A DISCRETE-ELEMENT METHOD OF ANALYSIS FOR COMBINED BENDING AND SHEAR DEFORMATIONS OF A BEAM

by

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Development of Methods for Computer Simulation
of Beam-Columns and Grid-Beam and Slab Systems

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PREFACE

This report presents a method for determining the contribution of shear deformations to the total deflections of beam-columns. The theory for the required discrete-element analytical procedure is developed and a computer program is documented. The method permits the solution of complex problems with any reasonable variation in member properties, loads or supports.

This is the twelfth in a series of reports that describe the work in Research Project No. 3-5-63-56, entitled "Development of Methods for Computer Simulation of Beam-Columns and Grid-Beam and Slab Systems." A review of earlier reports (see list of reports) will provide useful background information for the procedures presented herein.

The computer program described in this report is written in American Standard FORTRAN language for the CDC 6600 computer. Only minimal changes are required to make the program operational on other systems. Duplicate copies of the program deck and test data cards for the example problems may be obtained from the Center for Highway Research, The University of Texas at Austin.

This report is a product of the efforts of many people. Particular acknowledgement is made of the advice and assistance of Messrs. Hudson Matlock, Art Frakes and Don Fenner. The support of the U. S. Bureau of Public Roads is gratefully acknowledged. The excellent facilities of the Computation Center of The University of Texas and the cooperation of its staff have contributed significantly.

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ABSTRACT

A method of analysis for the combined effects of bending and shear deformations is presented. Although the method is primarily designed for the analysis of beams, it can be applied to other structural problems. The method is applicable to beams that have abrupt, or point-by-point, variations in their structural properties. Also, the beam may be subjected to any configuration of transverse or longitudinal loads, and it may be supported in any reasonable manner.

There are three important features of the method presented. First, a discrete-element model is substituted for the real structure. Second, a system of algebraic equations which describe the load-deflection behavior of the model is written. Finally, these equations are solved for the unknown deflections by a modified form of Gaussian elimination.

A computer program, SHRBM 1, which utilizes the method of analysis presented herein provides an efficient means of solving practical problems. The correct usage of the program and the generality of the method are demonstrated by a series of example problems.

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NOMENCLATURE

Symbol	Typical Units	Definition
a	in.	Distance from the joint at which the R force is applied
$a_{i,1}$ - $a_{i,8}$	-	Terms in coefficient and load matrices
A	in^2	Cross-section area
A_s	in^2	Effective shear area
b	in.	Width of beam section
$b_{i,1}$ - $b_{i,7}$	-	Terms in coefficient and load matrices
d	in.	Depth of beam section
E	lb/in^2	Modulus of elasticity
F	$lb\text{-}in^2$	Flexural stiffness = EI
G	lb/in^2	Shear modulus
h	in.	Increment length
i	-	Station and bar number
I	in^4	Moment of inertia
k	-	Constant $= \frac{A_s}{I^2} \iint \left(\frac{Q_y^2}{b^2} \right) dydz$
K	lb/in	Shear stiffness
L	in.	Beam length
M	in-lb	Bending moment

Symbol	Typical Units	Definition
P	lb	Longitudinal load
Q	lb	Transverse force
Q_y	in^3	First moment, about the neutral axis, of the cross-section area outside a distance y from the neutral axis of the beam
Q_R	lb	Support reaction
R	in-lb/rad	Rotational restraint
S	lb/in	Support spring stiffness
t	in.	Beam dimension
T	in-lb	Applied couple
V	lb	Shear
w	in.	Total vertical deflection
W_e	in-lb	External work
W_i	in-lb	Internal work
x	in.	Distance along the beam
Δx	in.	Incremental length of the beam
y	in.	Distance from the neutral axis of the beam
α	rad	Incremental angular deformation due to shear
γ	rad	Total angular deformation due to shear
δ_i	in.	Shear deflection in Bar i
θ_i	rad	Bar slope
$(\theta_J)_i$	rad	Average slope of two neighboring bars
τ_y	lb/in^2	Shear stress at a distance y from the neutral axis of the beam

Symbol	Typical Units	Definition
ϕ_i	rad	Angle change between two neighboring bars

LIST OF REPORTS

Report No. 56-1, "A Finite-Element Method of Solution for Linearly Elastic Beam-Columns" by Hudson Matlock and T. Allan Haliburton, presents a finite-element solution for beam-columns that is a basic tool in subsequent reports.

Report No. 56-2, "A Computer Program to Analyze Bending of Bent Caps" by Hudson Matlock and Wayne E. Ingram, describes the application of the beam-column solution to the particular problem of bent caps.

Report No. 56-3, "A Finite-Element Method of Solution for Structural Frames" by Hudson Matlock and Berry Ray Grubbs, describes a solution for frames with no sway.

Report No. 56-4, "A Computer Program to Analyze Beam-Columns under Movable Loads" by Hudson Matlock and Thomas P. Taylor, describes the application of the beam-column solution to problems with any configuration of movable non-dynamic loads.

Report No. 56-5, "A Finite-Element Method for Bending Analysis of Layered Structural Systems" by Wayne B. Ingram and Hudson Matlock, describes an alternating-direction iteration method for solving two-dimensional systems of layered grids-over-beams and plates-over-beams.

Report No. 56-6, "Discontinuous Orthotropic Plates and Pavement Slabs" by W. Ronald Hudson and Hudson Matlock, describes an alternating-direction iteration method for solving complex two-dimensional plate and slab problems with emphasis on pavement slabs.

Report No. 56-7, "A Finite-Element Analysis of Structural Frames" by T. Allan Haliburton and Hudson Matlock, describes a method of analysis for rectangular plane frames with three degrees of freedom at each joint.

Report No. 56-8, "A Finite-Element Method for Transverse Vibrations of Beams and Plates" by Harold Salani and Hudson Matlock, describes an implicit procedure for determining the transient and steady-state vibrations of beams and plates, including pavement slabs.

Report No. 56-9, "A Direct Computer Solution for Plates and Pavement Slabs" by C. Fred Stelzer, Jr., and W. Ronald Hudson, describes a direct method for solving complex two-dimensional plate and slab problems.

Report No. 56-10, "A Finite-Element Method of Analysis for Composite Beams" by Thomas P. Taylor and Hudson Matlock, describes a method of analysis for composite beams with any degree of horizontal shear interaction.

Report No. 56-11, "A Discrete-Element Solution of Plates and Pavement Slabs Using a Variable-Increment-Length Model" by Charles M. Pearre, III, and W. Ronald Hudson, presents a method of solving for the deflected shape of freely discontinuous plates and pavement slabs subjected to a variety of loads.

Report No. 56-12, "A Discrete-Element Method of Analysis for Combined Bending and Shear Deformations of a Beam" by David F. Tankersley and William P. Dawkins, presents a method of analysis for the combined effects of bending and shear deformations.

Report No. 56-13, "A Discrete-Element Method of Multiple-Loading Analysis for Two-Way Bridge Floor Slabs" by John J. Panak and Hudson Matlock, includes a procedure for analysis of two-way bridge floor slabs continuous over many supports.

CHAPTER 1. INTRODUCTION

Purpose

The purpose of this study is to develop an efficient method for the analysis of beams in which shear deformations are significant. In the analysis of many structural problems, the dimensions of the members are such that it is sufficient to consider only the effects of bending deformations. However, for large-flange, thin-web beams and short, deep beams the effects of shear deformations are significant. By considering these effects in the analysis of the structure, a more flexible member is represented. Consequently, for some members a significantly different moment and shear variation is predicted than would be expected by neglecting shear deformations. Typical structural members which should be analyzed for shear deformations are girders for supporting bridge floor beams, traveling-crane girders, bridge diaphragms, and flexural components of aircraft structures.

Brief Description of the Method of Analysis

The method of analysis presented herein allows for a very general description of the physical problem. A wide variation in loads, supports, and beam section and material properties is possible. A basic requirement of the method is the necessity to solve a large number of simultaneous equations. This is not practical without the aid of a computer.

The proposed method of analysis consists of three fundamental steps. First, the actual structure is replaced by an idealized model composed of a system of discrete bars and springs. Second, two load-deflection equations are derived from the conditions of equilibrium and geometric compatibility by means of the force-deformation relations for the model. The load-deflection equations are written in terms of two unknown deflections: the shear deflection and the total deflection. When the two governing equations are written for each bar and joint in the model, a diagonally-banded set of equations results. Solution of this system of equations is the final step of the analysis.

A computer program has been written to perform the three steps outlined above. The physical problem is described according to a data input form that is provided and the analysis of a structure is automatically completed by the program.

Order of the Discussion

The assumptions of elementary beam theory and some methods of analysis are presented in Chapter 2. In Chapter 3 a discrete-element model representation of the actual system is introduced, and from this model the governing equations are derived. The method of solution is discussed in Chapter 4. A detailed explanation of the computer program used in the solution is given in Chapter 5. Several example problems are solved in Chapter 6 to illustrate the usage of the program. In Chapter 7 a summary of the method and some recommendations for further work are given.

CHAPTER 2. ELEMENTARY BEAM THEORY

Contents of the Chapter

The analysis of structural problems based on elementary beam theory incorporates several simplifying assumptions which yield sufficiently accurate results for most engineering problems. The assumptions related to the study of combined bending and shear deformations will be presented in this chapter. The behavior of a beam element due to the effects of bending and shear is examined. Also, some methods of analysis are discussed.

Bending Deformations

Bending deformations are generally the most significant part of the total deformation in a beam. For the case of pure bending, the beam curvature is related to the bending moment M and the flexural stiffness EI by

$$\frac{d^2w}{dx^2} = \frac{M}{EI} \tag{2.1}$$

where the second derivative of the deflection w with respect to the distance x along the beam is an approximation of the beam curvature. This relationship neglects both the axial and shear deformations of the element and is further limited by the following assumptions:

(1) The beam is assumed to be initially straight.

(2) Plane cross sections are assumed to remain plane.

(3) Deflections are assumed to be small compared to the original cross-section dimensions.

(4) The beam is assumed to be of symmetrical cross section about the plane of loading.

(5) The material of the beam is assumed to be isotropic and linearly elastic.

Equation 2.1 is a force-deformation relation for a beam subjected to pure bending. However, it represents a good approximation of the beam behavior when the deformations due to shear and axial loads are insignificant. A more general relation can be derived which includes the effect of shear deformations.

Shear Deformations

A force-deformation relation which accounts for the shear deflection is developed in this section by application of the method of virtual work to an incremental length of an idealized beam. The deformed shape of the beam element due to the shear V is illustrated in Fig 2.1(a). The indicated shear strain γ is the total shear deformation which occurs over a finite distance Δx of the beam, and it represents a change in slope of the element. An expression for the total shear deformation is derived by equating the external work to the internal work done by the unit shear on the element shown in Fig 2.1(b).

The shear stress τ_y on any fiber at a distance y from the neutral axis of a prismatic[1] beam is determined from elementary beam theory by satisfying the condition of longitudinal equilibrium of a beam element. Crandall (Ref 3) gives the expression for the shear stress distribution as

$$\tau_y = \frac{VQ_y}{Ib} \tag{2.2}$$

where Q_y is the first moment, with respect to the neutral axis, of the cross-section area which is outside a distance y from the neutral axis. The moment of inertia of the cross section, referred to the neutral axis, is represented by I , and the width of the cross section at the distance y is given by b . The shear distortion of a fiber of the beam, shown in cross section in Fig 2.1(c), is illustrated in Fig 2.1(d). The angle of this shear distortion at the distance y from the neutral axis is designated by α .

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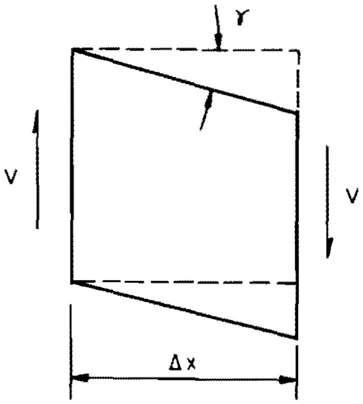
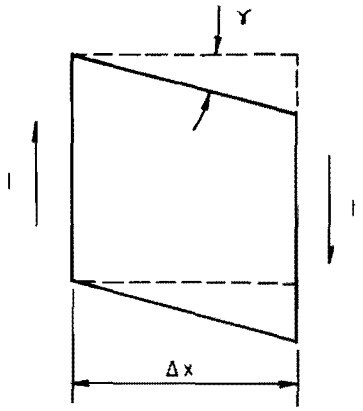
[1] A more general expression for the shear stress distribution in symmetrically tapered beams is derived by Timoshenko (Ref 18).



(a) Total shear on a beam element.



(b) Unit shear on a beam element.

(c) Beam cross section.

(d) Shear stress on a beam fiber.

Fig 2.1. Deformation of a beam element due to shear.

The internal work W_i done by the unit shear in distorting the beam element is

$$W_i = \int \frac{1 \cdot Q_y}{Ib} dA \cdot \alpha \cdot \Delta x \qquad (2.3)$$

Since $dA = dydz$ and $\alpha = \frac{\tau_y}{G} = \frac{VQ_y}{GIb}$, where G is the shear modulus, this equation reduces to

$$W_i = \frac{V}{I^2G} \iint \frac{Q_y^2}{b^2} dydz\Delta x \qquad (2.4)$$

The corresponding external work W_e done by the unit shear on the beam element is

$$W_e = 1 \cdot \gamma \cdot \Delta x \qquad (2.5)$$

Combination of Eqs 2.4 and 2.5 gives

$$\gamma = \frac{V}{I^2G} \iint \frac{Q_y^2}{b^2} dydz \qquad (2.6)$$

which relates the total shear strain on a finite beam element to the shear on the element. Evaluation of the double integral in Eq 2.6 for a particular beam cross section yields the equivalent relation

$$\gamma = k \frac{V}{A_sG} \quad , \quad k = \frac{A_s}{I^2} \iint \frac{Q_y^2}{b^2} dydz \qquad (2.7)$$

where A_s is the effective shear area. The value of the factor k depends on the shape of the cross section. For example, k is 1.2 for a rectangular cross section. Other values of k are given by Fife (Ref 5). Since k is very nearly equal to 1.0 for most cross sections, Eq 2.7 can be approximated by

$$\gamma = \frac{V}{A_s G} \qquad (2.8)$$

Combined Bending and Shear Deformations

The total deformation due to bending and shear is determined by superposition. The justification for this can be obtained from an examination of the effect of shear deformations on a beam. For a beam of rectangular cross section, Eq 2.2 indicates a parabolic shear stress distribution as shown in Fig 2.2(a). The corresponding strain is also parabolically distributed. This implies that the originally plane cross sections distort in the manner shown in Fig 2.2(b). Thus, due to the effect of shear, plane sections do not remain plane as assumed. However, for a constant shear force, it is observed that any longitudinal line parallel to the neutral surface does not change its length as the beam element deforms. A constant shear force, therefore, has little effect on the bending strain and, hence, the bending strain distribution. Crandall (Ref 3) also indicates that the error due to a varying shear force is small, particularly for long slender beams. The combined effect of bending and shear may, therefore, be determined by superposition.

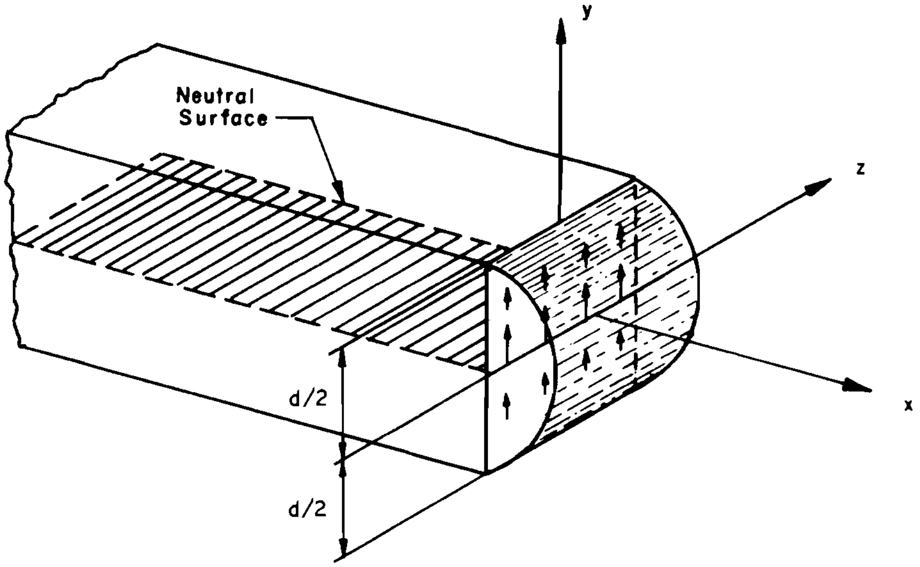
For the case of pure bending, the total slope $\frac{dw}{dx}$ of a beam element is due only to bending. Since shear deformations cause a change in slope equal to γ, the slope due to combined bending and shear is $\frac{dw}{dx} + \gamma$ by superposition. Substitution of this modified slope in Eq 2.1 yields the moment-curvature relation

$$\frac{d}{dx}\left(\frac{dw}{dx} + \gamma\right) = \frac{M}{EI} \qquad (2.9)$$

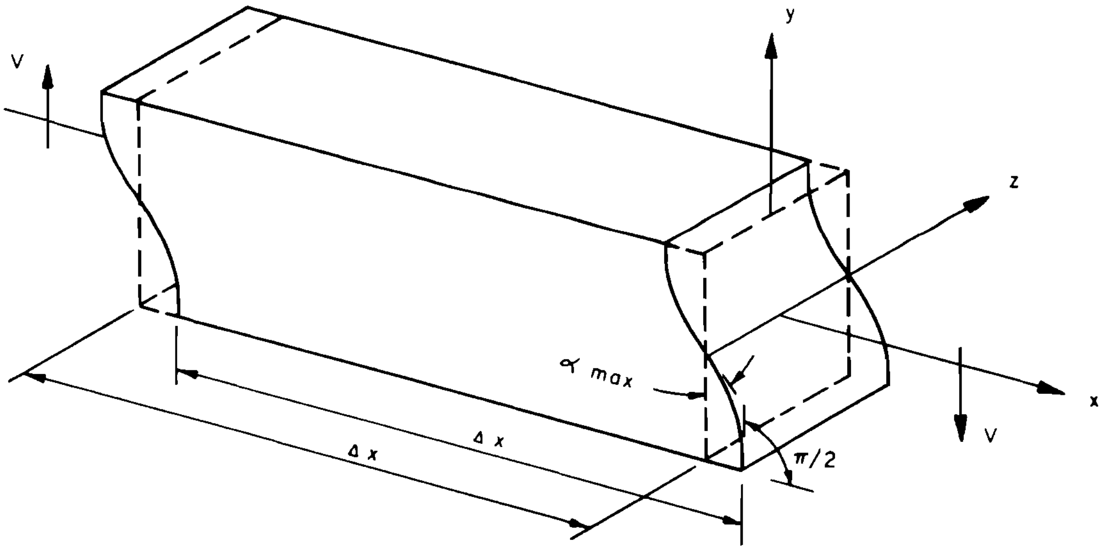
or

$$\frac{d^2w}{dx^2} + \frac{d\gamma}{dx} = \frac{M}{EI} \qquad (2.10)$$

which is the required relation.



(a) Parabolic shear stress distribution.



(b) Warped cross section due to parabolic shear stress distribution.

Fig 2.2. Effect of a constant shear force on a rectangular beam.

Methods of Analysis

Some methods of analysis which have contributed to this study of combined bending and shear deformations are mentioned in this section. No attempt is made to discuss each method in detail.

Two conventional methods of analysis are the virtual work method (Ref 10) and the conjugate beam method (Ref 17). With the virtual work method, deflections are determined by relating the internal energy of the structure to the external work done by a unit load. The conjugate beam method is a numerical technique for solution of the differential equation of the beam. Both of these methods utilize the principle of superposition to determine the combined effect due to shear and bending.

Numerical techniques have also been applied to the solution of beam problems by replacing the governing differential equation with finite-difference approximations of the derivatives.

Another approach to the problem is to model the structure physically by a system of discrete elements whose behavior can be described with algebraic equations. Newmark (Ref 7) was one of the first to use this method of analysis. For many problems, the finite-difference equations developed by direct substitution for the differential equation and the discrete-element model equations developed from a free-body analysis of the model are equivalent.

The method of analysis presented in this text has been greatly influenced by the numerical solutions for beam-columns on elastic foundations by Matlock (Ref 12). With this method the actual structure is replaced with a discrete-element model composed of rigid, weightless bars with hinged ends. The beam stiffness of each finite beam element is concentrated in the springs at the hinges. The development of the bar-and-spring model from a section of a beam element subjected to pure bending is shown in Fig 2.3.

Figure 2.3(a) shows an element of a beam subjected to bending moments and Fig 2.3(b) illustrates the stresses acting on the element. These distributed forces may be replaced by concentrated forces as indicated in Fig 2.3(c). The beam element may also be represented by the plates and springs as shown in Fig 2.3(d), and Fig 2.3(e) is an idealization of the structure by use of a series of these beam element models. A cruder model can be made by using rigid bars and springs as shown in Fig 2.3(f). Based on the latter model, a system of algebraic equations which express the load-deflection characteristics

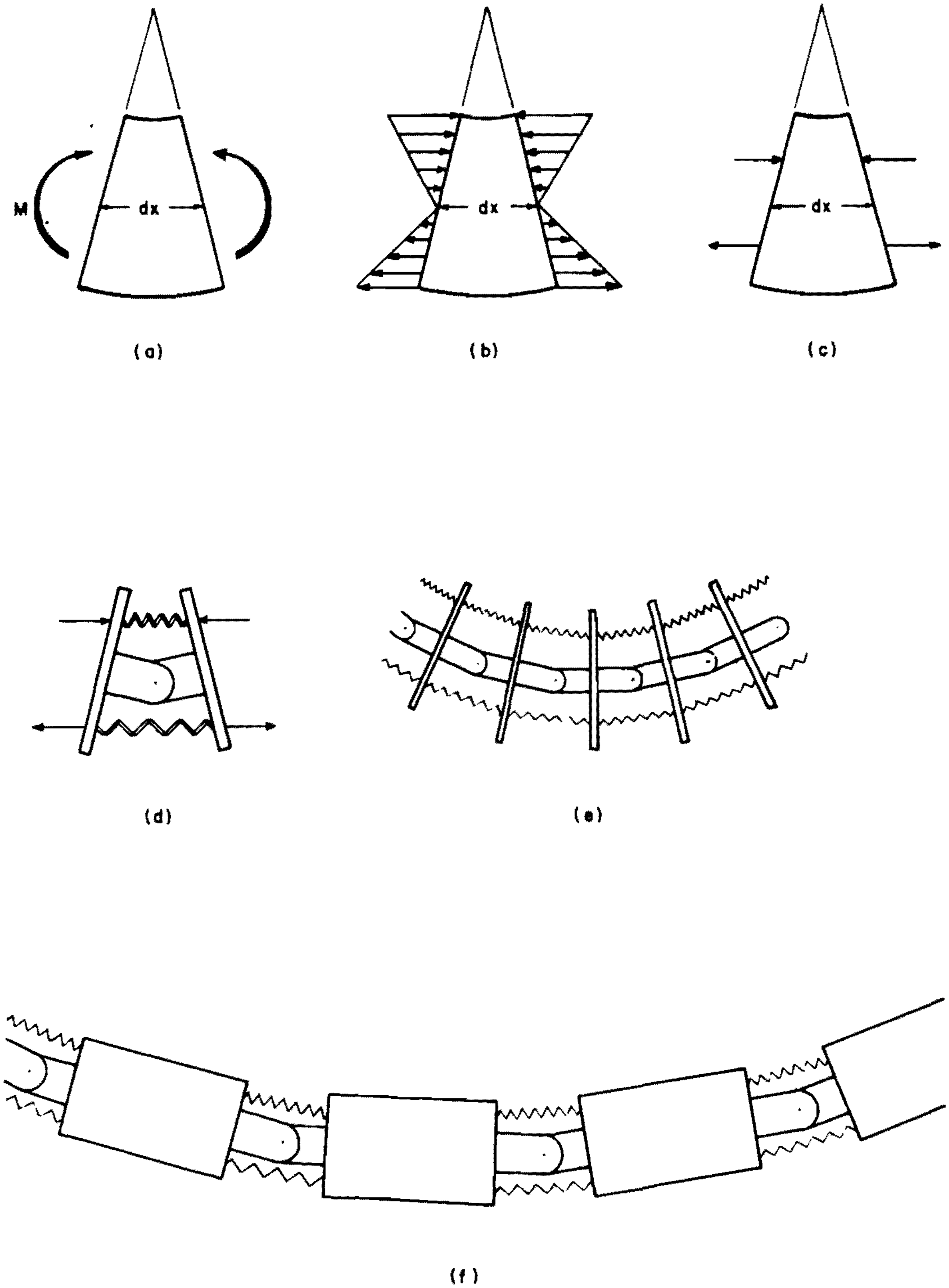


Fig 2.3. Discrete mechanical representation of a conventional beam.

of the system is derived. The accuracy of the solution for this model has been well documented previously (Ref 12).

CHAPTER 3. DISCRETE-ELEMENT MODEL

Contents of the Chapter

In this chapter a discrete-element model of the actual beam is presented. From this model the equilibrium equations and the geometric compatibility equations are derived. From these equations and the beam force-deformation relationships, the load-deflection equations for the beam are developed.

The Bar-and-Spring Model

The model that is used to represent the actual system is illustrated in Fig 3.1. The beam is represented by a series of bars and springs. The bending stiffness F of the actual system is concentrated in the springs shown at the hinged joints between each bar. Likewise, the shear stiffness K is concentrated at the center of each bar. In this manner the shear deformation δ is confined to the bar, whereas the bending deformation ϕ occurs only at the joint.

An important feature of the method is that a very general description of the actual system is possible. A point-by-point variation of all loads and stiffnesses may be modeled. All properties of the real system are represented as "lumped" quantities at discrete points in the model. As indicated above, a distinction can be made between the quantities associated with the bar and those associated with the joint. Other terms which may be defined as properties of the bar are the slope θ , the shear V , the axial tension P , and the shear stiffness K . Typical joint properties are the total deflection w , the bending stiffness F , the bending moment M , the transverse load Q , and the support spring stiffness S .

The rotational restraint R and the applied couple T may be considered as affecting the joint. Both the R and the T terms are felt by the model as two equal and opposite forces as indicated in Fig 3.2. Typical units of the rotational restraint are in-lb/rad . Shear deformations are

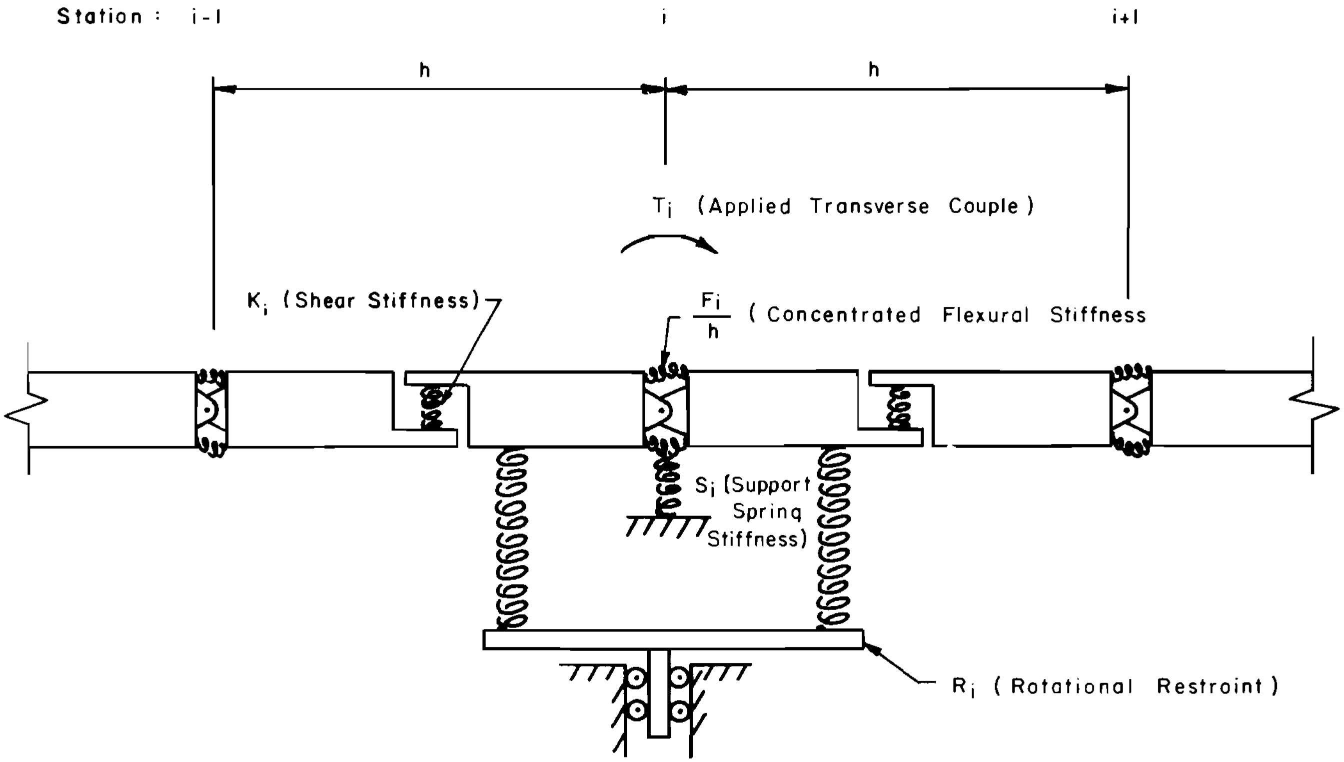


Fig 3.1. Bar-and-spring model.

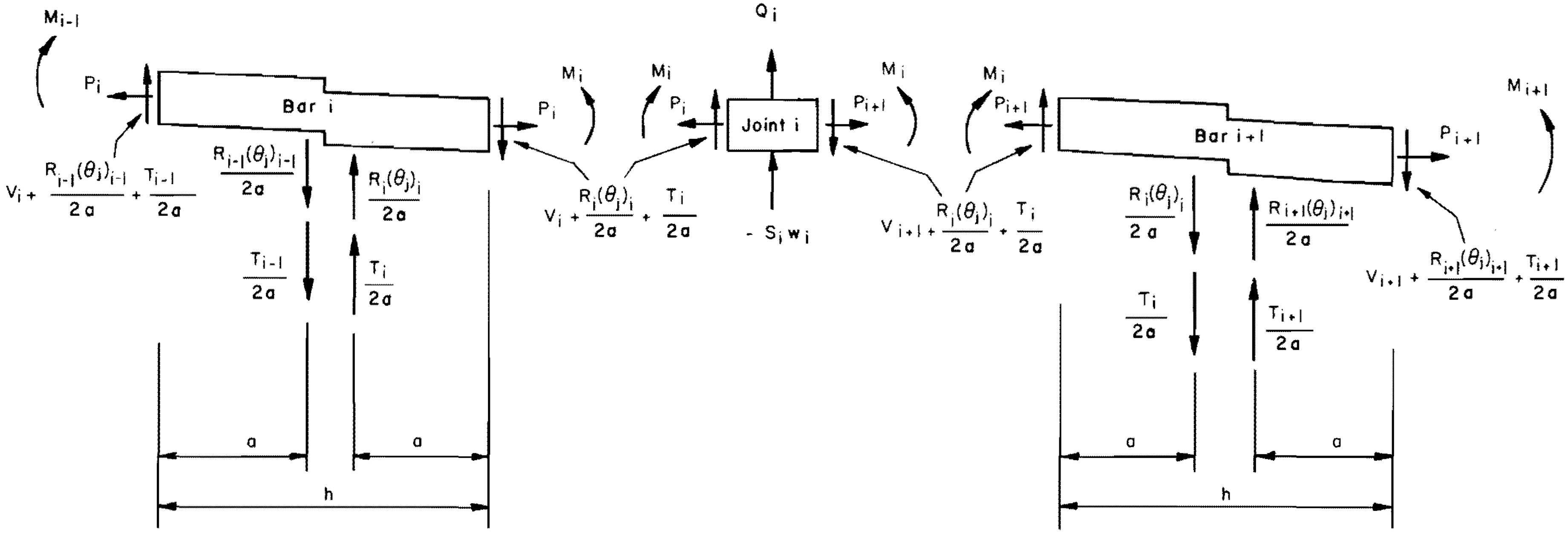


Fig 3.2. Free-body diagram.

unaltered when the rotational restraint forces and the applied couple forces are applied at the points indicated.

The sign convention which has been adopted is indicated in Fig 3.3. All quantities are shown in the positive sense. A subscript is used to identify the bar or joint with which each of the quantities is associated.

The entire model of the beam is composed of a number of these bar-and-spring elements. A typical bar-and-spring model representation of a beam is shown in Fig 3.4. Each joint, which is referred to as a "station," is numbered from left to right beginning with the left extremity of the beam as Station zero. In addition, two imaginary stations are defined at each end of the model. Likewise, the bars are numbered from left to right beginning with the first real bar as bar number one. It should be noted that all support points and end points of the actual beam correspond to joint locations in the model.

Equilibrium Equations

Two equations of equilibrium must be satisfied by the free-bodies shown in Fig 3.2. From the summation of vertical forces acting on Joint i

$$V_i + \frac{R_i(\theta_J)_i}{2a} + \frac{T_i}{2a} + Q_i - S_i w_i - \left(V_{i+1} + \frac{R_i(\theta_J)_i}{2a} + \frac{T_i}{2a} \right) = 0 \quad (3.1)$$

or, upon collecting like terms,

$$V_i - S_i w_i - V_{i+1} + Q_i = 0 \quad (3.2)$$

The second equilibrium condition to be satisfied, which results from the summation of moments about Station i-1 for Bar i, is

$$M_i - M_{i-1} - P_i \left(w_i - w_{i-1} \right) - \left(V_i + \frac{R_i(\theta_J)_i}{2a} + \frac{T_i}{2a} \right) h$$

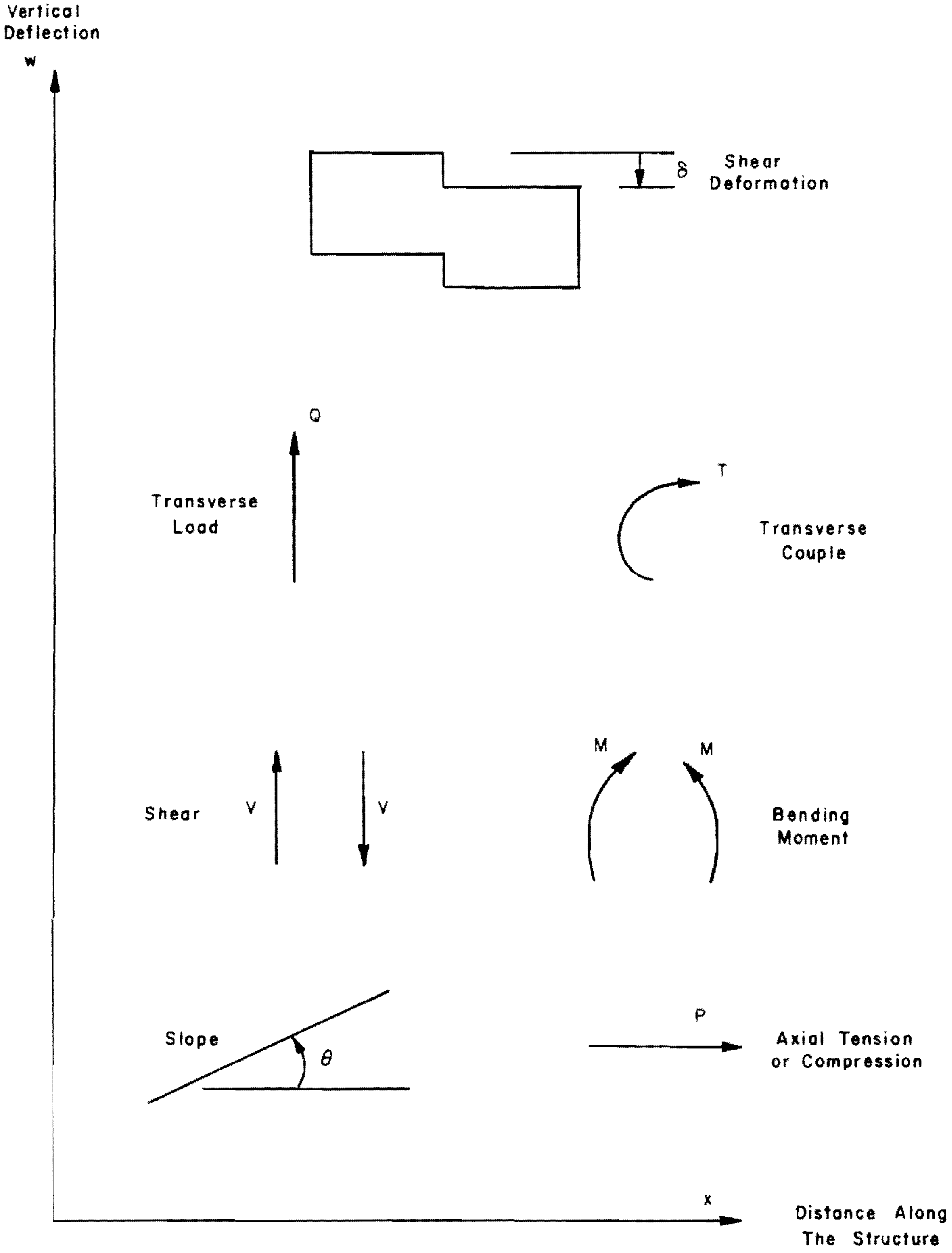
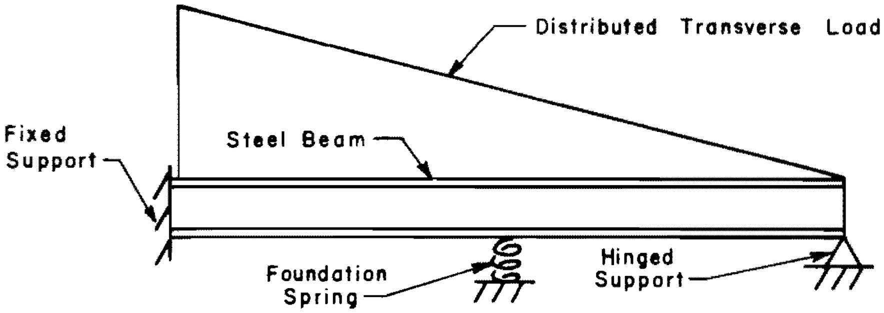
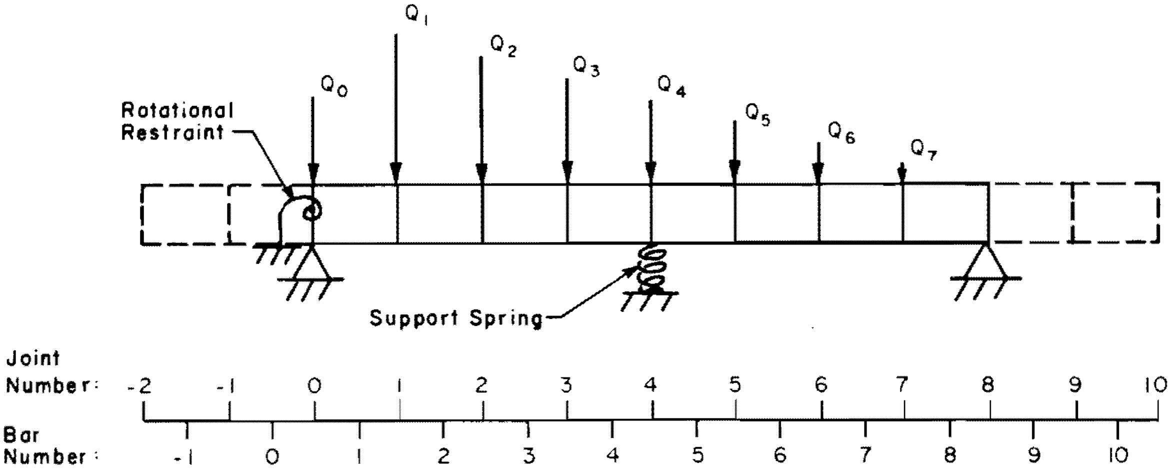


Fig 3.3. Sign convention. All quantities are shown in the positive sense with respect to distance along the beam, x .



(a) The actual beam to be analyzed.



(b) Bar-and-spring model of the beam.

Fig 3.4. Typical bar-and-spring model representation of a beam.

$$+ \left(\frac{R_i(\theta_J)_i}{2a} + \frac{T_i}{2a} \right) \left(h - a \right) - \left(\frac{R_{i-1}(\theta_J)_{i-1}}{2a} + \frac{T_{i-1}}{2a} \right) a$$

$$= 0 \qquad (3.3)$$

or after collecting like terms,

$$M_i - M_{i-1} - P_i(w_i - w_{i-1}) - V_i h - \frac{R_i(\theta_J)_i}{2} - \frac{T_i}{2} - \frac{R_{i-1}(\theta_J)_{i-1}}{2}$$

$$- \frac{T_{i-1}}{2} = 0 \qquad (3.4)$$

Note that this relation is independent of the distance "a" at which the R and T terms are applied to the bar.

Geometric Compatibility

The deformed shape of the centerline of the model is illustrated in Fig 3.5. This configuration corresponds to positive deformations. As indicated, two deflections are defined for the model. The total deflection w is measured at each joint with the undeflected centerline of the model as a reference. The shear deflection δ is measured at the center of each bar and represents only the deflection due to shear in a single bar. Expressions for the bar slope, the joint rotation, and the relative angle change between adjacent bars can be formulated based on the deformed shape of the model.

The slope θ for the bar-and-spring model is defined as the slope of each bar. Thus, from the model geometry, the slope of Bar i is related to the deflections by

$$\theta_i = \frac{w_i - (w_{i-1} - \delta_i)}{h} \qquad (3.5)$$

where h is the length of the bar. The slope of the model is not defined at the joint, but the slope of the actual beam represented by the model can be approximated as the average of the slopes of the adjacent bars:

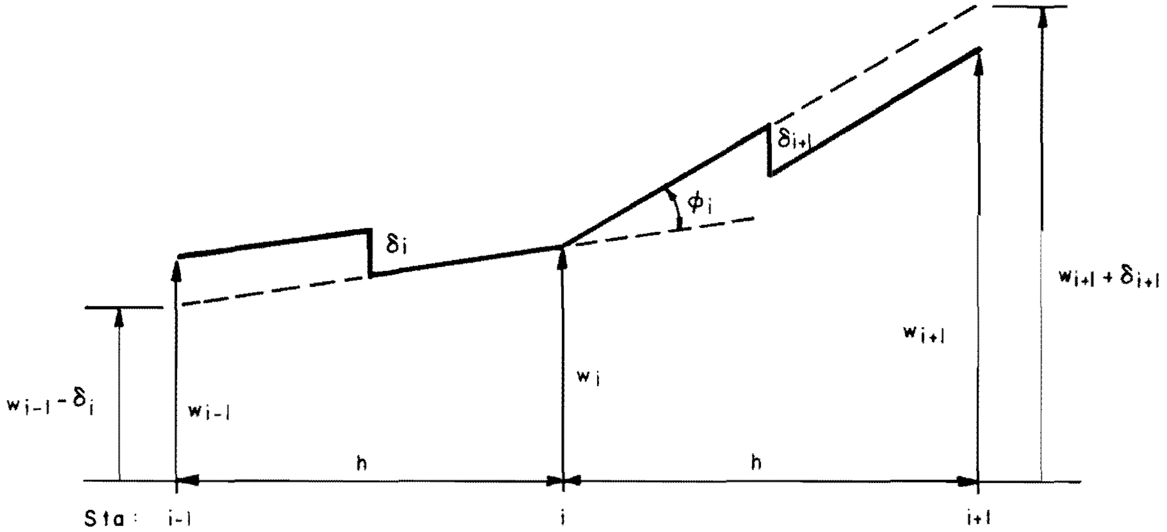


Fig 3.5. Deformed shape of the bar-and-spring model.

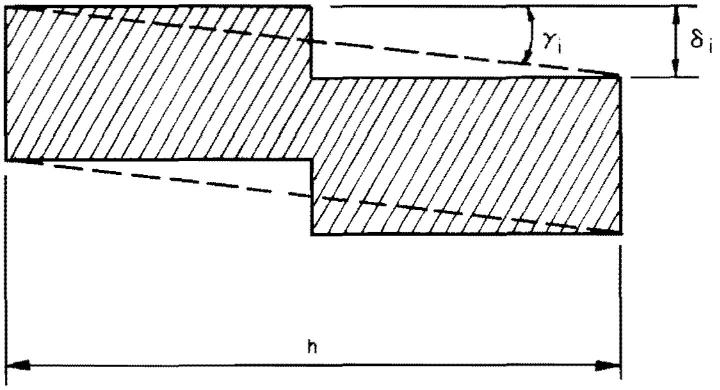


Fig 3.6. Geometric relation between a bar and an idealized beam element subjected to pure shear.

$$(\theta_J)_i = \frac{\theta_i + \theta_{i+1}}{2} = \frac{w_{i+1} + \delta_{i+1} - w_{i-1} + \delta_i}{2h} \qquad (3.6)$$

This is the angle of rotation which occurs at Joint i.

The relative angle change between adjacent bars of the model represents the deformation due to bending. At Station i the angle change is determined from the difference in slopes of Bar i+1 and Bar i:

$$\phi_i = \theta_{i+1} - \theta_i = \frac{w_{i-1} - 2w_i + w_{i+1} - \delta_i + \delta_{i+1}}{h} \qquad (3.7)$$

Each of the above expressions reduces to the relations for pure bending if the shear deflections are eliminated.

Force-Deformation Relations

In conventional beams, the bending moment is equal to the product of the flexural stiffness and the curvature. In the discrete-element model the flexibility of the beam and the curvature are lumped at the station points. The corresponding relation for bending moment M in the model is

$$M_i = \frac{F_i}{h} \phi_i \qquad (3.8)$$

where the flexural stiffness F_i is equal to the product $E_i I_i$ and the relative angle change ϕ_i is given by Eq 3.7 (Ref 12).

The shear deflection has been lumped at the center of each bar in the model. The geometric relation between the beam element discussed in Chapter 2 and a bar of the model is illustrated in Fig 3.6 with the incremental length Δx replaced by the bar length h. The total shear strain γ is, therefore, related to the shear deflection δ by

$$\gamma = \frac{\delta}{h} \qquad (3.9)$$

From Eqs 2.8 and 3.9 the shear in Bar i is

$$V_i = K_i \delta_i \tag{3.10}$$

where

$$K_i = \frac{G_i (A_s)_i}{h} \tag{3.11}$$

which is the desired shear spring constant for a bar. This shear spring constant implies a value of unity for the k factor discussed in Chapter 2. Although no explicit allowance has been made for other values of k , this effect can be considered by using $\frac{(A_s)_i}{k}$ in place of $(A_s)_i$.

By using Eq 3.10, it is possible to apply beam theory to the analysis of fabricated structures. From detailed considerations of the particular structure, an appropriate spring constant K_i representative of the shear stiffness may be determined. For example, a latticed strut or an airplane wing may be regarded as a beam (Ref 19). Even though Eq 3.11 does not apply for these structures, the simple relation between V and δ expressed in Eq 3.10 will still be admissible.

Load-Deflection Equations

The equilibrium equations can now be expressed in terms of the unknown deflections. Substitution of Eq 3.10 into Eq 3.2 gives

$$K_i \delta_i - S_i w_i - K_{i+1} \delta_{i+1} = -Q_i \tag{3.12}$$

Similarly, using Eqs 3.8 and 3.10 in Eq 3.4,

$$\frac{F_i \phi_i}{h} - \frac{F_{i-1} \phi_{i-1}}{h} - P_i \left(w_i - w_{i-1} \right) - K_i h \delta_i - \frac{R_i (\theta_J)_i}{2}$$

$$- \frac{T_i}{2} - \frac{R_{i-1} (\theta_J)_{i-1}}{2} - \frac{T_{i-1}}{2} = 0 \tag{3.13}$$

Substitution of Eqs 3.6 and 3.7 into Eq 3.13,

$$\frac{F_i}{h^2}\left(w_{i-1} - 2w_i + w_{i+1} - \delta_i + \delta_{i+1} \right)$$

$$- \frac{F_{i-1}}{h^2}\left(w_{i-2} - 2w_{i-1} + w_i - \delta_{i-1} + \delta_i \right)$$

$$- P_i\left(w_i - w_{i-1} \right) - K_i h\delta_i - \frac{R_i}{4h}\left(w_{i+1} + \delta_{i+1} - w_{i-1} + \delta_i \right)$$

$$- \frac{T_i}{2} - \frac{R_{i-1}}{4h}\left(w_i + \delta_i - w_{i-2} + \delta_{i-1} \right) - \frac{T_{i-1}}{2} = 0 \qquad (3.14)$$

Or

$$\left(- \frac{F_{i-1}}{h^2} + \frac{R_{i-1}}{4h} \right) w_{i-2} + \left(\frac{F_{i-1}}{h^2} - \frac{R_{i-1}}{4h} \right) \delta_{i-1} + \left(\frac{F_i}{h^2} + \frac{2F_{i-1}}{h^2} \right.$$

$$\left. + P_i + \frac{R_i}{4h} \right) w_{i-1} + \left(- \frac{F_i}{h^2} - \frac{F_{i-1}}{h^2} - K_i h - \frac{R_{i-1}}{4h} - \frac{R_i}{4h} \right) \delta_i$$

$$+ \left(- \frac{2F_i}{h^2} - \frac{F_{i-1}}{h^2} - P_i - \frac{R_{i-1}}{4h} \right) w_i + \left(\frac{F_i}{h^2} - \frac{R_i}{4h} \right) \delta_{i+1}$$

$$+ \left(\frac{F_i}{h^2} - \frac{R_i}{4h} \right) w_{i+1} = \frac{1}{2}\left(T_i + T_{i-1} \right) \qquad (3.15)$$

Equations 3.12 and 3.15 are the two load-deflection equations which must be satisfied for each bar and joint of the idealized system. By also requiring that these equations be satisfied at the first imaginary bar and joint at each end of the model, the beam end conditions are accounted for automatically. Thus, for a beam which is represented by m discrete bars, a system of 2m + 5 algebraic equations in 2m + 5 unknown deflections results.

General Remarks

The bar-and-spring model which has been discussed is limited by the assumptions of elementary beam theory. The primary purpose of the model has been to study shear deformations. For this reason effects of torsion, axial deformation, biaxial bending, and other conditions have not been considered. These effects could be included in the analysis by means of the discrete-element model approach. In each case the properties of the real system are felt at discrete points.

The basic difference between the model used for pure bending, as discussed in Chapter 2, and the model for combined bending and shear is that the latter has additional degrees of freedom representing the shear deflections. This results in a more flexible system which is a better approximation for some structural elements.

CHAPTER 4. METHOD OF SOLUTION

Contents of the Chapter

In this chapter the load-deflection equations derived in Chapter 3 are rewritten in a more convenient form for computer solution. The form of the resulting equations written about each bar and joint of the system is discussed. A matrix formulation of these equations is introduced and the elimination procedure used to solve the equations is described. Boundary conditions are discussed and the accuracy of the solution is evaluated. Finally, the formulas used to solve for the slope, moment, shear, and support reaction are given.

Conversion of Equations to Standard Form

The two load-deflection equations can be rewritten in a more convenient form. Equation 3.12 may be expressed as

$$b_{i,1}\delta_i + b_{i,2}w_i + b_{i,3}\delta_{i+1} + b_{i,4}w_{i+1} + b_{i,5}\delta_{i+2} + b_{i,6}w_{i+2}$$

$$= b_{i,7} \qquad (4.1)$$

where the coefficients $b_{i,n}$ are given by

$$b_{i,1} = K_i$$

$$b_{i,2} = -S_i$$

$$b_{i,3} = -K_{i+1}$$

$$b_{i,4} = 0.0$$

$$b_{i,5} = 0.0$$

$$b_{i,6} = 0.0$$

$$b_{i,7} = -Q_i$$

In a similar manner, Eq 3.15 may be rewritten in the form

$$a_{i,1}w_{i-2} + a_{i,2}\delta_{i-1} + a_{i,3}w_{i-1} + a_{i,4}\delta_i + a_{i,5}w_i + a_{i,6}\delta_{i+1}$$

$$+ a_{i,7}w_{i+1} = a_{i,8} \tag{4.2}$$

where the coefficients $a_{i,n}$ are

$$a_{i,1} = -\frac{F_{i-1}}{h^2} + \frac{R_{i-1}}{4h}$$

$$a_{i,2} = \frac{F_{i-1}}{h^2} - \frac{R_{i-1}}{4h}$$

$$a_{i,3} = \frac{F_i}{h^2} + 2\frac{F_{i-1}}{h^2} + P_i + \frac{R_i}{4h}$$

$$a_{i,4} = -\frac{F_i}{h^2} - \frac{F_{i-1}}{h^2} - K_i h - \frac{R_{i-1}}{4h} - \frac{R_i}{4h}$$

$$a_{i,5} = -2\frac{F_i}{h^2} - \frac{F_{i-1}}{h^2} - P_i - \frac{R_{i-1}}{4h}$$

$$a_{i,6} = \frac{F_i}{h^2} - \frac{R_i}{4h}$$

$$a_{i,7} = \frac{F_i}{h^2} - \frac{R_i}{4h}$$

$$a_{i,8} = \frac{1}{2} (T_i + T_{i-1})$$

The first subscript of the $a_{i,n}$ and $b_{i,n}$ coefficients represents the beam station or bar at which the equation is to be satisfied, while the second subscript indicates the position of the coefficient in the equation. The $a_{i,n}$ and $b_{i,n}$ are referred to as continuity coefficients.

Pattern of the Equations

Equations 4.1 and 4.2, respectively, must be satisfied at each bar and joint of the idealized model. The matrix form of these equations is shown in Fig 4.1. The system of $2m + 5$ equations has been written in sequential order of the station numbers from Station -1 to Station m+1 in obtaining the matrix representation. Thus, the coefficients of the two load-deflection equations are alternated throughout the coefficient and load matrices. The coefficient matrix represents the stiffness of the system. All non-zero terms of this matrix are centered about the diagonal, indicated in Fig 4.2, in a seven-wide band.

The set of simultaneous equations is solved by use of a modified Gaussian elimination. In using this elimination procedure, the non-zero coefficients below the main diagonal of the coefficient matrix are eliminated, allowing the unknown deflections to be solved for by back substitution. An efficient and rapid solution is obtained by taking advantage of the large number of zeros in the square matrix. Most of the terms which are zero before the elimination are not even considered. The $b_{i,4}$ term must be considered, however, since the initial zero value of this term may be altered by the elimination procedure. Two other terms, $b_{i,5}$ and $b_{i,6}$, which are initially zero must also be included since it is sometimes necessary to interchange rows of the matrix. If a zero is encountered on the diagonal of the coefficient matrix, terms below the diagonal cannot be eliminated unless the zero can be replaced by a non-zero term. This is effected by a row

$$\overset{\text{Coefficient Matrix}}{\left[\begin{array}{ccccccccccccccccccc}
 & b_{i-1,1} & b_{i-1,2} & b_{i-1,3} & b_{i-1,4} & b_{i-1,5} & b_{i-1,6} \\
a_{i,1} & a_{i,2} & a_{i,3} & a_{i,4} & a_{i,5} & a_{i,6} & a_{i,7} \\
 & & & b_{i,1} & b_{i,2} & b_{i,3} & b_{i,4} & b_{i,5} & b_{i,6} \\
 & & a_{i+1,1} & a_{i+1,2} & a_{i+1,3} & a_{i+1,4} & a_{i+1,5} & a_{i+1,6} & a_{i+1,7} \\
 & & & & & b_{i+1,1} & b_{i+1,2} & b_{i+1,3} & b_{i+1,4} & b_{i+1,5} & b_{i+1,6} \\
 & & & & a_{i+2,1} & a_{i+2,2} & a_{i+2,3} & a_{i+2,4} & a_{i+2,5} & a_{i+2,6} & a_{i+2,7} \\
 & & & & & & \cdot & \cdot & & \cdot & \cdot & \cdot \\
 & & & & & & & \cdot & \cdot & \ddots & \cdot & \cdot & \cdot \\
 & & & & & & & & \cdot & \cdot & & \cdot & \cdot & \cdot \\
 & & & & & & & & & b_{m-1,1} & b_{m-1,2} & b_{m-1,3} & b_{m-1,4} & b_{m-1,5} & b_{m-1,6} \\
 & & & & & & & & a_{m,1} & a_{m,2} & a_{m,3} & a_{m,4} & a_{m,5} & a_{m,6} & a_{m,7} \\
 & & & & & & & & & & & b_{m,1} & b_{m,2} & b_{m,3} & b_{m,4} & b_{m,5} & b_{m,6} \\
 & & & & & & & & & & a_{m+1,1} & a_{m+1,2} & a_{m+1,3} & a_{m+1,4} & a_{m+1,5} & a_{m+1,6} & a_{m+1,7} \\
 & & & & & & & & & & & & & b_{m+1,1} & b_{m+1,2} & b_{m+1,3} & b_{m+1,4} & b_{m+1,5} & b_{m+1,6}
\end{array}\right]}
\overset{\text{Deflection Matrix}}{\left\{\begin{array}{c}
W_{i-2} \\ \delta_{i-1} \\ W_{i-1} \\ \delta_{i} \\ W_{i} \\ \delta_{i+1} \\ W_{i+2} \\ \delta_{i+2} \\ \cdot \\ \cdot \\ \cdot \\ W_{m-1} \\ \delta_{m} \\ W_{m} \\ \delta_{m+1} \\ W_{m+1} \\ \delta_{m+2} \\ W_{m+2}
\end{array}\right\}}
=
\overset{\text{Load Matrix}}{\left\{\begin{array}{c}
b_{i-1,7} \\ a_{i,8} \\ b_{i,7} \\ a_{i+1,8} \\ b_{i+1,7} \\ a_{i+2,8} \\ \cdot \\ \cdot \\ \cdot \\ b_{m-1,7} \\ a_{m,8} \\ b_{m,7} \\ a_{m+1,8} \\ b_{m+1,7}
\end{array}\right\}}$$

Fig 4.1. Matrix representation of the equations of the model.

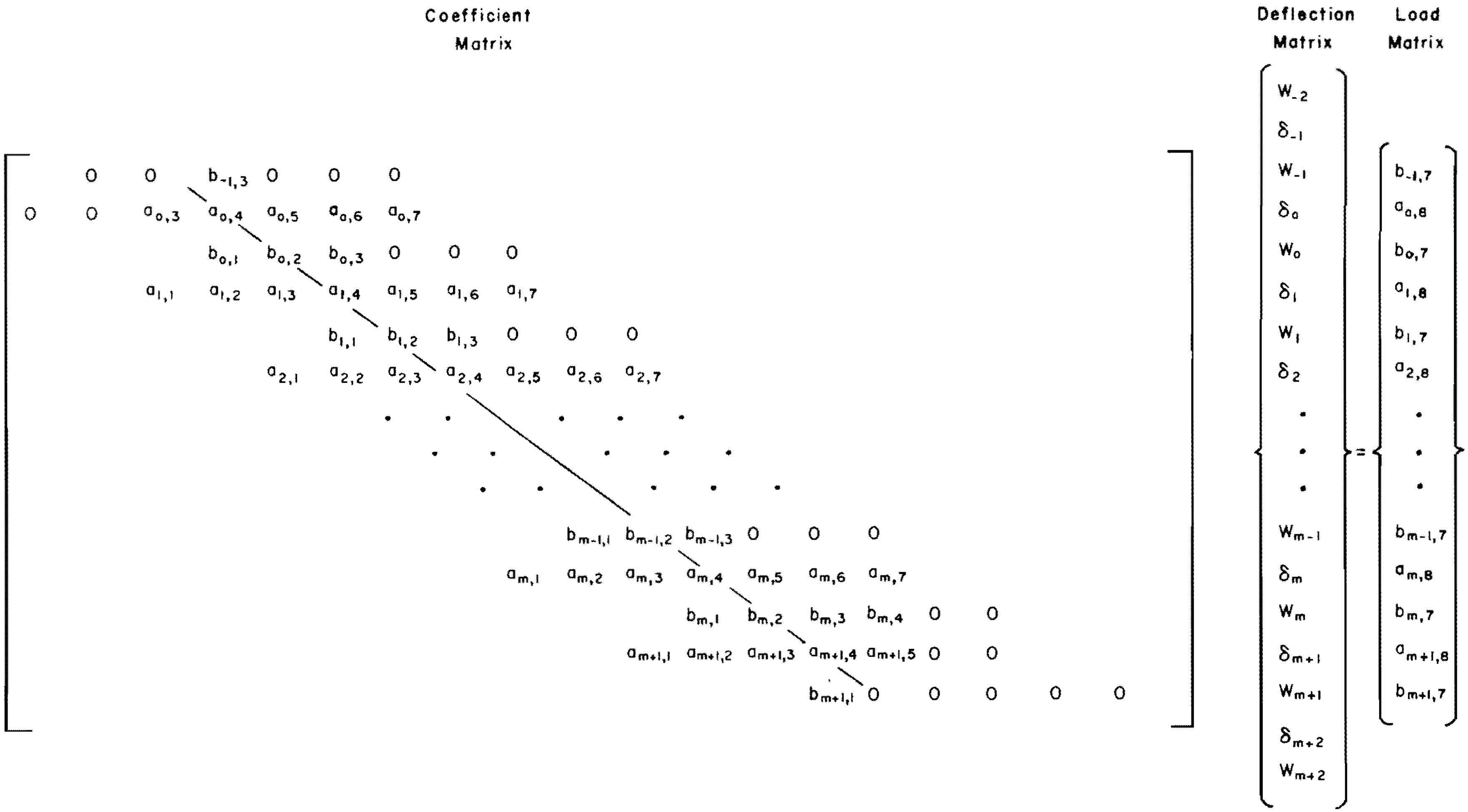


Fig 4.2. Illustration of the initial zero terms in the equations of the model.

interchange. The first two rows of the matrix must always be interchanged since the $b_{-1,2}$ term is zero.

Two back substitution formulas are required since there are two sets of coefficients used in the matrix. The total deflection and shear deflection for each station are determined by substitution into the equations

$$w_i = \frac{b_{i,7} - b_{i,6}w_{i+2} - b_{i,5}\delta_{i+2} - b_{i,4}w_{i+1} - b_{i,3}\delta_{i+1}}{b_{i,2}} \qquad (4.3)$$

$$\delta_i = \frac{a_{i,8} - a_{i,7}w_{i+1} - a_{i,6}\delta_{i+1} - a_{i,5}w_i}{a_{i,4}} \qquad (4.4)$$

beginning at the lower end of the matrix.

Boundary Equations and Specified Conditions

A very general description of support points is possible by use of several conditions which can be freely enforced at any desired station along the structure. In addition some boundary conditions are automatically created at the ends of the structure.

Two boundary conditions are implied by requiring that the load-deflection equations be satisfied at the imaginary stations of the beam. By writing Eq 4.1 at Station -1 and Eq 4.2 at Bar 0, it is observed that some of the continuity coefficients are always zero. These zero terms, some of which are outside the coefficient matrix, are automatically set by the physical properties of the system beyond the ends of the structure. The first of these equations indicates that the shear deformation δ_0 in Bar 0 is always zero. The second equation physically signifies that there is zero curvature at the ends of the beam. Thus, the condition of zero moment is automatically created by this equation.

The deflection of any station may be specified by proper adjustment of coefficients of Eq 4.1. Thus, by setting $b_{i,2}$ equal to 1.0, $b_{i,7}$ equal to the desired deflection, and all other $b_{i,n}$ coefficients equal to zero, a specified deflection is enforced at Station i. A zero deflection can also be prescribed at a station by placing a very stiff support spring at the joint.

Other boundary conditions can be enforced by proper adjustment of the values of the physical properties of the system. For example, the fixity or resistance to rotation of a member may be controlled at any station by specifying a rotational restraint. A rotational restraint spring acts as a couple which is equal to the product of the spring constant and the average slope at the joint. Zero slope can be enforced by a sufficiently large spring constant. The zero curvature condition at the ends of the beam is automatically overridden by the specification of a rotational restraint at these points.

A hinge can be created at any station by a zero flexural stiffness at this point. This condition is not applicable to the ends of the beam in creating a pin-ended condition, however. The automatically created conditions of zero curvature and the specification of a deflection or spring support are sufficient to insure the required end conditions for a pinned end.

Shear deformations can be prevented by specifying a large shear spring stiffness. This provides a means of obtaining the pure bending solution for a problem.

It is also possible to obtain several independent solutions from a single problem should this ever be desirable. A series of beams can be solved simultaneously by requiring that the beams be separated by two or more stations with zero flexural stiffness. If more than two consecutive stations have zero flexural stiffness, however, the resulting system of equations will not be independent. By placing a support spring at stations located two or more increments from all boundaries, no dependency will be introduced and in addition the solution will not be affected.

Results

Other results can be computed from the known deflections. Substitution of the shear deflections and the total deflections into the equations

$$\theta_i = \frac{w_i - w_{i-1} + \delta_i}{h} \qquad (3.5)$$

$$V_i = K_i \delta_i \tag{3.10}$$

and

$$M_i = \frac{F_i}{h^2} (w_{i-1} - 2w_i + w_{i+1} - \delta_i + \delta_{i+1}) \qquad \text{(3.7) and (3.8)}$$

determines the value of slope, shear, and bending moment, respectively, for each station. Also the support reaction can be computed from

$$(Q_R)_i = -V_i + V_{i+1} - Q_i \tag{4.5}$$

at support points where the deflection is specified. The above equation results from the summation of vertical forces at a joint which is not free to deflect vertically. For all other joints, the support reaction is determined by

$$(Q_R)_i = S_i w_i \tag{4.6}$$

Accuracy of the Solution

Approximation errors are introduced when the discrete-element model is substituted for the real structure. Within the limits of the assumptions of the model, this type of error can be reduced by dividing the model into more increments. The number of increments required to obtain a specified degree of accuracy depends upon the complexity of the particular problem. An excessive number of increments should be avoided because computation time increases in simple proportion to the number of increments.

Because of the large number of arithmetic operations involved in the solutions, round-off errors may occur. A CDC 6600 computer using approximately 14 decimal digits has been used to verify the method of solution and no significant round-off errors have been observed in the practical problems that have been solved. Errors have been found to occur when an unreasonably large value of the rotational restraint is specified. In general the magnitude of this quantity should not exceed 10^4 times the bending stiffness of the member at that station.

To verify that this value of rotational restraint is sufficient to prevent joint rotation for a particular problem, the solution should be checked to assure that the bar slopes on either side of the joint are equal in magnitude and opposite in direction.

CHAPTER 5. THE COMPUTER PROGRAM

General

Program SHRBM 1 (SHeaR BeaM - 1st version) has been developed for an efficient solution of the equations derived in Chapter 3. The computer program is written in FORTRAN 63 language for the Control Data Corporation 6600 Computer. With minor changes, the program would be compatible with other computers. Compile time for this program on the 6600 Computer is approximately 8 seconds. The program storage requirement is 22,954 decimal words. Two subroutines, INTERP4 and TIC TOC (J), are included in the program.

A summary flow diagram for SHRBM 1 is given in Appendix 2. A more detailed flow diagram of the main program and subroutine INTERP4 are also included in Appendix 2. Appendix 3 contains a glossary of the notation used in program SHRBM 1, and is followed by a complete listing of the program in Appendix 4. Several comment cards have been inserted in the program to facilitate the understanding of the program logic.

To describe a physical problem for a computer solution using SHRBM 1, it is first necessary to divide the member into a number of equal increments and to designate points between the increments by station numbers. The program is currently dimensioned for a maximum of 200 increments. The left end of the structure must correspond to Station 0. The bar numbering convention adopted in Chapter 3 and used in program SHRBM 1 identifies each bar in the model with the same number as the station to its right.

All loads and stiffness properties of an actual system are defined at discrete points of the beam model. As discussed in Chapter 3, some properties of the physical system are associated with the joints while others are associated with the bars. Distributed quantities which are "lumped" at the joints are representative of one-half an increment of the physical system on each side of the joint. Joint quantities should, therefore, receive half values at the end stations of a distribution sequence. Terms which are concentrated in the bars, however, should be distributed as full values throughout the model. Subroutine INTERP4 was written by Taylor (Ref 16) and is used in program SHRBM 1 for the distribution of input data. For given values at the initial and final stations in a distribution sequence, INTERP4 performs a linear interpolation between these extreme values and stores the appropriate value at each station, including half values at the end station. Concentrated loads that occur between stations should be divided between the two adjacent stations such that the amount of load placed at each station is inversely proportional to the distance between the station and the point of application of the load.

Any system of units may be used to describe the problem (for example, pounds and inches), but the system must be used consistently.

A plot routine, FORTRAN 63 Plot Routine, is used in SHRBM 1 to plot all results computed by the main program. This routine was written for The University of Texas Computation Center and instructions for its use are given in the Plot Routine Operation Manual (Ref 6). The required plot parameters are automatically determined by program SHRBM 1.

The time required to run problems depends on the desired results and size of the particular system. Problems with a greater number of increments and which exercise the plot option require more time. Subroutine TIC TOC (J) provides a check on the time requirement by automatically printing the run time for each problem.

Procedure for Data Input

A guide for data input is provided in Appendix 1. The guide is a self-contained instruction manual which is designed such that additional copies may be furnished as separately bound extracts for routine use.

Included in the guide is an illustration of the proper deck sequence. Any number of problems may be stacked and run together. The problem sequence is preceded by two cards which describe the run. The first card of each problem is provided for the problem number and a brief description of the problem. A blank card at the end of each run terminates the program.

Tables of Data Input

All data input is arranged in tabular form for convenience and clarity. Table 1 contains the control data. It consists of a single card which must be input in each problem. The data-hold options, the number of cards in the remaining tables, and the plot options are specified in this table. The data-hold options allow the user to retain data from any of the tables of the preceding problem. If the data from Table 2 or 3 are held, no cards may be added to these tables. Data in Tables 4A, 4B, and 5 may be modified by the addition of new cards, but the total number of cards accumulated in each of these tables must not exceed 100.

One of the following three plot options may be specified in Table 1:

(1) Plot on 8-1/2 x 11-inch paper with 1-inch and 5-inch axes.

(2) Plot on 8-1/2 x 11-inch paper with 2-inch and 10-inch axes.

(3) Plot on 11 x 17-inch paper with 1-inch and 15-inch axes.

If one of these options is specified, scales for six sets of axes are automatically determined for plotting the total deflection, shear deflection, slope, moment, shear, and support reaction vs distance along the beam. A blank or zero plot option indicates no plots are desired.

In Table 2 one card is used to specify the number of increments and the increment length. The number of increments includes only the number of bars which are used to represent the actual structure. The imaginary bars are created internally by SHRBM 1. A maximum of 200 increments is allowed.

Table 3 provides for vertical deflections to be specified at any station along the beam. Not more than 20 deflections may be specified. Each specification requires a separate card. The cards in this table may be stacked in any order.

The beam section and material properties are described in Table 4A. Any variation of the modulus of elasticity, the shear modulus, the moment of inertia, and the effective shear area may be specified in this table. These properties are used to compute the shear and flexural stiffnesses of the beam. The method used for description of distributed data is illustrated in Appendix 1. Half-values of the modulus of elasticity are automatically created at the end of each distribution sequence. Half-values are not created for the moment of inertia since the beam flexural stiffness (EI) would then only be a quarter-value. Likewise, the modulus of shear and the effective shear area are bar properties and must, therefore, recieve full-values. All of the values in Table 4A are accumulated algebraically in storage. There are no restrictions on the order of the cards, except that within a distribution sequence the stations must be in ascending order.

Additional stiffness data may be specified in Table 4B. The data from this table are automatically added to the stiffnesses computed in Table 4A. Table 4B provides a means for specifying more general stiffness values. The data-input rules of Table 4A apply to Table 4B.

Table 5 is used to describe transverse forces, spring supports, applied couples, rotational restraints, and axial tensions or compressions. Applied couples and rotational restraints are concentrated effects. The transverse forces and spring supports are distributed with half-values. Axial tensions or compressions receive full values. The rules of Table 4A for data input apply to Table 5.

Special Programming Features

Certain programming features concerning data input should be mentioned at this point. For example, zero data are automatically created for points where no data are specified in Tables 4A, 4B, and 5. Also, an arbitrarily large value of shear stiffness is assigned to points where zero shear stiffnesses are computed. Furthermore, provision has been made to automatically insert the necessary spring supports in order to solve a discontinuous series of beams as discussed in Chapter 4.

Output

All data input in Tables 1 through 5 is reflected in tabular form in the output. In addition, the computed values of total deflection, moment, and support reaction are printed with the corresponding beam station in Table 6. The values of shear deflection, slope, and shear are printed between the quantities computed for the stations. If one of the plot options is specified, the values used at the ends of the axes are printed in Table 7.

Error Messages

Several checks on data errors are provided in SHRBM 1. An error message is printed if any of the following conditions occurs:

(1) More than one deflection is specified at a station.
(2) No data are specified for a table (excluding Tables 3 and 4A).
(3) The hold option is exercised without having input data for the previous problem.

(4) Data are erroneously held in Table 2 or 3.

(5) The allowable number of cards for an input table is exceeded.

(6) The station numbers in a distribution sequence are out of order.

In addition to these specific error messages, a general purpose error message - "UNSPECIFIED ERROR STOP" - is provided. Should this error message occur, the program must be investigated to determine its source since this message may be caused by one of several different errors. Any error detected by the program will cause the run to be terminated. No check is provided for the specification of data beyond the ends of the beam. These data will interfere with the automatically created boundary conditions and cause the solution to be in error.

CHAPTER 6. SAMPLE PROBLEMS

General

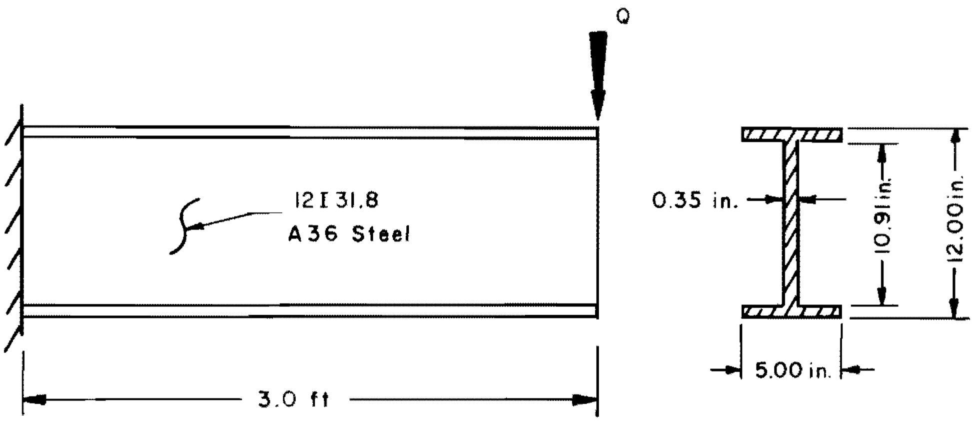
This chapter contains several example problems which have been solved to verify the method of analysis and to demonstrate the use of program SHRBM 1. It is primarily intended that these sample problems be helpful to the reader in modeling the actual system and in coding problems for the computer solution.

Several different types of problems have been selected. The first problem, Problem Series 100, is a determinate structural problem which has been solved to compare the computer results with closed-form solutions. In Problem Series 200, the solution of a highway bridge diaphragm subjected to three different load conditions is examined. Problem Series 300 illustrates the effect of shear deformations on a three-span overhanging beam. Each of these problems has been solved in two parts. In Part A the actual shear stiffness of the member was modeled while in Part B a very large shear stiffness was used to determine the effect of neglecting shear deformations. A listing of the data input and sample codings for each problem are given in Appendix 5. Appendix 6 contains the computer output including plots for these problems.

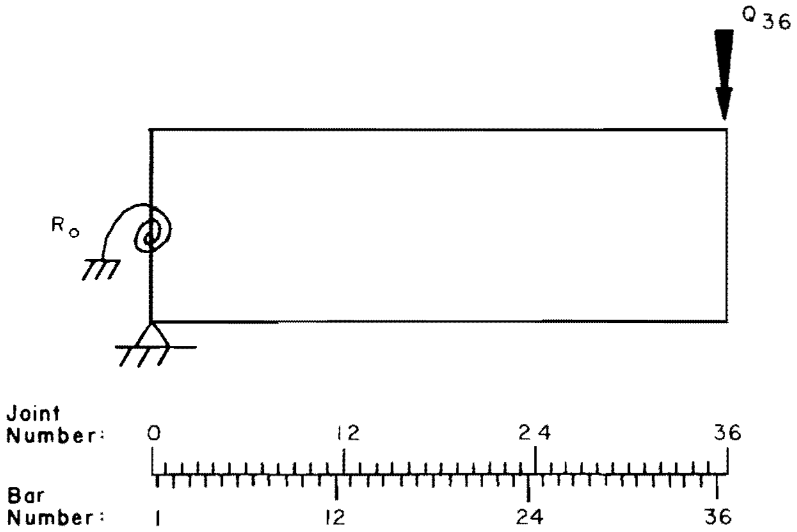
Problem Series 100 - Comparison of the Method with Closed-Form Solutions

Two sample problems have been solved in this section using the discrete-element method of analysis to compare the results with closed-form solutions. The member analyzed in the first problem of this series, Problem 101, is illustrated in Fig 6.1(a). It is a 3-foot cantilevered 12I31.8 steel beam. The material and section properties of this member are tabulated in Fig 6.1. The beam is subjected to a 22,000-pound concentrated load and a uniform beam dead weight of 2.65 lbs/in.

The idealized model of the structure is illustrated in Fig 6.1(b). The beam is represented by 36 1-inch increments. The fixed end support is



(a) Cantilevered prismatic beam.



(b) Bar-and-spring model.

Fig 6.1. Beam solved in Problem 101.

Section Properties

$I = 215.8 \text{ in}^4$

$A_s = 3.82 \text{ in}^2$

Material Properties

$E = 30 \times 10^6 \text{ lb/in}^2$

$G = 11 \times 10^6 \text{ lb/in}^2$

Load

$q = -2.65 \text{ lb/in}$

$Q = 22{,}000 \text{ lb}$

Other Data

$R_o = 1 \times 10^{15} \text{ in-lb/rad}$

$h = 1.0 \text{ in}$

modeled with a zero specified deflection and a rotational restraint of 1×10^{15} in-lb/rad to enforce a zero slope. It should be noted that the limits of the data represent bar numbers for bar quantities and joint numbers for joint quantities.

A comparison of the results computed by SHRBM 1 with the closed-form results for this problem are shown in Table 1(a). The beam deflection at Station 36 and the bending moment at Station 0 are selected as a basis for comparison. Shear deformations account for approximately 26 percent of the total deflection for this problem. The bending moment at Station 0 given by the computer program is approximately one-half the theoretical value since this station has a half-value of stiffness.

In the second problem of this series, Problem 102, the 3-foot tapered cantilevered beam shown in Fig 6.2(a) is analyzed. The member section properties, expressed as a function of distance along the beam, are tabulated in Fig 6.2. The properties at selected points along the structure were used to model the actual system. The idealized representation of the beam is illustrated in Fig 6.2(b). The only load considered in this problem is the 7,000-pound concentrated load at the end of the beam.

The closed-form solutions of the beam deflections at Station 36 and the bending moment at Station 0 are compared with the computer solutions for this problem. These results are shown in Table 1(b). A value of 1.2 was used for the k factor in both solutions. Also the beam taper was included in the closed-form solution. The computer solutions indicate close agreement with the closed-form solutions.

Problem Series 200 - A Bridge Diaphragm

The interior diaphragm of a highway bridge illustrated in Fig 6.3(a) is analyzed in this problem series. A 15 [33.9 section has been selected for the diaphragms and 30 WF 99 sections are used for the supporting girders. Section and material properties for these members are given in Fig 6.3.
To analyze the diaphragm using Program SHRBM 1, it is necessary to model the system as shown in Fig 6.3(b). The bridge deck slab has not been considered with this model. The effect of each girder is represented by two springs. The stiffness of the rotational restraint spring is determined from the

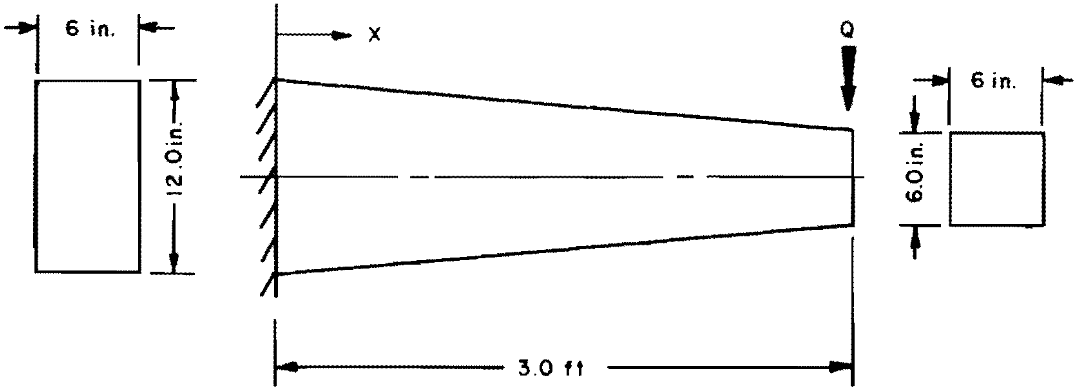
TABLE 1. COMPARISON OF THE DISCRETE-ELEMENT METHOD WITH THEORY

	SHRBM 1	CLOSED-FORM SOLUTION
Deflection at Station 36 due to bending	-5.296×10^{-2} in	-5.294×10^{-2} in
Deflection at Station 36 due to shear	-1.888×10^{-2} in	-1.889×10^{-2} in
Total deflection at Station 36	-7.184×10^{-2} in	-7.183×10^{-2} in
Bending moment at Station 0	-3.969×10^{5} in-lb	-7.937×10^{5} in-lb

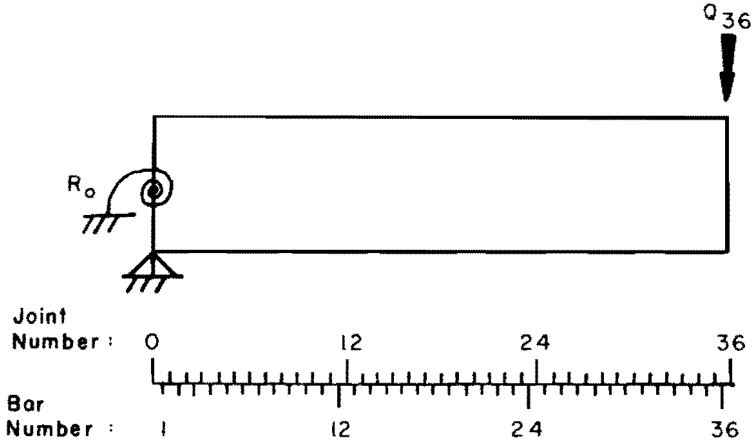
(a) Problem 101 - Cantilevered I-beam

	SHRBM 1	CLOSED-FORM SOLUTION
Deflection at Station 36 due to bending	-6.834×10^{-2} in	-6.870×10^{-2} in
Deflection at Station 36 due to shear	-0.459×10^{-2} in	-0.492×10^{-2} in
Total deflection at Station 36	-7.293×10^{-2} in	-7.362×10^{-2} in
Bending moment at Station 0	-1.260×10^{5} in-lb	-2.520×10^{5} in-lb

(b) Problem 102 - Cantilevered tapered beam



(a) Symmetrically tapered cantilever beam.



(b) Bar-and-spring model.

Section Properties

$A_s = (72 - X)\ \text{in}^2$

$I = 1/2\ (12 - X/6)^3\ \text{in}^4$

$k = 1.2$

Material Properties

$E = 3 \times 10^6\ \text{lb/in}^2$

$G = 1.27 \times 10^6\ \text{lb/in}^2$

Loads

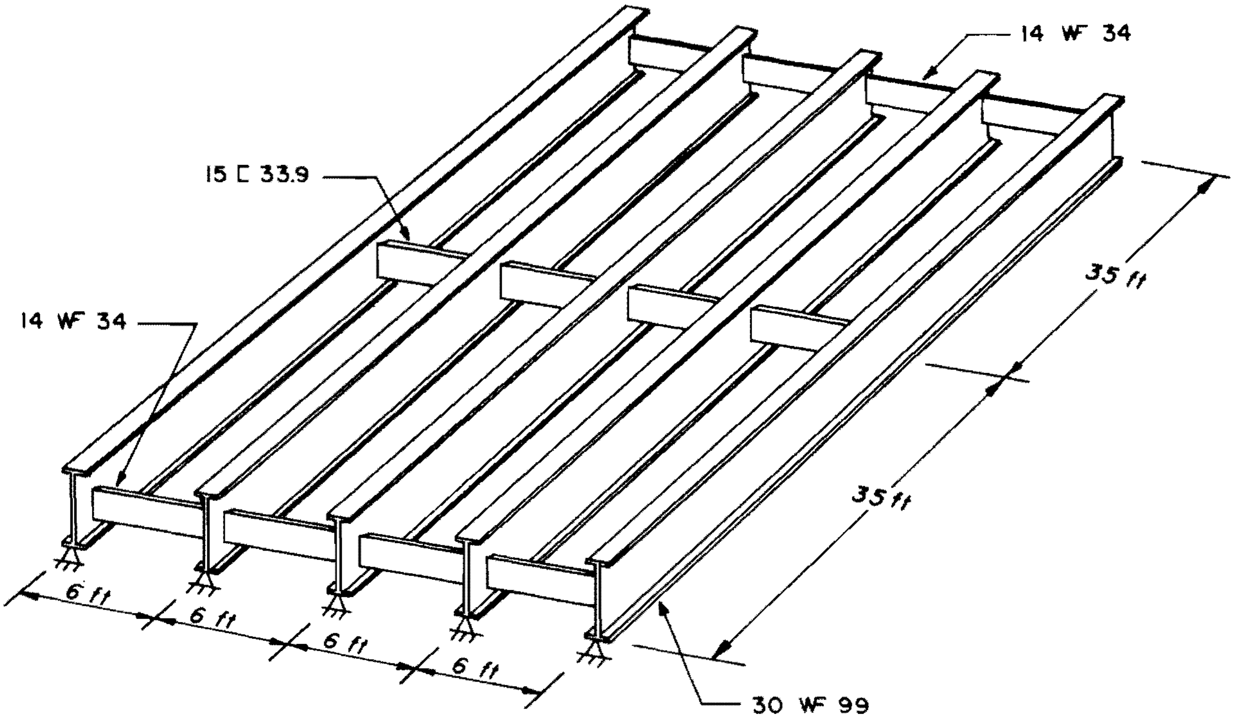
$Q = 7{,}000\ \text{lb}$

Other Data

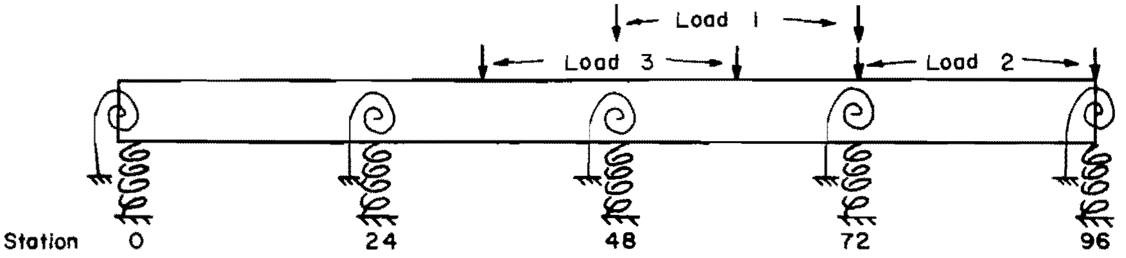
$R_o = 1 \times 10^{13}\ \text{in-lb/rad}$

$h = 1.0\ \text{in.}$

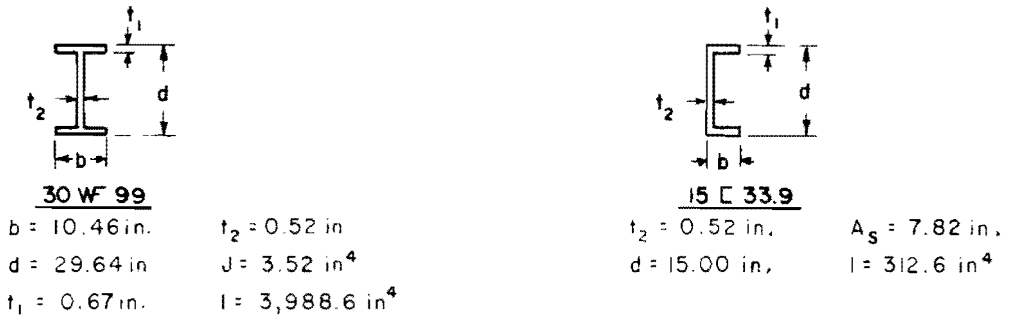
Fig 6.2. Beam solved in Problem 102.



(a) Highway bridge beam grid system.



(b) Model of interior bridge diaphragm.



30 WF 99

b = 10.46 in.
d = 29.64 in
t_1 = 0.67 in.
t_2 = 0.52 in
J = 3.52 in^4
I = 3,988.6 in^4

15 [33.9

t_2 = 0.52 in.
d = 15.00 in.
A_S = 7.82 in.
I = 312.6 in^4

(c) Section properties.

Fig 6.3. Structure analyzed in Problem Series 200.

torsional resistance of the girder assuming fixity at each end. Using the torsional constant of the girder computed by

$$J = \frac{2bt_1^3 + dt_2^3}{3} = \frac{(2)(10.46\ \text{in})(0.67\ \text{in})^3 + (29.64\ \text{in})(0.52\ \text{in})^3}{3}$$

$$= 3.52\ \text{in}^4$$

the rotational restraint is determined to be

$$R = \frac{4GJ}{L} = \frac{(4)(11.0 \times 10^6\ \text{lb/in}^2)(3.52\ \text{in}^4)}{(70\ \text{ft})(12\ \text{in/ft})}$$

$$= 1.84 \times 10^5\ \text{in-lb/rad}$$

Determination of the support spring stiffness which replaces each of the girders is based on the deflection of a simply supported beam with a concentrated load at the center. Thus,

$$S = \frac{48EI}{L^3} = \frac{(48)(30 \times 10^6\ \text{lb/in}^2)(3988.6\ \text{in}^4)}{(70\ \text{ft})^3(12\ \text{in/ft})^3}$$

$$= 9.7 \times 10^5\ \text{lb/in}$$

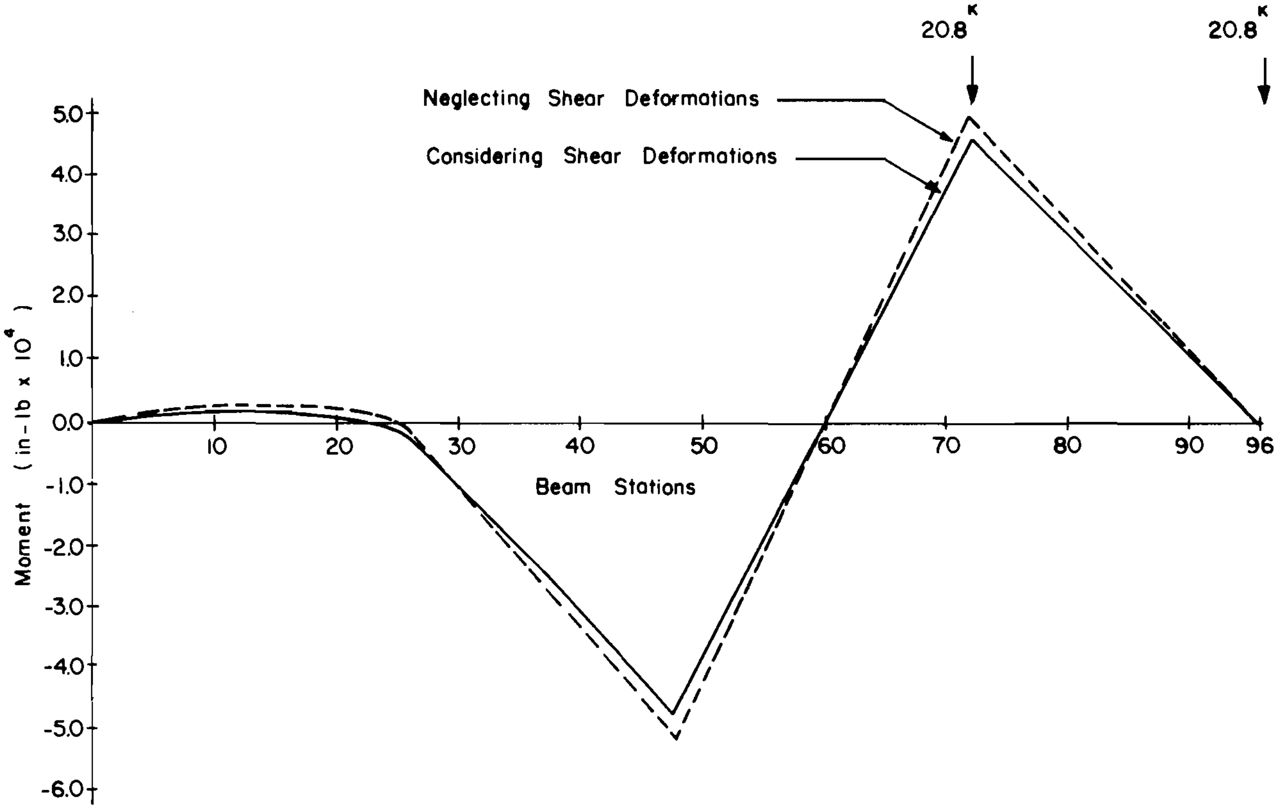
The uniform dead weight of the diaphragm of

$$q = (33.9\ \text{lb/ft})(1\ \text{ft/12 in})(3\ \text{in/sta}) = 8.48\ \text{lb/sta}$$

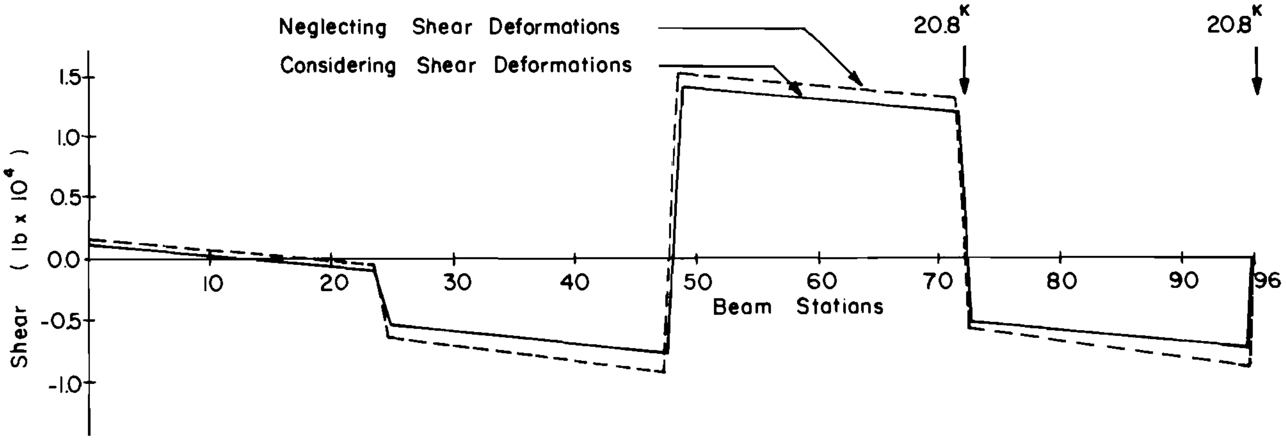
is included in the analysis.

The member is also subjected to the AASHO standard HS 20 truck wheel design load of 20.8 kips, including a 30 percent impact factor. A solution is given for each of the three load positions indicated in Fig 6.3(b).

The computer results using SHRBM 1 indicate that the shear deformations for this problem are relatively small compared with the deflections due to



(a) Moment diagram.



(b) Shear diagram.

Fig 6.4. Effect of shear deformations in a bridge diaphragm.

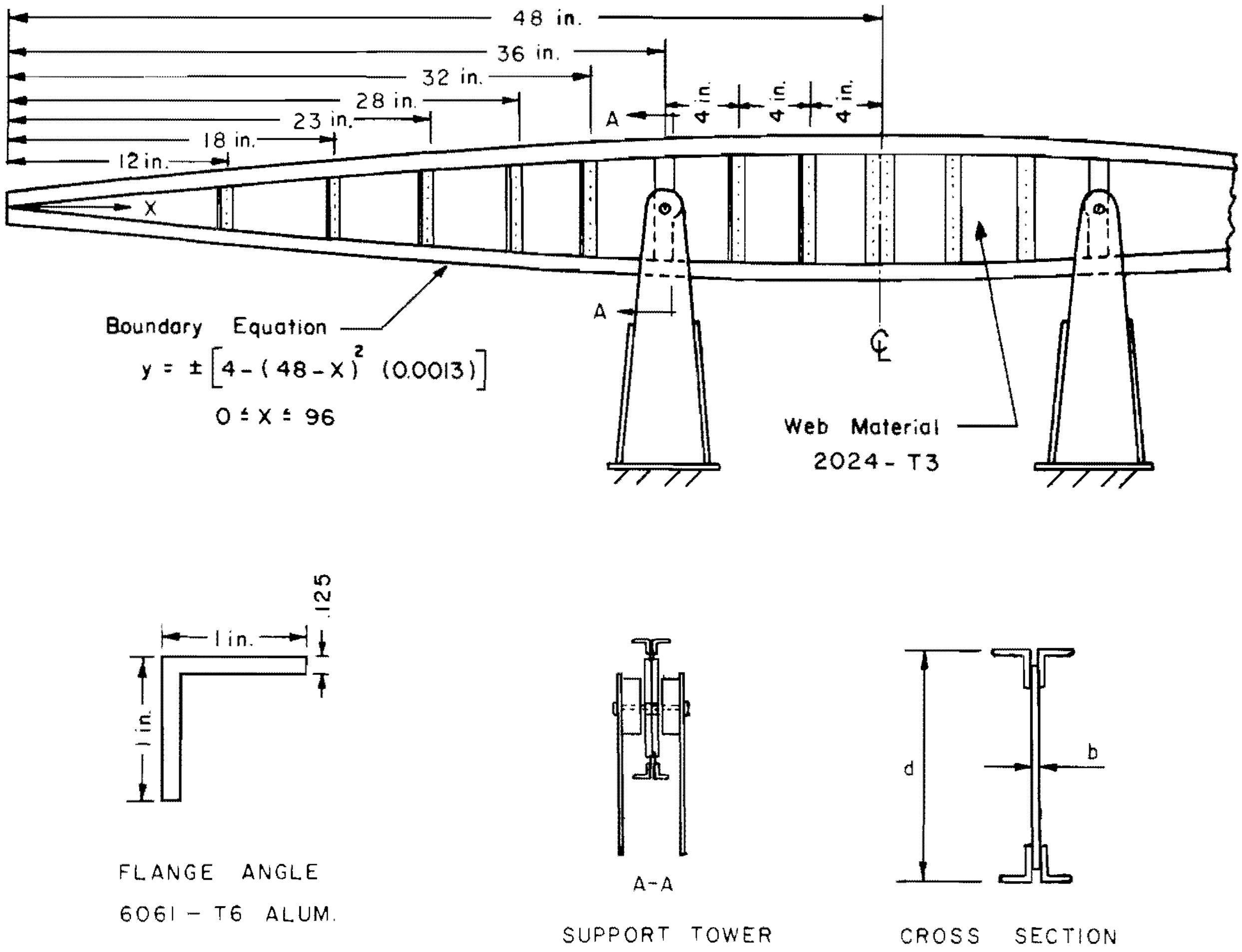
the combined effect of bending and shear. Significant effects in the moments and shears in the structure are apparent, however. Moment and shear diagrams for the diaphragm with the wheel loads at Stations 72 and 96 are shown in Figs 6.4(a) and (b). The solid-line curves indicate the solutions using the actual shear stiffness of the structure and the dashed-line curves indicate the results considering only bending effects. Both the moment and the shear in the diaphragm are reduced when shear deformations are considered. For this problem, the maximum negative and positive moments are decreased by 7.7 percent, and the maximum negative and positive shears are decreased 9.0 percent and 7.2 percent, respectively.

Problem Series 300 - A Three-Span Overhanging Beam

The purpose of this problem series is to verify the method of solution by comparison with the results of an experimental investigation conducted by Duncan (Ref 4). The beam used in this study was a built-up aluminum section as shown in Fig 6.5(a). The flange angle material used was 6061-T6 aluminum and the web was constructed from 2024-T3 aluminum. The beam is symmetrical about the vertical and horizontal centerlines, and has a second degree taper. Stiffeners were placed only on the left and center spans of the beam. In the tests performed by Duncan, an incremental loading was applied through a screw jack. Dial indicators were placed at selected stations along the beam and initial readings were recorded before the concentrated load was applied. The measured deflections do not include the effect of the dead weight of the structure.

The member is modeled by 96 1-inch increments with zero deflection specified at the supports. Section properties were computed with the parabolic boundary equation for selected points along the beam. The stiffeners were not modeled for the computer solution. A modulus of elasticity of 10.0×10^6 lb/in^2 was used for the 6061-T6 aluminum. A shear modulus of 4.0×10^6 lb/in^2 was used for the web material. Required section and material properties are tabulated in Fig 6.6(b).

The deflections measured by Duncan for 300, 500, and 700-pound loads at Station 0 are shown in Table 2. Computer solutions using SHRBM 1 were obtained for these same load conditions. A comparison of these results is shown in Fig 6.6. The experimental values are indicated by the "+" symbols. The



(a) Three-span overhanging beam with a concentrated load at the left end.

$b = 0.032 \text{ in}$

$d = 2\left[4 - (48 - X)^2 (0.0013)\right] \text{ in} \quad 0 \leq X \leq 96$

$$I = \frac{bd^3}{12} + 2\left[\frac{(2)(0.125)^3}{12} + \left(\frac{d - 0.125}{2}\right)^2 (2)(0.125) + \frac{(0.250)(0.875)^3}{12} + (0.250)(0.875)\left(\frac{d}{2} - 0.125 - \frac{0.875}{2}\right)^2\right] \text{ in}^4$$

$A_S = bd \text{ in}^2$

$E = 1 \times 10^7 \text{ lb/in}^2$

$G = 4 \times 10^6 \text{ lb/in}^2$

(b) Section and material properties.

Fig 6.5. Beam solved in Problem Series 300.

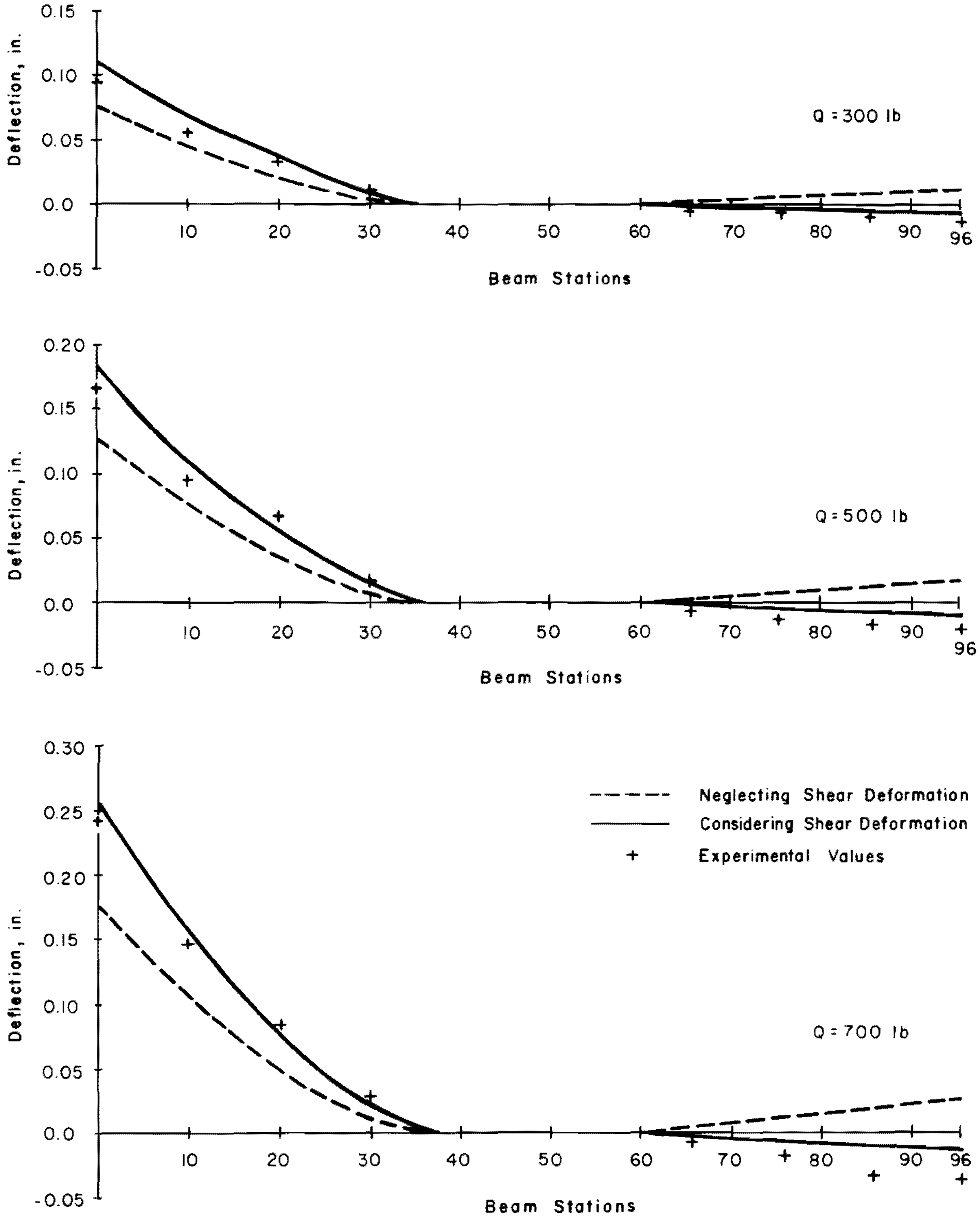


Fig 6.6. Deflection curves for a concentrated load Q at the left end of the beam.

solid-line curves represent the computed values of deflection considering shear deformations, and the dashed-line curves represent the deflection neglecting shear deformations. In most cases the computed values of deflection due to combined bending and shear are very nearly equal to the measured deflections. The maximum difference in calculated and measured deflections for the left span is 0.0152 inch or approximately 8 percent at Station 0. Some error in the analysis is due to the fact that the effect of moment on the shear deformations in a tapered beam has not been considered (Ref 18). Significant differences in the computed and the measured values of deflection occur in the right span.

It is important to note the effect of shear deformations on the beam deflections. The negative deflections in the right span of the structure were not predicted by the bending solution.

TABLE 2. MEASURED VALUES OF DEFLECTION OF A THREE-SPAN OVERHANGING BEAM

	LOAD AT STATION 0		
Station	300 lb	500 lb	700 lb
0	0.0982 in.	0.1685 in.	0.2431 in.
10	0.0547	0.0966	0.1460
20	0.0326	0.0679	0.0821
30	0.0114	0.0171	0.0288
66	-0.0032	-0.0056	-0.0089
76	-0.0060	-0.0112	-0.0174
86	-0.0099	-0.0191	-0.0312
96	-0.0104	-0.0200	-0.0348

CHAPTER 7. SUMMARY AND CONCLUSIONS

A method of analyzing a structure for the combined effects of bending and shear deformations has been presented. The method provides for a more accurate solution of problems in which shear deflections are significant. The principal features of the method are

(1) A finite-element model is used to simulate the real structure.

(2) The load-deflection behavior of the system is described by two equations which are written for each station in the structure.

(3) A special version of Gaussian elimination is used for an efficient solution of the system of equations.

A computer program, SHRBM 1, has been written which utilizes the method of analysis. The accuracy of the method and of the program have been demonstrated by comparison of the solutions for a range of problems with experimental data or results obtained by other accepted analytical procedures.

The analysis of highway bridge grid floor systems has been investigated by Ingram (Ref 9). The effects of shear deformations were not included in that analysis. By a combination of that work and the results of the study included in this report, a method of analysis could be developed for structural elements in which the effects of shear deformations are important. In particular a more accurate determination of the benefits of diaphragms in bridge floor systems may be made using such a combined analytical procedure.

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APPENDIX 1

GUIDE FOR DATA INPUT FOR SHRBM 1

GUIDE FOR DATA INPUT FOR SHRBM 1

With Supplementary Notes

extract from

A DISCRETE-ELEMENT METHOD OF ANALYSIS FOR COMBINED BENDING AND SHEAR DEFORMATIONS OF A BEAM

Report No. 56-12

by

David F. Tankersley and William P. Dawkins

December 1969

SHRBM 1 GUIDE FOR DATA INPUT - Card Forms

IDENTIFICATION OF PROGRAM AND RUN (2 alphanumeric cards per run)

Account number, project, date, etc.	1	80
Description of run	1	80

IDENTIFICATION OF PROBLEM (one card each problem; program stops if PROB NUM is blank)

PROB NUM	1	5
Description of problem (alphanumeric)	11	80

TABLE 1. PROGRAM CONTROL DATA (one card each problem)

ENTER "1" TO HOLD PRIOR TABLE	2	5
	3	10
	4A	15
	4B	20
	5	25
NUM CARDS ADDED FOR TABLE	2	35
	3	38 40
	4A	43 45
	4B	48 50
	5	53 55
ENTER 1,2, OR 3 TO PLOT		65

TABLE 2. CONSTANTS (one card, or none if Table 2 of preceding problem is held)

NUM INCRS	6	10
INCR LENGTH	21	30

TABLE 3. SPECIFIED DEFLECTIONS (number of cards according to Table 1; none if preceding Table 3 is held)

STATION	6	10
DEFLECTION	21	30

TABLE 4A. SECTION AND MATERIAL PROPERTIES

FROM STA	TO STA	ENTER 1 IF CONT'D ON NEXT CARD	E Modulus Of Elasticity	G Modulus Of Shear	I Moment Of Inertia	A_s Effective Shear Area

6 10 15 20 30 40 50 60

TABLE 4B. STIFFNESS DATA

FROM STA	TO STA	ENTER 1 IF CONT'D ON NEXT CARD	K Shear Stiffness	F Flexural Stiffness

6 10 15 20 30 40

TABLE 5. LOAD DATA

FROM STA	TO STA	ENTER 1 IF CONT'D ON NEXT CARD	Q Transverse Force	S Spring Support	T Applied Couple	R Rotational Restraint	P Axial Tension or Compression

6 10 15 20 30 40 50 60 70

STOP CARD (one blank card at end of run stops program)

1 80

GENERAL PROGRAM NOTES

The data cards must be stacked in proper order for the program to run.

A consistent system of units must be used for all input data, for example, pounds and inches.

All 5-space words are understood to be right-justified integers or whole decimal numbers . . . . . $\boxed{-43}$

All 10-space words are right-justified floating-point decimal numbers . . . . $\boxed{-4.321E + 03}$

TABLE 1. PROGRAM-CONTROL DATA

In Tables 2 and 3, either the data from the preceding problem must be held or entirely new data must be entered. If the hold option for either of these tables is set equal to 1, the number of cards input for that table must be zero.

In Tables 4A, 4B, and 5, the data are accumulated by adding to previously stored data. The number of cards input is independent of the hold option, except the cumulative total of cards in each of the tables cannot exceed 100.

Card counts in Table 1 should be rechecked after the coding of each problem is completed.

The plot option has four possible values. If the plot is blank or zero, no plots are drawn. If the plot option is specified as 1, 2, or 3 then each of w , δ , dw , M , V , and Q_R is plotted versus station number, with the size of the axes depending on the value of the plot option. If the plot option is 1, the plots are drawn on 1 X 5 in. axes such that the group of six plots will fit on an 8-1/2 X 11 in. page. If the plot option is 2, the plots are drawn on 2 X 10 in. axes such that the group of six plots will fit on 2 8-1/2 X 11 in. pages. If the plot option is 3, the plots are drawn on 1 X 15 in. axes such that the group of six plots will fit on an 11 X 17 in. page.

TABLE 2. CONSTANTS

Typical units for the increment length are inches.

The maximum number of increments into which the beam may be divided is 200.

TABLE 3. SPECIFIED DEFLECTIONS

The maximum number of stations for which deflections may be specified is 20.

TABLE 4A. SECTION AND MATERIAL PROPERTIES

Typical units

variables:	E	G	I	A_s
values per station:	lb/in^2	lb/in^2	in^4	in^2

Data should not be entered (nor held from the preceding problem) which would express effects beyond the ends of the beam.

The left end of the beam must be located at Station 0.

The variations in the interpolation and distribution process are explained and illustrated on page 71.

There are no restrictions on the order of cards in Table 4A, except that within a distribution sequence the stations must be in ascending order.

At end stations of each distribution sequence, half-values are automatically created for the modulus of elasticity.

TABLE 4B. STIFFNESS DATA

Typical units

variables:	K	F
values per station:	lb/in	lb-in^2

Data in Table 4B are governed by the same rules as Table 4A.

The distributed values of stiffness input in Table 4B are automatically added to the stiffnesses computed from the section and material properties of Table 4A.

At end stations of each distribution sequence, half-values are automatically created for the flexural stiffness.

TABLE 5. LOAD DATA

Typical units

variables:	Q	S	T	R	P
values per station:	lb	lb/in	in-lb	in-lb/rad	lb

Data in Table 5 are governed by the same rules as Table 4A.

At end stations of each distribution sequence, half-values are automatically created for the transverse force, spring support, applied couple, and rotational restraint.

Individual Card Input

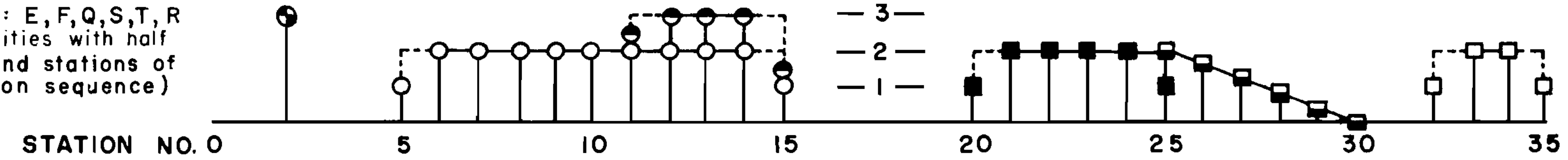
	FROM STA	TO STA	CONT'D TO NEXT CARD?	TYPE 1 DATA	TYPE 2 DATA	TYPE 3 DATA	
Data concentrated at one station	2	2	0=NO	3.0		3.0	◕
Data uniformly distributed	0	10	0=NO		2.0		◒
	11	15	0=NO	1.0	4.0	2.0	◓
	5	15	0=NO	2.0			○
	1	15	0=NO			1.0	●

Multiple Card Sequence

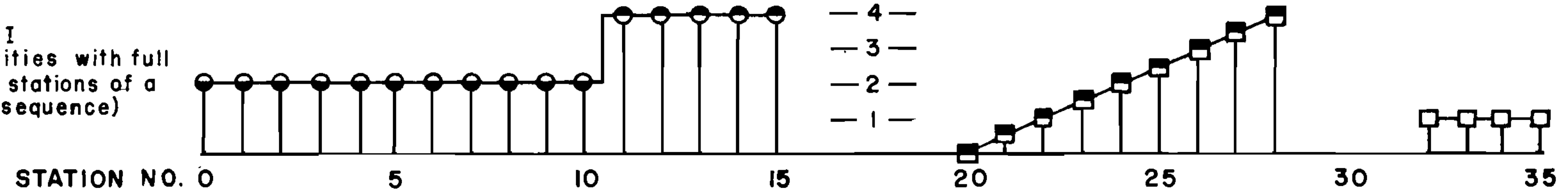
First of sequence	20		1=YES	2.0			■
Interior of sequence		25	1=YES	2.0			⬓
End of sequence		30	0=NO	0.0			
	20		1=YES		0.0	2.0	⬒
		28	0=NO		4.0	2.0	
	32		1=YES	2.0	1.0	0.0	□
		35	0=NO	2.0	1.0	3.0	

Resulting Distribution of Data

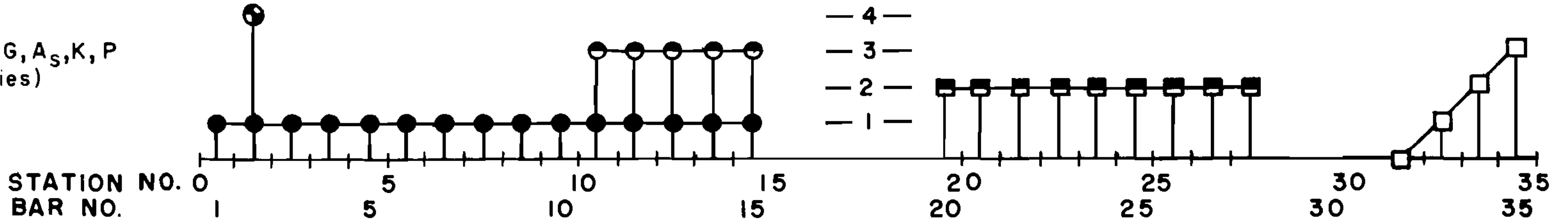
TYPE 1 DATA: E, F, Q, S, T, R
(Joint quantities with half values at end stations of a distribution sequence)

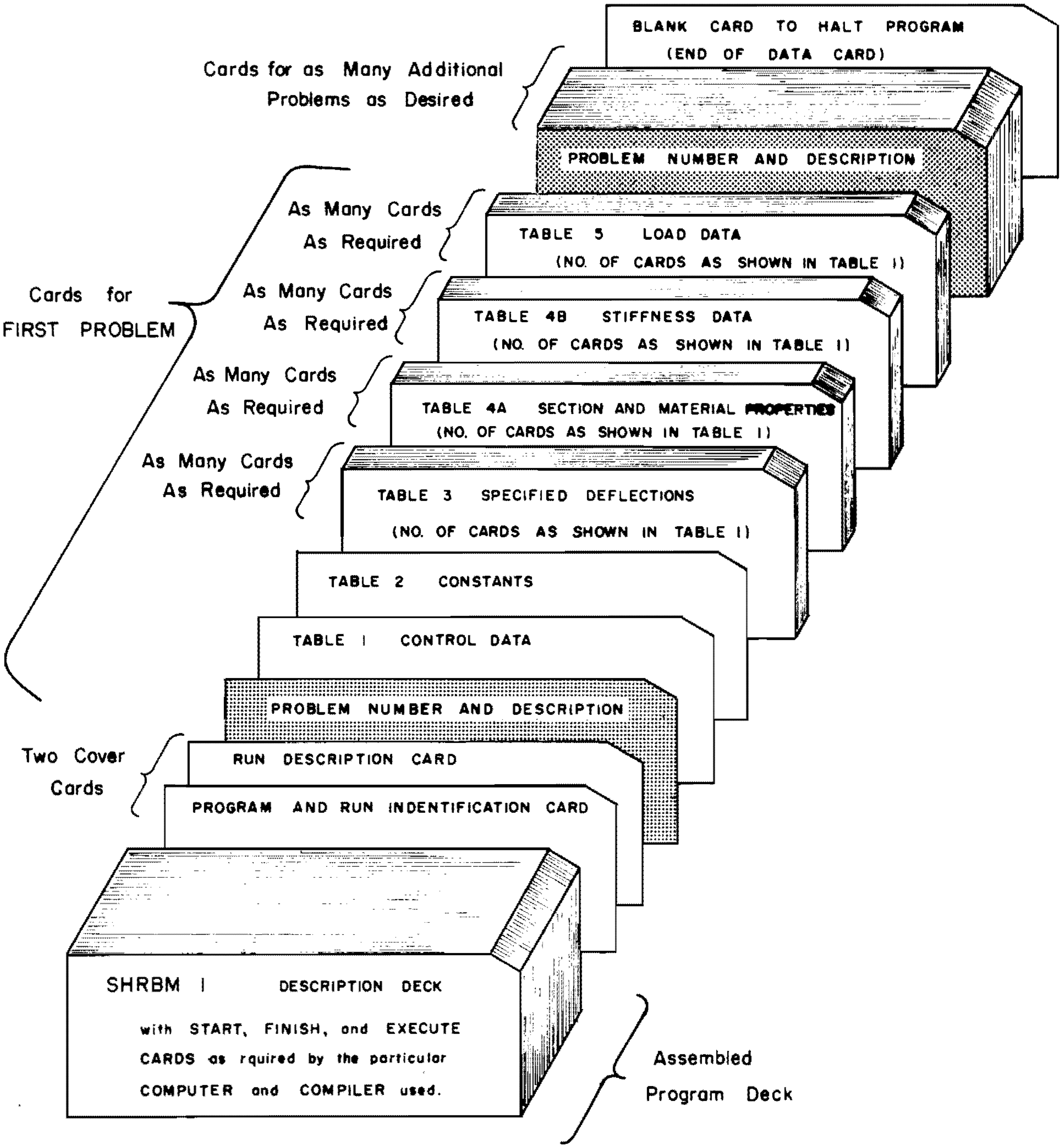


TYPE 2 DATA: I
(Joint quantities with full values at end stations of a distribution sequence)



TYPE 3 DATA: G, A_S, K, P
(Bar quantities)



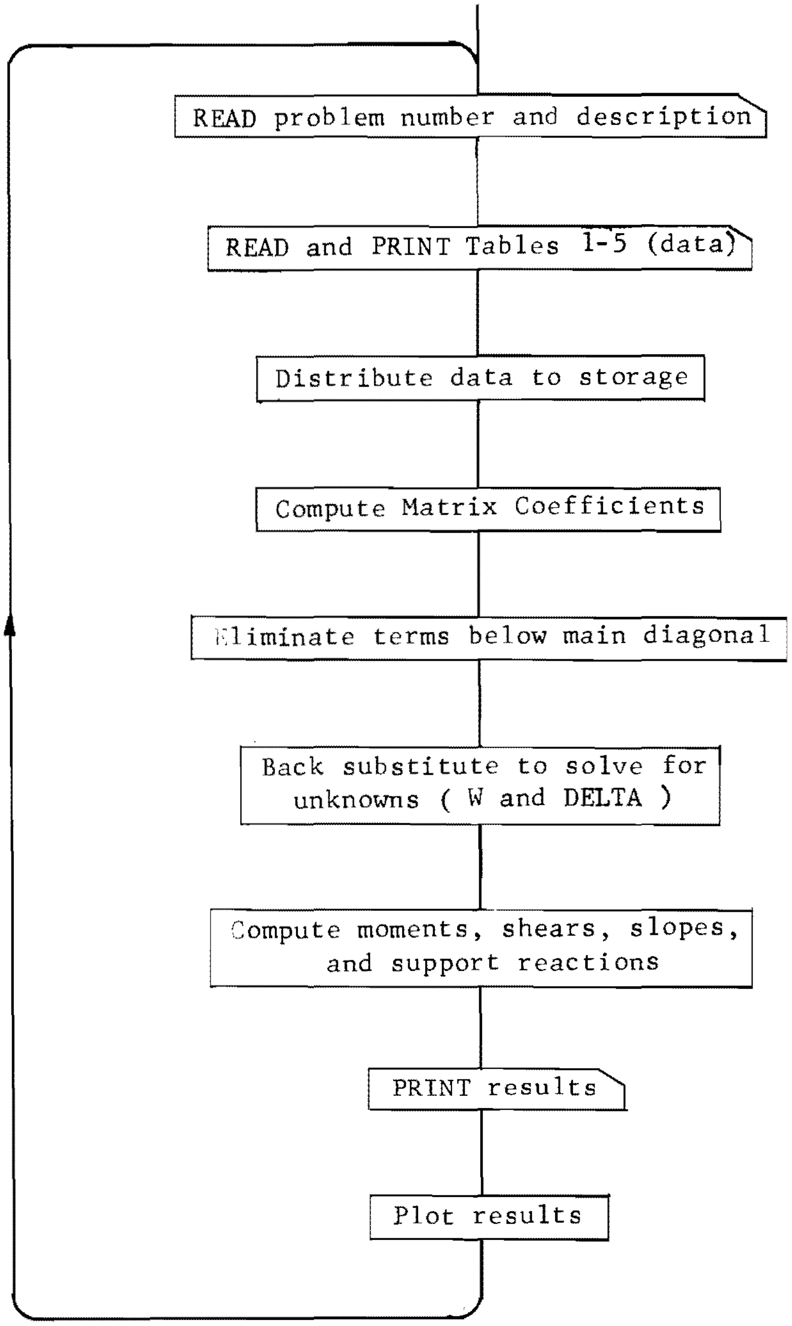


Organization of program deck.

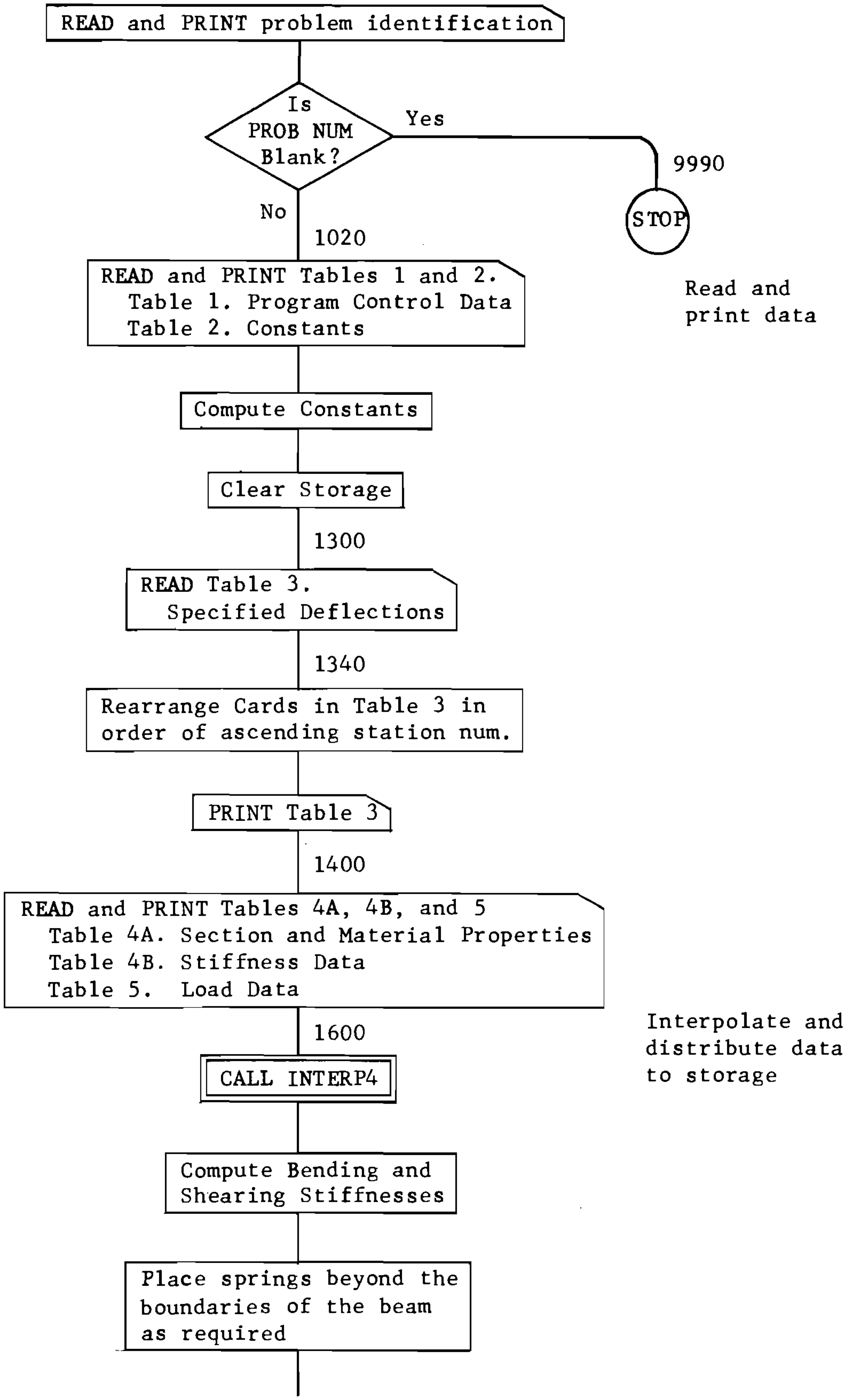
APPENDIX 2

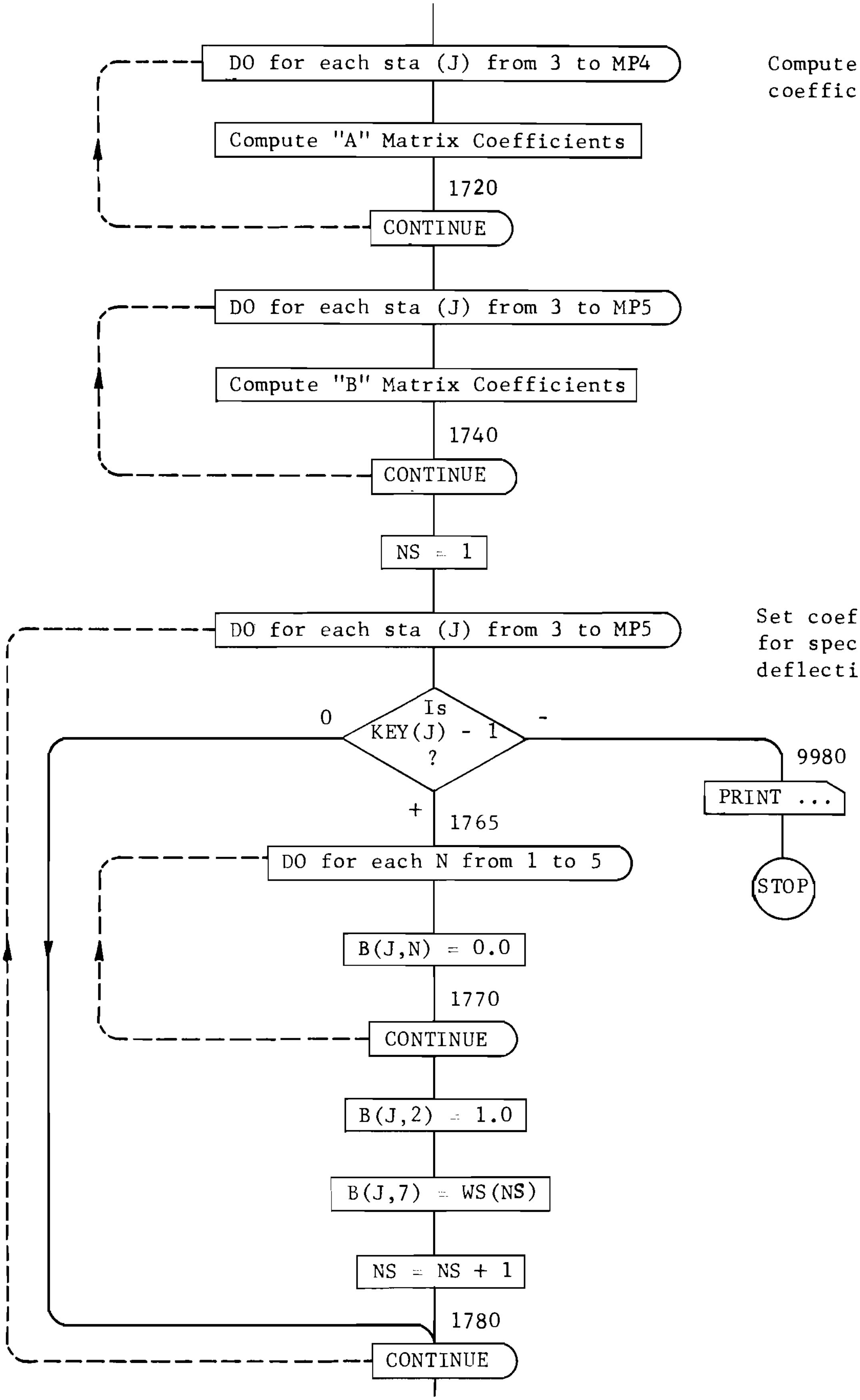
FLOW DIAGRAMS FOR PROGRAM SHRBM 1

SUMMARY FLOW DIAGRAM FOR PROGRAM SHRBM 1



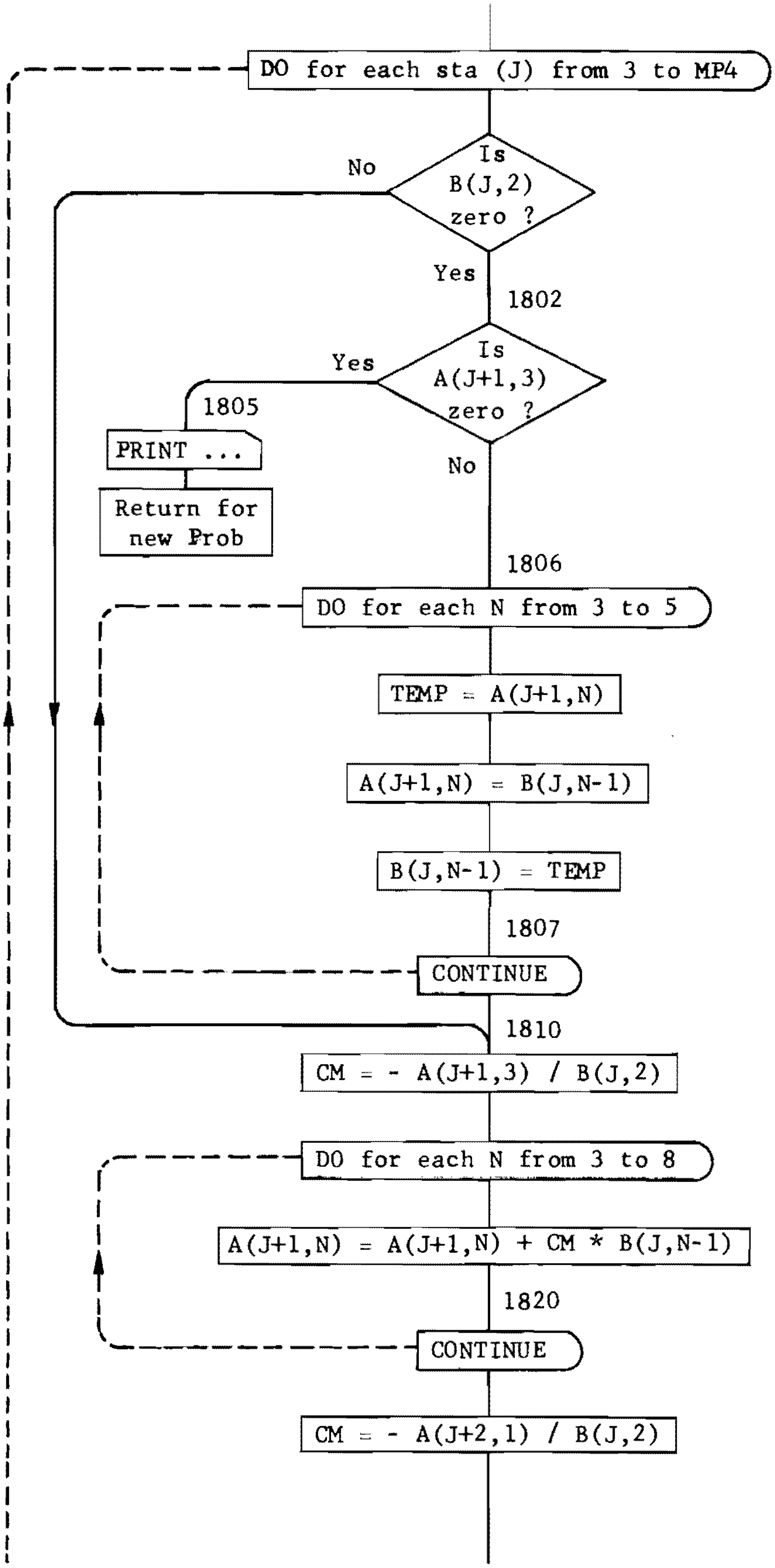
GENERAL FLOW DIAGRAM FOR PROGRAM SHRBM 1





Compute matrix coefficients

Set coefficients for specified deflections

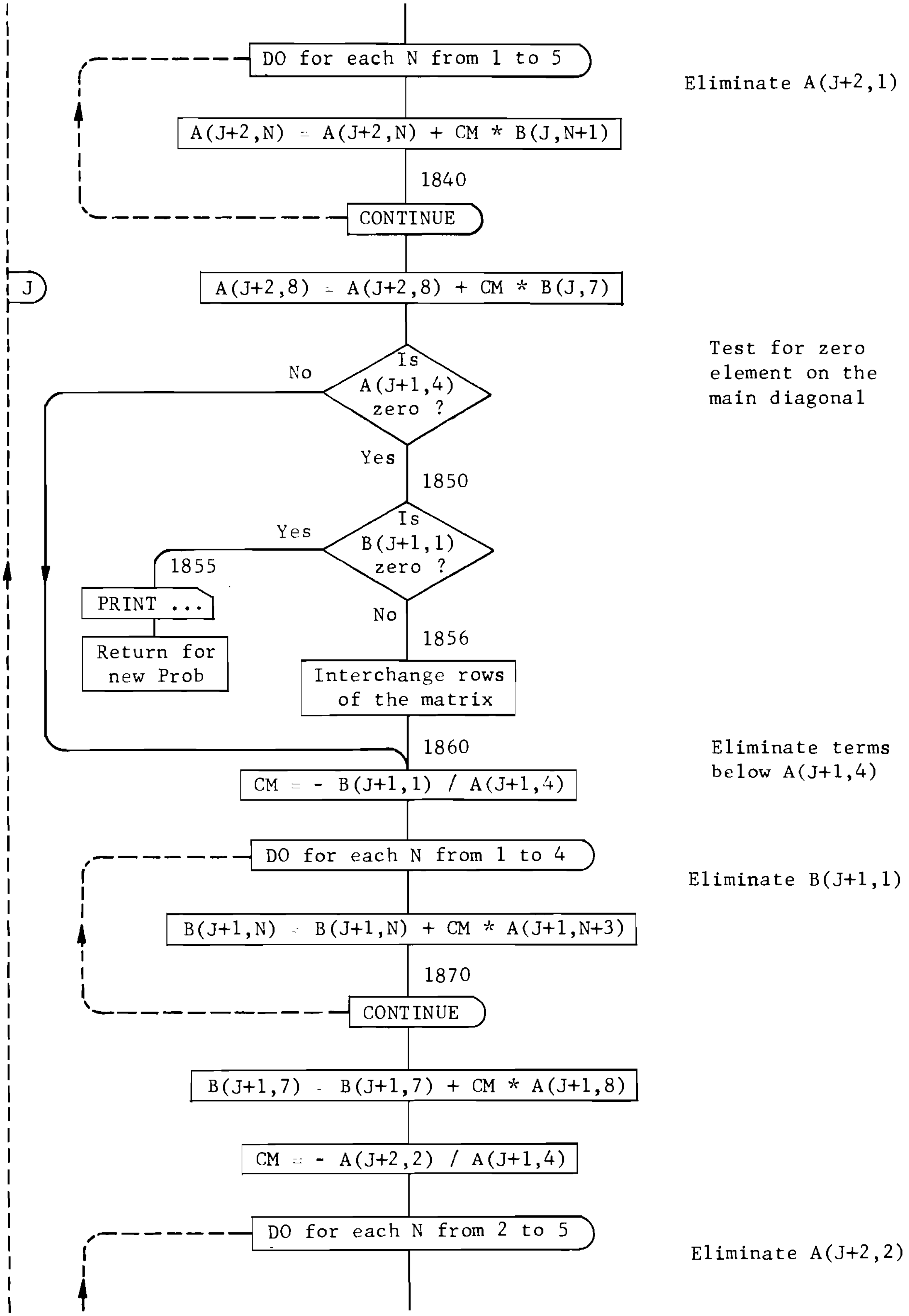


Test for zero
element on the
main diagonal

Interchange
rows of the
matrix

Eliminate terms
below B(J,2)

Eliminate A(J+1,3)



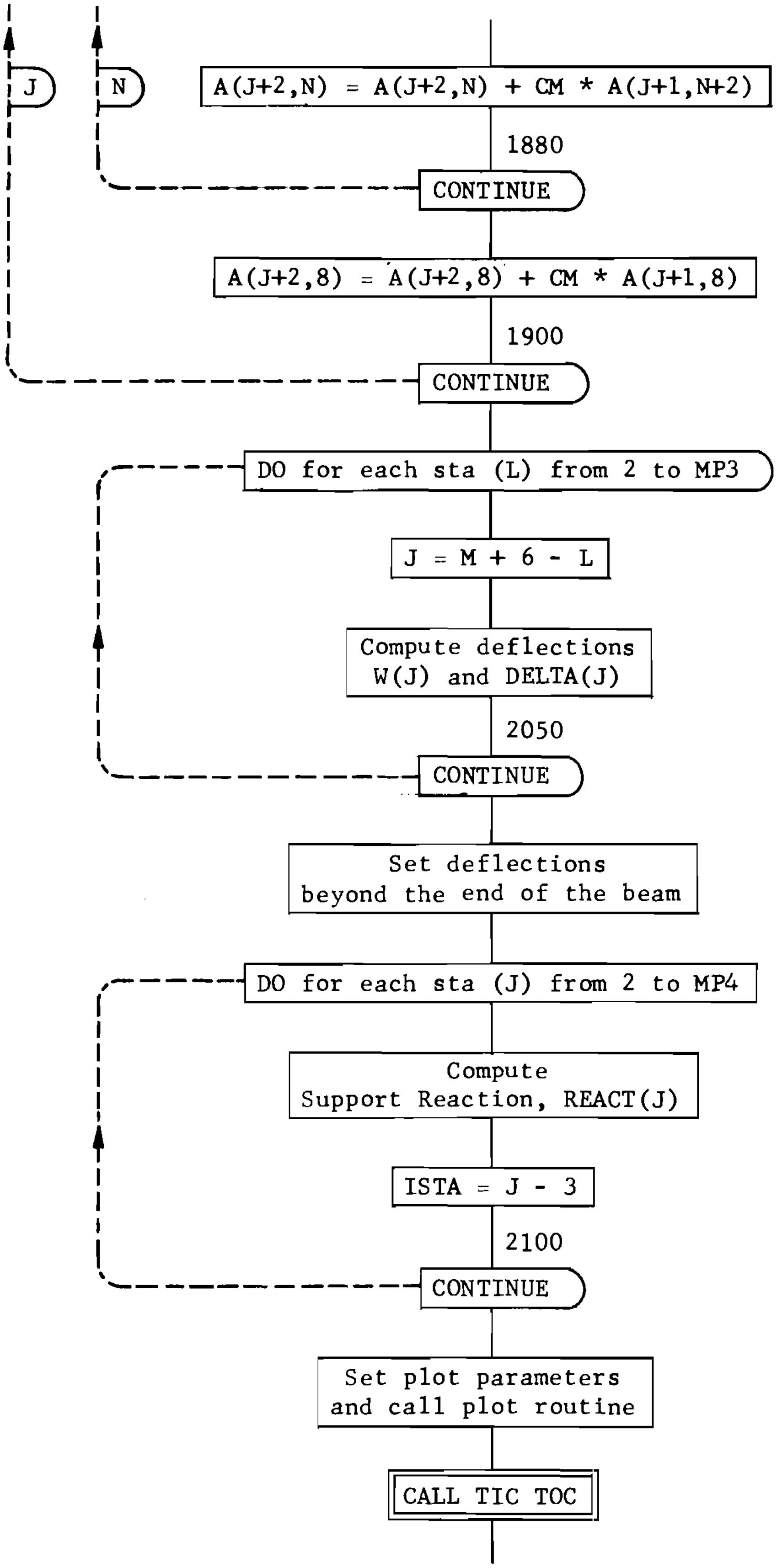
Eliminate A(J+2,1)

Test for zero element on the main diagonal

Eliminate terms below A(J+1,4)

Eliminate B(J+1,1)

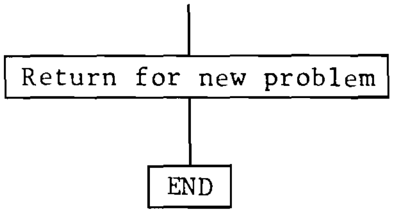
Eliminate A(J+2,2)



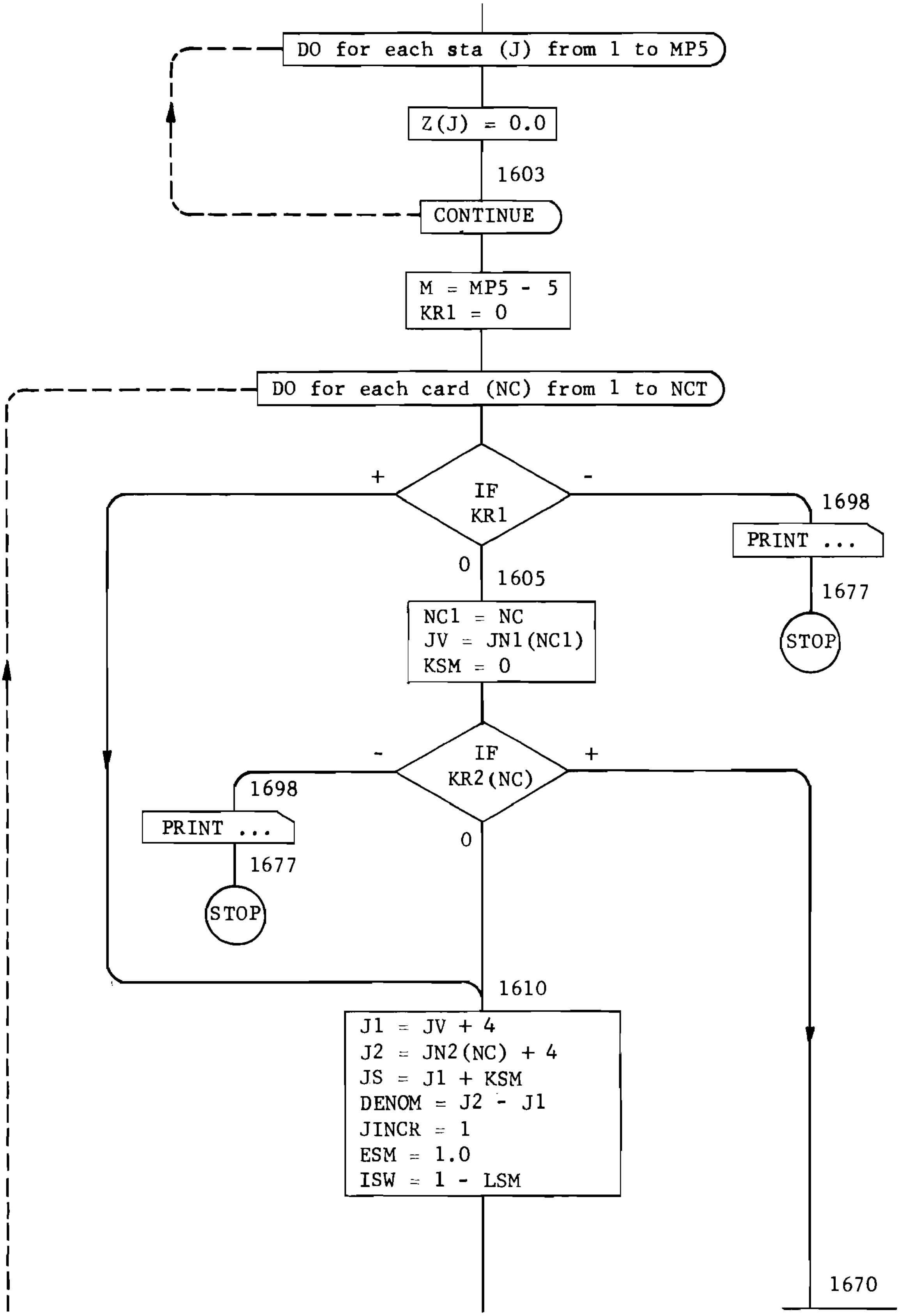
Back substitute

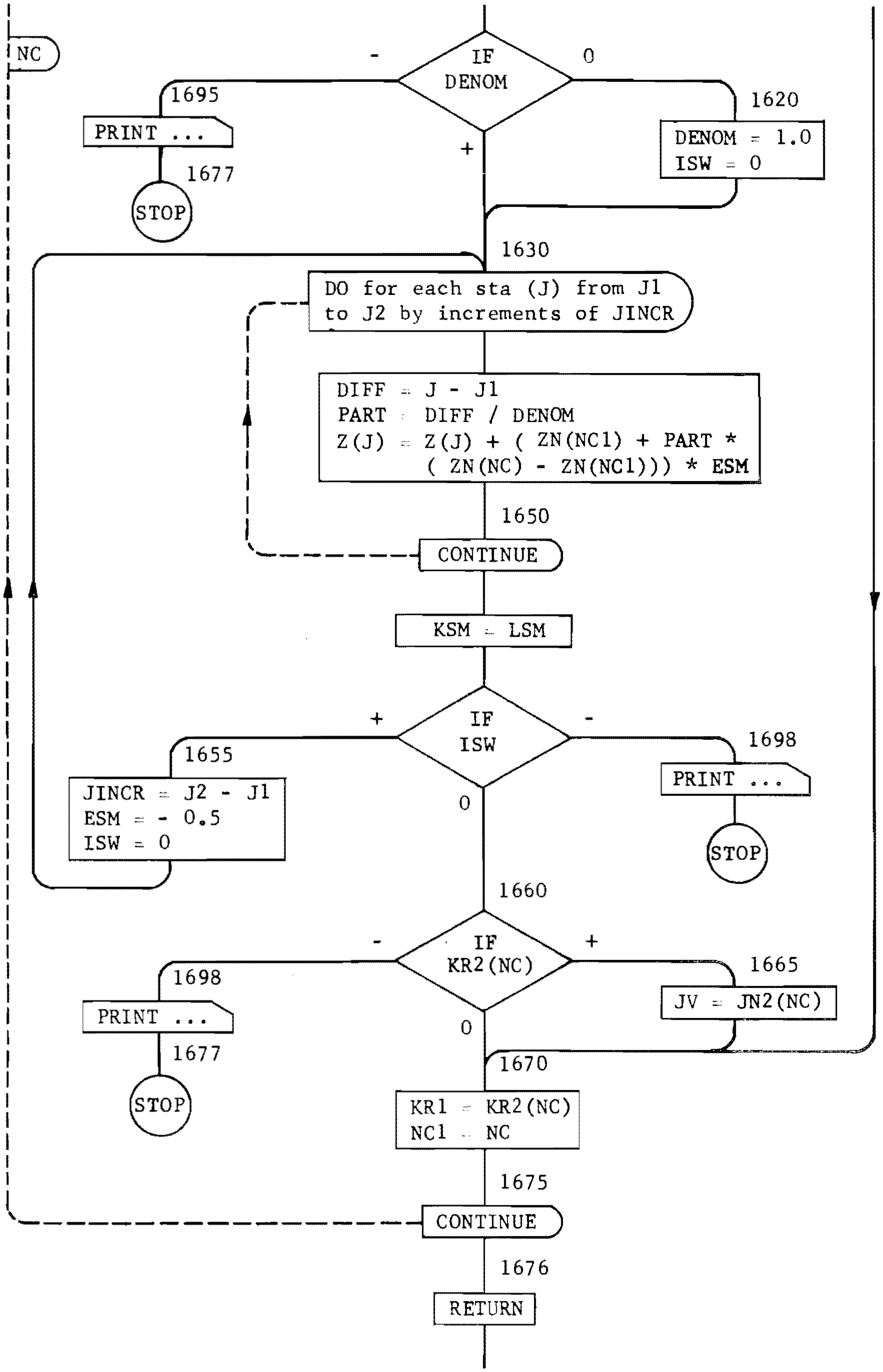
Compute and
print results

Plot results


Return for new problem
END

SUBROUTINE INTERP4




NC
IF DENOM
-
0
+
1695
PRINT ...
1677
STOP
1620
DENOM = 1.0
ISW = 0
1630
DO for each sta (J) from J1 to J2 by increments of JINCR
DIFF = J - J1
PART = DIFF / DENOM
Z(J) = Z(J) + (ZN(NC1) + PART * (ZN(NC) - ZN(NC1))) * ESM
1650
CONTINUE
KSM = LSM
IF ISW
+
-
0
1655
JINCR = J2 - J1
ESM = - 0.5
ISW = 0
1698
PRINT ...
STOP
1660
IF KR2(NC)
-
+
0
1698
PRINT ...
1677
STOP
1665
JV = JN2(NC)
1670
KR1 = KR2(NC)
NC1 = NC
1675
CONTINUE
1676
RETURN

APPENDIX 3

GLOSSARY OF NOTATION FOR SHRBM 1

```
C-----NOTATION FOR SHRBM 1                                              15AP8
C         A( , )              MATRIX COEFFICIENT IN MOMENT EQUATION     28FE8
C         AN1( ), AN2( )      IDENTIFICATION AND REMARKS (ALPH-NUM)     28FE8
C         B( , )              MATRIX COEFFICIENT IN SHEAR EQUATION      28FE8
C         BM(J)               BENDING MOMENT AT STA J                   28FE8
C         CM                  COEFFICIENT MULTIPLIER USED IN GUASSIAN   28FE8
C                             ELIMINATION                               28FE8
C         DELTA(J)            DEFLECTION IN BAR J DUE TO SHEAR          28FE8
C         DENOM               DENOMINATOR                               28FE8
C         DIFF                DIFFERENCE                                28FE8
C         DW(J)               SLOPE OF BAR J                            13MR8
C         E( ), E1( )         MODULUS OF ELASTICITY (DISTRIBUTED, INPUT)28FE8
C         ESM                 MULTIPLIER FOR END STATIONS               28FE8
C         F( ), F1( )         FLEXURAL STIFFNESS PER STA (DISTRIBUTED,  07MR8
C                             INPUT)                                    07MR8
C         G( ), G1( )         SHEAR MODULUS (DISTRIBUTED, INPUT)        28FE8
C         H                   INCREMENT LENGTH                          28FE8
C         HE2                 H SQUARED                                 28FE8
C         HE3                 H CUBED                                   28FE8
C         HT2                 H TIMES 2                                 28FE8
C         IN13( )             EXTERNAL STA NUMBER FOR SPECIFIED DEFLECT 28FE8
C         IN14A( ) THRU       INITIAL EXTERNAL STA USED IN TABLE 4A     07MR8
C                  IN15( )    THRU TABLE 5                              07MR8
C         IN24A( ) THRU       FINAL EXTERNAL STA USED IN TABLE 4A THRU  07MR8
C                  IN25( )    TABLE 5                                   07MR8
C         IP1                 I PLUS 1                                  28FE8
C         ITEST               = 5 ALPHANUMERIC BLANKS USED TO TERMINATE 28FE8
C                             PROGRAM                                   28FE8
C         ISTA                OUTPUT VALUE OF BEAM STA NUMBER           28FE8
C         ISW                 ROUTING SWITCH                            28FE8
C         J                   DO LOOP INDEX (STA NUMBER)                28FE8
C         J1                  INITIAL STA IN THE DISTRIBUTION SEQUENCE  28FE8
C         J2                  FINAL STA IN THE DISTRIBUTION SEQUENCE    28FE8
C         JINCR               INCREMENTATION INDEX                      28FE8
C         JN1( ), JN2( )      INITIAL AND FINAL EXTERNAL STA NUMBER     28FE8
C                             OF THE DISTRIBUTION SEQUENCE              28FE8
C         JS                  STA AT WHICH DEFLECTION IS SPECIFIED      28FE8
C         JV                  INITIAL STA NUMBER ON PREVIOUS CARD       28FE8
C         KEEP2 THRU KEEP5    IF = 1, KEEP PRIOR DATA, TABLES 2-5       28FE8
C         KERR                ERROR SWITCH USED IN TABLES 4A AND 4B     15AP8
C         KEY(J), KEYJ        ROUTING SWITCH FOR SPECIFIED DEFLECTION   28FE8
C         KPLOT               OPTION TO PLOT                            28FE8
C                             IF = 0 DO NOT PLOT                        28FE8
C                             IF = 1, PLOT ON 8.5 X 11 PAGE WITH        15AP8
C                                  1 INCH AND 5 INCH AXES               28FE8
C                             IF = 2, PLOT ON 2 - 8.5 X 11 PAGES WITH   15AP8
C                                  2 INCH AND 10 INCH AXES              28FE8
C                             IF = 3, PLOT ON 8.5 X 11 PAGE WITH        15AP8
C                                  1 INCH AND 15 INCH AXES              28FE8
C         KR1                 PRIOR VALUE OF KR24A( ), KR24B( ), OR     15AP8
C                             KR25( )                                   15AP8
C         KR24A( ) THRU       CONTINUE SWITCH USED IN TABLE 4A THRU     07MR8
C                  KR25( )    TABLE 5                                   07MR8
C         KSM                 SWITCH USED FOR DISTRIBUTING VALUES TO    28FE8
C                             HALF STATIONS                             28FE8
```

```
C           KSTOP                   ROUTING SWITCH FOR PLOT TAPE TERMINATION  28FE8
C           KSW4A( ) THRU           CONTINUE SWITCH USED IN TABLE 4A THRU     07MR8
C                   KSW5( )         TABLE 5                                   07MR8
C           L                       DO LOOP INDEX                             28FE8
C           LSM                     SWITCH USED FOR DISTRIBUTING VALUES TO    28FE8
C                                   HALF STATIONS                             28FE8
C           M                       NUMBER OF INCREMENTS                      28FE8
C           MP2 THRU MP7            M PLUS 2 THRU M PLUS 7                    28FE8
C           N                       DO LOOP INDEX                             28FE8
C           NCD2 THRU NCD5          NUM CARDS IN TABLES 2 THRU 5, THIS PROB   28FE8
C           NCT2 THRU NCT5          TOTAL NUM CARDS IN TABLES 2 THRU 5        28FE8
C           NC13 THRU NC15          INITIAL INDEX FOR DATA INPUT THIS PROB    28FE8
C                                   FOR TABLES 3 THRU 5                       28FE8
C           NCT3M1                  NCT3 MINUS 1                              28FE8
C           NS                      INDEX NUMBER FOR SPECIFIED CONDITIONS     28FE8
C           NPROB                   PROBLEM NUMBER (PROG STOPS IF ZERO)       28FE8
C           ODH                     ONE DIVIDED BY H                          15AP8
C           ODHE2                   ONE DIVIDED BY H SQUARED                  15AP8
C           ODHT4                   ONE DIVIDED BY H TIMES FOUR               15AP8
C           P( ), P1( )             AXIAL LOAD (DISTRIBUTED, INPUT)           28FE8
C           PART                    INTERPOLATION FRACTION                    28FE8
C           Q( ) , Q1( )            TRANSVERSE LOAD (DISTRIBUTED, INPUT)      28FE8
C           REACT( )                SUPPORT REACTION                          28FE8
C           R( ), R1( )             ROTATIONAL RESTRAINT (DISTRIBUTED, INPUT) 28FE8
C           S( ), S1( )             SPRING SUPPORT STIFFNESS (DISTRIBUTED,    13MR8
C                                   INPUT)                                    13MR8
C           SA( ), SA1( )           SHEAR AREA (DISTRIBUTED, INPUT)           07AP8
C           SI( ), SI1( )           MOMENT OF INERTIA (DISTRIBUTED, INPUT)    28FE8
C           SK( ), SK1( )           SHEAR SPRING STIFFNESS (DISTRIBUTED,      07MR8
C                                   INPUT)                                    07MR8
C           T( ), T1( )             TRANSVERSE COUPLE (DISTRIBUTED, INPUT)    07MR8
C           TEMP                    TEMPORARY STORAGE LOCATION                28FE8
C           V(J)                    SHEAR IN BAR J                            28FE8
C           W(J)                    TOTAL DEFLECTION AT STA J                 28FE8
C           WS( )                   SPECIFIED VALUE OF DEFLECTION             28FE8
C           Z( )                    INTERPOLATED VALUE                        28FE8
C           ZN( )                   INPUT VALUE FOR INTERPOLATION             28FE8
```

APPENDIX 4

PROGRAM LISTING OF SHRBM 1

```
DTANK,17,160,60000,200.CE244010,MATLOCK.
RUN(S,,,,,,20000)
LGO.
      PROGRAM SHRBM 1 ( INPUT, OUTPUT )
      DIMENSION     A(205,8), AN1(32), AN2(14), B(203,7), BM(205),       06MR8
     1              DELTA(205), DW(205), E(205),                        08AP8
     2              E1(100), F1(100), F(205), G(205), G1(100), HAXIS(7),06MR8
     3              HPLOT(205), IN13(20), IN14A(100), IN24A(100),       06MR8
     4              IN14B(100), IN24B(100), IN15(100), IN25(100),       0NM98
     5              KEY(205), KR24A(100), KR24B(100), KR25(100),        06MR8
     6              KSW4A(100), KSW4B(100), KSW5(100), P(205), P1(100), 06MR8
     7              Q(205), Q1(100), R(205), R1(100), REACT(205), S(205)08AP8
     8              , S1(100), SA(205), SA1(100), SI(205), SI1(100),    08AP8
     9              SK1(100), SK(205), T(205), T1(100), V(205),         06MR8
     1              VPLOT(205), W(205), WS(20), ZI(205)                 06MR8
    1 FORMAT (   43H     PROGRAM SHRBM 1 - DAWKINS - TANKERSLEY )       26AP7
   10 FORMAT (    5H      ,80X, 10HI-----TRIM )                         26AP7
   11 FORMAT (    5H1     ,80X, 10HI-----TRIM )                         04MY7
   12 FORMAT ( 16A5 )                                                   26AP7
   13 FORMAT ( 5X, 16A5 )                                               26AP7
   14 FORMAT ( A5, 5X, 14A5 )                                           26AP7
   15 FORMAT (///10H     PROB , / ,  4X, A5, 5X, 14A5 )                 09JE7
   16 FORMAT (///17H     PROB (CONTD), / , 4X, A5, 5X, 14A5 )           28FE8
   19 FORMAT (///48H     RETURN THIS PAGE TO TIME RECORD FILE -- HM )   04MY7
   20 FORMAT ( 2(5I5,5X), I5 )                                          05MR8
   21 FORMAT ( 5X, I5, 10X, E10.3 )                                     26AP7
   31 FORMAT ( 5X, I5, 10X, E10.3 )                                     26AP7
   41 FORMAT ( 5X, 3I5, 4E10.3 )                                        08AP8
   45 FORMAT ( 5X, 3I5, 2E10.3 )                                        10AP8
   51 FORMAT ( 5X, 3I5, 5E10.3 )                                        26AP7
  100 FORMAT (///35H     TABLE 1 - PROGRAM-CONTROL DATA                 26AP7
     1   /  58X, 30H        TABLES NUMBER                               08MR8
     2   /  57X, 30H     2    3    4A   4B   5                          05MR8
     3  //       39H          PRIOR-DATA OPTIONS (1 = HOLD), 19X, 5I5,  05MR8
     4   /       38H          NUM CARDS INPUT THIS PROBLEM, 20X, 5I5,   05MR8
     5  //       37H          OPTION (IF=1, 2, 3) TO PLOT, 21X, I5 )    05MR8
  200 FORMAT (///24H     TABLE 2 - CONSTANTS / )                        26AP7
  202 FORMAT (    25H          NUM INCREMENTS , 53X, I5,                09JE7
     1    /      27H          INCREMENT LENGTH , 46X, E10.3 )          09JE7
  300 FORMAT (///36H     TABLE 3 - SPECIFIED DEFLECTIONS                26AP7
     1  //    5X, 25H     STA        DEFLECTION , / )                   26AP7
  302 FORMAT (    46H     MORE THAN ONE DEFLECTION SPECIFIED AT STA,    26AP7
     1         5X, I4 )                                                 26AP7
  311 FORMAT ( 8X, I4, 9X, E10.3 )                                      28FE8
  400 FORMAT (///47H     TABLE 4A - SECTION AND MATERIAL PROPERTIES ,   05MR8
     1  //       48H     FROM TO CONID     E         G           I      28FE8
     2           11H        SA   , / )                                  08AP8
  411 FORMAT ( 4X, 3I4, 1X, 4E11.3 )                                    08AP8
  412 FORMAT ( 4X, I4, 4X, I4, 1X, 4E11.3 )                             08AP8
  413 FORMAT ( 8X, 2I4, 1X, 4E11.3 )                                    08AP8
  450 FORMAT (///30H     TABLE 4B - STIFFNESS DATA ,                    05MR8
     1  //       35H     FROM TO CONTD     SK         F , / )           05MR8
  461 FORMAT ( 4X, 3I4, 1X, 2E11.3 )                                    05MR8
  462 FORMAT ( 4X, I4, 4X, I4, 1X, 2E11.3 )                             05MR8
  463 FORMAT ( 8X, 2I4, 1X, 2E11.3 )                                    05MR8
```

```
  500 FORMAT (// 24H     TABLE 5 - LOAD DATA                            26AP7
     1   //        48H     FROM TO CONTD      Q          S          T     26AP7
     2           20H        R          P , / )                          26AP7
  511 FORMAT ( 4X, 3I4, 1X, 5E11.3 )                                    28FE8
  512 FORMAT ( 4X, I4, 4X, I4, 1X, 5E11.3 )                             28FE8
  513 FORMAT ( 8X, 2I4, 1X, 5E11.3 )                                    28FE8
  801 FORMAT (    29H     ZERO ELEMENT ON DIAGONAL )                    26AP7
  805 FORMAT ( //51H     TABLE 7 -- SCALES FOR PLOT OUTPUT -- VALUES AT 20NO4
     1           13H ENDS OF AXES                                       20NO4
     2        // 51H     STA      X          W        DELTA       DW   28FE8
     3           35H        M          V      SUP REACT )               28FE8
  810 FORMAT ( 4X, I4, 7E11.3 )                                         28FE8
  901 FORMAT (    38H     NO DATA SPECIFIED FOR THIS TABLE )            15AP8
  902 FORMAT (    50H     NO DATA IN THIS TABLE FROM THE PREVIOUS PROB ) 15AP8
  903 FORMAT ( / 25H                    NONE )                          26AP7
  904 FORMAT (// 40H     TOO MUCH DATA FOR AVAILABLE STORAGE // )       26AP7
  905 FORMAT (    45H          DATA HELD FROM THE PREVIOUS PROBLEM )    26AP7
  906 FORMAT (    50H     DATA HELD ERRONEOUSLY FROM THE PREVIOUS PROB ) 15AP8
  910 FORMAT (    48H          ADDITIONAL DATA INPUT FOR THIS PROBLEM ) 26AP7
  980 FORMAT ( / 51H     UNSPECIFIED ERROR STOP -- PROGRAM TERMINATED ) 04MY7
  991 FORMAT (///22H     TABLE 6 - RESULTS                              28FE8
     1   //        41H       STA      W        DELTA      SLOPE         26AP7
     2           35H       MOM       SHEAR    SUP REACT , / )           26AP7
  992 FORMAT ( 21X, 2E11.3, 11X, E11.3 )                                26AP7
  993 FORMAT ( 5X, I4, 1X, E11.3, 22X, E11.3, 11X, E11.3 )              26AP7
C-----START EXECUTION OF PROGRAM                                        26AP7
               KSTOP = 0                                                26AP7
               ITEST = 5H                                               26AP7
 1000 PRINT 10                                                          26AP7
      CALL TIC TOC(1)                                                   26AP7
      READ 12, ( AN1(N), N = 1, 32 )                                    26AP7
 1010 READ 14, NPROB, ( AN2(N), N = 1, 14 )                             28AP7
          IF( NPROB - ITEST ) 1020, 9990, 1020                          26AP7
 1020 PRINT 11                                                          26AP7
      PRINT 13, ( AN1(N), N = 1, 32 )                                   26AP7
      PRINT 15, NPROB, ( AN2(N), N = 1, 14 )                            26AP7
C-----INPUT TABLE 1. PROGRAM CONTROL DATA                               28FE8
 1100 READ 20, KEEP2, KEEP3, KEEP4A, KEEP4B, KEEP5, NCD2, NCD3, NCD4A,  05MR8
     1         NCD4B, NCD5, KPLOT                                       05MR8
      PRINT 100, KEEP2, KEEP3, KEEP4A, KEEP4B, KEEP5, NCD2, NCD3,       05MR8
     1           NCD4A, NCD4B, NCD5, KPLOT                              05MR8
C-----INPUT TABLE 2. CONSTANTS                                          28FE8
 1200 PRINT 200                                                         26AP7
          IF( KEEP2 ) 9980, 1205, 1203                                  11JL7
 1203 PRINT 905                                                         11JL7
          IF ( NCD2.LT.1 ) GO TO 1230                                   15AP8
      PRINT 906                                                         15AP8
          GO TO 9990                                                    15AP8
 1205     IF( NCD2 ) 9980, 1207, 1210                                   26AP7
 1207 PRINT 901                                                         15AP8
          GO TO 9990                                                    26AP7
 1210 READ 21, M, H                                                     26AP7
 1230 PRINT 202, M, H                                                   11JL7
C-----COMPUTE CONSTANTS AND INDICES                                     26AP7
               HT2 = H + H                                              26AP7
```

```
               HT4 = HT2 + HT2                                          08AP8
               HE2 = H * H                                              26AP7
               HE3 = H * HE2                                            26AP7
               ODH = 1.0 / H                                            08AP8
               ODHE2 = 1.0 / HE2                                        08AP8
               ODHT4 = 1.0 / HT4                                        08AP8
               MP1 = M + 1                                              28FE8
               MP2 = M + 2                                              26AP7
               MP3 = M + 3                                              26AP7
               MP4 = M + 4                                              26AP7
               MP5 = M + 5                                              26AP7
C-----CLEAR STORAGE                                                     26AP7
          DO 1260  J = 1, MP5                                           06MR8
               W(J) = 0.0                                               26AP7
               V(J) = 0.0                                               26AP7
               DW(J) = 0.0                                              26AP7
               BM(J) = 0.0                                              26AP7
               DELTA(J) = 0.0                                           26AP7
               REACT(J) = 0.0                                           26AP7
          DO 1240  N = 1, 8                                             26AP7
               A(J,N) = 0.0                                             26AP7
 1240     CONTINUE                                                      26AP7
          DO 1250  N = 1, 7                                             09AP8
               B(J,N) = 0.0                                             26AP7
 1250     CONTINUE                                                      26AP7
 1260     CONTINUE                                                      26AP7
C-----INPUT TABLE 3. SPECIFIED DEFLECTIONS                              28FE8
 1300 PRINT 300                                                         26AP7
          IF ( KEEP3 ) 9980, 1310, 1305                                 28FE8
 1305 PRINT 905                                                         26AP7
          IF ( NCD3.LT.1 ) GO TO 1307                                   15AP8
      PRINT 906                                                         15AP8
          GO TO 9990                                                    15AP8
 1307           NCD3 = NCT3                                             15AP8
          IF ( NCD3 ) 9980, 1308, 1360                                  15AP8
 1308 PRINT 902                                                         15AP8
          GO TO 9990                                                    15AP8
 1310     DO 1315  J = 2, MP4                                           06MR8
               KEY(J) = 1                                               26AP7
 1315     CONTINUE                                                      26AP7
          IF ( NCD3 ) 9980, 1320, 1325                                  15AP8
 1320 PRINT 903                                                         15AP8
          GO TO 1399                                                    15AP8
 1325     IF( NCD3 - 20 ) 1327, 1327, 1326                              26AP7
 1326 PRINT 904                                                         26AP7
          GO TO 9990                                                    28FE8
 1327     DO 1330  N = 1, NCD3                                          28FE8
      READ 31, IN13(N), WS(N)                                           09JE7
 1330     CONTINUE                                                      16MY7
C-----ARRANGE CARDS IN ASCENDING ORDER OF STA NUMBER                     26AP7
          IF( NCD3 - 2 ) 1360, 1340, 1340                               26AP7
 1340           NCD3M1 = NCD3 - 1                                       26AP7
          DO 1357 I = 1, NCD3M1                                         12MY7
               IP1 = I + 1                                              26AP7
          DO 1355  N = IP1, NCD3                                        04MY7
```

```
          IF( IN13(I) - IN13(N) ) 1355, 1348, 1350                       12MY7
 1348 PRINT 302, IN13(N)                                                 26AP7
          GO TO 9990                                                     26AP7
 1350          TEMP = IN13(I)                                            26AP7
               IN13(I) = IN13(N)                                         26AP7
               IN13(N) = TEMP                                            26AP7
               TEMP = WS(I)                                              26AP7
               WS(I) = WS(N)                                             26AP7
               WS(N) = TEMP                                              26AP7
 1355     CONTINUE                                                       26AP7
 1357     CONTINUE                                                       12MY7
 1360     CONTINUE                                                       26AP7
C-----SET INDICES FOR FUTURE CONTROL OF SPECIFIED CONDITION ROUTINES     26AP7
          DO 1398  N = 1, NCD3                                           12JL7
               JS = IN13(N) + 3                                          06MR8
               KEY(JS) = 2                                               26AP7
      PRINT 311, IN13(N), WS(N)                                          26AP7
 1398     CONTINUE                                                       12MY7
 1399     CONTINUE                                                       26AP7
               NCT3 = NCD3                                               12JL7
C-----INPUT TABLE 4A. SECTION AND MATERIAL PROPERTIES                    05MR8
 1400 PRINT 400                                                          26AP7
               KERR = 0                                                  15AP8
          IF( KEEP4A ) 9980, 1401, 1409                                  05MR8
 1401          NCT4A = 0                                                 05MR8
          IF( NCD4A ) 9980, 1402, 1428                                   05MR8
 1402 PRINT 903                                                          05MR8
               KERR = 1                                                  15AP8
          GO TO 1450                                                     05MR8
 1409 PRINT 905                                                          28FE8
          IF( NCT4A ) 9980, 1410, 1411                                   05MR8
 1410 PRINT 902                                                          28FE8
          GO TO 9990                                                     28FE8
 1411     DO 1427  N = 1, NCT4A                                          05MR8
               KSW4AN = KSW4A(N)                                         05MR8
          GO TO ( 1413, 1417, 1421, 1421 ), KSW4AN                       05MR8
 1413 PRINT 411, IN14A(N), IN24A(N), KR24A(N), E1(N), G1(N), SI1(N),     05MR8
     1           SA1(N)                                                  08AP8
          GO TO 1425                                                     05MR8
 1417 PRINT 412, IN14A(N), KR24A(N), E1(N), G1(N), SI1(N), SA1(N)       08AP8
          GO TO 1425                                                     05MR8
 1421 PRINT 413, IN24A(N), KR24A(N), E1(N), G1(N), SI1(N), SA1(N)       08AP8
 1425     CONTINUE                                                       05MR8
 1427     CONTINUE                                                       05MR8
          IF( NCD4A ) 9980, 1450, 1428                                   05MR8
 1428          NC14A = NCT4A + 1                                         05MR8
               NCT4A = NCT4A + NCD4A                                     05MR8
          IF( NCT4A - 100 ) 1435, 1435, 1433                             05MR8
 1433 PRINT 904                                                          26AP7
          GO TO 9990                                                     26AP7
 1435 PRINT 910                                                          28FE8
 1440          KR1 = 0                                                   26AP7
          DO 1449  N = NC14A, NCT4A                                      05MR8
      READ 41, IN14A(N), IN24A(N), KR24A(N), E1(N), G1(N), SI1(N),       05MR8
     1           SA1(N)                                                  08AP8
```

```
               KSW4A(N) = 1 + KR24A(N) + 2.0 * KR1                      05MR8
               KR1 = KR24A(N)                                           05MR8
               KSW4AN = KSW4A(N)                                        05MR8
          GO TO ( 1443, 1445, 1447, 1447 ), KSW4AN                      05MR8
 1443 PRINT 411, IN14A(N), IN24A(N), KR24A(N), E1(N), G1(N), SI1(N),    05MR8
     1           SA1(N)                                                 08AP8
          GO TO 1448                                                    05MR8
 1445 PRINT 412, IN14A(N), KR24A(N), E1(N), G1(N), SI1(N), SA1(N)       08AP8
          GO TO 1448                                                    05MR8
 1447 PRINT 413, IN24A(N), KR24A(N), E1(N), G1(N), SI1(N), SA1(N)       08AP8
 1448 CONTINUE                                                          05MR8
 1449 CONTINUE                                                          05MR8
C-----INPUT TABLE 4B. STIFFNESS DATA                                    05MR8
 1450 PRINT 450                                                         05MR8
          IF( KEEP4B ) 9980, 1451, 1459                                 05MR8
 1451          NCT4B = 0                                                05MR8
          IF( NCD4B ) 9980, 1452, 1478                                  05MR8
 1452 PRINT 903                                                         05MR8
          IF ( KERR.NE.1 ) GO TO 1500                                   15AP8
      PRINT 901                                                         15AP8
          GO TO 9990                                                    15AP8
 1459 PRINT 905                                                         05MR8
          IF( NCT4B ) 9980, 1460, 1461                                  05MR8
 1460 PRINT 902                                                         05MR8
          GO TO 9990                                                    05MR8
 1461     DO 1477  N = 1, NCT4B                                         05MR8
               KSW4BN = KSW4B(N)                                        05MR8
          GO TO ( 1463, 1467, 1471, 1471 ), KSW4BN                      05MR8
 1463 PRINT 461, IN14B(N), IN24B(N), KR24B(N), SK1(N), F1(N)            05MR8
          GO TO 1475                                                    05MR8
 1467 PRINT 462, IN14B(N), KR24B(N), SK1(N), F1(N)                      05MR8
          GO TO 1475                                                    05MR8
 1471 PRINT 463, IN24B(N), KR24B(N), SK1(N), F1(N)                      05MR8
 1475     CONTINUE                                                      05MR8
 1477     CONTINUE                                                      05MR8
          IF( NCD4B ) 9980, 1500, 1478                                  05MR8
 1478          NC14B = NCT4B + 1                                        05MR8
               NCT4B = NCT4B + NCD4B                                    05MR8
          IF( NCT4B - 100 ) 1485, 1485, 1483                            05MR8
 1483 PRINT 904                                                         05MR8
          GO TO 9990                                                    05MR8
 1485 PRINT 910                                                         05MR8
 1490          KR1 = 0                                                  05MR8
               DO 1499  N = NC14B, NCT4B                                05MR8
      READ 45, IN14B(N), IN24B(N), KR24B(N), SK1(N), F1(N)              05MR8
               KSW4B(N) = 1 + KR24B(N) + 2.0 * KR1                      05MR8
               KR1 = KR24B(N)                                           05MR8
               KSW4BN = KSW4B(N)                                        05MR8
          GO TO ( 1493, 1495, 1497, 1497 ), KSW4BN                      05MR8
 1493 PRINT 461, IN14B(N), IN24B(N), KR24B(N), SK1(N), F1(N)            05MR8
          GO TO 1498                                                    05MR8
 1495 PRINT 462, IN14B(N), KR24B(N), SK1(N), F1(N)                      05MR8
          GO TO 1498                                                    05MR8
 1497 PRINT 463, IN24B(N), KR24B(N), SK1(N), F1(N)                      05MR8
 1498     CONTINUE                                                      05MR8
```

```
 1499      CONTINUE                                                     05MR8
C-----INPUT TABLE 5. LOAD DATA                                          28FE8
 1500 PRINT 500                                                         26AP7
           IF( KEEP5 ) 9980, 1501, 1509                                 26AP7
 1501            NCT5 = 0                                               28FE8
           IF( NCD5 ) 9980, 1502, 1528                                  05SE7
 1502 PRINT 901                                                         15AP8
           GO TO 9990                                                   26AP7
 1509 PRINT 905                                                         26AP7
           IF( NCT5 ) 9980, 1510, 1511                                  28FE8
 1510 PRINT 902                                                         28FE8
           GO TO 9990                                                   28FE8
 1511      DO 1527  N = 1, NCT5                                         12MY7
                 KSW5N = KSW5(N)                                        26AP7
           GO TO ( 1513, 1517, 1521, 1521 ), KSW5N                      26AP7
 1513 PRINT 511, IN15(N), IN25(N), KR25(N), Q1(N), S1(N), T1(N), R1(N), 26AP7
     1           P1(N)                                                  26AP7
           GO TO 1525                                                   26AP7
 1517 PRINT 512, IN15(N), KR25(N), Q1(N), S1(N), T1(N), R1(N), P1(N)    26AP7
           GO TO 1525                                                   26AP7
 1521 PRINT 513, IN25(N), KR25(N), Q1(N), S1(N), T1(N), R1(N), P1(N)    26AP7
 1525      CONTINUE                                                     26AP7
 1527      CONTINUE                                                     26AP7
           IF( NCD5 ) 9980, 1600, 1528                                  05SE7
 1528            NC15 = NCT5 + 1                                        26AP7
                 NCT5 = NCT5 + NCD5                                     26AP7
           IF( NCT5 - 100 ) 1535, 1535, 1533                            26AP7
 1533 PRINT 904                                                         26AP7
           GO TO 9990                                                   26AP7
 1535 PRINT 910                                                         28FE8
 1540            KR1 = 0                                                26AP7
           DO 1571  N = NC15, NCT5                                      12MY7
      READ 51, IN15(N), IN25(N), KR25(N), Q1(N), S1(N), T1(N), R1(N),   28AP7
     1           P1(N)                                                  26AP7
                 KSW5(N) = 1 + KR25(N) + 2 * KR1                        05MY7
                 KR1 = KR25(N)                                          26AP7
                 KSW5N = KSW5(N)                                        28AP7
           GO TO ( 1550, 1555, 1560, 1560 ), KSW5N                      28AP7
 1550 PRINT 511, IN15(N), IN25(N), KR25(N), Q1(N), S1(N), T1(N), R1(N), 26AP7
     1           P1(N)                                                  26AP7
           GO TO 1570                                                   26AP7
 1555 PRINT 512, IN15(N), KR25(N), Q1(N), S1(N), T1(N), R1(N), P1(N)    26AP7
           GO TO 1570                                                   26AP7
 1560 PRINT 513, IN25(N), KR25(N), Q1(N), S1(N), T1(N), R1(N), P1(N)    26AP7
 1570      CONTINUE                                                     26AP7
 1571      CONTINUE                                                     12MY7
C-----INTERPOLATE AND DISTRIBUTE DATA FROM TABLE 4A                     05MR8
 1600            LSM = 1                                                26AP7
      CALL INTERP4 ( MP5, NCT4A, IN14A, IN24A, KR24A, G1, G, LSM )      06MR8
      CALL INTERP4 ( MP5, NCT4A, IN14A, IN24A, KR24A, SI1, SI, LSM )    06MR8
      CALL INTERP4 ( MP5, NCT4A, IN14A, IN24A, KR24A, SA1, SA, LSM )    08AP8
                 LSM = 0                                                26AP7
      CALL INTERP4 ( MP5, NCT4A, IN14A, IN24A, KR24A, E1, E, LSM )      06MR8
C-----INTERPOLATE AND DISTRIBUTE DATA FROM TABLE 4B                     05MR8
 1675            LSM = 1                                                05MR8
```

```
      CALL INTERP4 ( MP5, NCT4B, IN14B, IN24B, KR24B, SK1, SK, LSM )    06MR8
               LSM = 0                                                  05MR8
      CALL INTERP4 ( MP5, NCT4B, IN14B, IN24B, KR24B, F1, F, LSM )      06MR8
C-----INTERPOLATE AND DISTRIBUTE DATA FROM TABLE 5                      26AP7
 1680          LSM = 0                                                  05MR8
      CALL INTERP4 ( MP5, NCT5, IN15, IN25, KR25, Q1, Q, LSM )          06MR8
      CALL INTERP4 ( MP5, NCT5, IN15, IN25, KR25, S1, S, LSM )          06MR8
      CALL INTERP4 ( MP5, NCT5, IN15, IN25, KR25, T1, T, LSM )          06MR8
      CALL INTERP4 ( MP5, NCT5, IN15, IN25, KR25, R1, R, LSM )          06MR8
               LSM = 1                                                  10MR8
      CALL INTERP4 ( MP5, NCT5, IN15, IN25, KR25, P1, P, LSM )          06MR8
C-----COMPUTE STIFFNESSES AND PLACE SPRINGS BEYOND THE BOUNDARIES        15AP8
               DO 1695  J = 3, MP3                                      10AP8
               F(J) = E(J) * SI(J) + F(J)                               05MR8
          IF ( F(J-2).NE.0.0 ) GO TO 1690                               09AP8
          IF ( F(J-1).NE.0.0 ) GO TO 1690                               09AP8
          IF ( F(J).NE.0.0 ) GO TO 1690                                 09AP8
               S(J-1) = 1.0E 20                                         08AP8
 1690          SK(J) = G(J) * SA(J) * ODH + SK(J)                       08AP8
          IF ( SK(J).NE.0.0 ) GO TO 1695                                10AP8
               SK(J) = 1.0E 20                                          08AP8
 1695     CONTINUE                                                      26AP7
               SK(3) = SK(4)                                            06MR8
               SK(MP4) = SK(MP3)                                        06MR8
C-----COMPUTE A(J,N) MATRIX COEFFICIENTS                                 28FE8
          DO 1720  J = 3, MP4                                           08AP8
               A(J,1) = - F(J-1) * ODHE2 + R(J-1) * ODHT4               08AP8
               A(J,2) = F(J-1) * ODHE2 - R(J-1) * ODHT4                 08AP8
               A(J,3) = ( F(J) + 2.0 * F(J-1) ) * ODHE2 + P(J) + R(J)   08AP8
     1                  * ODHT4                                         08AP8
               A(J,4) = - ( F(J) + F(J-1) ) * ODHE2 - SK(J) * H - (     08AP8
     1                  R(J-1) + R(J) ) * ODHT4                         08AP8
               A(J,5) = - ( 2.0 * F(J) + F(J-1) ) * ODHE2 - P(J) -      08AP8
     1                  R(J-1) * ODHT4                                  08AP8
               A(J,6) = F(J) * ODHE2 - R(J) * ODHT4                     08AP8
               A(J,7) = F(J) * ODHE2 - R(J) * ODHT4                     08AP8
               A(J,8) = 0.5 * ( T(J) + T(J-1) )                         08AP8
 1720     CONTINUE                                                      26AP7
C-----COMPUTE B(J,N) MATRIX COEFFICIENTS                                 28FE8
          DO 1740  J = 2, MP4                                           06MR8
               B(J,1) = SK(J)                                           05MR8
               B(J,2) = - S(J)                                          05MR8
               B(J,3) = - SK(J+1)                                       05MR8
               B(J,7) = - Q(J)                                          05MR8
 1740     CONTINUE                                                      26AP7
C-----RESET COEFFICIENTS FOR SPECIFIED DEFLECTIONS                       26AP7
               NS = 1                                                   26AP7
          DO 1780  J = 2, MP4                                           06MR8
          IF( KEY(J) - 1 ) 9980, 1775, 1765                             28FE8
 1765     DO 1770  N = 1, 6                                             09AP8
               B(J,N) = 0.0                                             26AP7
 1770     CONTINUE                                                      26AP7
               B(J,2) = 1.0                                             05MR8
               B(J,7) = WS(NS)                                          09AP8
               NS = NS + 1                                              26AP7
```

```
 1775     CONTINUE                                                      28FE8
 1780     CONTINUE                                                      26AP7
C-----BEGIN GUASSIAN ELIMINATION                                        26AP7
          DO 1900  J = 2, MP3                                           06MR8
C-----TEST FOR ZERO ELEMENT ON THE DIAGONAL                             28FE8
          IF( ABSF( B(J,2) ) ) 9980, 1802, 1810                         05MR8
 1802     IF ( ABSF( A(J+1,3) ) ) 9980, 1805, 1806                      19AP8
 1805 PRINT 801                                                         26AP7
          GO TO 9970                                                    28FE8
C-----INTERCHANGE ROWS OF THE MATRIX                                    28FE8
 1806     DO 1807  N = 3, 8                                             28FE8
               TEMP = A(J+1,N)                                          28FE8
               A(J+1,N) = B(J,N-1)                                      05MR8
               B(J,N-1) = TEMP                                          05MR8
 1807     CONTINUE                                                      28FE8
C-----ELIMINATE ALL TERMS BELOW B(J,2)                                  05MR8
 1810          CM = - A(J+1,3) / B(J,2)                                 08AP8
          DO 1820  N = 3, 8                                             26AP7
               A(J+1,N) = A(J+1,N) + CM * B(J,N-1)                      08AP8
 1820     CONTINUE                                                      26AP7
               CM = - A(J+2,1) / B(J,2)                                 08AP8
          DO 1840  N = 1, 5                                             28AP7
               A(J+2,N) = A(J+2,N) + CM * B(J,N+1)                      08AP8
 1840     CONTINUE                                                      26AP7
               A(J+2,8) = A(J+2,8) + CM * B(J,7)                        05MR8
C-----TEST FOR ZERO ELEMENT ON THE DIAGONAL                             28FE8
               IF ( ABSF ( A(J+1,4) ) ) 9980, 1850, 1860                05MR8
 1850     IF( ABSF( B(J+1,1) ) ) 9980, 1855, 1856                       07MR8
 1855 PRINT 801                                                         05MR8
          GO TO 9970                                                    05MR8
C-----INTERCHANGE ROWS OF THE MATRIX                                    05MR8
 1856     DO 1857  N = 1, 4                                             05MR8
               TEMP = B(J+1,N)                                          07MR8
               B(J+1,N) = A(J+1,N+3)                                    07MR8
               A(J+1,N+3) = TEMP                                        07MR8
 1857     CONTINUE                                                      05MR8
               TEMP = B(J+1,7)                                          07MR8
               B(J+1,7) = A(J+1,8)                                      07MR8
               A(J+1,8) = TEMP                                          07MR8
C-----ELIMINATE ALL TERMS BELOW A(J+1,4)                                07MR8
 1860          CM = - B(J+1,1) / A(J+1,4)                               05MR8
          DO 1870  N = 1, 4                                             05MR8
               B(J+1,N) = B(J+1,N) + CM * A(J+1,N+3)                    05MR8
 1870     CONTINUE                                                      26AP7
               B(J+1,7) = B(J+1,7) + CM * A(J+1,8)                      05MR8
               CM = - A(J+2,2) / A(J+1,4)                               26AP7
          DO 1880  N = 2, 5                                             26AP7
               A(J+2,N) = A(J+2,N) + CM * A(J+1,N+2)                    19AP8
 1880     CONTINUE                                                      26AP7
               A(J+2,8) = A(J+2,8) + CM * A(J+1,8)                      19AP8
 1900     CONTINUE                                                      26AP7
C-----BEGIN BACK SUBSTITUTION                                           26AP7
          DO 2050  L = 2, MP3                                           06MR8
               J = M + 6 - L                                            06MR8
               W(J) = ( B(J,7) - B(J,6) * W(J+2) - B(J,5) * DELTA(J+2)  05MR8
```

```
     1                 - B(J,4) * W(J+1) - B(J,3) * DELTA(J+1) ) / B(J,2)05MR8
               DELTA(J) = ( A(J,8) - A(J,7) * W(J+1) - A(J,6) *         08AP8
     1                     DELTA(J+1) - A(J,5) * W(J) ) / A(J,4)        08AP8
 2050     CONTINUE                                                      26AP7
               W(2) = ( B(2,7) - B(2,6) * W(4) - B(2,5) * DELTA(4)      06MR8
     1                 - B(2,4) * W(3) - B(2,3) * DELTA(3) ) / B(2,2)   06MR8
               W(1) = 2.0 * W(2) - W(3) - DELTA(3)                      06MR8
               W(MP5) = 2.0 * W(MP4) - W(MP3) + DELTA(MP4)              06MR8
C-----COMPUTE AND PRINT RESULTS                                         26AP7
          DO 2070  J = 2, MP4                                           06MR8
               BM(J) = F(J) * ( W(J-1) - 2.0 * W(J) + W(J+1) - DELTA(J) 26AP7
     1                  + DELTA(J+1) ) * ODHE2                          09AP8
               V(J) = SK(J) * DELTA(J)                                  26AP7
               DW(J) = ( W(J) - W(J-1) + DELTA(J) ) * ODH               09AP8
 2070     CONTINUE                                                      26AP7
      PRINT 11                                                          26AP7
      PRINT 13, ( AN1(N), N = 1, 32 )                                   28AP7
      PRINT 16, NPROB, ( AN2(N), N = 1, 14 )                            26AP7
      PRINT 991                                                         26AP7
          DO 2100  J = 2, MP4                                           06MR8
          IF ( KEY(J) - 1 ) 9980, 2080, 2075                            28FE8
 2075          REACT(J) = V(J+1) - V(J) - Q(J)                          26DE7
          GO TO 2082                                                    28FE8
 2080          REACT(J) = S(J) * W(J)                                   28FE8
 2082          ISTA = J - 3                                             10MR8
               ZI(J) = ISTA                                             28FE8
          IF ( J - 3 ) 2085, 2084, 2084                                 10MR8
 2084 PRINT 992, DELTA(J), DW(J), V(J)                                  26AP7
 2085 PRINT 993, ISTA, W(J), BM(J), REACT(J)                            26AP7
 2100     CONTINUE                                                      26AP7
C-----BEGIN AUTOMATIC PLOT ROUTINE                                      16MR4
      PRINT 805                                                         28FE8
          IF ( KPLOT )  9980, 8300, 8310                                19JE4
 8300 PRINT 903                                                         23MR4
          GO TO 8700                                                    23MR4
C-----DETERMINE STATION NUMBER AT END OF STATION AXES                   19JE4
 8310          KSTOP = 1                                                19JE4
          IF ( M - 200 ) 8320, 8350, 8340                               19JE4
 8320     IF ( M - 100 ) 8330, 8360, 8350                               25FE4
 8330     IF ( M - 50 ) 8370, 8370, 8360                                25FE4
 8340          VEND = -500.0                                            01JE4
          GO TO 8400                                                    25FE4
 8350          VEND = -200.0                                            01JE4
          GO TO 8400                                                    25FE4
 8360          VEND = -100.0                                            01JE4
          GO TO 8400                                                    25FE4
 8370          VEND = -50.0                                             01JE4
C-----SET PLOT ARRAY EQUAL TO W, DELTA, DW, M, V, SUP REACT             28FE8
 8400     DO 8650   N = 1, 6                                            14MR8
          GO TO ( 8410, 8420, 8430, 8440, 8450, 8456 ), N               28FE8
 8410     DO 8415  J = 3, MP3                                           06MR8
               HPLOT(J-2) = W(J)                                        09MR8
               VPLOT(J-2) = -ZI(J)                                      10MR8
 8415     CONTINUE                                                      25FE4
               NT = 1                                                   14MR8
```

```
               SPACE = 2.0                                              12JA8
          GO TO 8465                                                    16MR4
 8420     DO 8425  J = 3, MP3                                           06MR8
               HPLOT(J-2) = DELTA(J)                                    09MR8
 8425     CONTINUE                                                      25FE4
               NT = 1                                                   14MR8
          GO TO 8460                                                    25FE4
 8430     DO 8435  J = 3, MP3                                           06MR8
               HPLOT(J-2) = DW(J)                                       09MR8
 8435     CONTINUE                                                      25FE4
               NT = 2                                                   14MR8
          GO TO 8460                                                    25FE4
 8440     DO 8445  J = 3, MP3                                           06MR8
               HPLOT(J-2) = BM(J)                                       09MR8
 8445     CONTINUE                                                      25FE4
               NT = 1                                                   14MR8
          GO TO 8460                                                    25FE4
 8450     DO 8455  J = 3, MP3                                           06MR8
               HPLOT(J-2) = V(J)                                        09MR8
 8455     CONTINUE                                                      25FE4
               NT = 1                                                   14MR8
          GO TO 8460                                                    28FE8
 8456     DO 8458  J = 3, MP3                                           06MR8
               HPLOT(J-2) = REACT(J)                                    09MR8
 8458     CONTINUE                                                      28FE8
 8460          SPACE = SPACE + 1.5                                      23MR4
 8465          HMAX = 0.0                                               01JE4
C-----DETERMINE LARGEST VALUE IN NEXT ARRAY TO BE PLOTTED               16MR4
          DO 8470  J = 3, MP3                                           06MR8
               ZTMP = ABSF( HPLOT(J-2) )                                09MR8
               HMAX = MAX1F( ZTMP, HMAX )                               01JE4
 8470     CONTINUE                                                      25FE4
C-----DETERMINE EXPONENT OF MAX VALUE OF FUNCTION AND SET H-AXIS SCALE  23JE4
               KEXP = 0                                                 01JE4
          IF ( HMAX - 1.0E-10 ) 8570, 8570, 8500                        06MR8
 8500     DO 8530  L = 1, 100                                           25JE4ARB
          IF ( 1.0 - HMAX )  8505, 8570, 8510                           01JE4
 8505          HMAX = HMAX / 10.0                                       01JE4
               KEXP = KEXP + 1                                          01JE4
          GO TO 8530                                                    18MR4
 8510     IF ( 0.1 - HMAX )  8540, 8560, 8520                           01JE4
 8520          HMAX = HMAX * 10.0                                       01JE4
               KEXP = KEXP - 1                                          01JE4
 8530     CONTINUE                                                      18MR4
          GO TO 9980                                                    19JE4
 8540     IF ( 0.2 - HMAX )  8550, 8580, 8580                           01JE4
 8550     IF ( 0.5 - HMAX )  8570, 8590, 8590                           01JE4
 8560          HEND = 0.1                                               01JE4
          GO TO 8595                                                    18MR4
 8570          HEND = 1.0                                               01JE4
          GO TO 8595                                                    18MR4
 8580          HEND = 0.2                                               01JE4
          GO TO 8595                                                    18MR4
 8590          HEND = 0.5                                               01JE4
C-----SET PLOT VARIABLE VALUE AT END OF VARIABLE AXES                   01JE4
```

```
 8595           HEND = HEND * 10.0**KEXP                                    01JE4
                HAXIS(N) = HEND                                             19JE4
C-----SET REMAINING AXES AND PLOT ARGUMENTS                                 23JE4
                VPOS  = 0.0                                                 19JE4
                VNEG  = 5.0 * KPLOT                                         19JE4
                HTCKS = HEND                                                19JE4
                VTCKS = -VEND                                               30JE4
                NUMPTS = MP1                                                19JE4
                KPS = 1                                                     19JE4
           IF ( KPLOT - 2 )  8596, 8597, 8596                               19JE4
C-----DRAW AXES AND  PLOT FOR KPLOT = 1 AND 3                               23JE4
 8596           HPOS = 0.5                                                  19JE4
                HNEG = 0.5                                                  19JE4
                KAXES = 0                                                   19JE4
      CALL AXES ( HEND, HPOS, HNEG, SPACE, VEND, VPOS, VNEG, HTCKS,         19JE4
     1             VTCKS, KAXES )                                           19JE4
      CALL PLOT ( HPLOT, VPLOT, NUMPTS, KPS )                               19JE4
C-----SET PEN FOR NEXT PLOT                                                 19JE4
                HPLTTMP = 0.0                                               24JL4
                VPLTTMP = VEND                                              24JL4
                NUMPTS = 1                                                  19JE4
                KPS = 8                                                     19JE4
      CALL PLOT  ( HPLTTMP, VPLTTMP, NUMPTS, KPS )                          24JL4
          GO TO 8650                                                        02AP8
C-----DRAW AXES AND PLOT FOR KPLOT = 2                                      23JE4
 8597           HPOS = 1.0                                                  19JE4
                HNEG = 1.0                                                  19JE4
                SPACE = 0.75                                                19JE4
                KAXES = 1                                                   19JE4
           IF (NT - 2)  8599, 8598, 8599                                    14MR8
 8598           VINCH = 4.0                                                 15MR8
          GO TO 8600                                                        14MR8
 8599           VINCH = 0.5                                                 15MR8
 8600 CALL AXES ( HEND, HPOS, HNEG, SPACE, VEND, VPOS, VNEG, HTCKS,         19JE4
     1             VTCKS, KAXES )                                           01JE4
      CALL PLOT ( HPLOT, VPLOT, NUMPTS, KPS )                               01JE4
C-----SET PEN FOR NEXT PLOT                                                 23JE4
      CALL AXTERM ( 1 )                                                     21JL7
                INCH = 0                                                    06JL4
                INCV = ( -4.0 + VINCH ) * 100.0                             06JL4
                KPS = 8                                                     06JL4
      CALL STRPLOT ( INCH, INCV, KPS )                                      06JL4
 8650      CONTINUE                                                         14MR8
C-----PRINT PLOT SCALES AND ROLL PAPER FOR NEXT PROBLEM                     01JE4
                MAXSTA = -VEND                                              01JE4
                VAXIS = -VEND * H                                           19JE4
      PRINT 810, MAXSTA, VAXIS, ( HAXIS(N), N = 1, 6 )                      28FE8
      CALL AXTERM ( 1 )                                                     21JL7
 8700      CONTINUE                                                         23MR4
 9970 CALL TIC TOC(4)                                                       26AP7
C-----RETURN FOR NEW PROBLEM                                                26AP7
          GO TO 1010                                                        26AP7
 9980 PRINT 980                                                             26AP7
 9990    CONTINUE                                                           28AP7
          IF ( KSTOP )  9995, 9995, 9992                                    19JE4
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```
 9992 CALL AXTERM ( 0 )                                                   21JL7
 9995     CONTINUE                                                        26AP7
 9999     CONTINUE                                                        26AP7
      PRINT 11                                                            26AP7
      PRINT 1                                                             26AP7
      PRINT 13, ( AN1(N), N = 1, 32 )                                     26AP7
      PRINT 19                                                            26AP7
      END                                                                 26AP7
```

```
      SUBROUTINE INTERP4 ( MP5, NCT, JN1, JN2, KR2, ZN, Z, LSM )         06MR8
      DIMENSION JN1(100), JN2(100), KR2(100), ZN(100), Z(205)           06MR8
  905 FORMAT ( //40H     ERROR STOP -- STATIONS NOT IN ORDER )           14MY5
  908 FORMAT ( //43H    UNDESIGNATED ERROR STOP IN SUBROUTINE   )        14MY5
          DO 1603  J = 1, MP5                                            06MR8
               Z(J) = 0.0                                                28FE8
 1603     CONTINUE                                                       28FE8
               KR1 = 0                                                   12JA5
          IF( 1      .GT.NCT     ) GO TO 1676                            01SE66
          DO 1675  NC = 1, NCT                                           26MR5
          IF ( KR1 ) 1698, 1605, 1610                                    02JL6
 1605          NC1 = NC                                                  12JA5
               JV = JN1(NC1)                                             28JE6
               KSM = 0                                                   28JE6
          IF ( KR2(NC) ) 1698, 1610, 1670                                02JL6
 1610          J1 = JV + 3                                               06MR8
               J2 = JN2(NC) + 3                                          06MR8
               JS = J1 + KSM                                             02JL6
               DENOM = J2 - J1                                           28JE6
               JINCR = 1                                                 28JE6
               ESM = 1.0                                                 28JE6
               ISW = 1 - LSM                                             28JE6
          IF ( DENOM ) 1695, 1620, 1630                                  12JA5
 1620          DENOM = 1.0                                               12JA5
               ISW = 0                                                   12JA5
 1630     DO 1650  J = JS, J2, JINCR                                     28JE6
               DIFF = J - J1                                             28JE6
               PART = DIFF / DENOM                                       02JL6
               Z(J) = Z(J) + ( ZN(NC1) + PART * ( ZN(NC) - ZN(NC1) ) )  28JE6
     1               * ESM                                               28JE6
 1650     CONTINUE                                                       12JA5
               KSM = LSM                                                 28JE6
          IF ( ISW ) 1698, 1660, 1655                                    28JE6
 1655          JINCR = J2 - J1                                           12JA5
               ESM = -0.5                                                12JA5
               ISW = 0                                                   12JA5
          GO TO 1630                                                     12JA5
 1660     IF ( KR2(NC) ) 1698, 1670, 1665                                12JA5
 1665          JV = JN2(NC)                                              28JE6
 1670          KR1 = KR2(NC)                                             12JA5
               NC1 = NC                                                  12JA5
 1675     CONTINUE                                                       12JA5
 1676 RETURN                                                             14MY5
 1677 STOP 1677                                                          26OC4
 1695 PRINT 905                                                          14MY5
          GO TO 1677                                                     12JA5
 1698 PRINT 908                                                          14MY5
          GO TO 1677                                                     12JA5
      END                                                                04MA3 ID
```

```
      SUBROUTINE TIC TOC (J)                                            240C66
   10 FORMAT(///30X19HELAPSED CPU TIME = I5,8H MINUTESF9.3,8H SECONDS ) 25SE66
   11 FORMAT(///30X15HCOMPILE TIME = ,I5,8H MINUTES,F9.3,8H SECONDS   ) 25SE66
   12 FORMAT(///30X24HTIME FOR THIS PROBLEM = ,I5,8H MINUTES,F9.3,      25SE66
     1       8H SECONDS  )                                              25SE66
               I = J - 2                                                240C66
          IF( I-1 ) 40,30,30                                            25SE66
   30          FI4 = F                                                  25SE66
   40 CALL SECOND (F)                                                   25SE66
               II1 = F                                                  25SE66
               I1 = II1 / 60                                            25SE66
               FI2 =  F - I1*60                                         25SE66
          IF( I ) 50,70,60                                              25SE66
   50 PRINT 11, I1,FI2                                                  25SE66
          GO TO 990                                                     25SE66
   60          FI3 = F - FI4                                            25SE66
               I2 = FI3 / 60                                            25SE66
               FI3 = FI3 - I2*60                                        25SE66
      PRINT 12, I2, FI3                                                 25SE66
          IF( I-1 ) 990,990,70                                          25SE66
   70 PRINT 10, I1,FI2                                                  25SE66
  990 CONTINUE                                                          25SE66
      RETURN                                                            25SE66
      END                                                               25SE66
                                                                        28FE8
```

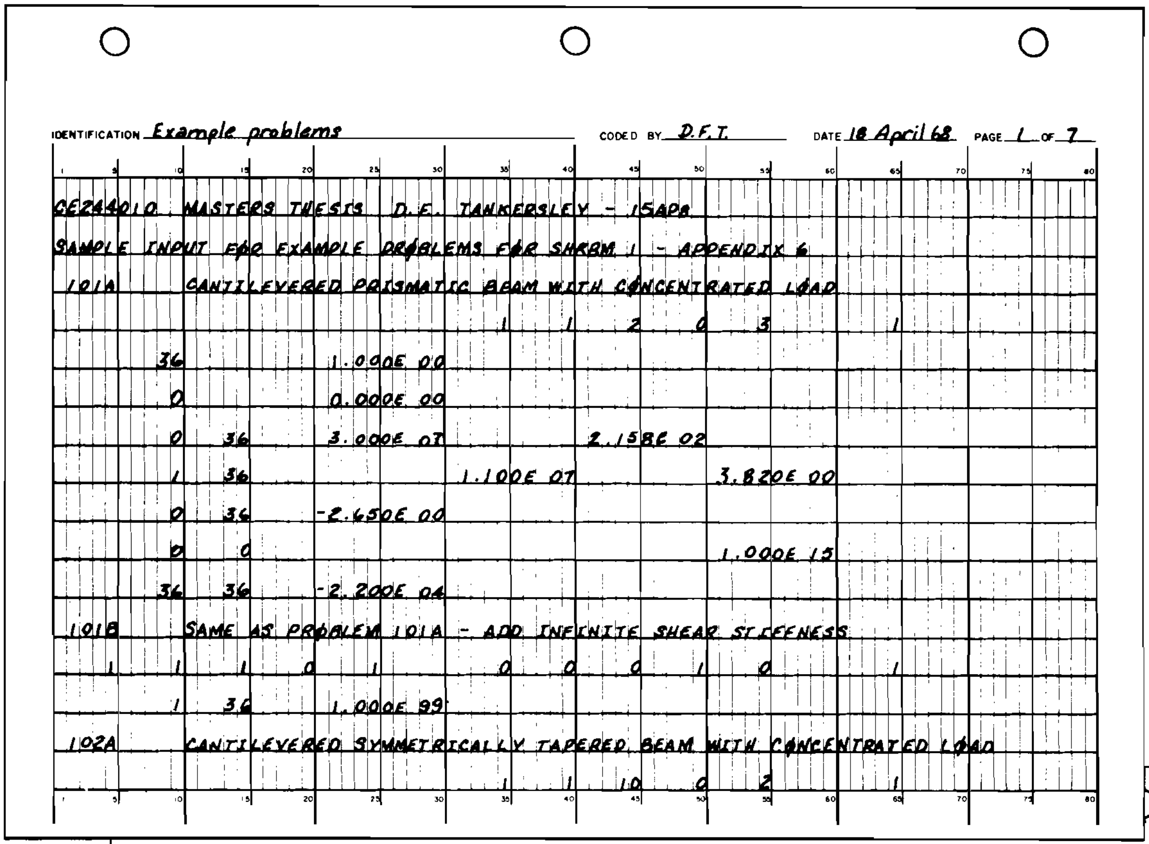
APPENDIX 5

DATA LISTING AND CODING FORMS FOR EXAMPLE PROBLEMS

```
SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1  -  APPENDIX 6
 101A     CANTILEVERED PRISMATIC BEAM WITH CONCENTRATED LOAD
                                  1    1    2    0    3         1
        36          1.000E 00
         0          0.000E 00
         0   36     3.000E 07           2.158E 02
         1   36                1.100E 07          3.820E 00
         0   36    -2.650E 00
         0    0                                   1.000E 15
        36   36    -2.200E 04
 101B     SAME AS PROBLEM 101A - ADD INFINITE SHEAR STIFFNESS
    1    1    1    0    1         0    0    0    1    0         1
         1   36     1.000E 99
 102A     CANTILEVERED SYMMETRICALLY TAPERED BEAM WITH CONCENTRATED LOAD
                                  1    1   10    0    2         1
        36          1.000E 00
         0          0.000E 00
         0   36     3.000E 06
         1         1           1.270E 06          7.200E 01
             36                1.270E 06          3.600E 01
         0         1                    8.640E 02
             6     1                    6.660E 02
            12     1                    5.000E 02
            18     1                    3.640E 02
            24     1                    2.560E 02
            30     1                    1.720E 02
            36                          1.080E 02
        36   36    -7.000E 03
         0    0                                   1.000E 15
 102B     SAME AS PROBLEM 102A - ADD INFINITE SHEAR STIFFNESS
    1    1    1    0    1         0    0    0    1    0         1
         1   36     1.000E 99
 102C     SAME AS PROBLEM 102A WITH MODIFIED SHEAR AREA FOR K = 1.2
    1    1    1    0    1         0    0    2    0    0         1
         1         1                             -1.200E 01
            36     0                             -0.600E 01
```

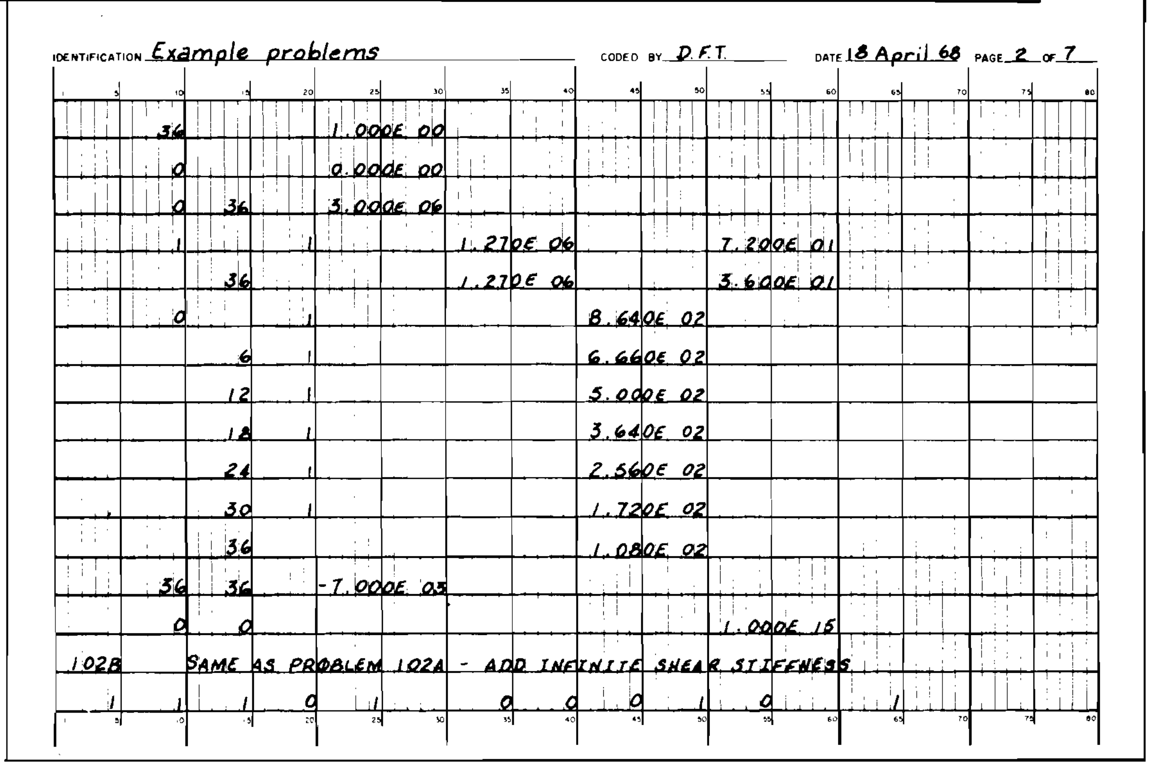
```
201A     STEEL BRIDGE DIAPHRAGMS WITH WHEEL LOAD ON OUTSIDE BEAM
                                 1    0    2    0    8         1
       96           3.000E 00
        0   96      3.000E 07           3.126E 02
        1   96                1.100E 07           7.820E 00
        0    0                9.700E 05           1.840E 05
       24   24                9.700E 05           1.840E 05
       48   48                9.700E 05           1.840E 05
       72   72                9.700E 05           1.840E 05
       96   96                9.700E 05           1.840E 05
        0   96     -8.480E 00
       72   72     -2.080E 04
       96   96     -2.080E 04
201B     SAME AS PROBLEM 201A - ADD INFINITE SHEAR STIFFNESS
   1    0    1    0    1         0    0    0    1    0         1
        1   96      1.000E 99
202A     STEEL BRIDGE DIAPHRAGMS WITH WHEEL LOAD ON INTERIOR BEAMS
   1    0    1    0    1         0    0    0    0    2         1
       96   96      2.080E 04
       48   48     -2.080E 04
202B     SAME AS PROBLEM 202A - ADD INFINITE SHEAR STIFFNESS
   1    0    1    0    1         0    0    0    1    0         1
        1   96      1.000E 99
203A     STEEL BRIDGE DIAPHRAGMS WITH WHEEL LOAD AT CENTER OF DIAPHRAGM
   1    0    1    0    1         0    0    0    0    4         1
       48   48      2.080E 04
       72   72      2.080E 04
       36   36     -2.080E 04
       60   60     -2.080E 04
203B     SAME AS PROBLEM 203A - ADD INFINITE SHEAR STIFFNESS
   1    0    1    0    1         0    0    0    1    0         1
        1   96      1.000E 99
```

```
301A     TAPERED THREE-SPAN OVERHANGING BEAM WITH 300 LB LOAD AT STA 0
                                 1    2   22    0    1         1
       96           1.000E 00
       60           0.000E 00
       36           0.000E 00
        0   96    0 1.000E 07
        1   96    0           4.000E 06
        0    0    0                     5.546E-01
        1         1                     7.421E-01 7.200E-02
             3    1                     1.193E 00 8.740E-02
             6    1                     2.034E 00 1.090E-01
            10    1                     3.395E 00 1.360E-01
            14    1                     4.937E 00 1.600E-01
            18    1                     6.566E 00 1.810E-01
            23    1                     8.592E 00 2.040E-01
            28    1                     1.047E 01 2.220E-01
            35    1                     1.260E 01 2.420E-01
            48    1                     1.429E 01 2.560E-01
            61    1                     1.260E 01 2.420E-01
            68    1                     1.047E 01 2.220E-01
            73    1                     8.592E 00 2.040E-01
            78    1                     6.566E 00 1.810E-01
            82    1                     4.937E 00 1.600E-01
            86    1                     3.395E 00 1.360E-01
            90    1                     2.034E 00 1.090E-01
            93    1                     1.193E 00 8.740E-02
            96                          5.546E-01 6.440E-02
        0    0       3.000E 02
301B     SAME AS PROBLEM 301A - ADD INFINITE SHEAR STIFFNESS
   1    1    1    0    1         0    0    0    1    0         1
        1   96       1.000E 99
302A     TAPERED THREE-SPAN OVERHANGING BEAM WITH 500 LB LOAD AT STA 0
   1    1    1    0    0         0    0    0    0    1         1
        0    0       5.000E 02
302B     SAME AS PROBLEM 302A - ADD INFINITE SHEAR STIFFNESS
   1    1    1    0    1         0    0    0    1    0         1
        1   96       1.000E 99
303A     TAPERED THREE-SPAN OVERHANGING BEAM WITH 700 LB LOAD AT STA 0
   1    1    1    0    0         0    0    0    0    1         1
        0    0       7.000E 02
303B     SAME AS PROBLEM 303A - ADD INFINITE SHEAR STIFFNESS
   1    1    1    0    1         0    0    0    1    0         1
        1   96       1.000E 99
```



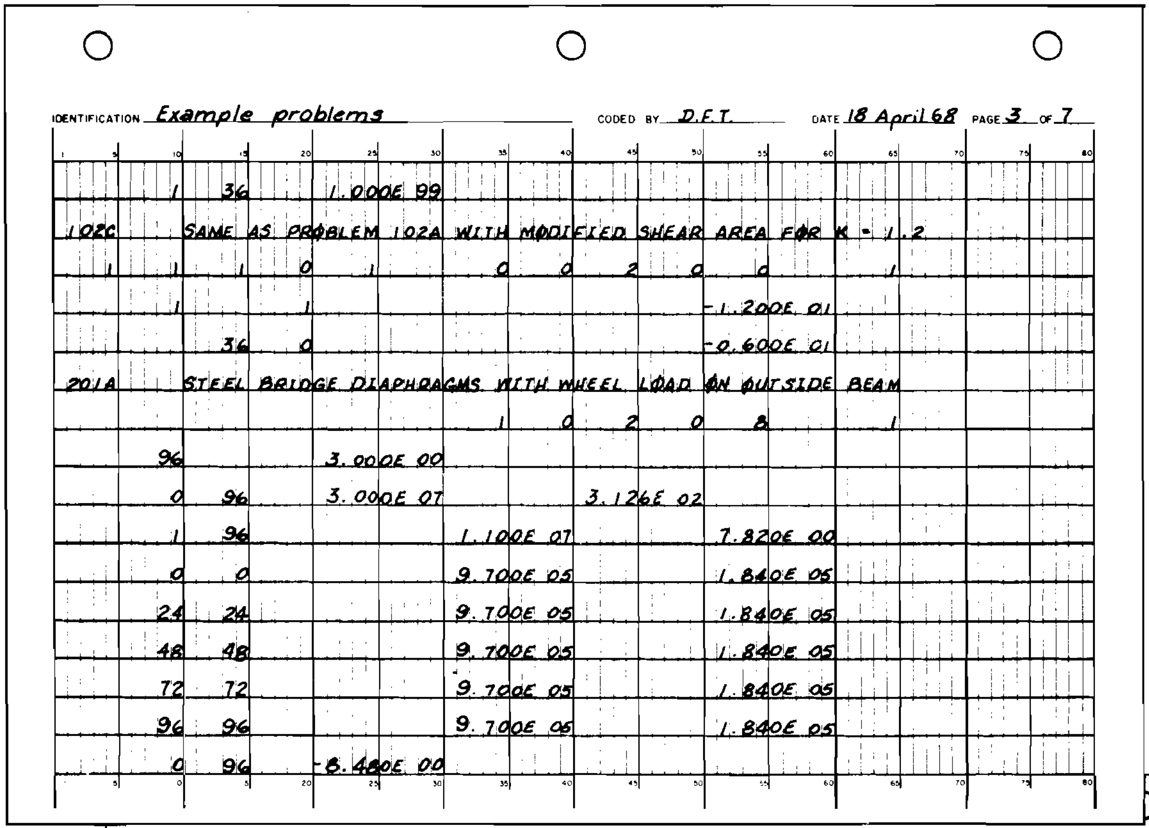
IDENTIFICATION Example problems CODED BY D.F.T. DATE 18 April 68 PAGE 1 OF 7

```
CE244010  MASTERS THESIS  D.F.  TANKERSLEY - 15APR
SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1 - APPENDIX 6
 101A     CANTILEVERED PRISMATIC BEAM WITH CONCENTRATED LOAD
                                  1    1    2    0    3         1
        36           1.000E 00
         0           0.000E 00
         0   36      3.000E 07           2.158E 02
         1   36                1.100E 07           3.820E 00
         0   36     -2.650E 00
         0    0                                    1.000E 15
        36   36     -2.200E 04
 101B     SAME AS PROBLEM 101A - ADD INFINITE SHEAR STIFFNESS
    1    1    1    0    1         0    0    0    1    0         1
         1   36      1.000E 99
 102A     CANTILEVERED SYMMETRICALLY TAPERED BEAM WITH CONCENTRATED LOAD
                                  1    1   10    0    2         1
```



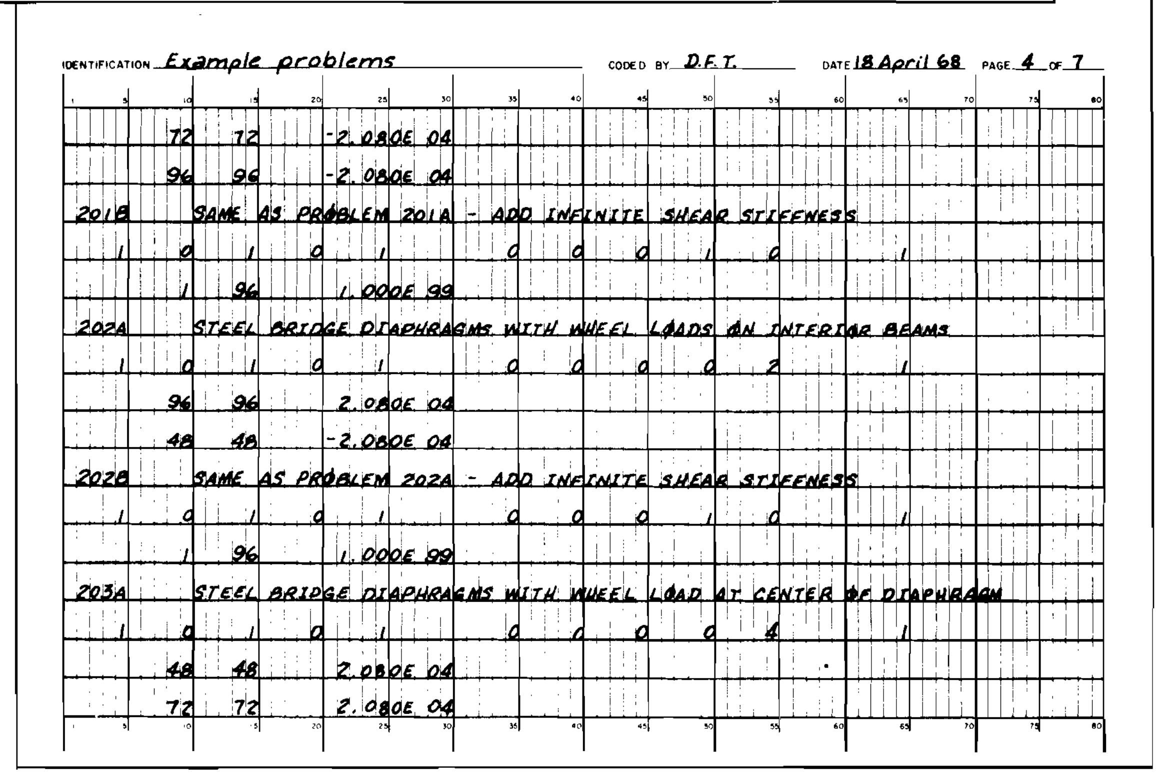
IDENTIFICATION Example problems CODED BY D.F.T. DATE 18 April 68 PAGE 2 OF 7

```
        36           1.000E 00
         0           0.000E 00
         0   36      3.000E 06
         1         1           1.270E 06           7.200E 01
            36                 1.270E 06           3.600E 01
         0         1                     8.640E 02
              6    1                     6.660E 02
             12    1                     5.000E 02
             18    1                     3.640E 02
             24    1                     2.560E 02
             30    1                     1.720E 02
             36                          1.080E 02
        36   36     -7.000E 05
         0    0                                    1.000E 15
 102B     SAME AS PROBLEM 102A - ADD INFINITE SHEAR STIFFNESS
    1    1    1    0    1         0    0    0    1    0         1
```



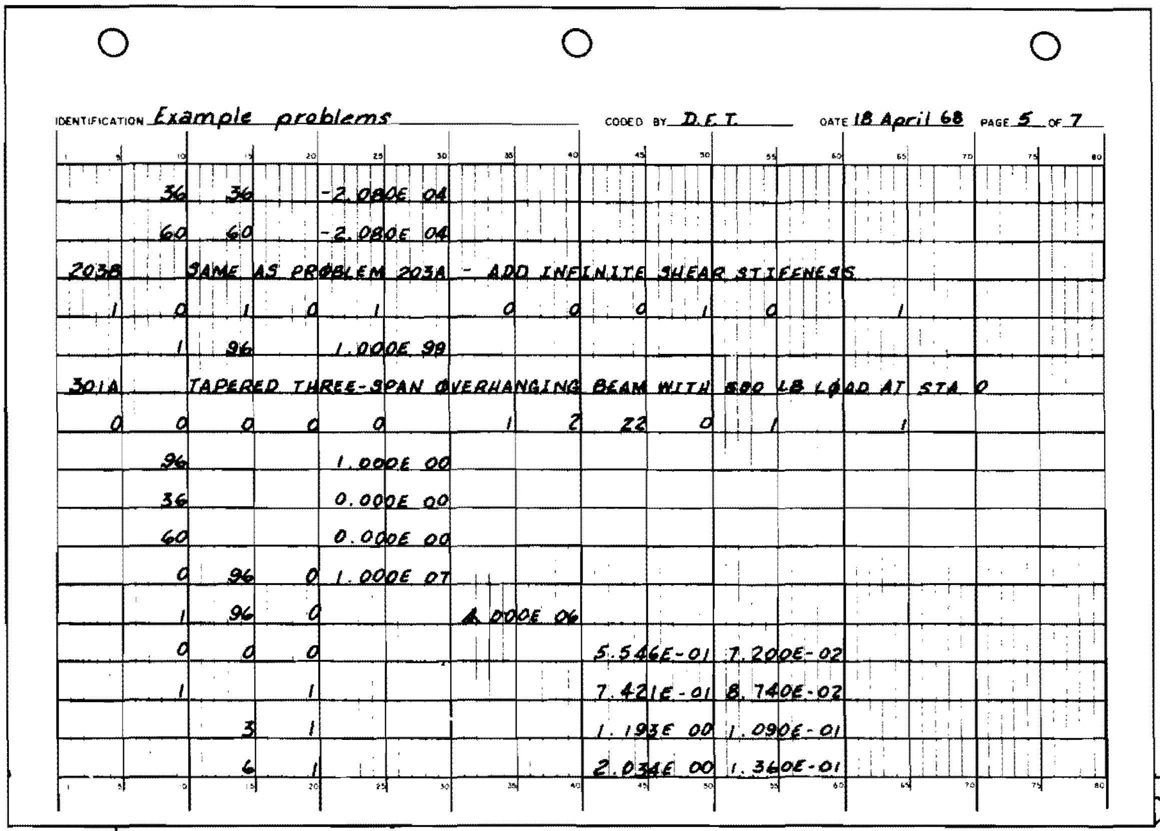
IDENTIFICATION *Example problems* CODED BY *D.F.T.* DATE *18 April 68* PAGE *3* OF *7*

```
         1   36      1.000E 99
 102C     SAME AS PROBLEM 102A WITH MODIFIED SHEAR AREA FOR K = 1.2
    1    1    1    0    1         0    0    2    0    0         1
         1         1                              -1.200E 01
             36    0                              -0.600E 01
 201A     STEEL BRIDGE DIAPHRAGMS WITH WHEEL LOAD ON OUTSIDE BEAM
                                  1    0    2    0    8         1
        96           3.000E 00
         0   96      3.000E 07           3.126E 02
         1   96                1.100E 07           7.820E 00
         0    0                9.700E 05           1.840E 05
        24   24                9.700E 05           1.840E 05
        48   48                9.700E 05           1.840E 05
        72   72                9.700E 05           1.840E 05
        96   96                9.700E 05           1.840E 05
         0   96     -8.480E 00
```



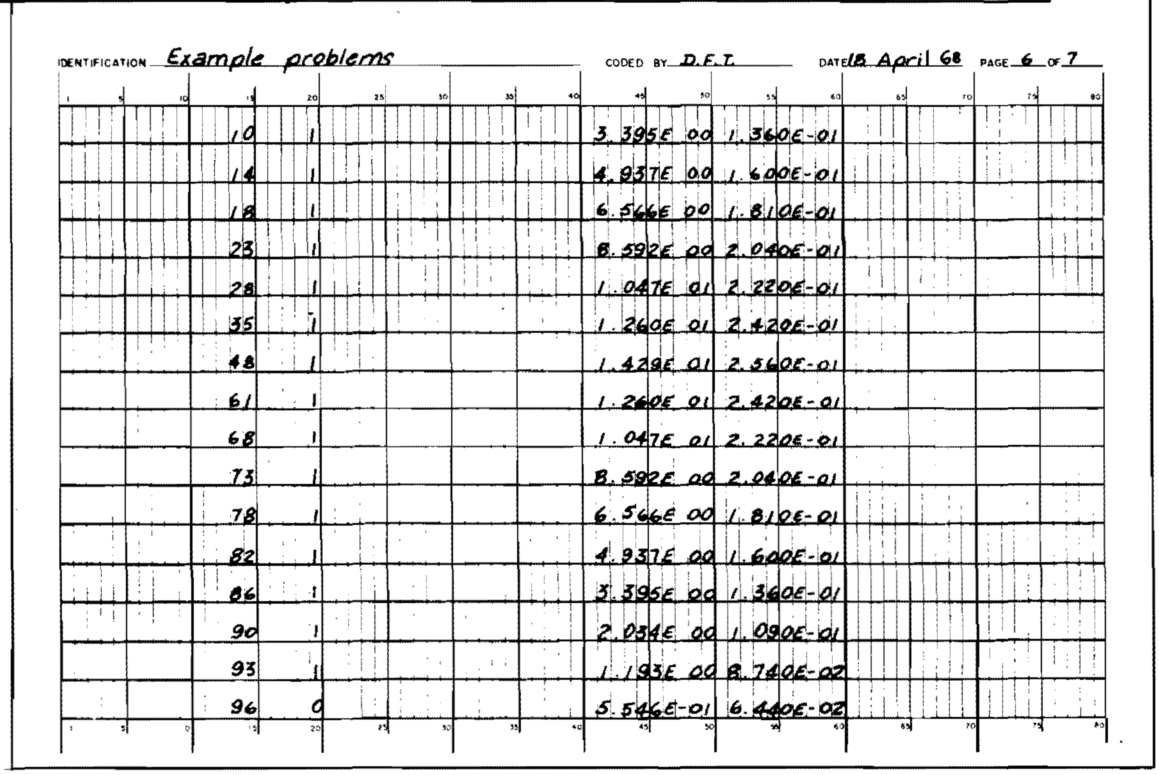
IDENTIFICATION *Example problems* CODED BY *D.F.T.* DATE *18 April 68* PAGE *4* OF *7*

```
        72   72     -2.080E 04
        96   96     -2.080E 04
 201B     SAME AS PROBLEM 201A - ADD INFINITE SHEAR STIFFNESS
    1    0    1    0    1         0    0    0    1    0         1
         1   96      1.000E 99
 202A     STEEL BRIDGE DIAPHRAGMS WITH WHEEL LOADS ON INTERIOR BEAMS
    1    0    1    0    1         0    0    0    0    2         1
        96   96      2.080E 04
        48   48     -2.080E 04
 202B     SAME AS PROBLEM 202A - ADD INFINITE SHEAR STIFFNESS
    1    0    1    0    1         0    0    0    1    0         1
         1   96      1.000E 99
 203A     STEEL BRIDGE DIAPHRAGMS WITH WHEEL LOAD AT CENTER OF DIAPHRAGM
    1    0    1    0    1         0    0    0    0    4         1
        48   48      2.080E 04
        72   72      2.080E 04
```



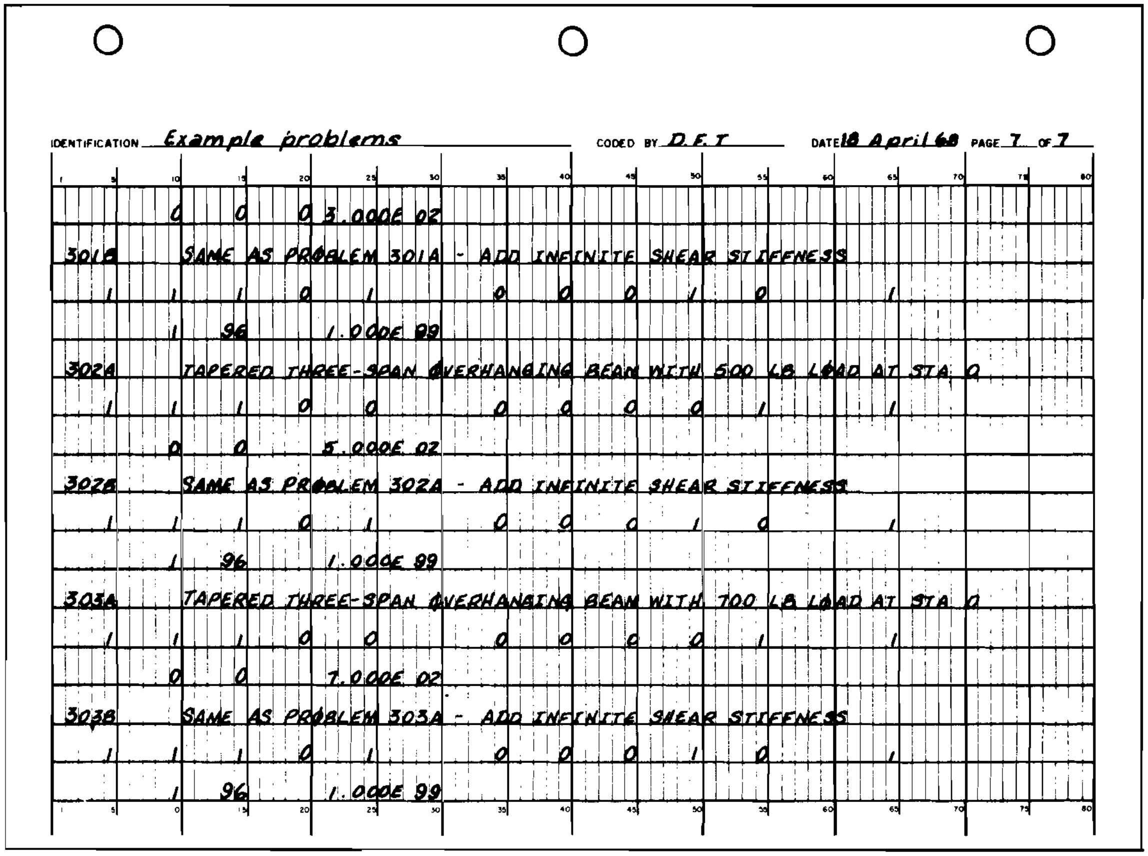
IDENTIFICATION Example problems CODED BY D.F.T. DATE 18 April 68 PAGE 5 OF 7

```
        36   36     -2.080E 04
        60   60     -2.080E 04
203B      SAME AS PROBLEM 203A - ADD INFINITE SHEAR STIFFNESS
    1    0    1    0    1         0    0    0    1    0         1
         1   96      1.000E 99
301A      TAPERED THREE-SPAN OVERHANGING BEAM WITH 800 LB LOAD AT STA 0
    0    0    0    0    0         1    2   22    0    1         1
        96           1.000E 00
        36           0.000E 00
        60           0.000E 00
         0   96    0 1.000E 07
         1   96    0           4.000E 06
         0    0    0                     5.546E-01 7.200E-02
         1         1                     7.421E-01 8.740E-02
              3    1                     1.193E 00 1.090E-01
              6    1                     2.034E 00 1.360E-01
```



IDENTIFICATION Example problems CODED BY D.F.T. DATE 18 April 68 PAGE 6 OF 7

```
             10    1                     3.395E 00 1.360E-01
             14    1                     4.937E 00 1.600E-01
             18    1                     6.566E 00 1.810E-01
             23    1                     8.592E 00 2.040E-01
             28    1                     1.047E 01 2.220E-01
             35    1                     1.260E 01 2.420E-01
             48    1                     1.429E 01 2.560E-01
             61    1                     1.260E 01 2.420E-01
             68    1                     1.047E 01 2.220E-01
             73    1                     8.592E 00 2.040E-01
             78    1                     6.566E 00 1.810E-01
             82    1                     4.937E 00 1.600E-01
             86    1                     3.395E 00 1.360E-01
             90    1                     2.034E 00 1.090E-01
             93    1                     1.193E 00 8.740E-02
             96    0                     5.546E-01 6.440E-02
```



IDENTIFICATION Example problems CODED BY D.F.T DATE 18 April 68 PAGE 7 OF 7

```
         0    0    0 3.000E 02
301B      SAME AS PROBLEM 301A - ADD INFINITE SHEAR STIFFNESS
    1    1    1    0    1         0    0    0    1    0         1
         1   96      1.000E 99
302A      TAPERED THREE-SPAN OVERHANGING BEAM WITH 500 LB LOAD AT STA 0
    1    1    1    0    0         0    0    0    0    1         1
         0    0      5.000E 02
302B      SAME AS PROBLEM 302A - ADD INFINITE SHEAR STIFFNESS
    1    1    1    0    1         0    0    0    1    0         1
         1   96      1.000E 99
303A      TAPERED THREE-SPAN OVERHANGING BEAM WITH 700 LB LOAD AT STA 0
    1    1    1    0    0         0    0    0    0    1         1
         0    0      7.000E 02
303B      SAME AS PROBLEM 303A - ADD INFINITE SHEAR STIFFNESS
    1    1    1    0    1         0    0    0    1    0         1
         1   96      1.000E 99
```

APPENDIX 6

COMPUTER RESULTS FOR EXAMPLE PROBLEMS

```
SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1  -  APPENDIX 6


PROB
101A     CANTILEVERED PRISMATIC BEAM WITH CONCENTRATED LOAD


TABLE 1 - PROGRAM-CONTROL DATA
                                                          TABLES NUMBER
                                                      2     3     4A    4B    5

     PRIOR-DATA OPTIONS (1 = HOLD)                   -0    -0    -0    -0    -0
     NUM CARDS INPUT THIS PROBLEM                     1     1     2     0     3

     OPTION (IF=1, 2, 3) TO PLOT                      1


TABLE 2 - CONSTANTS

     NUM INCREMENTS                                                         36
     INCREMENT LENGTH                                                1.000E+00


TABLE 3 - SPECIFIED DEFLECTIONS

     STA         DEFLECTION

      0           0.


TABLE 4A - SECTION AND MATERIAL PROPERTIES

FROM TO CONTD      E           G           I           SA

     ADDITIONAL DATA INPUT FOR THIS PROBLEM
  0   36  -0    3.000E+07 -0.         2.158E+02 -0.
  1   36  -0   -0.         1.100E+07 -0.         3.820E+00


TABLE 4B - STIFFNESS DATA

FROM TO CONTD     SK          F


                  NONE


TABLE 5 - LOAD DATA

FROM TO CONTD      Q           S           T           R           P

     ADDITIONAL DATA INPUT FOR THIS PROBLEM
  0   36  -0   -2.650E+00 -0.         -0.         -0.         -0.
  0    0  -0   -0.         -0.         -0.          1.000E+15 -0.
 36   36  -0   -2.200E+04 -0.         -0.         -0.         -0.
```

PROB (CONTD)
101A CANTILEVERED PRISMATIC BEAM WITH CONCENTRATED LOAD

TABLE 6 - RESULTS

```
  STA      W        DELTA       SLOPE       MOM         SHEAR      SUP REACT

  -1  -6.130E-05                         0.                    0.
                  0.         6.130E-05              0.
   0   0.                               -3.969E+05             2.210E+04
                  5.258E-04 -6.130E-05              2.209E+04
   1  -5.871E-04                        -7.716E+05             0.
                  5.257E-04 -1.805E-04              2.209E+04
   2  -1.293E-03                        -7.495E+05             0.
                  5.257E-04 -2.963E-04              2.209E+04
   3  -2.115E-03                        -7.274E+05             0.
                  5.256E-04 -4.086E-04              2.209E+04
   4  -3.050E-03                        -7.054E+05             0.
                  5.255E-04 -5.176E-04              2.208E+04
   5  -4.093E-03                        -6.833E+05             0.
                  5.255E-04 -6.231E-04              2.208E+04
   6  -5.241E-03                        -6.612E+05             0.
                  5.254E-04 -7.253E-04              2.208E+04
   7  -6.492E-03                        -6.391E+05             0.
                  5.254E-04 -8.240E-04              2.208E+04
   8  -7.841E-03                        -6.170E+05             0.
                  5.253E-04 -9.193E-04              2.207E+04
   9  -9.286E-03                        -5.950E+05             0.
                  5.252E-04 -1.011E-03              2.207E+04
  10  -1.082E-02                        -5.729E+05             0.
                  5.252E-04 -1.100E-03              2.207E+04
  11  -1.245E-02                        -5.508E+05             0.
                  5.251E-04 -1.185E-03              2.206E+04
  12  -1.416E-02                        -5.288E+05             0.
                  5.250E-04 -1.266E-03              2.206E+04
  13  -1.595E-02                        -5.067E+05             0.
                  5.250E-04 -1.345E-03              2.206E+04
  14  -1.782E-02                        -4.846E+05             0.
                  5.249E-04 -1.420E-03              2.206E+04
  15  -1.976E-02                        -4.626E+05             0.
                  5.249E-04 -1.491E-03              2.205E+04
  16  -2.178E-02                        -4.405E+05             0.
                  5.248E-04 -1.559E-03              2.205E+04
  17  -2.386E-02                        -4.185E+05             0.
                  5.247E-04 -1.624E-03              2.205E+04
  18  -2.601E-02                        -3.964E+05             0.
                  5.247E-04 -1.685E-03              2.205E+04
  19  -2.822E-02                        -3.744E+05             0.
                  5.246E-04 -1.743E-03              2.204E+04
  20  -3.049E-02                        -3.523E+05             0.
                  5.245E-04 -1.797E-03              2.204E+04
  21  -3.281E-02                        -3.303E+05             0.
                  5.245E-04 -1.848E-03              2.204E+04
```

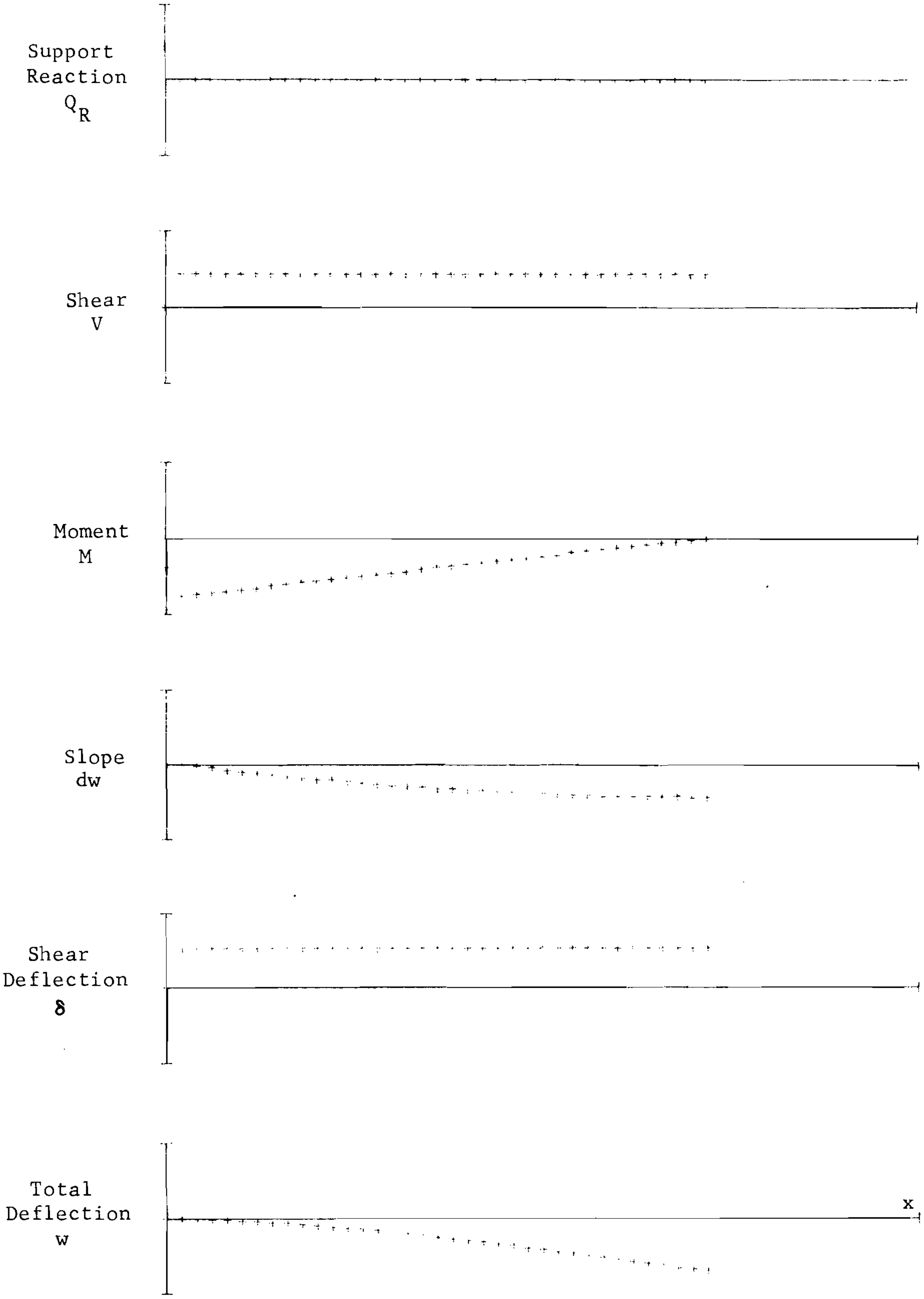
```
  22  -3.518E-02                       -3.083E+05             0.
                  5.244E-04 -1.896E-03             2.204E+04
  23  -3.760E-02                       -2.862E+05             0.
                  5.243E-04 -1.940E-03             2.203E+04
  24  -4.007E-02                       -2.642E+05             0.
                  5.243E-04 -1.981E-03             2.203E+04
  25  -4.257E-02                       -2.422E+05             0.
                  5.242E-04 -2.018E-03             2.203E+04
  26  -4.511E-02                       -2.201E+05             0.
                  5.242E-04 -2.052E-03             2.203E+04
  27  -4.769E-02                       -1.981E+05             0.
                  5.241E-04 -2.083E-03             2.202E+04
  28  -5.030E-02                       -1.761E+05             0.
                  5.240E-04 -2.110E-03             2.202E+04
  29  -5.293E-02                       -1.541E+05             0.
                  5.240E-04 -2.134E-03             2.202E+04
  30  -5.559E-02                       -1.320E+05             0.
                  5.239E-04 -2.154E-03             2.201E+04
  31  -5.827E-02                       -1.100E+05             0.
                  5.238E-04 -2.171E-03             2.201E+04
  32  -6.096E-02                       -8.802E+04             0.
                  5.238E-04 -2.185E-03             2.201E+04
  33  -6.367E-02                       -6.601E+04             0.
                  5.237E-04 -2.195E-03             2.201E+04
  34  -6.639E-02                       -4.401E+04             0.
                  5.237E-04 -2.202E-03             2.200E+04
  35  -6.912E-02                       -2.200E+04             0.
                  5.236E-04 -2.205E-03             2.200E+04
  36  -7.184E-02                       -6.264E-07             0.
                 -2.690E-18 -2.205E-03            -1.130E-10
  37  -7.405E-02                        0.                    0.

TABLE 7 -- SCALES FOR PLOT OUTPUT -- VALUES AT ENDS OF AXES

STA      X          W        DELTA       DW          M          V      SUP REACT
 50  5.000E+01  1.000E-01  1.000E-03  5.000E-03  1.000E+06  5.000E+04  5.000E+04


                         TIME FOR THIS PROBLEM =     0 MINUTES    2.696 SECONDS


                         ELAPSED CPU TIME =     0 MINUTES   10.586 SECONDS
```



Prob 101A. Cantilevered prismatic beam with concentrated load.

```
SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1  -  APPENDIX 6


PROB
101B      SAME AS PROBLEM 101A - ADD INFINITE SHEAR STIFFNESS


TABLE 1 - PROGRAM-CONTROL DATA
                                                               TABLES NUMBER
                                                          2    3    4A   4B   5

     PRIOR-DATA OPTIONS (1 = HOLD)                        1    1    1    0    1
     NUM CARDS INPUT THIS PROBLEM                         0    0    0    1    0

     OPTION (IF=1, 2, 3) TO PLOT                          1


TABLE 2 - CONSTANTS

     DATA HELD FROM THE PREVIOUS PROBLEM
     NUM INCREMENTS                                                          36
     INCREMENT LENGTH                                                 1.000E+00


TABLE 3 - SPECIFIED DEFLECTIONS

     STA        DEFLECTION

     DATA HELD FROM THE PREVIOUS PROBLEM
      0          0.


TABLE 4A - SECTION AND MATERIAL PROPERTIES

FROM TO CONTD      E          G           I          SA

     DATA HELD FROM THE PREVIOUS PROBLEM
  0  36  -0   3.000E+07 -0.        2.158E+02 -0.
  1  36  -0  -0.        1.100E+07 -0.        3.820E+00


TABLE 4B - STIFFNESS DATA

FROM TO CONTD     SK          F

     ADDITIONAL DATA INPUT FOR THIS PROBLEM
  1  36  -0   1.000E+99 -0.

TABLE 5 - LOAD DATA

FROM TO CONTD      Q          S           T          R          P

     DATA HELD FROM THE PREVIOUS PROBLEM
  0  36  -0  -2.650E+00 -0.        -0.        -0.        -0.
  0   0  -0  -0.        -0.        -0.         1.000E+15 -0.
 36  36  -0  -2.200E+04 -0.        -0.        -0.        -0.
```

```
SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1  -  APPENDIX 6


PROB (CONTD)
101B     SAME AS PROBLEM 101A - ADD INFINITE SHEAR STIFFNESS


TABLE 6 - RESULTS

 STA       W          DELTA       SLOPE        MOM         SHEAR     SUP REACT

  -1  -6.130E-05                              0.                      0.
                   0.          6.130E-05                 0.
   0   0.                                  -3.969E+05                 2.210E+04
                   2.209E-95 -6.130E-05                  2.209E+04
   1  -6.130E-05                           -7.716E+05                 0.
                   2.209E-95 -1.805E-04                  2.209E+04
   2  -2.418E-04                           -7.495E+05                 0.
                   2.209E-95 -2.963E-04                  2.209E+04
   3  -5.381E-04                           -7.274E+05                 0.
                   2.209E-95 -4.086E-04                  2.209E+04
   4  -9.467E-04                           -7.054E+05                 0.
                   2.208E-95 -5.176E-04                  2.208E+04
   5  -1.464E-03                           -6.833E+05                 0.
                   2.208E-95 -6.231E-04                  2.208E+04
   6  -2.087E-03                           -6.612E+05                 0.
                   2.208E-95 -7.253E-04                  2.208E+04
   7  -2.813E-03                           -6.391E+05                 0.
                   2.208E-95 -8.240E-04                  2.208E+04
   8  -3.637E-03                           -6.170E+05                 0.
                   2.207E-95 -9.193E-04                  2.207E+04
   9  -4.556E-03                           -5.950E+05                 0.
                   2.207E-95 -1.011E-03                  2.207E+04
  10  -5.567E-03                           -5.729E+05                 0.
                   2.207E-95 -1.100E-03                  2.207E+04
  11  -6.667E-03                           -5.508E+05                 0.
                   2.206E-95 -1.185E-03                  2.206E+04
  12  -7.852E-03                           -5.288E+05                 0.
                   2.206E-95 -1.266E-03                  2.206E+04
  13  -9.118E-03                           -5.067E+05                 0.
                   2.206E-95 -1.345E-03                  2.206E+04
  14  -1.046E-02                           -4.846E+05                 0.
                   2.206E-95 -1.420E-03                  2.206E+04
  15  -1.188E-02                           -4.626E+05                 0.
                   2.205E-95 -1.491E-03                  2.205E+04
  16  -1.337E-02                           -4.405E+05                 0.
                   2.205E-95 -1.559E-03                  2.205E+04
  17  -1.493E-02                           -4.185E+05                 0.
                   2.205E-95 -1.624E-03                  2.205E+04
  18  -1.656E-02                           -3.964E+05                 0.
                   2.205E-95 -1.685E-03                  2.205E+04
  19  -1.824E-02                           -3.744E+05                 0.
                   2.204E-95 -1.743E-03                  2.204E+04
  20  -1.998E-02                           -3.523E+05                 0.
                   2.204E-95 -1.797E-03                  2.204E+04
  21  -2.178E-02                           -3.303E+05                 0.
                   2.204E-95 -1.848E-03                  2.204E+04
```

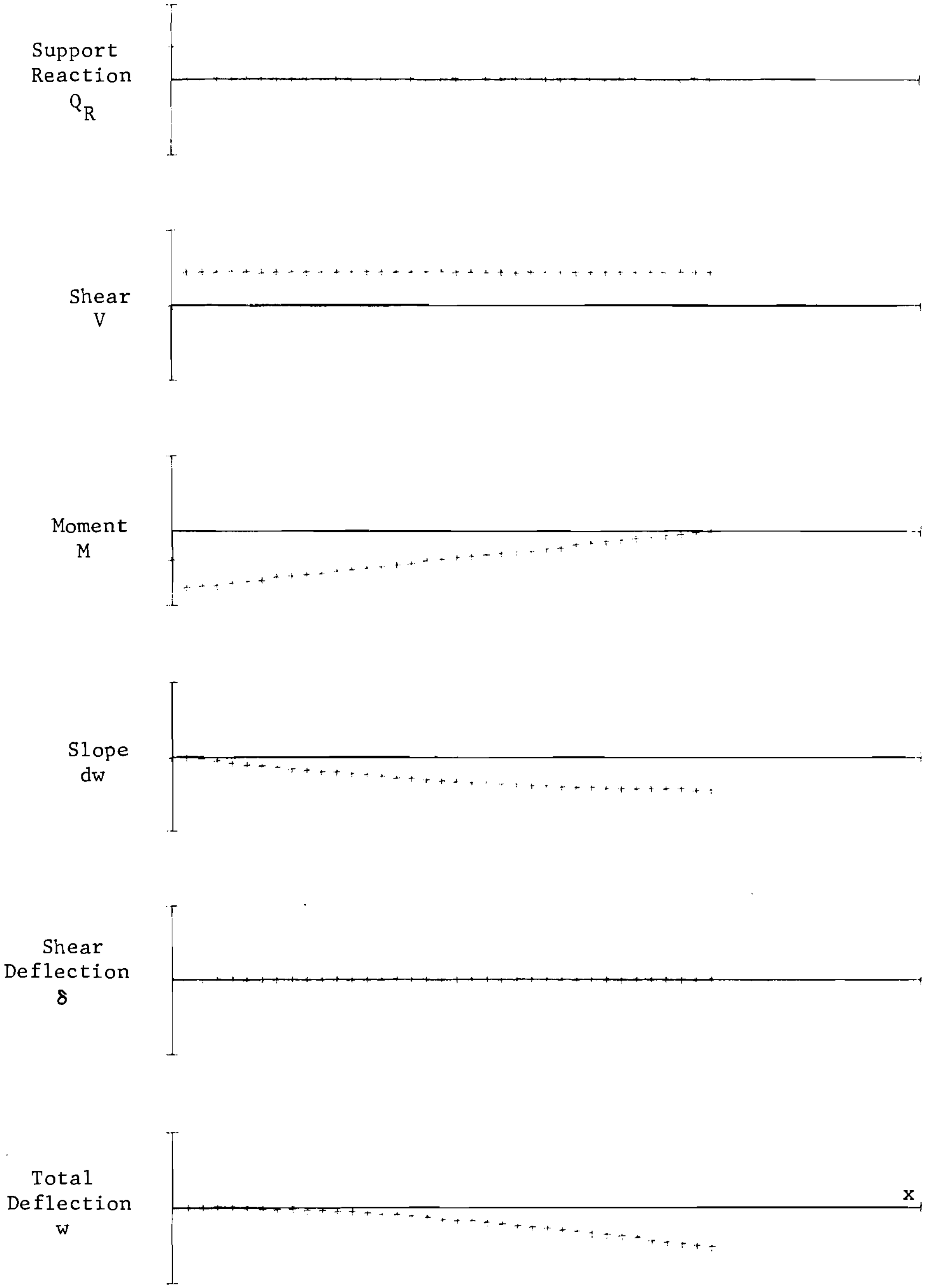
```
  22  -2.363E-02                   -3.083E+05           0.
                2.204E-95 -1.896E-03          2.204E+04
  23  -2.552E-02                   -2.862E+05           0.
                2.203E-95 -1.940E-03          2.203E+04
  24  -2.746E-02                   -2.642E+05           0.
                2.203E-95 -1.981E-03          2.203E+04
  25  -2.945E-02                   -2.422E+05           0.
                2.203E-95 -2.018E-03          2.203E+04
  26  -3.146E-02                   -2.201E+05           0.
                2.203E-95 -2.052E-03          2.203E+04
  27  -3.352E-02                   -1.981E+05           0.
                2.202E-95 -2.083E-03          2.202E+04
  28  -3.560E-02                   -1.761E+05           0.
                2.202E-95 -2.110E-03          2.202E+04
  29  -3.771E-02                   -1.541E+05           0.
                2.202E-95 -2.134E-03          2.202E+04
  30  -3.984E-02                   -1.320E+05           0.
                2.201E-95 -2.154E-03          2.201E+04
  31  -4.200E-02                   -1.100E+05           0.
                2.201E-95 -2.171E-03          2.201E+04
  32  -4.417E-02                   -8.802E+04           0.
                2.201E-95 -2.185E-03          2.201E+04
  33  -4.635E-02                   -6.601E+04           0.
                2.201E-95 -2.195E-03          2.201E+04
  34  -4.855E-02                   -4.401E+04           0.
                2.200E-95 -2.202E-03          2.200E+04
  35  -5.075E-02                   -2.200E+04           0.
                2.200E-95 -2.205E-03          2.200E+04
  36  -5.296E-02                   -7.122E-86           0.
               -7.559-110 -2.205E-03         -7.559E-11
  37  -5.516E-02                    0.                  0.

TABLE 7 -- SCALES FOR PLOT OUTPUT -- VALUES AT ENDS OF AXES

STA     X         W      DELTA       DW         M         V     SUP REACT
 50 5.000E+01 1.000E-01 1.000E+00 5.000E-03 1.000E+06 5.000E+04 5.000E+04


                       TIME FOR THIS PROBLEM =  0 MINUTES   2.282 SECONDS


                       ELAPSED CPU TIME =   0 MINUTES  12.868 SECONDS
```



Prob 101B. Same as Prob 101A, neglecting shear deformations.

```
SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1  -  APPENDIX 6


PROB
102A     CANTILEVERED SYMMETRICALLY TAPERED BEAM WITH CONCENTRATED LOAD


TABLE 1 - PROGRAM-CONTROL DATA
                                                             TABLES NUMBER
                                                          2    3    4A   4B    5

     PRIOR-DATA OPTIONS (1 = HOLD)                       -0   -0   -0   -0    -0
     NUM CARDS INPUT THIS PROBLEM                         1    1   10    0     2

     OPTION (IF=1, 2, 3) TO PLOT                          1


TABLE 2 - CONSTANTS

     NUM INCREMENTS                                                            36
     INCREMENT LENGTH                                                   1.000E+00


TABLE 3 - SPECIFIED DEFLECTIONS

     STA         DEFLECTION

      0            0.


TABLE 4A - SECTION AND MATERIAL PROPERTIES

FROM TO CONTD      E           G              I           SA

     ADDITIONAL DATA INPUT FOR THIS PROBLEM
  0  36  -0   3.000E+06 -0.         -0.          -0.
  1       1  -0.         1.270E+06 -0.           7.200E+01
     36  -0  -0.         1.270E+06 -0.           3.600E+01
  0       1  -0.        -0.          8.640E+02 -0.
      6   1  -0.        -0.          6.660E+02 -0.
     12   1  -0.        -0.          5.000E+02 -0.
     18   1  -0.        -0.          3.640E+02 -0.
     24   1  -0.        -0.          2.560E+02 -0.
     30   1  -0.        -0.          1.720E+02 -0.
     36  -0  -0.        -0.          1.080E+02 -0.


TABLE 4B - STIFFNESS DATA

FROM TO CONTD     SK          F


               NONE
```

```
TABLE 5 - LOAD DATA

FROM TO CONTD      Q             S             T             R             P

     ADDITIONAL DATA INPUT FOR THIS PROBLEM
 36   36   -0   -7.000E+03 -0.          -0.          -0.          -0.
  0    0   -0   -0.          -0.          -0.           1.000E+15 -0.
```

SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1 - APPENDIX 6

PROB (CONTD)
102A CANTILEVERED SYMMETRICALLY TAPERED BEAM WITH CONCENTRATED LOAD

```
TABLE 6 - RESULTS

  STA      W        DELTA      SLOPE       MOM       SHEAR    SUP REACT

  -1  -4.861E-05                        0.                    0.
                  0.         4.861E-05             0.
   0   0.                              -1.260E+05             7.000E+03
                  7.655E-05 -4.861E-05             7.000E+03
   1  -1.252E-04                       -2.450E+05             0.
                  7.766E-05 -1.469E-04             7.000E+03
   2  -3.497E-04                       -2.380E+05             0.
                  7.880E-05 -2.463E-04             7.000E+03
   3  -6.748E-04                       -2.310E+05             0.
                  7.998E-05 -3.470E-04             7.000E+03
   4  -1.102E-03                       -2.240E+05             0.
                  8.119E-05 -4.490E-04             7.000E+03
   5  -1.632E-03                       -2.170E+05             0.
                  8.244E-05 -5.524E-04             7.000E+03
   6  -2.267E-03                       -2.100E+05             0.
                  8.373E-05 -6.575E-04             7.000E+03
   7  -3.008E-03                       -2.030E+05             0.
                  8.506E-05 -7.636E-04             7.000E+03
   8  -3.857E-03                       -1.960E+05             0.
                  8.643E-05 -8.705E-04             7.000E+03
   9  -4.814E-03                       -1.890E+05             0.
                  8.785E-05 -9.786E-04             7.000E+03
  10  -5.880E-03                       -1.820E+05             0.
                  8.931E-05 -1.088E-03             7.000E+03
  11  -7.057E-03                       -1.750E+05             0.
                  9.083E-05 -1.198E-03             7.000E+03
  12  -8.346E-03                       -1.680E+05             0.
                  9.239E-05 -1.310E-03             7.000E+03
  13  -9.749E-03                       -1.610E+05             0.
                  9.401E-05 -1.423E-03             7.000E+03
  14  -1.127E-02                       -1.540E+05             0.
                  9.569E-05 -1.536E-03             7.000E+03
  15  -1.290E-02                       -1.470E+05             0.
                  9.743E-05 -1.649E-03             7.000E+03
  16  -1.464E-02                       -1.400E+05             0.
                  9.924E-05 -1.763E-03             7.000E+03
  17  -1.651E-02                       -1.330E+05             0.
                  1.011E-04 -1.878E-03             7.000E+03
  18  -1.849E-02                       -1.260E+05             0.
                  1.031E-04 -1.993E-03             7.000E+03
  19  -2.058E-02                       -1.190E+05             0.
                  1.051E-04 -2.108E-03             7.000E+03
  20  -2.279E-02                       -1.120E+05             0.
                  1.072E-04 -2.222E-03             7.000E+03
  21  -2.512E-02                       -1.050E+05             0.
                  1.094E-04 -2.335E-03             7.000E+03
```

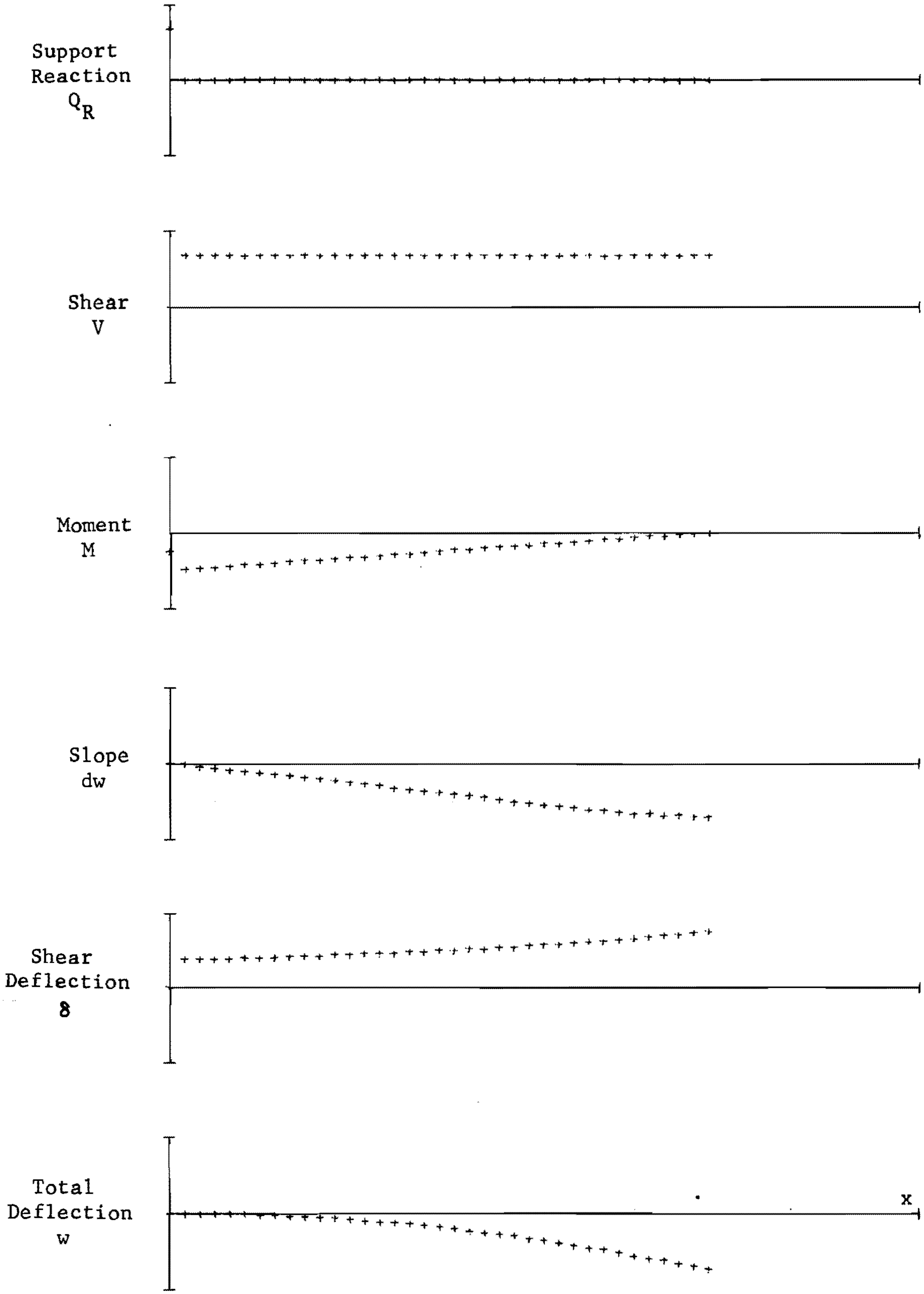
```
 22   -2.757E-02                                  -9.800E+04                  0.
                      1.116E-04 -2.446E-03                     7.000E+03
 23   -3.013E-02                                  -9.100E+04                  0.
                      1.140E-04 -2.557E-03                     7.000E+03
 24   -3.280E-02                                  -8.400E+04                  0.
                      1.165E-04 -2.667E-03                     7.000E+03
 25   -3.558E-02                                  -7.700E+04                  0.
                      1.191E-04 -2.773E-03                     7.000E+03
 26   -3.847E-02                                  -7.000E+04                  0.
                      1.218E-04 -2.875E-03                     7.000E+03
 27   -4.147E-02                                  -6.300E+04                  0.
                      1.246E-04 -2.973E-03                     7.000E+03
 28   -4.457E-02                                  -5.600E+04                  0.
                      1.276E-04 -3.066E-03                     7.000E+03
 29   -4.776E-02                                  -4.900E+04                  0.
                      1.307E-04 -3.154E-03                     7.000E+03
 30   -5.104E-02                                  -4.200E+04                  0.
                      1.340E-04 -3.236E-03                     7.000E+03
 31   -5.441E-02                                  -3.500E+04                  0.
                      1.374E-04 -3.308E-03                     7.000E+03
 32   -5.786E-02                                  -2.800E+04                  0.
                      1.410E-04 -3.370E-03                     7.000E+03
 33   -6.137E-02                                  -2.100E+04                  0.
                      1.448E-04 -3.420E-03                     7.000E+03
 34   -6.493E-02                                  -1.400E+04                  0.
                      1.489E-04 -3.456E-03                     7.000E+03
 35   -6.854E-02                                  -7.000E+03                  0.
                      1.531E-04 -3.476E-03                     7.000E+03
 36   -7.217E-02                                  -1.179E-07                  0.
                     -9.718E-19 -3.476E-03                    -4.443E-11
 37   -7.564E-02                                   0.                         0.

TABLE 7 -- SCALES FOR PLOT OUTPUT -- VALUES AT ENDS OF AXES

STA       X          W         DELTA        DW          M           V       SUP REACT
 50  5.000E+01  1.000E-01  2.000E-04  5.000E-03  5.000E+05  1.000E+04  1.000E+04


                                  TIME FOR THIS PROBLEM =      0 MINUTES    2.337 SECONDS


                                  ELAPSED CPU TIME =      0 MINUTES   15.205 SECONDS
```



Prob 102A. Cantilevered symmetrically tapered beam with concentrated load.

```
SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1  -  APPENDIX 6


PROB
102B     SAME AS PROBLEM 102A - ADD INFINITE SHEAR STIFFNESS


TABLE 1 - PROGRAM-CONTROL DATA
                                                            TABLES NUMBER
                                                         2    3    4A   4B    5

     PRIOR-DATA OPTIONS (1 = HOLD)                       1    1    1    0     1
     NUM CARDS INPUT THIS PROBLEM                        0    0    0    1     0

     OPTION (IF=1, 2, 3) TO PLOT                         1


TABLE 2 - CONSTANTS

     DATA HELD FROM THE PREVIOUS PROBLEM
     NUM INCREMENTS                                                              36
     INCREMENT LENGTH                                                     1.000E+00


TABLE 3 - SPECIFIED DEFLECTIONS

     STA         DEFLECTION

     DATA HELD FROM THE PREVIOUS PROBLEM
      0           0.


TABLE 4A - SECTION AND MATERIAL PROPERTIES

FROM TO CONTD        E          G            I          SA

     DATA HELD FROM THE PREVIOUS PROBLEM
  0  36  -0    3.000E+06 -0.        -0.        -0.
  1       1   -0.         1.270E+06 -0.         7.200E+01
     36  -0   -0.         1.270E+06 -0.         3.600E+01
  0       1   -0.        -0.         8.640E+02 -0.
      6   1   -0.        -0.         6.660E+02 -0.
     12   1   -0.        -0.         5.000E+02 -0.
     18   1   -0.        -0.         3.640E+02 -0.
     24   1   -0.        -0.         2.560E+02 -0.
     30   1   -0.        -0.         1.720E+02 -0.
     36  -0   -0.        -0.         1.080E+02 -0.


TABLE 4B - STIFFNESS DATA

FROM TO CONTD     SK         F
```

```
     ADDITIONAL DATA INPUT FOR THIS PROBLEM
  1  36  -0    1.000E+99 -0.


TABLE 5 - LOAD DATA

FROM TO CONTD       Q           S           T           R           P

     DATA HELD FROM THE PREVIOUS PROBLEM
 36  36  -0  -7.000E+03 -0.         -0.         -0.         -0.
  0   0  -0  -0.        -0.         -0.          1.000E+15 -0.
```

SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1 - APPENDIX 6

```
PROB (CONTD)
102B      SAME AS PROBLEM 102A - ADD INFINITE SHEAR STIFFNESS


TABLE 6 - RESULTS

 STA       W          DELTA       SLOPE        MOM         SHEAR      SUP REACT

 -1  -4.861E-05                              0.                       0.
                  0.          4.861E-05               0.
  0   0.                                  -1.260E+05                  7.000E+03
                  7.000E-96 -4.861E-05                7.000E+03
  1  -4.861E-05                           -2.450E+05                  0.
                  7.000E-96 -1.469E-04                7.000E+03
  2  -1.955E-04                           -2.380E+05                  0.
                  7.000E-96 -2.463E-04                7.000E+03
  3  -4.418E-04                           -2.310E+05                  0.
                  7.000E-96 -3.470E-04                7.000E+03
  4  -7.888E-04                           -2.240E+05                  0.
                  7.000E-96 -4.490E-04                7.000E+03
  5  -1.238E-03                           -2.170E+05                  0.
                  7.000E-96 -5.524E-04                7.000E+03
  6  -1.790E-03                           -2.100E+05                  0.
                  7.000E-96 -6.575E-04                7.000E+03
  7  -2.448E-03                           -2.030E+05                  0.
                  7.000E-96 -7.636E-04                7.000E+03
  8  -3.211E-03                           -1.960E+05                  0.
                  7.000E-96 -8.705E-04                7.000E+03
  9  -4.082E-03                           -1.890E+05                  0.
                  7.000E-96 -9.786E-04                7.000E+03
 10  -5.060E-03                           -1.820E+05                  0.
                  7.000E-96 -1.088E-03                7.000E+03
 11  -6.148E-03                           -1.750E+05                  0.
                  7.000E-96 -1.198E-03                7.000E+03
 12  -7.347E-03                           -1.680E+05                  0.
                  7.000E-96 -1.310E-03                7.000E+03
 13  -8.657E-03                           -1.610E+05                  0.
                  7.000E-96 -1.423E-03                7.000E+03
 14  -1.008E-02                           -1.540E+05                  0.
                  7.000E-96 -1.536E-03                7.000E+03
 15  -1.162E-02                           -1.470E+05                  0.
                  7.000E-96 -1.649E-03                7.000E+03
 16  -1.326E-02                           -1.400E+05                  0.
                  7.000E-96 -1.763E-03                7.000E+03
 17  -1.503E-02                           -1.330E+05                  0.
                  7.000E-96 -1.878E-03                7.000E+03
 18  -1.691E-02                           -1.260E+05                  0.
                  7.000E-96 -1.993E-03                7.000E+03
 19  -1.890E-02                           -1.190E+05                  0.
                  7.000E-96 -2.108E-03                7.000E+03
 20  -2.101E-02                           -1.120E+05                  0.
                  7.000E-96 -2.222E-03                7.000E+03
 21  -2.323E-02                           -1.050E+05                  0.
                  7.000E-96 -2.335E-03                7.000E+03
```

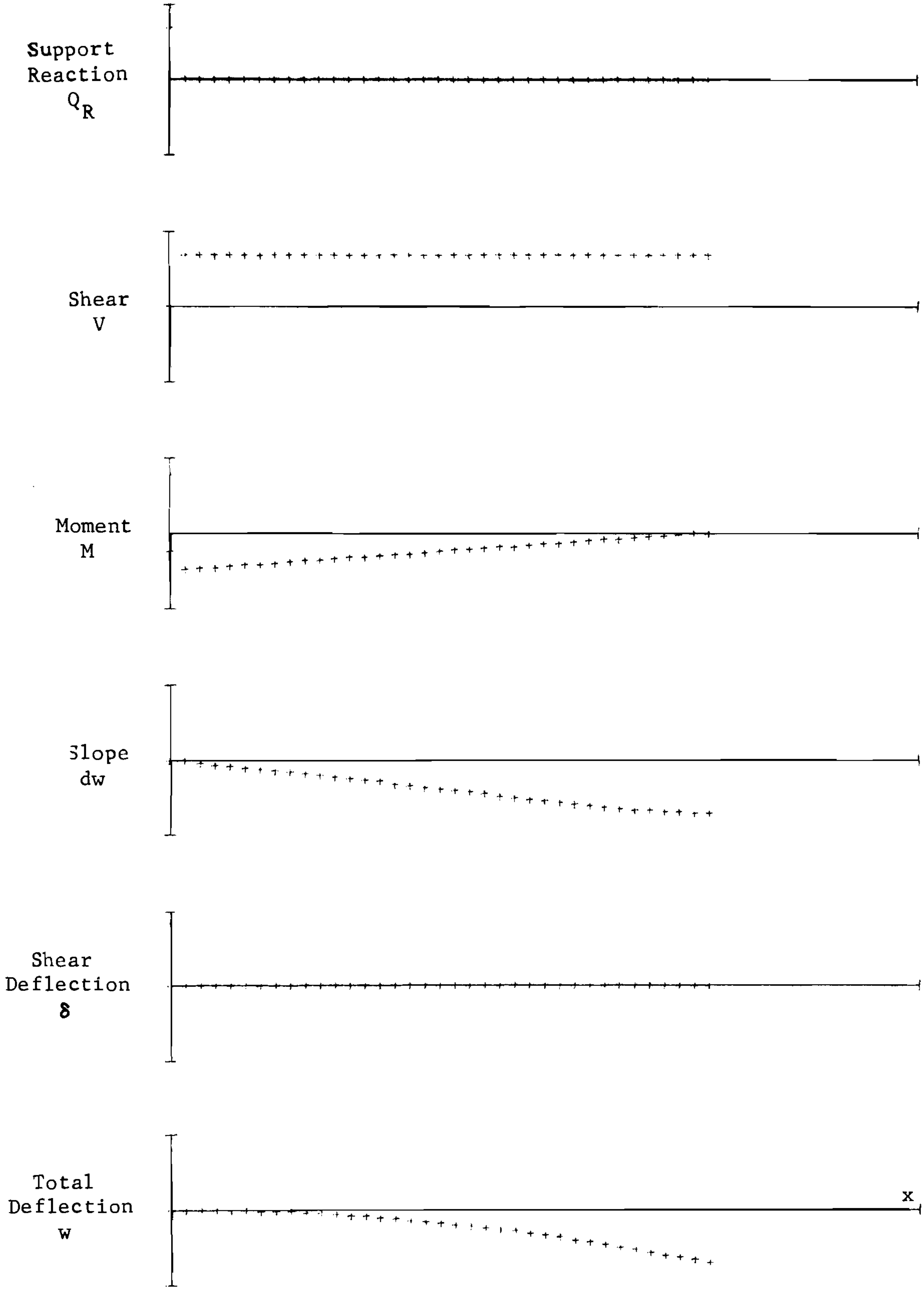
```
  22 -2.556E-02                    -9.800E+04           0.
                7.000E-96 -2.446E-03           7.000E+03
  23 -2.801E-02                    -9.100E+04           0.
                7.000E-96 -2.557E-03           7.000E+03
  24 -3.057E-02                    -8.400E+04           0.
                7.000E-96 -2.667E-03           7.000E+03
  25 -3.323E-02                    -7.700E+04           0.
                7.000E-96 -2.773E-03           7.000E+03
  26 -3.601E-02                    -7.000E+04           0.
                7.000E-96 -2.875E-03           7.000E+03
  27 -3.888E-02                    -6.300E+04           0.
                7.000E-96 -2.973E-03           7.000E+03
  28 -4.185E-02                    -5.600E+04           0.
                7.000E-96 -3.066E-03           7.000E+03
  29 -4.492E-02                    -4.900E+04           0.
                7.000E-96 -3.154E-03           7.000E+03
  30 -4.807E-02                    -4.200E+04           0.
                7.000E-96 -3.236E-03           7.000E+03
  31 -5.131E-02                    -3.500E+04           0.
                7.000E-96 -3.308E-03           7.000E+03
  32 -5.462E-02                    -2.800E+04           0.
                7.000E-96 -3.370E-03           7.000E+03
  33 -5.799E-02                    -2.100E+04           0.
                7.000E-96 -3.420E-03           7.000E+03
  34 -6.141E-02                    -1.400E+04           0.
                7.000E-96 -3.456E-03           7.000E+03
  35 -6.486E-02                    -7.000E+03           0.
                7.000E-96 -3.476E-03           7.000E+03
  36 -6.834E-02                     7.194E-08           0.
               -4.677-110 -3.476E-03          -4.677E-11
  37 -7.181E-02                     0.                  0.

TABLE 7 -- SCALES FOR PLOT OUTPUT -- VALUES AT ENDS OF AXES

STA     X         W       DELTA      DW         M         V      SUP REACT
 50  5.000E+01 1.000E-01 1.000E+00 5.000E-03 5.000E+05 1.000E+04 1.000E+04


                       TIME FOR THIS PROBLEM =     0 MINUTES    2.303 SECONDS


                       ELAPSED CPU TIME =     0 MINUTES   17.508 SECONDS
```



Prob 102B. Same as Prob 102A, neglecting shear deformations.

```
SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1  -  APPENDIX 6


PROB
102C      SAME AS PROBLEM 102A WITH MODIFIED SHEAR AREA FOR K = 1.2


TABLE 1 - PROGRAM-CONTROL DATA
                                                                 TABLES NUMBER
                                                          2     3     4A    4B    5

     PRIOR-DATA OPTIONS (1 = HOLD)                        1     1     1     0     1
     NUM CARDS INPUT THIS PROBLEM                         0     0     2     0     0

     OPTION (IF=1, 2, 3) TO PLOT                          1


TABLE 2 - CONSTANTS

     DATA HELD FROM THE PREVIOUS PROBLEM
     NUM INCREMENTS                                                              36
     INCREMENT LENGTH                                                     1.000E+00


TABLE 3 - SPECIFIED DEFLECTIONS

     STA         DEFLECTION

     DATA HELD FROM THE PREVIOUS PROBLEM
      0            0.


TABLE 4A - SECTION AND MATERIAL PROPERTIES

FROM TO CONTD       E           G            I            SA

     DATA HELD FROM THE PREVIOUS PROBLEM
  0  36   -0   3.000E+06 -0.         -0.          -0.
  1        1  -0.         1.270E+06 -0.            7.200E+01
     36   -0  -0.         1.270E+06 -0.            3.600E+01
  0        1  -0.        -0.          8.640E+02 -0.
      6    1  -0.        -0.          6.660E+02 -0.
     12    1  -0.        -0.          5.000E+02 -0.
     18    1  -0.        -0.          3.640E+02 -0.
     24    1  -0.        -0.          2.560E+02 -0.
     30    1  -0.        -0.          1.720E+02 -0.
     36   -0  -0.        -0.          1.080E+02 -0.
     ADDITIONAL DATA INPUT FOR THIS PROBLEM
  1        1  -0.        -0.         -0.          -1.200E+01
     36    0  -0.        -0.         -0.          -6.000E+00


TABLE 4B - STIFFNESS DATA
```

```
FROM TO CONTD    SK            F

                NONE

TABLE 5 - LOAD DATA

FROM TO CONTD      Q              S              T              R              P

     DATA HELD FROM THE PREVIOUS PROBLEM
 36   36   -0   -7.000E+03 -0.          -0.          -0.          -0.
  0    0   -0   -0.          -0.          -0.           1.000E+15 -0.
```

```
SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1  -  APPENDIX 6


PROB (CONTD)
102C     SAME AS PROBLEM 102A WITH MODIFIED SHEAR AREA FOR K = 1.2


TABLE 6 - RESULTS

  STA      W          DELTA       SLOPE        MOM         SHEAR      SUP REACT

  -1   -4.861E-05                            0.                        0.
                    0.          4.861E-05                0.
   0    0.                                 -1.260E+05                  7.000E+03
                    9.186E-05  -4.861E-05               7.000E+03
   1   -1.405E-04                          -2.450E+05                  0.
                    9.319E-05  -1.469E-04               7.000E+03
   2   -3.806E-04                          -2.380E+05                  0.
                    9.457E-05  -2.463E-04               7.000E+03
   3   -7.214E-04                          -2.310E+05                  0.
                    9.598E-05  -3.470E-04               7.000E+03
   4   -1.164E-03                          -2.240E+05                  0.
                    9.743E-05  -4.490E-04               7.000E+03
   5   -1.711E-03                          -2.170E+05                  0.
                    9.893E-05  -5.524E-04               7.000E+03
   6   -2.362E-03                          -2.100E+05                  0.
                    1.005E-04  -6.575E-04               7.000E+03
   7   -3.120E-03                          -2.030E+05                  0.
                    1.021E-04  -7.636E-04               7.000E+03
   8   -3.986E-03                          -1.960E+05                  0.
                    1.037E-04  -8.705E-04               7.000E+03
   9   -4.960E-03                          -1.890E+05                  0.
                    1.054E-04  -9.786E-04               7.000E+03
  10   -6.044E-03                          -1.820E+05                  0.
                    1.072E-04  -1.088E-03               7.000E+03
  11   -7.239E-03                          -1.750E+05                  0.
                    1.090E-04  -1.198E-03               7.000E+03
  12   -8.546E-03                          -1.680E+05                  0.
                    1.109E-04  -1.310E-03               7.000E+03
  13   -9.968E-03                          -1.610E+05                  0.
                    1.128E-04  -1.423E-03               7.000E+03
  14   -1.150E-02                          -1.540E+05                  0.
                    1.148E-04  -1.536E-03               7.000E+03
  15   -1.315E-02                          -1.470E+05                  0.
                    1.169E-04  -1.649E-03               7.000E+03
  16   -1.492E-02                          -1.400E+05                  0.
                    1.191E-04  -1.763E-03               7.000E+03
  17   -1.680E-02                          -1.330E+05                  0.
                    1.213E-04  -1.878E-03               7.000E+03
  18   -1.880E-02                          -1.260E+05                  0.
                    1.237E-04  -1.993E-03               7.000E+03
  19   -2.092E-02                          -1.190E+05                  0.
                    1.261E-04  -2.108E-03               7.000E+03
  20   -2.315E-02                          -1.120E+05                  0.
                    1.286E-04  -2.222E-03               7.000E+03
  21   -2.550E-02                          -1.050E+05                  0.
                    1.312E-04  -2.335E-03               7.000E+03
```

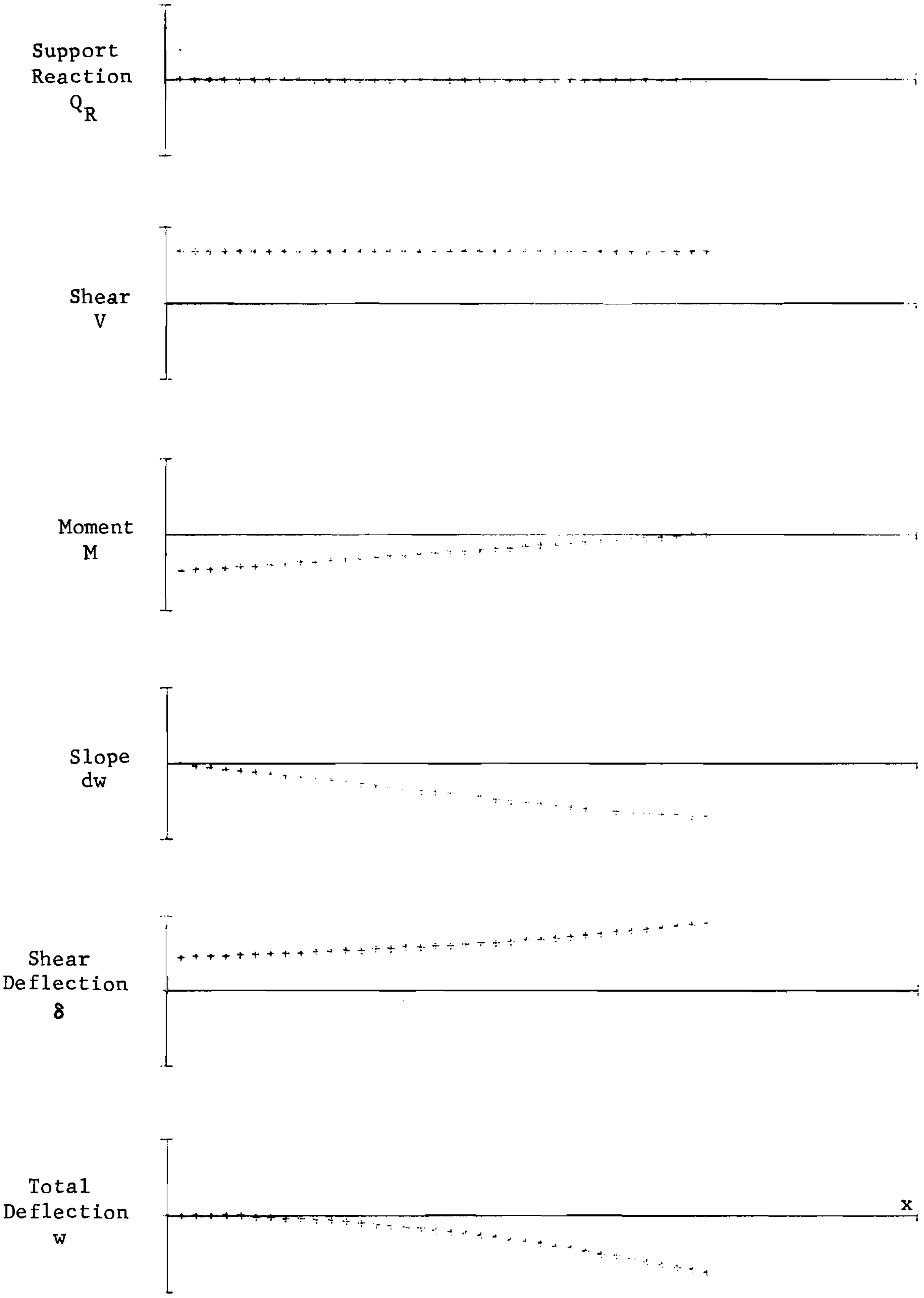
```
  22  -2.797E-02                       -9.800E+04             0.
                  1.340E-04 -2.446E-03             7.000E+03
  23  -3.055E-02                       -9.100E+04             0.
                  1.368E-04 -2.557E-03             7.000E+03
  24  -3.324E-02                       -8.400E+04             0.
                  1.398E-04 -2.667E-03             7.000E+03
  25  -3.605E-02                       -7.700E+04             0.
                  1.429E-04 -2.773E-03             7.000E+03
  26  -3.896E-02                       -7.000E+04             0.
                  1.461E-04 -2.875E-03             7.000E+03
  27  -4.199E-02                       -6.300E+04             0.
                  1.495E-04 -2.973E-03             7.000E+03
  28  -4.511E-02                       -5.600E+04             0.
                  1.531E-04 -3.066E-03             7.000E+03
  29  -4.833E-02                       -4.900E+04             0.
                  1.568E-04 -3.154E-03             7.000E+03
  30  -5.164E-02                       -4.200E+04             0.
                  1.608E-04 -3.236E-03             7.000E+03
  31  -5.503E-02                       -3.500E+04             0.
                  1.649E-04 -3.308E-03             7.000E+03
  32  -5.851E-02                       -2.800E+04             0.
                  1.692E-04 -3.370E-03             7.000E+03
  33  -6.205E-02                       -2.100E+04             0.
                  1.738E-04 -3.420E-03             7.000E+03
  34  -6.564E-02                       -1.400E+04             0.
                  1.786E-04 -3.456E-03             7.000E+03
  35  -6.927E-02                       -7.000E+03             0.
                  1.837E-04 -3.476E-03             7.000E+03
  36  -7.293E-02                        7.752E-08             0.
                 -1.155E-18 -3.476E-03            -4.399E-11
  37  -7.641E-02                        0.                    0.

TABLE 7 -- SCALES FOR PLOT OUTPUT -- VALUES AT ENDS OF AXES

STA      X          W        DELTA       DW          M          V      SUP REACT
 50  5.000E+01  1.000E-01  2.000E-04  5.000E-03  5.000E+05  1.000E+04  1.000E+04


                         TIME FOR THIS PROBLEM =    0 MINUTES    2.306 SECONDS


                         ELAPSED CPU TIME =    0 MINUTES   19.814 SECONDS
```



Prob 102C. Same as Prob 102A, considering the factor K = 1.2 .

```
SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1  -  APPENDIX 6


PROB
201A     STEEL BRIDGE DIAPHRAGMS WITH WHEEL LOAD ON OUTSIDE BEAM


TABLE 1 - PROGRAM-CONTROL DATA
                                                           TABLES NUMBER
                                                       2     3    4A    4B     5

     PRIOR-DATA OPTIONS (1 = HOLD)                    -0    -0    -0    -0    -0
     NUM CARDS INPUT THIS PROBLEM                      1     0     2     0     8

     OPTION (IF=1, 2, 3) TO PLOT                       1


TABLE 2 - CONSTANTS

     NUM INCREMENTS                                                           96
     INCREMENT LENGTH                                                  3.000E+00


TABLE 3 - SPECIFIED DEFLECTIONS

     STA         DEFLECTION


                 NONE


TABLE 4A - SECTION AND MATERIAL PROPERTIES

FROM TO CONTD       E          G            I            SA

     ADDITIONAL DATA INPUT FOR THIS PROBLEM
  0  96   -0   3.000E+07 -0.           3.126E+02 -0.
  1  96   -0  -0.           1.100E+07 -0.          7.820E+00


TABLE 4B - STIFFNESS DATA

FROM TO CONTD     SK         F


                 NONE

TABLE 5 - LOAD DATA

FROM TO CONTD       Q          S            T            R            P

     ADDITIONAL DATA INPUT FOR THIS PROBLEM
```

```
 0   0  -0  -0.         9.700E+05 -0.         1.840E+05 -0.
24  24  -0  -0.         9.700E+05 -0.         1.840E+05 -0.
48  48  -0  -0.         9.700E+05 -0.         1.840E+05 -0.
72  72  -0  -0.         9.700E+05 -0.         1.840E+05 -0.
96  96  -0  -0.         9.700E+05 -0.         1.840E+05 -0.
 0  96  -0  -8.480E+00 -0.        -0.        -0.        -0.
72  72  -0  -2.080E+04 -0.        -0.        -0.        -0.
96  96  -0  -2.080E+04 -0.        -0.        -0.        -0.
```

SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1 - APPENDIX 6

PROB (CONTD)
201A   STEEL BRIDGE DIAPHRAGMS WITH WHEEL LOAD ON OUTSIDE BEAM

TABLE 6 - RESULTS

```
  STA      W          DELTA       SLOPE        MOM         SHEAR      SUP REACT

   -1 -1.124E-04                           0.                       0.
                   0.          3.621E-06               0.
    0 -1.016E-04                           3.331E-01              -9.853E+01
                   3.288E-06   3.621E-06               9.429E+01
    1 -9.400E-05                           2.835E+02                0.
                   2.993E-06   3.711E-06               8.581E+01
    2 -8.586E-05                           5.410E+02                0.
                   2.697E-06   3.885E-06               7.733E+01
    3 -7.690E-05                           7.730E+02                0.
                   2.401E-06   4.132E-06               6.885E+01
    4 -6.691E-05                           9.795E+02                0.
                   2.105E-06   4.445E-06               6.037E+01
    5 -5.568E-05                           1.161E+03                0.
                   1.810E-06   4.816E-06               5.189E+01
    6 -4.304E-05                           1.316E+03                0.
                   1.514E-06   5.237E-06               4.341E+01
    7 -2.884E-05                           1.447E+03                0.
                   1.218E-06   5.700E-06               3.493E+01
    8 -1.296E-05                           1.551E+03                0.
                   9.224E-07   6.196E-06               2.645E+01
    9  4.708E-06                           1.631E+03                0.
                   6.267E-07   6.718E-06               1.797E+01
   10  2.424E-05                           1.685E+03                0.
                   3.309E-07   7.257E-06               9.489E+00
   11  4.568E-05                           1.713E+03                0.
                   3.520E-08   7.805E-06               1.009E+00
   12  6.906E-05                           1.716E+03                0.
                  -2.605E-07   8.354E-06              -7.471E+00
   13  9.438E-05                           1.694E+03                0.
                  -5.563E-07   8.896E-06              -1.595E+01
   14  1.216E-04                           1.646E+03                0.
                  -8.520E-07   9.422E-06              -2.443E+01
   15  1.507E-04                           1.572E+03                0.
                  -1.148E-06   9.925E-06              -3.291E+01
   16  1.817E-04                           1.474E+03                0.
                  -1.444E-06   1.040E-05              -4.139E+01
   17  2.143E-04                           1.350E+03                0.
                  -1.739E-06   1.083E-05              -4.987E+01
   18  2.485E-04                           1.200E+03                0.
                  -2.035E-06   1.121E-05              -5.835E+01
   19  2.842E-04                           1.025E+03                0.
                  -2.331E-06   1.154E-05              -6.683E+01
   20  3.211E-04                           8.244E+02                0.
                  -2.627E-06   1.180E-05              -7.531E+01
   21  3.592E-04                           5.985E+02                0.
                  -2.922E-06   1.200E-05              -8.379E+01
```

```
22   3.981E-04                        3.471E+02             0.
               -3.218E-06  1.211E-05            -9.227E+01
23   4.376E-04                        7.031E+01             0.
               -3.514E-06  1.213E-05            -1.008E+02
24   4.775E-04                       -2.308E+02             4.632E+02
               -1.996E-05  1.206E-05            -5.724E+02
25   5.337E-04                       -1.947E+03             0.
               -2.026E-05  1.143E-05            -5.809E+02
26   5.882E-04                       -3.690E+03             0.
               -2.056E-05  1.025E-05            -5.894E+02
27   6.395E-04                       -5.458E+03             0.
               -2.085E-05  8.506E-06            -5.979E+02
28   6.859E-04                       -7.252E+03             0.
               -2.115E-05  6.186E-06            -6.064E+02
29   7.256E-04                       -9.071E+03             0.
               -2.144E-05  3.284E-06            -6.148E+02
30   7.569E-04                       -1.092E+04             0.
               -2.174E-05 -2.073E-07            -6.233E+02
31   7.780E-04                       -1.279E+04             0.
               -2.203E-05 -4.297E-06            -6.318E+02
32   7.872E-04                       -1.468E+04             0.
               -2.233E-05 -8.993E-06            -6.403E+02
33   7.825E-04                       -1.660E+04             0.
               -2.263E-05 -1.430E-05            -6.488E+02
34   7.622E-04                       -1.855E+04             0.
               -2.292E-05 -2.024E-05            -6.572E+02
35   7.244E-04                       -2.052E+04             0.
               -2.322E-05 -2.680E-05            -6.657E+02
36   6.672E-04                       -2.252E+04             0.
               -2.351E-05 -3.400E-05            -6.742E+02
37   5.887E-04                       -2.454E+04             0.
               -2.381E-05 -4.185E-05            -6.827E+02
38   4.870E-04                       -2.659E+04             0.
               -2.410E-05 -5.036E-05            -6.912E+02
39   3.600E-04                       -2.866E+04             0.
               -2.440E-05 -5.953E-05            -6.996E+02
40   2.058E-04                       -3.076E+04             0.
               -2.470E-05 -6.937E-05            -7.081E+02
41   2.242E-05                       -3.288E+04             0.
               -2.499E-05 -7.989E-05            -7.166E+02
42  -1.922E-04                       -3.503E+04             0.
               -2.529E-05 -9.109E-05            -7.251E+02
43  -4.402E-04                       -3.721E+04             0.
               -2.558E-05 -1.030E-04            -7.336E+02
44  -7.237E-04                       -3.941E+04             0.
               -2.588E-05 -1.156E-04            -7.420E+02
45  -1.045E-03                       -4.164E+04             0.
               -2.617E-05 -1.289E-04            -7.505E+02
46  -1.405E-03                       -4.389E+04             0.
               -2.647E-05 -1.430E-04            -7.590E+02
47  -1.808E-03                       -4.616E+04             0.
               -2.677E-05 -1.577E-04            -7.675E+02
48  -2.254E-03                       -4.848E+04            -2.186E+03
                 4.919E-05 -1.732E-04             1.410E+03
49  -2.823E-03                       -4.427E+04             0.
                 4.889E-05 -1.874E-04             1.402E+03
50  -3.434E-03                       -4.006E+04             0.
                 4.860E-05 -2.002E-04             1.393E+03
51  -4.083E-03                       -3.588E+04             0.
                 4.830E-05 -2.117E-04             1.385E+03
52  -4.767E-03                       -3.172E+04             0.
```

```
                4.801E-05 -2.218E-04          1.377E+03
  53  -5.480E-03                   -2.759E+04           0.
                4.771E-05 -2.307E-04          1.368E+03
  54  -6.220E-03                   -2.349E+04           0.
                4.742E-05 -2.382E-04          1.360E+03
  55  -6.982E-03                   -1.941E+04           0.
                4.712E-05 -2.444E-04          1.351E+03
  56  -7.762E-03                   -1.536E+04           0.
                4.682E-05 -2.493E-04          1.343E+03
  57  -8.557E-03                   -1.133E+04           0.
                4.653E-05 -2.529E-04          1.334E+03
  58  -9.362E-03                   -7.328E+03           0.
                4.623E-05 -2.553E-04          1.326E+03
  59  -1.017E-02                   -3.351E+03           0.
                4.594E-05 -2.563E-04          1.317E+03
  60  -1.099E-02                    6.003E+02           0.
                4.564E-05 -2.562E-04          1.309E+03
  61  -1.180E-02                    4.526E+03           0.
                4.535E-05 -2.547E-04          1.300E+03
  62  -1.261E-02                    8.427E+03           0.
                4.505E-05 -2.520E-04          1.292E+03
  63  -1.341E-02                    1.230E+04           0.
                4.475E-05 -2.481E-04          1.283E+03
  64  -1.420E-02                    1.615E+04           0.
                4.446E-05 -2.429E-04          1.275E+03
  65  -1.498E-02                    1.998E+04           0.
                4.416E-05 -2.365E-04          1.266E+03
  66  -1.573E-02                    2.378E+04           0.
                4.387E-05 -2.289E-04          1.258E+03
  67  -1.646E-02                    2.755E+04           0.
                4.357E-05 -2.201E-04          1.249E+03
  68  -1.716E-02                    3.130E+04           0.
                4.328E-05 -2.101E-04          1.241E+03
  69  -1.784E-02                    3.502E+04           0.
                4.298E-05 -1.989E-04          1.232E+03
  70  -1.848E-02                    3.872E+04           0.
                4.268E-05 -1.865E-04          1.224E+03
  71  -1.908E-02                    4.239E+04           0.
                4.239E-05 -1.729E-04          1.215E+03
  72  -1.964E-02                    4.602E+04          -1.905E+04
               -1.888E-05 -1.582E-04         -5.415E+02
  73  -2.010E-02                    4.438E+04           0.
               -1.918E-05 -1.440E-04         -5.500E+02
  74  -2.051E-02                    4.273E+04           0.
               -1.948E-05 -1.304E-04         -5.584E+02
  75  -2.088E-02                    4.105E+04           0.
               -1.977E-05 -1.172E-04         -5.669E+02
  76  -2.121E-02                    3.935E+04           0.
               -2.007E-05 -1.046E-04         -5.754E+02
  77  -2.151E-02                    3.763E+04           0.
               -2.036E-05 -9.259E-05         -5.839E+02
  78  -2.176E-02                    3.588E+04           0.
               -2.066E-05 -8.112E-05         -5.924E+02
  79  -2.199E-02                    3.410E+04           0.
               -2.095E-05 -7.021E-05         -6.008E+02
  80  -2.218E-02                    3.230E+04           0.
               -2.125E-05 -5.988E-05         -6.093E+02
  81  -2.233E-02                    3.047E+04           0.
               -2.155E-05 -5.013E-05         -6.178E+02
  82  -2.246E-02                    2.861E+04           0.
               -2.184E-05 -4.098E-05         -6.263E+02
```

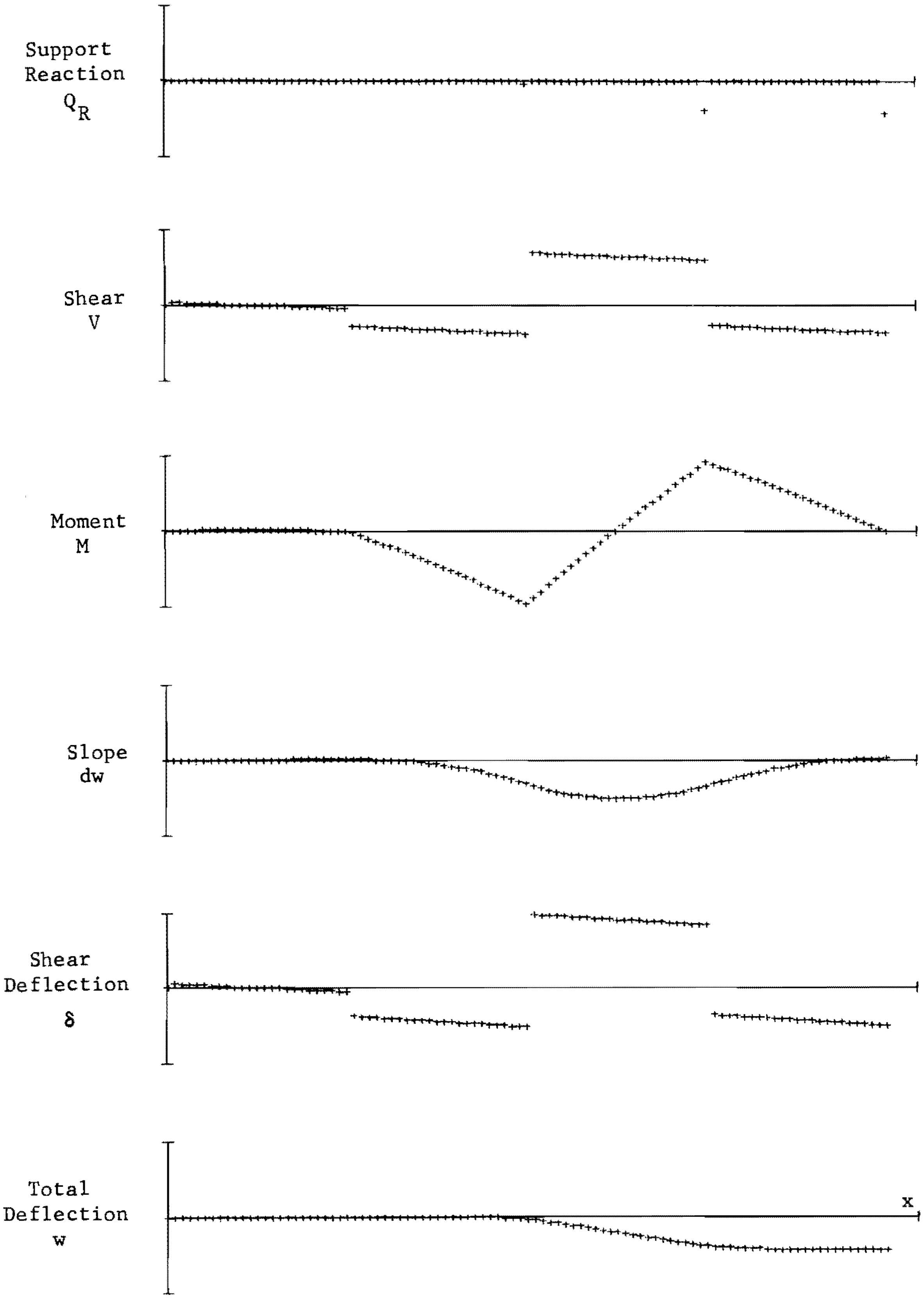
```
 83  -2.256E-02                             2.674E+04                 0.
                -2.214E-05 -3.243E-05                 -6.348E+02
 84  -2.264E-02                             2.483E+04                 0.
                -2.243E-05 -2.448E-05                 -6.432E+02
 85  -2.269E-02                             2.290E+04                 0.
                -2.273E-05 -1.716E-05                 -6.517E+02
 86  -2.272E-02                             2.095E+04                 0.
                -2.302E-05 -1.045E-05                 -6.602E+02
 87  -2.273E-02                             1.897E+04                 0.
                -2.332E-05 -4.388E-06                 -6.687E+02
 88  -2.272E-02                             1.696E+04                 0.
                -2.362E-05  1.038E-06                 -6.772E+02
 89  -2.269E-02                             1.493E+04                 0.
                -2.391E-05  5.814E-06                 -6.856E+02
 90  -2.265E-02                             1.287E+04                 0.
                -2.421E-05  9.931E-06                 -6.941E+02
 91  -2.260E-02                             1.079E+04                 0.
                -2.450E-05  1.338E-05                 -7.026E+02
 92  -2.253E-02                             8.682E+03                 0.
                -2.480E-05  1.616E-05                 -7.111E+02
 93  -2.246E-02                             6.549E+03                 0.
                -2.509E-05  1.825E-05                 -7.196E+02
 94  -2.238E-02                             4.390E+03                 0.
                -2.539E-05  1.966E-05                 -7.280E+02
 95  -2.229E-02                             2.206E+03                 0.
                -2.569E-05  2.036E-05                 -7.365E+02
 96  -2.221E-02                            -1.874E+00                -2.154E+04
                -2.922E-18  2.036E-05                 -8.379E-11
 97  -2.215E-02                             0.                        0.

TABLE 7 -- SCALES FOR PLOT OUTPUT -- VALUES AT ENDS OF AXES

STA      X          W        DELTA       DW          M          V       SUP REACT
100  3.000E+02  5.000E-02  5.000E-05  5.000E-04  5.000E+04  2.000E+03  5.000E+04


                           TIME FOR THIS PROBLEM =     0 MINUTES    3.555 SECONDS


                           ELAPSED CPU TIME =     0 MINUTES   21.167 SECONDS
```



Prob 201A. Steel bridge diaphragms with wheel load on outside beam.

```
SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1  -  APPENDIX 6


PROB
201B     SAME AS PROBLEM 201A - ADD INFINITE SHEAR STIFFNESS


TABLE 1 - PROGRAM-CONTROL DATA
                                                             TABLES NUMBER
                                                          2    3    4A   4B   5

     PRIOR-DATA OPTIONS (1 = HOLD)                        1    0    1    0    1
     NUM CARDS INPUT THIS PROBLEM                         0    0    0    1    0

     OPTION (IF=1, 2, 3) TO PLOT                          1


TABLE 2 - CONSTANTS

     DATA HELD FROM THE PREVIOUS PROBLEM
     NUM INCREMENTS                                                          96
     INCREMENT LENGTH                                                 3.000E+00


TABLE 3 - SPECIFIED DEFLECTIONS

     STA       DEFLECTION


               NONE


TABLE 4A - SECTION AND MATERIAL PROPERTIES

FROM TO CONTD     E         G           I          SA

     DATA HELD FROM THE PREVIOUS PROBLEM
  0  96  -0   3.000E+07 -0.        3.126E+02 -0.
  1  96  -0  -0.        1.100E+07 -0.        7.820E+00


TABLE 4B - STIFFNESS DATA

FROM TO CONTD    SK         F

     ADDITIONAL DATA INPUT FOR THIS PROBLEM
  1  96  -0   1.000E+99 -0.


TABLE 5 - LOAD DATA

FROM TO CONTD     Q          S          T          R          P
```

```
     DATA HELD FROM THE PREVIOUS PROBLEM
  0   0  -0  -0.          9.700E+05 -0.          1.840E+05 -0.
 24  24  -0  -0.          9.700E+05 -0.          1.840E+05 -0.
 48  48  -0  -0.          9.700E+05 -0.          1.840E+05 -0.
 72  72  -0  -0.          9.700E+05 -0.          1.840E+05 -0.
 96  96  -0  -0.          9.700E+05 -0.          1.840E+05 -0.
  0  96  -0  -8.480E+00 -0.         -0.         -0.         -0.
 72  72  -0  -2.080E+04 -0.         -0.         -0.         -0.
 96  96  -0  -2.080E+04 -0.         -0.         -0.         -0.
```

SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1 - APPENDIX 6

PROB (CONTD)
201B SAME AS PROBLEM 201A - ADD INFINITE SHEAR STIFFNESS

TABLE 6 - RESULTS

```
  STA       W        DELTA       SLOPE        MOM        SHEAR     SUP REACT

  -1 -1.323E-04                           0.                       0.
                  0.          3.501E-06               0.
   0 -1.218E-04                           3.221E-01               -1.182E+02
                  1.139E-97   3.502E-06               1.139E+02
   1 -1.113E-04                           3.424E+02                0.
                  1.055E-97   3.611E-06               1.055E+02
   2 -1.005E-04                           6.588E+02                0.
                  9.697E-98   3.822E-06               9.697E+01
   3 -8.902E-05                           9.497E+02                0.
                  8.849E-98   4.126E-06               8.849E+01
   4 -7.665E-05                           1.215E+03                0.
                  8.001E-98   4.514E-06               8.001E+01
   5 -6.310E-05                           1.455E+03                0.
                  7.153E-98   4.980E-06               7.153E+01
   6 -4.816E-05                           1.670E+03                0.
                  6.305E-98   5.514E-06               6.305E+01
   7 -3.162E-05                           1.859E+03                0.
                  5.457E-98   6.109E-06               5.457E+01
   8 -1.330E-05                           2.023E+03                0.
                  4.609E-98   6.756E-06               4.609E+01
   9  6.971E-06                           2.161E+03                0.
                  3.761E-98   7.447E-06               3.761E+01
  10  2.931E-05                           2.274E+03                0.
                  2.913E-98   8.174E-06               2.913E+01
  11  5.384E-05                           2.361E+03                0.
                  2.065E-98   8.930E-06               2.065E+01
  12  8.063E-05                           2.423E+03                0.
                  1.217E-98   9.705E-06               1.217E+01
  13  1.097E-04                           2.460E+03                0.
                  3.693E-99   1.049E-05               3.693E+00
  14  1.412E-04                           2.471E+03                0.
                 -4.787E-99   1.128E-05              -4.787E+00
  15  1.751E-04                           2.456E+03                0.
                 -1.327E-98   1.207E-05              -1.327E+01
  16  2.113E-04                           2.417E+03                0.
                 -2.175E-98   1.284E-05              -2.175E+01
  17  2.498E-04                           2.351E+03                0.
                 -3.023E-98   1.359E-05              -3.023E+01
  18  2.906E-04                           2.261E+03                0.
                 -3.871E-98   1.432E-05              -3.871E+01
  19  3.335E-04                           2.145E+03                0.
                 -4.719E-98   1.500E-05              -4.719E+01
  20  3.785E-04                           2.003E+03                0.
                 -5.567E-98   1.564E-05              -5.567E+01
  21  4.255E-04                           1.836E+03                0.
                 -6.415E-98   1.623E-05              -6.415E+01
```

```
22   4.741E-04                        1.644E+03             0.
               -7.263E-98  1.676E-05             -7.263E+01
23   5.244E-04                        1.426E+03             0.
               -8.111E-98  1.721E-05             -8.111E+01
24   5.761E-04                        1.184E+03             5.588E+02
               -6.484E-97  1.759E-05             -6.484E+02
25   6.288E-04                       -7.595E+02             0.
               -6.568E-97  1.735E-05             -6.568E+02
26   6.809E-04                       -2.730E+03             0.
               -6.653E-97  1.647E-05             -6.653E+02
27   7.303E-04                       -4.726E+03             0.
               -6.738E-97  1.496E-05             -6.738E+02
28   7.752E-04                       -6.747E+03             0.
               -6.823E-97  1.280E-05             -6.823E+02
29   8.136E-04                       -8.794E+03             0.
               -6.908E-97  9.991E-06             -6.908E+02
30   8.436E-04                       -1.087E+04             0.
               -6.992E-97  6.515E-06             -6.992E+02
31   8.631E-04                       -1.296E+04             0.
               -7.077E-97  2.368E-06             -7.077E+02
32   8.702E-04                       -1.509E+04             0.
               -7.162E-97 -2.458E-06             -7.162E+02
33   8.629E-04                       -1.724E+04             0.
               -7.247E-97 -7.972E-06             -7.247E+02
34   8.389E-04                       -1.941E+04             0.
               -7.332E-97 -1.418E-05             -7.332E+02
35   7.964E-04                       -2.161E+04             0.
               -7.416E-97 -2.109E-05             -7.416E+02
36   7.331E-04                       -2.383E+04             0.
               -7.501E-97 -2.872E-05             -7.501E+02
37   6.470E-04                       -2.608E+04             0.
               -7.586E-97 -3.706E-05             -7.586E+02
38   5.358E-04                       -2.836E+04             0.
               -7.671E-97 -4.614E-05             -7.671E+02
39   3.974E-04                       -3.066E+04             0.
               -7.756E-97 -5.594E-05             -7.756E+02
40   2.295E-04                       -3.299E+04             0.
               -7.840E-97 -6.650E-05             -7.840E+02
41   3.003E-05                       -3.534E+04             0.
               -7.925E-97 -7.780E-05             -7.925E+02
42  -2.034E-04                       -3.772E+04             0.
               -8.010E-97 -8.987E-05             -8.010E+02
43  -4.730E-04                       -4.012E+04             0.
               -8.095E-97 -1.027E-04             -8.095E+02
44  -7.811E-04                       -4.255E+04             0.
               -8.180E-97 -1.163E-04             -8.180E+02
45  -1.130E-03                       -4.500E+04             0.
               -8.264E-97 -1.307E-04             -8.264E+02
46  -1.522E-03                       -4.748E+04             0.
               -8.349E-97 -1.459E-04             -8.349E+02
47  -1.960E-03                       -4.999E+04             0.
               -8.434E-97 -1.619E-04             -8.434E+02
48  -2.446E-03                       -5.253E+04            -2.372E+03
                1.520E-96 -1.787E-04              1.520E+03
49  -2.982E-03                       -4.799E+04             0.
                1.512E-96 -1.940E-04              1.512E+03
50  -3.564E-03                       -4.345E+04             0.
                1.503E-96 -2.079E-04              1.503E+03
51  -4.188E-03                       -3.894E+04             0.
                1.495E-96 -2.204E-04              1.495E+03
52  -4.849E-03                       -3.446E+04             0.
```

```
                1.486E-96 -2.314E-04             1.486E+03
53  -5.543E-03                       -3.000E+04             0.
                1.478E-96 -2.410E-04             1.478E+03
54  -6.266E-03                       -2.557E+04             0.
                1.469E-96 -2.492E-04             1.469E+03
55  -7.014E-03                       -2.116E+04             0.
                1.461E-96 -2.560E-04             1.461E+03
56  -7.782E-03                       -1.677E+04             0.
                1.452E-96 -2.613E-04             1.452E+03
57  -8.566E-03                       -1.242E+04             0.
                1.444E-96 -2.653E-04             1.444E+03
58  -9.362E-03                       -8.085E+03             0.
                1.436E-96 -2.679E-04             1.436E+03
59  -1.017E-02                       -3.778E+03             0.
                1.427E-96 -2.691E-04             1.427E+03
60  -1.097E-02                        5.031E+02             0.
                1.419E-96 -2.689E-04             1.419E+03
61  -1.178E-02                        4.759E+03             0.
                1.410E-96 -2.674E-04             1.410E+03
62  -1.258E-02                        8.989E+03             0.
                1.402E-96 -2.645E-04             1.402E+03
63  -1.338E-02                        1.319E+04             0.
                1.393E-96 -2.603E-04             1.393E+03
64  -1.416E-02                        1.737E+04             0.
                1.385E-96 -2.548E-04             1.385E+03
65  -1.492E-02                        2.153E+04             0.
                1.376E-96 -2.479E-04             1.376E+03
66  -1.566E-02                        2.566E+04             0.
                1.368E-96 -2.397E-04             1.368E+03
67  -1.638E-02                        2.976E+04             0.
                1.359E-96 -2.302E-04             1.359E+03
68  -1.707E-02                        3.384E+04             0.
                1.351E-96 -2.193E-04             1.351E+03
69  -1.773E-02                        3.789E+04             0.
                1.342E-96 -2.072E-04             1.342E+03
70  -1.835E-02                        4.191E+04             0.
                1.334E-96 -1.938E-04             1.334E+03
71  -1.893E-02                        4.592E+04             0.
                1.325E-96 -1.791E-04             1.325E+03
72  -1.947E-02                        4.988E+04            -1.889E+04
               -5.951E-97 -1.632E-04            -5.951E+02
73  -1.996E-02                        4.808E+04             0.
               -6.035E-97 -1.478E-04            -6.035E+02
74  -2.041E-02                        4.626E+04             0.
               -6.120E-97 -1.330E-04            -6.120E+02
75  -2.080E-02                        4.443E+04             0.
               -6.205E-97 -1.188E-04            -6.205E+02
76  -2.116E-02                        4.257E+04             0.
               -6.290E-97 -1.052E-04            -6.290E+02
77  -2.148E-02                        4.068E+04             0.
               -6.375E-97 -9.214E-05            -6.375E+02
78  -2.175E-02                        3.877E+04             0.
               -6.459E-97 -7.973E-05            -6.459E+02
79  -2.199E-02                        3.683E+04             0.
               -6.544E-97 -6.795E-05            -6.544E+02
80  -2.220E-02                        3.487E+04             0.
               -6.629E-97 -5.680E-05            -6.629E+02
81  -2.237E-02                        3.288E+04             0.
               -6.714E-97 -4.628E-05            -6.714E+02
82  -2.250E-02                        3.086E+04             0.
               -6.799E-97 -3.641E-05            -6.799E+02
```

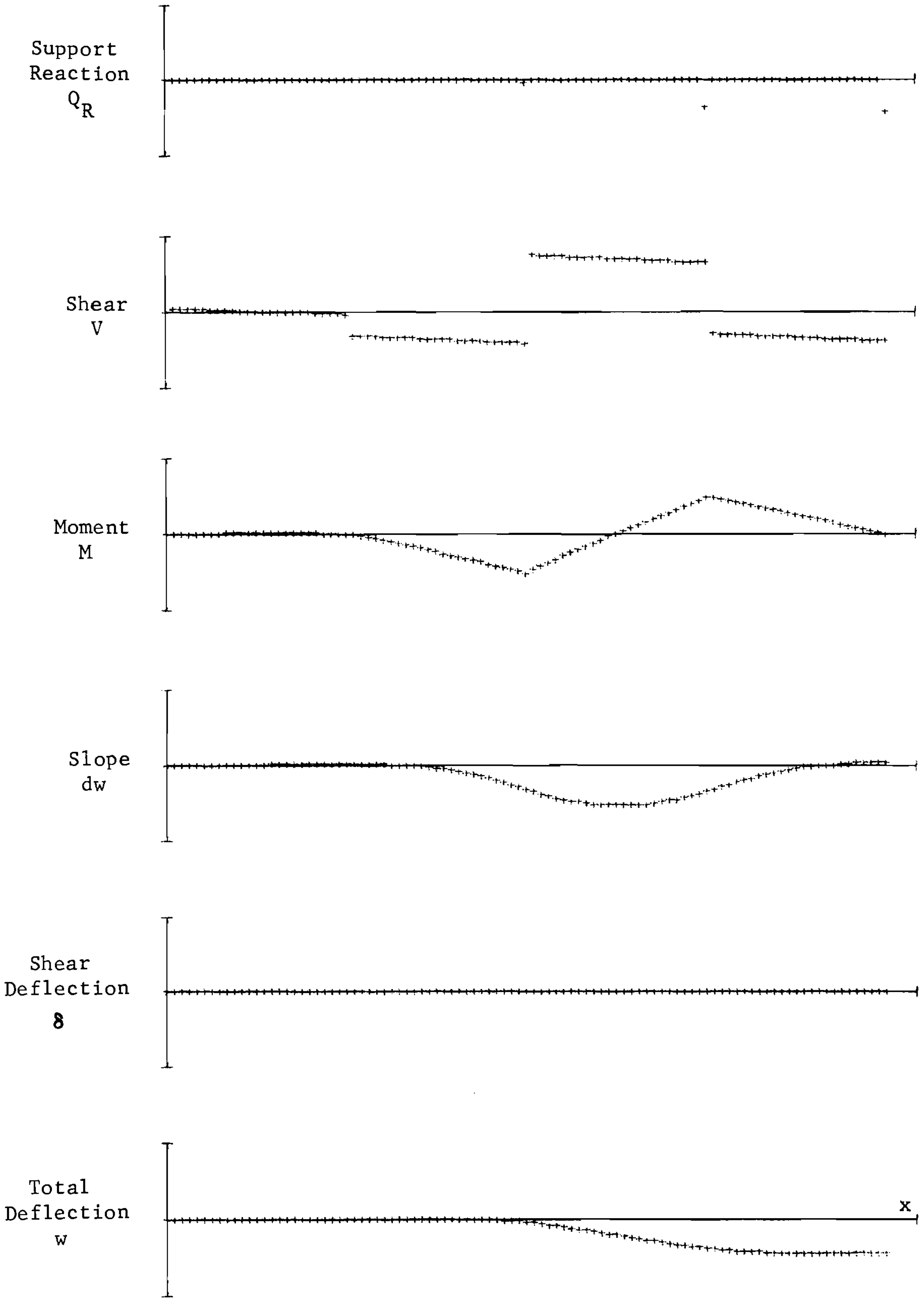
```
  83  -2.261E-02                        2.882E+04             0.
                 -6.883E-97 -2.719E-05            -6.883E+02
  84  -2.270E-02                        2.676E+04             0.
                 -6.968E-97 -1.863E-05            -6.968E+02
  85  -2.275E-02                        2.467E+04             0.
                 -7.053E-97 -1.074E-05            -7.053E+02
  86  -2.278E-02                        2.255E+04             0.
                 -7.138E-97 -3.521E-06            -7.138E+02
  87  -2.279E-02                        2.041E+04             0.
                 -7.223E-97  3.008E-06            -7.223E+02
  88  -2.278E-02                        1.824E+04             0.
                 -7.307E-97  8.845E-06            -7.307E+02
  89  -2.276E-02                        1.605E+04             0.
                 -7.392E-97  1.398E-05            -7.392E+02
  90  -2.272E-02                        1.383E+04             0.
                 -7.477E-97  1.841E-05            -7.477E+02
  91  -2.266E-02                        1.159E+04             0.
                 -7.562E-97  2.211E-05            -7.562E+02
  92  -2.259E-02                        9.323E+03             0.
                 -7.647E-97  2.510E-05            -7.647E+02
  93  -2.252E-02                        7.029E+03             0.
                 -7.731E-97  2.734E-05            -7.731E+02
  94  -2.244E-02                        4.710E+03             0.
                 -7.816E-97  2.885E-05            -7.816E+02
  95  -2.235E-02                        2.365E+03             0.
                 -7.901E-97  2.961E-05            -7.901E+02
  96  -2.226E-02                       -2.724E+00            -2.159E+04
                 -1.718-109  2.961E-05            -1.718E-10
  97  -2.217E-02                        0.                    0.

TABLE 7 -- SCALES FOR PLOT OUTPUT -- VALUES AT ENDS OF AXES

STA      X          W        DELTA        DW          M          V       SUP REACT
100  3.000E+02  5.000E-02  1.000E+00  5.000E-04  1.000E+05  2.000E+03  5.000E+04


                         TIME FOR THIS PROBLEM =     0 MINUTES    3.515 SECONDS


                         ELAPSED CPU TIME =     0 MINUTES   24.682 SECONDS
```



Prob 201B. Same as Prob 201A, neglecting shear deformations.

```
SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1  -  APPENDIX 6


PROB
202A     STEEL BRIDGE DIAPHRAGMS WITH WHEEL LOAD ON INTERIOR BEAMS


TABLE 1 - PROGRAM-CONTROL DATA
                                                              TABLES NUMBER
                                                          2     3     4A    4B    5

     PRIOR-DATA OPTIONS (1 = HOLD)                        1     0     1     0     1
     NUM CARDS INPUT THIS PROBLEM                         0     0     0     0     2

     OPTION (IF=1, 2, 3) TO PLOT                          1


TABLE 2 - CONSTANTS

     DATA HELD FROM THE PREVIOUS PROBLEM
     NUM INCREMENTS                                                              96
     INCREMENT LENGTH                                                     3.000E+00


TABLE 3 - SPECIFIED DEFLECTIONS

     STA         DEFLECTION


                 NONE


TABLE 4A - SECTION AND MATERIAL PROPERTIES

FROM TO CONTD       E           G           I           SA

     DATA HELD FROM THE PREVIOUS PROBLEM
  0  96   -0   3.000E+07 -0.          3.126E+02 -0.
  1  96   -0   -0.          1.100E+07 -0.          7.820E+00


TABLE 4B - STIFFNESS DATA

FROM TO CONTD      SK          F


                 NONE


TABLE 5 - LOAD DATA

FROM TO CONTD       Q           S           T           R           P
```

```
    DATA HELD FROM THE PREVIOUS PROBLEM
 0   0  -0  -0.        9.700E+05 -0.        1.840E+05 -0.
24  24  -0  -0.        9.700E+05 -0.        1.840E+05 -0.
48  48  -0  -0.        9.700E+05 -0.        1.840E+05 -0.
72  72  -0  -0.        9.700E+05 -0.        1.840E+05 -0.
96  96  -0  -0.        9.700E+05 -0.        1.840E+05 -0.
 0  96  -0  -8.480E+00 -0.       -0.       -0.        -0.
72  72  -0  -2.080E+04 -0.       -0.       -0.        -0.
96  96  -0  -2.080E+04 -0.       -0.       -0.        -0.
    ADDITICNAL DATA INPUT FOR THIS PROBLEM
96  96  -0   2.080F+04 -0.       -0.       -0.        -0.
48  48  -0  -2.080E+04 -0.       -0.       -0.        -0.
```

```
SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1  -  APPENDIX 6


PROB (CONTD)
202A     STEEL BRIDGE DIAPHRAGMS WITH WHEEL LOAD ON INTERIOR BEAMS


TABLE 6 - RESULTS

  STA      W        DELTA      SLOPE      MOM       SHEAR    SUP REACT

  -1   5.705E-04                        0.                   0.
                  0.         1.082E-05             0.
   0   6.030E-04                        9.952E-01            5.849E+02
                 -2.055E-05  1.082E-05            -5.891E+02
   1   6.560E-04                       -1.765E+03            0.
                 -2.084E-05  1.025E-05            -5.976E+02
   2   7.076E-04                       -3.558E+03            0.
                 -2.114E-05  9.115E-06            -6.061E+02
   3   7.561E-04                       -5.377E+03            0.
                 -2.143E-05  7.395E-06            -6.146E+02
   4   7.997E-04                       -7.220E+03            0.
                 -2.173E-05  5.085E-06            -6.231E+02
   5   8.367E-04                       -9.090E+03            0.
                 -2.203E-05  2.178E-06            -6.315E+02
   6   8.653E-04                       -1.098E+04            0.
                 -2.232E-05 -1.336E-06            -6.400E+02
   7   8.836E-04                       -1.290E+04            0.
                 -2.262E-05 -5.464E-06            -6.485E+02
   8   8.898E-04                       -1.485E+04            0.
                 -2.291E-05 -1.021E-05            -6.570E+02
   9   8.821E-04                       -1.682E+04            0.
                 -2.321E-05 -1.560E-05            -6.655E+02
  10   8.585E-04                       -1.882E+04            0.
                 -2.350E-05 -2.162E-05            -6.739E+02
  11   8.171E-04                       -2.084E+04            0.
                 -2.380E-05 -2.828E-05            -6.824E+02
  12   7.561E-04                       -2.289E+04            0.
                 -2.410E-05 -3.560E-05            -6.909E+02
  13   6.734E-04                       -2.496E+04            0.
                 -2.439E-05 -4.359E-05            -6.994E+02
  14   5.670E-04                       -2.706E+04            0.
                 -2.469E-05 -5.224E-05            -7.079E+02
  15   4.350E-04                       -2.918E+04            0.
                 -2.498E-05 -6.158E-05            -7.163E+02
  16   2.752E-04                       -3.133E+04            0.
                 -2.528E-05 -7.160E-05            -7.248E+02
  17   8.569E-05                       -3.350E+04            0.
                 -2.557E-05 -8.232E-05            -7.333E+02
  18  -1.357E-04                       -3.570E+04            0.
                 -2.587E-05 -9.374E-05            -7.418E+02
  19  -3.910E-04                       -3.793E+04            0.
                 -2.617E-05 -1.059E-04            -7.503E+02
  20  -6.825E-04                       -4.018E+04            0.
                 -2.646E-05 -1.187E-04            -7.587E+02
  21  -1.012E-03                       -4.246E+04            0.
                 -2.676E-05 -1.323E-04            -7.672E+02
```

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22  -1.382E-03                          -4.476E+04               0.
               -2.705E-05 -1.466E-04               -7.757E+02
23  -1.795E-03                          -4.709E+04               0.
               -2.735E-05 -1.617E-04               -7.842E+02
24  -2.253E-03                          -4.945E+04              -2.185E+03
                4.857E-05 -1.775E-04                1.393E+03
25  -2.834E-03                          -4.529E+04               0.
                4.827E-05 -1.920E-04                1.384E+03
26  -3.458E-03                          -4.114E+04               0.
                4.798E-05 -2.052E-04                1.376E+03
27  -4.122E-03                          -3.701E+04               0.
                4.768E-05 -2.170E-04                1.367E+03
28  -4.820E-03                          -3.291E+04               0.
                4.739E-05 -2.275E-04                1.359E+03
29  -5.550E-03                          -2.883E+04               0.
                4.709E-05 -2.368E-04                1.350E+03
30  -6.308E-03                          -2.478E+04               0.
                4.680E-05 -2.447E-04                1.342E+03
31  -7.089E-03                          -2.076E+04               0.
                4.650E-05 -2.513E-04                1.333E+03
32  -7.889E-03                          -1.676E+04               0.
                4.620E-05 -2.567E-04                1.325E+03
33  -8.705E-03                          -1.278E+04               0.
                4.591E-05 -2.608E-04                1.316E+03
34  -9.533E-03                          -8.834E+03               0.
                4.561E-05 -2.636E-04                1.308E+03
35  -1.037E-02                          -4.910E+03               0.
                4.532E-05 -2.652E-04                1.299E+03
36  -1.121E-02                          -1.012E+03               0.
                4.502E-05 -2.655E-04                1.291E+03
37  -1.205E-02                           2.861E+03               0.
                4.473E-05 -2.646E-04                1.282E+03
38  -1.289E-02                           6.708E+03               0.
                4.443E-05 -2.624E-04                1.274E+03
39  -1.372E-02                           1.053E+04               0.
                4.413E-05 -2.591E-04                1.265E+03
40  -1.454E-02                           1.433E+04               0.
                4.384E-05 -2.545E-04                1.257E+03
41  -1.535E-02                           1.810E+04               0.
                4.354E-05 -2.487E-04                1.249E+03
42  -1.614E-02                           2.184E+04               0.
                4.325E-05 -2.417E-04                1.240E+03
43  -1.691E-02                           2.556E+04               0.
                4.295E-05 -2.335E-04                1.232E+03
44  -1.765E-02                           2.926E+04               0.
                4.266E-05 -2.242E-04                1.223E+03
45  -1.837E-02                           3.293E+04               0.
                4.236E-05 -2.136E-04                1.215E+03
46  -1.905E-02                           3.657E+04               0.
                4.206E-05 -2.019E-04                1.206E+03
47  -1.970E-02                           4.019E+04               0.
                4.177E-05 -1.891E-04                1.198E+03
48  -2.031E-02                           4.376E+04              -1.970E+04
                3.054E-06 -1.751E-04                8.756E+01
49  -2.084E-02                           4.401E+04               0.
                2.758E-06 -1.610E-04                7.908E+01
50  -2.132E-02                           4.425E+04               0.
                2.462E-06 -1.468E-04                7.060E+01
51  -2.176E-02                           4.446E+04               0.
                2.167E-06 -1.326E-04                6.212E+01
52  -2.216E-02                           4.465E+04               0.
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                1.871E-06 -1.183E-04             5.364E+01
53  -2.252E-02                        4.481E+04              0.
                1.575E-06 -1.040E-04             4.516E+01
54  -2.284E-02                        4.494E+04              0.
                1.279E-06 -8.963E-05             3.668E+01
55  -2.311E-02                        4.505E+04              0.
                9.836E-07 -7.521E-05             2.820E+01
56  -2.333E-02                        4.514E+04              0.
                6.879E-07 -6.077E-05             1.972E+01
57  -2.351E-02                        4.520E+04              0.
                3.922E-07 -4.632E-05             1.124E+01
58  -2.365E-02                        4.523E+04              0.
                9.641E-08 -3.185E-05             2.765E+00
59  -2.375E-02                        4.524E+04              0.
               -1.993E-07 -1.738E-05            -5.715E+00
60  -2.380E-02                        4.522E+04              0.
               -4.951E-07 -2.909E-06            -1.420E+01
61  -2.381E-02                        4.518E+04              0.
               -7.908E-07  1.154E-05            -2.268E+01
62  -2.377E-02                        4.511E+04              0.
               -1.087E-06  2.597E-05            -3.116E+01
63  -2.370E-02                        4.502E+04              0.
               -1.382E-06  4.038E-05            -3.964E+01
64  -2.357E-02                        4.490E+04              0.
               -1.678E-06  5.474E-05            -4.812E+01
65  -2.341E-02                        4.475E+04              0.
               -1.974E-06  6.905E-05            -5.660E+01
66  -2.320E-02                        4.458E+04              0.
               -2.270E-06  8.332E-05            -6.508E+01
67  -2.295E-02                        4.439E+04              0.
               -2.565E-06  9.752E-05            -7.356E+01
68  -2.265E-02                        4.417E+04              0.
               -2.861E-06  1.116E-04            -8.204E+01
69  -2.231E-02                        4.392E+04              0.
               -3.157E-06  1.257E-04            -9.052E+01
70  -2.193E-02                        4.365E+04              0.
               -3.453E-06  1.397E-04            -9.900E+01
71  -2.151E-02                        4.335E+04              0.
               -3.748E-06  1.535E-04            -1.075E+02
72  -2.105E-02                        4.305E+04             -2.041E+04
               -1.749E-05  1.673E-04            -5.014E+02
73  -2.053E-02                        4.156E+04              0.
               -1.778E-05  1.806E-04            -5.099E+02
74  -1.997E-02                        4.003E+04              0.
               -1.808E-05  1.934E-04            -5.184E+02
75  -1.937E-02                        3.847E+04              0.
               -1.837E-05  2.057E-04            -5.268E+02
76  -1.873E-02                        3.689E+04              0.
               -1.867E-05  2.175E-04            -5.353E+02
77  -1.806E-02                        3.529E+04              0.
               -1.897E-05  2.288E-04            -5.438E+02
78  -1.736E-02                        3.365E+04              0.
               -1.926E-05  2.396E-04            -5.523E+02
79  -1.662E-02                        3.200E+04              0.
               -1.956E-05  2.498E-04            -5.608E+02
80  -1.585E-02                        3.031E+04              0.
               -1.985E-05  2.595E-04            -5.692E+02
81  -1.505E-02                        2.861E+04              0.
               -2.015E-05  2.686E-04            -5.777E+02
82  -1.423E-02                        2.687E+04              0.
               -2.044E-05  2.772E-04            -5.862E+02
```

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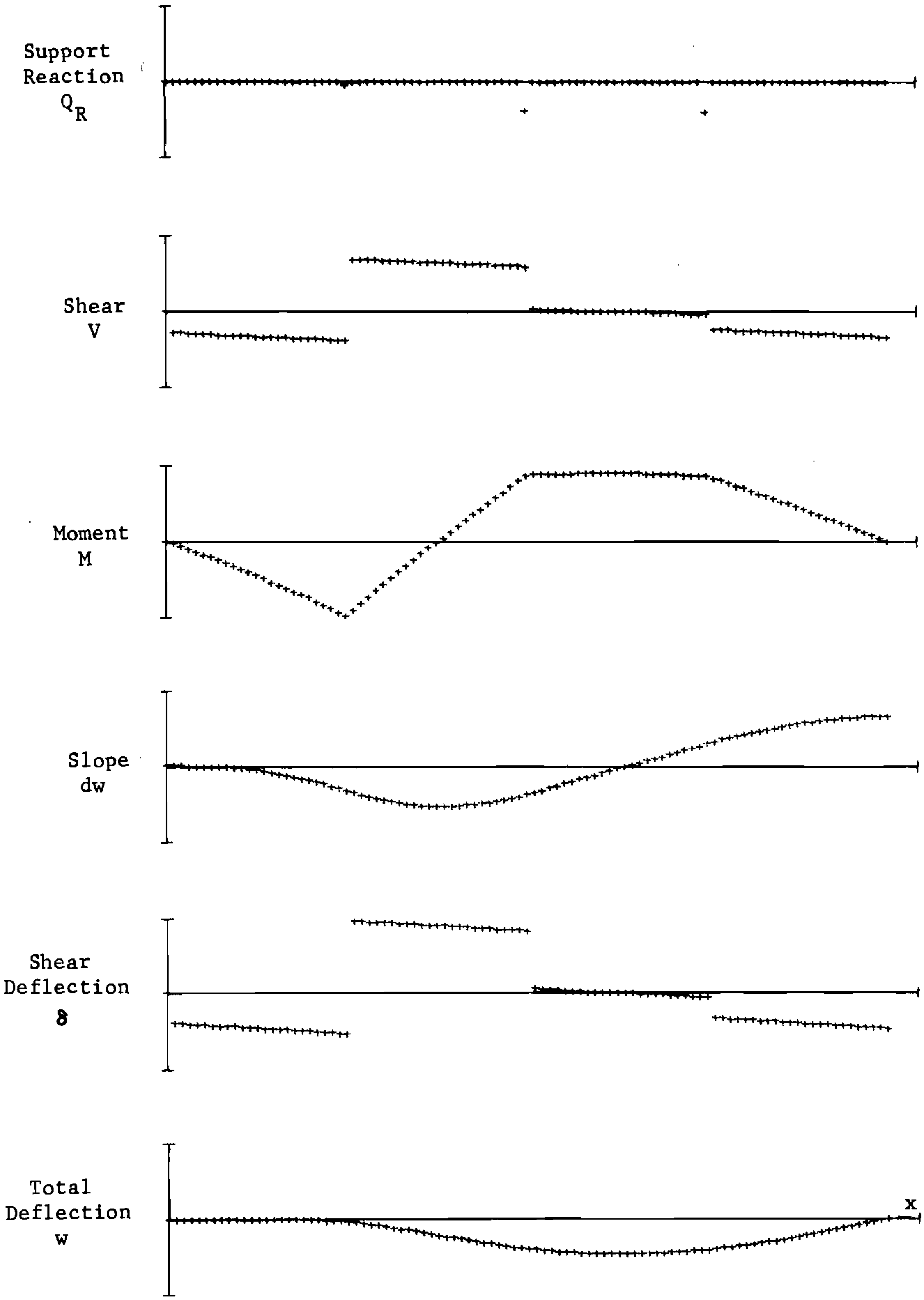
  83  -1.337E-02                      2.512E+04             0.
                -2.074E-05  2.853E-04           -5.947E+02
  84  -1.250E-02                      2.333E+04             0.
                -2.104E-05  2.927E-04           -6.032E+02
  85  -1.160E-02                      2.152E+04             0.
                -2.133E-05  2.996E-04           -6.116E+02
  86  -1.068E-02                      1.969E+04             0.
                -2.163E-05  3.059E-04           -6.201E+02
  87  -9.738E-03                      1.783E+04             0.
                -2.192E-05  3.116E-04           -6.286E+02
  88  -8.781E-03                      1.594E+04             0.
                -2.222E-05  3.167E-04           -6.371E+02
  89  -7.809E-03                      1.403E+04             0.
                -2.251E-05  3.212E-04           -6.456E+02
  90  -6.822E-03                      1.209E+04             0.
                -2.281E-05  3.251E-04           -6.540E+02
  91  -5.824E-03                      1.013E+04             0.
                -2.311E-05  3.283E-04           -6.625E+02
  92  -4.816E-03                      8.143E+03             0.
                -2.340E-05  3.309E-04           -6.710E+02
  93  -3.800E-03                      6.130E+03             0.
                -2.370E-05  3.329E-04           -6.795E+02
  94  -2.778E-03                      4.092E+03             0.
                -2.399E-05  3.342E-04           -6.880E+02
  95  -1.751E-03                      2.028E+03             0.
                -2.429E-05  3.348E-04           -6.964E+02
  96  -7.224E-04                     -3.080E+01            -7.007E+02
                 4.566E-20  3.348E-04            1.309E-12
  97   2.821E-04                      0.                    0.

TABLE 7 -- SCALES FOR PLOT OUTPUT -- VALUES AT ENDS OF AXES

STA       X          W        DELTA       DW          M          V      SUP REACT
100  3.000E+02  5.000E-02  5.000E-05  5.000E-04  5.000E+04  2.000E+03  5.000E+04


                        TIME FOR THIS PROBLEM =     0 MINUTES    3.554 SECONDS


                        ELAPSED CPU TIME =     0 MINUTES   28.236 SECONDS
```



Prob 202A. Steel bridge diaphragms with wheel loads on interior beams.

```
SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1  -  APPENDIX 6


PROB
202B     SAME AS PROBLEM 202A - ADD INFINITE SHEAR STIFFNESS


TABLE 1 - PROGRAM-CONTROL DATA
                                                             TABLES NUMBER
                                                         2    3    4A   4B   5

     PRIOR-DATA OPTIONS (1 = HOLD)                       1    0    1    0    1
     NUM CARDS INPUT THIS PROBLEM                        0    0    0    1    0

     OPTION (IF=1, 2, 3) TO PLOT                         1


TABLE 2 - CONSTANTS

     DATA HELD FROM THE PREVIOUS PROBLEM
     NUM INCREMENTS                                                         96
     INCREMENT LENGTH                                                3.000E+00


TABLE 3 - SPECIFIED DEFLECTIONS

     STA       DEFLECTION


               NONE


TABLE 4A - SECTION AND MATERIAL PROPERTIES

FROM TO CONTD     E         G           I          SA

     DATA HELD FROM THE PREVIOUS PROBLEM
  0  96  -0   3.000E+07 -0.         3.126E+02 -0.
  1  96  -0  -0.         1.100E+07 -0.         7.820E+00


TABLE 4B - STIFFNESS DATA

FROM TO CONTD    SK         F

     ADDITIONAL DATA INPUT FOR THIS PROBLEM
  1  96  -0   1.000E+99 -0.

TABLE 5 - LOAD DATA

FROM TO CONTD     Q          S          T          R          P
```

```
      DATA HELD FROM THE PREVIOUS PROBLEM
  0    0   -0   -0.            9.700E+05 -0.           1.840E+05 -0.
 24   24   -0   -0.            9.700E+05 -0.           1.840E+05 -0.
 48   48   -0   -0.            9.700E+05 -0.           1.840E+05 -0.
 72   72   -0   -0.            9.700E+05 -0.           1.840E+05 -0.
 96   96   -0   -0.            9.700E+05 -0.           1.840E+05 -0.
  0   96   -0   -8.480E+00 -0.         -0.         -0.          -0.
 72   72   -0   -2.080E+04 -0.         -0.         -0.          -0.
 96   96   -0   -2.080E+04 -0.         -0.         -0.          -0.
 96   96   -0    2.080E+04 -0.         -0.         -0.          -0.
 48   48   -0   -2.080E+04 -0.         -0.         -0.          -0.
```

```
PROB (CONTD)
202B      SAME AS PROBLEM 202A - ADD INFINITE SHEAR STIFFNESS


TABLE 6 - RESULTS

 STA       W          DELTA       SLOPE        MOM         SHEAR      SUP REACT

 -1   5.958E-04                               0.                      0.
                   0.          2.091E-05                 0.
  0   6.586E-04                               1.924E+00               6.388E+02
                 -6.431E-97   2.091E-05                -6.431E+02
  1   7.213E-04                              -1.925E+03               0.
                 -6.515E-97   2.030E-05                -6.515E+02
  2   7.822E-04                              -3.880E+03               0.
                 -6.600E-97   1.906E-05                -6.600E+02
  3   8.394E-04                              -5.860E+03               0.
                 -6.685E-97   1.718E-05                -6.685E+02
  4   8.909E-04                              -7.865E+03               0.
                 -6.770E-97   1.467E-05                -6.770E+02
  5   9.349E-04                              -9.896E+03               0.
                 -6.855E-97   1.150E-05                -6.855E+02
  6   9.694E-04                              -1.195E+04               0.
                 -6.939E-97   7.678E-06                -6.939E+02
  7   9.925E-04                              -1.403E+04               0.
                 -7.024E-97   3.188E-06                -7.024E+02
  8   1.002E-03                              -1.614E+04               0.
                 -7.109E-97  -1.976E-06                -7.109E+02
  9   9.961E-04                              -1.827E+04               0.
                 -7.194E-97  -7.822E-06                -7.194E+02
 10   9.726E-04                              -2.043E+04               0.
                 -7.279E-97  -1.436E-05                -7.279E+02
 11   9.296E-04                              -2.262E+04               0.
                 -7.363E-97  -2.159E-05                -7.363E+02
 12   8.648E-04                              -2.483E+04               0.
                 -7.448E-97  -2.953E-05                -7.448E+02
 13   7.762E-04                              -2.706E+04               0.
                 -7.533E-97  -3.819E-05                -7.533E+02
 14   6.616E-04                              -2.932E+04               0.
                 -7.618E-97  -4.757E-05                -7.618E+02
 15   5.189E-04                              -3.160E+04               0.
                 -7.703E-97  -5.768E-05                -7.703E+02
 16   3.459E-04                              -3.392E+04               0.
                 -7.787E-97  -6.853E-05                -7.787E+02
 17   1.403E-04                              -3.625E+04               0.
                 -7.872E-97  -8.013E-05                -7.872E+02
 18  -1.001E-04                              -3.861E+04               0.
                 -7.957E-97  -9.248E-05                -7.957E+02
 19  -3.775E-04                              -4.100E+04               0.
                 -8.042E-97  -1.056E-04                -8.042E+02
 20  -6.943E-04                              -4.341E+04               0.
                 -8.127E-97  -1.195E-04                -8.127E+02
 21  -1.053E-03                              -4.585E+04               0.
                 -8.211E-97  -1.342E-04                -8.211E+02
```

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22  -1.455E-03                    -4.831E+04           0.
              -8.296E-97 -1.496E-04         -8.296E+02
23  -1.904E-03                    -5.080E+04           0.
              -8.381E-97 -1.659E-04         -8.381E+02
24  -2.402E-03                    -5.333E+04          -2.330E+03
               1.483E-96 -1.829E-04          1.483E+03
25  -2.950E-03                    -4.890E+04           0.
               1.475E-96 -1.986E-04          1.475E+03
26  -3.546E-03                    -4.448E+04           0.
               1.466E-96 -2.128E-04          1.466E+03
27  -4.184E-03                    -4.008E+04           0.
               1.458E-96 -2.256E-04          1.458E+03
28  -4.861E-03                    -3.571E+04           0.
               1.449E-96 -2.370E-04          1.449E+03
29  -5.572E-03                    -3.136E+04           0.
               1.441E-96 -2.471E-04          1.441E+03
30  -6.314E-03                    -2.704E+04           0.
               1.432E-96 -2.557E-04          1.432E+03
31  -7.081E-03                    -2.274E+04           0.
               1.424E-96 -2.630E-04          1.424E+03
32  -7.870E-03                    -1.847E+04           0.
               1.415E-96 -2.689E-04          1.415E+03
33  -8.676E-03                    -1.422E+04           0.
               1.407E-96 -2.734E-04          1.407E+03
34  -9.497E-03                    -1.000E+04           0.
               1.398E-96 -2.766E-04          1.398E+03
35  -1.033E-02                    -5.810E+03           0.
               1.390E-96 -2.785E-04          1.390E+03
36  -1.116E-02                    -1.641E+03           0.
               1.381E-96 -2.790E-04          1.381E+03
37  -1.200E-02                     2.503E+03           0.
               1.373E-96 -2.782E-04          1.373E+03
38  -1.283E-02                     6.621E+03           0.
               1.364E-96 -2.761E-04          1.364E+03
39  -1.366E-02                     1.071E+04           0.
               1.356E-96 -2.727E-04          1.356E+03
40  -1.448E-02                     1.478E+04           0.
               1.347E-96 -2.680E-04          1.347E+03
41  -1.528E-02                     1.882E+04           0.
               1.339E-96 -2.619E-04          1.339E+03
42  -1.607E-02                     2.284E+04           0.
               1.330E-96 -2.546E-04          1.330E+03
43  -1.683E-02                     2.683E+04           0.
               1.322E-96 -2.460E-04          1.322E+03
44  -1.757E-02                     3.080E+04           0.
               1.313E-96 -2.362E-04          1.313E+03
45  -1.828E-02                     3.474E+04           0.
               1.305E-96 -2.251E-04          1.305E+03
46  -1.896E-02                     3.865E+04           0.
               1.296E-96 -2.127E-04          1.296E+03
47  -1.959E-02                     4.254E+04           0.
               1.288E-96 -1.991E-04          1.288E+03
48  -2.019E-02                     4.639E+04          -1.959E+04
               6.514E-98 -1.843E-04          6.514E+01
49  -2.074E-02                     4.656E+04           0.
               5.666E-98 -1.694E-04          5.666E+01
50  -2.125E-02                     4.673E+04           0.
               4.818E-98 -1.544E-04          4.818E+01
51  -2.172E-02                     4.688E+04           0.
               3.970E-98 -1.394E-04          3.970E+01
52  -2.213E-02                     4.700E+04           0.
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               3.122E-98 -1.244E-04             3.122E+01
53  -2.251E-02                       4.709E+04            0.
               2.274E-98 -1.093E-04             2.274E+01
54  -2.284E-02                       4.716E+04            0.
               1.426E-98 -9.425E-05             1.426E+01
55  -2.312E-02                       4.720E+04            0.
               5.781E-99 -7.915E-05             5.781E+00
56  -2.336E-02                       4.722E+04            0.
              -2.699E-99 -6.404E-05            -2.699E+00
57  -2.355E-02                       4.721E+04            0.
              -1.118E-98 -4.894E-05            -1.118E+01
58  -2.369E-02                       4.718E+04            0.
              -1.966E-98 -3.384E-05            -1.966E+01
59  -2.380E-02                       4.712E+04            0.
              -2.814E-98 -1.877E-05            -2.814E+01
60  -2.385E-02                       4.703E+04            0.
              -3.662E-98 -3.725E-06            -3.662E+01
61  -2.386E-02                       4.692E+04            0.
              -4.510E-98  1.129E-05            -4.510E+01
62  -2.383E-02                       4.679E+04            0.
              -5.358E-98  2.625E-05            -5.358E+01
63  -2.375E-02                       4.663E+04            0.
              -6.206E-98  4.117E-05            -6.206E+01
64  -2.363E-02                       4.644E+04            0.
              -7.054E-98  5.603E-05            -7.054E+01
65  -2.346E-02                       4.623E+04            0.
              -7.902E-98  7.082E-05            -7.902E+01
66  -2.325E-02                       4.599E+04            0.
              -8.750E-98  8.553E-05            -8.750E+01
67  -2.299E-02                       4.573E+04            0.
              -9.598E-98  1.002E-04            -9.598E+01
68  -2.269E-02                       4.544E+04            0.
              -1.045E-97  1.147E-04            -1.045E+02
69  -2.235E-02                       4.513E+04            0.
              -1.129E-97  1.291E-04            -1.129E+02
70  -2.196E-02                       4.479E+04            0.
              -1.214E-97  1.435E-04            -1.214E+02
71  -2.153E-02                       4.443E+04            0.
              -1.299E-97  1.577E-04            -1.299E+02
72  -2.105E-02                       4.405E+04           -2.042E+04
              -5.154E-97  1.718E-04            -5.154E+02
73  -2.054E-02                       4.252E+04            0.
              -5.239E-97  1.854E-04            -5.239E+02
74  -1.998E-02                       4.095E+04            0.
              -5.324E-97  1.985E-04            -5.324E+02
75  -1.939E-02                       3.935E+04            0.
              -5.408E-97  2.111E-04            -5.408E+02
76  -1.875E-02                       3.773E+04            0.
              -5.493E-97  2.231E-04            -5.493E+02
77  -1.809E-02                       3.608E+04            0.
              -5.578E-97  2.347E-04            -5.578E+02
78  -1.738E-02                       3.441E+04            0.
              -5.663E-97  2.457E-04            -5.663E+02
79  -1.664E-02                       3.271E+04            0.
              -5.748E-97  2.561E-04            -5.748E+02
80  -1.588E-02                       3.099E+04            0.
              -5.832E-97  2.661E-04            -5.832E+02
81  -1.508E-02                       2.924E+04            0.
              -5.917E-97  2.754E-04            -5.917E+02
82  -1.425E-02                       2.746E+04            0.
              -6.002E-97  2.842E-04            -6.002E+02
```

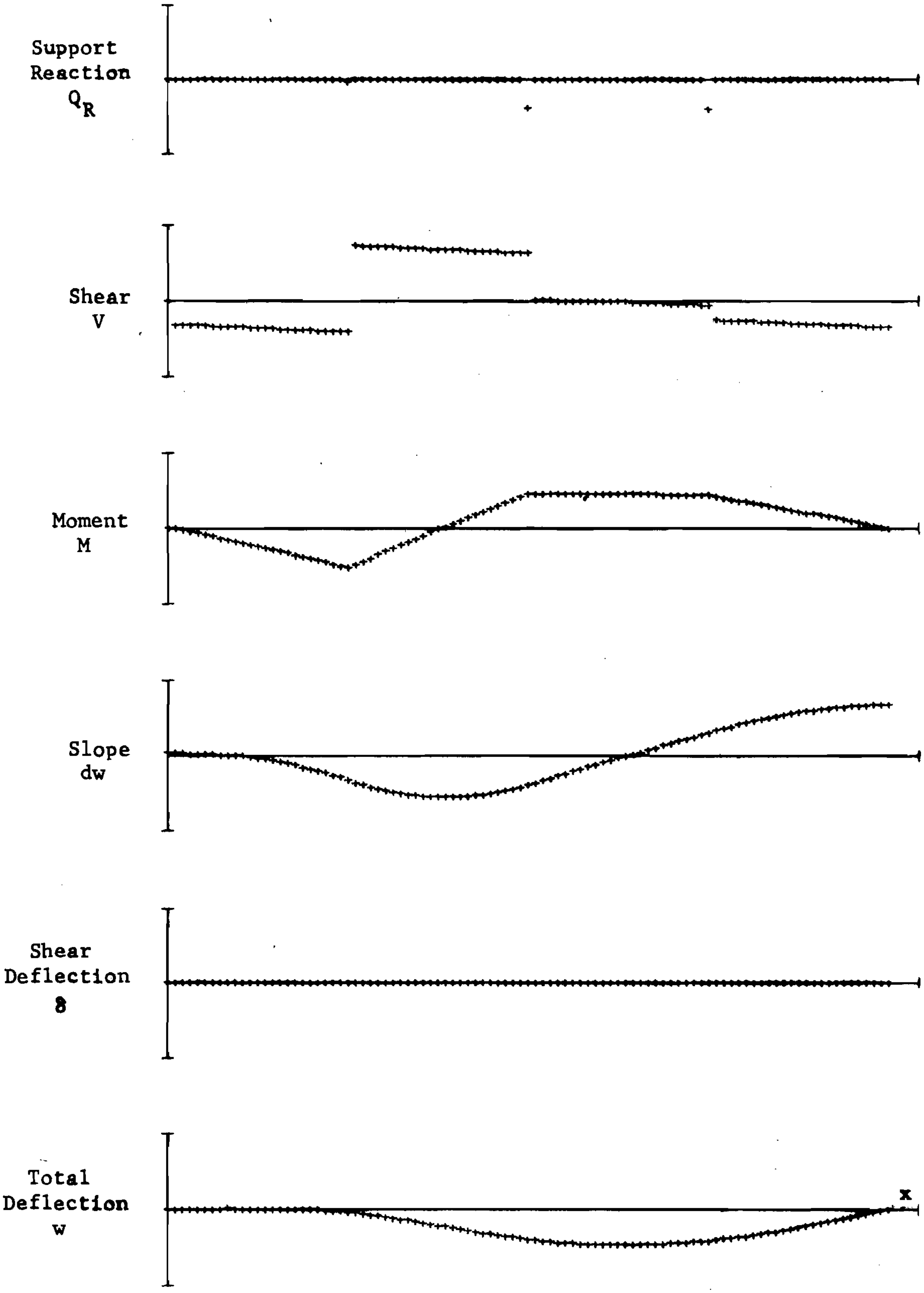
```
  83  -1.340E-02                     2.566E+04           0.
                -6.087E-97 2.924E-04          -6.087E+02
  84  -1.252E-02                     2.383E+04           0.
                -6.172E-97 3.000E-04          -6.172E+02
  85  -1.162E-02                     2.198E+04           0.
                -6.256E-97 3.071E-04          -6.256E+02
  86  -1.070E-02                     2.011E+04           0.
                -6.341E-97 3.135E-04          -6.341E+02
  87  -9.760E-03                     1.820E+04           0.
                -6.426E-97 3.193E-04          -6.426E+02
  88  -8.802E-03                     1.628E+04           0.
                -6.511E-97 3.245E-04          -6.511E+02
  89  -7.828E-03                     1.432E+04           0.
                -6.596E-97 3.291E-04          -6.596E+02
  90  -6.841E-03                     1.234E+04           0.
                -6.680E-97 3.330E-04          -6.680E+02
  91  -5.842E-03                     1.034E+04           0.
                -6.765E-97 3.364E-04          -6.765E+02
  92  -4.833E-03                     8.310E+03           0.
                -6.850E-97 3.390E-04          -6.850E+02
  93  -3.816E-03                     6.255E+03           0.
                -6.935E-97 3.410E-04          -6.935E+02
  94  -2.793E-03                     4.174E+03           0.
                -7.020E-97 3.423E-04          -7.020E+02
  95  -1.766E-03                     2.068E+03           0.
                -7.104E-97 3.430E-04          -7.104E+02
  96  -7.368E-04                    -3.156E+01          -7.147E+02
                 1.343-111 3.430E-04           1.343E-12
  97   2.922E-04                     0.                  0.

TABLE 7 -- SCALES FOR PLOT OUTPUT -- VALUES AT ENDS OF AXES

STA       X          W        DELTA        DW          M          V      SUP REACT
100  3.000E+02  5.000E-02  1.000E+00  5.000E-04  1.000E+05  2.000E+03  5.000E+04


                                  TIME FOR THIS PROBLEM =     0 MINUTES    3.523 SECONDS


                                  ELAPSED CPU TIME =     0 MINUTES   31.759 SECONDS
```



Prob 202B. Same as Prob 202A, neglecting shear deformations.

```
SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1  -  APPENDIX 6


PROB
203A     STEEL BRIDGE DIAPHRAGMS WITH WHEEL LOAD AT CENTER OF DIAPHRAGM


TABLE 1 - PROGRAM-CONTROL DATA
                                                             TABLES NUMBER
                                                         2    3    4A   4B   5

     PRIOR-DATA OPTIONS (1 = HOLD)                       1    0    1    0    1
     NUM CARDS INPUT THIS PROBLEM                        0    0    0    0    4

     OPTION (IF=1, 2, 3) TO PLOT                         1


TABLE 2 - CONSTANTS

     DATA HELD FROM THE PREVIOUS PROBLEM
     NUM INCREMENTS                                                            96
     INCREMENT LENGTH                                                   3.000E+00


TABLE 3 - SPECIFIED DEFLECTIONS

     STA       DEFLECTION


               NONE


TABLE 4A - SECTION AND MATERIAL PROPERTIES

FROM TO CONTD     E         G           I          SA

     DATA HELD FROM THE PREVIOUS PROBLEM
  0  96  -0    3.000E+07 -0.          3.126E+02 -0.
  1  96  -0   -0.          1.100E+07 -0.          7.820E+00


TABLE 4B - STIFFNESS DATA

FROM TO CONTD    SK         F


               NONE

TABLE 5 - LOAD DATA

FROM TO CONTD     Q          S          T          R          P
```

```
    DATA HELD FROM THE PREVIOUS PROBLEM
 0   0  -0  -0.         9.700E+05 -0.          1.840E+05 -0.
24  24  -0  -0.         9.700E+05 -0.          1.840E+05 -0.
48  48  -0  -0.         9.700E+05 -0.          1.840E+05 -0.
72  72  -0  -0.         9.700E+05 -0.          1.840E+05 -0.
96  96  -0  -0.         9.700E+05 -0.          1.840E+05 -0.
 0  96  -0  -8.480E+00 -0.        -0.         -0.        -0.
72  72  -0  -2.080E+04 -0.        -0.         -0.        -0.
96  96  -0  -2.080E+04 -0.        -0.         -0.        -0.
96  96  -0   2.080E+04 -0.        -0.         -0.        -0.
48  48  -0  -2.080E+04 -0.        -0.         -0.        -0.
    ADDITIONAL DATA INPUT FOR THIS PROBLEM
48  48  -0   2.080E+04 -0.        -0.         -0.        -0.
72  72  -0   2.080E+04 -0.        -0.         -0.        -0.
36  36  -0  -2.080E+04 -0.        -0.         -0.        -0.
60  60  -0  -2.080E+04 -0.        -0.         -0.        -0.
```

PROB (CONTD)
203A STEEL BRIDGE DIAPHRAGMS WITH WHEEL LOAD AT CENTER OF DIAPHRAGM

TABLE 6 - RESULTS

```
 STA      W          DELTA      SLOPE           MOM          SHEAR       SUP REACT

  -1   1.520E-03                        0.                      0.
                  0.         -7.133E-05             0.
   0   1.306E-03                        -6.563E+00              1.267E+03
                  -4.433E-05 -7.133E-05             -1.271E+03
   1   1.136E-03                        -3.826E+03              0.
                  -4.462E-05 -7.256E-05             -1.279E+03
   2   9.632E-04                        -7.664E+03              0.
                  -4.492E-05 -7.501E-05             -1.288E+03
   3   7.831E-04                        -1.153E+04              0.
                  -4.521E-05 -7.870E-05             -1.296E+03
   4   5.922E-04                        -1.542E+04              0.
                  -4.551E-05 -8.363E-05             -1.305E+03
   5   3.868E-04                        -1.933E+04              0.
                  -4.581E-05 -8.981E-05             -1.313E+03
   6   1.632E-04                        -2.327E+04              0.
                  -4.610E-05 -9.726E-05             -1.322E+03
   7  -8.248E-05                        -2.724E+04              0.
                  -4.640E-05 -1.060E-04             -1.330E+03
   8  -3.540E-04                        -3.123E+04              0.
                  -4.669E-05 -1.160E-04             -1.339E+03
   9  -6.552E-04                        -3.525E+04              0.
                  -4.699E-05 -1.272E-04             -1.347E+03
  10  -9.899E-04                        -3.929E+04              0.
                  -4.728E-05 -1.398E-04             -1.356E+03
  11  -1.362E-03                        -4.335E+04              0.
                  -4.758E-05 -1.537E-04             -1.364E+03
  12  -1.775E-03                        -4.745E+04              0.
                  -4.788E-05 -1.689E-04             -1.373E+03
  13  -2.234E-03                        -5.157E+04              0.
                  -4.817E-05 -1.853E-04             -1.381E+03
  14  -2.742E-03                        -5.571E+04              0.
                  -4.847E-05 -2.032E-04             -1.390E+03
  15  -3.303E-03                        -5.988E+04              0.
                  -4.876E-05 -2.223E-04             -1.398E+03
  16  -3.921E-03                        -6.407E+04              0.
                  -4.906E-05 -2.428E-04             -1.407E+03
  17  -4.601E-03                        -6.829E+04              0.
                  -4.935E-05 -2.647E-04             -1.415E+03
  18  -5.345E-03                        -7.254E+04              0.
                  -4.965E-05 -2.879E-04             -1.424E+03
  19  -6.159E-03                        -7.681E+04              0.
                  -4.995E-05 -3.124E-04             -1.432E+03
  20  -7.047E-03                        -8.111E+04              0.
                  -5.024E-05 -3.384E-04             -1.441E+03
  21  -8.012E-03                        -8.543E+04              0.
                  -5.054E-05 -3.657E-04             -1.449E+03
```

```
22  -9.058E-03                       -8.977E+04             0.
               -5.083E-05 -3.944E-04            -1.458E+03
23  -1.019E-02                       -9.415E+04             0.
               -5.113E-05 -4.246E-04            -1.466E+03
24  -1.141E-02                       -9.859E+04            -1.107E+04
                3.347E-04 -4.561E-04             9.596E+03
25  -1.312E-02                       -6.984E+04             0.
                3.344E-04 -4.784E-04             9.588E+03
26  -1.489E-02                       -4.107E+04             0.
                3.341E-04 -4.916E-04             9.579E+03
27  -1.669E-02                       -1.234E+04             0.
                3.338E-04 -4.955E-04             9.571E+03
28  -1.852E-02                        1.638E+04             0.
                3.335E-04 -4.903E-04             9.562E+03
29  -2.032E-02                        4.506E+04             0.
                3.332E-04 -4.759E-04             9.554E+03
30  -2.208E-02                        7.373E+04             0.
                3.329E-04 -4.523E-04             9.545E+03
31  -2.377E-02                        1.024E+05             0.
                3.326E-04 -4.195E-04             9.537E+03
32  -2.536E-02                        1.310E+05             0.
                3.323E-04 -3.776E-04             9.529E+03
33  -2.683E-02                        1.596E+05             0.
                3.320E-04 -3.266E-04             9.520E+03
34  -2.814E-02                        1.881E+05             0.
                3.317E-04 -2.664E-04             9.512E+03
35  -2.927E-02                        2.167E+05             0.
                3.314E-04 -1.971E-04             9.503E+03
36  -3.019E-02                        2.452E+05             0.
               -3.943E-04 -1.187E-04            -1.131E+04
37  -3.015E-02                        2.112E+05             0.
               -3.946E-04 -5.110E-05            -1.131E+04
38  -2.991E-02                        1.773E+05             0.
               -3.949E-04  5.621E-06            -1.132E+04
39  -2.950E-02                        1.433E+05             0.
               -3.952E-04  5.147E-05            -1.133E+04
40  -2.895E-02                        1.093E+05             0.
               -3.955E-04  8.645E-05            -1.134E+04
41  -2.830E-02                        7.533E+04             0.
               -3.958E-04  1.106E-04            -1.135E+04
42  -2.757E-02                        4.129E+04             0.
               -3.961E-04  1.238E-04            -1.136E+04
43  -2.680E-02                        7.216E+03             0.
               -3.964E-04  1.261E-04            -1.136E+04
44  -2.603E-02                       -2.688E+04             0.
               -3.966E-04  1.175E-04            -1.137E+04
45  -2.528E-02                       -6.100E+04             0.
               -3.969E-04  9.796E-05            -1.138E+04
46  -2.459E-02                       -9.514E+04             0.
               -3.972E-04  6.752E-05            -1.139E+04
47  -2.399E-02                       -1.293E+05             0.
               -3.975E-04  2.615E-05            -1.140E+04
48  -2.351E-02                       -1.635E+05            -2.281E+04
                3.975E-04 -2.615E-05             1.140E+04
49  -2.399E-02                       -1.293E+05             0.
                3.972E-04 -6.752E-05             1.139E+04
50  -2.459E-02                       -9.514E+04             0.
                3.969E-04 -9.796E-05             1.138E+04
51  -2.528E-02                       -6.100E+04             0.
                3.966E-04 -1.175E-04             1.137E+04
52  -2.603E-02                       -2.688E+04             0.
```

```
                3.964E-04 -1.261E-04             1.136E+04
 53 -2.680E-02                        7.216E+03             0.
                3.961E-04 -1.238E-04             1.136E+04
 54 -2.757E-02                        4.129E+04             0.
                3.958E-04 -1.106E-04             1.135E+04
 55 -2.830E-02                        7.533E+04             0.
                3.955E-04 -8.645E-05             1.134E+04
 56 -2.895E-02                        1.093E+05             0.
                3.952E-04 -5.147E-05             1.133E+04
 57 -2.950E-02                        1.433E+05             0.
                3.949E-04 -5.621E-06             1.132E+04
 58 -2.991E-02                        1.773E+05             0.
                3.946E-04  5.110E-05             1.131E+04
 59 -3.015E-02                        2.112E+05             0.
                3.943E-04  1.187E-04             1.131E+04
 60 -3.019E-02                        2.452E+05             0.
               -3.314E-04  1.971E-04            -9.503E+03
 61 -2.927E-02                        2.167E+05             0.
               -3.317E-04  2.664E-04            -9.512E+03
 62 -2.814E-02                        1.881E+05             0.
               -3.320E-04  3.266E-04            -9.520E+03
 63 -2.683E-02                        1.596E+05             0.
               -3.323E-04  3.776E-04            -9.529E+03
 64 -2.536E-02                        1.310E+05             0.
               -3.326E-04  4.195E-04            -9.537E+03
 65 -2.377E-02                        1.024E+05             0.
               -3.329E-04  4.523E-04            -9.545E+03
 66 -2.208E-02                        7.373E+04             0.
               -3.332E-04  4.759E-04            -9.554E+03
 67 -2.032E-02                        4.506E+04             0.
               -3.335E-04  4.903E-04            -9.562E+03
 68 -1.852E-02                        1.638E+04             0.
               -3.338E-04  4.955E-04            -9.571E+03
 69 -1.669E-02                       -1.234E+04             0.
               -3.341E-04  4.916E-04            -9.579E+03
 70 -1.489E-02                       -4.107E+04             0.
               -3.344E-04  4.784E-04            -9.588E+03
 71 -1.312E-02                       -6.984E+04             0.
               -3.347E-04  4.561E-04            -9.596E+03
 72 -1.141E-02                       -9.859E+04            -1.107E+04
                5.113E-05  4.246E-04             1.466E+03
 73 -1.019E-02                       -9.415E+04             0.
                5.083E-05  3.944E-04             1.458E+03
 74 -9.058E-03                       -8.977E+04             0.
                5.054E-05  3.657E-04             1.449E+03
 75 -8.012E-03                       -8.543E+04             0.
                5.024E-05  3.384E-04             1.441E+03
 76 -7.047E-03                       -8.111E+04             0.
                4.995E-05  3.124E-04             1.432E+03
 77 -6.159E-03                       -7.681E+04             0.
                4.965E-05  2.879E-04             1.424E+03
 78 -5.345E-03                       -7.254E+04             0.
                4.935E-05  2.647E-04             1.415E+03
 79 -4.601E-03                       -6.829E+04             0.
                4.906E-05  2.428E-04             1.407E+03
 80 -3.921E-03                       -6.407E+04             0.
                4.876E-05  2.223E-04             1.398E+03
 81 -3.303E-03                       -5.988E+04             0.
                4.847E-05  2.032E-04             1.390E+03
 82 -2.742E-03                       -5.571E+04             0.
                4.817E-05  1.853E-04             1.381E+03
```

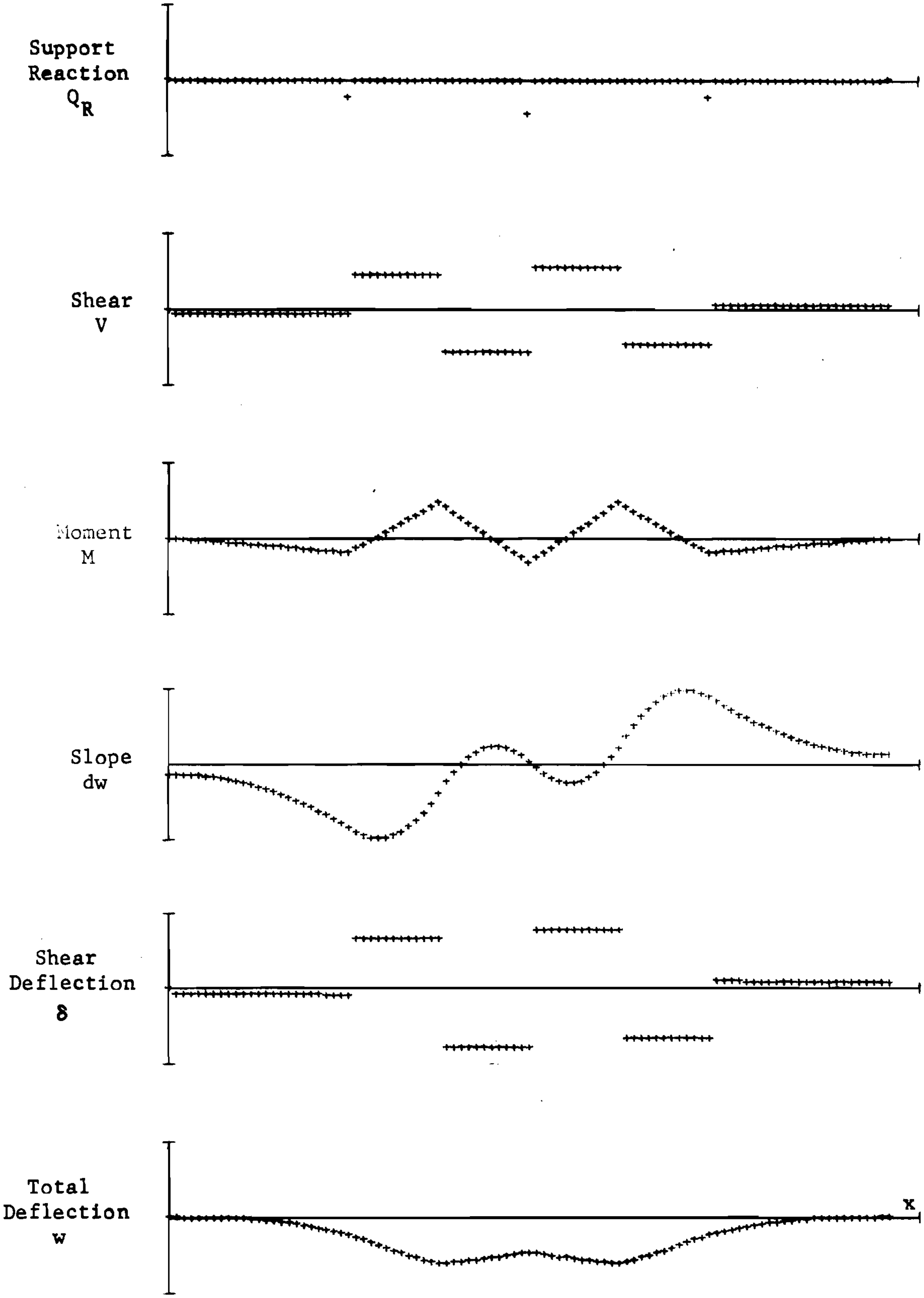
```
83  -2.234E-03                     -5.157E+04            0.
               4.788E-05  1.689E-04            1.373E+03
84  -1.775E-03                     -4.745E+04            0.
               4.758E-05  1.537E-04            1.364E+03
85  -1.362E-03                     -4.335E+04            0.
               4.728E-05  1.398E-04            1.356E+03
86  -9.899E-04                     -3.929E+04            0.
               4.699E-05  1.272E-04            1.347E+03
87  -6.552E-04                     -3.525E+04            0.
               4.669E-05  1.160E-04            1.339E+03
88  -3.540E-04                     -3.123E+04            0.
               4.640E-05  1.060E-04            1.330E+03
89  -8.248E-05                     -2.724E+04            0.
               4.610E-05  9.726E-05            1.322E+03
90   1.632E-04                     -2.327E+04            0.
               4.581E-05  8.981E-05            1.313E+03
91   3.868E-04                     -1.933E+04            0.
               4.551E-05  8.363E-05            1.305E+03
92   5.922E-04                     -1.542E+04            0.
               4.521E-05  7.870E-05            1.296E+03
93   7.831E-04                     -1.153E+04            0.
               4.492E-05  7.501E-05            1.288E+03
94   9.632E-04                     -7.664E+03            0.
               4.462E-05  7.256E-05            1.279E+03
95   1.136E-03                     -3.826E+03            0.
               4.433E-05  7.133E-05            1.271E+03
96   1.306E-03                     -6.563E+00            1.267E+03
               3.653E-19  7.133E-05            1.047E-11
97   1.520E-03                      0.                   0.

TABLE 7 -- SCALES FOR PLOT OUTPUT -- VALUES AT ENDS OF AXES

STA      X          W         DELTA        DW          M          V        SUP REACT
100  3.000E+02  5.000E-02  5.000E-04  5.000E-04  5.000E+05  2.000E+04  5.000E+04


                        TIME FOR THIS PROBLEM =     0 MINUTES    3.573 SECONDS


                        ELAPSED CPU TIME =     0 MINUTES   35.332 SECONDS
```



Prob 203A. Steel bridge diaphragms with wheel load at center of diaphragm.

```
SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1  -  APPENDIX 6


PROB
203B     SAME AS PROBLEM 203A - ADD INFINITE SHEAR STIFFNESS


TABLE 1 - PROGRAM-CONTROL DATA
                                                              TABLES NUMBER
                                                          2    3    4A   4B    5

     PRIOR-DATA OPTIONS (1 = HOLD)                        1    0    1    0     1
     NUM CARDS INPUT THIS PROBLEM                         0    0    0    1     0

     OPTION (IF=1, 2, 3) TO PLOT                          1


TABLE 2 - CONSTANTS

     DATA HELD FROM THE PREVIOUS PROBLEM
     NUM INCREMENTS                                                               96
     INCREMENT LENGTH                                                      3.000E+00


TABLE 3 - SPECIFIED DEFLECTIONS

     STA       DEFLECTION


               NONE


TABLE 4A - SECTION AND MATERIAL PROPERTIES

FROM TO CONTD     E         G           I          SA

     DATA HELD FROM THE PREVIOUS PROBLEM
  0  96  -0    3.000E+07 -0.         3.126E+02 -0.
  1  96  -0   -0.         1.100E+07 -0.         7.820E+00


TABLE 4B - STIFFNESS DATA

FROM TO CONTD    SK         F

     ADDITIONAL DATA INPUT FOR THIS PROBLEM
  1  96  -0    1.000E+99 -0.

TABLE 5 - LOAD DATA

FROM TO CONTD     Q          S          T          R          P
```

```
     DATA HELD FROM THE PREVIOUS PROBLEM
  0   0  -0  -0.         9.700E+05 -0.         1.840E+05 -0.
 24  24  -0  -0.         9.700E+05 -0.         1.840E+05 -0.
 48  48  -0  -0.         9.700E+05 -0.         1.840E+05 -0.
 72  72  -0  -0.         9.700E+05 -0.         1.840E+05 -0.
 96  96  -0  -0.         9.700E+05 -0.         1.840E+05 -0.
  0  96  -0  -8.480E+00 -0.        -0.        -0.        -0.
 72  72  -0  -2.080E+04 -0.        -0.        -0.        -0.
 96  96  -0  -2.080E+04 -0.        -0.        -0.        -0.
 96  96  -0   2.080E+04 -0.        -0.        -0.        -0.
 48  48  -0  -2.080E+04 -0.        -0.        -0.        -0.
 48  48  -0   2.080E+04 -0.        -0.        -0.        -0.
 72  72  -0   2.080E+04 -0.        -0.        -0.        -0.
 36  36  -0  -2.080E+04 -0.        -0.        -0.        -0.
 60  60  -0  -2.080E+04 -0.        -0.        -0.        -0.
```

```
SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1  -  APPENDIX 6


PROB  (CONTD)
203B     SAME AS PROBLEM 203A - ADD INFINITE SHEAR STIFFNESS


TABLE 6 - RESULTS

  STA      W        DELTA      SLOPE      MOM        SHEAR   SUP REACT

  -1    1.478E-03                        0.                   0.
                  0.        -5.438E-05            0.
   0    1.315E-03                      -5.003E+00             1.275E+03
                 -1.279E-96 -5.438E-05           -1.279E+03
   1    1.151E-03                      -3.848E+03             0.
                 -1.288E-96 -5.562E-05           -1.288E+03
   2    9.845E-04                      -7.711E+03             0.
                 -1.296E-96 -5.808E-05           -1.296E+03
   3    8.103E-04                      -1.160E+04             0.
                 -1.305E-96 -6.179E-05           -1.305E+03
   4    6.249E-04                      -1.551E+04             0.
                 -1.313E-96 -6.676E-05           -1.313E+03
   5    4.246E-04                      -1.945E+04             0.
                 -1.322E-96 -7.298E-05           -1.322E+03
   6    2.057E-04                      -2.342E+04             0.
                 -1.330E-96 -8.047E-05           -1.330E+03
   7   -3.574E-05                      -2.741E+04             0.
                 -1.339E-96 -8.924E-05           -1.339E+03
   8   -3.035E-04                      -3.143E+04             0.
                 -1.347E-96 -9.929E-05           -1.347E+03
   9   -6.013E-04                      -3.547E+04             0.
                 -1.356E-96 -1.106E-04           -1.356E+03
  10   -9.333E-04                      -3.953E+04             0.
                 -1.364E-96 -1.233E-04           -1.364E+03
  11   -1.303E-03                      -4.363E+04             0.
                 -1.373E-96 -1.372E-04           -1.373E+03
  12   -1.715E-03                      -4.774E+04             0.
                 -1.381E-96 -1.525E-04           -1.381E+03
  13   -2.172E-03                      -5.189E+04             0.
                 -1.390E-96 -1.691E-04           -1.390E+03
  14   -2.680E-03                      -5.606E+04             0.
                 -1.398E-96 -1.870E-04           -1.398E+03
  15   -3.241E-03                      -6.025E+04             0.
                 -1.407E-96 -2.063E-04           -1.407E+03
  16   -3.860E-03                      -6.447E+04             0.
                 -1.415E-96 -2.269E-04           -1.415E+03
  17   -4.541E-03                      -6.872E+04             0.
                 -1.423E-96 -2.489E-04           -1.423E+03
  18   -5.287E-03                      -7.299E+04             0.
                 -1.432E-96 -2.723E-04           -1.432E+03
  19   -6.104E-03                      -7.728E+04             0.
                 -1.440E-96 -2.970E-04           -1.440E+03
  20   -6.995E-03                      -8.160E+04             0.
                 -1.449E-96 -3.231E-04           -1.449E+03
  21   -7.965E-03                      -8.595E+04             0.
                 -1.457E-96 -3.506E-04           -1.457E+03
```

```
  22 -9.016E-03                     -9.032E+04            0.
               -1.466E-96-3.795E-04          -1.466E+03
  23 -1.015E-02                     -9.472E+04            0.
               -1.474E-96-4.098E-04          -1.474E+03
  24 -1.138E-02                     -9.918E+04          -1.104E+04
                9.560E-96-4.415E-04           9.560E+03
  25 -1.271E-02                     -7.054E+04            0.
                9.551E-96-4.641E-04           9.551E+03
  26 -1.410E-02                     -4.189E+04            0.
                9.543E-96-4.775E-04           9.543E+03
  27 -1.553E-02                     -1.326E+04            0.
                9.534E-96-4.817E-04           9.534E+03
  28 -1.698E-02                      1.534E+04            0.
                9.526E-96-4.768E-04           9.526E+03
  29 -1.841E-02                      4.392E+04            0.
                9.517E-96-4.628E-04           9.517E+03
  30 -1.980E-02                      7.247E+04            0.
                9.509E-96-4.396E-04           9.509E+03
  31 -2.112E-02                      1.010E+05            0.
                9.500E-96-4.073E-04           9.500E+03
  32 -2.234E-02                      1.295E+05            0.
                9.492E-96-3.658E-04           9.492E+03
  33 -2.344E-02                      1.580E+05            0.
                9.483E-96-3.153E-04           9.483E+03
  34 -2.438E-02                      1.864E+05            0.
                9.475E-96-2.557E-04           9.475E+03
  35 -2.515E-02                      2.149E+05            0.
                9.467E-96-1.869E-04           9.467E+03
  36 -2.571E-02                      2.433E+05            0.
               -1.134E-95-1.091E-04          -1.134E+04
  37 -2.604E-02                      2.092E+05            0.
               -1.135E-95-4.219E-05          -1.135E+04
  38 -2.616E-02                      1.752E+05            0.
               -1.136E-95 1.385E-05          -1.136E+04
  39 -2.617E-02                      1.411E+05            0.
               -1.137E-95 5.899E-05          -1.137E+04
  40 -2.594E-02                      1.070E+05            0.
               -1.138E-95 9.321E-05          -1.138E+04
  41 -2.566E-02                      7.287E+04            0.
               -1.138E-95 1.165E-04          -1.138E+04
  42 -2.532E-02                      3.872E+04            0.
               -1.139E-95 1.289E-04          -1.139E+04
  43 -2.493E-02                      4.538E+03            0.
               -1.140E-95 1.304E-04          -1.140E+04
  44 -2.454E-02                     -2.967E+04            0.
               -1.141E-95 1.209E-04          -1.141E+04
  45 -2.417E-02                     -6.390E+04            0.
               -1.142E-95 1.004E-04          -1.142E+04
  46 -2.387E-02                     -9.815E+04            0.
               -1.143E-95 6.903E-05          -1.143E+04
  47 -2.367E-02                     -1.324E+05            0.
               -1.144E-95 2.667E-05          -1.144E+04
  48 -2.359E-02                     -1.667E+05          -2.288E+04
                1.144E-95-2.667E-05           1.144E+04
  49 -2.367E-02                     -1.324E+05            0.
                1.143E-95-6.903E-05           1.143E+04
  50 -2.387E-02                     -9.815E+04            0.
                1.142E-95-1.004E-04           1.142E+04
  51 -2.417E-02                     -6.390E+04            0.
                1.141E-95-1.209E-04           1.141E+04
  52 -2.454E-02                     -2.967E+04            0.
```

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                1.140E-95 -1.304E-04             1.140E+04
53  -2.493E-02                        4.538E+03             0.
                1.139E-95 -1.289E-04             1.139E+04
54  -2.532E-02                        3.872E+04             0.
                1.138E-95 -1.165E-04             1.138E+04
55  -2.566E-02                        7.287E+04             0.
                1.138E-95 -9.321E-05             1.138E+04
56  -2.594E-02                        1.070E+05             0.
                1.137E-95 -5.899E-05             1.137E+04
57  -2.612E-02                        1.411E+05             0.
                1.136E-95 -1.385E-05             1.136E+04
58  -2.616E-02                        1.752E+05             0.
                1.135E-95  4.219E-05             1.135E+04
59  -2.604E-02                        2.092E+05             0.
                1.134E-95  1.091E-04             1.134E+04
60  -2.571E-02                        2.433E+05             0.
               -9.467E-96  1.869E-04            -9.467E+03
61  -2.515E-02                        2.149E+05             0.
               -9.475E-96  2.557E-04            -9.475E+03
62  -2.438E-02                        1.864E+05             0.
               -9.483E-96  3.153E-04            -9.483E+03
63  -2.344E-02                        1.580E+05             0.
               -9.492E-96  3.658E-04            -9.492E+03
64  -2.234E-02                        1.295E+05             0.
               -9.500E-96  4.073E-04            -9.500E+03
65  -2.112E-02                        1.010E+05             0.
               -9.509E-96  4.396E-04            -9.509E+03
66  -1.980E-02                        7.247E+04             0.
               -9.517E-96  4.628E-04            -9.517E+03
67  -1.841E-02                        4.392E+04             0.
               -9.526E-96  4.768E-04            -9.526E+03
68  -1.698E-02                        1.534E+04             0.
               -9.534E-96  4.817E-04            -9.534E+03
69  -1.553E-02                       -1.326E+04             0.
               -9.543E-96  4.775E-04            -9.543E+03
70  -1.410E-02                       -4.189E+04             0.
               -9.551E-96  4.641E-04            -9.551E+03
71  -1.271E-02                       -7.054E+04             0.
               -9.560E-96  4.415E-04            -9.560E+03
72  -1.138E-02                       -9.918E+04            -1.104E+04
                1.474E-96  4.098E-04             1.474E+03
73  -1.015E-02                       -9.472E+04             0.
                1.466E-96  3.795E-04             1.466E+03
74  -9.016E-03                       -9.032E+04             0.
                1.457E-96  3.506E-04             1.457E+03
75  -7.965E-03                       -8.595E+04             0.
                1.449E-96  3.231E-04             1.449E+03
76  -6.995E-03                       -8.160E+04             0.
                1.440E-96  2.970E-04             1.440E+03
77  -6.104E-03                       -7.728E+04             0.
                1.432E-96  2.723E-04             1.432E+03
78  -5.287E-03                       -7.299E+04             0.
                1.423E-96  2.489E-04             1.423E+03
79  -4.541E-03                       -6.872E+04             0.
                1.415E-96  2.269E-04             1.415E+03
80  -3.860E-03                       -6.447E+04             0.
                1.407E-96  2.063E-04             1.407E+03
81  -3.241E-03                       -6.025E+04             0.
                1.398E-96  1.870E-04             1.398E+03
82  -2.680E-03                       -5.606E+04             0.
                1.390E-96  1.691E-04             1.390E+03
```

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  83  -2.172E-03                       -5.189E+04            0.
                  1.381E-96  1.525E-04             1.381E+03
  84  -1.715E-03                       -4.774E+04            0.
                  1.373E-96  1.372E-04             1.373E+03
  85  -1.303E-03                       -4.363E+04            0.
                  1.364E-96  1.233E-04             1.364E+03
  86  -9.333E-04                       -3.953E+04            0.
                  1.356E-96  1.106E-04             1.356E+03
  87  -6.013E-04                       -3.547E+04            0.
                  1.347E-96  9.929E-05             1.347E+03
  88  -3.035E-04                       -3.143E+04            0.
                  1.339E-96  8.924E-05             1.339E+03
  89  -3.574E-05                       -2.741E+04            0.
                  1.330E-96  8.047E-05             1.330E+03
  90   2.057E-04                       -2.342E+04            0.
                  1.322E-96  7.298E-05             1.322E+03
  91   4.246E-04                       -1.945E+04            0.
                  1.313E-96  6.676E-05             1.313E+03
  92   6.249E-04                       -1.551E+04            0.
                  1.305E-96  6.179E-05             1.305E+03
  93   8.103E-04                       -1.160E+04            0.
                  1.296E-96  5.808E-05             1.296E+03
  94   9.845E-04                       -7.711E+03            0.
                  1.288E-96  5.562E-05             1.288E+03
  95   1.151E-03                       -3.848E+03            0.
                  1.279E-96  5.438E-05             1.279E+03
  96   1.315E-03                       -5.003E+00            1.275E+03
                  1.074-110  5.438E-05             1.074E-11
  97   1.478E-03                        0.                   0.

TABLE 7 -- SCALES FOR PLOT OUTPUT -- VALUES AT ENDS OF AXES

STA      X          W        DELTA        DW          M          V        SUP REACT
100  3.000E+02  5.000E-02  1.000E+00  5.000E-04  5.000E+05  2.000E+04  5.000E+04


                         TIME FOR THIS PROBLEM =     0 MINUTES    3.533 SECONDS


                         ELAPSED CPU TIME =     0 MINUTES   38.865 SECONDS
```

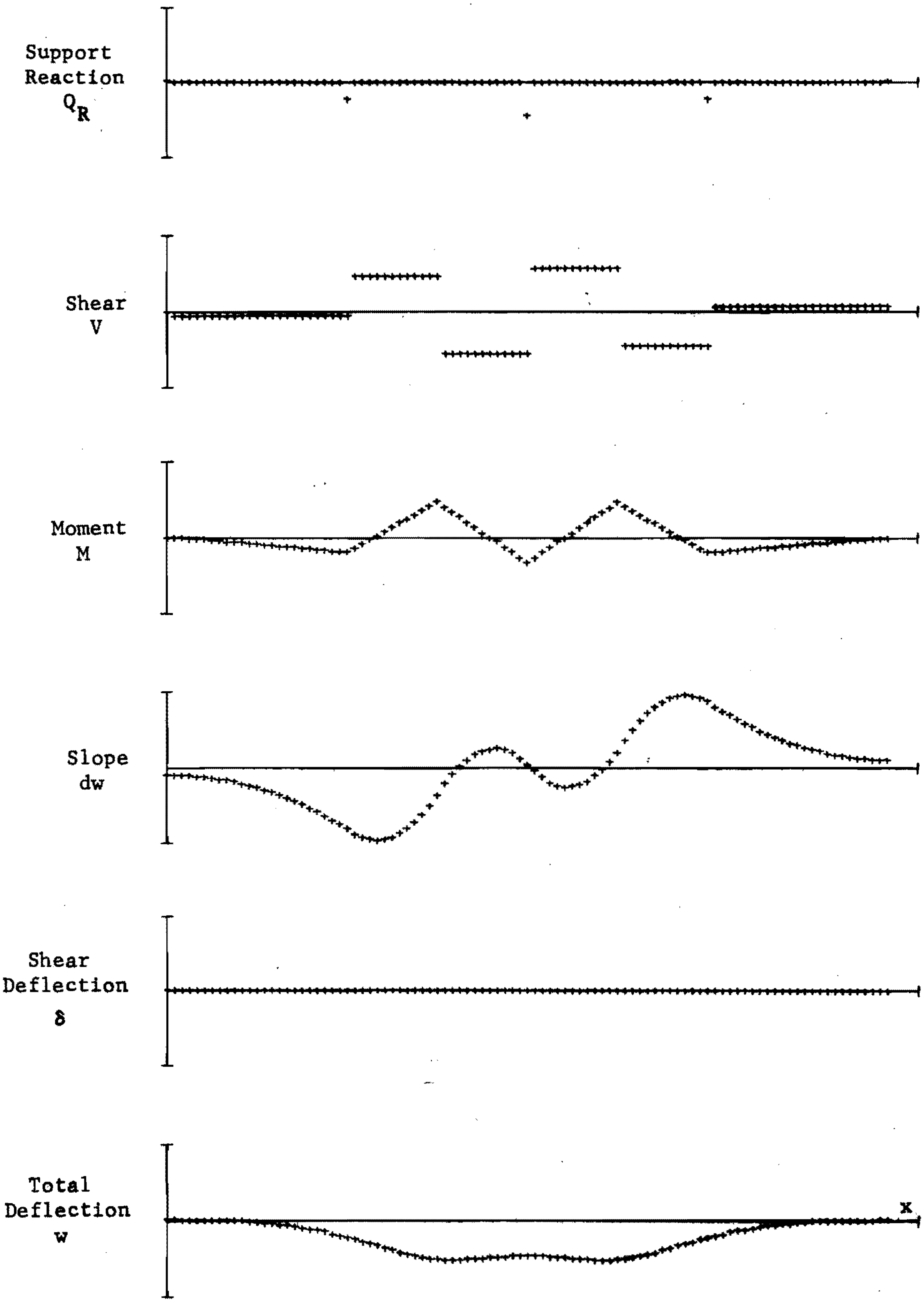

Prob 203B. Same as Prob 203A, neglecting shear deformations.

```
SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1  -  APPENDIX 6


PROB
301A     TAPERED THREE-SPAN OVERHANGING BEAM WITH 300 LB LOAD AT STA 0


TABLE 1 - PROGRAM-CONTROL DATA
                                                                TABLES NUMBER
                                                           2     3     4A    4B    5

     PRIOR-DATA OPTIONS (1 = HOLD)                        -0    -0    -0    -0    -0
     NUM CARDS INPUT THIS PROBLEM                          1     2    22     0     1

     OPTION (IF=1, 2, 3) TO PLOT                           1


TABLE 2 - CONSTANTS

     NUM INCREMENTS                                                               96
     INCREMENT LENGTH                                                      1.000E+00


TABLE 3 - SPECIFIED DEFLECTIONS

     STA         DEFLECTION

     36            0.
     60            0.


TABLE 4A - SECTION AND MATERIAL PROPERTIES

FROM TO CONTD      E            G            I            SA

     ADDITIONAL DATA INPUT FOR THIS PROBLEM
  0  96   0   1.000E+07 -0.          -0.          -0.
  1  96   0  -0.          4.000E+06 -0.          -0.
  0   0   0  -0.         -0.          5.546E-01 -0.
  1       1  -0.         -0.          7.421E-01  7.200E-02
      3   1  -0.         -0.          1.193E+00  8.740E-02
      6   1  -0.         -0.          2.034E+00  1.090E-01
     10   1  -0.         -0.          3.395E+00  1.360E-01
     14   1  -0.         -0.          4.937E+00  1.600E-01
     18   1  -0.         -0.          6.566E+00  1.810E-01
     23   1  -0.         -0.          8.592E+00  2.040E-01
     28   1  -0.         -0.          1.047E+01  2.220E-01
     35   1  -0.         -0.          1.260E+01  2.420E-01
     48   1  -0.         -0.          1.429E+01  2.560E-01
     61   1  -0.         -0.          1.260E+01  2.420E-01
     68   1  -0.         -0.          1.047E+01  2.220E-01
     73   1  -0.         -0.          8.592E+00  2.040E-01
     78   1  -0.         -0.          6.566E+00  1.810E-01
     82   1  -0.         -0.          4.937E+00  1.600E-01
```

```
     86    1  -0.           -0.           3.395E+00  1.360E-01
     90    1  -0.           -0.           2.034E+00  1.090E-01
     93    1  -0.           -0.           1.193E+00  8.740E-02
     96   -0  -0.           -0.           5.546E-01  6.440E-02


TABLE 4B - STIFFNESS DATA

FROM TO CONTD     SK           F


                NONE


TABLE 5 - LOAD DATA

FROM TO CONTD      Q            S            T            R            P

     ADDITIONAL DATA INPUT FOR THIS PROBLEM
  0    0  -0    3.000E+02 -0.         -0.          -0.          -0.
```

```
SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1  -  APPENDIX 6


PROB (CONTD)
301A     TAPERED THREE-SPAN OVERHANGING BEAM WITH 300 LB LOAD AT STA 0


TABLE 6 - RESULTS

 STA      W          DELTA       SLOPE        MOM        SHEAR      SUP REACT

  -1   1.142E-01                             0.                      0.
                   0.         -3.984E-03                0.
   0   1.102E-01                          -1.078E-09                 0.
                   1.042E-03 -3.984E-03                 3.000E+02
   1   1.052E-01                             3.000E+02               0.
                   9.410E-04 -3.944E-03                 3.000E+02
   2   1.003E-01                             6.000E+02               0.
                   8.581E-04 -3.882E-03                 3.000E+02
   3   9.556E-02                             9.000E+02               0.
                   7.928E-04 -3.806E-03                 3.000E+02
   4   9.097E-02                             1.200E+03               0.
                   7.367E-04 -3.725E-03                 3.000E+02
   5   8.650E-02                             1.500E+03               0.
                   6.881E-04 -3.639E-03                 3.000E+02
   6   8.218E-02                             1.800E+03               0.
                   6.479E-04 -3.551E-03                 3.000E+02
   7   7.798E-02                             2.100E+03               0.
                   6.122E-04 -3.462E-03                 3.000E+02
   8   7.390E-02                             2.400E+03               0.
                   5.803E-04 -3.374E-03                 3.000E+02
   9   6.995E-02                             2.700E+03               0.
                   5.515E-04 -3.285E-03                 3.000E+02
  10   6.611E-02                             3.000E+03               0.
                   5.282E-04 -3.197E-03                 3.000E+02
  11   6.239E-02                             3.300E+03               0.
                   5.068E-04 -3.110E-03                 3.000E+02
  12   5.877E-02                             3.600E+03               0.
                   4.870E-04 -3.023E-03                 3.000E+02
  13   5.526E-02                             3.900E+03               0.
                   4.687E-04 -2.938E-03                 3.000E+02
  14   5.185E-02                             4.200E+03               0.
                   4.539E-04 -2.853E-03                 3.000E+02
  15   4.855E-02                             4.500E+03               0.
                   4.399E-04 -2.768E-03                 3.000E+02
  16   4.534E-02                             4.800E+03               0.
                   4.267E-04 -2.685E-03                 3.000E+02
  17   4.223E-02                             5.100E+03               0.
                   4.144E-04 -2.602E-03                 3.000E+02
  18   3.921E-02                             5.400E+03               0.
                   4.041E-04 -2.520E-03                 3.000E+02
  19   3.629E-02                             5.700E+03               0.
                   3.943E-04 -2.438E-03                 3.000E+02
  20   3.346E-02                             6.000E+03               0.
                   3.850E-04 -2.357E-03                 3.000E+02
  21   3.071E-02                             6.300E+03               0.
                   3.761E-04 -2.276E-03                 3.000E+02
```

```
22   2.806E-02                         6.600E+03             0.
                3.676E-04 -2.195E-03              3.000E+02
23   2.550E-02                         6.900E+03             0.
                3.613E-04 -2.115E-03              3.000E+02
24   2.302E-02                         7.200E+03             0.
                3.551E-04 -2.035E-03              3.000E+02
25   2.063E-02                         7.500E+03             0.
                3.492E-04 -1.954E-03              3.000E+02
26   1.833E-02                         7.800E+03             0.
                3.434E-04 -1.874E-03              3.000E+02
27   1.611E-02                         8.100E+03             0.
                3.378E-04 -1.794E-03              3.000E+02
28   1.398E-02                         8.400E+03             0.
                3.335E-04 -1.714E-03              3.000E+02
29   1.193E-02                         8.700E+03             0.
                3.294E-04 -1.633E-03              3.000E+02
30   9.972E-03                         9.000E+03             0.
                3.253E-04 -1.552E-03              3.000E+02
31   8.095E-03                         9.300E+03             0.
                3.213E-04 -1.470E-03              3.000E+02
32   6.304E-03                         9.600E+03             0.
                3.174E-04 -1.388E-03              3.000E+02
33   4.598E-03                         9.900E+03             0.
                3.136E-04 -1.305E-03              3.000E+02
34   2.980E-03                         1.020E+04             0.
                3.099E-04 -1.222E-03              3.000E+02
35   1.447E-03                         1.050E+04             0.
                3.085E-04 -1.139E-03              3.000E+02
36   0.                                1.080E+04            -7.500E+02
               -4.608E-04 -1.054E-03             -4.500E+02
37  -5.933E-04                         1.035E+04             0.
               -4.588E-04 -9.736E-04             -4.500E+02
38  -1.108E-03                         9.900E+03             0.
               -4.567E-04 -8.974E-04             -4.500E+02
39  -1.549E-03                         9.450E+03             0.
               -4.548E-04 -8.253E-04             -4.500E+02
40  -1.919E-03                         9.000E+03             0.
               -4.528E-04 -7.574E-04             -4.500E+02
41  -2.224E-03                         8.550E+03             0.
               -4.508E-04 -6.935E-04             -4.500E+02
42  -2.467E-03                         8.100E+03             0.
               -4.489E-04 -6.335E-04             -4.500E+02
43  -2.651E-03                         7.650E+03             0.
               -4.470E-04 -5.775E-04             -4.500E+02
44  -2.782E-03                         7.200E+03             0.
               -4.451E-04 -5.252E-04             -4.500E+02
45  -2.862E-03                         6.750E+03             0.
               -4.432E-04 -4.766E-04             -4.500E+02
46  -2.895E-03                         6.300E+03             0.
               -4.413E-04 -4.317E-04             -4.500E+02
47  -2.886E-03                         5.850E+03             0.
               -4.395E-04 -3.904E-04             -4.500E+02
48  -2.837E-03                         5.400E+03             0.
               -4.413E-04 -3.526E-04             -4.500E+02
49  -2.748E-03                         4.950E+03             0.
               -4.432E-04 -3.176E-04             -4.500E+02
50  -2.622E-03                         4.500E+03             0.
               -4.451E-04 -2.856E-04             -4.500E+02
51  -2.463E-03                         4.050E+03             0.
               -4.470E-04 -2.564E-04             -4.500E+02
52  -2.272E-03                         3.600E+03             0.
```

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                -4.489E-04 -2.303E-04           -4.500E+02
53  -2.054E-03                         3.150E+03             0.
                -4.508E-04 -2.072E-04           -4.500E+02
54  -1.810E-03                         2.700E+03             0.
                -4.528E-04 -1.872E-04           -4.500E+02
55  -1.544E-03                         2.250E+03             0.
                -4.548E-04 -1.704E-04           -4.500E+02
56  -1.260E-03                         1.800E+03             0.
                -4.567E-04 -1.568E-04           -4.500E+02
57  -9.601E-04                         1.350E+03             0.
                -4.588E-04 -1.465E-04           -4.500E+02
58  -6.479E-04                         9.000E+02             0.
                -4.608E-04 -1.396E-04           -4.500E+02
59  -3.267E-04                         4.500E+02             0.
                -4.628E-04 -1.361E-04           -4.500E+02
60   0.                               -4.124E-09             4.500E+02
                -1.382E-16 -1.361E-04           -1.338E-10
61  -1.361E-04                        -3.286E-09             0.
                -1.383E-16 -1.361E-04           -1.323E-10
62  -2.722E-04                        -3.201E-09             0.
                -1.366E-16 -1.361E-04           -1.291E-10
63  -4.083E-04                        -3.095E-09             0.
                -1.381E-16 -1.361E-04           -1.289E-10
64  -5.444E-04                        -4.247E-09             0.
                -1.362E-16 -1.361E-04           -1.257E-10
65  -6.805E-04                        -3.742E-09             0.
                -1.344E-16 -1.361E-04           -1.224E-10
66  -8.166E-04                        -4.378E-09             0.
                -1.358E-16 -1.361E-04           -1.221E-10
67  -9.527E-04                        -4.703E-09             0.
                -1.309E-16 -1.361E-04           -1.162E-10
68  -1.089E-03                        -5.838E-09             0.
                -1.242E-16 -1.361E-04           -1.085E-10
69  -1.225E-03                        -6.336E-09             0.
                -1.176E-16 -1.361E-04           -1.010E-10
70  -1.361E-03                        -7.458E-09             0.
                -1.110E-16 -1.361E-04           -9.380E-11
71  -1.497E-03                        -4.587E-09             0.
                -1.046E-16 -1.361E-04           -8.687E-11
72  -1.633E-03                        -4.965E-09             0.
                -1.045E-16 -1.361E-04           -8.524E-11
73  -1.769E-03                        -6.691E-09             0.
                -9.907E-17 -1.361E-04           -7.902E-11
74  -1.905E-03                        -5.754E-09             0.
                -9.996E-17 -1.361E-04           -7.789E-11
75  -2.041E-03                        -9.802E-09             0.
                -1.010E-16 -1.361E-04           -7.686E-11
76  -2.177E-03                        -6.789E-09             0.
                -9.592E-17 -1.361E-04           -7.121E-11
77  -2.314E-03                        -6.935E-09             0.
                -8.438E-17 -1.361E-04           -6.109E-11
78  -2.450E-03                        -5.628E-09             0.
                -7.294E-17 -1.361E-04           -5.128E-11
79  -2.586E-03                        -3.531E-09             0.
                -7.476E-17 -1.361E-04           -5.099E-11
80  -2.722E-03                        -4.913E-09             0.
                -7.691E-17 -1.361E-04           -5.084E-11
81  -2.858E-03                        -4.972E-09             0.
                -8.668E-17 -1.361E-04           -5.547E-11
82  -2.994E-03                        -4.962E-09             0.
                -9.004E-17 -1.361E-04           -5.547E-11
```

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  83  -3.130E-03                       -1.090E-09             0.
                 -8.624E-17 -1.361E-04            -5.105E-11
  84  -3.266E-03                       -3.312E-09             0.
                 -8.247E-17 -1.361E-04            -4.684E-11
  85  -3.402E-03                       -2.481E-09             0.
                 -7.870E-17 -1.361E-04            -4.281E-11
  86  -3.538E-03                       -1.266E-09             0.
                 -7.435E-17 -1.361E-04            -3.844E-11
  87  -3.675E-03                       -1.712E-09             0.
                 -7.488E-17 -1.361E-04            -3.669E-11
  88  -3.811E-03                       -1.244E-09             0.
                 -6.519E-17 -1.361E-04            -3.018E-11
  89  -3.947E-03                        2.641E-10             0.
                 -5.407E-17 -1.361E-04            -2.357E-11
  90  -4.083E-03                        1.576E-10             0.
                 -4.632E-17 -1.361E-04            -1.886E-11
  91  -4.219E-03                       -1.301E-09             0.
                 -3.725E-17 -1.361E-04            -1.410E-11
  92  -4.355E-03                       -1.187E-09             0.
                 -3.454E-17 -1.361E-04            -1.207E-11
  93  -4.491E-03                       -8.176E-10             0.
                 -1.980E-17 -1.361E-04            -6.316E-12
  94  -4.627E-03                       -5.820E-10             0.
                 -2.366E-17 -1.361E-04            -6.822E-12
  95  -4.763E-03                       -1.016E-10             0.
                 -9.147E-18 -1.361E-04            -2.356E-12
  96  -4.899E-03                        1.786E-10             0.
                 -2.583E-19 -1.361E-04            -6.653E-14
  97  -5.035E-03                        0.                    0.

TABLE 7 -- SCALES FOR PLOT OUTPUT -- VALUES AT ENDS OF AXES

STA      X          W        DELTA       DW          M          V      SUP REACT
100  1.000E+02  2.000E-01  2.000E-03  5.000E-03  2.000E+04  5.000E+02  1.000E+03


                                    TIME FOR THIS PROBLEM =      0 MINUTES    3.599 SECONDS


                                    ELAPSED CPU TIME =      0 MINUTES   23.413 SECONDS
```

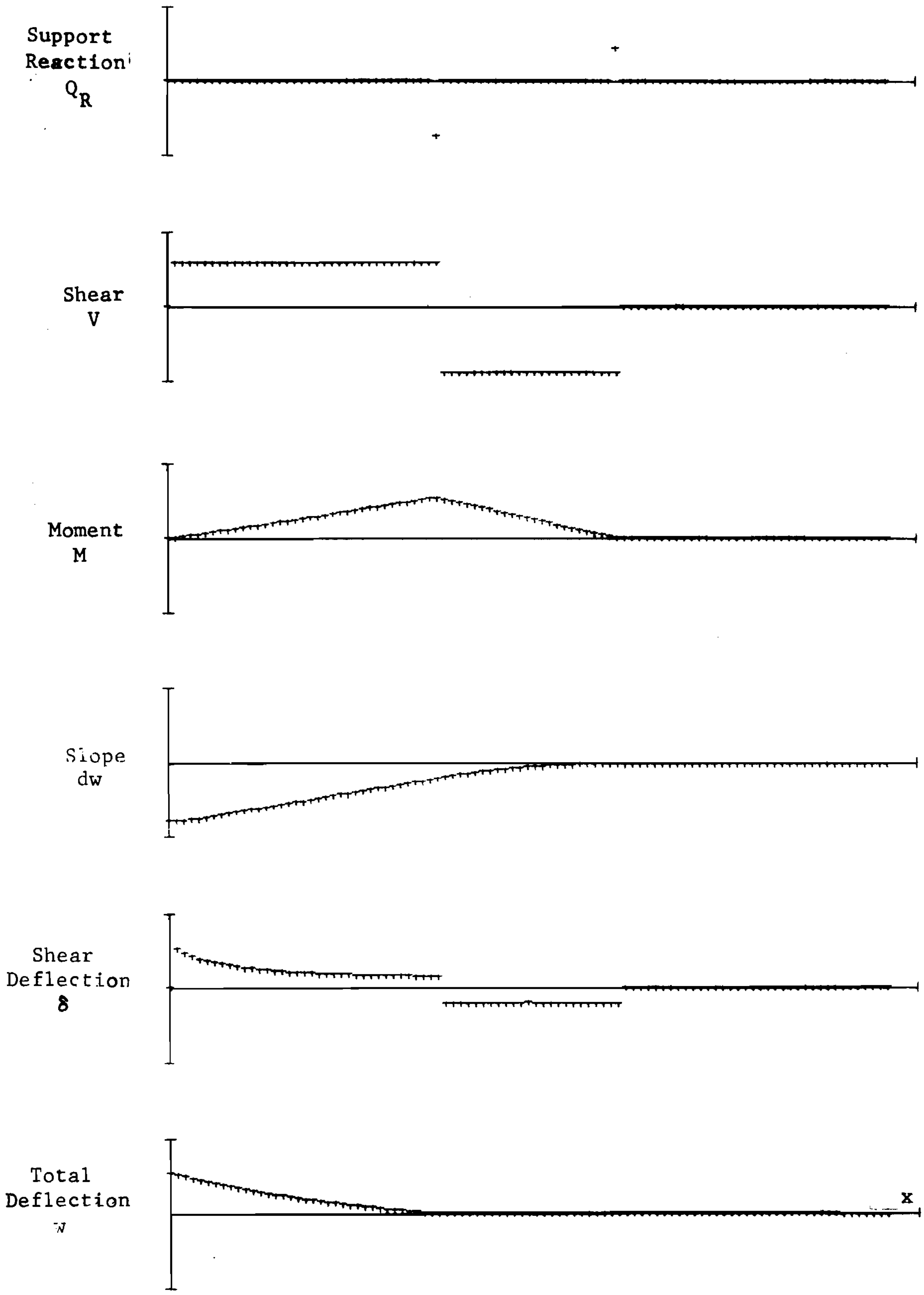

Prob 301A. **Tapered three-span overhanging beam with 300-lb load at Sta 0.**

```
SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1  -  APPENDIX 6


PROB
301B     SAME AS PROBLEM 301A - ADD INFINITE SHEAR STIFFNESS


TABLE 1 - PROGRAM-CONTROL DATA
                                                             TABLES NUMBER
                                                          2    3   4A   4B    5

     PRIOR-DATA OPTIONS (1 = HOLD)                        1    1    1    0    1
     NUM CARDS INPUT THIS PROBLEM                         0    0    0    1    0

     OPTION (IF=1, 2, 3) TO PLOT                          1


TABLE 2 - CONSTANTS

     DATA HELD FROM THE PREVIOUS PROBLEM
     NUM INCREMENTS                                                          96
     INCREMENT LENGTH                                                 1.000E+00


TABLE 3 - SPECIFIED DEFLECTIONS

     STA       DEFLECTION

     DATA HELD FROM THE PREVIOUS PROBLEM
     36          0.
     60          0.


TABLE 4A - SECTION AND MATERIAL PROPERTIES

FROM TO CONTD     E         G          I          SA

     DATA HELD FROM THE PREVIOUS PROBLEM
  0  96   0   1.000E+07 -0.        -0.        -0.
  1  96   0  -0.         4.000E+06 -0.        -0.
  0   0   0  -0.        -0.         5.546E-01 -0.
  1       1  -0.        -0.         7.421E-01  7.200E-02
      3   1  -0.        -0.         1.193E+00  8.740E-02
      6   1  -0.        -0.         2.034E+00  1.090E-01
     10   1  -0.        -0.         3.395E+00  1.360E-01
     14   1  -0.        -0.         4.937E+00  1.600E-01
     18   1  -0.        -0.         6.566E+00  1.810E-01
     23   1  -0.        -0.         8.592E+00  2.040E-01
     28   1  -0.        -0.         1.047E+01  2.220E-01
     35   1  -0.        -0.         1.260E+01  2.420E-01
     48   1  -0.        -0.         1.429E+01  2.560E-01
     61   1  -0.        -0.         1.260E+01  2.420E-01
     68   1  -0.        -0.         1.047E+01  2.220E-01
     73   1  -0.        -0.         8.592E+00  2.040E-01
```

```
     78    1  -0.         -0.          6.566E+00  1.810E-01
     82    1  -0.         -0.          4.937E+00  1.600E-01
     86    1  -0.         -0.          3.395E+00  1.360E-01
     90    1  -0.         -0.          2.034E+00  1.090E-01
     93    1  -0.         -0.          1.193E+00  8.740E-02
     96   -0  -0.         -0.          5.546E-01  6.440E-02


TABLE 4B - STIFFNESS DATA

FROM TO CONTD    SK          F

     ADDITIONAL DATA INPUT FOR THIS PROBLEM
  1  96  -0    1.000E+99 -0.


TABLE 5 - LOAD DATA

FROM TO CONTD      Q          S          T          R          P

     DATA HELD FROM THE PREVIOUS PROBLEM
  0   0  -0    3.000E+02 -0.        -0.        -0.        -0.
```

SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1 - **APPENDIX 6**

PROB (CONTD)
301B SAME AS PROBLEM 301A - ADD INFINITE SHEAR STIFFNESS

TABLE 6 - RESULTS

```
  STA      W        DELTA      SLOPE       MOM        SHEAR     SUP REACT

  -1  8.010E-02                         0.                    0.
                  0.        -3.533E-03              0.
   0  7.657E-02                       -2.463E-09              0.
                  3.000E-97 -3.533E-03              3.000E+02
   1  7.304E-02                         3.000E+02             0.
                  3.000E-97 -3.493E-03              3.000E+02
   2  6.955E-02                         6.000E+02             0.
                  3.000E-97 -3.431E-03              3.000E+02
   3  6.612E-02                         9.000E+02             0.
                  3.000E-97 -3.355E-03              3.000E+02
   4  6.276E-02                         1.200E+03             0.
                  3.000E-97 -3.274E-03              3.000E+02
   5  5.949E-02                         1.500E+03             0.
                  3.000E-97 -3.188E-03              3.000E+02
   6  5.630E-02                         1.800E+03             0.
                  3.000E-97 -3.100E-03              3.000E+02
   7  5.320E-02                         2.100E+03             0.
                  3.000E-97 -3.011E-03              3.000E+02
   8  5.019E-02                         2.400E+03             0.
                  3.000E-97 -2.923E-03              3.000E+02
   9  4.726E-02                         2.700E+03             0.
                  3.000E-97 -2.834E-03              3.000E+02
  10  4.443E-02                         3.000E+03             0.
                  3.000E-97 -2.746E-03              3.000E+02
  11  4.168E-02                         3.300E+03             0.
                  3.000E-97 -2.659E-03              3.000E+02
  12  3.903E-02                         3.600E+03             0.
                  3.000E-97 -2.572E-03              3.000E+02
  13  3.645E-02                         3.900E+03             0.
                  3.000E-97 -2.487E-03              3.000E+02
  14  3.397E-02                         4.200E+03             0.
                  3.000E-97 -2.402E-03              3.000E+02
  15  3.156E-02                         4.500E+03             0.
                  3.000E-97 -2.317E-03              3.000E+02
  16  2.925E-02                         4.800E+03             0.
                  3.000E-97 -2.234E-03              3.000E+02
  17  2.701E-02                         5.100E+03             0.
                  3.000E-97 -2.151E-03              3.000E+02
  18  2.486E-02                         5.400E+03             0.
                  3.000E-97 -2.069E-03              3.000E+02
  19  2.279E-02                         5.700E+03             0.
                  3.000E-97 -1.987E-03              3.000E+02
  20  2.081E-02                         6.000E+03             0.
                  3.000E-97 -1.906E-03              3.000E+02
  21  1.890E-02                         6.300E+03             0.
                  3.000E-97 -1.825E-03              3.000E+02
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22   1.708E-02                         6.600E+03              0.
                 3.000E-97 -1.744E-03             3.000E+02
23   1.533E-02                         6.900E+03              0.
                 3.000E-97 -1.664E-03             3.000E+02
24   1.367E-02                         7.200E+03              0.
                 3.000E-97 -1.584E-03             3.000E+02
25   1.208E-02                         7.500E+03              0.
                 3.000E-97 -1.503E-03             3.000E+02
26   1.058E-02                         7.800E+03              0.
                 3.000E-97 -1.423E-03             3.000E+02
27   9.157E-03                         8.100E+03              0.
                 3.000E-97 -1.343E-03             3.000E+02
28   7.814E-03                         8.400E+03              0.
                 3.000E-97 -1.263E-03             3.000E+02
29   6.552E-03                         8.700E+03              0.
                 3.000E-97 -1.182E-03             3.000E+02
30   5.370E-03                         9.000E+03              0.
                 3.000E-97 -1.101E-03             3.000E+02
31   4.269E-03                         9.300E+03              0.
                 3.000E-97 -1.019E-03             3.000E+02
32   3.250E-03                         9.600E+03              0.
                 3.000E-97 -9.368E-04             3.000E+02
33   2.313E-03                         9.900E+03              0.
                 3.000E-97 -8.542E-04             3.000E+02
34   1.459E-03                         1.020E+04              0.
                 3.000E-97 -7.713E-04             3.000E+02
35   6.880E-04                         1.050E+04              0.
                 3.000E-97 -6.880E-04             3.000E+02
36   0.                                1.080E+04             -7.500E+02
                -4.500E-97 -6.031E-04            -4.500E+02
37  -6.031E-04                         1.035E+04              0.
                -4.500E-97 -5.226E-04            -4.500E+02
38  -1.126E-03                         9.900E+03              0.
                -4.500E-97 -4.464E-04            -4.500E+02
39  -1.572E-03                         9.450E+03              0.
                -4.500E-97 -3.744E-04            -4.500E+02
40  -1.947E-03                         9.000E+03              0.
                -4.500E-97 -3.065E-04            -4.500E+02
41  -2.253E-03                         8.550E+03              0.
                -4.500E-97 -2.426E-04            -4.500E+02
42  -2.496E-03                         8.100E+03              0.
                -4.500E-97 -1.826E-04            -4.500E+02
43  -2.678E-03                         7.650E+03              0.
                -4.500E-97 -1.265E-04            -4.500E+02
44  -2.805E-03                         7.200E+03              0.
                -4.500E-97 -7.424E-05            -4.500E+02
45  -2.879E-03                         6.750E+03              0.
                -4.500E-97 -2.567E-05            -4.500E+02
46  -2.905E-03                         6.300E+03              0.
                -4.500E-97  1.923E-05            -4.500E+02
47  -2.885E-03                         5.850E+03              0.
                -4.500E-97  6.054E-05            -4.500E+02
48  -2.825E-03                         5.400E+03              0.
                -4.500E-97  9.833E-05            -4.500E+02
49  -2.727E-03                         4.950E+03              0.
                -4.500E-97  1.333E-04            -4.500E+02
50  -2.593E-03                         4.500E+03              0.
                -4.500E-97  1.654E-04            -4.500E+02
51  -2.428E-03                         4.050E+03              0.
                -4.500E-97  1.945E-04            -4.500E+02
52  -2.233E-03                         3.600E+03              0.
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               -4.500E-97  2.206E-04           -4.500E+02
53  -2.013E-03                       3.150E+03             0.
               -4.500E-97  2.437E-04           -4.500E+02
54  -1.769E-03                       2.700E+03             0.
               -4.500E-97  2.637E-04           -4.500E+02
55  -1.505E-03                       2.250E+03             0.
               -4.500E-97  2.805E-04           -4.500E+02
56  -1.225E-03                       1.800E+03             0.
               -4.500E-97  2.941E-04           -4.500E+02
57  -9.306E-04                       1.350E+03             0.
               -4.500E-97  3.044E-04           -4.500E+02
58  -6.262E-04                       9.000E+02             0.
               -4.500E-97  3.113E-04           -4.500E+02
59  -3.148E-04                       4.500E+02             0.
               -4.500E-97  3.148E-04           -4.500E+02
60   0.                              9.054E-09             4.500E+02
                3.260-108  3.148E-04            3.260E-09
61   3.148E-04                       1.180E-08             0.
                2.522-108  3.148E-04            2.522E-09
62   6.297E-04                       1.450E-08             0.
                2.154-108  3.148E-04            2.154E-09
63   9.445E-04                       1.581E-08             0.
                1.663-108  3.148E-04            1.663E-09
64   1.259E-03                       1.541E-08             0.
                1.365-108  3.148E-04            1.365E-09
65   1.574E-03                       1.817E-08             0.
                1.166-108  3.148E-04            1.166E-09
66   1.889E-03                       1.845E-08             0.
                1.024-108  3.148E-04            1.024E-09
67   2.204E-03                       1.944E-08             0.
                8.262-109  3.148E-04            8.262E-10
68   2.519E-03                       2.034E-08             0.
                8.398-109  3.148E-04            8.398E-10
69   2.834E-03                       1.821E-08             0.
                7.770-109  3.148E-04            7.770E-10
70   3.148E-03                       2.023E-08             0.
                7.259-109  3.148E-04            7.259E-10
71   3.463E-03                       2.334E-08             0.
                6.837-109  3.148E-04            6.837E-10
72   3.778E-03                       1.493E-08             0.
                6.053-109  3.148E-04            6.053E-10
73   4.093E-03                       1.669E-08             0.
                5.431-109  3.148E-04            5.431E-10
74   4.408E-03                       1.591E-08             0.
                4.918-109  3.148E-04            4.918E-10
75   4.723E-03                       1.512E-08             0.
                4.812-109  3.148E-04            4.812E-10
76   5.037E-03                       1.228E-08             0.
                4.429-109  3.148E-04            4.429E-10
77   5.352E-03                       1.548E-08             0.
                4.106-109  3.148E-04            4.106E-10
78   5.667E-03                       1.276E-08             0.
                3.834-109  3.148E-04            3.834E-10
79   5.982E-03                       1.026E-08             0.
                3.364-109  3.148E-04            3.364E-10
80   6.297E-03                       9.578E-09             0.
                3.184-109  3.148E-04            3.184E-10
81   6.612E-03                       1.038E-08             0.
                3.033-109  3.148E-04            3.033E-10
82   6.927E-03                      -2.741E-09             0.
                2.484-109  3.148E-04            2.484E-10
```

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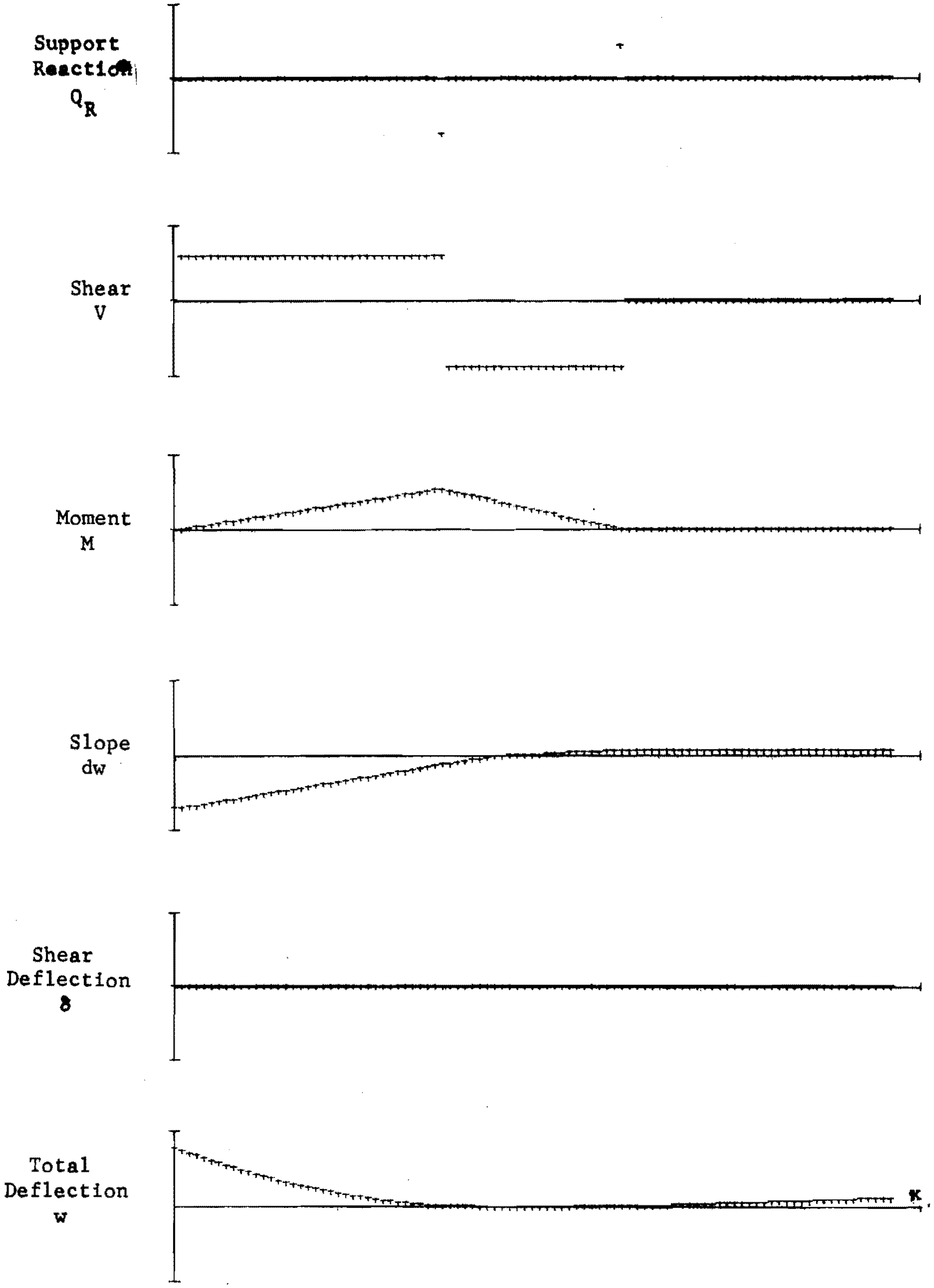
  83    7.241E-03                         -5.053E-09           0.
                  2.391-109   3.148E-04               2.391E-10
  84    7.556E-03                         -2.313E-09           0.
                  2.125-109   3.148E-04               2.125E-10
  85    7.871E-03                         -6.296E-09           0.
                  1.889-109   3.148E-04               1.889E-10
  86    8.186E-03                         -9.423E-09           0.
                  1.658-109   3.148E-04               1.658E-10
  87    8.501E-03                         -6.783E-09           0.
                  1.451-109   3.148E-04               1.451E-10
  88    8.816E-03                         -6.027E-09           0.
                  1.085-109   3.148E-04               1.085E-10
  89    9.130E-03                         -1.054E-08           0.
                  9.129-110   3.148E-04               9.129E-11
  90    9.445E-03                         -6.775E-09           0.
                  7.302-110   3.148E-04               7.302E-11
  91    9.760E-03                         -3.894E-09           0.
                  5.577-110   3.148E-04               5.577E-11
  92    1.007E-02                         -2.454E-09           0.
                  3.877-110   3.148E-04               3.877E-11
  93    1.039E-02                         -2.649E-09           0.
                  2.969-110   3.148E-04               2.969E-11
  94    1.070E-02                         -8.626-104           0.
                  2.089-110   3.148E-04               2.089E-11
  95    1.102E-02                         -1.704E-09           0.
                  9.116-111   3.148E-04               9.116E-12
  96    1.133E-02                         -1.539E-10           0.
                  1.709-112   3.148E-04               1.709E-13
  97    1.165E-02                           0.                 0.

TABLE 7 -- SCALES FOR PLOT OUTPUT -- VALUES AT ENDS OF AXES

STA      X          W         DELTA        DW          M           V       SUP REACT
100  1.000E+02  1.000E-01  1.000E+00  5.000E-03  2.000E+04  5.000E+02  1.000E+03


                          TIME FOR THIS PROBLEM =      0 MINUTES    3.532 SECONDS


                          ELAPSED CPU TIME =      0 MINUTES   26.945 SECONDS
```



Prob 301B. Same as Prob 301A, neglecting shear deformations.

```
SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1  -  APPENDIX 6


PROB
302A     TAPERED THREE-SPAN OVERHANGING BEAM WITH 500 LB LOAD AT STA 0


TABLE 1 - PROGRAM-CONTROL DATA
                                                      TABLES NUMBER
                                                  2     3     4A    4B    5

   PRIOR-DATA OPTIONS (1 = HOLD)                  1     1     1     0     0
   NUM CARDS INPUT THIS PROBLEM                   0     0     0     0     1

   OPTION (IF=1, 2, 3) TO PLOT                    1


TABLE 2 - CONSTANTS

   DATA HELD FROM THE PREVIOUS PROBLEM
   NUM INCREMENTS                                                        96
   INCREMENT LENGTH                                               1.000E+00


TABLE 3 - SPECIFIED DEFLECTIONS

   STA        DEFLECTION

   DATA HELD FROM THE PREVIOUS PROBLEM
   36           0.
   60           0.


TABLE 4A - SECTION AND MATERIAL PROPERTIES

FROM TO CONTD      E           G           I           SA

   DATA HELD FROM THE PREVIOUS PROBLEM
  0  96   0    1.000E+07 -0.          -0.         -0.
  1  96   0   -0.           4.000E+06 -0.         -0.
  0   0   0   -0.          -0.          5.546E-01 -0.
  1       1   -0.          -0.          7.421E-01  7.200E-02
      3   1   -0.          -0.          1.193E+00  8.740E-02
      6   1   -0.          -0.          2.034E+00  1.090E-01
     10   1   -0.          -0.          3.395E+00  1.360E-01
     14   1   -0.          -0.          4.937E+00  1.600E-01
     18   1   -0.          -0.          6.566E+00  1.810E-01
     23   1   -0.          -0.          8.592E+00  2.040E-01
     28   1   -0.          -0.          1.047E+01  2.220E-01
     35   1   -0.          -0.          1.260E+01  2.420E-01
     48   1   -0.          -0.          1.429E+01  2.560E-01
     61   1   -0.          -0.          1.260E+01  2.420E-01
     68   1   -0.          -0.          1.047E+01  2.220E-01
     73   1   -0.          -0.          8.592E+00  2.040E-01
```

```
       78    1  -0.           -0.           6.566E+00  1.810E-01
       82    1  -0.           -0.           4.937E+00  1.600E-01
       86    1  -0.           -0.           3.395E+00  1.360E-01
       90    1  -0.           -0.           2.034E+00  1.090E-01
       93    1  -0.           -0.           1.193E+00  8.740E-02
       96   -0  -0.           -0.           5.546E-01  6.440E-02


TABLE 4B - STIFFNESS DATA

FROM TO CONTD     SK           F


                NONE


TABLE 5 - LOAD DATA

FROM TO CONTD      Q            S            T            R            P

       ADDITIONAL DATA INPUT FOR THIS PROBLEM
   0    0  -0    5.000E+02 -0.          -0.          -0.          -0.
```

```
SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1  -  APPENDIX 6


PROB (CONTD)
302A     TAPERED THREE-SPAN OVERHANGING BEAM WITH 500 LB LOAD AT STA 0


TABLE 6 - RESULTS
  STA       W         DELTA       SLOPE        MOM         SHEAR      SUP REACT

  -1    1.903E-01                             0.                      0.
                    0.         -6.640E-03                0.
   0    1.837E-01                             3.540E-09               0.
                    1.736E-03 -6.640E-03                 5.000E+02
   1    1.753E-01                             5.000E+02               0.
                    1.568E-03 -6.573E-03                 5.000E+02
   2    1.672E-01                             1.000E+03               0.
                    1.430E-03 -6.469E-03                 5.000E+02
   3    1.593E-01                             1.500E+03               0.
                    1.321E-03 -6.344E-03                 5.000E+02
   4    1.516E-01                             2.000E+03               0.
                    1.228E-03 -6.208E-03                 5.000E+02
   5    1.442E-01                             2.500E+03               0.
                    1.147E-03 -6.065E-03                 5.000E+02
   6    1.370E-01                             3.000E+03               0.
                    1.080E-03 -5.918E-03                 5.000E+02
   7    1.300E-01                             3.500E+03               0.
                    1.020E-03 -5.770E-03                 5.000E+02
   8    1.232E-01                             4.000E+03               0.
                    9.671E-04 -5.623E-03                 5.000E+02
   9    1.166E-01                             4.500E+03               0.
                    9.191E-04 -5.476E-03                 5.000E+02
  10    1.102E-01                             5.000E+03               0.
                    8.803E-04 -5.328E-03                 5.000E+02
  11    1.040E-01                             5.500E+03               0.
                    8.446E-04 -5.183E-03                 5.000E+02
  12    9.795E-02                             6.000E+03               0.
                    8.117E-04 -5.039E-03                 5.000E+02
  13    9.210E-02                             6.500E+03               0.
                    7.812E-04 -4.896E-03                 5.000E+02
  14    8.642E-02                             7.000E+03               0.
                    7.564E-04 -4.754E-03                 5.000E+02
  15    8.091E-02                             7.500E+03               0.
                    7.331E-04 -4.614E-03                 5.000E+02
  16    7.557E-02                             8.000E+03               0.
                    7.112E-04 -4.475E-03                 5.000E+02
  17    7.038E-02                             8.500E+03               0.
                    6.906E-04 -4.337E-03                 5.000E+02
  18    6.535E-02                             9.000E+03               0.
                    6.735E-04 -4.200E-03                 5.000E+02
  19    6.048E-02                             9.500E+03               0.
                    6.572E-04 -4.063E-03                 5.000E+02
  20    5.576E-02                             1.000E+04               0.
                    6.417E-04 -3.928E-03                 5.000E+02
  21    5.119E-02                             1.050E+04               0.
                    6.269E-04 -3.793E-03                 5.000E+02
```

```
22   4.677E-02                        1.100E+04             0.
                6.127E-04 -3.659E-03             5.000E+02
23   4.250E-02                        1.150E+04             0.
                6.021E-04 -3.525E-03             5.000E+02
24   3.837E-02                        1.200E+04             0.
                5.919E-04 -3.391E-03             5.000E+02
25   3.439E-02                        1.250E+04             0.
                5.819E-04 -3.257E-03             5.000E+02
26   3.055E-02                        1.300E+04             0.
                5.723E-04 -3.123E-03             5.000E+02
27   2.685E-02                        1.350E+04             0.
                5.631E-04 -2.990E-03             5.000E+02
28   2.330E-02                        1.400E+04             0.
                5.559E-04 -2.856E-03             5.000E+02
29   1.989E-02                        1.450E+04             0.
                5.489E-04 -2.721E-03             5.000E+02
30   1.662E-02                        1.500E+04             0.
                5.421E-04 -2.586E-03             5.000E+02
31   1.349E-02                        1.550E+04             0.
                5.355E-04 -2.450E-03             5.000E+02
32   1.051E-02                        1.600E+04             0.
                5.290E-04 -2.313E-03             5.000E+02
33   7.664E-03                        1.650E+04             0.
                5.227E-04 -2.175E-03             5.000E+02
34   4.966E-03                        1.700E+04             0.
                5.165E-04 -2.037E-03             5.000E+02
35   2.412E-03                        1.750E+04             0.
                5.142E-04 -1.898E-03             5.000E+02
36   0.                               1.800E+04            -1.250E+03
               -7.680E-04 -1.757E-03            -7.500E+02
37  -9.888E-04                        1.725E+04             0.
               -7.646E-04 -1.623E-03            -7.500E+02
38  -1.847E-03                        1.650E+04             0.
               -7.612E-04 -1.496E-03            -7.500E+02
39  -2.581E-03                        1.575E+04             0.
               -7.579E-04 -1.376E-03            -7.500E+02
40  -3.199E-03                        1.500E+04             0.
               -7.546E-04 -1.262E-03            -7.500E+02
41  -3.706E-03                        1.425E+04             0.
               -7.514E-04 -1.156E-03            -7.500E+02
42  -4.111E-03                        1.350E+04             0.
               -7.482E-04 -1.056E-03            -7.500E+02
43  -4.419E-03                        1.275E+04             0.
               -7.450E-04 -9.624E-04            -7.500E+02
44  -4.636E-03                        1.200E+04             0.
               -7.418E-04 -8.753E-04            -7.500E+02
45  -4.770E-03                        1.125E+04             0.
               -7.386E-04 -7.943E-04            -7.500E+02
46  -4.825E-03                        1.050E+04             0.
               -7.355E-04 -7.195E-04            -7.500E+02
47  -4.809E-03                        9.750E+03             0.
               -7.324E-04 -6.507E-04            -7.500E+02
48  -4.728E-03                        9.000E+03             0.
               -7.355E-04 -5.877E-04            -7.500E+02
49  -4.580E-03                        8.250E+03             0.
               -7.386E-04 -5.294E-04            -7.500E+02
50  -4.370E-03                        7.500E+03             0.
               -7.418E-04 -4.760E-04            -7.500E+02
51  -4.105E-03                        6.750E+03             0.
               -7.450E-04 -4.274E-04            -7.500E+02
52  -3.787E-03                        6.000E+03             0.
```

```
               -7.482E-04 -3.838E-04            -7.500E+02
53  -3.423E-03                        5.250E+03            0.
               -7.514E-04 -3.453E-04            -7.500E+02
54  -3.017E-03                        4.500E+03            0.
               -7.546E-04 -3.120E-04            -7.500E+02
55  -2.574E-03                        3.750E+03            0.
               -7.579E-04 -2.840E-04            -7.500E+02
56  -2.100E-03                        3.000E+03            0.
               -7.612E-04 -2.614E-04            -7.500E+02
57  -1.600E-03                        2.250E+03            0.
               -7.646E-04 -2.442E-04            -7.500E+02
58  -1.080E-03                        1.500E+03            0.
               -7.680E-04 -2.327E-04            -7.500E+02
59  -5.445E-04                        7.500E+02            0.
               -7.714E-04 -2.268E-04            -7.500E+02
60   0.                              -4.620E-09            7.500E+02
               -2.167E-16 -2.268E-04            -2.098E-10
61  -2.268E-04                       -4.918E-09            0.
               -2.158E-16 -2.268E-04            -2.065E-10
62  -4.536E-04                       -5.642E-09            0.
               -2.132E-16 -2.268E-04            -2.015E-10
63  -6.805E-04                       -5.451E-09            0.
               -2.170E-16 -2.268E-04            -2.026E-10
64  -9.073E-04                       -6.910E-09            0.
               -2.206E-16 -2.268E-04            -2.034E-10
65  -1.134E-03                       -7.501E-09            0.
               -2.240E-16 -2.268E-04            -2.041E-10
66  -1.361E-03                       -6.586E-09            0.
               -2.210E-16 -2.268E-04            -1.988E-10
67  -1.588E-03                       -7.984E-09            0.
               -2.119E-16 -2.268E-04            -1.881E-10
68  -1.815E-03                       -8.790E-09            0.
               -1.987E-16 -2.268E-04            -1.736E-10
69  -2.041E-03                       -1.114E-08            0.
               -1.980E-16 -2.268E-04            -1.701E-10
70  -2.268E-03                       -1.343E-08            0.
               -1.974E-16 -2.268E-04            -1.667E-10
71  -2.495E-03                       -7.883E-09            0.
               -1.846E-16 -2.268E-04            -1.533E-10
72  -2.722E-03                       -8.688E-09            0.
               -1.843E-16 -2.268E-04            -1.504E-10
73  -2.949E-03                       -1.324E-08            0.
               -1.858E-16 -2.268E-04            -1.482E-10
74  -3.176E-03                       -1.036E-08            0.
               -1.874E-16 -2.268E-04            -1.460E-10
75  -3.402E-03                       -1.537E-08            0.
               -1.768E-16 -2.268E-04            -1.345E-10
76  -3.629E-03                       -1.151E-08            0.
               -1.663E-16 -2.268E-04            -1.234E-10
77  -3.856E-03                       -1.178E-08            0.
               -1.688E-16 -2.268E-04            -1.222E-10
78  -4.083E-03                       -1.213E-08            0.
               -1.591E-16 -2.268E-04            -1.119E-10
79  -4.310E-03                       -8.791E-09            0.
               -1.631E-16 -2.268E-04            -1.112E-10
80  -4.536E-03                       -6.655E-09            0.
               -1.678E-16 -2.268E-04            -1.109E-10
81  -4.763E-03                       -9.197E-09            0.
               -1.734E-16 -2.268E-04            -1.109E-10
82  -4.990E-03                       -7.442E-09            0.
               -1.576E-16 -2.268E-04            -9.707E-11
```

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  83  -5.217E-03                       -1.778E-09             0.
                 -1.411E-16 -2.268E-04            -8.354E-11
  84  -5.444E-03                       -1.931E-09             0.
                 -1.319E-16 -2.268E-04            -7.495E-11
  85  -5.671E-03                       -4.225E-09             0.
                 -1.049E-16 -2.268E-04            -5.708E-11
  86  -5.897E-03                        7.227E-10             0.
                 -8.365E-17 -2.268E-04            -4.324E-11
  87  -6.124E-03                       -1.276E-09             0.
                 -6.989E-17 -2.268E-04            -3.425E-11
  88  -6.351E-03                       -6.259E-10             0.
                 -6.519E-17 -2.268E-04            -3.018E-11
  89  -6.578E-03                       -8.228E-10             0.
                 -7.209E-17 -2.268E-04            -3.143E-11
  90  -6.805E-03                       -1.573E-09             0.
                 -6.617E-17 -2.268E-04            -2.695E-11
  91  -7.031E-03                       -2.805E-09             0.
                 -5.960E-17 -2.268E-04            -2.255E-11
  92  -7.258E-03                       -2.212E-09             0.
                 -4.317E-17 -2.268E-04            -1.509E-11
  93  -7.485E-03                       -8.327E-10             0.
                 -2.970E-17 -2.268E-04            -9.474E-12
  94  -7.712E-03                       -4.849E-10             0.
                 -2.366E-17 -2.268E-04            -6.822E-12
  95  -7.939E-03                        5.140E-10             0.
                 -1.220E-17 -2.268E-04            -3.142E-12
  96  -8.166E-03                        3.239E-11             0.
                 -5.166E-19 -2.268E-04            -1.331E-13
  97  -8.392E-03                        0.                    0.

TABLE 7 -- SCALES FOR PLOT OUTPUT -- VALUES AT ENDS OF AXES

STA      X          W        DELTA       DW         M          V       SUP REACT
100  1.000E+02  2.000E-01  2.000E-03  1.000E-02  2.000E+04  1.000E+03  2.000E+03


                         TIME FOR THIS PROBLEM =      0 MINUTES    3.555 SECONDS


                         ELAPSED CPU TIME =      0 MINUTES   30.500 SECONDS
```

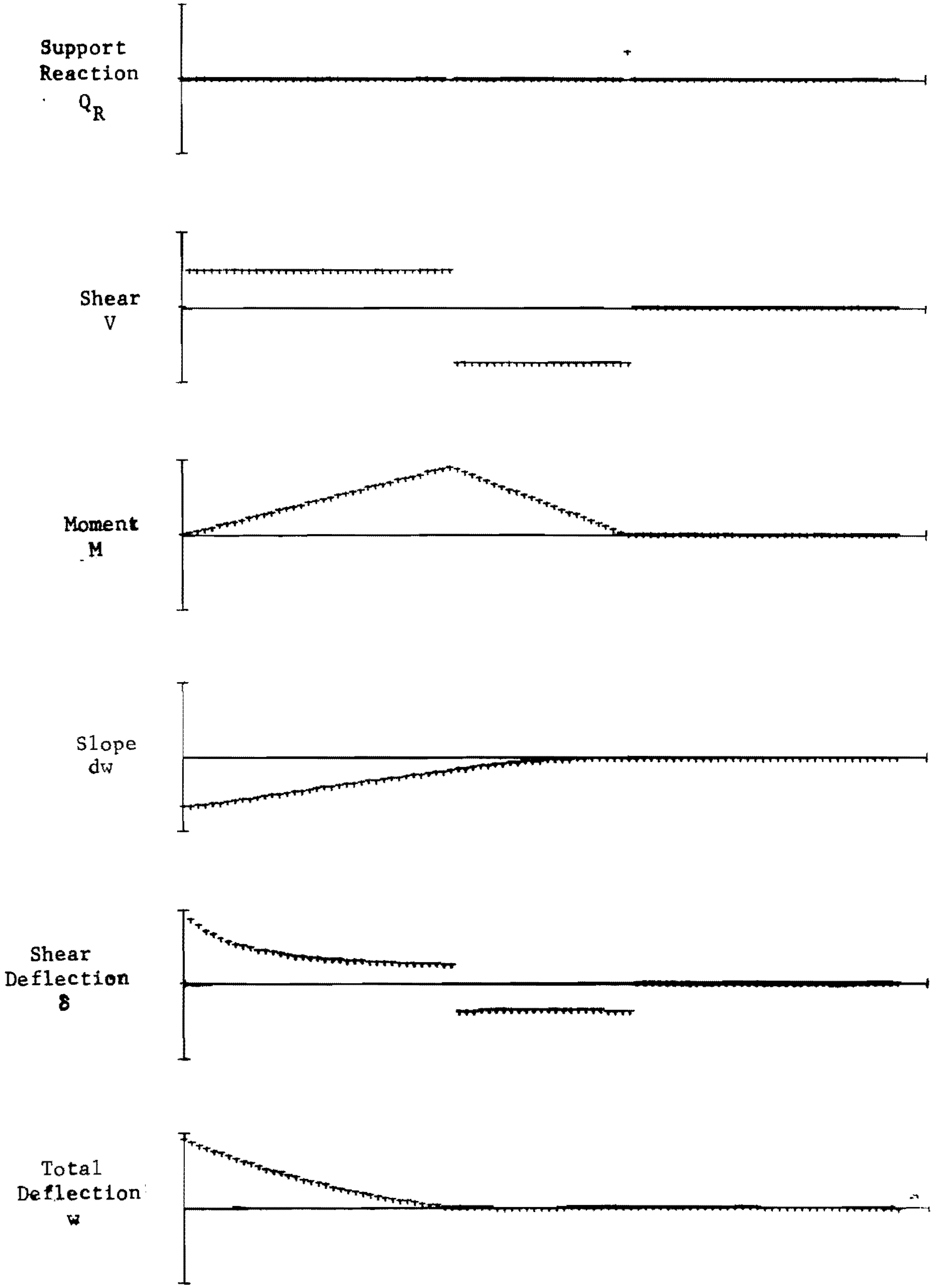

Prob 302A. Tapered three-span overhanging beam with 500-lb load at Sta 0.

```
SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1  -  APPENDIX 6


PROB
302B     SAME AS PROBLEM 302A - ADD INFINITE SHEAR STIFFNESS


TABLE 1 - PROGRAM-CONTROL DATA
                                                             TABLES NUMBER
                                                          2    3   4A   4B    5

     PRIOR-DATA OPTIONS (1 = HOLD)                        1    1   1    0     1
     NUM CARDS INPUT THIS PROBLEM                         0    0   0    1     0

     OPTION (IF=1, 2, 3) TO PLOT                          1


TABLE 2 - CONSTANTS

     DATA HELD FROM THE PREVIOUS PROBLEM
     NUM INCREMENTS                                                              96
     INCREMENT LENGTH                                                     1.000E+00


TABLE 3 - SPECIFIED DEFLECTIONS

     STA       DEFLECTION

     DATA HELD FROM THE PREVIOUS PROBLEM
     36          0.
     60          0.


TABLE 4A - SECTION AND MATERIAL PROPERTIES

FROM TO CONTD     E         G           I          SA

     DATA HELD FROM THE PREVIOUS PROBLEM
  0 96    0   1.000E+07 -0.        -0.        -0.
  1 96    0  -0.         4.000E+06 -0.        -0.
  0  0    0  -0.        -0.         5.546E-01 -0.
  1       1  -0.        -0.         7.421E-01 7.200E-02
      3   1  -0.        -0.         1.193E+00 8.740E-02
      6   1  -0.        -0.         2.034E+00 1.090E-01
     10   1  -0.        -0.         3.395E+00 1.360E-01
     14   1  -0.        -0.         4.937E+00 1.600E-01
     18   1  -0.        -0.         6.566E+00 1.810E-01
     23   1  -0.        -0.         8.592E+00 2.040E-01
     28   1  -0.        -0.         1.047E+01 2.220E-01
     35   1  -0.        -0.         1.260E+01 2.420E-01
     48   1  -0.        -0.         1.429E+01 2.560E-01
     61   1  -0.        -0.         1.260E+01 2.420E-01
     68   1  -0.        -0.         1.047E+01 2.220E-01
     73   1  -0.        -0.         8.592E+00 2.040E-01
```

```
     78    1  -0.          -0.          6.566E+00  1.810E-01
     82    1  -0.          -0.          4.937E+00  1.600E-01
     86    1  -0.          -0.          3.395E+00  1.360E-01
     90    1  -0.          -0.          2.034E+00  1.090E-01
     93    1  -0.          -0.          1.193E+00  8.740E-02
     96   -0  -0.          -0.          5.546E-01  6.440E-02


TABLE 4B - STIFFNESS DATA

FROM TO CONTD    SK          F

     ADDITIONAL DATA INPUT FOR THIS PROBLEM
  1  96  -0   1.000E+99 -0.


TABLE 5 - LOAD DATA

FROM TO CONTD      Q           S           T           R           P

     DATA HELD FROM THE PREVIOUS PROBLEM
  0   0  -0   5.000E+02 -0.         -0.         -0.         -0.
```

```
SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1  -  APPENDIX 6


PROB (CONTD)
302B     SAME AS PROBLEM 302A - ADD INFINITE SHEAR STIFFNESS


TABLE 6 - RESULTS

 STA       W          DELTA       SLOPE        MOM        SHEAR     SUP REACT

  -1   1.335E-01                             0.                        0.
                   0.          -5.888E-03              0.
   0   1.276E-01                          -3.694E-09                   0.
                   5.000E-97  -5.888E-03               5.000E+02
   1   1.217E-01                           5.000E+02                   0.
                   5.000E-97  -5.821E-03               5.000E+02
   2   1.159E-01                           1.000E+03                   0.
                   5.000E-97  -5.718E-03               5.000E+02
   3   1.102E-01                           1.500E+03                   0.
                   5.000E-97  -5.592E-03               5.000E+02
   4   1.046E-01                           2.000E+03                   0.
                   5.000E-97  -5.456E-03               5.000E+02
   5   9.914E-02                           2.500E+03                   0.
                   5.000E-97  -5.314E-03               5.000E+02
   6   9.383E-02                           3.000E+03                   0.
                   5.000E-97  -5.166E-03               5.000E+02
   7   8.866E-02                           3.500E+03                   0.
                   5.000E-97  -5.019E-03               5.000E+02
   8   8.365E-02                           4.000E+03                   0.
                   5.000E-97  -4.871E-03               5.000E+02
   9   7.877E-02                           4.500E+03                   0.
                   5.000E-97  -4.724E-03               5.000E+02
  10   7.405E-02                           5.000E+03                   0.
                   5.000E-97  -4.577E-03               5.000E+02
  11   6.947E-02                           5.500E+03                   0.
                   5.000E-97  -4.431E-03               5.000E+02
  12   6.504E-02                           6.000E+03                   0.
                   5.000E-97  -4.287E-03               5.000E+02
  13   6.075E-02                           6.500E+03                   0.
                   5.000E-97  -4.144E-03               5.000E+02
  14   5.661E-02                           7.000E+03                   0.
                   5.000E-97  -4.003E-03               5.000E+02
  15   5.261E-02                           7.500E+03                   0.
                   5.000E-97  -3.862E-03               5.000E+02
  16   4.875E-02                           8.000E+03                   0.
                   5.000E-97  -3.723E-03               5.000E+02
  17   4.502E-02                           8.500E+03                   0.
                   5.000E-97  -3.585E-03               5.000E+02
  18   4.144E-02                           9.000E+03                   0.
                   5.000E-97  -3.448E-03               5.000E+02
  19   3.799E-02                           9.500E+03                   0.
                   5.000E-97  -3.312E-03               5.000E+02
  20   3.468E-02                           1.000E+04                   0.
                   5.000E-97  -3.176E-03               5.000E+02
  21   3.150E-02                           1.050E+04                   0.
                   5.000E-97  -3.041E-03               5.000E+02
```

```
22   2.846E-02                        1.100E+04             0.
                5.000E-97 -2.907E-03             5.000E+02
23   2.555E-02                        1.150E+04             0.
                5.000E-97 -2.773E-03             5.000E+02
24   2.278E-02                        1.200E+04             0.
                5.000E-97 -2.639E-03             5.000E+02
25   2.014E-02                        1.250E+04             0.
                5.000E-97 -2.506E-03             5.000E+02
26   1.763E-02                        1.300E+04             0.
                5.000E-97 -2.372E-03             5.000E+02
27   1.526E-02                        1.350E+04             0.
                5.000E-97 -2.238E-03             5.000E+02
28   1.302E-02                        1.400E+04             0.
                5.000E-97 -2.104E-03             5.000E+02
29   1.092E-02                        1.450E+04             0.
                5.000E-97 -1.970E-03             5.000E+02
30   8.950E-03                        1.500E+04             0.
                5.000E-97 -1.834E-03             5.000E+02
31   7.115E-03                        1.550E+04             0.
                5.000E-97 -1.698E-03             5.000E+02
32   5.417E-03                        1.600E+04             0.
                5.000E-97 -1.561E-03             5.000E+02
33   3.856E-03                        1.650E+04             0.
                5.000E-97 -1.424E-03             5.000E+02
34   2.432E-03                        1.700E+04             0.
                5.000E-97 -1.285E-03             5.000E+02
35   1.147E-03                        1.750E+04             0.
                5.000E-97 -1.147E-03             5.000E+02
36   0.                               1.800E+04            -1.250E+03
               -7.500E-97 -1.005E-03            -7.500E+02
37  -1.005E-03                        1.725E+04             0.
               -7.500E-97 -8.710E-04            -7.500E+02
38  -1.876E-03                        1.650E+04             0.
               -7.500E-97 -7.440E-04            -7.500E+02
39  -2.620E-03                        1.575E+04             0.
               -7.500E-97 -6.240E-04            -7.500E+02
40  -3.244E-03                        1.500E+04             0.
               -7.500E-97 -5.108E-04            -7.500E+02
41  -3.755E-03                        1.425E+04             0.
               -7.500E-97 -4.043E-04            -7.500E+02
42  -4.159E-03                        1.350E+04             0.
               -7.500E-97 -3.043E-04            -7.500E+02
43  -4.464E-03                        1.275E+04             0.
               -7.500E-97 -2.109E-04            -7.500E+02
44  -4.675E-03                        1.200E+04             0.
               -7.500E-97 -1.237E-04            -7.500E+02
45  -4.798E-03                        1.125E+04             0.
               -7.500E-97 -4.279E-05            -7.500E+02
46  -4.841E-03                        1.050E+04             0.
               -7.500E-97  3.205E-05            -7.500E+02
47  -4.809E-03                        9.750E+03             0.
               -7.500E-97  1.009E-04            -7.500E+02
48  -4.708E-03                        9.000E+03             0.
               -7.500E-97  1.639E-04            -7.500E+02
49  -4.544E-03                        8.250E+03             0.
               -7.500E-97  2.221E-04            -7.500E+02
50  -4.322E-03                        7.500E+03             0.
               -7.500E-97  2.756E-04            -7.500E+02
51  -4.046E-03                        6.750E+03             0.
               -7.500E-97  3.242E-04            -7.500E+02
52  -3.722E-03                        6.000E+03             0.
```

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                 -7.500E-97  3.677E-04             -7.500E+02
53  -3.355E-03                          5.250E+03              0.
                 -7.500E-97  4.062E-04             -7.500E+02
54  -2.948E-03                          4.500E+03              0.
                 -7.500E-97  4.395E-04             -7.500E+02
55  -2.509E-03                          3.750E+03              0.
                 -7.500E-97  4.676E-04             -7.500E+02
56  -2.041E-03                          3.000E+03              0.
                 -7.500E-97  4.902E-04             -7.500E+02
57  -1.551E-03                          2.250E+03              0.
                 -7.500E-97  5.074E-04             -7.500E+02
58  -1.044E-03                          1.500E+03              0.
                 -7.500E-97  5.189E-04             -7.500E+02
59  -5.247E-04                          7.500E+02              0.
                 -7.500E-97  5.247E-04             -7.500E+02
60   0.                                 1.634E-08              7.500E+02
                  4.657-108  5.247E-04              4.657E-09
61   5.247E-04                          2.098E-08              0.
                  3.491-108  5.247E-04              3.491E-09
62   1.049E-03                          2.474E-08              0.
                  3.016-108  5.247E-04              3.016E-09
63   1.574E-03                          2.663E-08              0.
                  3.048-108  5.247E-04              3.048E-09
64   2.099E-03                          2.919E-08              0.
                  2.535-108  5.247E-04              2.535E-09
65   2.624E-03                          3.317E-08              0.
                  2.187-108  5.247E-04              2.187E-09
66   3.148E-03                          3.075E-08              0.
                  1.821-108  5.247E-04              1.821E-09
67   3.673E-03                          3.589E-08              0.
                  1.744-108  5.247E-04              1.744E-09
68   4.198E-03                          4.068E-08              0.
                  1.527-108  5.247E-04              1.527E-09
69   4.723E-03                          2.802E-08              0.
                  1.295-108  5.247E-04              1.295E-09
70   5.247E-03                          3.237E-08              0.
                  1.117-108  5.247E-04              1.117E-09
71   5.772E-03                          3.371E-08              0.
                  9.767-109  5.247E-04              9.767E-10
72   6.297E-03                          2.240E-08              0.
                  8.647-109  5.247E-04              8.647E-10
73   6.822E-03                          3.100E-08              0.
                  8.535-109  5.247E-04              8.535E-10
74   7.346E-03                          3.181E-08              0.
                  8.431-109  5.247E-04              8.431E-10
75   7.871E-03                          3.024E-08              0.
                  7.700-109  5.247E-04              7.700E-10
76   8.396E-03                          2.047E-08              0.
                  7.087-109  5.247E-04              7.087E-10
77   8.920E-03                          2.322E-08              0.
                  6.022-109  5.247E-04              6.022E-10
78   9.445E-03                          1.822E-08              0.
                  5.113-109  5.247E-04              5.113E-10
79   9.970E-03                          1.709E-08              0.
                  4.326-109  5.247E-04              4.326E-10
80   1.049E-02                          1.277E-08              0.
                  3.184-109  5.247E-04              3.184E-10
81   1.102E-02                          1.137E-08              0.
                  3.466-109  5.247E-04              3.466E-10
82   1.154E-02                         -7.617-103              0.
                  3.312-109  5.247E-04              3.312E-10
```

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  83   1.207E-02                       -7.580E-09             0.
                  2.789-109  5.247E-04             2.789E-10
  84   1.259E-02                       -6.938E-09             0.
                  2.705-109  5.247E-04             2.705E-10
  85   1.312E-02                       -1.049E-08             0.
                  2.267-109  5.247E-04             2.267E-10
  86   1.364E-02                       -1.508E-08             0.
                  2.026-109  5.247E-04             2.026E-10
  87   1.417E-02                       -1.187E-08             0.
                  1.451-109  5.247E-04             1.451E-10
  88   1.469E-02                       -1.356E-08             0.
                  9.038-110  5.247E-04             9.038E-11
  89   1.522E-02                       -1.845E-08             0.
                  7.303-110  5.247E-04             7.303E-11
  90   1.574E-02                       -9.033E-09             0.
                  5.477-110  5.247E-04             5.477E-11
  91   1.627E-02                       -3.894E-09             0.
                  5.577-110  5.247E-04             5.577E-11
  92   1.679E-02                       -3.271E-09             0.
                  5.815-110  5.247E-04             5.815E-11
  93   1.732E-02                       -1.324E-09             0.
                  4.949-110  5.247E-04             4.949E-11
  94   1.784E-02                       -2.176E-09             0.
                  4.178-110  5.247E-04             4.178E-11
  95   1.837E-02                       -1.704E-09             0.
                  1.823-110  5.247E-04             1.823E-11
  96   1.889E-02                       -4.866-104             0.
                  6.836-112  5.247E-04             6.836E-13
  97   1.942E-02                        0.                    0.

TABLE 7 -- SCALES FOR PLOT OUTPUT -- VALUES AT ENDS OF AXES

STA      X          W        DELTA       DW          M          V      SUP REACT
100  1.000E+02  2.000E-01  1.000E+00  1.000E-02  2.000E+04  1.000E+03  2.000E+03


                         TIME FOR THIS PROBLEM =     0 MINUTES    3.564 SECONDS


                         ELAPSED CPU TIME =     0 MINUTES   34.064 SECONDS
```

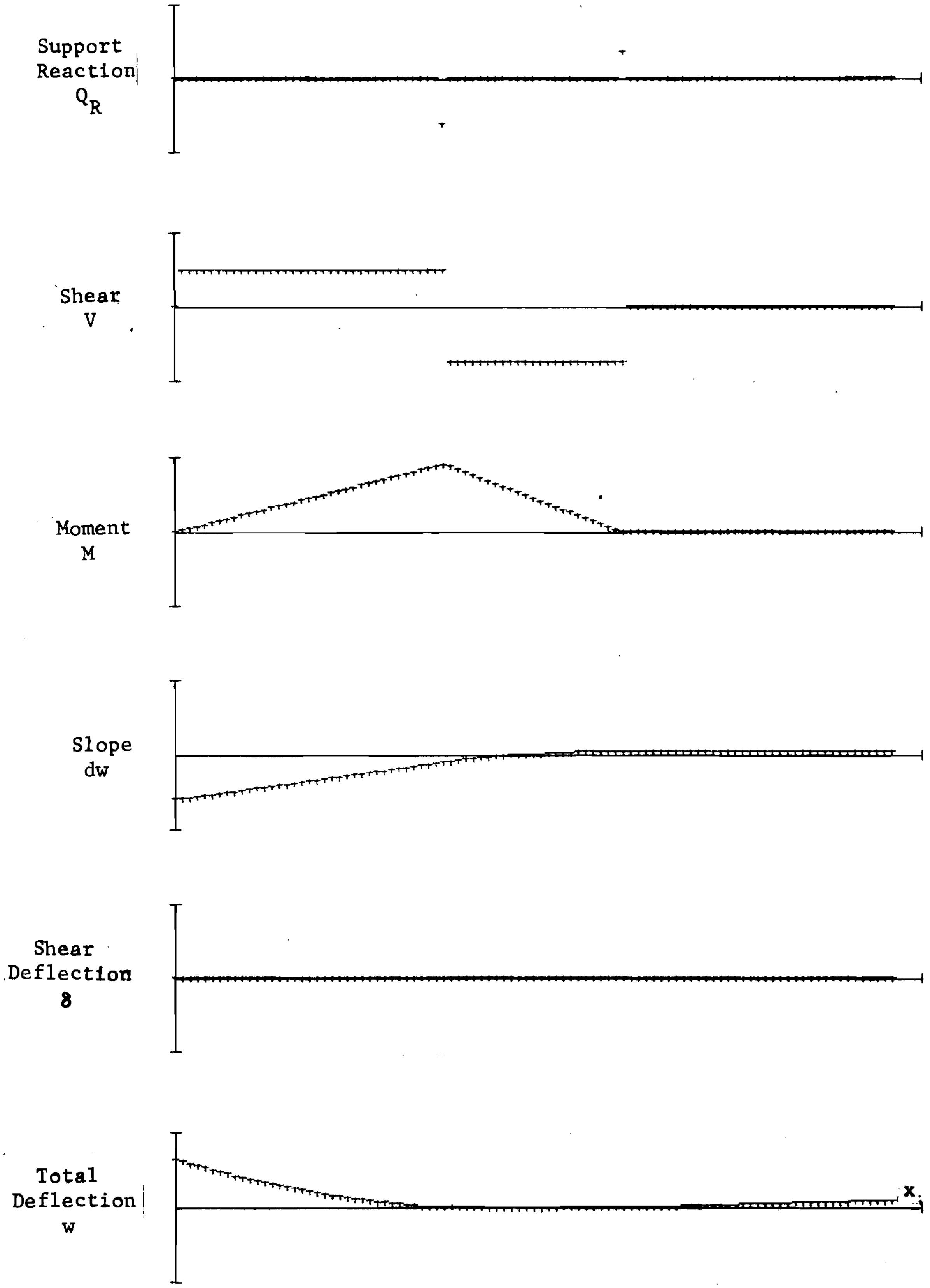

Prob 302B. **Same as Prob 302A, neglecting shear deformations.**

```
SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1  -  APPENDIX 6


PROB
303A     TAPERED THREE-SPAN OVERHANGING BEAM WITH 700 LB LOAD AT STA 0


TABLE 1 - PROGRAM-CONTROL DATA
                                                             TABLES NUMBER
                                                         2    3   4A    4B    5

     PRIOR-DATA OPTIONS (1 = HOLD)                       1    1    1'   0    0
     NUM CARDS INPUT THIS PROBLEM                        0    0    0    0    1

     OPTION (IF=1, 2, 3) TO PLOT                         1


TABLE 2 - CONSTANTS

     DATA HELD FROM THE PREVIOUS PROBLEM
     NUM INCREMENTS                                                         96
     INCREMENT LENGTH                                                1.000E+00


TABLE 3 - SPECIFIED DEFLECTIONS

     STA       DEFLECTION

     DATA HELD FROM THE PREVIOUS PROBLEM
     36          0.
     60          0.


TABLE 4A - SECTION AND MATERIAL PROPERTIES

FROM TO CONTD     E         G           I          SA

     DATA HELD FROM THE PREVIOUS PROBLEM
  0  96   0   1.000E+07 -0.        -0.        -0.
  1  96   0  -0.         4.000E+06 -0.        -0.
  0   0   0  -0.        -0.         5.546E-01 -0.
  1       1  -0.        -0.         7.421E-01  7.200E-02
      3   1  -0.        -0.         1.193E+00  8.740E-02
      6   1  -0.        -0.         2.034E+00  1.090E-01
     10   1  -0.        -0.         3.395E+00  1.360E-01
     14   1  -0.        -0.         4.937E+00  1.600E-01
     18   1  -0.        -0.         6.566E+00  1.810E-01
     23   1  -0.        -0.         8.592E+00  2.040E-01
     28   1  -0.        -0.         1.047E+01  2.220E-01
     35   1  -0.        -0.         1.260E+01  2.420E-01
     48   1  -0.        -0.         1.429E+01  2.560E-01
     61   1  -0.        -0.         1.260E+01  2.420E-01
     68   1  -0.        -0.         1.047E+01  2.220E-01
     73   1  -0.        -0.         8.592E+00  2.040E-01
```

```
     78    1  -0.          -0.          6.566E+00  1.810E-01
     82    1  -0.          -0.          4.937E+00  1.600E-01
     86    1  -0.          -0.          3.395E+00  1.360E-01
     90    1  -0.          -0.          2.034E+00  1.090E-01
     93    1  -0.          -0.          1.193E+00  8.740E-02
     96   -0  -0.          -0.          5.546E-01  6.440E-02


TABLE 48 - STIFFNESS DATA

FROM TO CONTD     SK          F


                NONE


TABLE 5 - LOAD DATA

FROM TO CONTD      Q           S           T           R           P

     ADDITIONAL DATA INPUT FOR THIS PROBLEM
  0    0  -0    7.000E+02 -0.        -0.         -0.         -0.
```

```
SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1  -  APPENDIX 6


PROB (CONTD)
303A      TAPERED THREE-SPAN OVERHANGING BEAM WITH 700 LB LOAD AT STA 0


TABLE 6 - RESULTS

  STA       W          DELTA       SLOPE         MOM         SHEAR      SUP REACT

  -1    2.665E-01                              0.                       0.
                    0.          -9.296E-03                0.
   0    2.572E-01                            -7.851E-09                 0.
                    2.431E-03 -9.296E-03                  7.000E+02
   1    2.454E-01                              7.000E+02                0.
                    2.196E-03 -9.202E-03                  7.000E+02
   2    2.340E-01                              1.400E+03                0.
                    2.002E-03 -9.057E-03                  7.000E+02
   3    2.230E-01                              2.100E+03                0.
                    1.850E-03 -8.881E-03                  7.000E+02
   4    2.123E-01                              2.800E+03                0.
                    1.719E-03 -8.691E-03                  7.000E+02
   5    2.018E-01                              3.500E+03                0.
                    1.606E-03 -8.491E-03                  7.000E+02
   6    1.917E-01                              4.200E+03                0.
                    1.512E-03 -8.285E-03                  7.000E+02
   7    1.819E-01                              4.900E+03                0.
                    1.429E-03 -8.078E-03                  7.000E+02
   8    1.724E-01                              5.600E+03                0.
                    1.354E-03 -7.872E-03                  7.000E+02
   9    1.632E-01                              6.300E+03                0.
                    1.287E-03 -7.666E-03                  7.000E+02
  10    1.543E-01                              7.000E+03                0.
                    1.232E-03 -7.460E-03                  7.000E+02
  11    1.456E-01                              7.700E+03                0.
                    1.182E-03 -7.256E-03                  7.000E+02
  12    1.371E-01                              8.400E+03                0.
                    1.136E-03 -7.054E-03                  7.000E+02
  13    1.289E-01                              9.100E+03                0.
                    1.094E-03 -6.854E-03                  7.000E+02
  14    1.210E-01                              9.800E+03                0.
                    1.059E-03 -6.656E-03                  7.000E+02
  15    1.133E-01                              1.050E+04                0.
                    1.026E-03 -6.459E-03                  7.000E+02
  16    1.058E-01                              1.120E+04                0.
                    9.957E-04 -6.265E-03                  7.000E+02
  17    9.853E-02                              1.190E+04                0.
                    9.669E-04 -6.072E-03                  7.000E+02
  18    9.149E-02                              1.260E+04                0.
                    9.429E-04 -5.880E-03                  7.000E+02
  19    8.467E-02                              1.330E+04                0.
                    9.201E-04 -5.689E-03                  7.000E+02
  20    7.806E-02                              1.400E+04                0.
                    8.984E-04 -5.499E-03                  7.000E+02
  21    7.167E-02                              1.470E+04                0.
                    8.776E-04 -5.310E-03                  7.000E+02
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```
22   6.548E-02                        1.540E+04             0.
                8.578E-04 -5.122E-03             7.000E+02
23   5.950E-02                        1.610E+04             0.
                8.430E-04 -4.935E-03             7.000E+02
24   5.372E-02                        1.680E+04             0.
                8.286E-04 -4.747E-03             7.000E+02
25   4.814E-02                        1.750E+04             0.
                8.147E-04 -4.560E-03             7.000E+02
26   4.277E-02                        1.820E+04             0.
                8.013E-04 -4.373E-03             7.000E+02
27   3.760E-02                        1.890E+04             0.
                7.883E-04 -4.186E-03             7.000E+02
28   3.262E-02                        1.960E+04             0.
                7.783E-04 -3.998E-03             7.000E+02
29   2.785E-02                        2.030E+04             0.
                7.685E-04 -3.810E-03             7.000E+02
30   2.327E-02                        2.100E+04             0.
                7.590E-04 -3.620E-03             7.000E+02
31   1.889E-02                        2.170E+04             0.
                7.497E-04 -3.430E-03             7.000E+02
32   1.471E-02                        2.240E+04             0.
                7.406E-04 -3.238E-03             7.000E+02
33   1.073E-02                        2.310E+04             0.
                7.318E-04 -3.045E-03             7.000E+02
34   6.952E-03                        2.380E+04             0.
                7.231E-04 -2.852E-03             7.000E+02
35   3.377E-03                        2.450E+04             0.
                7.199E-04 -2.657E-03             7.000E+02
36   0.                               2.520E+04            -1.750E+03
               -1.075E-03 -2.459E-03            -1.050E+03
37  -1.384E-03                        2.415E+04             0.
               -1.070E-03 -2.272E-03            -1.050E+03
38  -2.586E-03                        2.310E+04             0.
               -1.066E-03 -2.094E-03            -1.050E+03
39  -3.614E-03                        2.205E+04             0.
               -1.061E-03 -1.926E-03            -1.050E+03
40  -4.478E-03                        2.100E+04             0.
               -1.057E-03 -1.767E-03            -1.050E+03
41  -5.189E-03                        1.995E+04             0.
               -1.052E-03 -1.618E-03            -1.050E+03
42  -5.755E-03                        1.890E+04             0.
               -1.047E-03 -1.478E-03            -1.050E+03
43  -6.186E-03                        1.785E+04             0.
               -1.043E-03 -1.347E-03            -1.050E+03
44  -6.491E-03                        1.680E+04             0.
               -1.038E-03 -1.225E-03            -1.050E+03
45  -6.677E-03                        1.575E+04             0.
               -1.034E-03 -1.112E-03            -1.050E+03
46  -6.755E-03                        1.470E+04             0.
               -1.030E-03 -1.007E-03            -1.050E+03
47  -6.733E-03                        1.365E+04             0.
               -1.025E-03 -9.109E-04            -1.050E+03
48  -6.619E-03                        1.260E+04             0.
               -1.030E-03 -8.227E-04            -1.050E+03
49  -6.412E-03                        1.155E+04             0.
               -1.034E-03 -7.412E-04            -1.050E+03
50  -6.119E-03                        1.050E+04             0.
               -1.038E-03 -6.663E-04            -1.050E+03
51  -5.747E-03                        9.450E+03             0.
               -1.043E-03 -5.983E-04            -1.050E+03
52  -5.302E-03                        8.400E+03             0.
```

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                 -1.047E-03 -5.373E-04             -1.050E+03
53  -4.792E-03                         7.350E+03               0.
                 -1.052E-03 -4.835E-04             -1.050E+03
54  -4.223E-03                         6.300E+03               0.
                 -1.057E-03 -4.368E-04             -1.050E+03
55  -3.604E-03                         5.250E+03               0.
                 -1.061E-03 -3.976E-04             -1.050E+03
56  -2.940E-03                         4.200E+03               0.
                 -1.066E-03 -3.659E-04             -1.050E+03
57  -2.240E-03                         3.150E+03               0.
                 -1.070E-03 -3.419E-04             -1.050E+03
58  -1.512E-03                         2.100E+03               0.
                 -1.075E-03 -3.257E-04             -1.050E+03
59  -7.624E-04                         1.050E+03               0.
                 -1.080E-03 -3.176E-04             -1.050E+03
60   0.                               -7.560E-09               1.050E+03
                 -1.843E-16 -3.176E-04             -1.784E-10
61  -3.176E-04                        -7.170E-09               0.
                 -1.787E-16 -3.176E-04             -1.710E-10
62  -6.351E-04                        -7.815E-09               0.
                 -1.798E-16 -3.176E-04             -1.700E-10
63  -9.527E-04                        -8.042E-09               0.
                 -1.775E-16 -3.176E-04             -1.658E-10
64  -1.270E-03                        -8.593E-09               0.
                 -1.817E-16 -3.176E-04             -1.675E-10
65  -1.588E-03                        -7.560E-09               0.
                 -1.856E-16 -3.176E-04             -1.691E-10
66  -1.905E-03                        -9.787E-09               0.
                 -1.768E-16 -3.176E-04             -1.590E-10
67  -2.223E-03                        -1.156E-08               0.
                 -1.869E-16 -3.176E-04             -1.660E-10
68  -2.540E-03                        -1.446E-08               0.
                 -1.863E-16 -3.176E-04             -1.627E-10
69  -2.858E-03                        -1.799E-08               0.
                 -1.980E-16 -3.176E-04             -1.701E-10
70  -3.176E-03                        -1.763E-08               0.
                 -1.850E-16 -3.176E-04             -1.563E-10
71  -3.493E-03                        -1.163E-08               0.
                 -1.846E-16 -3.176E-04             -1.533E-10
72  -3.811E-03                        -1.491E-08               0.
                 -1.343E-16 -3.176E-04             -1.504E-10
73  -4.128E-03                        -1.707E-08               0.
                 -1.610E-16 -3.176E-04             -1.284E-10
74  -4.446E-03                        -1.375E-08               0.
                 -1.624E-16 -3.176E-04             -1.266E-10
75  -4.763E-03                        -1.859E-08               0.
                 -1.515E-16 -3.176E-04             -1.153E-10
76  -5.081E-03                        -1.259E-08               0.
                 -1.279E-16 -3.176E-04             -9.494E-11
77  -5.398E-03                        -1.664E-08               0.
                 -1.168E-16 -3.176E-04             -8.458E-11
78  -5.716E-03                        -1.483E-08               0.
                 -9.284E-17 -3.176E-04             -6.526E-11
79  -6.033E-03                        -9.527E-09               0.
                 -1.087E-16 -3.176E-04             -7.416E-11
80  -6.351E-03                        -9.758E-09               0.
                 -1.119E-16 -3.176E-04             -7.394E-11
81  -6.669E-03                        -1.284E-08               0.
                 -1.300E-16 -3.176E-04             -8.321E-11
82  -6.986E-03                        -1.058E-08               0.
                 -1.501E-16 -3.176E-04             -9.244E-11
```

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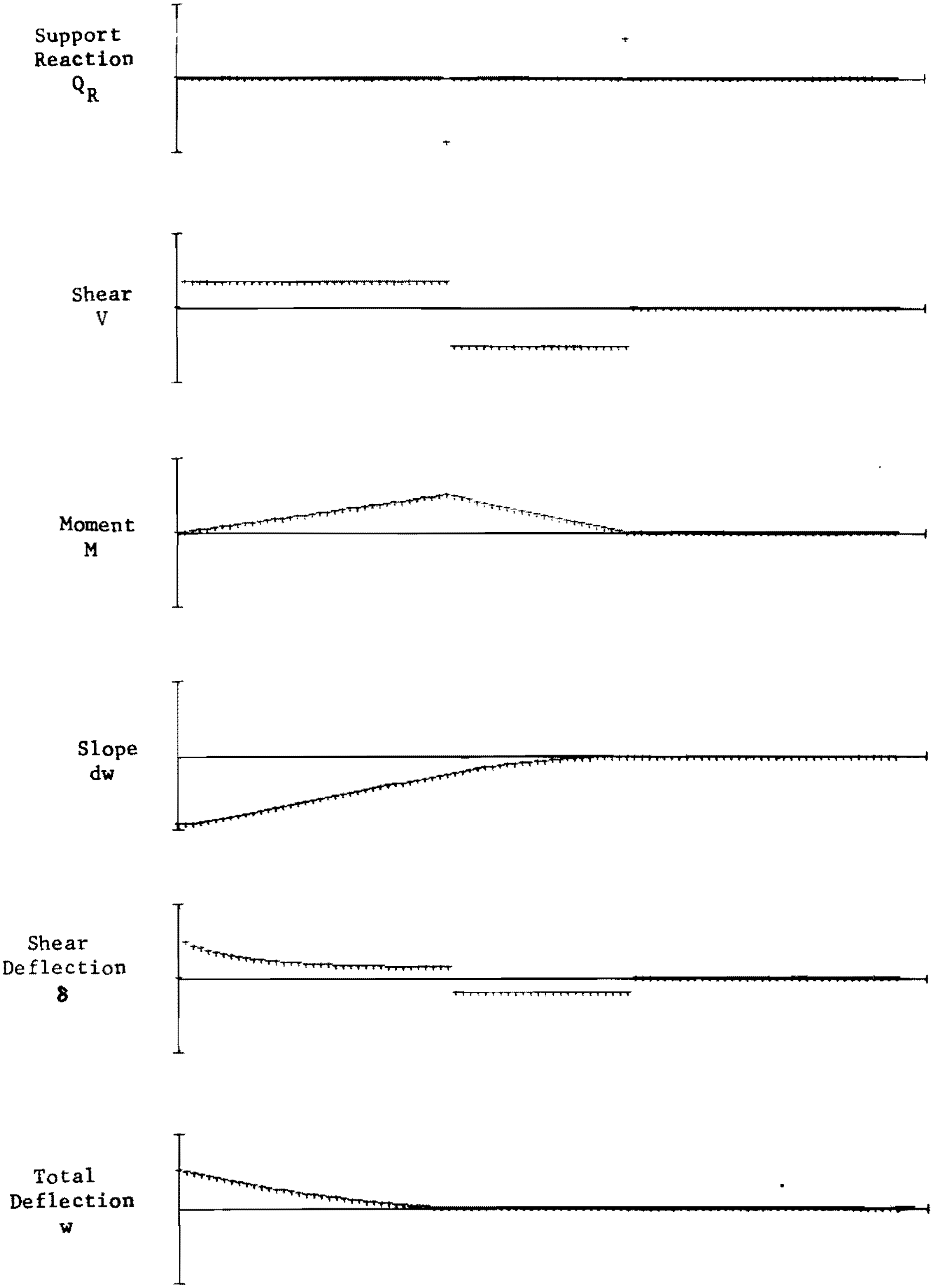
  83  -7.304E-03                       -4.646E-09             0.
                 -1.411E-16 -3.176E-04            -8.354E-11
  84  -7.621E-03                       -6.556E-09             0.
                 -1.319E-16 -3.176E-04            -7.495E-11
  85  -7.939E-03                       -8.034E-09             0.
                 -1.224E-16 -3.176E-04            -6.660E-11
  86  -8.256E-03                       -2.768E-09             0.
                 -9.294E-17 -3.176E-04            -4.805E-11
  87  -8.574E-03                       -4.212E-09             0.
                 -1.198E-16 -3.176E-04            -5.871E-11
  88  -8.891E-03                       -1.204E-09             0.
                 -1.087E-16 -3.176E-04            -5.031E-11
  89  -9.209E-03                        5.828E-10             0.
                 -8.411E-17 -3.176E-04            -3.667E-11
  90  -9.527E-03                       -1.893E-09             0.
                 -6.617E-17 -3.176E-04            -2.695E-11
  91  -9.844E-03                       -3.779E-09             0.
                 -5.960E-17 -3.176E-04            -2.255E-11
  92  -1.016E-02                       -1.521E-09             0.
                 -5.181E-17 -3.176E-04            -1.811E-11
  93  -1.048E-02                       -1.959E-09             0.
                 -4.951E-17 -3.176E-04            -1.579E-11
  94  -1.080E-02                       -9.509E-10             0.
                 -3.550E-17 -3.176E-04            -1.023E-11
  95  -1.111E-02                        6.048E-10             0.
                 -1.220E-17 -3.176E-04            -3.142E-12
  96  -1.143E-02                        1.863E-10             0.
                 -5.166E-19 -3.176E-04            -1.331E-13
  97  -1.175E-02                        0.                    0.

TABLE 7 -- SCALES FOR PLOT OUTPUT -- VALUES AT ENDS OF AXES

STA      X          W        DELTA       DW          M          V       SUP REACT
100  1.000E+02  5.000E-01  5.000E-03  1.000E-02  5.000E+04  2.000E+03  2.000E+03


                         TIME FOR THIS PROBLEM =     0 MINUTES    3.527 SECONDS


                         ELAPSED CPU TIME =     0 MINUTES   37.591 SECONDS
```



Prob 303A. Tapered three-span overhanging beam with 700-lb load at Sta 0.

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SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1  -  APPENDIX 6


PROB
303B     SAME AS PROBLEM 303A - ADD INFINITE SHEAR STIFFNESS


TABLE 1 - PROGRAM-CONTROL DATA
                                                             TABLES NUMBER
                                                          2    3    4A   4B    5

     PRIOR-DATA OPTIONS (1 = HOLD)                        1    1    1    0     1
     NUM CARDS INPUT THIS PROBLEM                         0    0    0    1     0

     OPTION (IF=1, 2, 3) TO PLOT                          1


TABLE 2 - CONSTANTS

     DATA HELD FROM THE PREVIOUS PROBLEM
     NUM INCREMENTS                                                             96
     INCREMENT LENGTH                                                    1.000E+00


TABLE 3 - SPECIFIED DEFLECTIONS

     STA        DEFLECTION

     DATA HELD FROM THE PREVIOUS PROBLEM
     36           0.
     60           0.


TABLE 4A - SECTION AND MATERIAL PROPERTIES

FROM TO CONTD      E         G            I          SA

     DATA HELD FROM THE PREVIOUS PROBLEM
  0  96   0   1.000E+07 -0.         -0.         -0.
  1  96   0  -0.          4.000E+06 -0.         -0.
  0   0   0  -0.        -0.         5.546E-01 -0.
  1        1  -0.        -0.         7.421E-01  7.200E-02
      3    1  -0.        -0.         1.193E+00  8.740E-02
      6    1  -0.        -0.         2.034E+00  1.090E-01
     10    1  -0.        -0.         3.395E+00  1.360E-01
     14    1  -0.        -0.         4.937E+00  1.600E-01
     18    1  -0.        -0.         6.566E+00  1.810E-01
     23    1  -0.        -0.         8.592E+00  2.040E-01
     28    1  -0.        -0.         1.047E+01  2.220E-01
     35    1  -0.        -0.         1.260E+01  2.420E-01
     48    1  -0.        -0.         1.429E+01  2.560E-01
     61    1  -0.        -0.         1.260E+01  2.420E-01
     68    1  -0.        -0.         1.047E+01  2.220E-01
     73    1  -0.        -0.         8.592E+00  2.040E-01
```

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     78   1  -0.          -0.           6.566E+00  1.810E-01
     82   1  -0.          -0.           4.937E+00  1.600E-01
     86   1  -0.          -0.           3.395E+00  1.360E-01
     90   1  -0.          -0.           2.034E+00  1.090E-01
     93   1  -0.          -0.           1.193E+00  8.740E-02
     96  -0  -0.          -0.           5.546E-01  6.440E-02


TABLE 4B - STIFFNESS DATA

FROM TO CONTD    SK          F

     ADDITIONAL DATA INPUT FOR THIS PROBLEM
  1  96  -0   1.000E+99 -0.


TABLE 5 - LOAD DATA

FROM TO CONTD     Q          S          T          R          P

     DATA HELD FROM THE PREVIOUS PROBLEM
  0   0  -0   7.000E+02 -0.       -0.        -0.        -0.
```

```
SAMPLE INPUT FOR EXAMPLE PROBLEMS FOR SHRBM 1  -  APPENDIX 6


PROB (CONTD)
303B     SAME AS PROBLEM 303A - ADD INFINITE SHEAR STIFFNESS


TABLE 6 - RESULTS

  STA      W        DELTA      SLOPE      MOM        SHEAR    SUP REACT

  -1   1.869E-01                       0.                   0.
                  0.        -8.244E-03            0.
   0   1.787E-01                       1.941E-90            0.
                  7.000E-97 -8.244E-03            7.000E+02
   1   1.704E-01                       7.000E+02            0.
                  7.000E-97 -8.149E-03            7.000E+02
   2   1.623E-01                       1.400E+03            0.
                  7.000E-97 -8.005E-03            7.000E+02
   3   1.543E-01                       2.100E+03            0.
                  7.000E-97 -7.829E-03            7.000E+02
   4   1.464E-01                       2.800E+03            0.
                  7.000E-97 -7.639E-03            7.000E+02
   5   1.388E-01                       3.500E+03            0.
                  7.000E-97 -7.439E-03            7.000E+02
   6   1.314E-01                       4.200E+03            0.
                  7.000E-97 -7.233E-03            7.000E+02
   7   1.241E-01                       4.900E+03            0.
                  7.000E-97 -7.026E-03            7.000E+02
   8   1.171E-01                       5.600E+03            0.
                  7.000E-97 -6.820E-03            7.000E+02
   9   1.103E-01                       6.300E+03            0.
                  7.000E-97 -6.614E-03            7.000E+02
  10   1.037E-01                       7.000E+03            0.
                  7.000E-97 -6.408E-03            7.000E+02
  11   9.726E-02                       7.700E+03            0.
                  7.000E-97 -6.204E-03            7.000E+02
  12   9.106E-02                       8.400E+03            0.
                  7.000E-97 -6.002E-03            7.000E+02
  13   8.506E-02                       9.100E+03            0.
                  7.000E-97 -5.802E-03            7.000E+02
  14   7.925E-02                       9.800E+03            0.
                  7.000E-97 -5.604E-03            7.000E+02
  15   7.365E-02                       1.050E+04            0.
                  7.000E-97 -5.407E-03            7.000E+02
  16   6.824E-02                       1.120E+04            0.
                  7.000E-97 -5.213E-03            7.000E+02
  17   6.303E-02                       1.190E+04            0.
                  7.000E-97 -5.019E-03            7.000E+02
  18   5.801E-02                       1.260E+04            0.
                  7.000E-97 -4.827E-03            7.000E+02
  19   5.318E-02                       1.330E+04            0.
                  7.000E-97 -4.637E-03            7.000E+02
  20   4.855E-02                       1.400E+04            0.
                  7.000E-97 -4.447E-03            7.000E+02
  21   4.410E-02                       1.470E+04            0.
                  7.000E-97 -4.258E-03            7.000E+02
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  22  3.984E-02                        1.540E+04              0.
                 7.000E-97 -4.070E-03             7.000E+02
  23  3.577E-02                        1.610E+04              0.
                 7.000E-97 -3.882E-03             7.000E+02
  24  3.189E-02                        1.680E+04              0.
                 7.000E-97 -3.695E-03             7.000E+02
  25  2.820E-02                        1.750E+04              0.
                 7.000E-97 -3.508E-03             7.000E+02
  26  2.469E-02                        1.820E+04              0.
                 7.000E-97 -3.321E-03             7.000E+02
  27  2.137E-02                        1.890E+04              0.
                 7.000E-97 -3.133E-03             7.000E+02
  28  1.823E-02                        1.960E+04              0.
                 7.000E-97 -2.946E-03             7.000E+02
  29  1.529E-02                        2.030E+04              0.
                 7.000E-97 -2.758E-03             7.000E+02
  30  1.253E-02                        2.100E+04              0.
                 7.000E-97 -2.568E-03             7.000E+02
  31  9.961E-03                        2.170E+04              0.
                 7.000E-97 -2.378E-03             7.000E+02
  32  7.584E-03                        2.240E+04              0.
                 7.000E-97 -2.186E-03             7.000E+02
  33  5.398E-03                        2.310E+04              0.
                 7.000E-97 -1.993E-03             7.000E+02
  34  3.405E-03                        2.380E+04              0.
                 7.000E-97 -1.800E-03             7.000E+02
  35  1.605E-03                        2.450E+04              0.
                 7.000E-97 -1.605E-03             7.000E+02
  36  0.                               2.520E+04             -1.750E+03
                -1.050E-96 -1.407E-03            -1.050E+03
  37 -1.407E-03                        2.415E+04              0.
                -1.050E-96 -1.219E-03            -1.050E+03
  38 -2.627E-03                        2.310E+04              0.
                -1.050E-96 -1.042E-03            -1.050E+03
  39 -3.668E-03                        2.205E+04              0.
                -1.050E-96 -8.736E-04            -1.050E+03
  40 -4.542E-03                        2.100E+04              0.
                -1.050E-96 -7.151E-04            -1.050E+03
  41 -5.257E-03                        1.995E+04              0.
                -1.050E-96 -5.660E-04            -1.050E+03
  42 -5.823E-03                        1.890E+04              0.
                -1.050E-96 -4.261E-04            -1.050E+03
  43 -6.249E-03                        1.785E+04              0.
                -1.050E-96 -2.952E-04            -1.050E+03
  44 -6.544E-03                        1.680E+04              0.
                -1.050E-96 -1.732E-04            -1.050E+03
  45 -6.718E-03                        1.575E+04              0.
                -1.050E-96 -5.991E-05            -1.050E+03
  46 -6.777E-03                        1.470E+04              0.
                -1.050E-96  4.487E-05            -1.050E+03
  47 -6.733E-03                        1.365E+04              0.
                -1.050E-96  1.413E-04            -1.050E+03
  48 -6.591E-03                        1.260E+04              0.
                -1.050E-96  2.294E-04            -1.050E+03
  49 -6.362E-03                        1.155E+04              0.
                -1.050E-96  3.110E-04            -1.050E+03
  50 -6.051E-03                        1.050E+04              0.
                -1.050E-96  3.858E-04            -1.050E+03
  51 -5.665E-03                        9.450E+03              0.
                -1.050E-96  4.538E-04            -1.050E+03
  52 -5.211E-03                        8.400E+03              0.
```

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              -1.050E-96   5.148E-04              -1.050E+03
53  -4.696E-03                          7.350E+03              0.
              -1.050E-96   5.687E-04              -1.050E+03
54  -4.128E-03                          6.300E+03              0.
              -1.050E-96   6.154E-04              -1.050E+03
55  -3.512E-03                          5.250E+03              0.
              -1.050E-96   6.546E-04              -1.050E+03
56  -2.858E-03                          4.200E+03              0.
              -1.050E-96   6.863E-04              -1.050E+03
57  -2.171E-03                          3.150E+03              0.
              -1.050E-96   7.103E-04              -1.050E+03
58  -1.461E-03                          2.100E+03              0.
              -1.050E-96   7.265E-04              -1.050E+03
59  -7.346E-04                          1.050E+03              0.
              -1.050E-96   7.346E-04              -1.050E+03
60   0.                                 1.678E-08              1.050E+03
               8.382-108   7.346E-04               8.382E-09
61   7.346E-04                          2.623E-08              0.
               6.983-108   7.346E-04               6.983E-09
62   1.469E-03                          3.413E-08              0.
               5.600-108   7.346E-04               5.600E-09
63   2.204E-03                          3.828E-08              0.
               5.543-108   7.346E-04               5.543E-09
64   2.939E-03                          4.055E-08              0.
               4.290-108   7.346E-04               4.290E-09
65   3.673E-03                          4.423E-08              0.
               4.373-108   7.346E-04               4.373E-09
66   4.408E-03                          5.227E-08              0.
               3.869-108   7.346E-04               3.869E-09
67   5.142E-03                          5.084E-08              0.
               3.489-108   7.346E-04               3.489E-09
68   5.877E-03                          5.812E-08              0.
               3.206-108   7.346E-04               3.206E-09
69   6.612E-03                          4.483E-08              0.
               2.849-108   7.346E-04               2.849E-09
70   7.346E-03                          4.856E-08              0.
               2.457-108   7.346E-04               2.457E-09
71   8.081E-03                          5.705E-08              0.
               2.051-108   7.346E-04               2.051E-09
72   8.816E-03                          3.485E-08              0.
               1.902-108   7.346E-04               1.902E-09
73   9.550E-03                          4.770E-08              0.
               1.862-108   7.346E-04               1.862E-09
74   1.028E-02                          4.999E-08              0.
               1.546-108   7.346E-04               1.546E-09
75   1.102E-02                          3.024E-08              0.
               1.347-108   7.346E-04               1.347E-09
76   1.175E-02                          2.457E-08              0.
               1.181-108   7.346E-04               1.181E-09
77   1.249E-02                          3.096E-08              0.
               1.040-108   7.346E-04               1.040E-09
78   1.322E-02                          2.916E-08              0.
               1.023-108   7.346E-04               1.023E-09
79   1.396E-02                          2.735E-08              0.
               8.171-109   7.346E-04               8.171E-10
80   1.469E-02                          1.277E-08              0.
               7.278-109   7.346E-04               7.278E-10
81   1.543E-02                          1.780E-08              0.
               6.066-109   7.346E-04               6.066E-10
82   1.616E-02                         -5.481E-09              0.
               4.968-109   7.346E-04               4.968E-10
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  83  1.690E-02                    -2.021E-08                0.
                3.985-109 7.346E-04           3.985E-10
  84  1.763E-02                    -9.250E-09                0.
                3.478-109 7.346E-04           3.478E-10
  85  1.837E-02                    -1.259E-08                0.
                3.022-109 7.346E-04           3.022E-10
  86  1.910E-02                    -2.262E-08                0.
                2.947-109 7.346E-04           2.947E-10
  87  1.983E-02                    -1.357E-08                0.
                2.540-109 7.346E-04           2.540E-10
  88  2.057E-02                    -1.808E-08                0.
                2.169-109 7.346E-04           2.169E-10
  89  2.130E-02                    -2.109E-08                0.
                2.191-109 7.346E-04           2.191E-10
  90  2.204E-02                    -1.355E-08                0.
                1.460-109 7.346E-04           1.460E-10
  91  2.277E-02                    -1.363E-08                0.
                9.296-110 7.346E-04           9.296E-11
  92  2.351E-02                    -8.179E-09                0.
                7.754-110 7.346E-04           7.754E-11
  93  2.424E-02                    -1.324E-09                0.
                5.938-110 7.346E-04           5.938E-11
  94  2.498E-02                    -7.014-104                0.
                5.223-110 7.346E-04           5.223E-11
  95  2.571E-02                    -3.408E-09                0.
                9.116-111 7.346E-04           9.116E-12
  96  2.645E-02                    -6.157E-10                0.
                0.        7.346E-04           0.
  97  2.718E-02                     0.                       0.

TABLE 7 -- SCALES FOR PLOT OUTPUT -- VALUES AT ENDS OF AXES

STA      X          W        DELTA        DW         M          V       SUP REACT
100  1.000E+02  2.000E-01  1.000E+00  1.000E-02  5.000E+04  2.000E+03  2.000E+03


                       TIME FOR THIS PROBLEM =     0 MINUTES    3.569 SECONDS


                       ELAPSED CPU TIME =     0 MINUTES   41.160 SECONDS
```

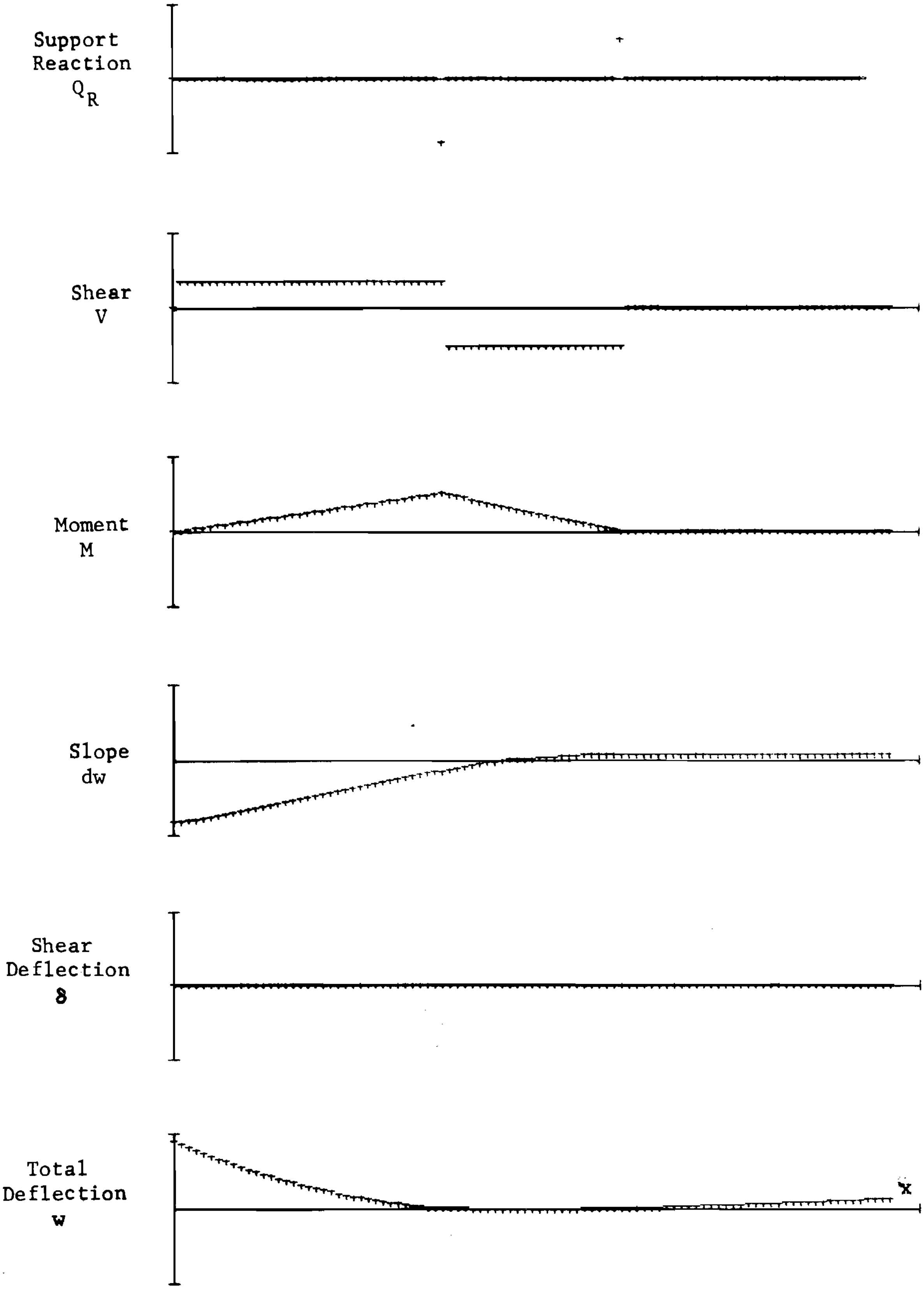

Prob 303B. Same as Prob 303A, neglecting shear deformations.