Effect of variation of member stiffness on behavior to timber bridge floor systems
by Arne Bengt Riple

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Civil Engineering
Montana State University

Abstract:
This paper investigates the effects incurred in a bridge floor system resulting from variation in member stiffnesses. If the stiffness in one stringer is reduced, without reducing the stiffness in the other members, a higher load must be carried by the nonreduced members. The increased loading condition results in reduced capacity for the floor system. The study is accomplished using a computer simulation to analyze the member reactions in the floor system. Using a structural grid as a model for the bridge floor, a matrix solution based on the stiffness method is solved by computer. Figures are presented to show the effects on member reactions resulting from variation in stiffness and loading conditions. Results show the effects occurring in both exterior and interior stringers as well as in the floor planks. The governing effects from these members are combined to show the effects in the floor system. Reducing the stiffness in an exterior stringer results in a greater reduce tion in capacity of the floor system, compared to reduction in capacity due to reduction in an interior stringer.

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A thesis submitted in partial fulfillment
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APPROVAL

of a thesis submitted by

Arne Bengt Ripple

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citation, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

June 21, 1985 — Date

Fred F Videon — Chairperson, Graduate Committee

Approved for the Major Department

June 21, 1985 — Date

Fred F Videon for Ted Lang — Head, Major Department

Approved for the College of Graduate Studies

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ABSTRACT

This paper investigates the effects incurred in a bridge floor system resulting from variation in member stiffnesses. If the stiffness in one stringer is reduced, without reducing the stiffness in the other members, a higher load must be carried by the nonreduced members. The increased loading condition results in reduced capacity for the floor system. The study is accomplished using a computer simulation to analyze the member reactions in the floor system. Using a structural grid as a model for the bridge floor, a matrix solution based on the stiffness method is solved by computer. Figures are presented to show the effects on member reactions resulting from variation in stiffness and loading conditions. Results show the effects occurring in both exterior and interior stringers as well as in the floor planks. The governing effects from these members are combined to show the effects in the floor system. Reducing the stiffness in an exterior stringer results in a greater reduction in capacity of the floor system, compared to reduction in capacity due to reduction in an interior stringer.

CHAPTER 1

INTRODUCTION

Background

Bridges are an important part of the United States road network. Over the last years, the traffic situation has become much heavier than many older bridges were designed for. In addition to the increased loading conditions, the bridges have also been deteriorating and several bridges are structurally deficient to handle present-day loading conditions [1].

This deficiency has proved to be a severe problem for many highway departments. The Federal Highway Administration (FHWA) [1] has worked together with the highway departments to find suitable solutions to solve these problems. Several methods of renovation have been considered.

A survey conducted by the author reveals that many highway departments feel that replacement of the older bridges is the best solution, and they are currently replacing the older bridges as soon as funding is available.

As of 1981, based on a study by Koppers Co. [2] using a National Bridge inventory maintained by FHWA, over 71,000 bridges in the U.S. used timber as a major material of construction. About 86% of these are off the Federal Aid system. Further, of the 297,566 off-system bridges of all materials and types, 33.4% were classified as structurally deficient and 27.4% were classified as functionally obsolete. It is reasonable to assume that the percentage for timber bridges are at least as high as these overall figures.

Through personal communication with Don Harrison, Bridge Superintendent in Cascade County in Montana [3], several aspects of bridge maintenance in the off-system were discussed. Due to lack of funds the off-system bridges are seldom replaced at the same rate as the Federal Highway bridges. One problem that was discussed is the deterioration of the top sides of the stringers due to trapped moisture between floor planks and stringers. As the top sides of the stringers deteriorate, the connection between stringer and floor plank tend to become insufficient. To obtain adequate connection between stringer and plank, the stringer has in several cases been turned upside down instead of being replaced. The effect of such a deteriorated stringer can be compared to a stringer with reduced volume, and thereby reduced stiffness.

Objective

The purpose of this research is to examine the effects on a bridge floor system due to reduction of stiffness in one stringer. The theoretical model of the floor system is discussed in Chapter 2. The effects of reduced stiffness in interior and exterior stringers are examined using the computer model. These effects are studied to determine the strength reduction of the bridge floor.

CHAPTER 2

ANALYSIS OF FLOOR SYSTEM

The floor system is analyzed using a structural grid as a model, as proposed by Ghali and Neville [4]. A structural grid is defined as a frame structure with rigid joints whose members and joints lie in a common plane, with all applied force loads being out of the plane and normal to the plane of the structure. The model grid is a rectangular system consisting of seven stringers and one floor plank as shown in Figure 1.

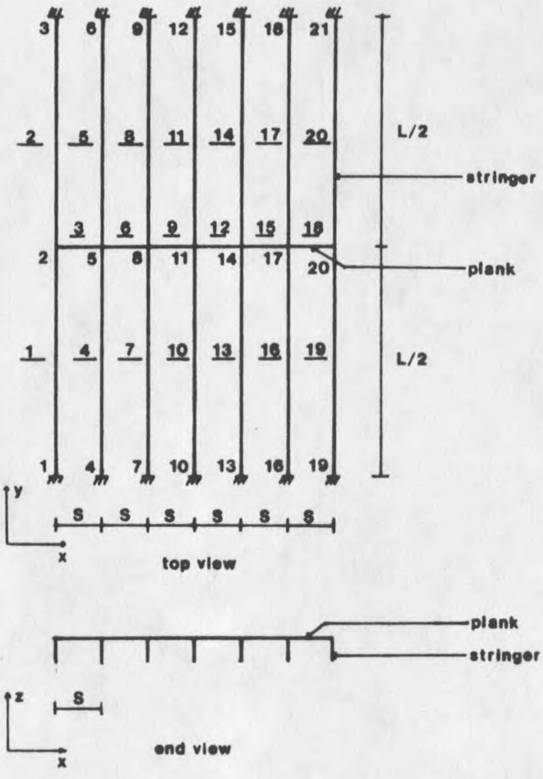

Figure 1. Grid model of floor system. "1" member number; "1" joint number.

Plank decks consist of individual planks spiked across the stringers. Since the planks are not connected to each other, all bending in the longitudinal y-direction occur in the stringers. The use of one floor plank is therefore sufficient to examine the transverse distribution of bending moment in the floor system. For maximum bending effects in the stringers, the plank is located at the center of the stringers.

At the supports, the stringers are unrestrained for bending rotation about the x-axis, but are restrained for translation in the z-direction and torsional rotation about the y-axis.

To solve the structural grid, the stiffness method as presented by Weaver and Gere [5] is used. The theory behind the stiffness method is not discussed in this paper, but the computer program is listed in the Appendix.

The dimensions used in the floor system are based upon requirements set by AASHTO [6]. To avoid the effects of buckling, the width to depth ratio, d/b = 2.0. From the length to depth ratio L/d = 15.0, the dimensions of the stringers are:

b = 10.0 in

d = 20.0 in

The dimensions of the reduced stringers are:

1. b = 10.0 in

   d = 18.0 in

2. b = 10.0 in

   d = 16.0 in

For the floor plank, the minimum thickness is 3.0 in. The width b of the floor plank is set to be 12.0 in, but the thickness is varied in one inch crements from 3.0 in to 6.0 in.

According to these dimensions, the computer simulation is run with a variation in the member stiffness as shown in Table 1.

Table 1. Variation in Stiffness for the Grid Members.

L/d	I_s/L (in^3)	I_{rs}/L (in^3)	I_p/S (in^3)
		32.680	
10.2	32.680	23.824	
		16.732	1.125
		22.222	2.667
15.0	22.222	16.200	
		11.378	5.208
		16.835	9.000
19.8	16.835	12.273	
		8.620	

I_s = moment of inertia of stringer; I_{rs} = moment of inertia of deteriorated stringer; I_p = moment of inertia of floor plank; L = length of stringers; S = spacing of stringers; d = depth of stringer.

The analysis of the grid is based on four loading conditions. A unit load P is individually placed at these locations:

1. Exterior stringer, joint 2
2. First interior stringer, joint 5
3. Second interior stringer, joint 8
4. Center stringer, joint 11

Each of these loading conditions give a set of influence lines that show the bending moment in each stringer, Figures 2-6. The bending moment in the loaded stringer is used as reference moment, and the bending moments in the other stringers are shown as a percentage of this reference moment.

Figures 3 and 4 show the bending moment in the stringers at the location of the plank with the load P located at joint 5. In Figure 3 the curves show the variation in the stringer stiffness. Figure 4 shows the variation in the stiffness in the floor plank.

Notice is Figure 4 that the bending moment in the exterior stringer for $I_p/S = 9.0$ is actually greater than the bending moment in the loaded first interior stringer. The low stiffness in the stringers, I_s/L = 16.8, allow large deflections, and the high stiffness in the

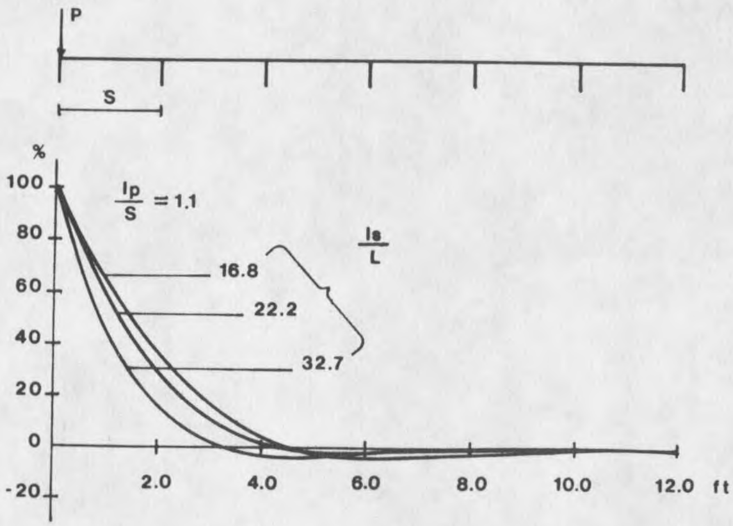

Figure 2. Bending moment in stringers at location of floor plank due to a unit load P at the exterior stringer. Curves show the effect of variation in stringer stiffness.

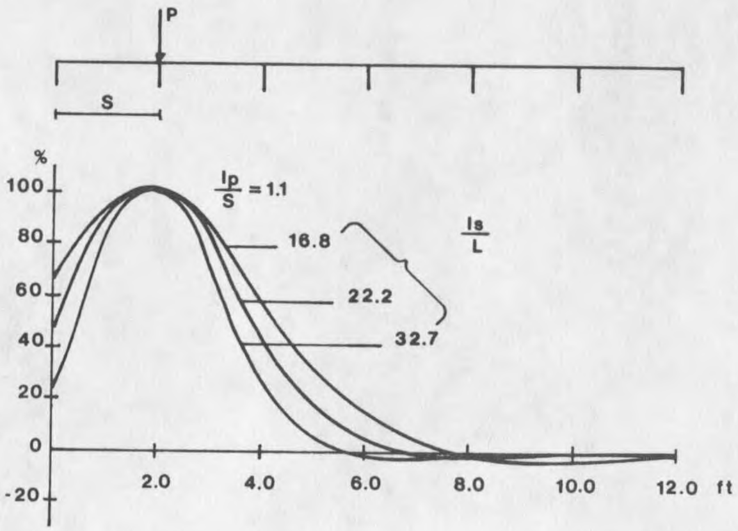

Figure 3. Bending moment in stringers at location of floor plank due to a unit load P at the first interior stringer. Curves show the effect of variation in stringer stiffness.

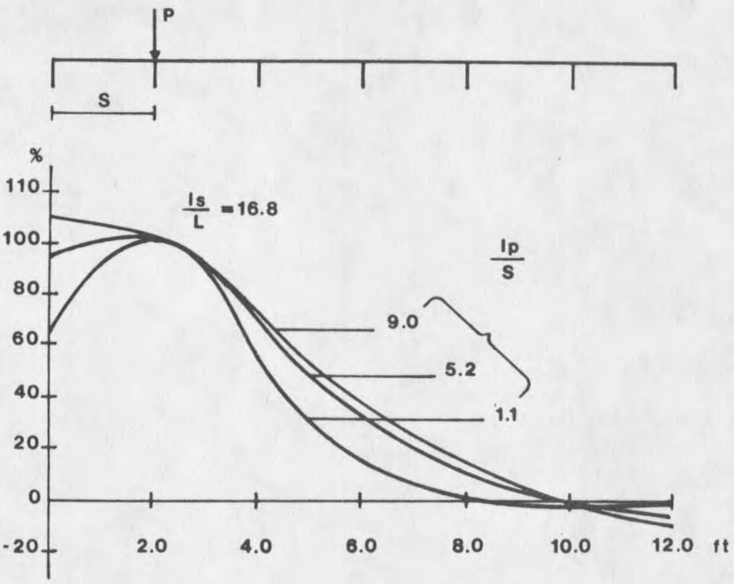

Figure 4. Bending moment in stringers at location of floor plank due to a unit load P at the first interior stringer. Curves show the effect of variation in plank stiffness.

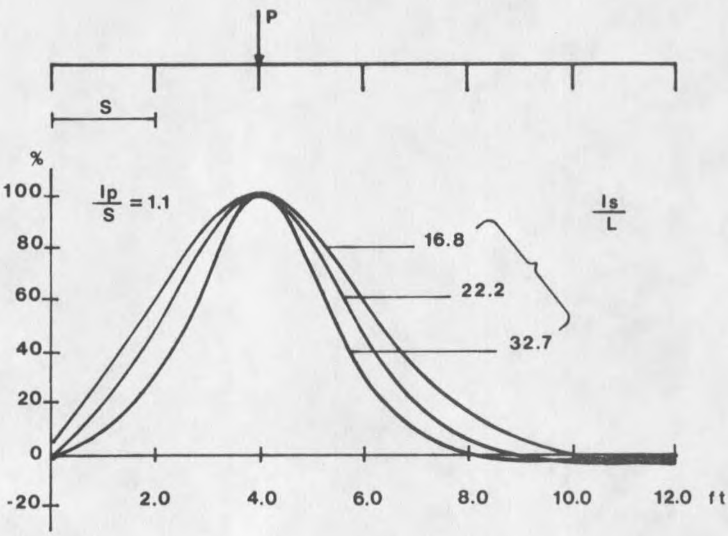

Figure 5. Bending moment in stringers at location of floor plank due to a unit load P at the second interior stringer. Curves show the effect of variation in stringer stiffness.

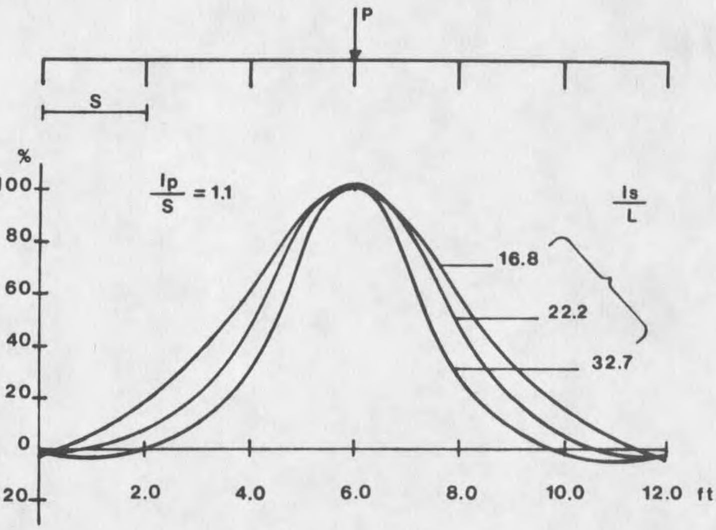

Figure 6. Bending moment in stringers at location of floor plank due to a unit load P at the center stringer. Curves show the effect of variation in stringer stiffness.

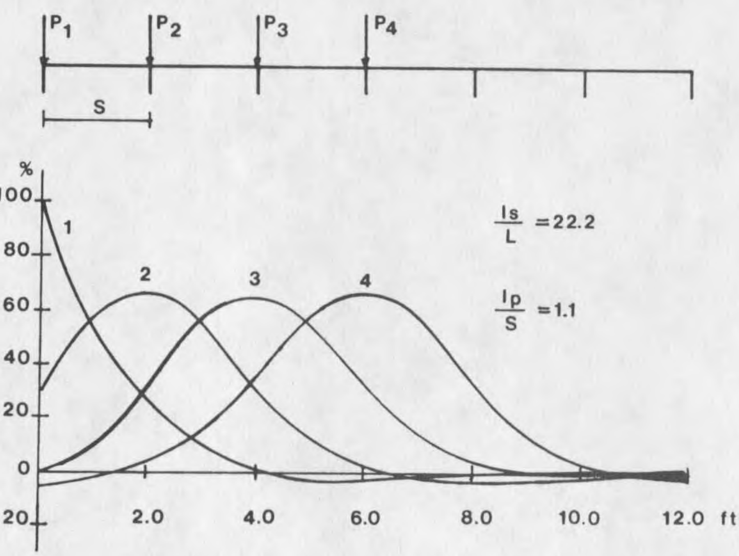

Figure 7. Bending moment in stringers at location of floor plank. Curves show the variation in location of the unit load P.

floor plank make the floor system act with a higher rigidity. This results in larger deflection and higher bending moment in the exterior stringer than in the first interior stringer.

As the stringer stiffness is increased, the distribution of bending moment from the loaded stringer to the adjacent stringer is reduced. This effect is reversed when looking at the stiffness in the plank. As the stiffness of the plank is increased, better distribution of bending moment is achieved. This capability of distributing the moment is important when looking at the effects of having a stringer with reduced stiffness.

When designing the stringers for maximum bending moment, the exterior stringers are designed for a larger moment than the interior stringers. All interior stringers are designed for the same maximum bending moment. Figure 7 shows the four loading conditions and the difference in bending moment between exterior and interior stringers.

When investigating the effects of a stringer with reduced stiffness, the greatest effects are noticed in the reduced stringer and the first adjacent stringer. Figures 8-11 show the percentage distributed bending moment from the loaded stringer to the first adjacent stringer. The curves show the effect of the variation in stringer and plank stiffnesses. As the stringer stiffness is decreased, more moment is distributed to the next stringer. This is reversed for the stiffness in the floor plank. Interpolation between the curves is possible for other magnitudes of member stiffness.

When investigating the effects of having the stiffness in one stringer reduced, it is only necessary to reduce the center stringer and the exterior stringer. The reduction in the center stringer is representative for all interior stringers, whereas the exterior stringer has to be investigated separately.

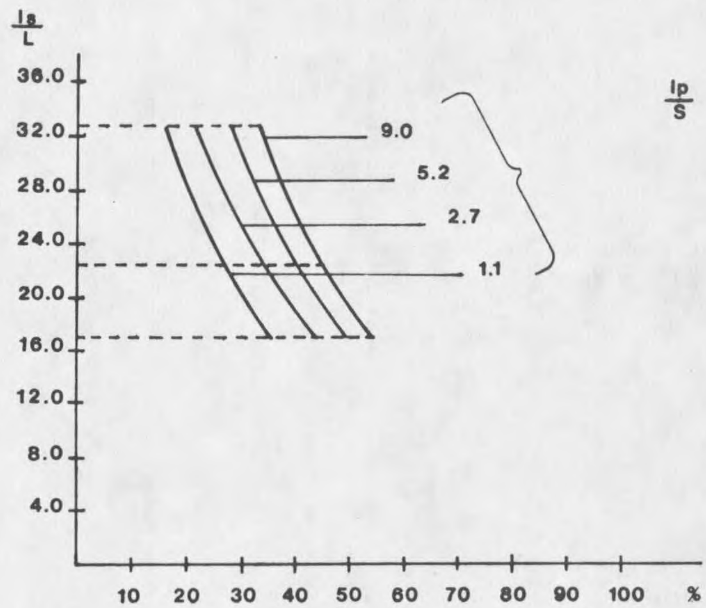

Figure 8. Distribution of bending moment from the exterior stringer to first interior stringer. Load is located at exterior stringer.

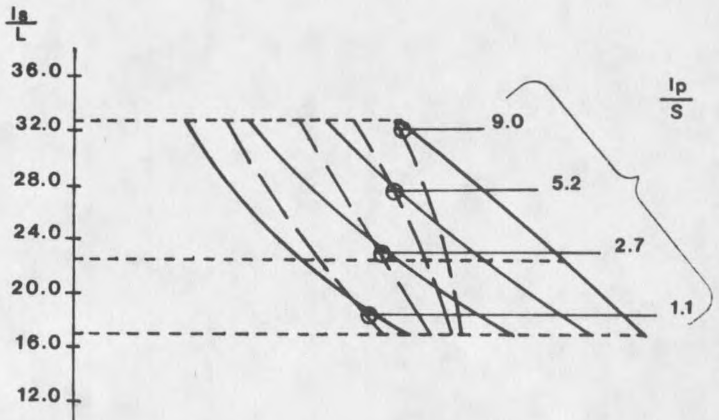

Figure 9. Distribution of bending moment from first interior stringer to:
—— exterior stringer
––– interior stringer
Load is located at first interior stringer.

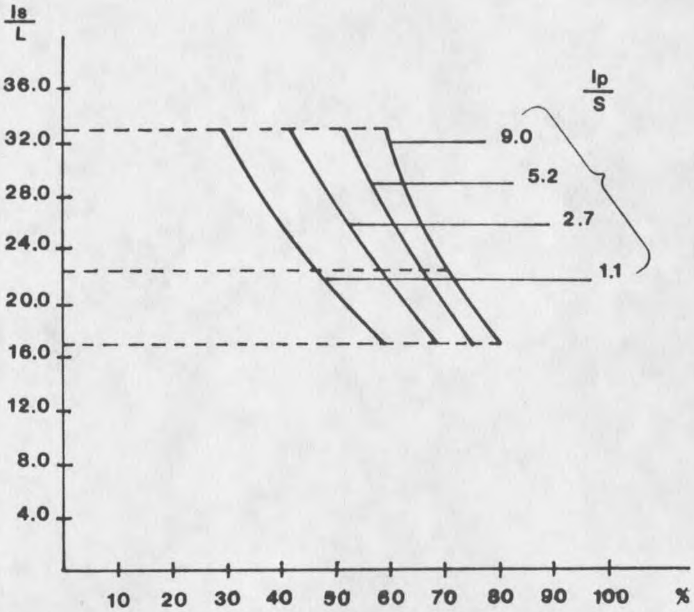

Figure 10. Distribution of bending moment from second interior stringer to first interior stringer. Load is located at second interior.

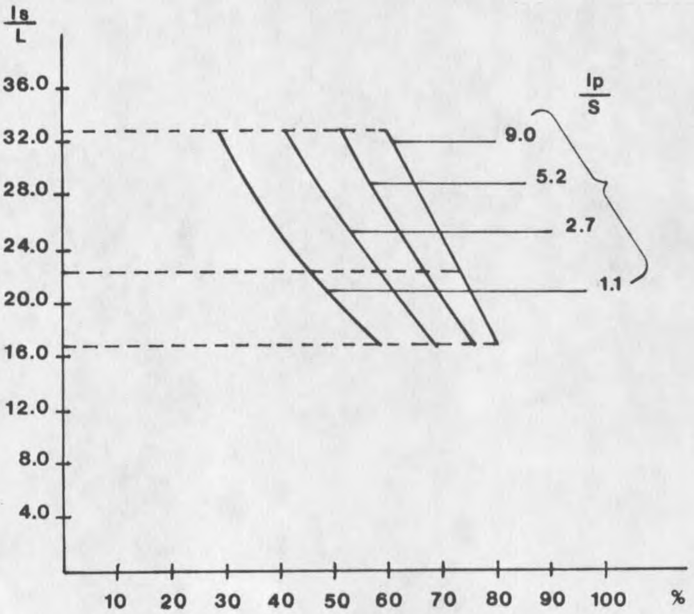

Figure 11. Distribution of bending moment from center stringer to second interior stringer. Load is located at center stringer.

CHAPTER 3

RESULTS

Bending in Stringers

Reduced Stiffness in Center Stringer

When the stiffness in the center stringer is reduced, the two adjacent stringers must help carry the extra load the center stringer can no longer carry itself. The bending moment in the reduced center stringer is reduced whereas the bending moments in the two adjacent stringers are increased, Figure 12.

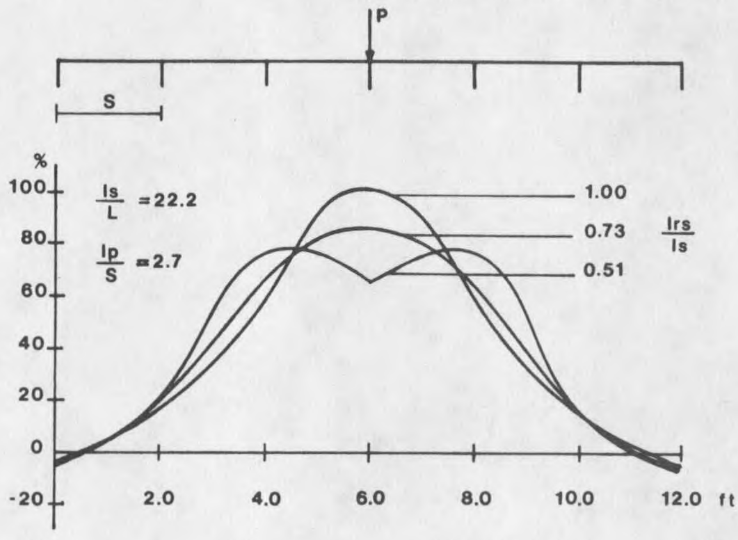

Figure 12. Reduction of stiffness in center stringer. Curves show the effect in bending moment in stringers.

Finding the governing effects of bending moment in the stringers requires two loading conditions.

1. unit force P at center stringer, joint 11

2. unit load P at second interior stringer, joint 8

Reducing the stiffness in the center stringer results in decreased moment capacity for this stringer. This reduction in moment capacity must be considered when comparing the effects of the change in bending moment in the stringers.

The moment capacity in a stringer is given in Equation 1.

$$M = f_b \cdot S_x \tag{1}$$

For a stringer with reduced stiffness, the moment capacity is

$$M_r = f_b \cdot S_{xr} \tag{2}$$

The relationship between these two equations is

$$f_b = \frac{M}{S_x} = \frac{M_r}{S_{xr}} \tag{3}$$

This gives

$$\frac{M_r}{M} = \frac{S_{xr}}{S_x} \tag{4}$$

The moment capacity for the reduced stringer used in this analysis is calculated using Eq. 4 and is listed in Table 2 as a function of I_{rs}/I_s.

Table 2. Moment Capacity for Reduced Stringer.

I_{rs}/I_s	1.0	0.73	0.51
M_r/M	1.0	0.81	0.64

With a reduction in stiffness to 51% of the full stiffness, the moment capacity is reduced to 64%.

The governing effects of a load placed at the reduced center stringer is noticed in the center stringer. Figures 13-15 show the effects in the center stringer. The straight line

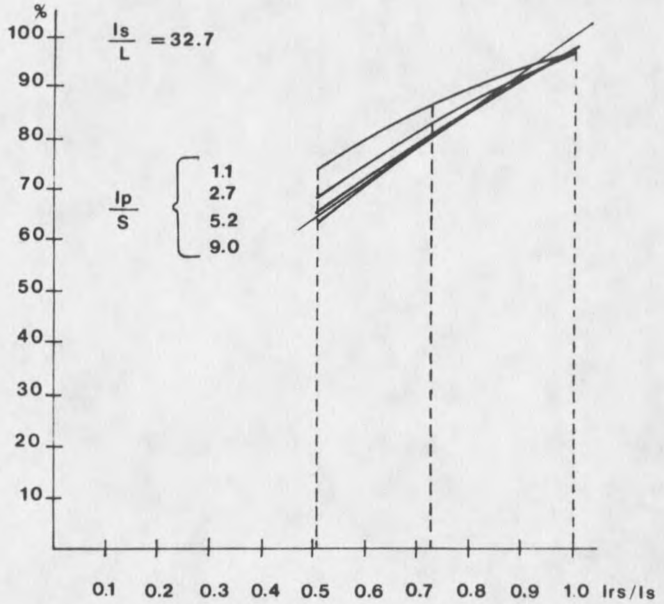

Figure 13. Reduced stiffness in center stringer. Effect in center stringer – $I_S/L = 32.7\ in^3$.

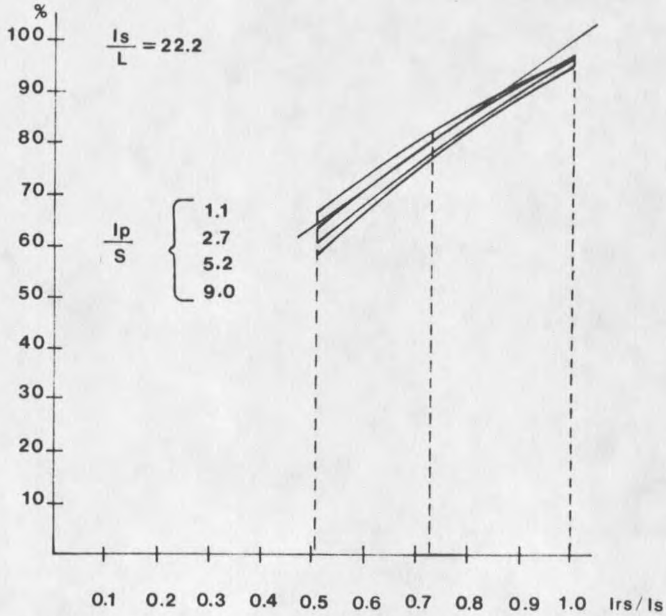

Figure 14. Reduced stiffness in center stringer. Effect in center stringer – $I_S/L = 22.2\ in^3$.

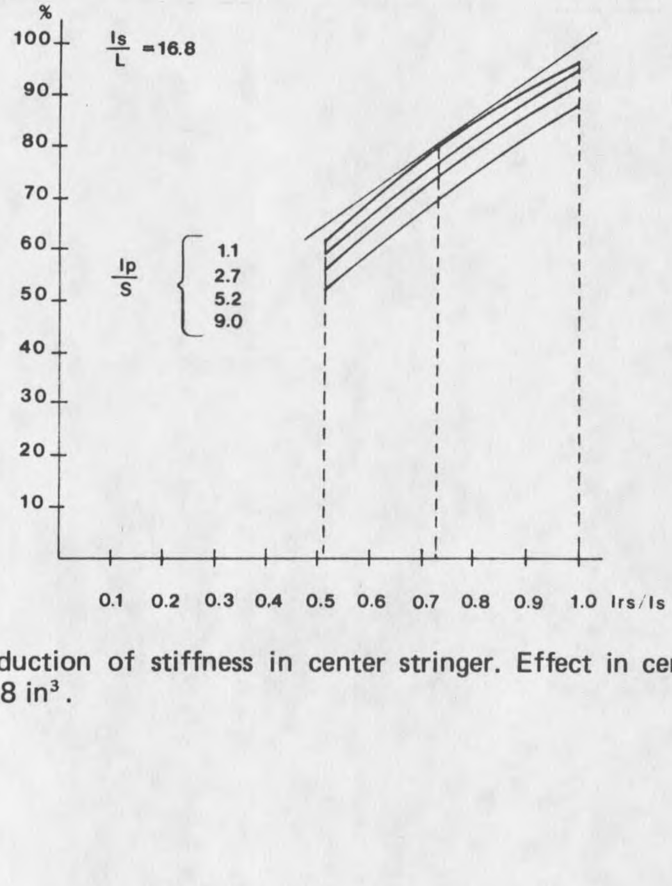

Figure 15. Reduction of stiffness in center stringer. Effect in center stringer — I_s/L = 16.8 in^3.

represents the moment capacity of the stringer. When the moment curve is above the moment capacity, the effect of bending is increased in the center stringer. Measuring the difference between the moment curve and the moment capacity gives a direct indication of the reduction in capacity of the member.

As the stiffness in the floor plank is increased, less effect in the reduced center stringer is noticed. The same effect is observed for the reduction in stringer stiffness.

For the second loading condition, where the load is located at the second interior stringer, the governing effect is noticed in the second interior stringer, Figures 16–18. As the stringer has no reduction in stiffness, the moment capacity is constant at 100%. The moment capacity for the full stiffness stringer is indicated by a straight line at 100% in the figures.

When the stiffness in the center stringer is reduced, deflection of the stringer will be increased. As the relative displacement between the reduced stringer and the main stringers is increased, the moment in the floor plank will also be increased. A higher stiffness in the floor plank will then transfer more moment to the adjacent stringers. High stiffness in the floor plank will therefore increase the effects in the adjacent stringers and reduce the effects in the reduced stringers.

Reduction in Exterior Stringer

Reducing the stiffness in the exterior stringer affects both the exterior and first interior stringers. To investigate the effects in the stringers, two loading conditions are used.

1. unit load P at exterior stringer, joint 2
2. unit load P at first interior stringer, joint 5

Since the exterior stringer does not have the advantage of having stringers on both sides, all distribution of forces go only in one direction. Because of this, the effects in the exterior stringer are more noticeable than in the center stringer. Figures 19–21 show the

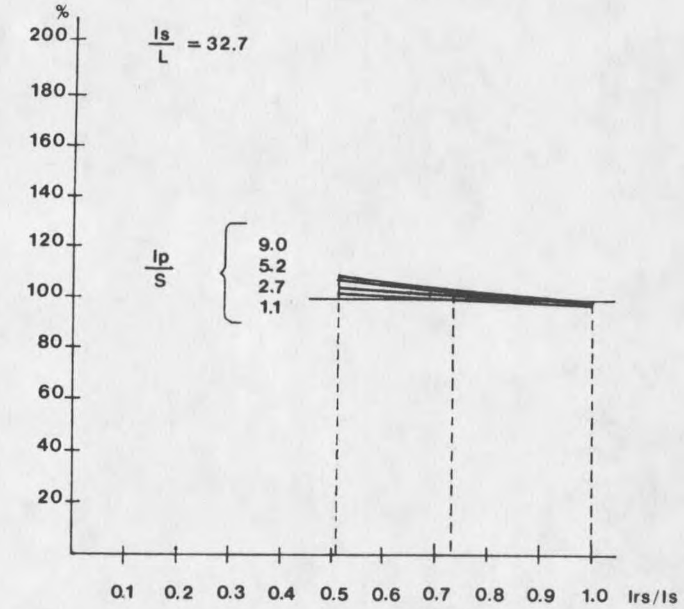

Figure 16. Reduction of stiffness in center stringer. Effect in second interior stringer — $I_s/L = 32.7\ in^3$.

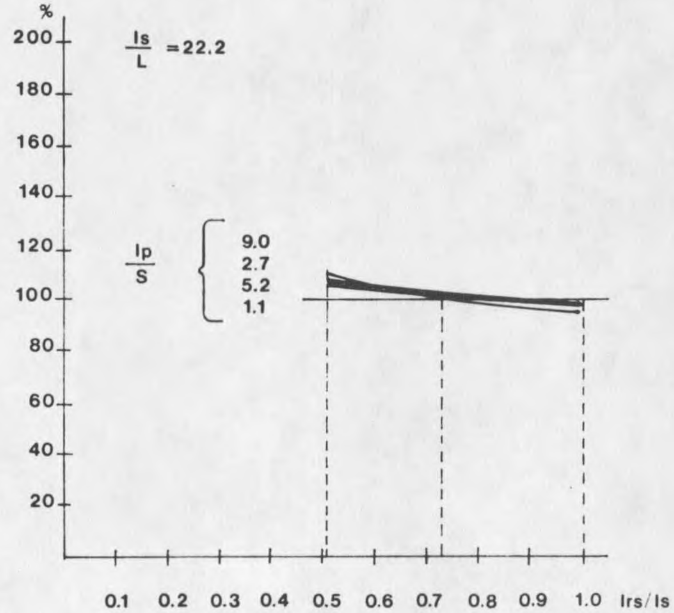

Figure 17. Reduction of stiffness in center stringer. Effect in second interior stringer — $I_s/L = 22.2\ in^3$.

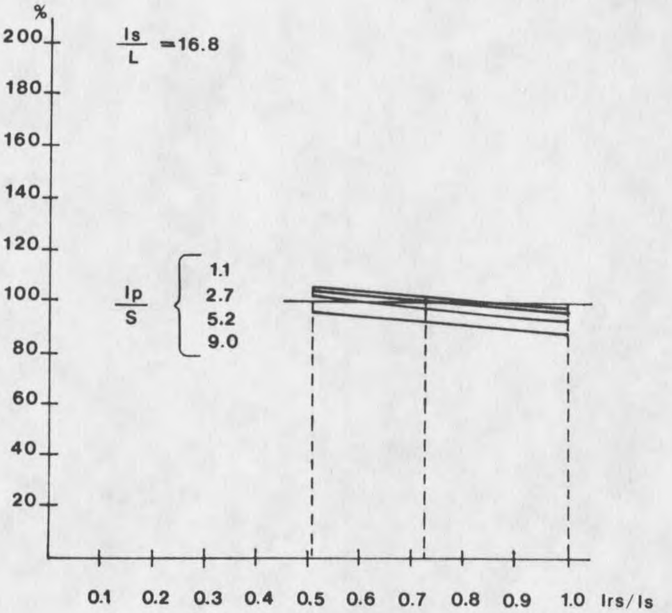

Figure 18. Reduction of stiffness in center stringer. Effect in second interior stringer — $I_s/L = 16.8\ in^3$.

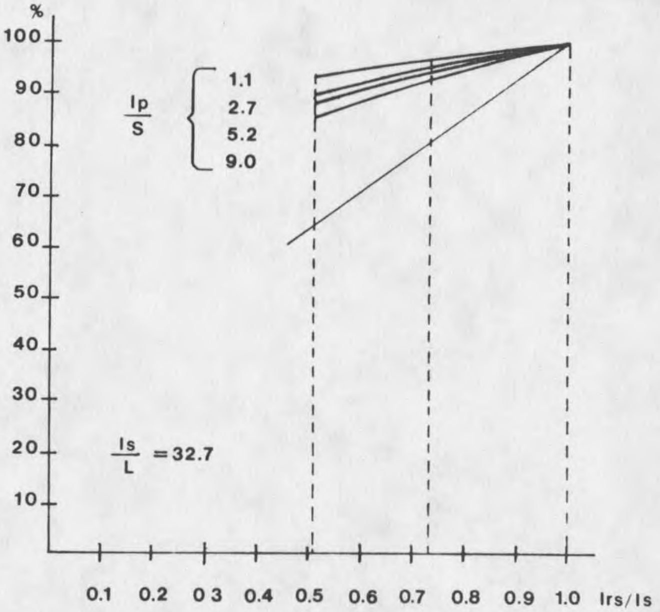

Figure 19. Reduction of stiffness in exterior stringer. Effect in exterior stringer — I_S/L = 32.7 in^3.

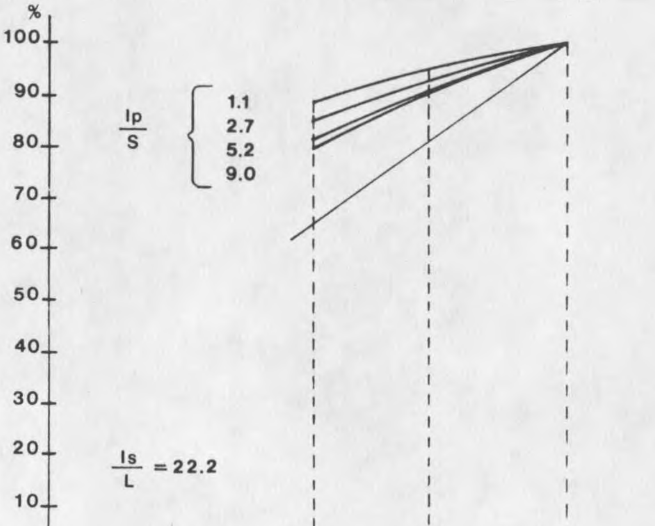

Figure 20. Reduction of stiffness in exterior stringer. Effect in exterior stringer — I_S/L = 22.2 in^3.

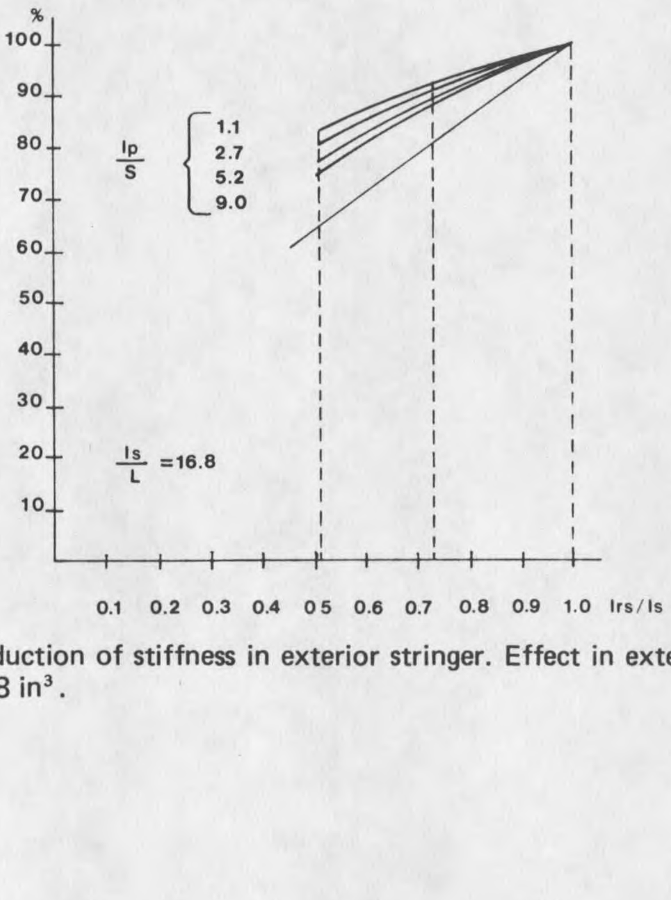

Figure 21. Reduction of stiffness in exterior stringer. Effect in exterior stringer – I_s/L = 16.8 in^3.

changes of bending moment in the exterior stringer. The moment capacity is represented by the same line as for the reduced center stringer.

When investigating the effects in the first interior stringer, both loading conditions are considered. Figures 22-24 show the changes in bending moment for the first interior stringer when the load is located at the exterior stringer.

Placing the load at the first interior stringer gives different results for the bending moment in the first interior stringer, Figures 25-27.

As the stiffness in the stringers are reduced from 32.7 in^3 to 16.8 in^3, the governing effects change with the loading condition. With high stiffness in the stringers, the effect of increased bending moment is governed by the second loading condition. This is reversed when the stringer stiffness is reduced.

The combined effects of these two loading conditions must therefore be considered to find the maximum effects in the first interior stringer, Figures 29-31.

Bending in Floor Plank

Reducing the stiffness in a stringer results in increased deflections. This deflection creates higher bending moment in the floor plank, so it is important to investigate the effects in the floor plank the same way as for the stringers.

To investigate the full effects, three loading conditions are used. Figures 31-33 show the moment distribution of the floor plank using these loading conditions. The maximum bending moment in the plank is used as reference for the percentage moment distribution.

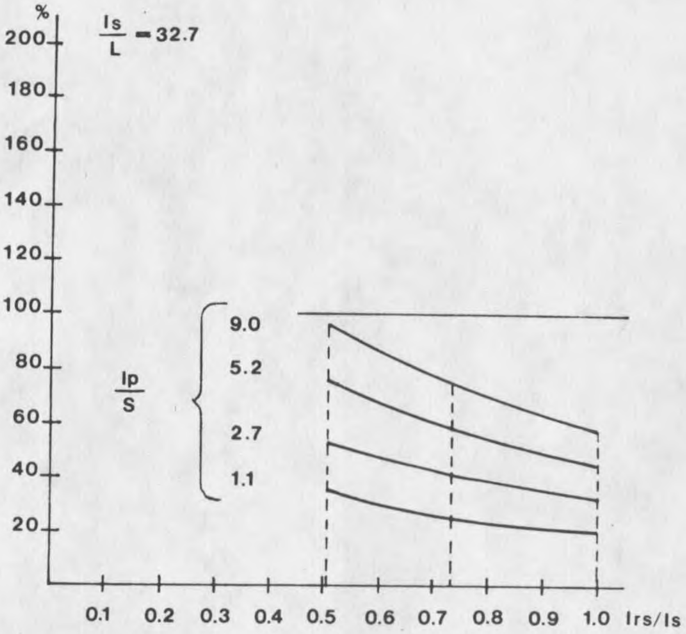

Figure 22. Reduction of stiffness in exterior stringer. Load at exterior stringer. Effect in first interior stringer – $I_s/L = 32.7$ in^3.

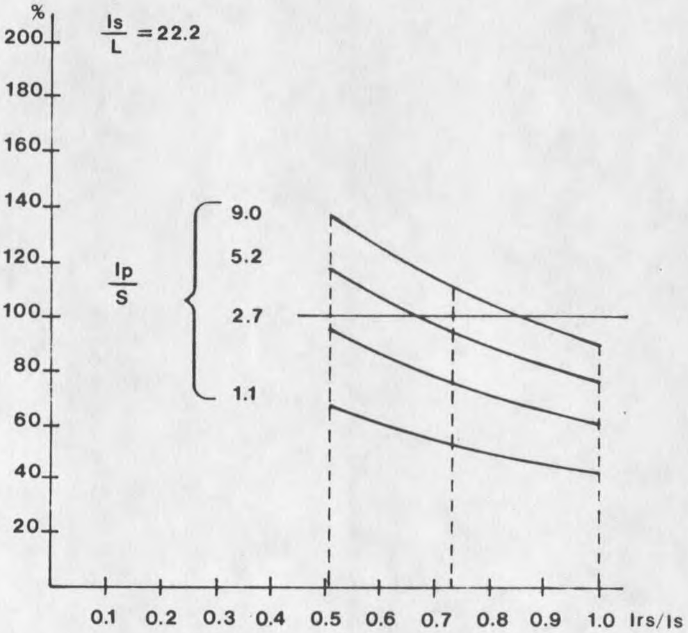

Figure 23. Reduction of stiffness in exterior stringer. Load at exterior stringer. Effect in first stringer – $I_s/L = 22.2$ in^3.

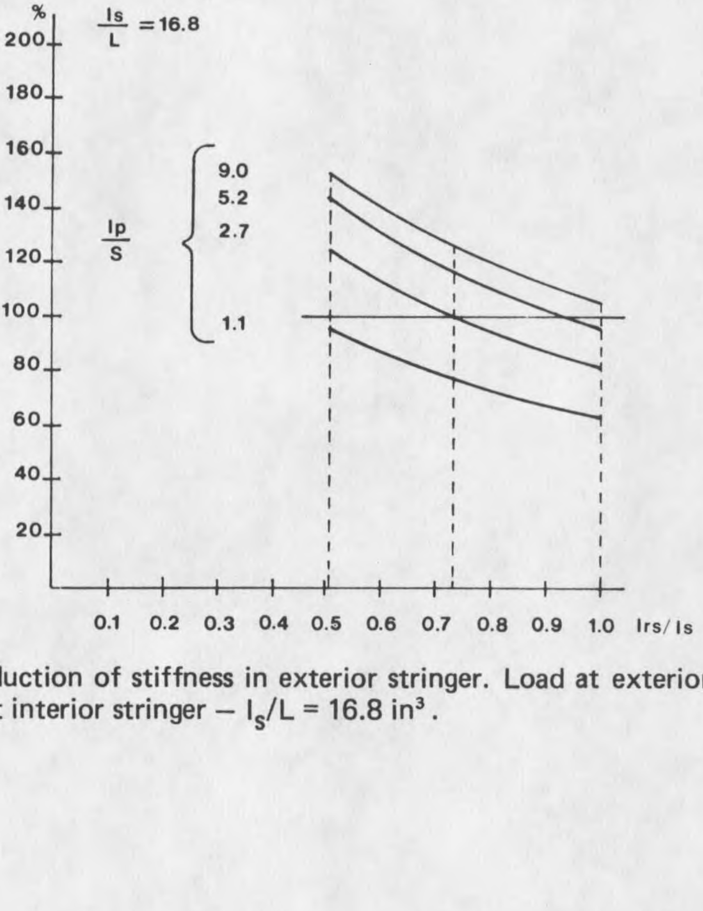

Figure 24. Reduction of stiffness in exterior stringer. Load at exterior stringer. Effect in first interior stringer – $I_s/L = 16.8\ in^3$.

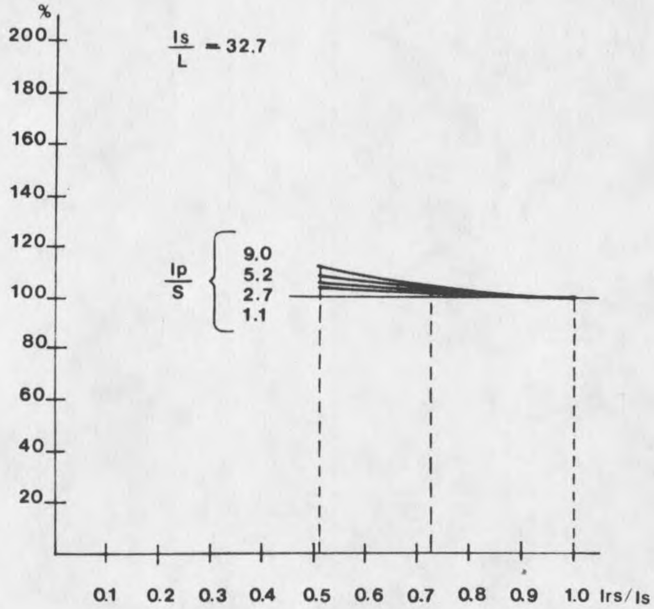

Figure 25. Reduction of stiffness in exterior stringer. Load at first interior stringer. Effect in first interior stringer — $I_s/L = 32.7$ in³.

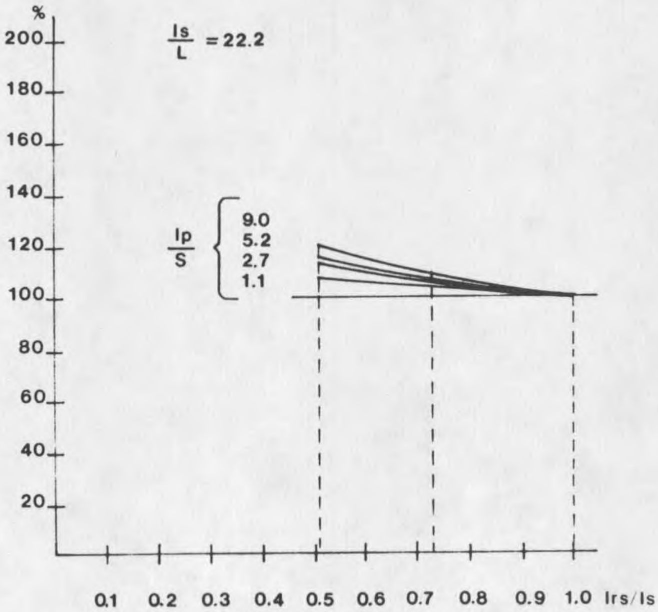

Figure 26. Reduction of stiffness in exterior stringer. Load at first interior stringer. Effect in first interior stringer — $I_s/L = 22.2$ in³.

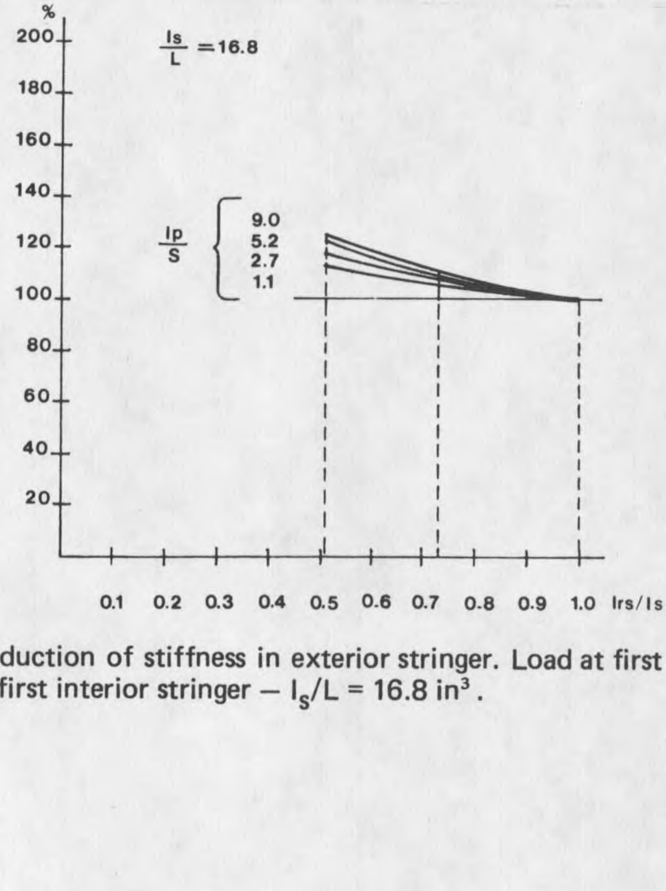

Figure 27. Reduction of stiffness in exterior stringer. Load at first interior stringer. Effect in first interior stringer – $I_s/L = 16.8\ in^3$.

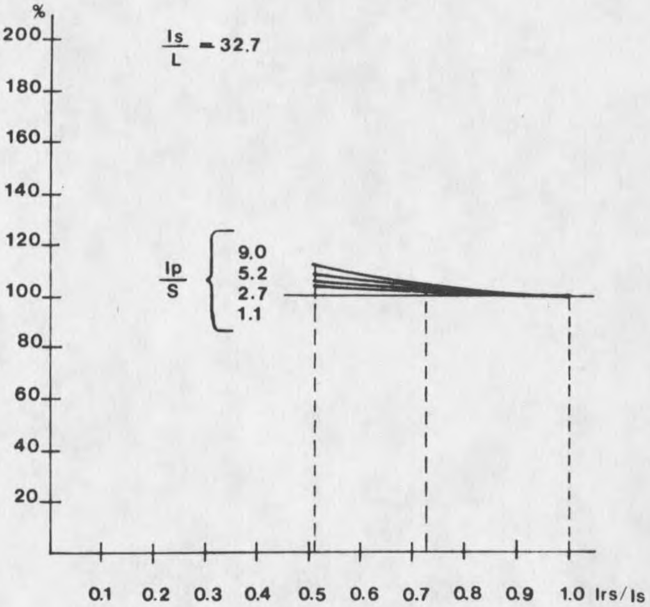

Figure 28. Reduction of stiffness in exterior stringer. Effect in first interior stringer from combined loading conditions — $I_s/L = 32.7$ in^3.

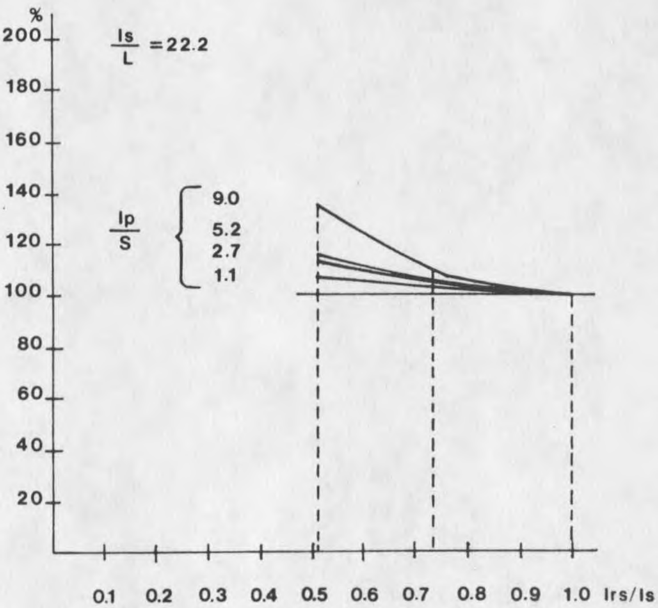

Figure 29. Reduction of stiffness in exterior stringer. Effect in first interior stringer from combined loading conditions — $I_s/L = 22.2$ in^3.

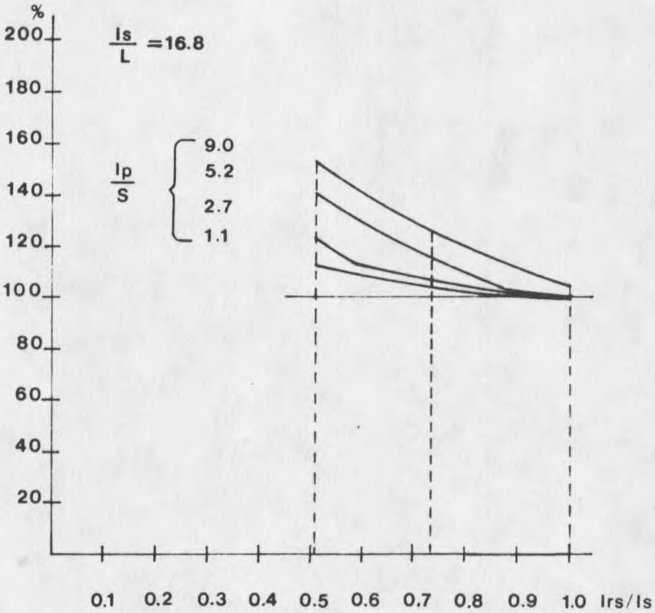

Figure 30. Reduction of stiffness in exterior stringer. Effect in first interior stringer from combined loading conditions – $I_s/L = 16.8\ in^3$.

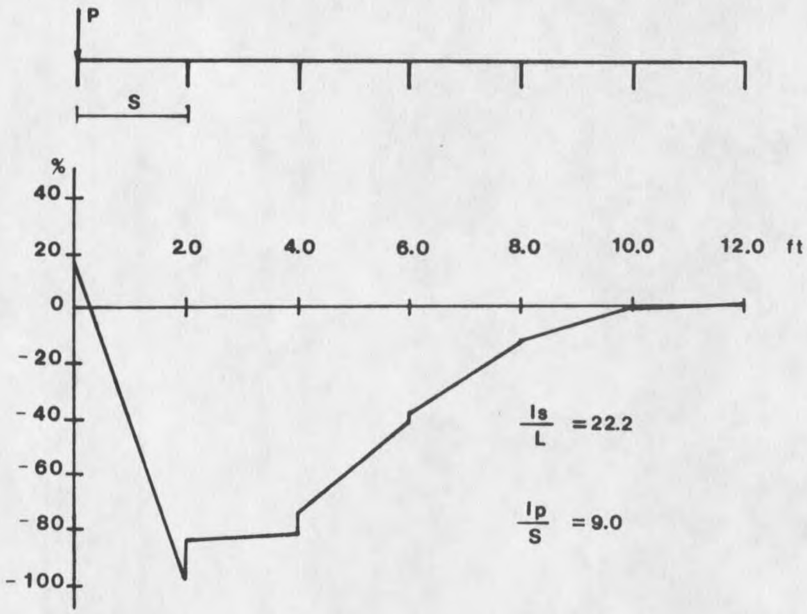

Figure 31. Moment diagram in floor plank. Load is located at exterior stringer.

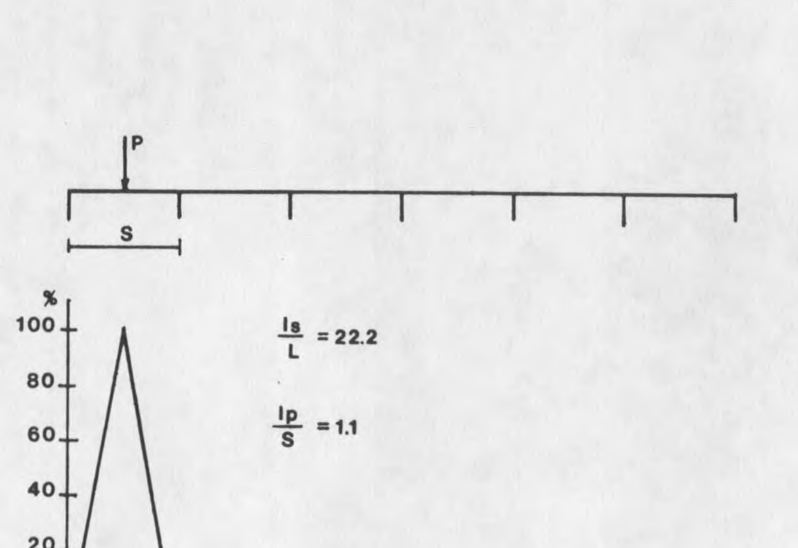

Figure 32. Load is located between the exterior and first interior stringer.

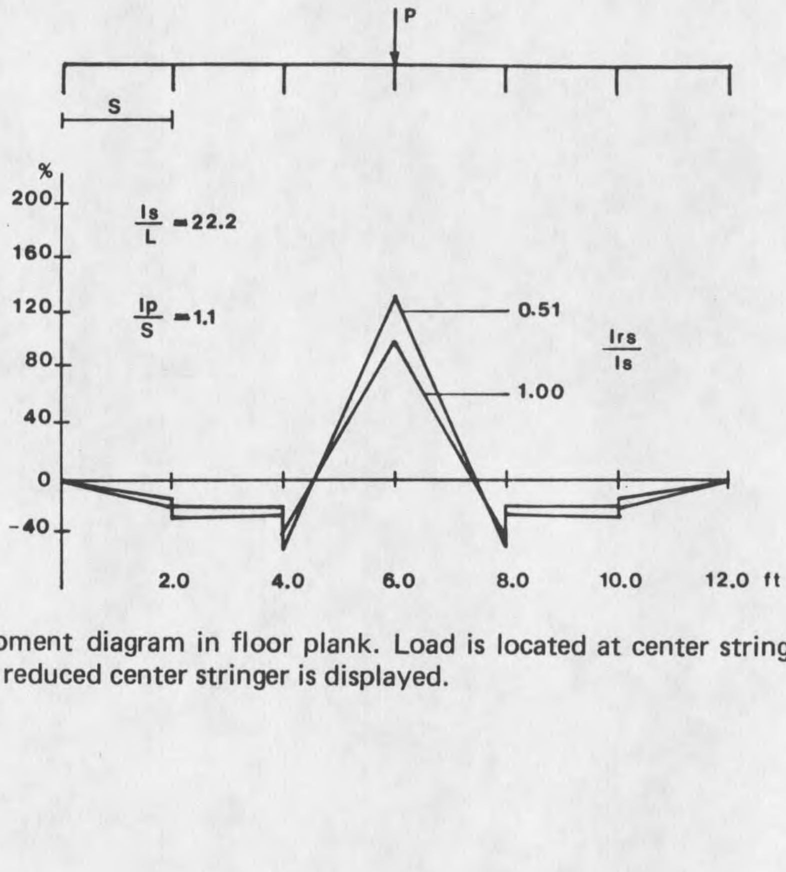

Figure 33. Moment diagram in floor plank. Load is located at center stringer. The effect of reduced center stringer is displayed.

Reduced Center Stringer

The effect of reduced stiffness in the center stringer is showed by Figure 33. This reduction in stiffness increases the bending moment in the floor plank markedly.

A load is located at the center stringer to create the governing effects in the floor plank as the center stringer is reduced. The increase in bending moment in the plank is shown in Figures 34-36. As for the stringers, the moment capacity is constant at 100%.

Reduced Exterior Stringer

When the stiffness in the exterior stringer is reduced, two loading conditions must be considered. The first location for the load is at the exterior stringer, Figure 31. The second location is at the center of the floor plank, between the exterior and first interior stringer, Figure 32.

Figures 37-39 show the effects of the first loading condition and Figures 40-42 show the effects of the second loading condition. These two sets of curves are combined to give the maximum effect in the floor plank when the exterior stringer is reduced, Figure 43-45.

Combined Effects in Floor

The governing effects of a reduction of stiffness may be in any of the three investigated members, depending on the member stiffnesses.

Figures 46-48 show the effects of reduced stiffness in the exterior stringer. These curves are a combination of the maximum effects in the investigated members. The horizontal line at 100% is the bending moment capacity of the floor system. The difference between the curves and the line of capacity is a direct measurement for the reduction in capacity of the floor system.

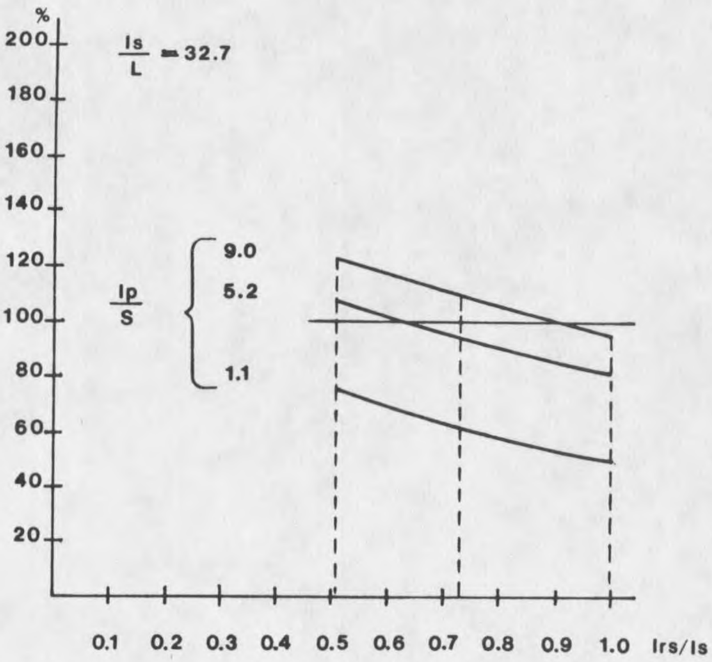

Figure 34. Reduction of stiffness in center stringer. Effect in floor plank – $I_s/L = 32.7$ in^3.

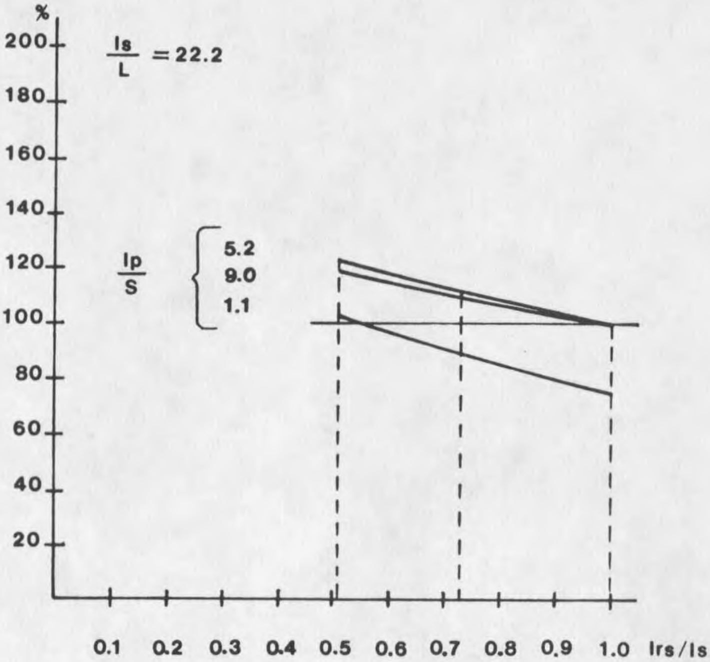

Figure 35. Reduction of stiffness in center stringer. Effect in floor plank – $I_s/L = 22.2$ in^3.

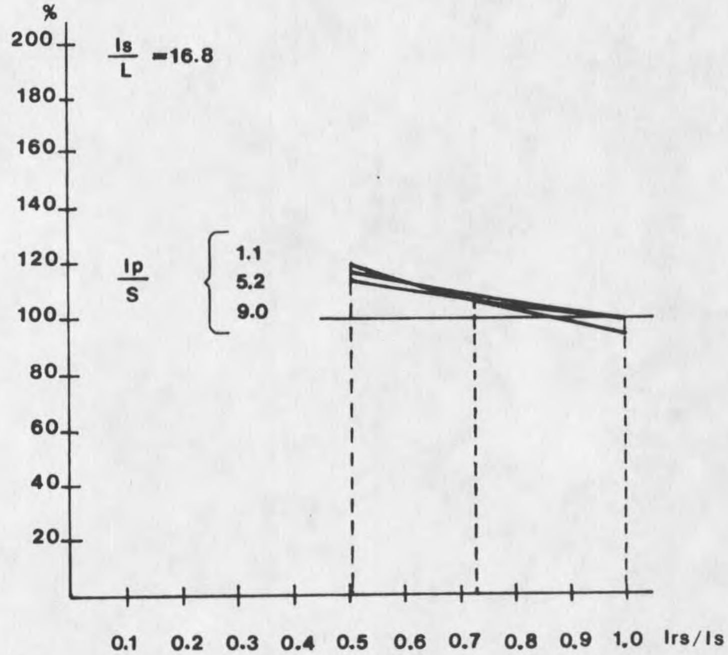

Figure 36. Reduction of stiffness in center stringer. Effect in floor plank – $I_S/L = 16.8\ in^3$.

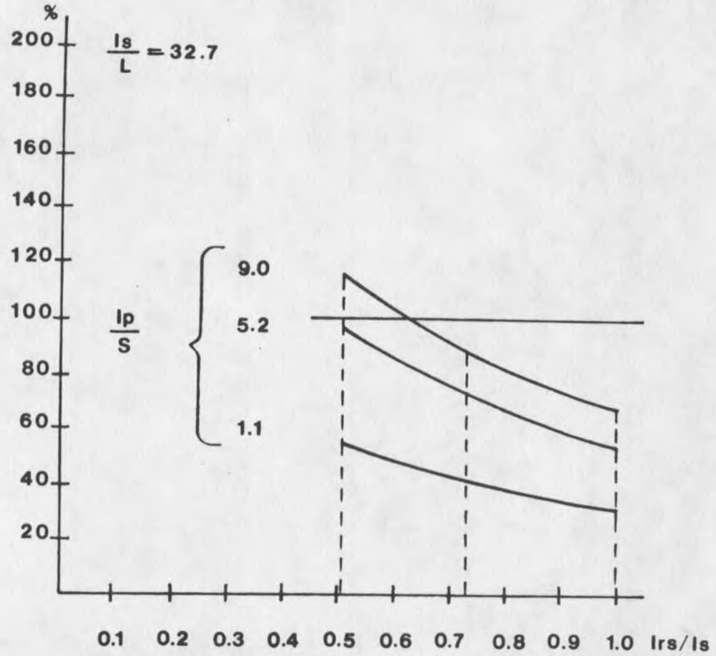

Figure 37. Reduction of stiffness in exterior stringer. Load at exterior stringer. Effect in floor plank – $I_S/L = 32.7\ in^3$.

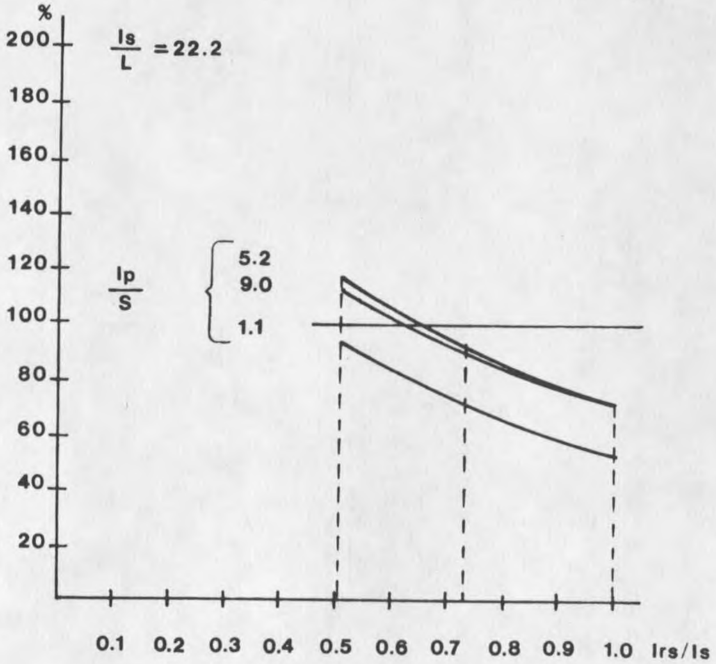

Figure 38. Reduction of stiffness in exterior stringer. Load at exterior stringer. Effect in floor plank – $I_S/L = 22.2\ in^3$.

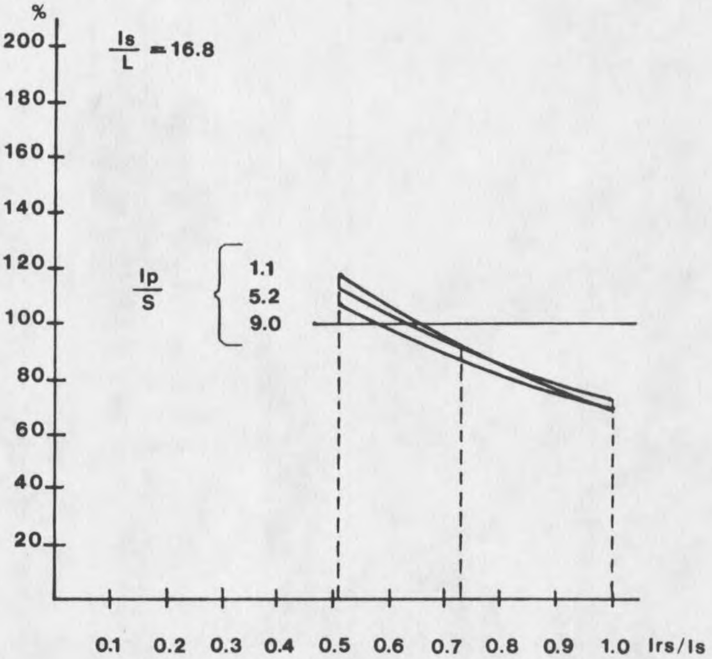

Figure 39. Reduction of stiffness in exterior stringer. Load at exterior stringer. Effect in floor plank – $I_s/L = 16.8$ in^3.

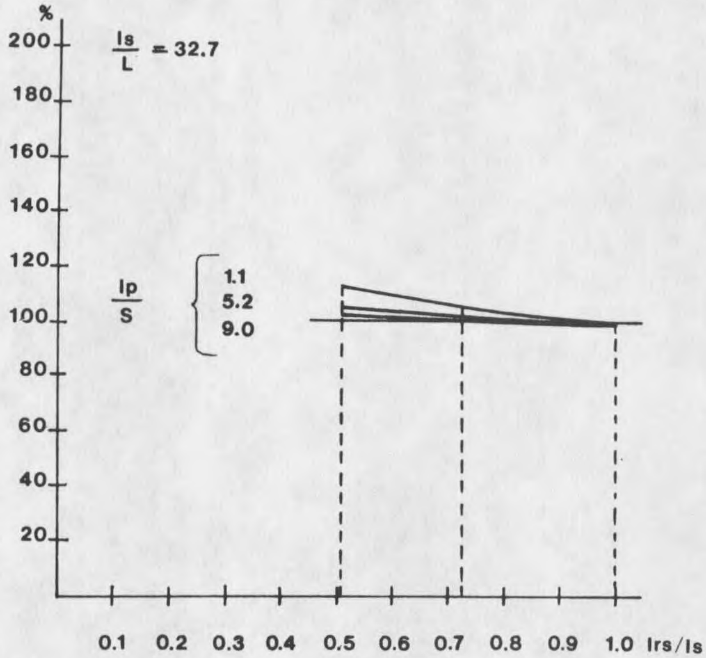

Figure 40. Reduction of stiffness in exterior stringer. Load between exterior and first interior stringer. Effect in floor plank – $I_s/L = 32.7\ in^3$.

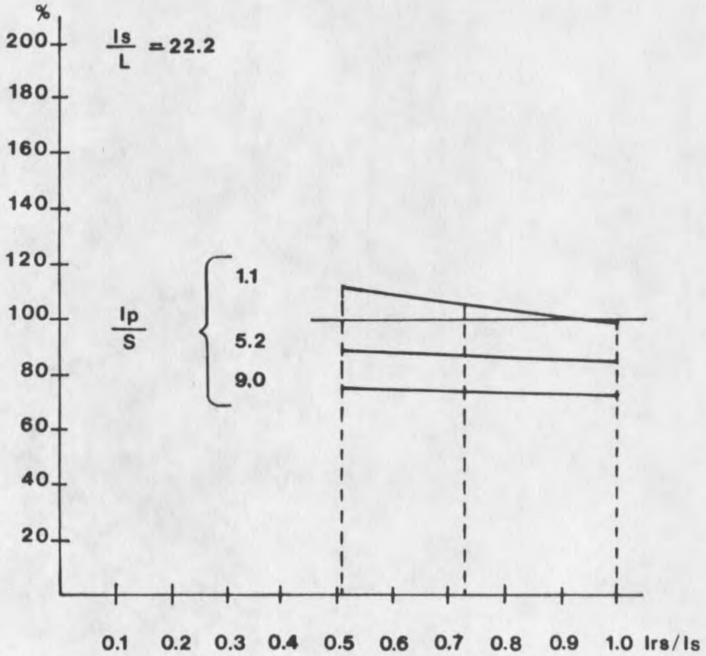

Figure 41. Reduction of stiffness in exterior stringer. Load between exterior and first interior stringer. Effect in floor plank – $I_s/L = 22.2\ in^3$.

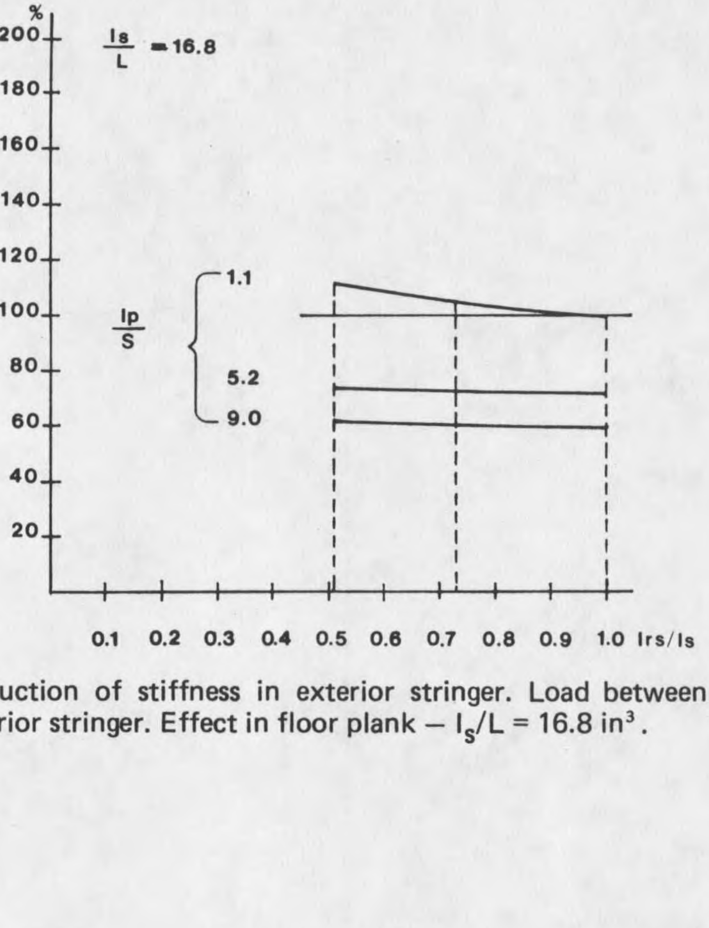

Figure 42. Reduction of stiffness in exterior stringer. Load between exterior and first interior stringer. Effect in floor plank – $I_s/L = 16.8\ in^3$.

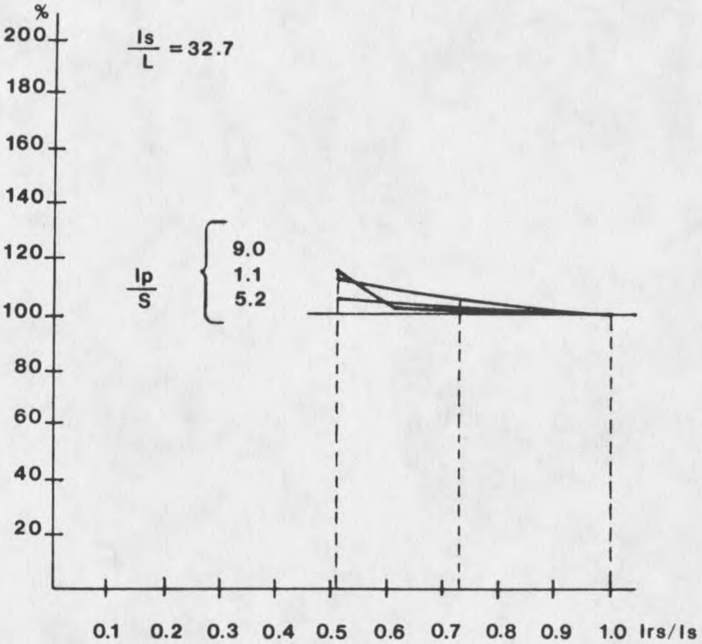

Figure 43. Reduction of stiffness in exterior stringer. Effect in floor plank due to combined loading conditions – $I_s/L = 32.7\ in^3$.

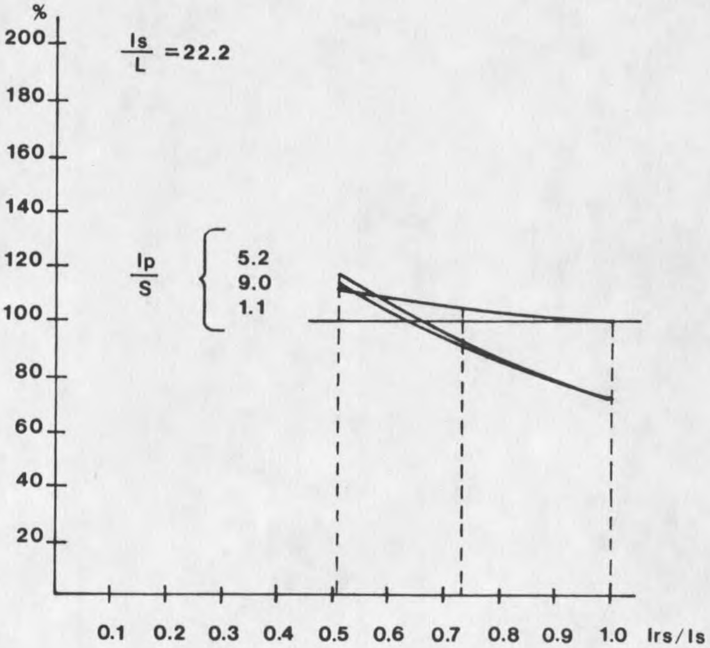

Figure 44. Reduction of stiffness in exterior stringer. Effect in floor plank due to combined loading conditions – $I_s/L = 22.2\ in^3$.

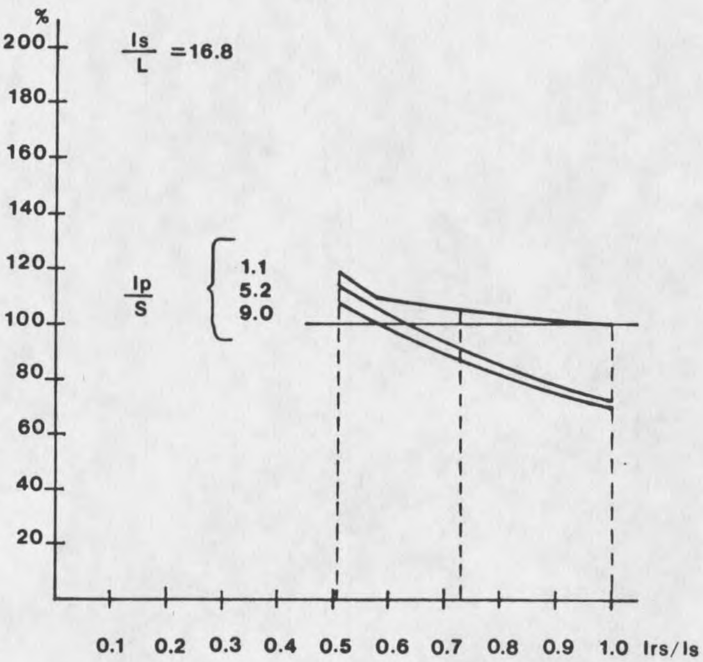

Figure 45. Reduction of stiffness in exterior stringer. Effect in floor plank due to combined loading conditions – $I_s/L = 16.8\ in^3$.

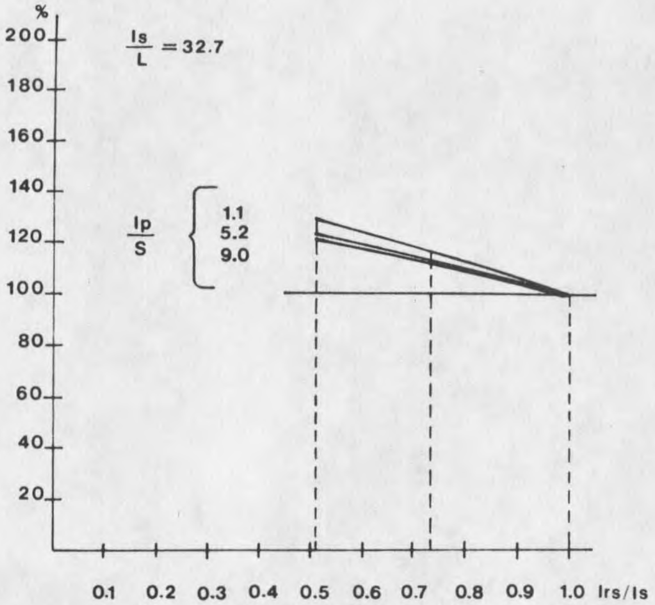

Figure 46. Reduction of stiffness in exterior stringer. Governing effect in floor system due to combined loading conditions – $I_S/L = 32.7\ in^3$.

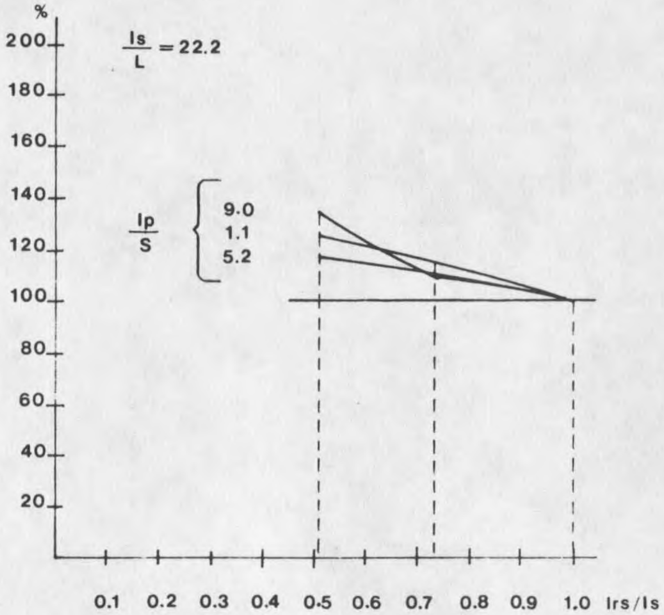

Figure 47. Reduction of stiffness in exterior stringer. Governing effect in floor system due to combined loading conditions – $I_S/L = 22.2\ in^3$.

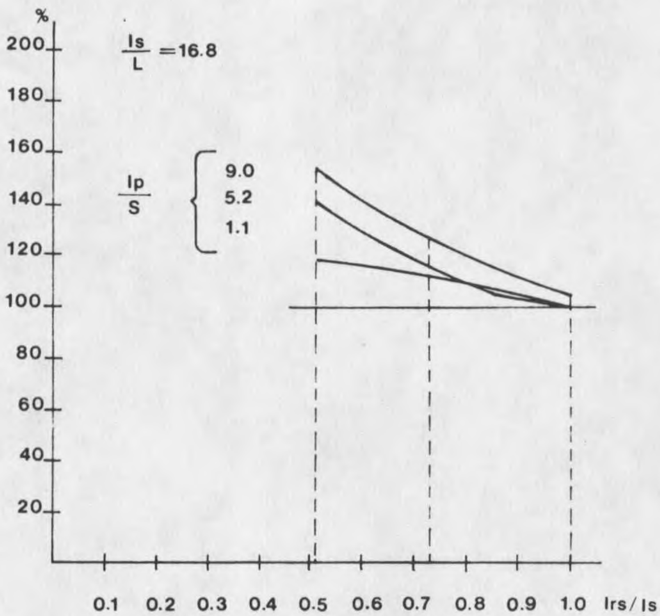

Figure 48. Reduction of stiffness in exterior stringer. Governing effect in floor system due to combined loading conditions – $I_s/L = 16.8\ in^3$.

Figures 49-51 show the effects of reduced stiffness in the interior stringer. These curves display the same effect as Figures 46-48. Notice that the reduction in capacity is less for the reduction in interior stringer compared to the exterior stringer.

Deflection and Shear

To find the total effects in the floor system, increased effects in shear and deflection must also be considered. As the stiffness is reduced in a stringer, the deflection in this stringer will be increased. This, in turn, results in the floor plank having to carry increased load to the adjacent stringers.

Deflection and shear are not as thoroughly investigated as the effects of bending. However, the analyses show that these effects are of about the same magnitude as the effects due to bending.

Less stiffness in the floor plank seems to increase the effects of both shear and deflection.

Further analyses of the effects of shear and deflection are recommended. For the effect of shear in the stringers, the floor plank is suggested moved to the end of the stringers.

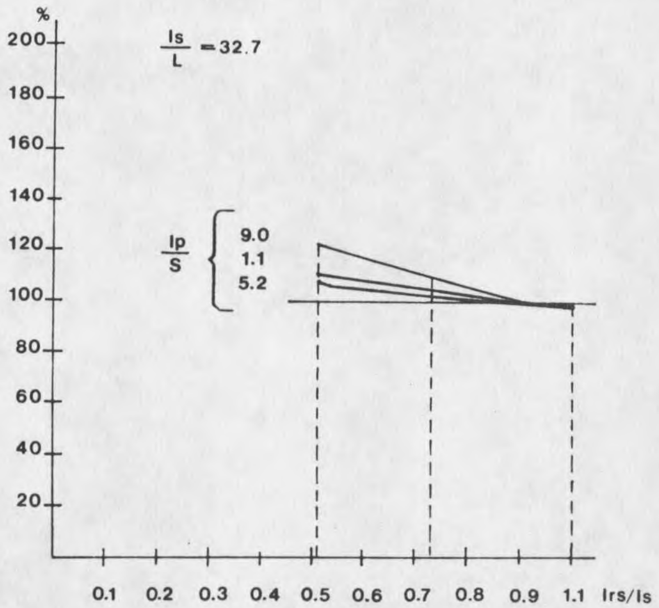

Figure 49. Reduction of stiffness in interior stringer. Governing effects in floor system due to combined loading conditions – $I_s/L = 32.7$ in^3.

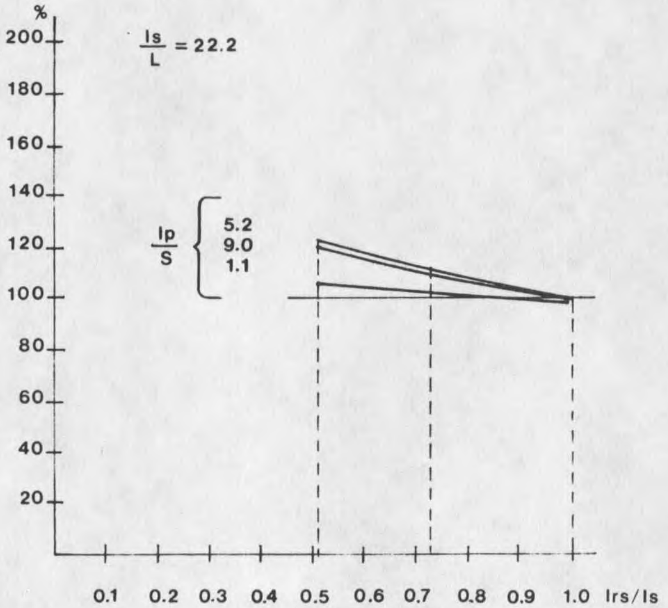

Figure 50. Reduction of stiffness in interior stringer. Governing effects in floor system due to combined loading conditions – $I_s/L = 22.2$ in^3.

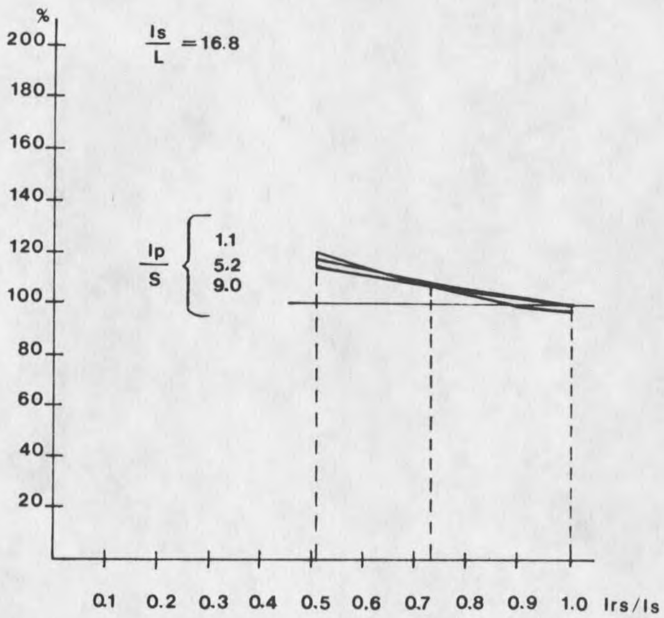

Figure 51. Reduction of stiffness in interior stringer. Governing effects in floor system due to combined loading conditions – $I_s/L = 16.8\ in^3$.

CHAPTER 4

SUMMARY AND CONCLUSION

The results of this investigation are best separated into two categories.

1. effect in floor system due to reduced stiffness in exterior stringer
2. effect in floor system due to reduced stiffness in interior stringer

Three members have been investigated for each reduction in stiffness and loading condition.

1. stringer with reduced stiffness
2. first adjacent stringer to the reduced member
3. floor plank

For each member and loading condition, three sets of curves have been developed. These curves show the increased bending moment in each member as a percentage of the maximum design moment for that specific member.

A horizontal line at 100% shows the maximum design moment for the floor plank and for a stringer having full stiffness. The reduced stringer has reduced moment capacity according to the reduction in section modulus, Table 2.

It is evident that a reduction of stiffness in a stringer has adverse effects on the floor system. Reducing the stiffness of the exterior stringer results in a more severe reduction in the capacity of the floor system than if an exterior stringer is reduced.

The effects on the floor system due to the reduction of member stiffness in one stringer depend on the combination of stiffnesses between the stringers and the planks. Reducing the exterior stringer depth from 20.0 in to 16.0 in reduces the capacity of the floor system by about 50% for $I_s/L = 16.8\ in^3$ and $I_p/S = 9.0\ in^3$, and by about 20% for

$I_s/L = 16.8\ in^3$ and $I_p/S = 1.1\ in^3$. Lesser stiffness in the floor plank show less reduction of capacity for this condition.

Reducing the center stringer depth from 20.0 in to 16.0 in reduces the capacity of the floor system by about 25% for $I_s/L = 32.7\ in^3$ and $I_p/S = 9.0\ in^3$, and by about 5% for $I_s/L = 22.2\ in^3$ and $I_p/S = 1.1\ in^3$. As the stiffness in the stringers is reduced, less reduction of capacity is obtained with increased stiffness in the floor planks.

It is recommended that the deteriorated stringers be replaced, and not simply turned over. If deteriorated stringers are turned over, the reduced depth of the stringer should be carefully examined, and the effects on the floor system should be investigated for the actual loading condition allowed on the bridge.

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REFERENCES CITED

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2. Itani, R. Y., and Faherty, K. F. "Structural wood research." ASCE. New York, New York, 1983.

3. Personal communication, Don Harrison, Bridge Superintendent in Cascade County. February 1985.

4. Ghali, A., and Neville, A. M. "Structural analysis, a unified classical and matrix approach." 2nd edition. Chapman and Hall, London, 1978.

5. Weaver, W. Jr., and Gere, M. M. "Matrix analysis of framed structures." 2nd edition. D. Van Nostrand Company, New York, 1980.

6. American Association of State Highway and Transportation Officials. "Standard specifications for highway bridges." AASHTO. 12th edition. Washington, D.C. 1977.

APPENDIX

COMPUTER RUNS

```
12:05 JUN 12 '85 LENE.ICEFV003

DRIBBLE ON @  11:42 06/12/85
!E GRIDA
EDIT 303 HERE
*TY
C      *************************************************************
C      *                                                           *
C      *   GRID PROGRAM, NAMED GRID                                *
C      *   ICEFVC03,RIPLE                                          *
C      *************************************************************
C
       DIMENSION X(100),Y(100),JJ(100),JK(100),XI(50),YI(50)
       DIMENSION AML(6,50),JRL(300),EL(50),CX(50),CY(50)
       DIMENSION ID(300),SFF(300,100),SMS(6,6),IM(6),LML(50)
       DIMENSION AR(300),AE(300),AJ(300),AC(300),DJ(300),DF(300)
       DIMENSION AMD(6),K(100),AM(6),KB(100),KC(50)
C
C      INPUT STATEMENTS
C
       ISN=1
       ICHNGE=0
688    WRITE*,"FOR PRESET GRID PRINT 1, ELSE 0"
       INPUT PRESET
       IF(PRESET .EQ. 0) GOTO 630
640    WRITE*,"INPUT NUMBER OF STRINGERS"
       INPUT NST
       WRITE*,"INPUT LENGTH OF STRINGERS"
       INPUT STL
       WRITE*,"INPUT SPACING OF STRINGERS"
       INPUT STS
       WRITE*,"INPUT DEPTH D, AND WIDTH B (in) OF STRINGERS"
       INPUT DS,BS
       WRITE*,"INPUT DEPTH D, AND WIDTH B (in) OF PLANK"
       INPUT DP,BP
       WRITE*,"INPUT DIMENSIONS OF REDUCED STRINGER, D AND B (in)"
       INPUT RDS,RBS
       WRITE*,"INPUT LOCATION OF REDUCED STRINGER, STRINGER NUMBER"
       INPUT RST
       WRITE*,"INPUT LOCATION OF PLANK, AS FRACTION OF STRINGER LENGTH"
       INPUT LFP
       WRITE*,"INPUT E AND G"
       INPUT E,G
       WRITE*,"INPUT NUMBER OF LOADED JOINTS (NLJ), AND"
       WRITE*,"NUMBER OF LOADED MEMBERS (NLM)"
       INPUT NLJ,NLM
       WRITE*,"INPUT NUMBER OF RESTRAINTS (NR)"
       INPUT NR
       WRITE*,"INPUT NUMBER OF RESTRAINED JOINTS (NRJ)"
       INPUT NRJ
660    STSI=STS*12
       STLI=STL*12
       NJ=3*NST
       M=(3*NST)-1
       NDJ=3
       ND=NDJ*NJ
       N=ND-NR
       DO 720 J=1,ND
       AR(J)=0.0
       AE(J)=0.0
720    CONTINUE
       DO 730 I=1,M
```

```
      LML(I)=0.0
730   CONTINUE
      XST=(BS*(DS**3)+DS*(BS**3))/12
      YST=BS*(DS**3)/12
      XFP=(BP*(DP**3)+DP*(BP**3))/12
      YFP=BP*(DP**3)/12
      XRST=(RBS*(RDS**3)+RDS*(RBS**3))/12
      YRST=RBS*(RDS**3)/12
      NK=NJ
      KX0=0.0
      DO 700 I=1,NK,3
      X(I)=KX0
      X(I+1)=KX0
      X(I+2)=KX0
      Y(I)=0.0
      Y(I+1)=STLI/LFP
      Y(I+2)=STLI
      KX0=KX0+STSI
      JJ(I)=I
      JK(I)=I+1
      JJ(I+1)=I+1
      JK(I+1)=I+2
      XI(I)=XST
      XI(I+1)=XST
      YI(I)=YST
      YI(I+1)=YST
      IF(I .LT. NK) THEN
      JJ(I+2)=I+1
      JK(I+2)=I+4
      XI(I+2)=XFP
      YI(I+2)=YFP
      ENDIF
700   CONTINUE
      JP=3*RST
      XI(JP-1)=XRST
      YI(JP-1)=YRST
      XI(JP-2)=XRST
      YI(JP-2)=YRST
      WRITE*," "
      IF(ICHNGE .GT. 0) THEN
      WRITE*,"IF ANY CHANGES HAS BEEN MADE TO THE RESTRAINED JOINTS,"
      WRITE*,"CHANGES MUST BE RECORDED IN THE JOINT RESTRAINT LIST."
      WRITE*,"PRINT 1 TO PERFORM THESE CHANGES, PRINT 0 TO CONTINUE"
      INPUT CHJRL
      IF(CHJRL. EQ. 0) GOTO 661
      ENDIF
      DO 732 J=1,ND
      JRL(J)=0
732   CONTINUE
      WRITE*,"INPUT JOINT RESTRAINT LIST"
      WRITE*,"K,JRL(3K-2),JRL(3K-1),JRL(3K)"
      DO 710 I=1,NRJ
      INPUT K(I),JRL(3*K(I)-2),JRL(3*K(I)-1),JRL(3*K(I))
710   CONTINUE
661   IF(ICHNGE .GT. 0) THEN
      WRITE*,"IF ANY CHANGES HAS BEEN MADE TO THE JOINT LOADS,"
      WRITE*,"THEN CHANGES MUST BE RECORDED"
      WRITE*,"PRINT 1 TO PERFORM THE CHANGES, PRINT 0 TO CONTINUE"
      INPUT CHJL
      IF(CHJL .EQ. 0) GOTO 662
      ENDIF
```

```
      DO 733 J=1,ND
      AJ(J)=0.0
733   CONTINUE
      IF(NLJ .NE. 0) THEN
      WRITE*,"INPUT JOINT LOADS"
      WRITE*,"K,AJ(3K-2),AJ(3K-1),AJ(3K)"
      DO 744 I=1,NLJ
      INPUT KB(I),AJ(3*KB(I)-2),AJ(3*KB(I)-1),AJ(3*KB(I))
744   CONTINUE
      ENDIF
662   IF(ICHNGE .GT. 0) THEN
      WRITE*,"IF ANY CHANGES HAS BEEN MADE TO THE MEMBER LOADS,"
      WRITE*,"THEN THESE CHANGES MUST BE RECORDED"
      WRITE*,"PRINT 1 TO RECORD THE CHANGES, PRINT 0 TO CONTINUE"
      INPUT CHML
      IF(CHML .EQ. 0) GOTO 663
      ENDIF
      DO 734 I=1,M
      DO 735 J=1,6
      AML(J,I)=0.0
735   CONTINUE
734   CONTINUE
      IF(NLM .NE. 0) THEN
      WRITE*,"INPUT MEMBER LOADS, I,AML(1,I),AML(2,I),AML(3,I)"
      WRITE*,"AML(4,I),AML(5,I),AML(6,I)"
      DO 745 I=1,NLM
      INPUT KC(I),AML(1,KC(I)),AML(2,KC(I)),AML(3,KC(I)),AML(4,KC(I)),
     *AML(5,KC(I)),AML(6,KC(I))
745   CONTINUE
      ENDIF
663   WRITE*,"*******************************************************"
      WRITE*,"*******************************************************"
      LOD=STLI/DS
      WRITE*,"SPACING=",STS
      WRITE*,"L/D=     ",LOD
      WRITE*,"MAIN STRINGERS     :",BS,"*",DS
      WRITE*,"REDUCED STRINGERS :",RBS,"*",RDS
      WRITE*,"PLANK              :",DP,"*",BP
      GOTO 699
C
630   WRITE*,"INPUT STATEMENTS START"
      WRITE*," "
      WRITE*,"  "
      WRITE*,"INPUT M,NJ,NR,NRJ,E,G"
      INPUT M,NJ,NR,NRJ,E,G
      WRITE*,"  "
      NDJ=3
      ND=NDJ*NJ
      N=ND-NR
C
C     CLEARING MATRIXES
C
      DO 350 J=1,ND
      AR(J)=0.0
      AJ(J)=0.0
      AE(J)=0.0
350   CONTINUE
      DO 360 I=1,M
      DO 370 J=1,6
      AML(J,I)=0.0
370   CONTINUE
```

```
      LML(I)=0.0
360   CONTINUE
      DO 170 J=1,ND
      JRL(J)=0
170   CONTINUE
C
C     CONTINUATION OF INPUT
C
      WRITE*,"INPUT X(J),Y(J)"
      DO 100 J=1,NJ
      INPUT X(J),Y(J)
100   CONTINUE
      WRITE*," "
      WRITE*,"INPUT JJ(I),JK(I),XI(I),YI(I)"
      DO 110 I=1,M
      INPUT JJ(I),JK(I),XI(I),YI(I)
110   CONTINUE
      WRITE*," "
      WRITE*,"INPUT K,JRL(3*K-2),JRL(3*K-1),JRL(3*K)"
      DO 120 I=1,NRJ
      INPUT K(I),JRL(3*K(I)-2),JRL(3*K(I)-1),JRL(3*K(I))
120   CONTINUE
      WRITE*," "
      WRITE*,"INPUT NLJ,NLM"
      INPUT NLJ,NLM
      WRITE*," "
      WRITE*,"INPUT K,AJ(3*K-2),AJ(3*K-1),AJ(3*K)"
      DO 130 I=1,NLJ
      INPUT KB(I),AJ(3*KB(I)-2),AJ(3*KB(I)-1),AJ(3*KB(I))
130   CONTINUE
      WRITE*," "
      WRITE*,"INPUT I,AML(1,I),AML(2,I),AML(3,I),AML(4,I),AML(5,I),
     *AML(6,I)"
      DO 140 I=1,NLM
      INPUT KC(I),AML(1,KC(I)),AML(2,KC(I)),AML(3,KC(I)),AML(4,KC(I)),
     *AML(5,KC(I)),AML(6,KC(I))
140   CONTINUE
      WRITE*," "
C
C     SDATA 4
C
699   WRITE*," "
      WRITE*,"STRUCTURAL PARAMETERS"
      WRITE(108,1)
1     FORMAT(6X,"M",4X,"N",3X,"NJ",3X,"NR",2X,"NRJ",8X,"E",8X,"G")
      WRITE(108,2)M,N,NJ,NR,NRJ,E,G
2     FORMAT(2X,5I5,2F9.2)
      WRITE*," "
      WRITE*,"JOINT COORDINATES"
      WRITE(108,3)
3     FORMAT(2X,"JOINT",9X,"X",9X,"Y")
      DO 150 J=1,NJ
      WRITE(108,4)J,X(J),Y(J)
4     FORMAT(2X,I5,2F10.3)
150   CONTINUE
      WRITE*," "
      WRITE*,"MEMBER INFORMATION"
      WRITE(108,5)
5     FORMAT(2X,"MEMBER",2X,"JJ",3X,"JK",8X,"XI",8X,"YI",8X,
     *"EL",8X,"CX",8X,"CY")
      MD=2*NDJ
```

```
      NB=0
      DO 160 I=1,M
      NBI=NDJ*(ABS(JK(I)-JJ(I))+1)
      IF(NBI .GT. NB) NB=NBI
      XCL=X(JK(I))-X(JJ(I))
      YCL=Y(JK(I))-Y(JJ(I))
      EL(I)=SQRT(XCL*XCL+YCL*YCL)
      CX(I)=XCL/EL(I)
      CY(I)=YCL/EL(I)
      WRITE(108,6)I,JJ(I),JK(I),XI(I),YI(I),EL(I),CX(I),CY(I)
6     FORMAT(2X,3I5,5F10.3)
160   CONTINUE
      WRITE*," "
      WRITE*,"JOINT RESTRAINTS"
      WRITE(108,7)
7     FORMAT(2X,"JOINT",2X,"JR1",2X,"JR2",2X,"JR3")
      DO 180 I=1,NRJ
      WRITE(108,8)K(I),JRL(3*K(I)-2),JRL(3*K(I)-1),JRL(3*K(I))
8     FORMAT(2X,4I5)
180   CONTINUE
      WRITE*," "
      N1=0
      DO 190 J=1,ND
      N1=N1+JRL(J)
      IF(JRL(J) .GT. 0) THEN
      ID(J)=N+N1
      ELSE
      ID(J)=J-N1
      ENDIF
190   CONTINUE
C
C     STIFF 4
C
      DO 200 J=1,N
      DO 210 KA=1,NB
      SFF(J,KA)=0.0
210   CONTINUE
200   CONTINUE
      DO 220 I=1,M
      SCM1=G*XI(I)/EL(I)
      SCM2=4.0*E*YI(I)/EL(I)
      SCM3=1.5*SCM2/EL(I)
      SCM4=2.0*SCM3/EL(I)
      SMS(1,1)=SCM1*CX(I)*CX(I)+SCM2*CY(I)*CY(I)
      SMS(1,2)=(SCM1-SCM2)*CX(I)*CY(I)
      SMS(1,3)=SCM3*CY(I)
      SMS(1,4)=-SCM1*CX(I)*CX(I)+0.5*SCM2*CY(I)*CY(I)
      SMS(1,5)=-(SCM1+0.5*SCM2)*CX(I)*CY(I)
      SMS(1,6)=-SMS(1,3)
      SMS(2,2)=SCM1*CY(I)*CY(I)+SCM2*CX(I)*CX(I)
      SMS(2,3)=-SCM3*CX(I)
      SMS(2,4)=SMS(1,5)
      SMS(2,5)=-SCM1*CY(I)*CY(I)+0.5*SCM2*CX(I)*CX(I)
      SMS(2,6)=-SMS(2,3)
      SMS(3,3)=SCM4
      SMS(3,4)=SMS(1,3)
      SMS(3,5)=SMS(2,3)
      SMS(3,6)=-SCM4
      SMS(4,4)=SMS(1,1)
      SMS(4,5)=SMS(1,2)
      SMS(4,6)=SMS(1,6)
```

```
      SMS(5,5)=SMS(2,2)
      SMS(5,6)=SMS(2,6)
      SMS(6,6)=SCM4
      IM(1)=3*JJ(I)-2
      IM(2)=3*JJ(I)-1
      IM(3)=3*JJ(I)
      IM(4)=3*JK(I)-2
      IM(5)=3*JK(I)-1
      IM(6)=3*JK(I)
      DO 230 J=1,MD
      I1=IM(J)
      IF(JRL(I1) .GT. 0) GOTO 230
      DO 240 KA=J,MD
      I2=IM(KA)
      IF(JRL(I2) .GT. 0) GOTO 240
      IR=ID(I1)
      IC=ID(I2)
      IF(IR .GT. IC) THEN
      ITEM=IR
      IR=IC
      IC=ITEM
      ENDIF
      IC=IC-IR+1
      SFF(IR,IC)=SFF(IR,IC)+SMS(J,KA)
240   CONTINUE
230   CONTINUE
220   CONTINUE
      WRITE*," "
C
C     BANFAC
C
      IF(SFF(1,1) .LE. 0.0) GOTO 600
      DO 390 J=2,N
      J1=J-1
      J2=J-NB+1
      IF(J2 .LT. 1) J2=1
      IF(J1 .EQ. 1) GOTO 601
      DO 400 I=2,J1
      I1=I-1
      IF(I1 .LT. J2) GOTO 400
      SUM=SFF(I,J-I+1)
      DO 410 KA=J2,I1
      SUM=SUM-SFF(KA,I-KA+1)*SFF(KA,J-KA+1)
410   CONTINUE
      SFF(I,J-I+1)=SUM
400   CONTINUE
601   SUM=SFF(J,1)
      DO 420 KA=J2,J1
      TEMP=SFF(KA,J-KA+1)/SFF(KA,1)
      SUM=SUM-TEMP*SFF(KA,J-KA+1)
      SFF(KA,J-KA+1)=TEMP
420   CONTINUE
      IF(SUM .LE. 0.0) GOTO 600
      SFF(J,1)=SUM
390   CONTINUE
C
C
C
C     LDATA 4
C
      WRITE*,"STRUCTURE NO.",ISN
```

```
      WRITE(108,9)
 9    FORMAT(4X,"NLJ",2X,"NLM")
      WRITE(108,10)NLJ,NLM
 10   FORMAT(2X,2I5)
      WRITE*," "
      IF(NLJ .NE. 0) THEN
      WRITE*,"ACTIONS AT JOINTS"
      WRITE(108,11)
 11   FORMAT(2X,"JOINT",7X,"AJ1",7X,"AJ2",7X,"AJ3")
      DO 250 J=1,NLJ
      WRITE(108,12)KB(J),AJ(3*KB(J)-2),AJ(3*KB(J)-1),AJ(3*KB(J))
 12   FORMAT(2X,I5,3F10.3)
 250  CONTINUE
      ENDIF
      WRITE*," "
      IF(NLM .NE. 0) THEN
      WRITE*,"ACTIONS AT ENDS OF RESTRAINED MEMBERS DUE TO LOADS"
      WRITE(108,13)
 13   FORMAT(2X,"MEMBER",5X,"AML1",6X,"AML2",6X,"AML3",6X,"AML4",
     *6X,"AML5",6X,"AML6")
      DO 260 I=1,NLM
      WRITE(108,14)KC(I),AML(1,KC(I)),AML(2,KC(I)),AML(3,KC(I)),
     *AML(4,KC(I)),AML(5,KC(I)),AML(6,KC(I))
 14   FORMAT(2X,I5,6F10.3)
      LML(KC(I))=1
 260  CONTINUE
      WRITE*,"  "
      ENDIF
C
C     LOADS 4
C
      IF(NLM .NE. 0) THEN
      DO 270 I=1,M
      IF(LML(I) .NE. 0) THEN
      J1=3*JJ(I)-2
      J2=3*JJ(I)-1
      J3=3*JJ(I)
      K1=3*JK(I)-2
      K2=3*JK(I)-1
      K3=3*JK(I)
      AE(J1)=AE(J1)-CX(I)*AML(1,I)+CY(I)*AML(2,I)
      AE(J2)=AE(J2)-CY(I)*AML(1,I)-CX(I)*AML(2,I)
      AE(J3)=AE(J3)-AML(3,I)
      AE(K1)=AE(K1)-CX(I)*AML(4,I)+CY(I)*AML(5,I)
      AE(K2)=AE(K2)-CY(I)*AML(4,I)-CX(I)*AML(5,I)
      AE(K3)=AE(K3)-AML(6,I)
      ENDIF
 270  CONTINUE
      ENDIF
      DO 280 J=1,ND
      JR=ID(J)
      AC(JR)=AJ(J)+AE(J)
 280  CONTINUE
C
C     BANSOL
C
      DO 430 I=1,N
      J=I-NB+1
      IF(I .LE. NB) J=1
      SUM=AC(I)
      K1=I-1
```

```
      IF(J .GT. K1) GOTO 603
      DO 440 KA=J,K1
      SUM=SUM-SFF(KA,I-KA+1)*DF(KA)
 440  CONTINUE
 603  DF(I)=SUM
 430  CONTINUE
      DO 450 I=1,N
      DF(I)=DF(I)/SFF(I,1)
 450  CONTINUE
      DO 460 I1=1,N
      I=N-I1+1
      J=I+NB-1
      IF(J .GT. N) J=N
      SUM=DF(I)
      K2=I+1
      IF(K2 .GT. J) GOTO 604
      DO 470 KA=K2,J
      SUM=SUM-SFF(I,KA-I+1)*DF(KA)
 470  CONTINUE
 604  DF(I)=SUM
 460  CONTINUE
C
C     RESUL 4
C
      J=N+1
      DO 290 KA=1,ND
      JE=ND-KA+1
      IF(JRL(JE) .EQ. 0) THEN
      J=J-1
      DJ(JE)=DF(J)
      ELSE
      DJ(JE)=0.0
      ENDIF
 290  CONTINUE
      WRITE*,"JOINT DISPLACEMENTS"
      WRITE(108,15)
 15   FORMAT(2X,"JOINT",7X,"DJ1",7X,"DJ2",7X,"DJ3")
      DO 300 J=1,NJ
      WRITE(108,16)J,DJ(3*J-2),DJ(3*J-1),DJ(3*J)
 16   FORMAT(2X,I5,3F10.3)
 300  CONTINUE
      WRITE*," "
      WRITE*,"MEMBER END-ACTIONS"
      WRITE(108,17)
 17   FORMAT(2X,"MEMBER",6X,"AM1",7X,"AM2",7X,"AM3",7X,"AM4",
     *7X,"AM5",7X,"AM6")
      DO 310 I=1,M
      J1=3*JJ(I)-2
      J2=3*JJ(I)-1
      J3=3*JJ(I)
      K1=3*JK(I)-2
      K2=3*JK(I)-1
      K3=3*JK(I)
      SCM1=G*XI(I)/EL(I)
      SCM2=4.0*E*YI(I)/EL(I)
      SCM3=1.5*SCM2/EL(I)
      SCM4=2.0*SCM3/EL(I)
      AMD(1)=SCM1*((DJ(J1)-DJ(K1))*CX(I)+(DJ(J2)-DJ(K2))*CY(I))
      AMD(2)=SCM2*(-(DJ(J1)+0.5*DJ(K1))*CY(I)+(DJ(J2)+0.5*DJ(K2))
     **CX(I))-SCM3*(DJ(J3)-DJ(K3))
      AMD(3)=SCM3*((DJ(J1)+DJ(K1))*CY(I)-(DJ(J2)+DJ(K2))*CX(I))
```

```
      *+SCM4*(DJ(J3)-DJ(K3))
       AMD(4)=-AMD(1)
       AMD(5)=SCM2*(-(0.5*DJ(J1)+DJ(K1))*CY(I)+(0.5*DJ(J2)+DJ(K2))
      **CX(I))-SCM3*(DJ(J3)-DJ(K3))
       AMD(6)=-AMD(3)
       DO 320 J=1,MD
       AM(J)=AML(J,I)+AMD(J)
320    CONTINUE
       IF(JRL(J1) .EQ. 1) THEN
       AR(J1)=AR(J1)+CX(I)*AMD(1)-CY(I)*AMD(2)
       ENDIF
       IF(JRL(J2) .EQ. 1) THEN
       AR(J2)=AR(J2)+CY(I)*AMD(1)+CX(I)*AMD(2)
       ENDIF
       IF(JRL(J3) .EQ. 1) THEN
       AR(J3)=AR(J3)+AMD(3)
       ENDIF
       IF(JRL(K1) .EQ. 1) THEN
       AR(K1)=AR(K1)+CX(I)*AMD(4)-CY(I)*AMD(5)
       ENDIF
       IF(JRL(K2) .EQ. 1) THEN
       AR(K2)=AR(K2)+CY(I)*AMD(4)+CX(I)*AMD(5)
       ENDIF
       IF(JRL(K3) .EQ. 1) THEN
       AR(K3)=AR(K3)+AMD(6)
       ENDIF
       WRITE(108,18)I,AM(1),AM(2),AM(3),AM(4),AM(5),AM(6)
18     FORMAT(2X,I5,6F10.3)
310    CONTINUE
       DO 330 J=1,ND
       IF(JRL(J) .NE. 0) THEN
       AR(J)=AR(J)-AJ(J)-AE(J)
       ENDIF
330    CONTINUE
       WRITE*," "
       WRITE*,"SUPPORT REACTIONS"
       WRITE(108,19)
19     FORMAT(2X,"JOINT",7X,"AR1",7X,"AR2",7X,"AR3")
       DO 340 J=1,NJ
       J1=3*J-2
       J2=3*J-1
       J3=3*J
       N1=JRL(J1)+JRL(J2)+JRL(J3)
       IF(N1 .NE. 0) THEN
       WRITE(108,20)J,AR(J1),AR(J2),AR(J3)
20     FORMAT(2X,I5,3F10.3)
       ENDIF
340    CONTINUE
C
C
       GOTO 620
600    WRITE*,"SFF NOT POSITIVE DEFINITE"
620    WRITE*,"***********************************************************"
       ISN=ISN+1
       WRITE*,"***********************************************************"
       WRITE*," 1  NEW PRESET GRID"
       WRITE*," 2  CHANGE IN PRESET GRID"
       WRITE*," 3  NONPRESET GRID"
       WRITE*," 0  STOP"
       WRITE*," "
       WRITE*," INPUT ONE OF THE ABOVE NUMBERS TO CONTINUE"
```

```
      WRITE*,"**********************************************************"
      WRITE*,"**********************************************************"
      INPUT NEW
      ICHNGE=0
      IF(NEW .EQ. 0) GOTO 800
      IF(NEW .EQ. 3) GOTO 630
      IF(NEW .EQ. 1) GOTO 640
      ICHNGE=ICHNGE+1
650   WRITE*,"**********************************************************"
      WRITE*," 1 NUMBER OF STRINGERS"
      WRITE*," 2 LENGTH OF STRINGERS"
      WRITE*," 3 SPACING OF STRINGERS"
      WRITE*," 4 DEPTH AND WIDTH OF STRINGERS"
      WRITE*," 5 DEPTH AND WIDTH OF PLANK"
      WRITE*," 6 DEPTH AND WIDTH OF REDUCED STRINGER"
      WRITE*," 7 LOCATION OF REDUCED STRINGER"
      WRITE*," 8 LOCATION OF PLANK"
      WRITE*," 9 E AND G"
      WRITE*,"10 NUMBER OF LOADED JOINTS"
      WRITE*,"11 NUMBER OF LOADED MEMBERS"
      WRITE*,"12 NUMBER OF RESTRAINTS"
      WRITE*,"13 NUMBER OF RESTRAINED JOINTS"
      WRITE*," 0 NO CHANGES"
      WRITE*," "
      WRITE*," INPUT ONE OF THE ABOVE NUMBERS FOR CHANGES"
      WRITE*,"**********************************************************"
      WRITE*,"**********************************************************"
      INPUT CHANGE
      IF(CHANGE .EQ. 1) THEN
      WRITE*," INPUT NUMBER OF STRINGERS"
      INPUT NST
      GOTO 650
      ENDIF
      IF(CHANGE .EQ. 2) THEN
      WRITE*," INPUT LENGTH OF STRINGERS"
      INPUT STL
      GOTO 650
      ENDIF
      IF(CHANGE .EQ. 3) THEN
      WRITE*," INPUT SPACING OF STRINGERS"
      INPUT STS
      GOTO 650
      ENDIF
      IF(CHANGE .EQ. 4) THEN
      WRITE*," INPUT DEPTH D, AND WIDTH B OF STRINGERS"
      INPUT DS,BS
      GOTO 650
      ENDIF
      IF(CHANGE .EQ. 5) THEN
      WRITE*," INPUT DEPTH D, AND WIDTH B OF PLANK"
      INPUT DP,BP
      GOTO 650
      ENDIF
      IF(CHANGE .EQ. 6) THEN
      WRITE*," INPUT DIMENSIONS OF REDUCED STRINGER, D AND B"
      INPUT RDS,RBS
      GOTO 650
      ENDIF
      IF(CHANGE .EQ. 7) THEN
      WRITE*," INPUT LOCATION OF REDUCED STRINGER, STRINGER #"
      INPUT RST
```

```
      GOTO 650
      ENDIF
      IF(CHANGE .EQ. 8) THEN
      WRITE*,"INPUT LOCATION OF PLANK AS FRACTION OF STRINGER LENGTH"
      INPUT LFP
      GOTO 650
      ENDIF
      IF(CHANGE .EQ. 9) THEN
      WRITE*,"INPUT E AND G"
      INPUT E,G
      GOTO 650
      ENDIF
      IF(CHANGE .EQ. 10) THEN
      WRITE*," INPUT NUMBER OF LOADED JOINTS"
      INPUT NLJ
      GOTO 650
      ENDIF
      IF(CHANGE .EQ. 11) THEN
      WRITE*," INPUT NUMBER OF LOADED MEMBERS"
      INPUT NLM
      GOTO 650
      ENDIF
      IF(CHANGE .EQ. 12) THEN
      WRITE*," INPUT NUMBER OF RESTRAINTS"
      INPUT NR
      GOTO 650
      ENDIF
      IF(CHANGE .EQ. 13) THEN
      WRITE*," INPUT NUMBER OF RESTRAINED JOINTS"
      INPUT NRJ
      GOTO 650
      ENDIF
      IF(CHANGE .EQ. 0) GOTO 660
800   END
*   EOF hit after 639.000
*E
!DONT DRIBBLE
DRIBBLE OFF @ 11:46 06/12/85
```

```
12:06 JUN 12 '85 ALENE.ICEFV003

DRIBBLE ON @  11:59 06/12/85
!GRID2.

FOR PRESET GRID PRINT 1, ELSE 0
?1

INPUT NUMBER OF STRINGERS
?7

INPUT LENGTH OF STRINGERS
?25.0

INPUT SPACING OF STRINGERS
?2.0

INPUT DEPTH D, AND WIDTH B (in) OF STRINGERS
?20.0,10.0

INPUT DEPTH D, AND WIDTH B (in) OF PLANK
?3.0,12.0

INPUT DIMENSIONS OF REDUCED STRINGER, D AND B (in)
?18.0,10.0

INPUT LOCATION OF REDUCED STRINGER, STRINGER NUMBER
?4

INPUT LOCATION OF PLANK, AS FRACTION OF STRINGER LENGTH
?2

INPUT E AND G
?1400.0,10.0

INPUT NUMBER OF LOADED JOINTS (NLJ), AND
NUMBER OF LOADED MEMBERS (NLM)
?1,0

INPUT NUMBER OF RESTRAINTS (NR)
?28

INPUT NUMBER OF RESTRAINED JOINTS (NRJ)
?14


INPUT JOINT RESTRAINT LIST
K,JRL(3K-2),JRL(3K-1),JRL(3K)
?1,0,1,1
?3,0,1,1
?4,0,1,1
?6,0,1,1
?7,0,1,1
?9,0,1,1
?10,0,1,1
?12,0,1,1
?13,0,1,1
?15,0,1,1
?16,0,1,1
?18,0,1,1
?19,0,1,1
?21,0,1,1
```

```
INPUT JOINT LOADS
K,AJ(3K-2),AJ(3K-1),AJ(3K)
?11,0.0,0.0,-10.0

**************************************************
**************************************************
SPACING= 2.000000
L/D=       15
MAIN STRINGERS        : 10.00000 * 20.00000
REDUCED STRINGERS : 10.00000 * 18.00000
PLANK                 : 3.000000 * 12.00000

STRUCTURAL PARAMETERS
     M     N    NJ    NR   NRJ          E          G
    20    35    21    28    14   1400.00      10.00

JOINT COORDINATES
 JOINT          X            Y
     1       .000         .000
     2       .000      150.000
     3       .000      300.000
     4     24.000         .000
     5     24.000      150.000
     6     24.000      300.000
     7     48.000         .000
     8     48.000      150.000
     9     48.000      300.000
    10     72.000         .000
    11     72.000      150.000
    12     72.000      300.000
    13     96.000         .000
    14     96.000      150.000
    15     96.000      300.000
    16    120.000         .000
    17    120.000      150.000
    18    120.000      300.000
    19    144.000         .000
    20    144.000      150.000
    21    144.000      300.000

MEMBER INFORMATION
 MEMBER   JJ   JK        XI         YI          EL          CX          CY
     1     1    2   8333.333   6666.667    150.000        .000       1.000
     2     2    3   8333.333   6666.667    150.000        .000       1.000
     3     2    5    459.000     27.000     24.000       1.000        .000
     4     4    5   8333.333   6666.667    150.000        .000       1.000
     5     5    6   8333.333   6666.667    150.000        .000       1.000
     6     5    8    459.000     27.000     24.000       1.000        .000
     7     7    8   8333.333   6666.667    150.000        .000       1.000
     8     8    9   8333.333   6666.667    150.000        .000       1.000
     9     8   11    459.000     27.000     24.000       1.000        .000
    10    10   11   6360.000   4860.000    150.000        .000       1.000
    11    11   12   6360.000   4860.000    150.000        .000       1.000
    12    11   14    459.000     27.000     24.000       1.000        .000
    13    13   14   8333.333   6666.667    150.000        .000       1.000
    14    14   15   8333.333   6666.667    150.000        .000       1.000
    15    14   17    459.000     27.000     24.000       1.000        .000
    16    16   17   8333.333   6666.667    150.000        .000       1.000
    17    17   18   8333.333   6666.667    150.000        .000       1.000
    18    17   20    459.000     27.000     24.000       1.000        .000
```