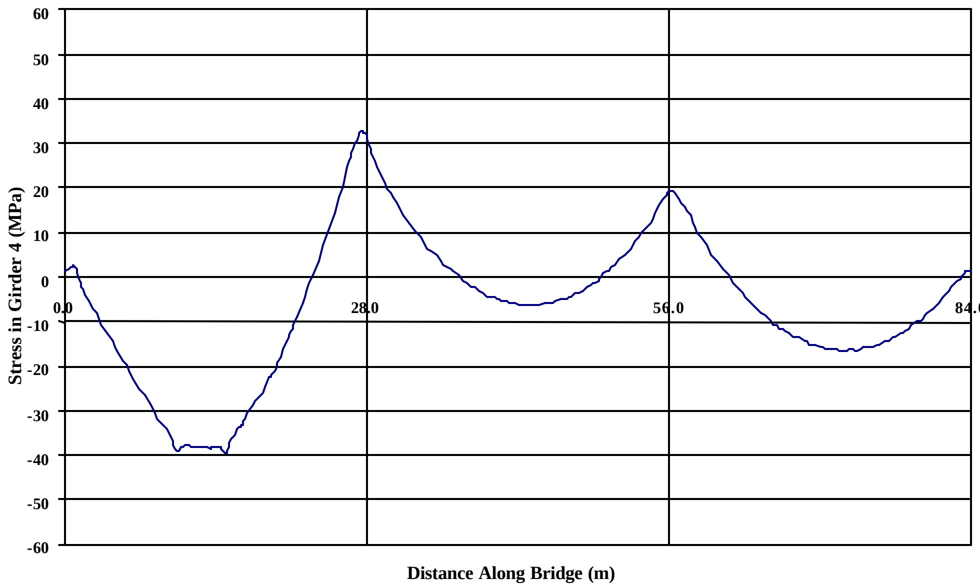

Figure 105
Type IV Girder - 10º Bridge Skew – Girder spacing 2.75m – Span Length 28.0m - 65º Diaphragm Skew – Strength I Maximum Loading Condition

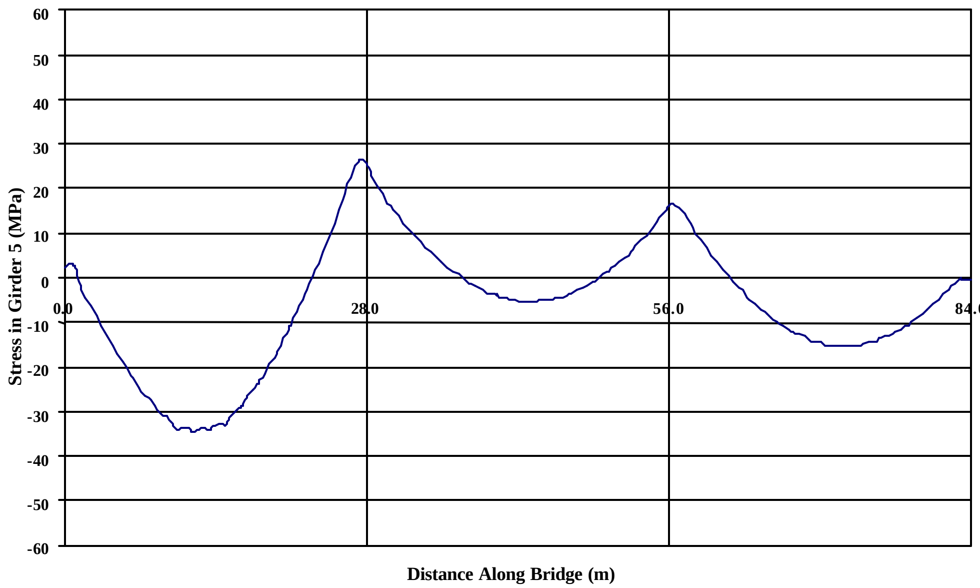

Figure 106
Type IV Girder - 10º Bridge Skew – Girder spacing 2.75m – Span Length 28.0m - 65º Diaphragm Skew – Strength I Maximum Loading Condition

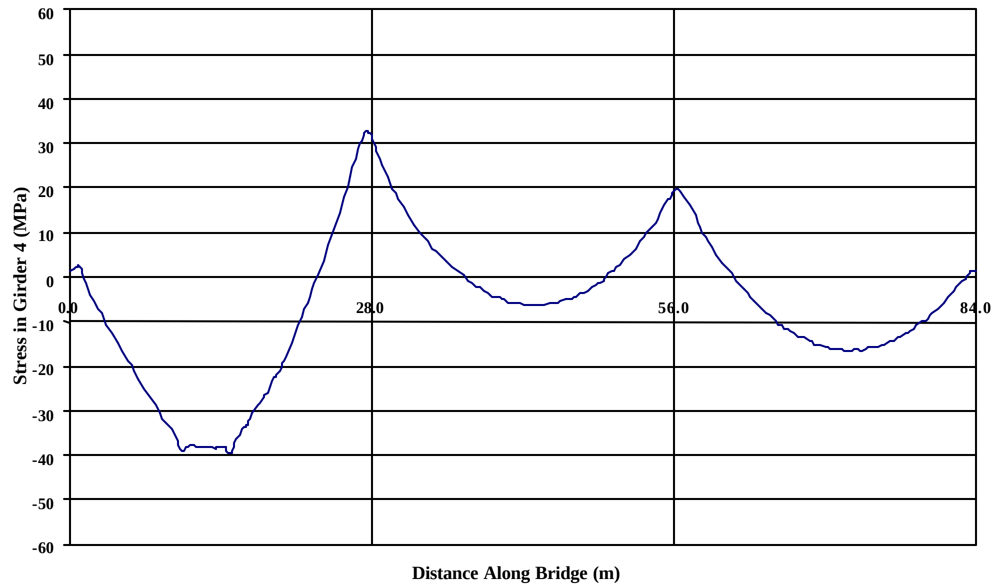

Figure 107
Type IV Girder - 10º Bridge Skew – Girder spacing 2.75m – Span Length 28.0m - No Diaphragm – Strength I Maximum Loading Condition

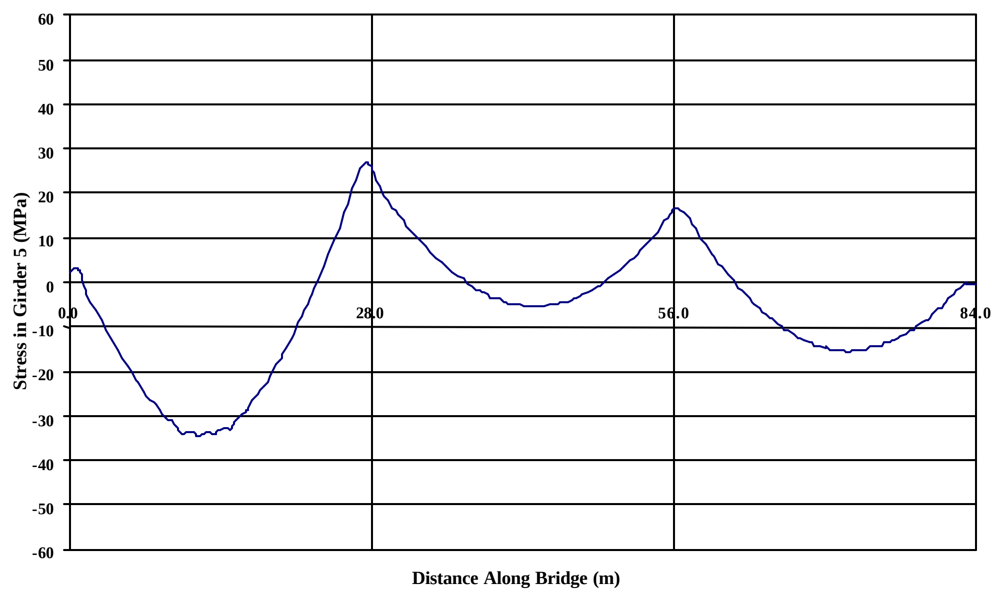

Figure 108
Type IV Girder - 10º Bridge Skew – Girder spacing 2.75m – Span Length 28.0m - No Diaphragm – Strength I Maximum Loading Condition

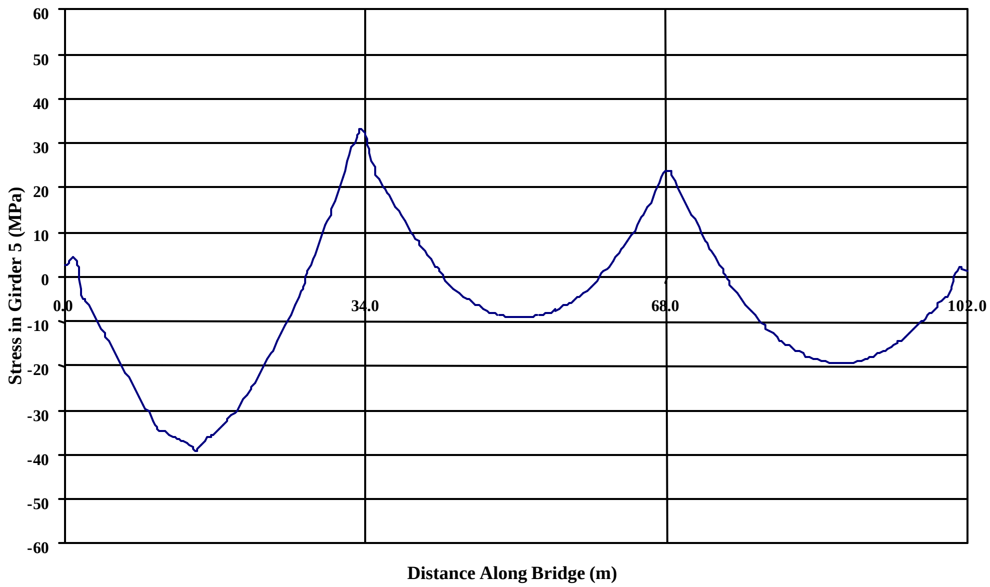

Figure 109
Type IV Girder - 20º Bridge Skew – Girder spacing 1.52m – Span Length 34.0m - 30º Diaphragm Skew – Strength I Maximum Loading Condition

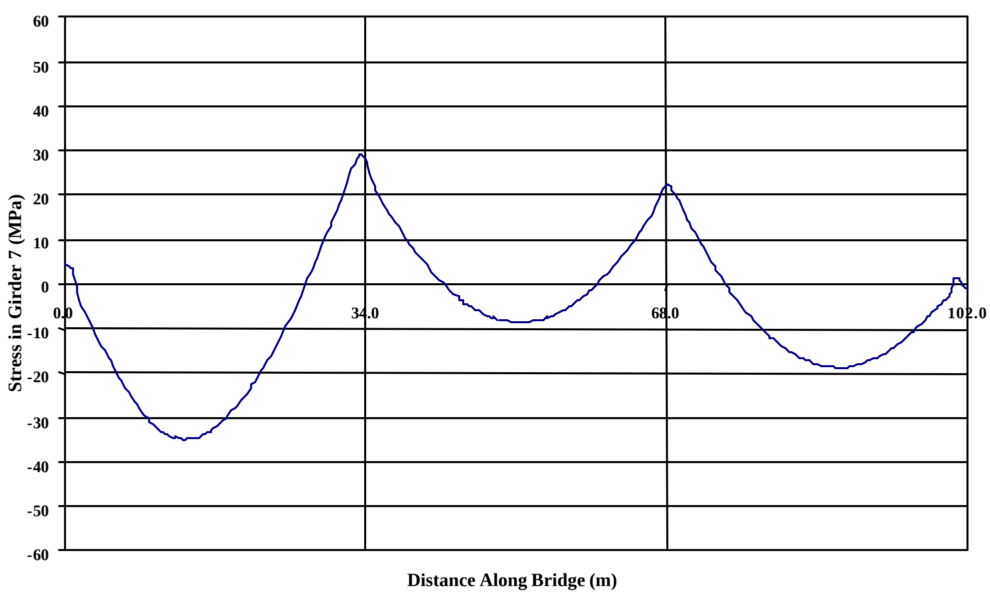

Figure 110
Type IV Girder - 20º Bridge Skew – Girder spacing 1.52m – Span Length 34.0m - 30º Diaphragm Skew – Strength I Maximum Loading Condition

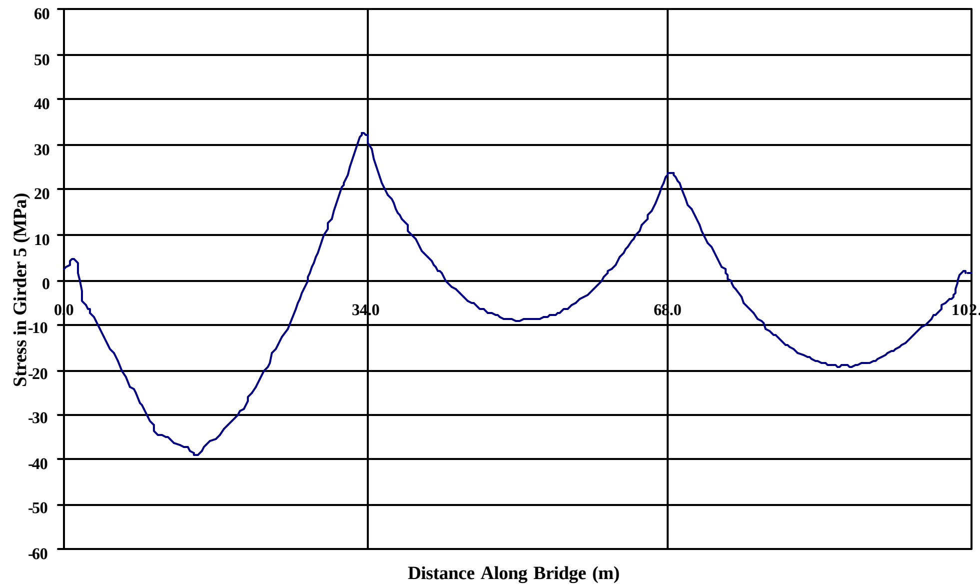

Figure 111
Type IV Girder - 20º Bridge Skew – Girder spacing 1.52m – Span Length 34.0m - 65º Diaphragm Skew – Strength I Maximum Loading Condition

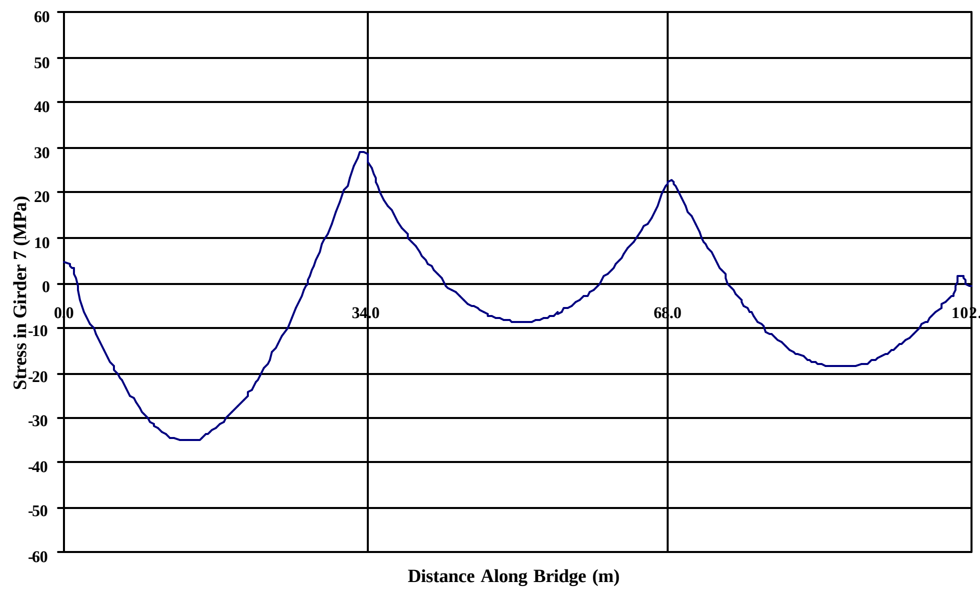

Figure 112
Type IV Girder - 20º Bridge Skew – Girder spacing 1.52m – Span Length 34.0m - 65º Diaphragm Skew – Strength I Maximum Loading Condition

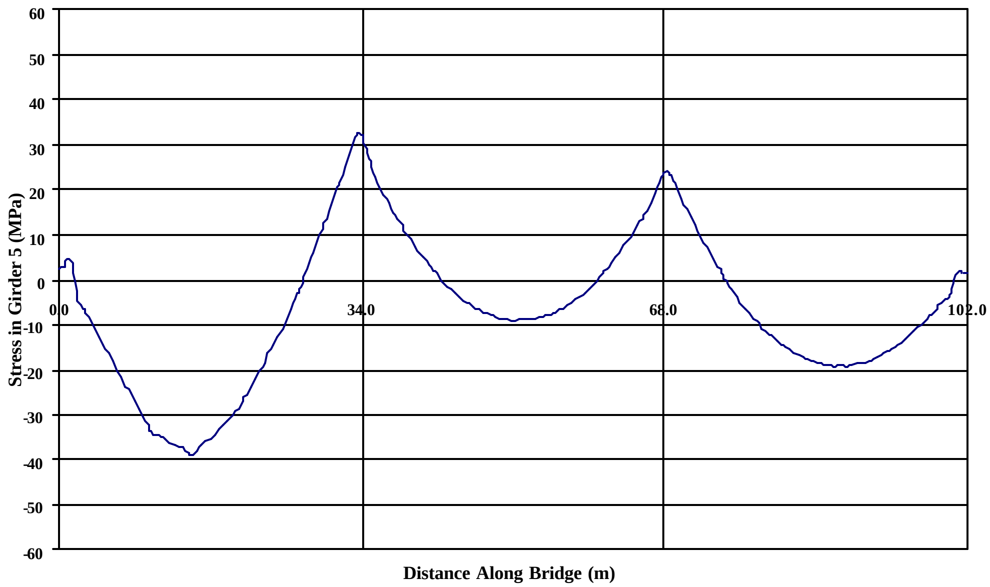

Figure 113
Type IV Girder - 20º Bridge Skew – Girder spacing 1.52m – Span Length 34.0m - No Diaphragm – Strength I Maximum Loading Condition

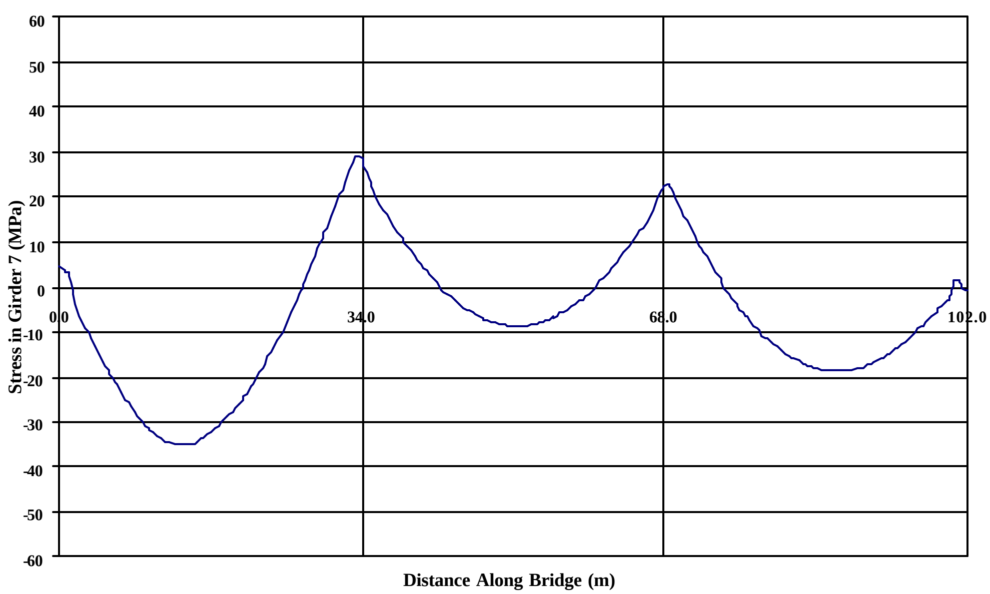

Figure 114
Type IV Girder - 20º Bridge Skew – Girder spacing 1.52m – Span Length 34.0m - No Diaphragm– Strength I Maximum Loading Condition

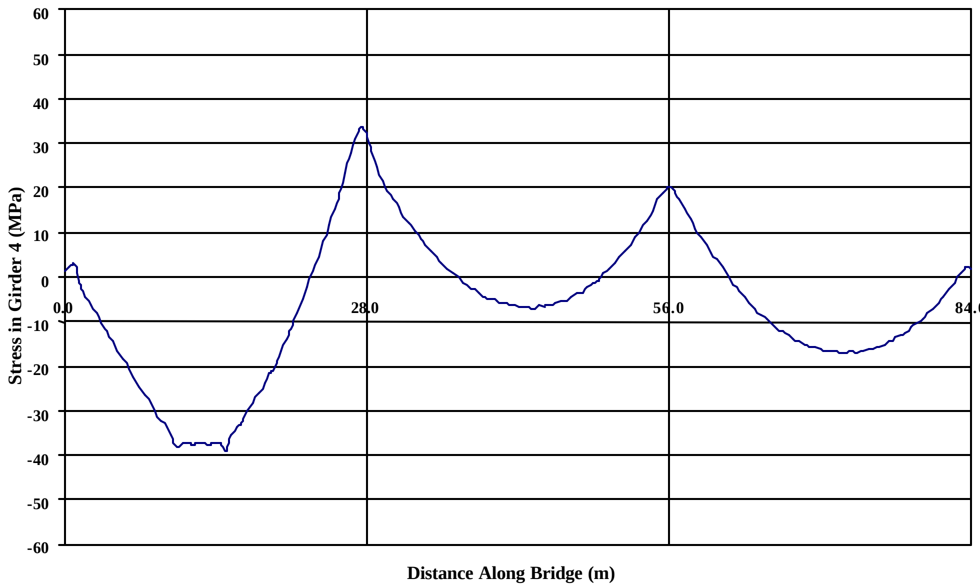

Figure 115
Type IV Girder - 20º Bridge Skew – Girder spacing 2.75m – Span Length 28.0m - 30º Diaphragm Skew – Strength I Maximum Loading Condition

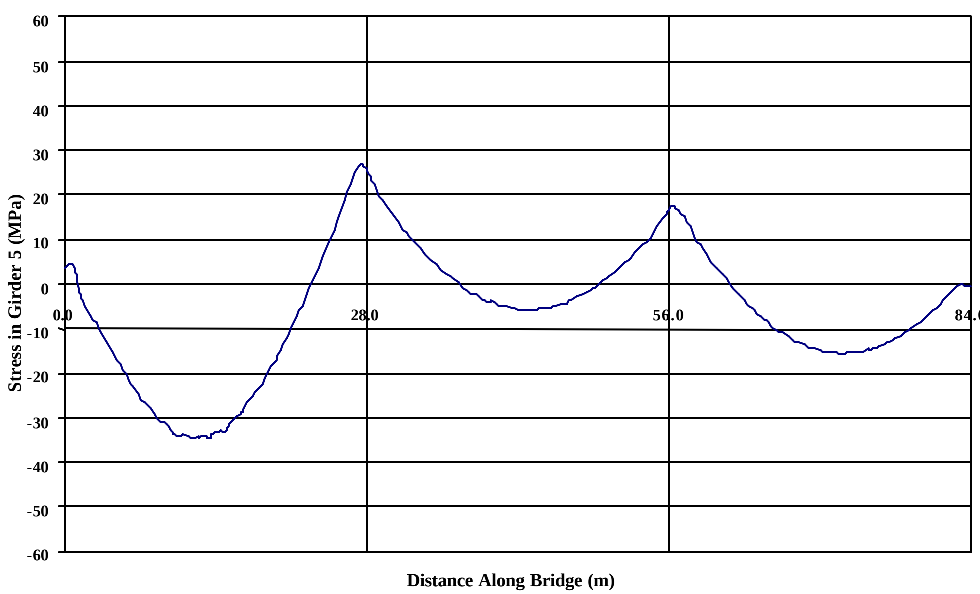

Figure 116
Type IV Girder - 20º Bridge Skew – Girder spacing 2.75m – Span Length 28.0m - 30º Diaphragm Skew – Strength I Maximum Loading Condition

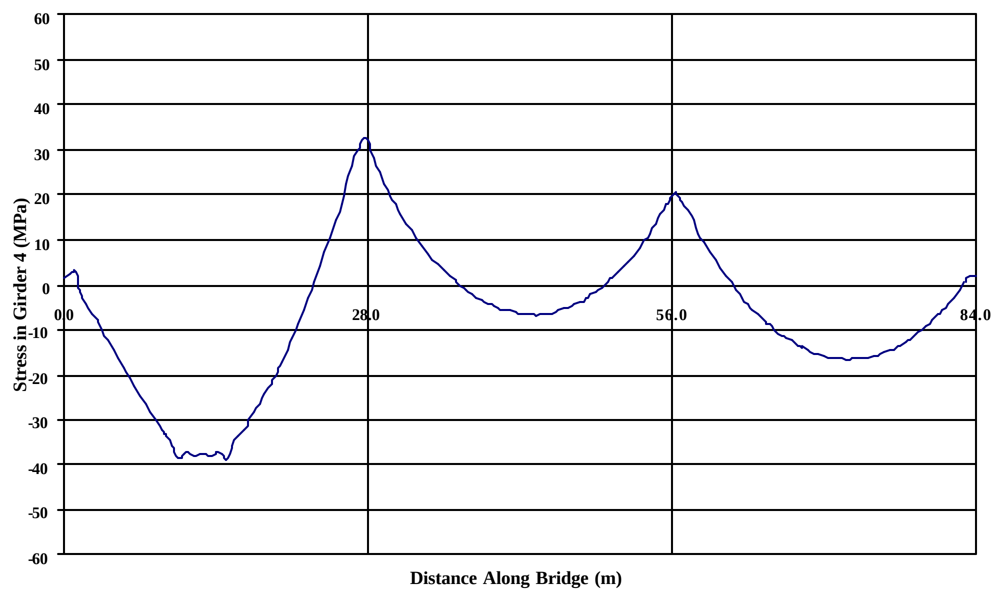

Figure 117
Type IV Girder - 20º Bridge Skew – Girder spacing 2.75m – Span Length 28.0m - 65º Diaphragm Skew – Strength I Maximum Loading Condition

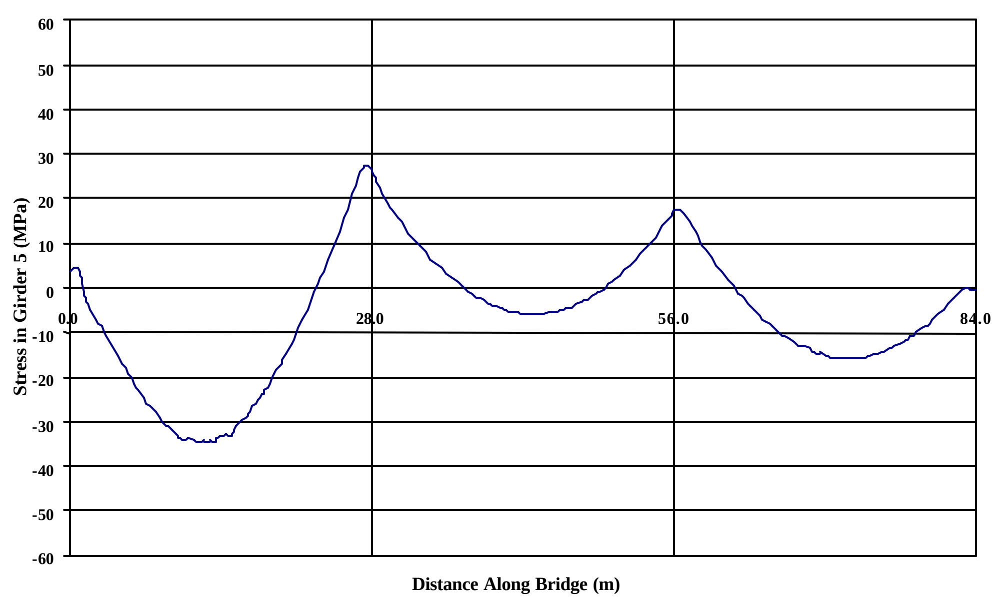

Figure 118
Type IV Girder - 20º Bridge Skew – Girder spacing 2.75m – Span Length 28.0m - 65º Diaphragm Skew – Strength I Maximum Loading Condition

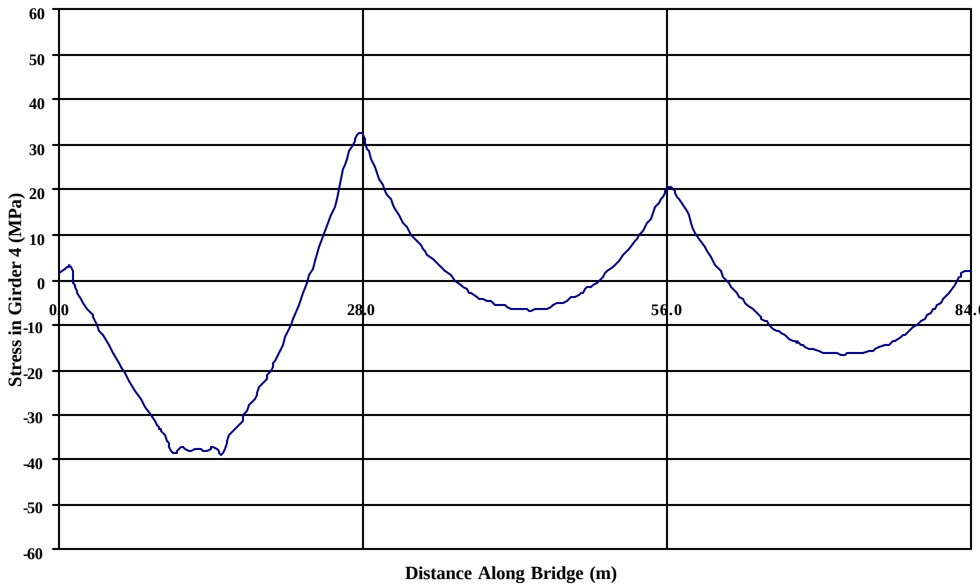

Figure 119
Type IV Girder - 20º Bridge Skew – Girder spacing 2.75m – Span Length 28.0m - No Diaphragm Skew – Strength I Maximum Loading Condition

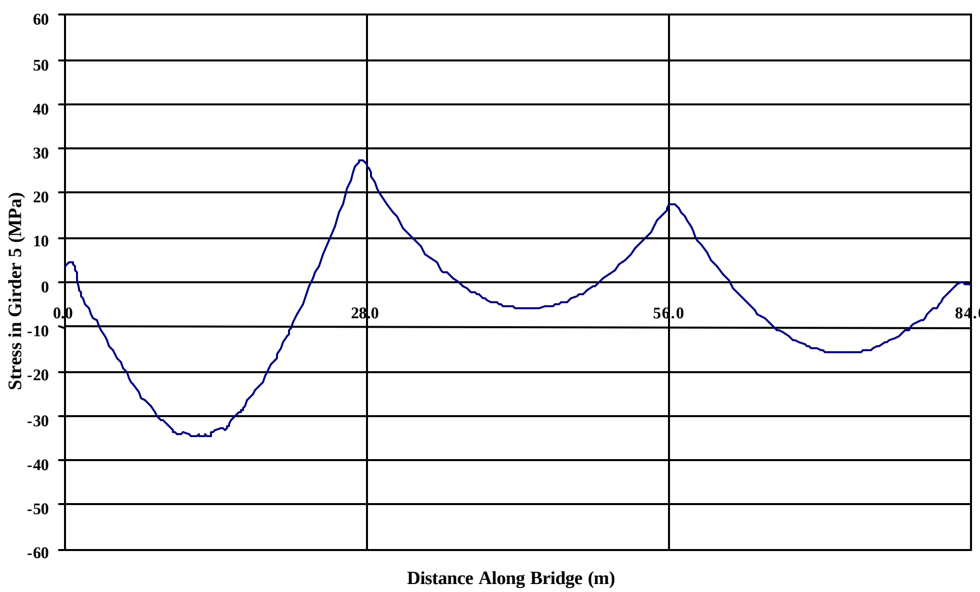

Figure 120
Type IV Girder - 20º Bridge Skew – Girder spacing 2.75m – Span Length 28.0m - No Diaphragm Skew – Strength I Maximum Loading Condition

APPENDIX F

GIRDER DEFLECTION RESULTS

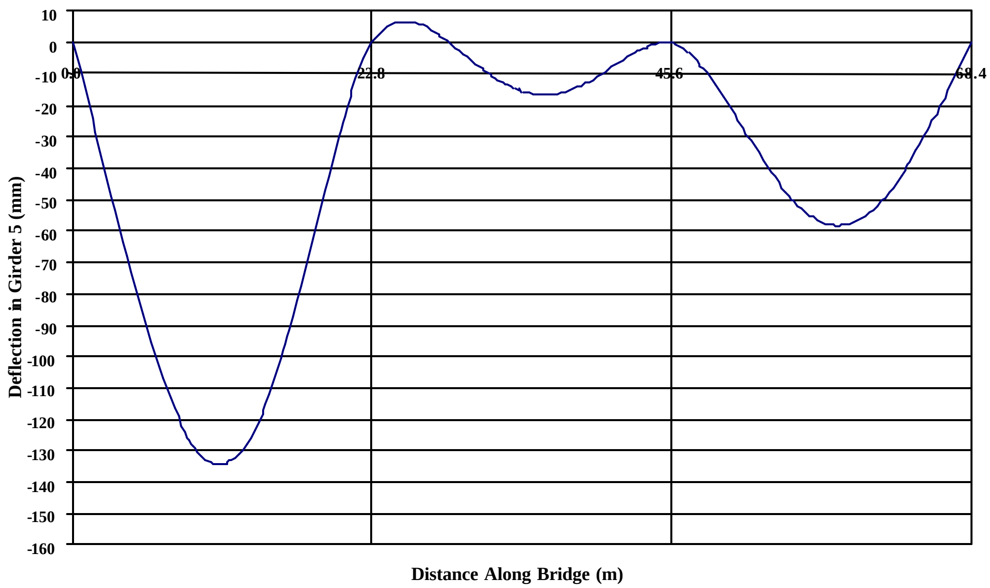

Figure 121
Type II Girder - 10° Bridge Skew - Girder Spacing 1.52 m - Span Length 22.8 m - 30° Diaphragm Skew - Strength I Maximum Loading Condition

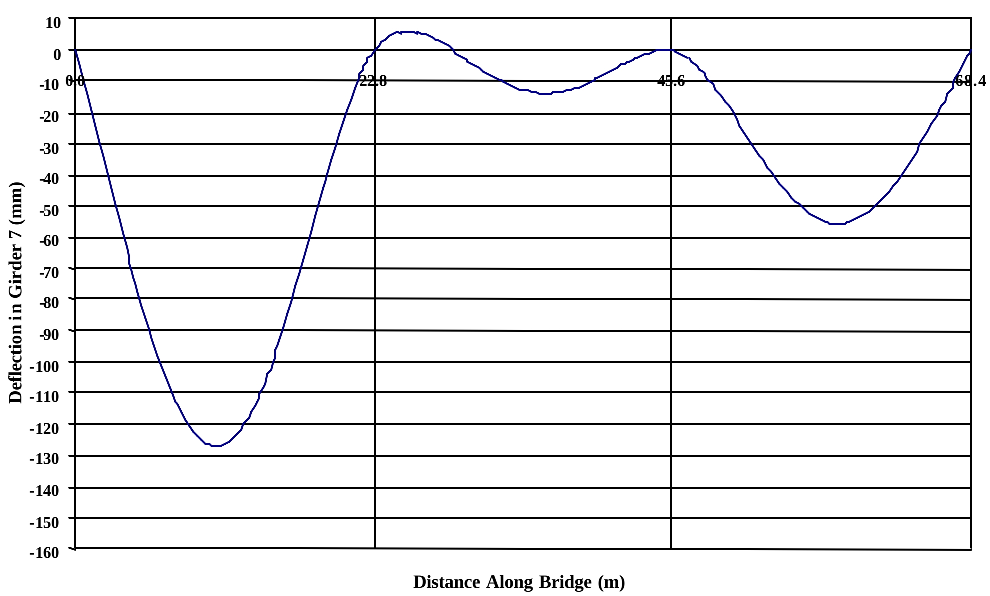

Figure 122
Type II Girder - 10° Bridge Skew - Girder Spacing 1.52 m - Span Length 22.8 m - 30° Diaphragm Skew - Strength I Maximum Loading Condition

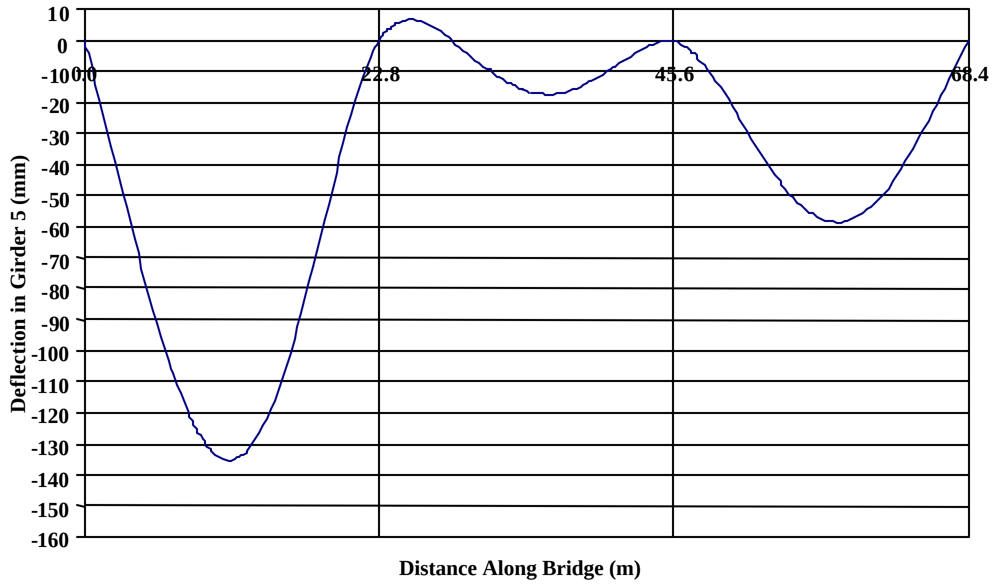

Figure 123
Type II Girder - 10° Bridge Skew - Girder Spacing 1.52 m - Span Length 22.8 m - 65° Diaphragm Skew - Strength I Maximum Loading Condition

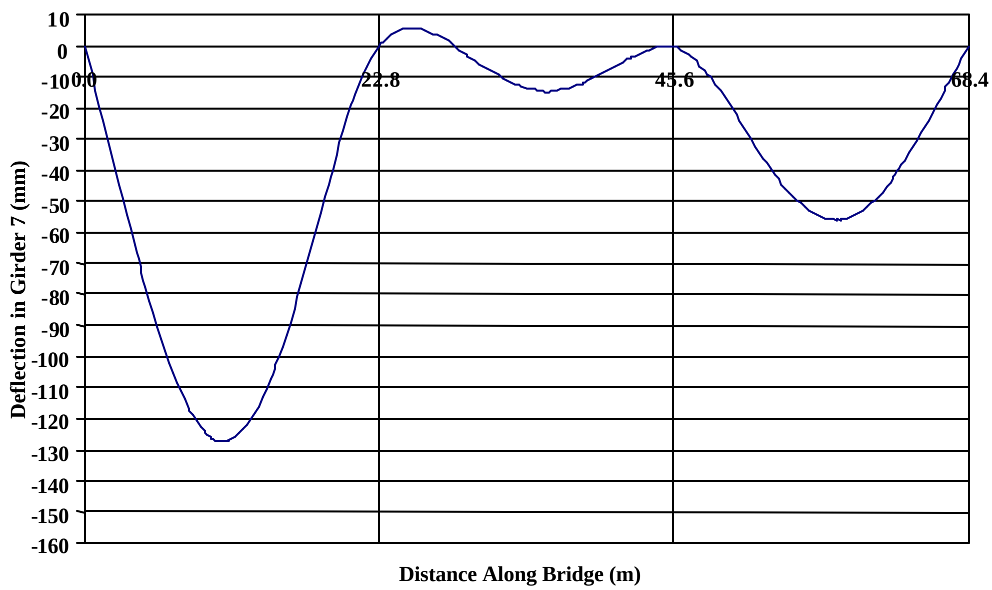

Figure 124
Type II Girder - 10° Bridge Skew - Girder Spacing 1.52 m - Span Length 22.8 m - 65° Diaphragm Skew - Strength I Maximum Loading Condition

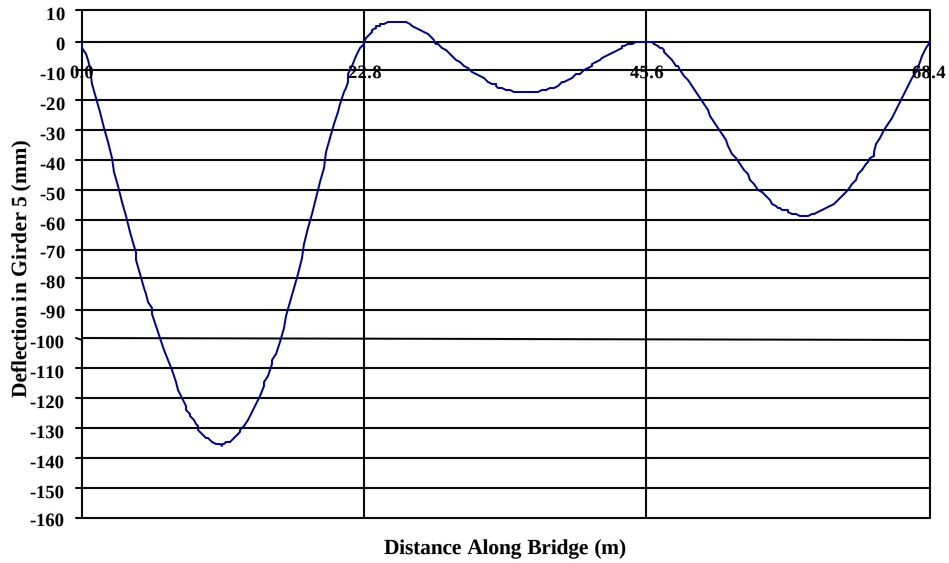

Figure 125
Type II Girder - 10° Bridge Skew - Girder Spacing 1.52 m - Span Length 22.8 m - No Diaphragm Skew - Strength I Maximum Loading Condition

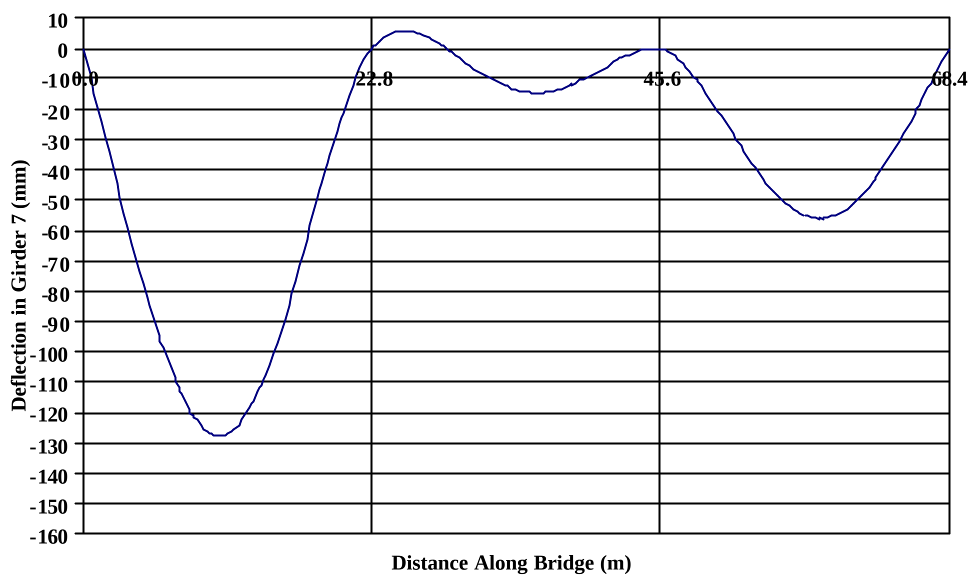

Figure 126
Type II Girder - 10° Bridge Skew - Girder Spacing 1.52 m - Span Length 22.8 m - No Diaphragm Skew - Strength I Maximum Loading Condition

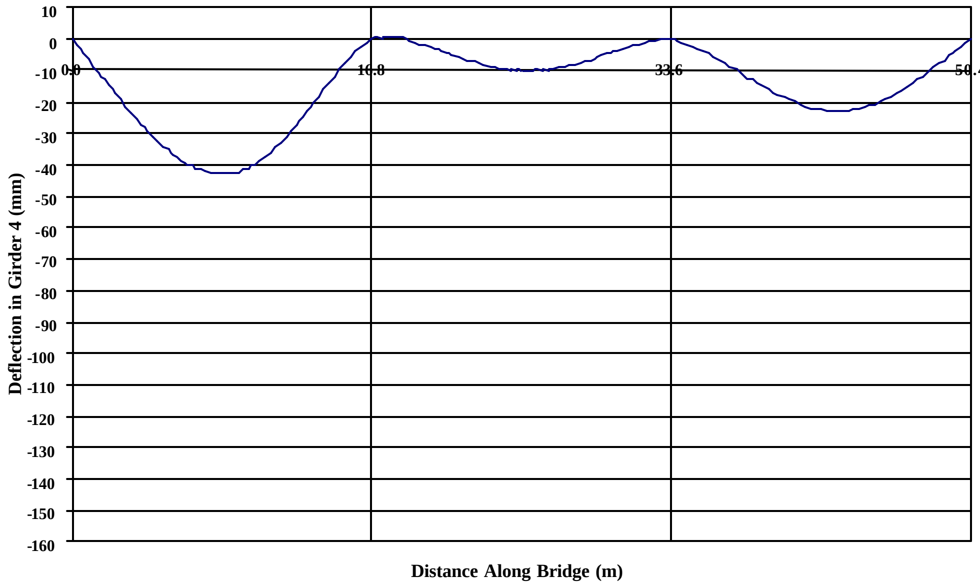

Figure 127
Type II Girder - 10° Bridge Skew - Girder Spacing 2.75 m - Span Length 16.8 m - 30° Diaphragm Skew - Strength I Maximum Loading Condition

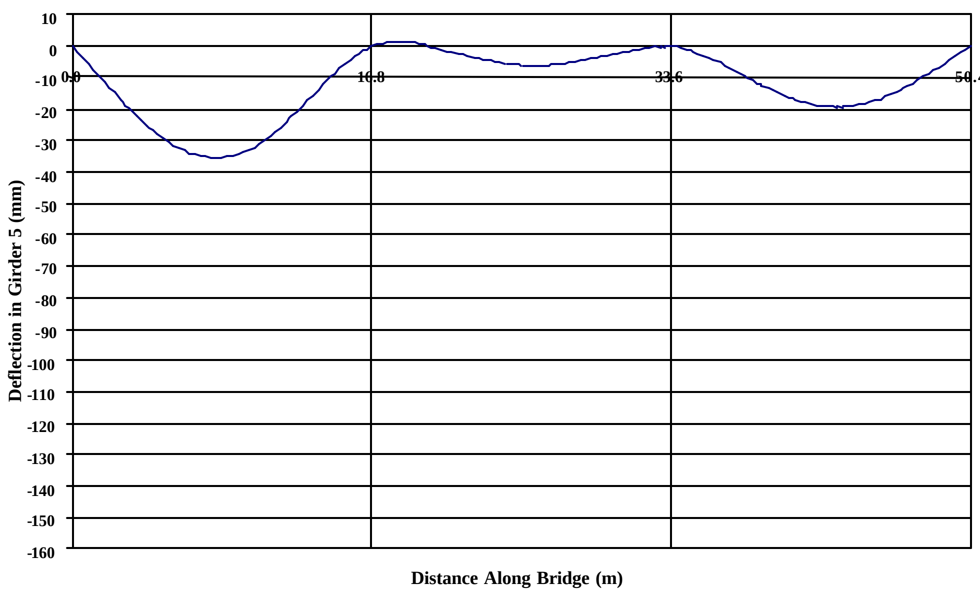

Figure 128
Type II Girder - 10° Bridge Skew - Girder Spacing 2.75 m - Span Length 16.8 m - 30° Diaphragm Skew - Strength I Maximum Loading Condition

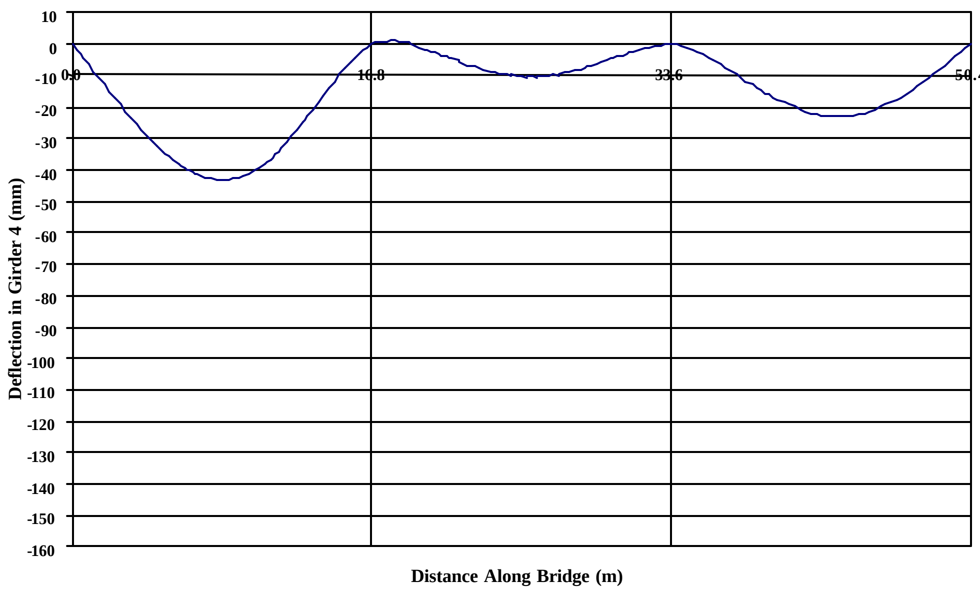

Figure 129
Type II Girder - 10° Bridge Skew - Girder Spacing 2.75 m - Span Length 16.8 m - 65° Diaphragm Skew - Strength I Maximum Loading Condition

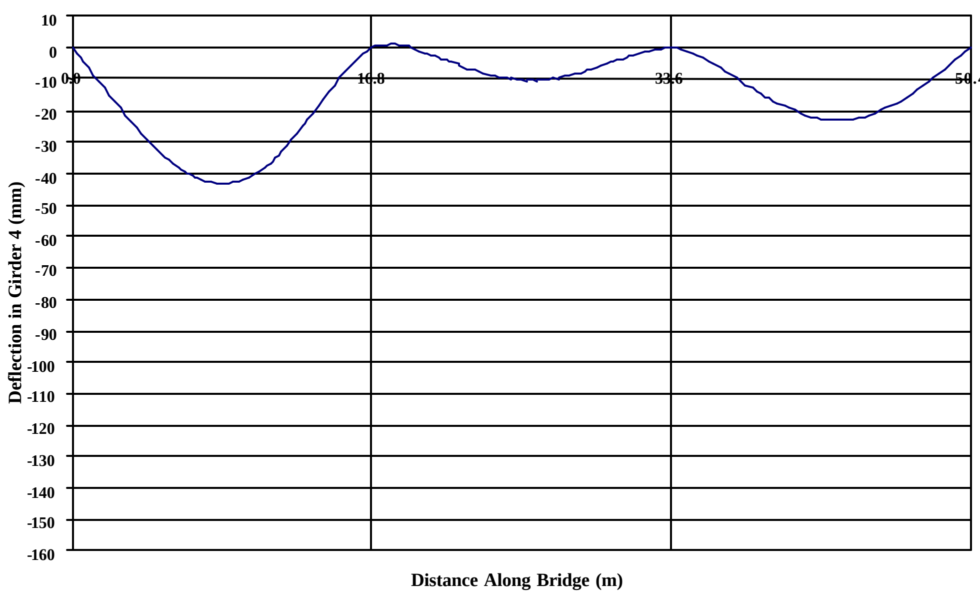

Figure 130
Type II Girder - 10° Bridge Skew - Girder Spacing 2.75 m - Span Length 16.8 m - 65° Diaphragm Skew - Strength I Maximum Loading Condition

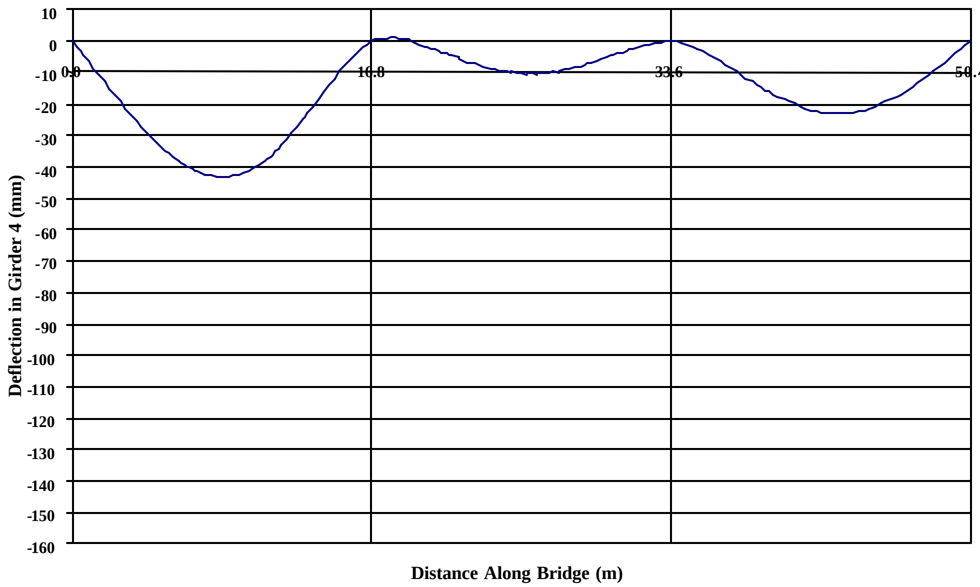

Figure 131

Type II Girder - 10° Bridge Skew - Girder Spacing 2.75 m - Span Length 16.8 m - 65° Diaphragm Skew - Strength I Maximum Loading Condition

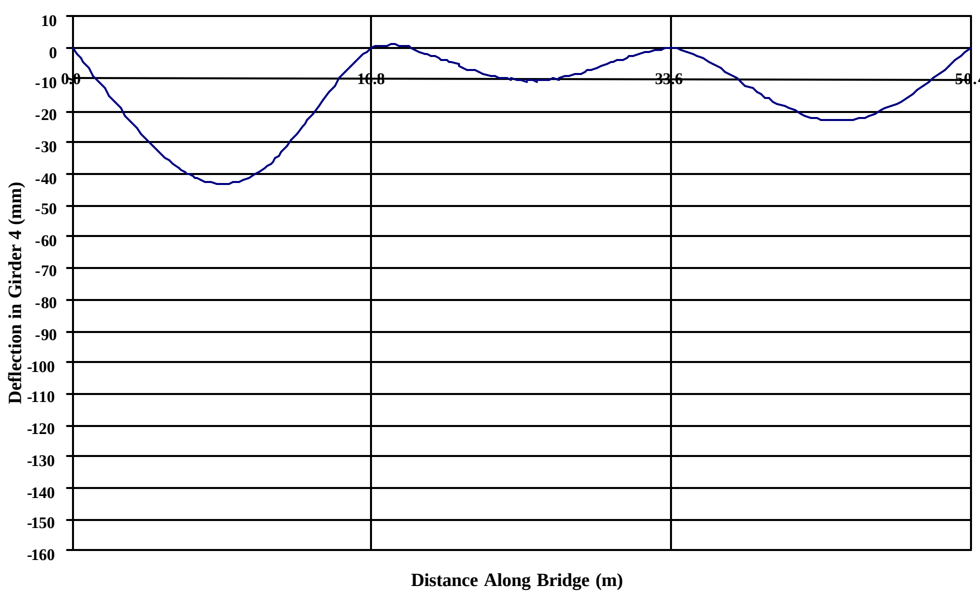

Figure 132

Type II Girder - 10° Bridge Skew - Girder Spacing 2.75 m - Span Length 16.8 m - 65° Diaphragm Skew - Strength I Maximum Loading Condition

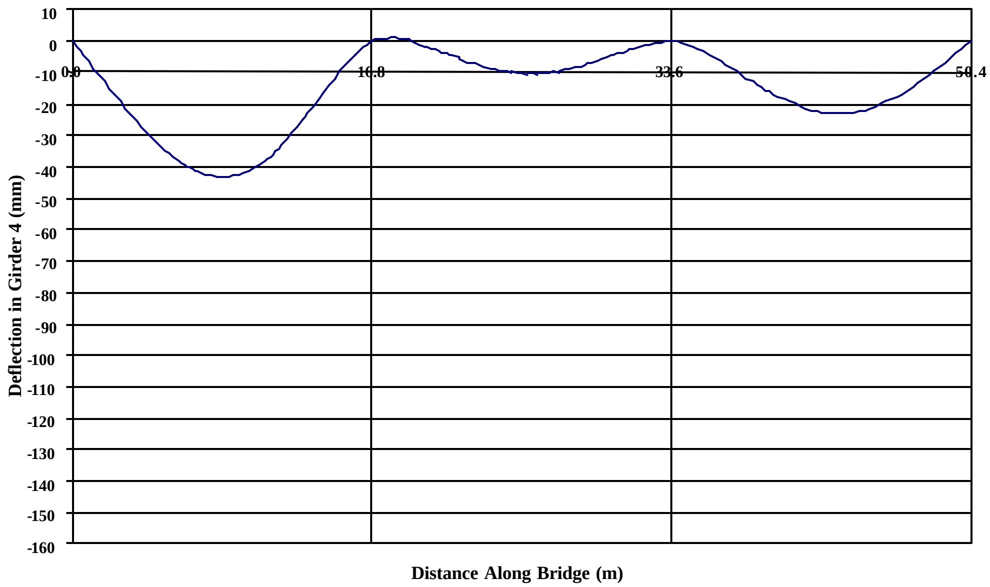

Figure 133

Type II Girder - 10° Bridge Skew - Girder Spacing 2.75 m - Span Length 16.8 m - 65° Diaphragm Skew - Strength I Maximum Loading Condition

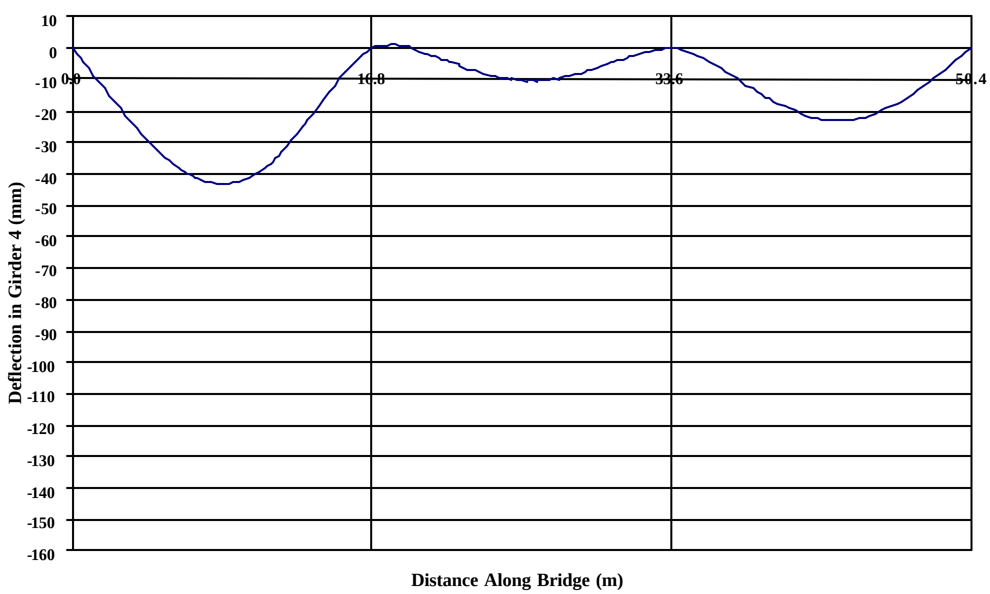

Figure 134

Type II Girder - 10° Bridge Skew - Girder Spacing 2.75 m - Span Length 16.8 m - 65° Diaphragm Skew - Strength I Maximum Loading Condition

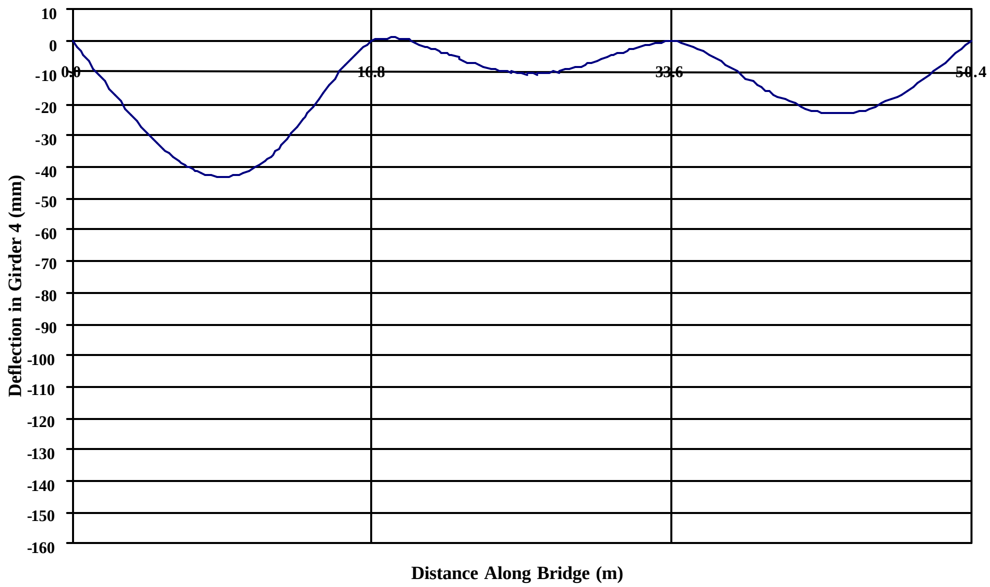

Figure 135
Type II Girder - 10° Bridge Skew - Girder Spacing 2.75 m - Span Length 16.8 m - 65° Diaphragm Skew - Strength I Maximum Loading Condition

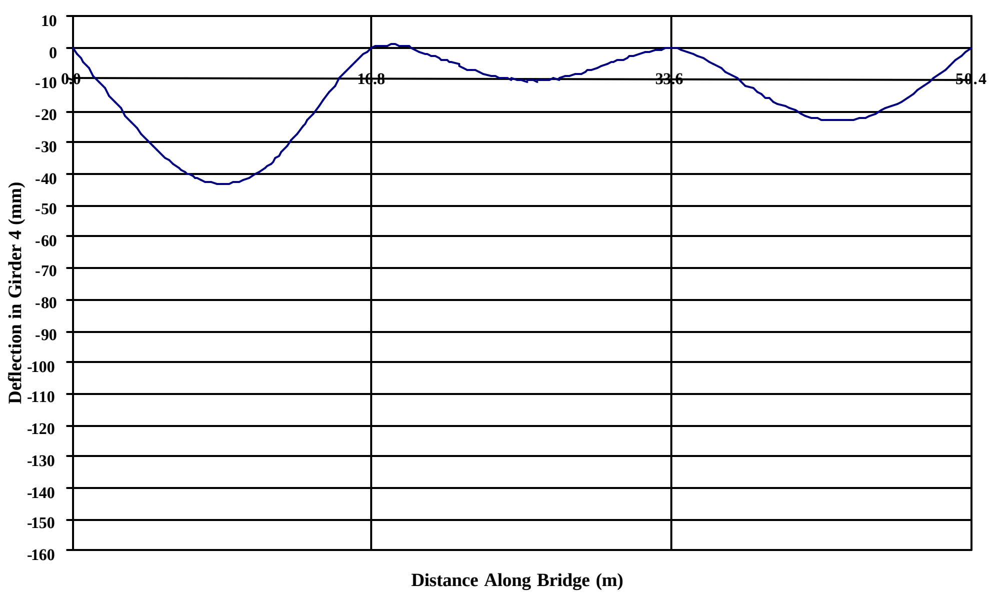

Figure 136
Type II Girder - 10° Bridge Skew - Girder Spacing 2.75 m - Span Length 16.8 m - 65° Diaphragm Skew - Strength I Maximum Loading Condition

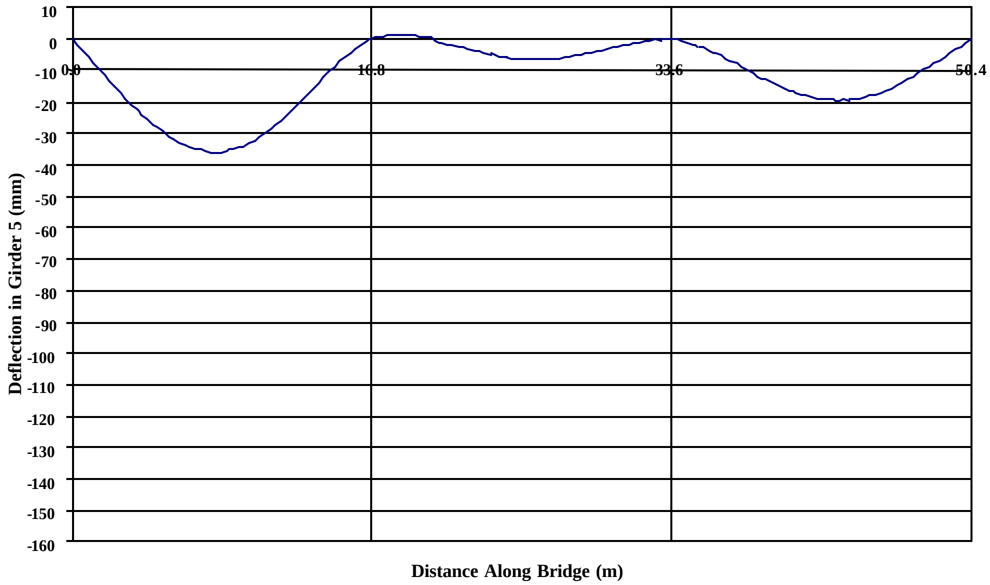

Figure 137
Type II Girder - 10° Bridge Skew - Girder Spacing 2.75 m - Span Length 16.8 m - 65° Diaphragm Skew - Strength I Maximum Loading Condition

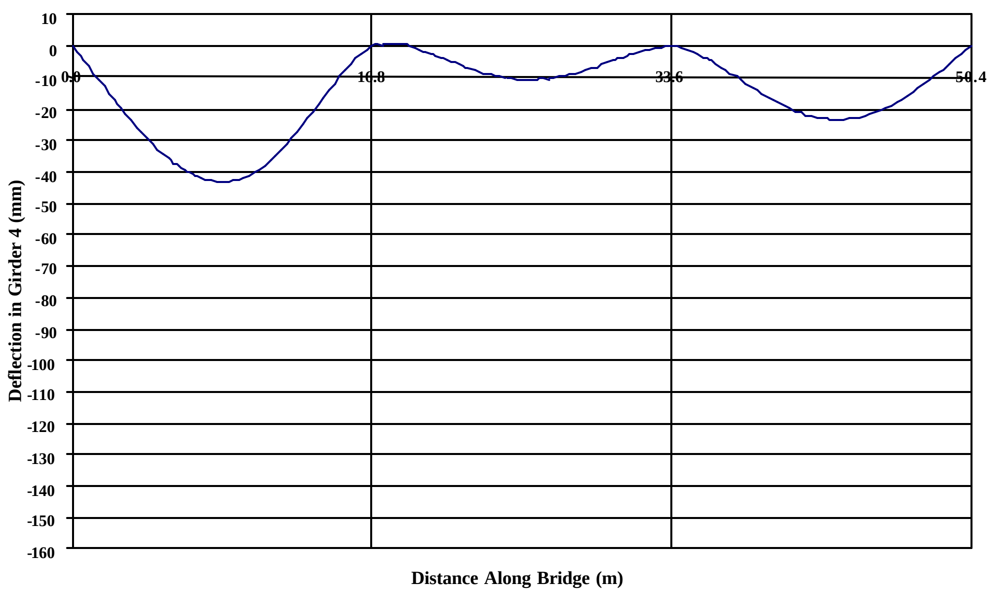

Figure 138
Type II Girder - 10° Bridge Skew - Girder Spacing 2.75 m - Span Length 16.8 m - No Diaphragm Skew - Strength I Maximum Loading Condition

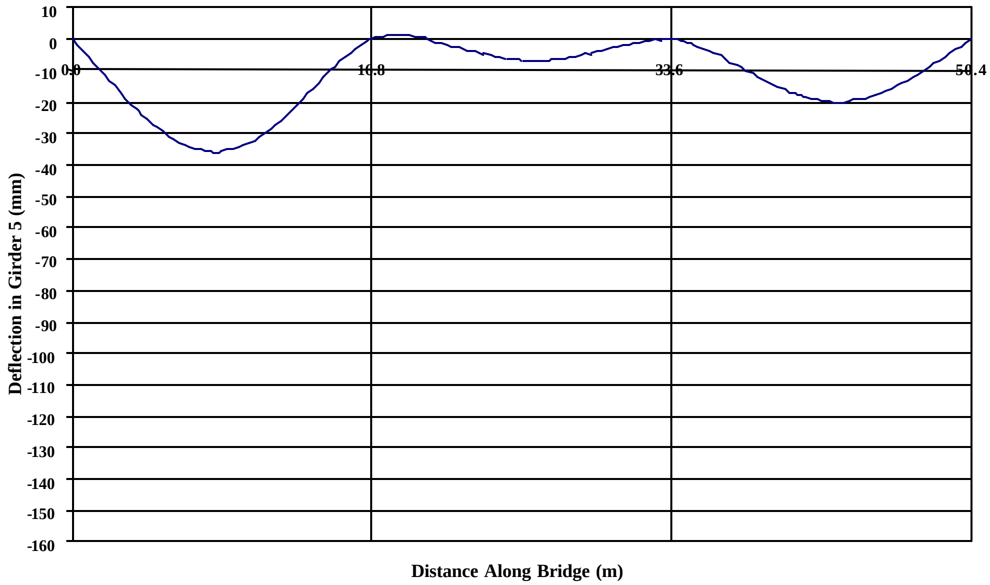

Figure 139
Type II Girder - 10° Bridge Skew - Girder Spacing 2.75 m - Span Length 16.8 m - No Diaphragm Skew - Strength I Maximum Loading Condition

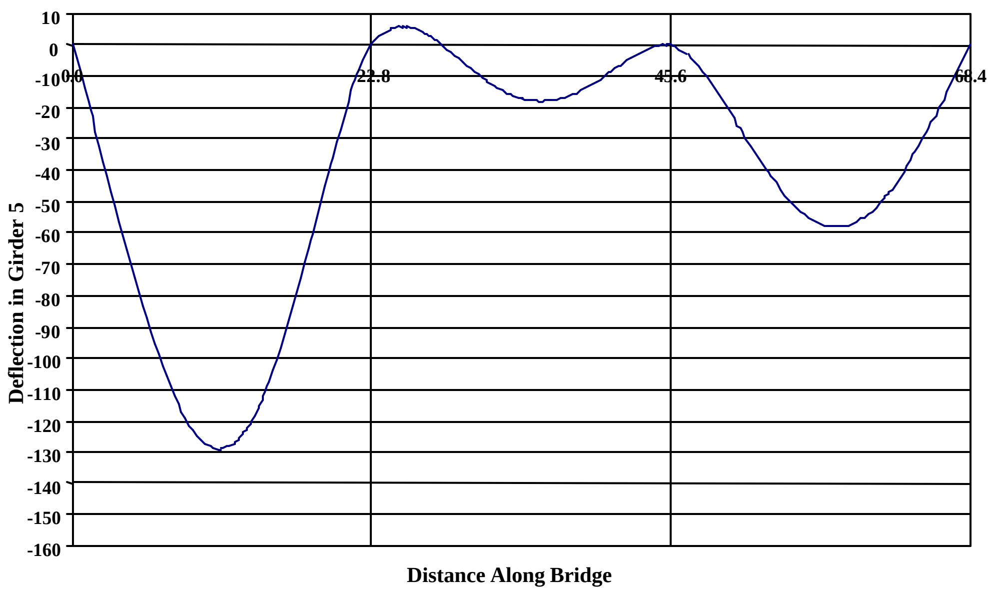

Figure 140
Type II Girder - 20° Bridge Skew - Girder Spacing 1.52 m - Span Length 22.8 m - 30° Diaphragm Skew - Strength I Maximum Loading Condition

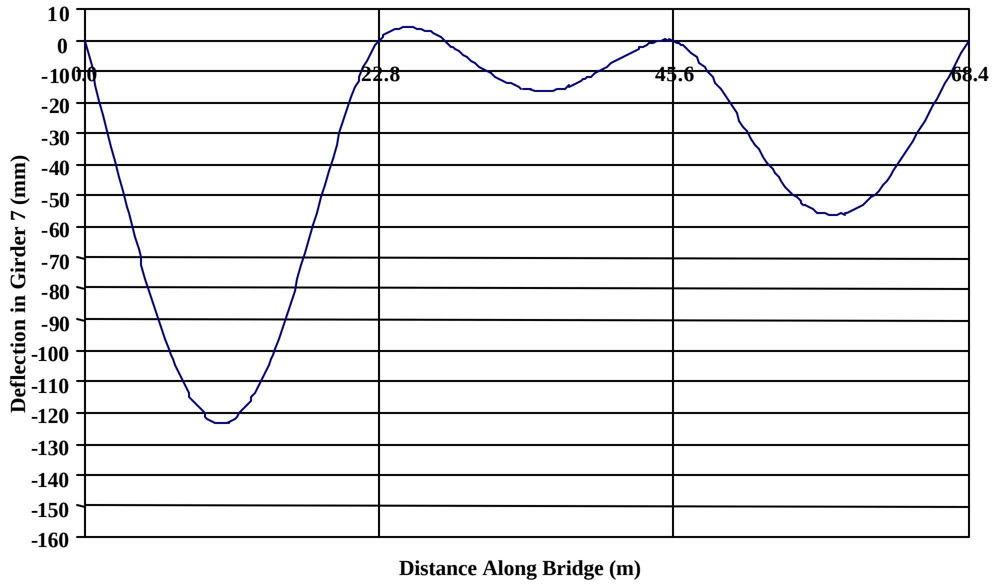

Figure 141
Type II Girder - 20° Bridge Skew - Girder Spacing 1.52 m - Span Length 22.8 m - 30° Diaphragm Skew - Strength I Maximum Loading Condition

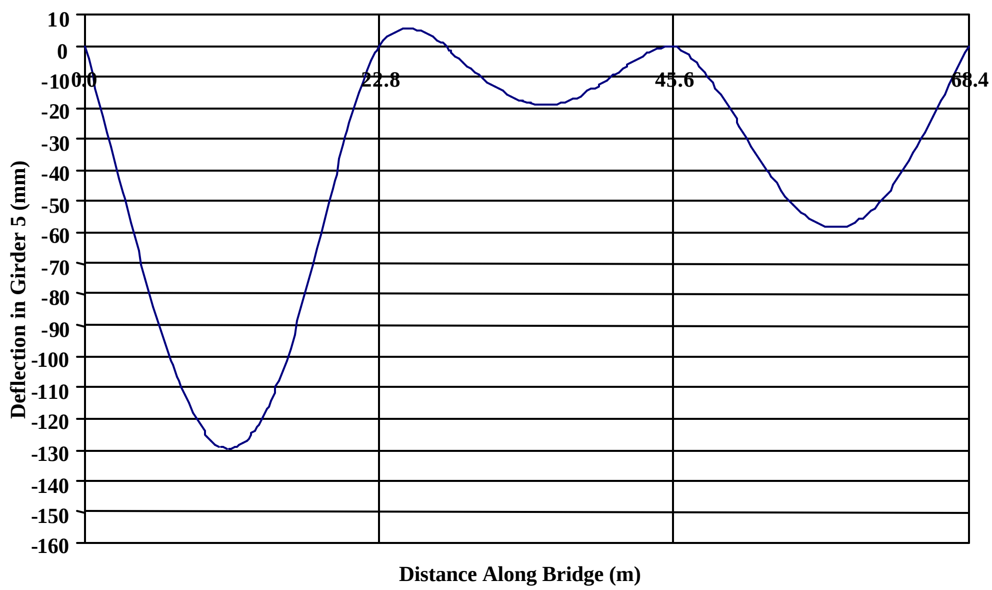

Figure 142
Type II Girder - 20° Bridge Skew - Girder Spacing 1.52 m - Span Length 22.8 m - 65° Diaphragm Skew - Strength I Maximum Loading Condition

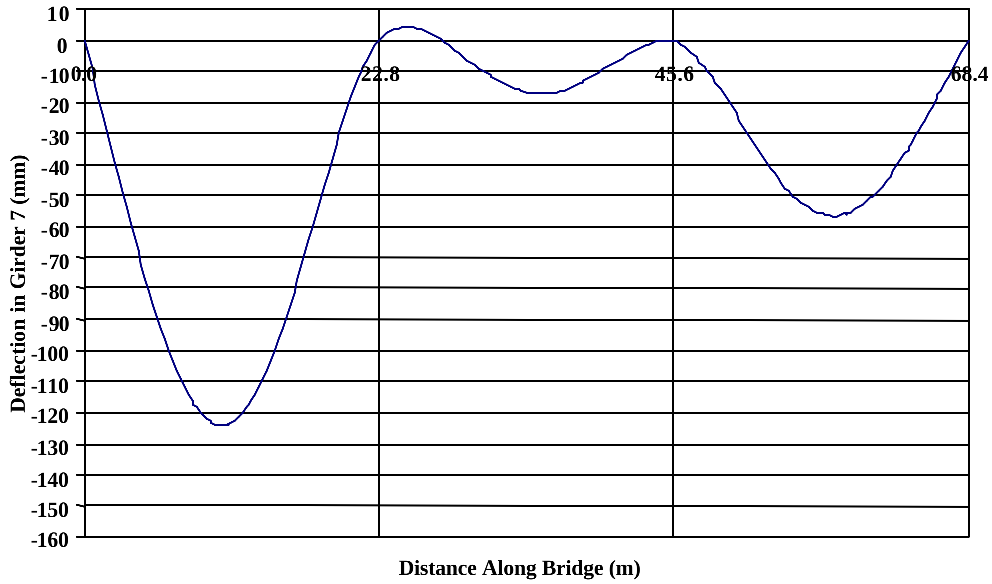

Figure 143
Type II Girder - 20° Bridge Skew - Girder Spacing 1.52 m - Span Length 22.8 m - 65° Diaphragm Skew - Strength I Maximum Loading Condition

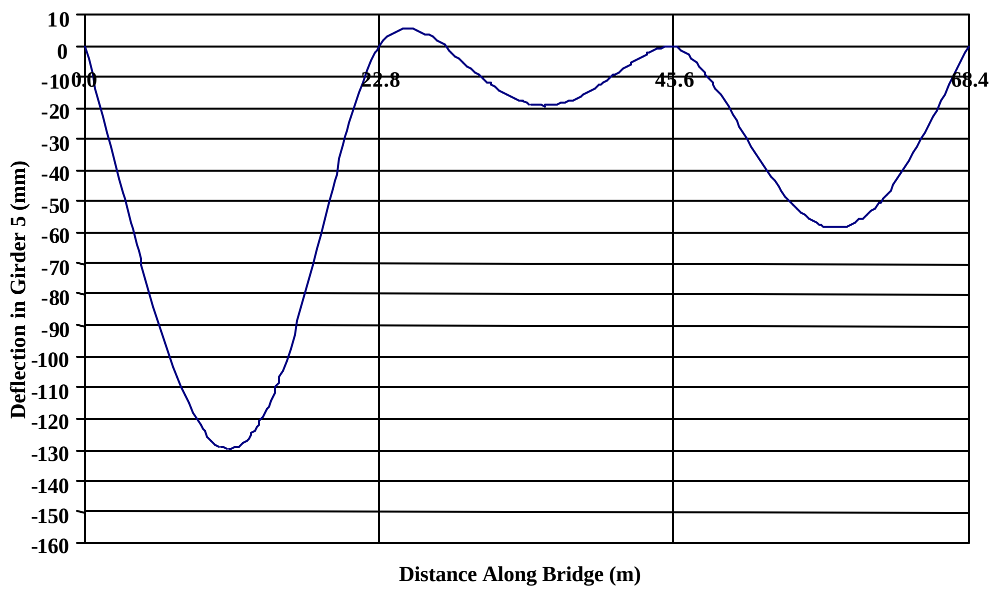

Figure 144
Type II Girder - 20° Bridge Skew - Girder Spacing 1.52 m - Span Length 22.8 m - No Diaphragm Skew - Strength I Maximum Loading Condition

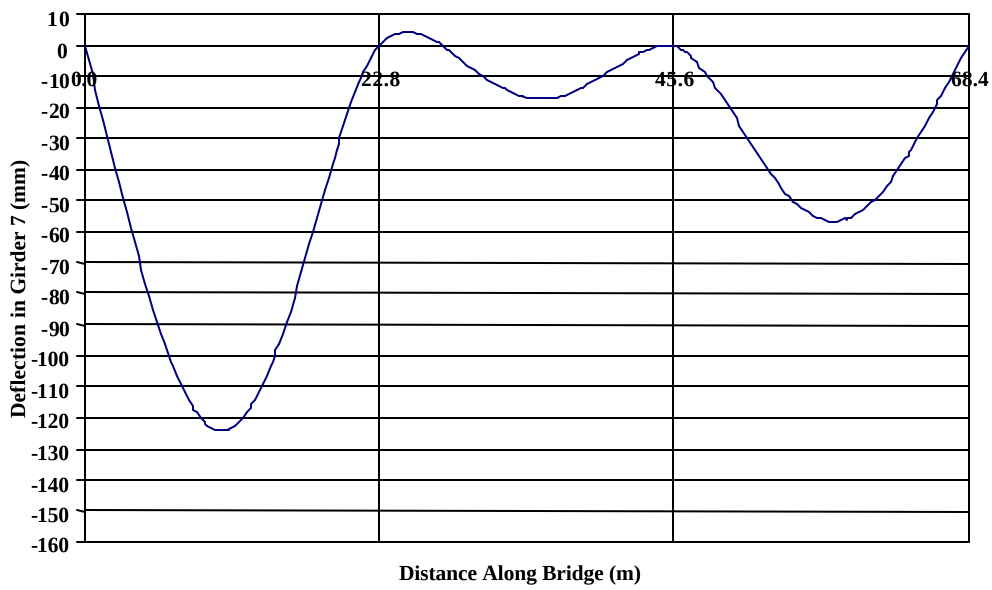

Figure 145
Type II Girder - 20° Bridge Skew - Girder Spacing 1.52 m - Span Length 22.8 m - No Diaphragm Skew - Strength I Maximum Loading Condition

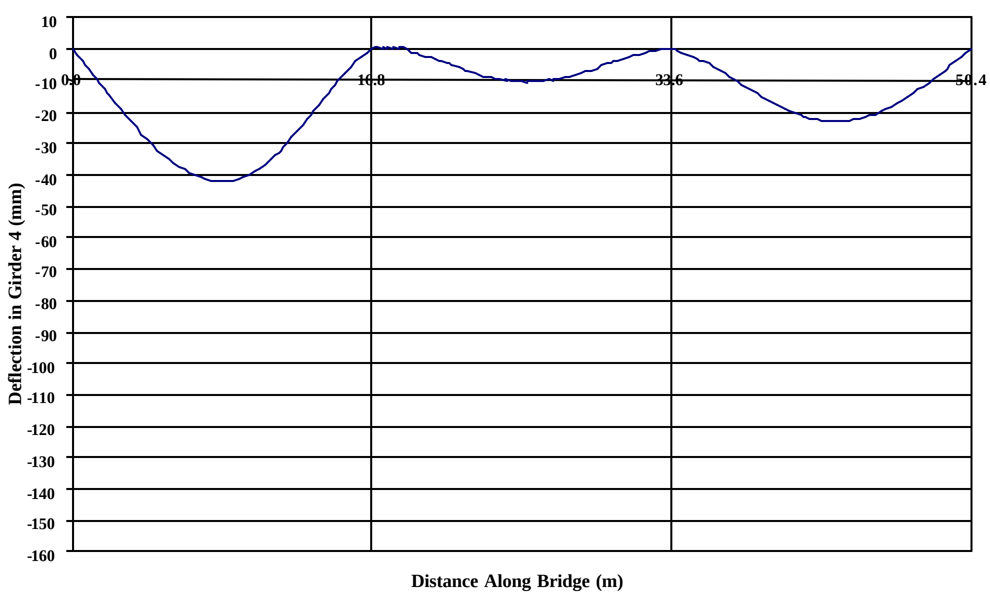

Figure 146
Type II Girder - 20° Bridge Skew - Girder Spacing 2.75 m - Span Length 16.8 m - 30° Diaphragm Skew - Strength I Maximum Loading Condition

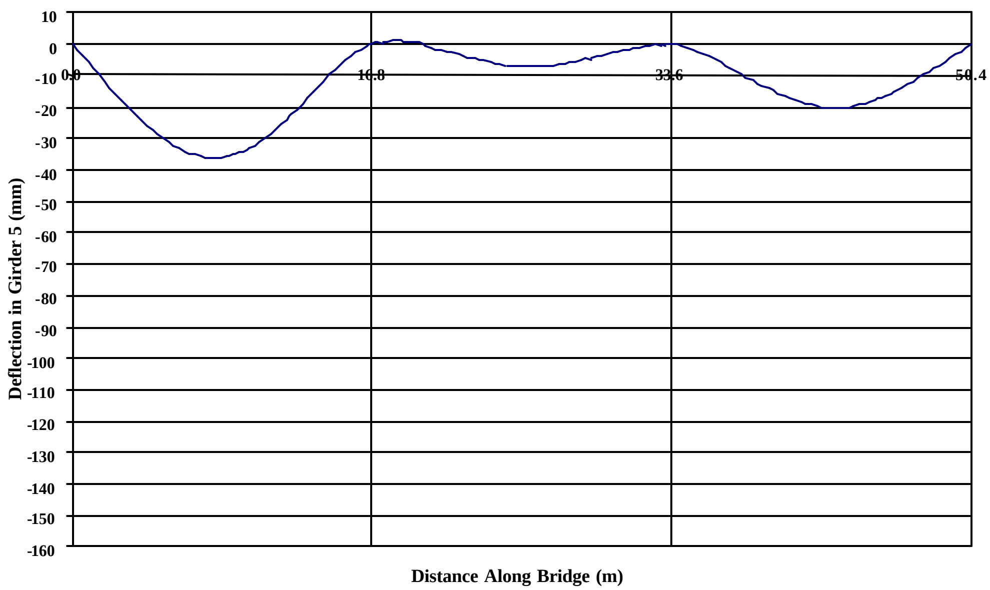

Figure 147
Type II Girder - 20° Bridge Skew - Girder Spacing 2.75 m - Span Length 16.8 m - 30° Diaphragm Skew - Strength I Maximum Loading Condition

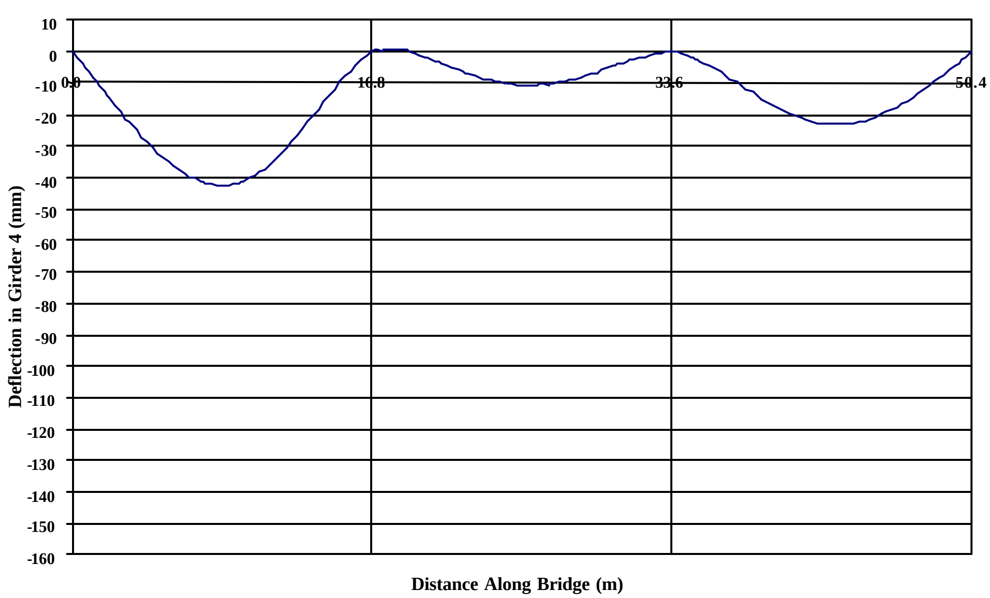

Figure 148
Type II Girder - 20° Bridge Skew - Girder Spacing 2.75 m - Span Length 16.8 m - 65° Diaphragm Skew - Strength I Maximum Loading Condition

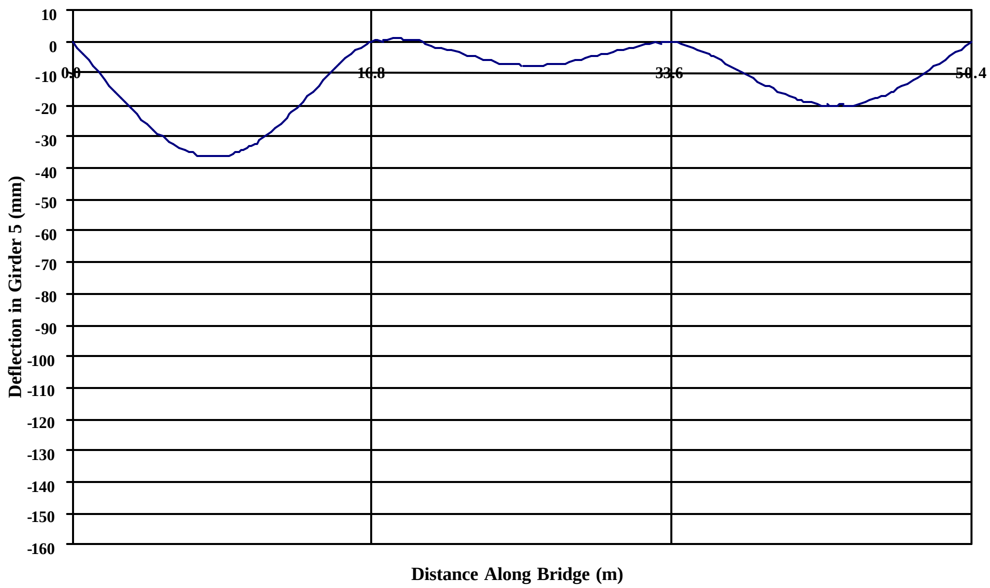

Figure 149
Type II Girder - 20° Bridge Skew - Girder Spacing 2.75 m - Span Length 16.8 m - 65° Diaphragm Skew - Strength I Maximum Loading Condition

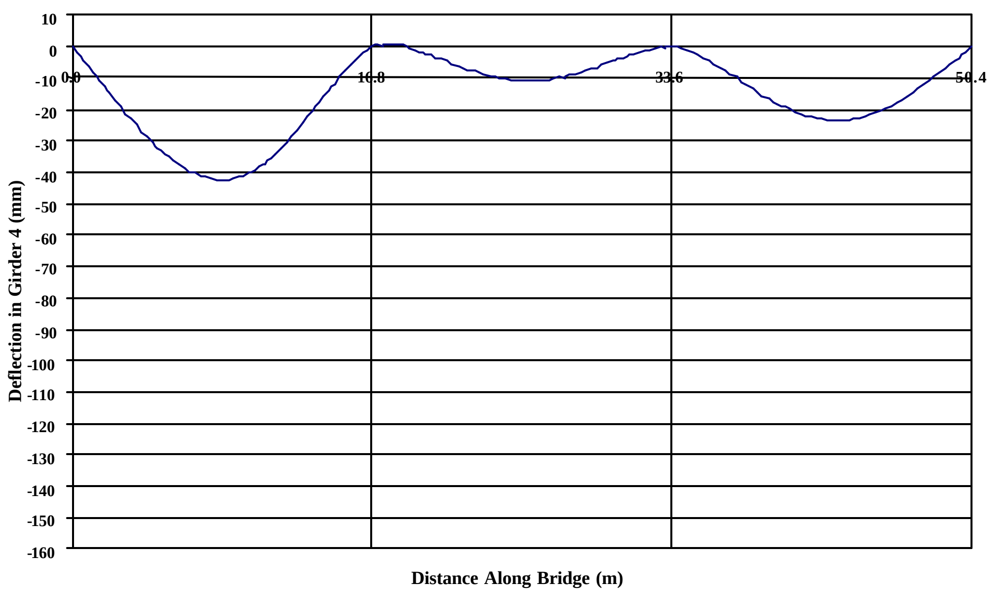

Figure 150
Type II Girder - 20° Bridge Skew - Girder Spacing 2.75 m - Span Length 16.8 m - No Diaphragm Skew - Strength I Maximum Loading Condition

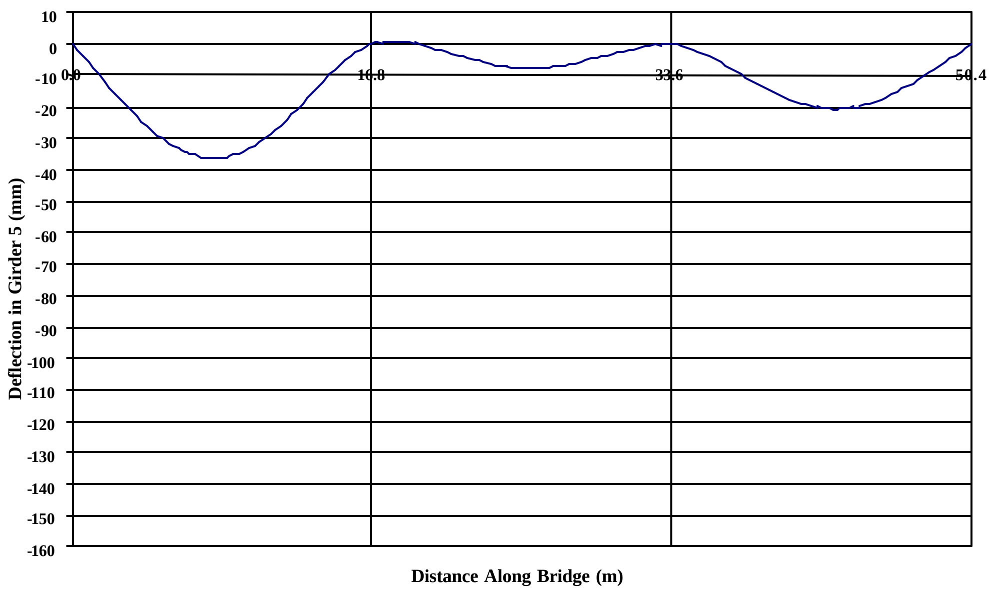

Figure 151
Type II Girder - 20° Bridge Skew - Girder Spacing 2.75 m - Span Length 16.8 m - No Diaphragm Skew - Strength I Maximum Loading Condition

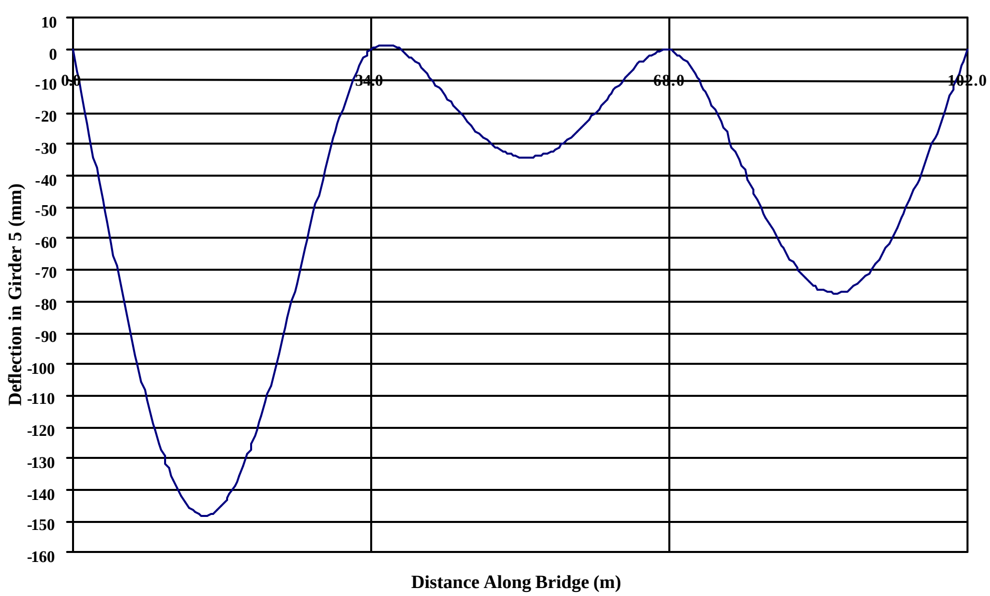

Figure 152
Type IV Girder - 10° Bridge Skew - Girder Spacing 1.52 m - Span Length 34.0 m - 30° Diaphragm Skew - Strength I Maximum Loading Condition

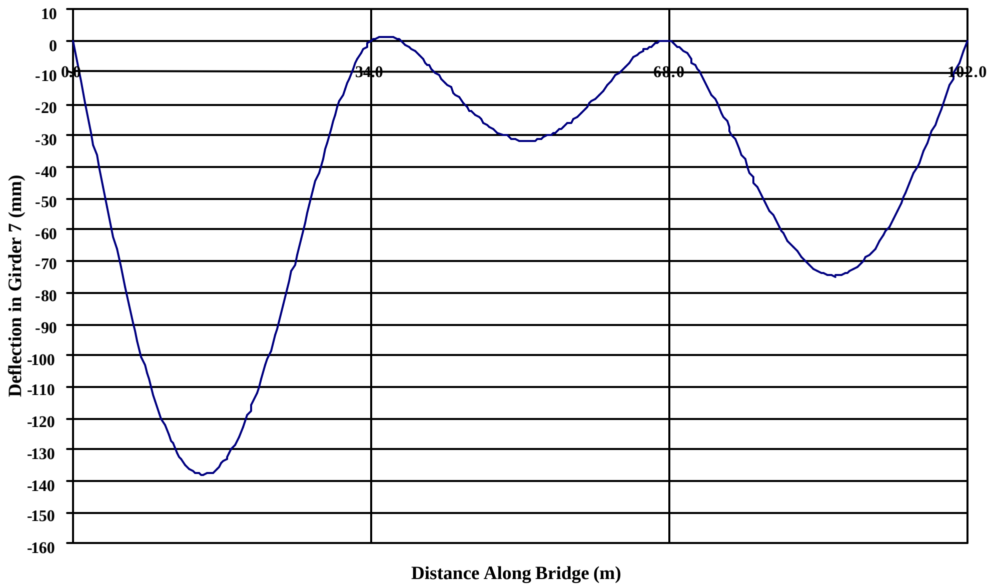

Figure 153
Type IV Girder - 10° Bridge Skew - Girder Spacing 1.52 m - Span Length 34.0 m - 30° Diaphragm Skew - Strength I Maximum Loading Condition

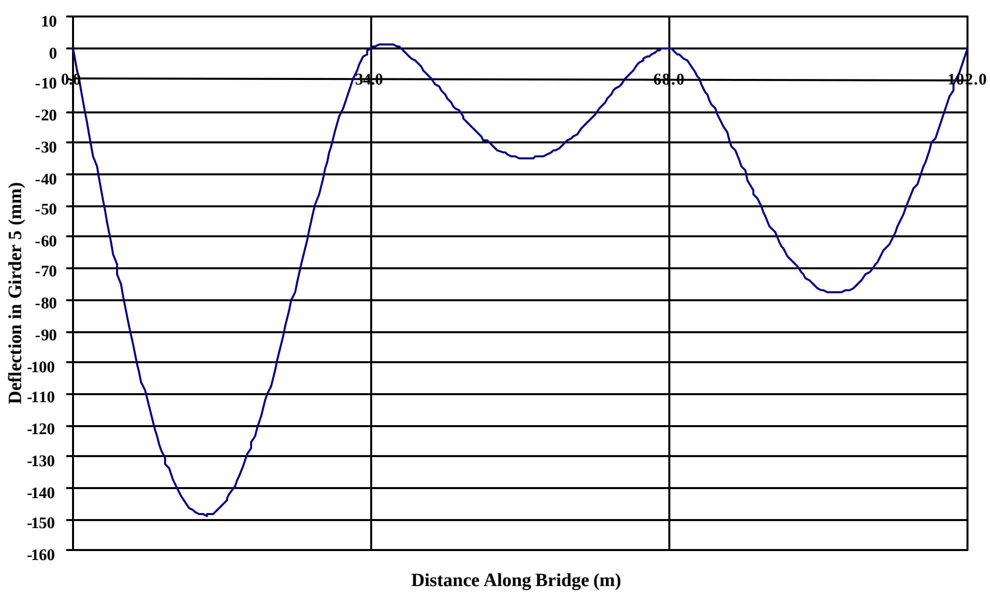

Figure 154
Type IV Girder - 10° Bridge Skew - Girder Spacing 1.52 m - Span Length 34.0 m - 65° Diaphragm Skew - Strength I Maximum Loading Condition

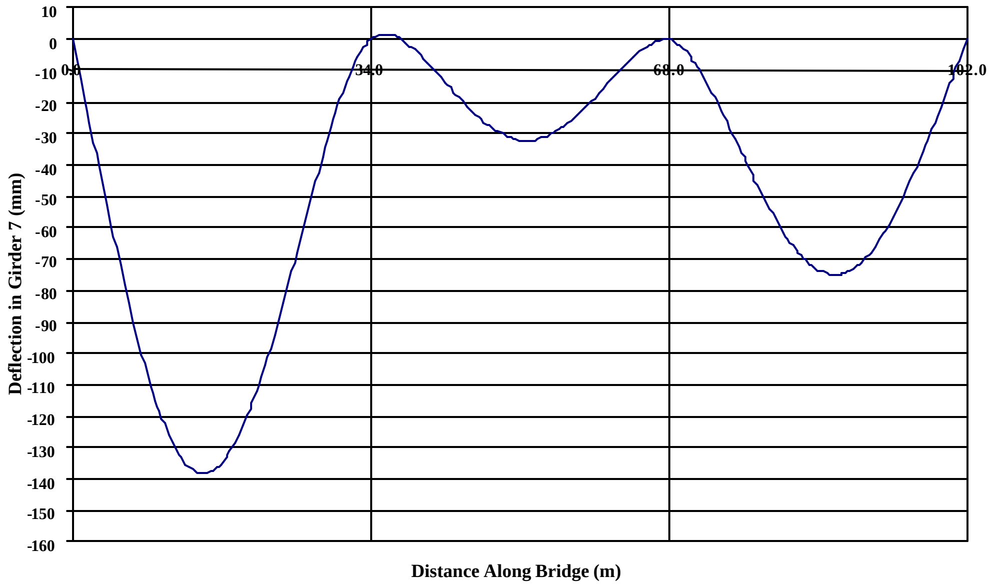

Figure 155
Type II Girder - 10° Bridge Skew - Girder Spacing 1.52 m - Span Length 34.0 m - 65° Diaphragm Skew - Strength I Maximum Loading Condition

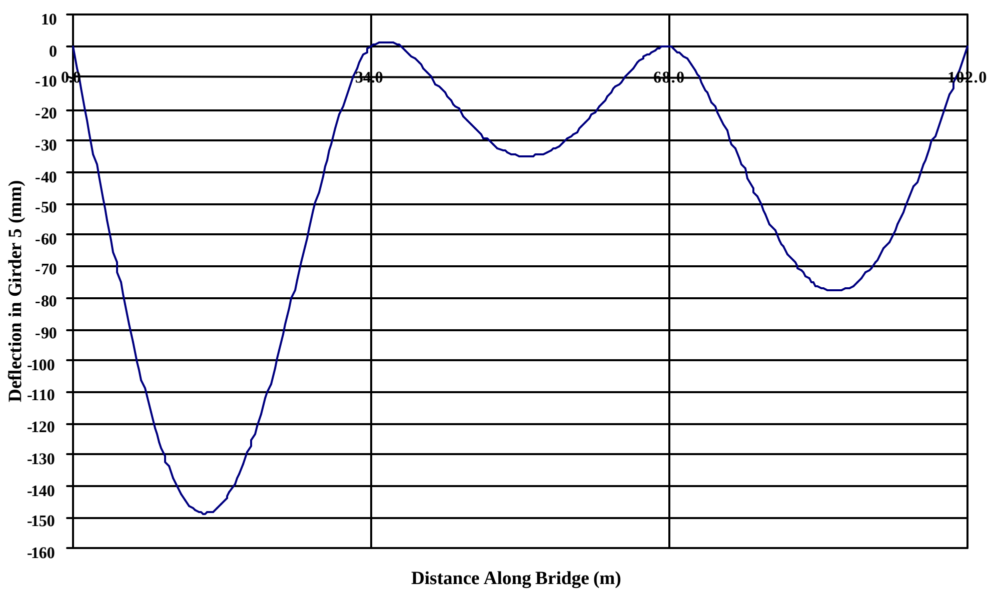

Figure 156
Type II Girder - 10° Bridge Skew - Girder Spacing 1.52 m - Span Length 34.0 m - No Diaphragm Skew - Strength I Maximum Loading Condition

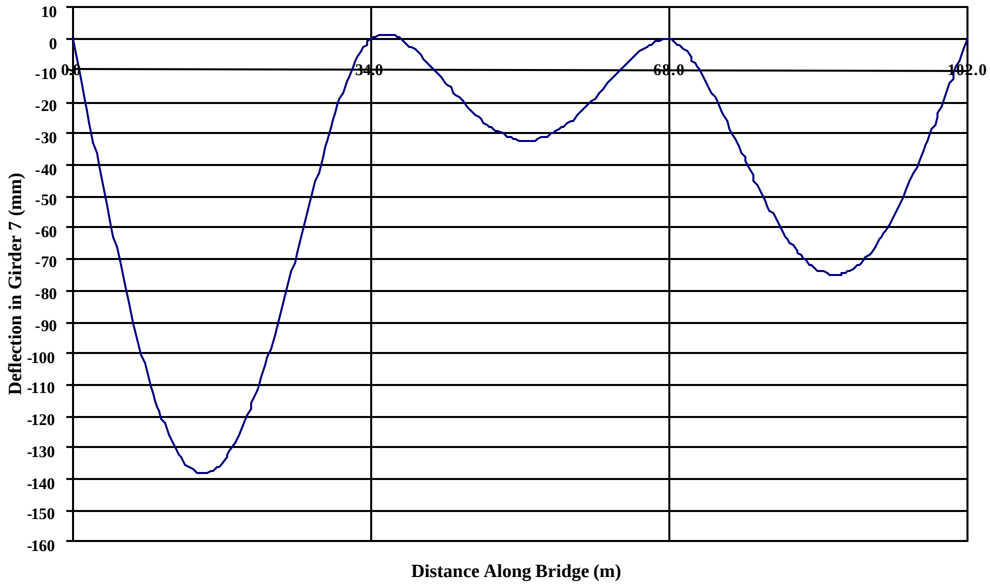

Figure 157
Type II Girder - 10° Bridge Skew - Girder Spacing 1.52 m - Span Length 34.0 m - No Diaphragm Skew - Strength I Maximum Loading Condition

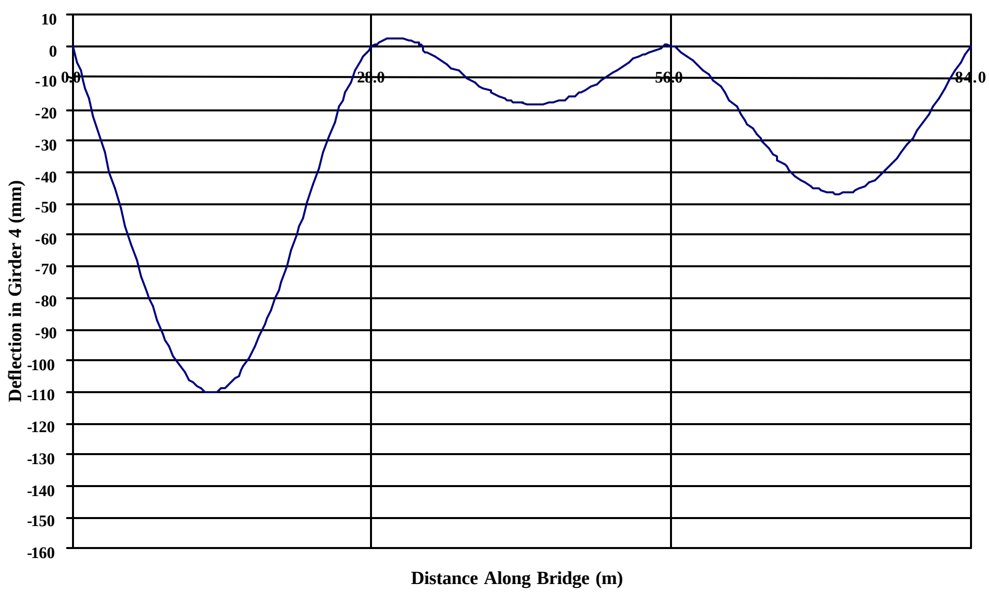

Figure 158
Type II Girder - 10° Bridge Skew - Girder Spacing 2.75 m - Span Length 28.0 m - 30° Diaphragm Skew - Strength I Maximum Loading Condition

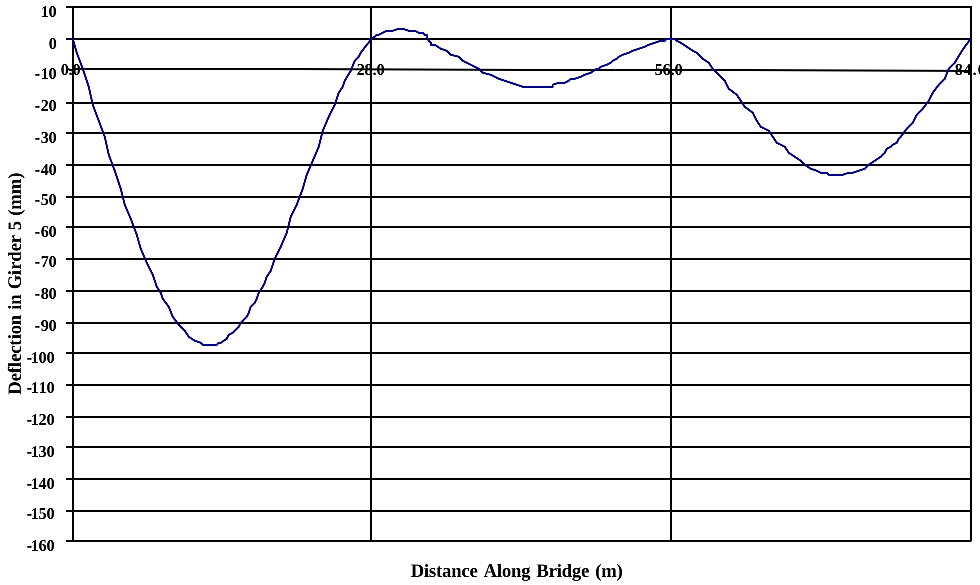

Figure 159
Type II Girder - 10° Bridge Skew - Girder Spacing 2.75 m - Span Length 28.0 m - 30° Diaphragm Skew - Strength I Maximum Loading Condition

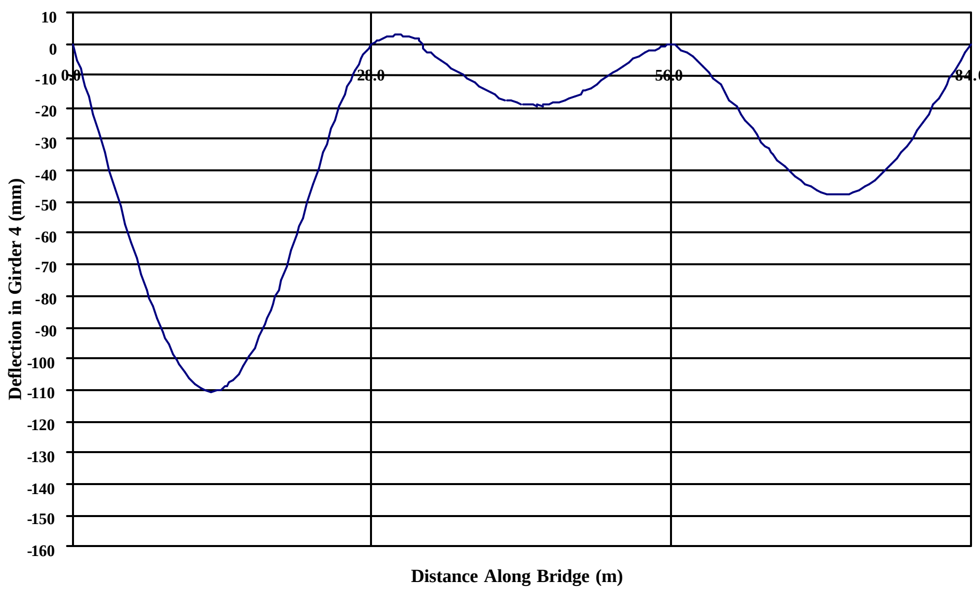

Figure 160
Type II Girder - 10° Bridge Skew - Girder Spacing 2.75 m - Span Length 28.0 m - 65° Diaphragm Skew - Strength I Maximum Loading Condition

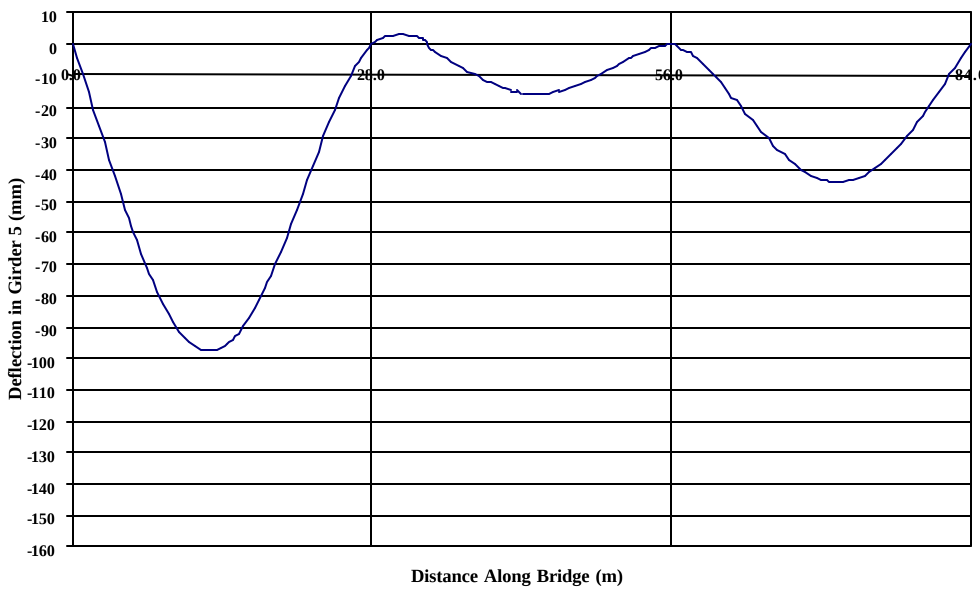

Figure 161
Type II Girder - 10° Bridge Skew - Girder Spacing 2.75 m - Span Length 28.0 m - 65° Diaphragm Skew - Strength I Maximum Loading Condition

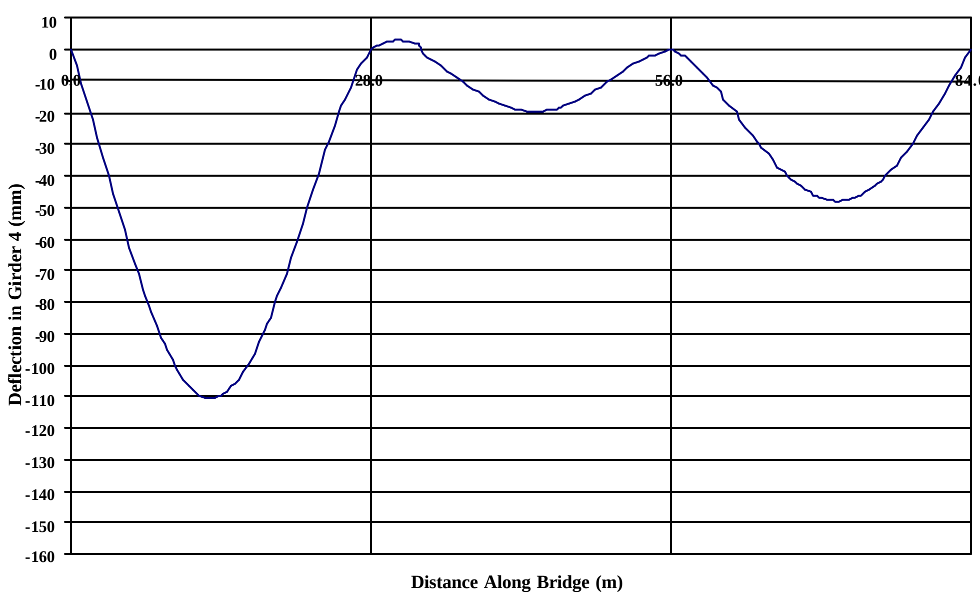

Figure 162
Type II Girder - 10° Bridge Skew - Girder Spacing 2.75 m - Span Length 28.0 m - No Diaphragm Skew - Strength I Maximum Loading Condition

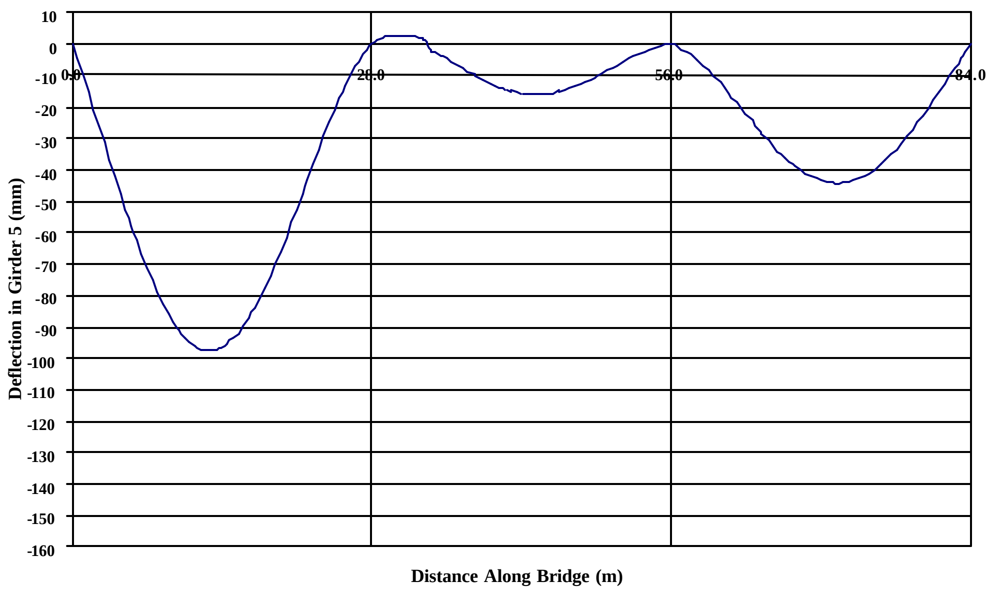

Figure 163
Type II Girder - 10° Bridge Skew - Girder Spacing 2.75 m - Span Length 28.0 m - No Diaphragm Skew - Strength I Maximum Loading Condition

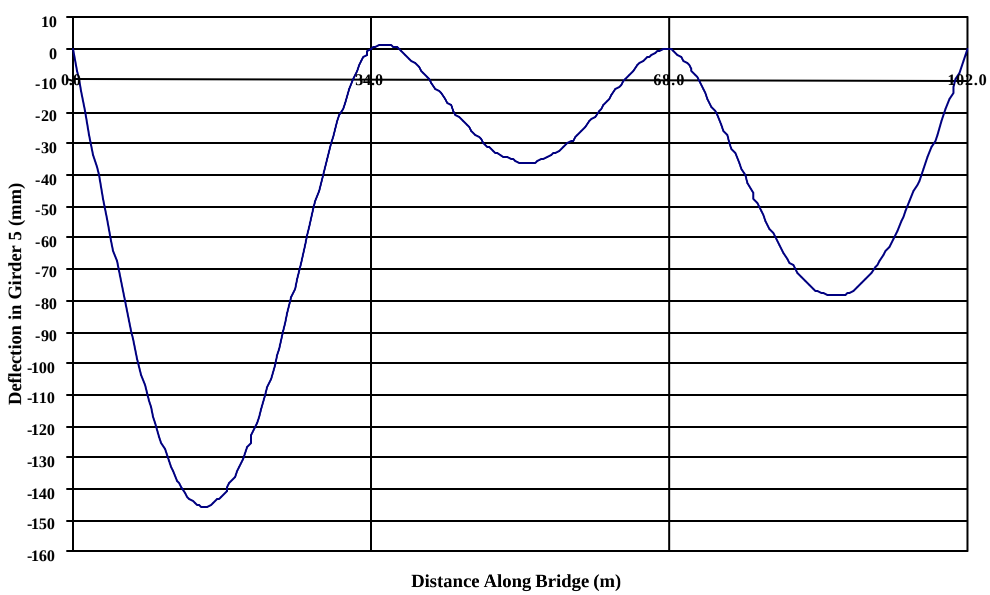

Figure 164
Type II Girder - 20° Bridge Skew - Girder Spacing 1.52 m - Span Length 34.0 m - 30° Diaphragm Skew - Strength I Maximum Loading Condition

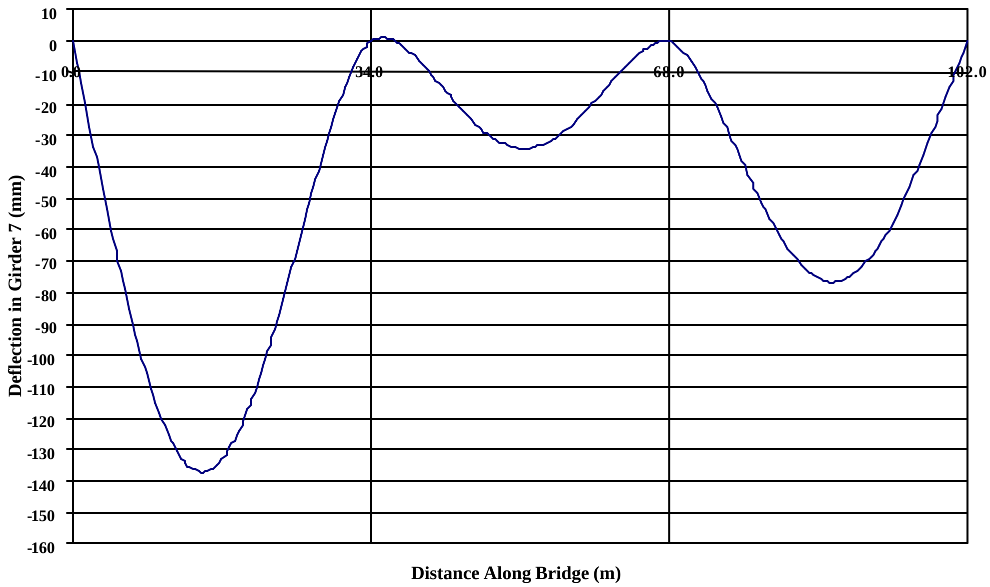

Figure 165
Type II Girder - 20° Bridge Skew - Girder Spacing 1.52 m - Span Length 34.0 m - 30° Diaphragm Skew - Strength I Maximum Loading Condition

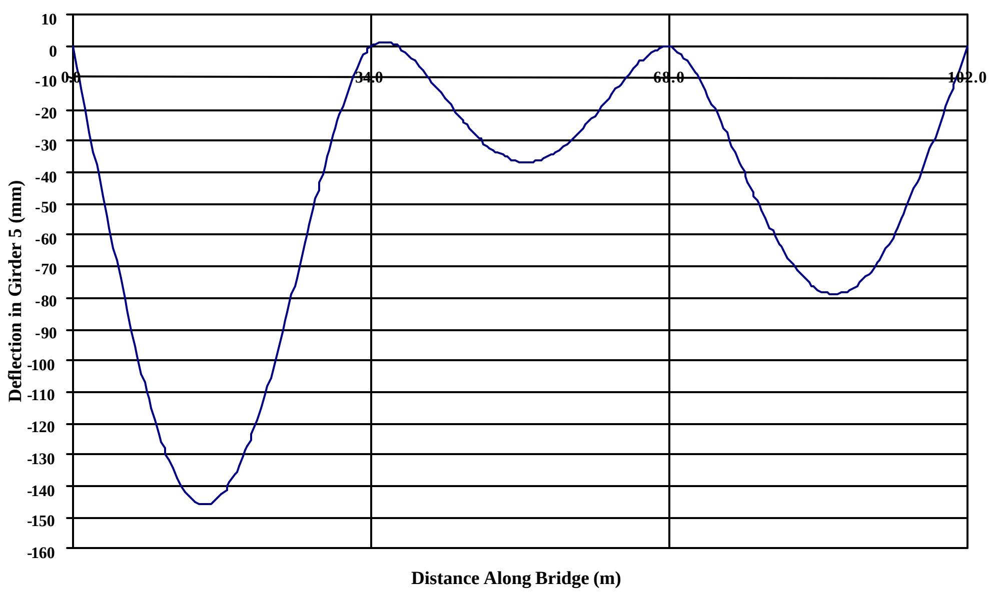

Figure 166
Type II Girder - 20° Bridge Skew - Girder Spacing 1.52 m - Span Length 34.0 m - 65° Diaphragm Skew - Strength I Maximum Loading Condition

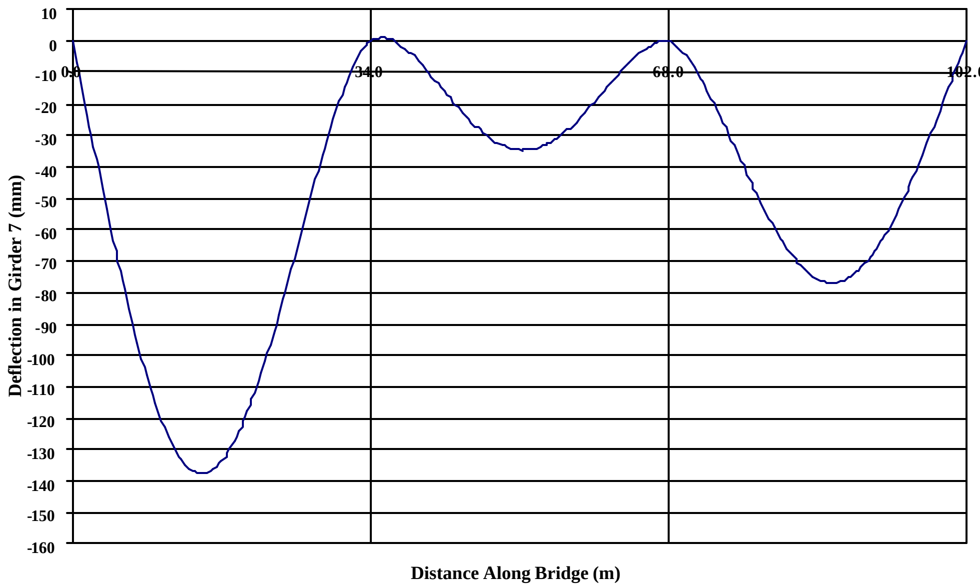

Figure 167
Type II Girder - 20° Bridge Skew - Girder Spacing 1.52 m - Span Length 34.0 m - 65° Diaphragm Skew - Strength I Maximum Loading Condition

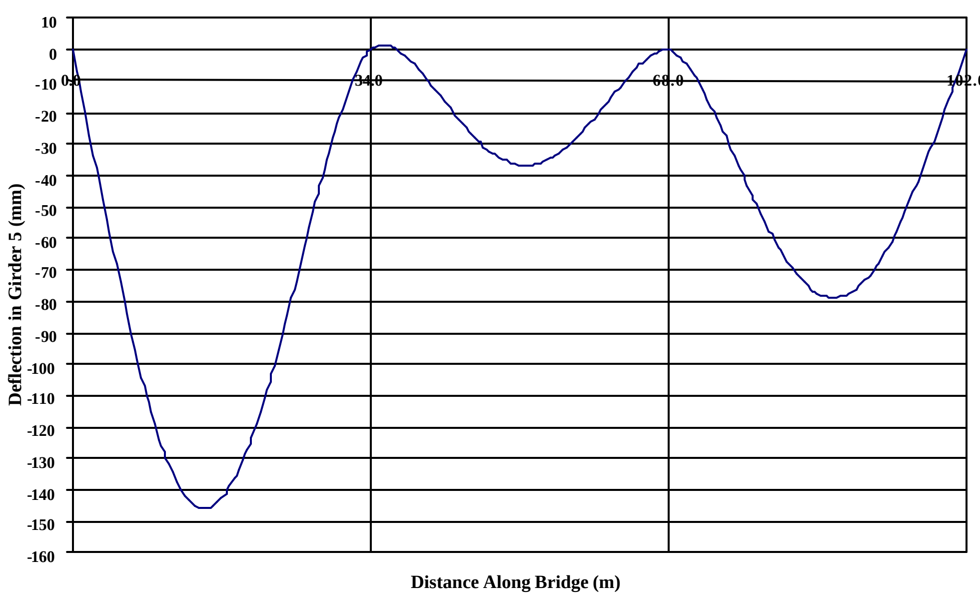

Figure 168
Type II Girder - 20° Bridge Skew - Girder Spacing 1.52 m - Span Length 34.0 m - No Diaphragm Skew - Strength I Maximum Loading Condition

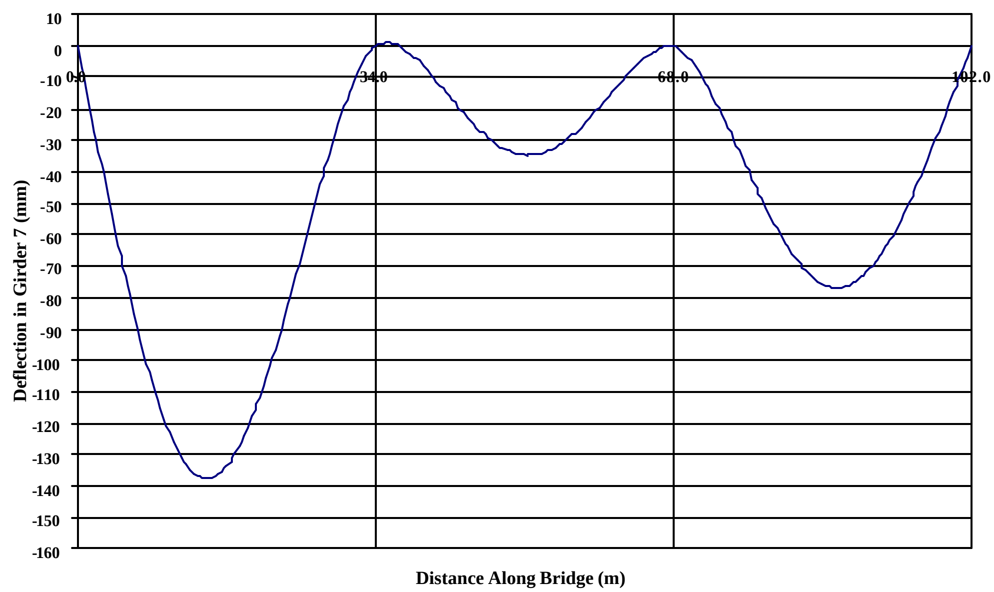

Figure 169
Type II Girder - 20° Bridge Skew - Girder Spacing 1.52 m - Span Length 34.0 m - No Diaphragm Skew - Strength I Maximum Loading Condition

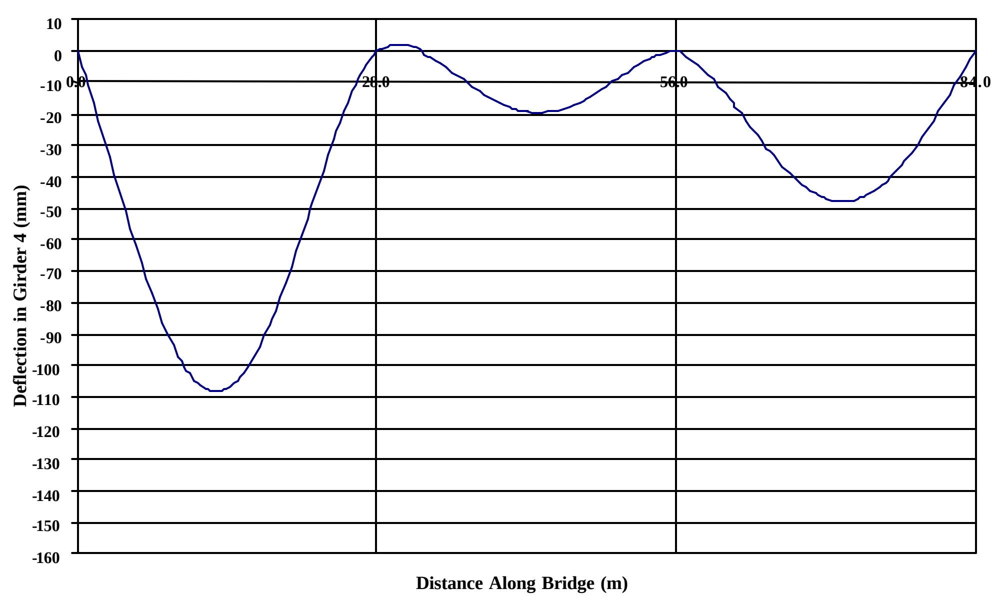

Figure 170
Type II Girder - 20° Bridge Skew - Girder Spacing 2.75 m - Span Length 28.0 m - 30° Diaphragm Skew - Strength I Maximum Loading Condition

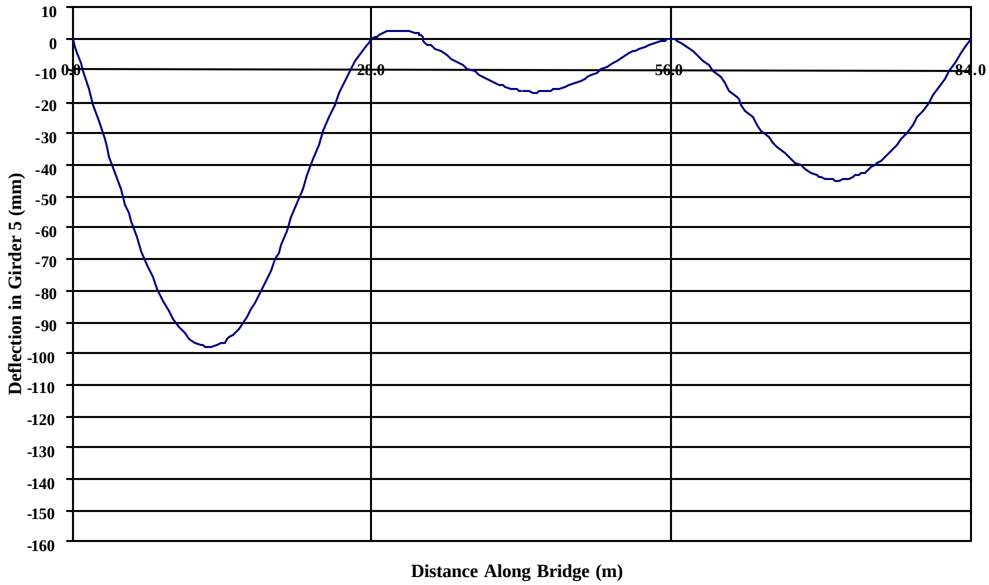

Figure 171
Type II Girder - 20° Bridge Skew - Girder Spacing 2.75 m - Span Length 28.0 m 30° Diaphragm Skew - Strength I Maximum Loading Condition

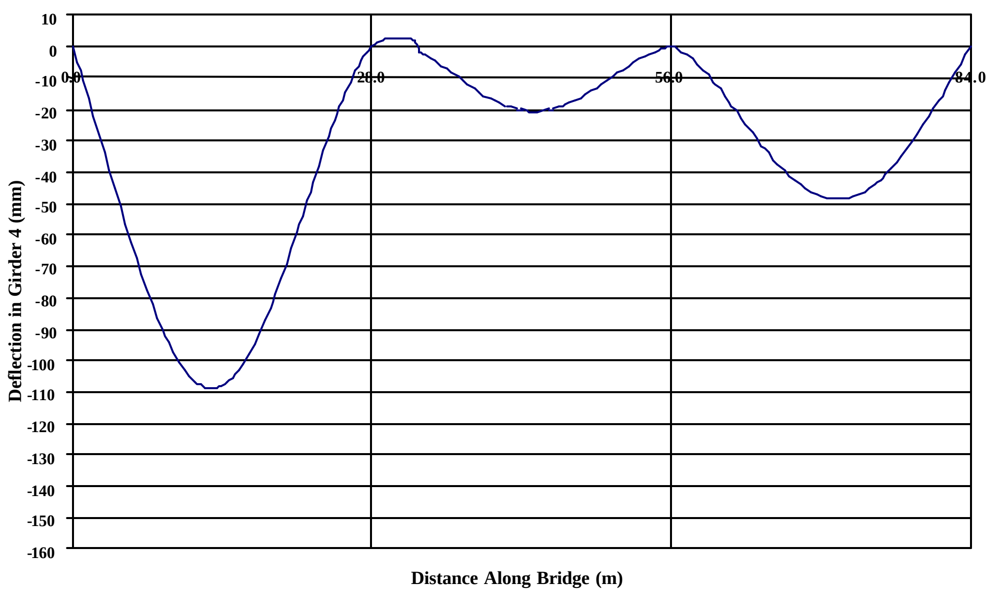

Figure 172
Type II Girder - 20° Bridge Skew - Girder Spacing 2.75 m - Span Length 28.0 m - 65° Diaphragm Skew - Strength I Maximum Loading Condition

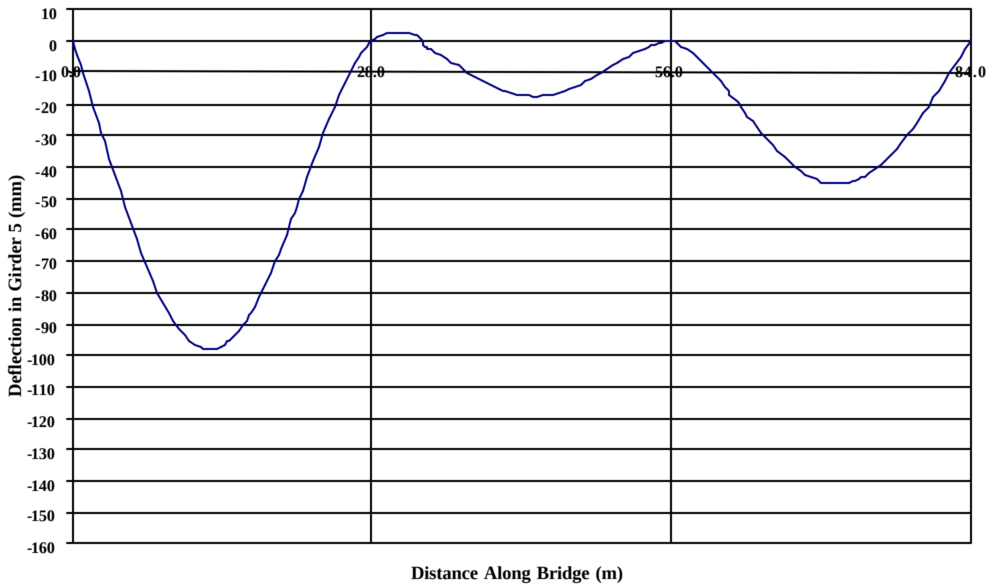

Figure 173
Type II Girder - 20° Bridge Skew - Girder Spacing 2.75 m - Span Length 28.0 m - 65° Diaphragm Skew - Strength I Maximum Loading Condition

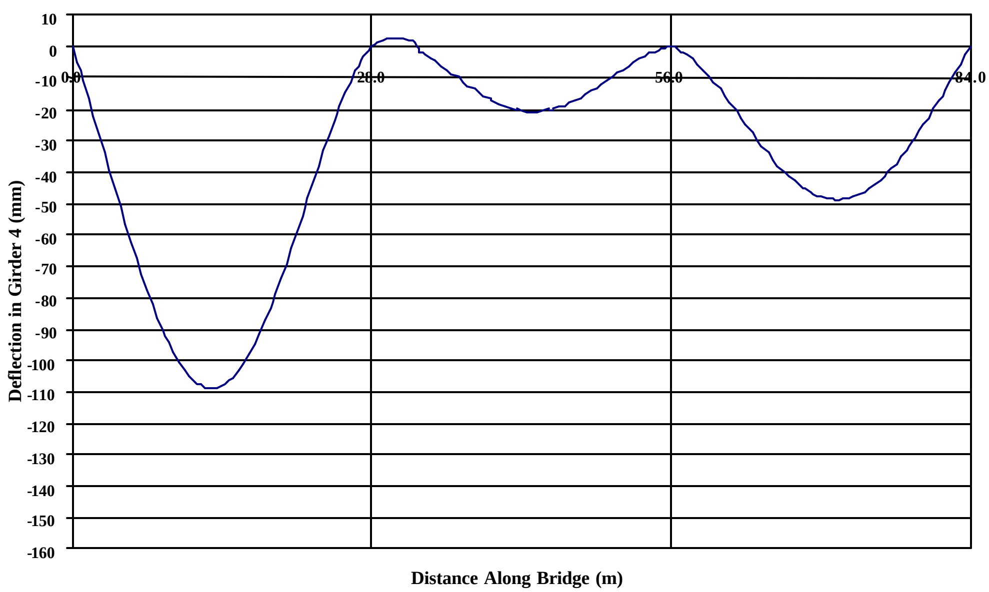

Figure 174
Type II Girder - 20° Bridge Skew - Girder Spacing 2.75 m - Span Length 28.0 m - No Diaphragm Skew - Strength I Maximum Loading Condition

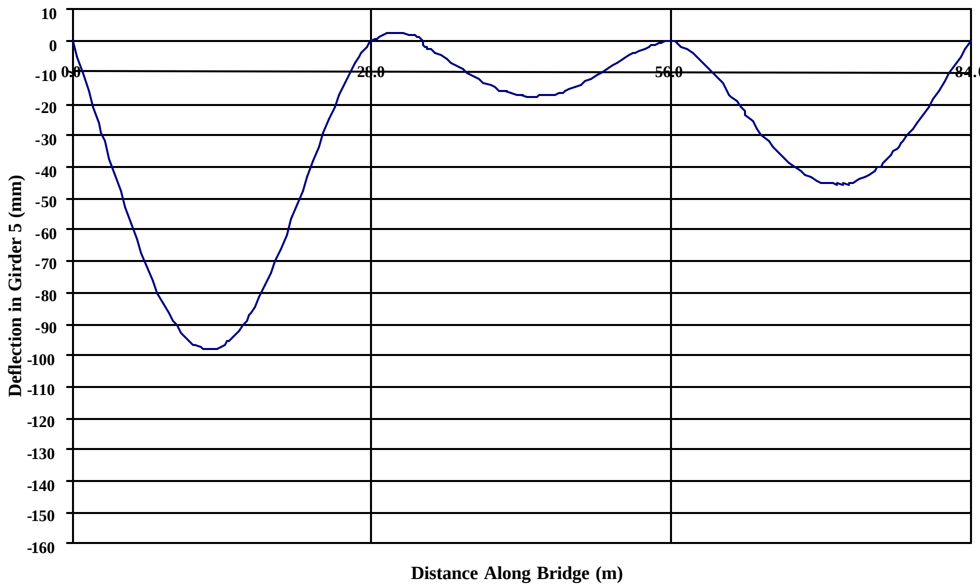

Figure 175
Type II Girder - 20° Bridge Skew - Girder Spacing 2.75 m - Span Length 28.0 m - No Diaphragm Skew - Strength I Maximum Loading Condition

APPENDIX G
RESULTS OF ANALYSES CRITICAL VALUES BRIDGE MODELS

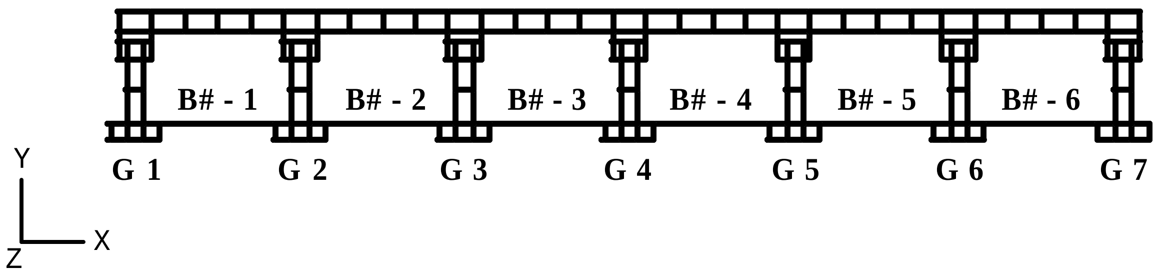

Figure 6 Repeated

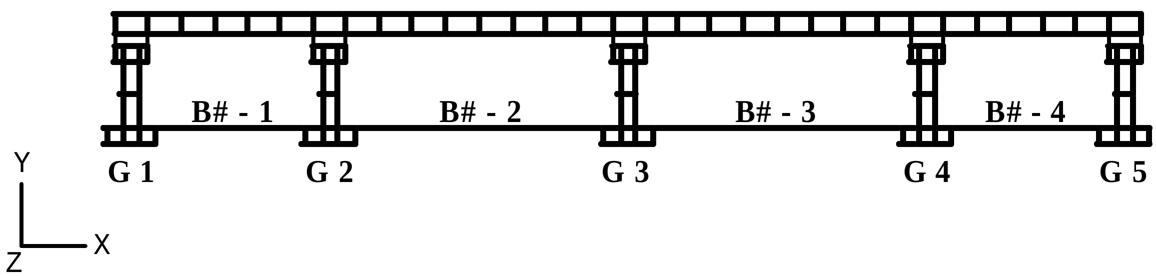

Figure 7 Repeated

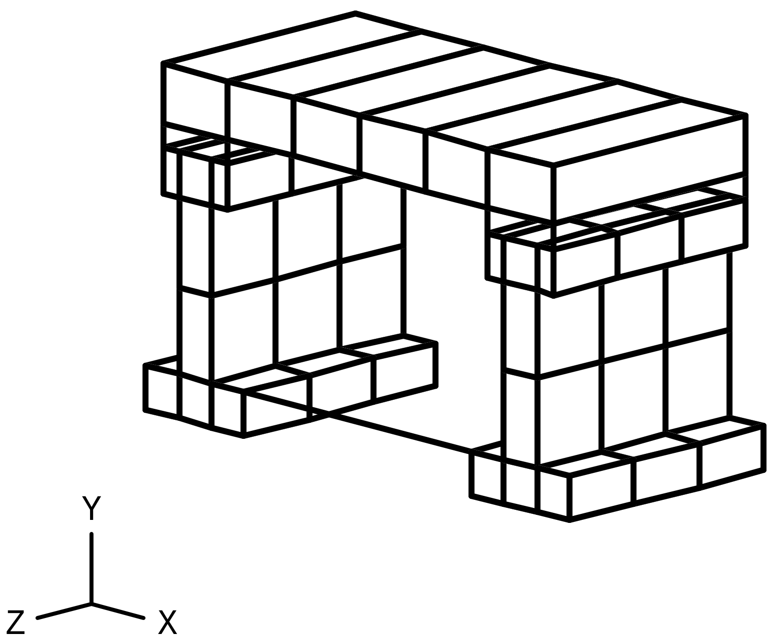

Figure 8 Repeated

Table 19
Maximum stresses in top surface of deck elements

Group	Model		Von Mises	SXX (MPa)	SYY (MPa)	SXY (MPa)
Group A	101	Min	77	-18.9	-16.2	-9.7
		Max	11,041	17.8	13.6	7.4
	102	Min	74	-19.0	-16.2	-9.8
		Max	11,081	17.9	13.4	7.4
	103	Min	71	-19.0	-16.2	-9.8
		Max	11,077	18.0	13.4	7.4
Group B	104	Min	81	-19.3	-15.5	-4.8
		Max	10,257	9.4	11.6	4.6
	105	Min	197	-19.4	-15.5	-4.8
		Max	10,282	9.5	11.5	4.6
	106	Min	168	-19.4	-15.5	-4.8
		Max	10,266	9.5	11.6	4.6
Group C	107	Min	65	-24.2	-16.1	-21.0
		Max	22,863	32.9	18.3	9.3
	108	Min	89	-24.4	-16.2	-21.1
		Max	22,933	33.3	18.4	9.4
	109	Min	94	-24.4	-16.2	-21.1
		Max	22,938	33.4	18.4	9.4
Group D	110	Min	138	-17.8	-15.7	-9.1
		Max	9,807	13.4	11.4	5.8
	111	Min	179	-17.9	-15.7	-9.2
		Max	9,821	13.3	11.4	5.9
	112	Min	146	-17.8	-15.7	-9.2
		Max	9,809	13.4	11.5	5.9
Group E	113	Min	67	-11.5	-7.6	-6.8
		Max	10,331	19.2	7.5	5.0
	114	Min	58	-11.5	-7.6	-6.8
		Max	10,388	19.3	7.5	5.1
	115	Min	58	-11.5	-7.6	-6.8
		Max	10,406	19.3	7.5	5.1
Group F	116	Min	22	-20.5	-14.0	-5.9
		Max	10,675	9.3	6.7	6.5
	117	Min	75	-20.5	-14.1	-5.9
		Max	10,685	9.3	6.5	6.6
	118	Min	89	-20.5	-14.1	-5.9
		Max	10,687	9.3	6.5	6.6
Group G	119	Min	71	-16.3	-8.4	-15.6
		Max	17,457	32.1	20.6	6.1
	120	Min	42	-16.4	-8.4	-15.6
		Max	17,459	32.3	20.7	6.1
	121	Min	42	-16.5	-8.4	-15.6
		Max	17,454	32.3	20.7	6.1
Group H	122	Min	129	-17.4	-14.6	-11.9
		Max	12,908	17.2	11.6	8.8
	123	Min	77	-17.5	-14.6	-11.9
		Max	12,896	17.2	11.6	8.9
	124	Min	104	-17.5	-14.6	-11.9
		Max	12,897	17.2	11.6	8.9

Table 20
Maximum stresses in bottom surface of deck elements

	Model		Von Mises	SXX (MPa)	SYY (MPa)	SXY (MPa)
Group A	101	Min	54	-17.8	-13.7	-7.4
		Max	11,047	18.9	16.1	9.7
	102	Min	54	-17.9	-13.4	-7.4
		Max	11,087	19.0	16.1	9.8
	103	Min	68	-18.0	-13.5	-7.4
		Max	11,083	19.0	16.2	9.8
Group B	104	Min	61	-9.4	-11.6	-4.6
		Max	10,250	19.3	15.4	4.8
	105	Min	178	-9.5	-11.6	-4.6
		Max	10,275	19.4	15.4	4.8
	106	Min	154	-9.5	-11.7	-4.6
		Max	10,258	19.4	15.4	4.8
Group C	107	Min	65	-32.9	-18.3	-9.3
		Max	22,861	24.2	16.0	21.0
	108	Min	56	-33.3	-18.4	-9.4
		Max	22,932	24.4	16.1	21.1
	109	Min	53	-33.4	-18.4	-9.4
		Max	22,937	24.4	16.1	21.1
Group D	110	Min	117	-13.4	-11.5	-5.8
		Max	9,800	17.8	15.7	9.1
	111	Min	153	-13.3	-11.4	-5.9
		Max	9,814	17.9	15.6	9.1
	112	Min	120	-13.4	-11.5	-5.9
		Max	9,801	17.9	15.6	9.2
Group E	113	Min	107	-19.2	-7.6	-5.0
		Max	10,339	11.5	7.4	6.8
	114	Min	98	-19.3	-7.7	-5.1
		Max	10,396	11.5	7.4	6.8
	115	Min	104	-19.3	-7.7	-5.1
		Max	10,413	11.5	7.4	6.8
Group F	116	Min	108	-8.7	-7.3	-6.6
		Max	10,673	20.5	14.1	5.5
	117	Min	101	-8.7	-7.1	-6.6
		Max	10,683	20.6	14.1	5.5
	118	Min	117	-8.7	-7.1	-6.6
		Max	10,685	20.6	14.1	5.5
Group G	119	Min	91	-32.1	-20.7	-6.1
		Max	17,457	16.3	8.2	15.6
	120	Min	78	-32.3	-20.8	-6.1
		Max	17,460	16.4	8.2	15.6
	121	Min	74	-32.3	-20.8	-6.1
		Max	17,455	16.4	8.2	15.6
Group H	122	Min	157	-16.2	-10.3	-8.9
		Max	12,162	17.6	14.7	11.4
	123	Min	72	-16.3	-10.5	-8.9
		Max	12,149	17.7	14.7	11.4
	124	Min	104	-16.3	-10.5	-8.9
		Max	12,146	17.6	14.7	11.4

Table 21
Maximum stresses in critical girder

Group			Von Mises	SXX (MPa)	SYY (MPa)	SZZ (MPa)	SXY (MPa)	SXZ (MPa)	SYZ (MPa)
Group A	101	Min	128	-17.3	-17.9	-68.0	-6.1	-18.9	-19.8
		Max	41,867	7.5	8.3	50.2	7.2	18.0	22.9
	102	Min	111	-23.6	-18.0	-65.2	-9.6	-6.8	-17.3
		Max	40,306	8.4	8.5	48.7	8.6	5.2	23.4
	103	Min	111	-11.9	-17.8	-64.5	-5.6	-6.6	-15.1
		Max	39,301	6.7	8.3	48.8	7.5	5.1	23.5
Group B	104	Min	150	-10.8	-19.7	-42.6	-8.5	-13.1	-12.1
		Max	26,964	6.3	4.8	36.9	7.1	10.4	13.4
	105	Min	205	-10.1	-19.5	-41.0	-8.4	-4.5	-8.9
		Max	25,905	6.2	4.5	35.8	7.0	3.7	13.8
	106	Min	202	-10.2	-19.6	-41.0	-8.4	-4.3	-8.5
		Max	25,839	6.2	4.4	36.3	7.2	3.6	13.9
Group C	107	Min	143	-20.8	-22.8	-66.1	-13.5	-22.6	-20.9
		Max	41,157	9.2	14.8	49.4	8.4	20.5	22.8
	108	Min	143	-12.1	-22.8	-62.9	-13.5	-8.9	-14.3
		Max	37,970	9.9	14.7	48.3	8.3	7.2	23.4
	109	Min	148	-12.2	-22.9	-62.8	-13.6	-9.9	-14.3
		Max	37,962	7.5	14.6	48.5	8.3	7.2	23.2
Group D	110	Min	164	-11.6	-20.4	-42.2	-9.0	-11.9	-11.1
		Max	26,685	6.4	4.8	36.4	7.5	11.6	13.4
	111	Min	146	-10.2	-20.3	-40.4	-8.8	-5.4	-8.4
		Max	25,561	6.3	4.6	35.2	7.4	4.8	13.9
	112	Min	163	-10.3	-20.4	-40.5	-8.8	-5.4	-8.4
		Max	25,610	6.3	4.5	35.7	7.6	4.8	13.9
Group E	113	Min	67	-9.4	-10.4	-46.6	-4.1	-11.6	-12.9
		Max	10,331	4.7	4.1	33.1	4.5	12.1	17.6
	114	Min	122	-8.0	-10.5	-44.9	-3.1	-5.4	-9.7
		Max	27,394	4.2	4.1	32.1	3.7	4.3	17.9
	115	Min	121	-8.0	-10.3	-44.8	-4.0	-5.3	-9.8
		Max	27,401	4.2	4.0	32.2	4.8	4.1	18.0
Group F	116	Min	369	-9.8	-16.5	-56.9	-6.1	-14.8	-15.0
		Max	34,740	6.3	4.5	33.6	3.7	8.4	21.8
	117	Min	392	-11.9	-16.3	-55.3	-6.0	-11.8	-13.4
		Max	33,575	6.3	4.5	32.6	3.6	5.3	22.1
	118	Min	406	-9.9	-16.3	-54.7	-6.0	-11.9	-11.7
		Max	33,792	6.3	4.4	32.6	3.9	5.6	22.4
Group G	119	Min	136	-11.3	-11.6	-46.1	-6.1	-12.1	-13.3
		Max	28,551	7.4	8.1	33.1	4.6	10.6	18.2
	120	Min	133	-8.2	-11.6	-44.7	-6.0	-7.3	-9.9
		Max	27,277	7.6	8.0	32.3	4.7	5.7	18.5
	121	Min	131	-8.2	-12.2	-44.6	-5.0	-8.3	-9.7
		Max	27,229	5.6	7.9	32.4	5.1	6.8	18.2
Group H	122	Min	318	-11.8	-15.6	-56.4	-5.8	-13.5	-15.2
		Max	34,611	7.4	4.2	33.6	4.3	9.5	19.0
	123	Min	340	-9.7	-15.5	-53.8	-4.6	-10.7	-10.9
		Max	32,534	7.6	4.2	32.5	4.5	5.1	19.2
	124	Min	343	-9.6	-15.3	-54.2	-5.6	-11.6	-11.4
		Max	32,961	6.1	4.2	32.7	4.3	5.6	21.5

Table 22
Maximum displacements in critical girder

Group	Model		X DISP. (mm)	Y DISP. (mm)	Z DISP. (mm)	X ROT. (rad)	Y ROT. (rad)	Z ROT. (rad)
Group A	101	Min	-2.4	-134.6	-13.5	-0.0166	0.0000	-0.0023
		Max	1.3	6.6	9.2	0.0170	0.0000	0.0044
	102	Min	-1.6	-135.3	-13.5	-0.0167	0.0000	-0.0023
		Max	1.4	6.6	9.4	0.0170	0.0000	0.0044
	103	Min	-1.7	-135.4	-13.5	-0.0167	0.0000	-0.0023
		Max	1.1	6.5	9.4	0.0171	0.0000	0.0044
Group B	104	Min	-2.0	-42.9	-5.9	-0.0071	0.0000	-0.0011
		Max	0.8	0.9	3.9	0.0075	0.0000	0.0045
	105	Min	-2.1	-43.2	-5.9	-0.0071	0.0000	-0.0011
		Max	0.8	1.0	4.0	0.0075	0.0000	0.0046
	106	Min	-2.1	-43.2	-5.9	-0.0071	0.0000	-0.0011
		Max	0.8	0.9	4.0	0.0075	0.0000	0.0047
Group C	107	Min	-4.3	-128.9	-12.8	-0.0156	0.0000	-0.0042
		Max	3.2	5.8	8.8	0.0161	0.0000	0.0076
	108	Min	-3.6	-129.7	-12.9	-0.0157	0.0000	-0.0042
		Max	2.7	5.6	9.0	0.0162	0.0000	0.0077
	109	Min	-3.4	-129.8	-12.8	-0.0157	0.0000	-0.0042
		Max	2.8	5.6	9.0	0.0162	0.0000	0.0077
Group D	110	Min	-2.1	-42.1	-5.7	-0.0067	0.0000	-0.0020
		Max	0.8	0.7	3.8	0.0074	0.0000	0.0033
	111	Min	-2.2	-42.4	-5.7	-0.0068	0.0000	-0.0021
		Max	0.8	0.9	3.9	0.0074	0.0000	0.0033
	112	Min	-2.2	-42.4	-5.7	-0.0068	0.0000	-0.0021
		Max	0.8	0.8	3.9	0.0074	0.0000	0.0033
Group E	113	Min	-2.4	-148.4	-17.3	-0.0139	0.0000	-0.0022
		Max	1.7	1.5	9.6	0.0115	0.0000	0.0039
	114	Min	-2.3	-148.9	-17.3	-0.0139	0.0000	-0.0022
		Max	1.4	1.5	9.7	0.0115	0.0000	0.0039
	115	Min	-2.3	-148.9	-17.3	-0.0139	0.0000	-0.0022
		Max	1.4	1.5	9.7	0.0115	0.0000	0.0039
Group F	116	Min	-2.1	-110.0	-13.8	-0.0115	0.0000	-0.0013
		Max	26.5	2.5	7.2	0.0107	0.0000	0.0079
	117	Min	-2.1	-110.5	-13.8	-0.0116	0.0000	-0.0013
		Max	26.3	3.1	7.3	0.0107	0.0000	0.0080
	118	Min	-2.1	-110.5	-13.8	-0.0116	0.0000	-0.0013
		Max	26.3	3.1	7.4	0.0107	0.0000	0.0080
Group G	119	Min	-4.8	-145.6	-16.9	-0.0133	0.0000	-0.0038
		Max	3.7	1.3	9.7	0.0112	0.0000	0.0065
	120	Min	-4.9	-146.0	-17.0	-0.0133	0.0000	-0.0038
		Max	3.0	1.3	9.8	0.0112	0.0000	0.0065
	121	Min	-4.7	-146.1	-17.0	-0.0133	0.0000	-0.0038
		Max	3.1	1.3	9.8	0.0112	0.0000	0.0065
Group H	122	Min	-1.8	-108.5	-13.6	-0.0111	0.0000	-0.0025
		Max	26.3	2.1	7.0	0.0107	0.0000	0.0067
	123	Min	-1.7	-109.0	-13.6	-0.0111	0.0000	-0.0026
		Max	25.9	2.8	7.2	0.0108	0.0000	0.0068
	124	Min	-1.8	-109.0	-13.6	-0.0111	0.0000	-0.0026
		Max	26.1	2.7	7.2	0.0108	0.0000	0.0068

Table 23
Maximum axial forces in diaphragms

	Model No.	Axial Force in Diaphragm (kN)
Group A	101	-751.5
	102	-304.9
	103	
Group B	104	-431.7
	105	-123.6
	106	
Group C	107	-661.4
	108	-53.0
	109	
Group D	110	-406.3
	111	-54.7
	112	
Group E	113	-1008.9
	114	-100.9
	115	
Group F	116	-1183.4
	117	-480.4
	118	
Group G	119	-842.6
	120	-40.0
	121	
Group H	122	-1104.1
	123	-129.3
	124	