NATIONAL BUREAU OF STANDARDS REPORT

10 038

MISCELLANEOUS STRUCTURAL COMPUTER PROGRAMS

Modified for IBM 1130

for: The Construction Research Division
Post Office Department

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

NATIONAL BUREAU OF STANDARDS

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[1] Headquarters and Laboratories at Gaithersburg, Maryland, unless otherwise noted; mailing address Washington, D. C. 20234.
[2] Located at Boulder, Colorado 80302.
[3] Located at 5285 Port Royal Road, Springfield, Virginia 22151.

NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT 4213417

NBS REPORT 10 038

MISCELLANEOUS STRUCTURAL COMPUTER PROGRAMS

Modified for IBM 1130
by
E. F. Carpenter

for: The Construction Research Division
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NBS

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TABLE OF CONTENTS

1. INTRODUCTION

1.1. General

This is the second of two reports designed to modify, consolidate, and coordinate certain existing structural computer programs, to make them compatible with current building codes and the IBM 1130/FORTRAN IV language. This report is intended as a reference manual for the structural engineering use of six-beam deflection and concrete-frame programs.

The following programs are included:

(1) Deflection of Cantilevered Beams;

(2) Deflection of a Continuous Beam with Uniform Loads;

(3) Deflection of Fixed-End Beams;

(4) Concrete Frame Analysis, including conduits, culverts, three-story frame analysis, up to seven-span continuous beams. (Three programs)

The original computer programs were written in various FORTRAN forms, including RCA 301/FORTRAN, and IBM 1620/FORTRAN. These have all been modified to IBM 1130/FORTRAN, operable with the following equipment:

(a) IBM 1130, Model 2C, 16-K Storage/Version II;

(b) IBM 1132 Printer

(c) IBM Card Read-Punch;

(d) IBM 2315 Disc Cartridge, Removable/Interchangeable.

1.2. Scope

Each program has been checked for building code references, and modified where necessary to meet ACI 318-63, or AISC-63 specifications.

Programs have been debugged by performing an illustrative problem. No comprehensive full-scale attempt has been made to check against manual solutions and establish analytical validity. The user must satisfy himself as to reliability by testing the program with problems of known solution. Good engineering practice dictates that each program be used initially as a checking analysis until the user gains sufficient confidence and insight into the program's behavior. The theoretical basis and program abstracts described in Sections 2 thru 7 are presented to provide the user a quick reference as to the general nature of the program. Several of these programs, notably 2.B.1, 2.B.2, and 2.B.3, have been previously documented in considerable detail. If further information is required, reference can be made to that documentation.

A standard description sheet of each program is included in the Summary, to provide a consolidated definition of the program.

2. PROGRAM 2.A.1 - FIXED-END BEAM DEFLECTION

2.1. Purpose

The purpose of Program 2.A.1 is to calculate the deflection and slope at the end of a cantilever. The cantilever can be of varying cross-section. The applied loads consist of the uniform load over the entire beam and/or a point load at the end.

2.2. Theoretical Basis

Analytical calculations are based on the conjugate beam theory, combined with a numerical incrementing procedure that requires the beam to be subdivided into nine segments.

2.3. Input

The input consists of the beam dimensions and load factors on punched cards. Since there are nine segments, there will be ten points at which the moment of inertia and point location must be specified. Within the program, these points are numbered #1 through #10, beginning at the point nearest the fixed end. As can be seen below, cards 2(a) and (b), and cards 3(a) and (b) provide the point information. If it were desirable to use fewer than ten points, say one point to represent a uniform beam of uniform cross-section, one would need only enter the

pertinent information in the first field of card 2(a) and 3(a), leaving the remaining fields of card 2(a), 2(b), 3(a), 3(b) blank. Input parameters are read by the computer in the following sequence:

Card 1
- SPAN - length of beam in feet
- UDL - uniformly distributed load (kips per lineal foot)
- XP - distance from the concentrated load to the fixed end in feet
- P - applied concentrated load in kips
- E - modulus of elasticity (KSI)

Card 2 (a) and (b)
- XI(1 through 10) - these are the moments of inertia at the various points (inches to the fourth power)

Card 3 (a) and (b)
- SL (1 through 10) - these two cards contain the distances of the points from the fixed end (feet)

2.4. Output

Output information includes the following:

A listing of the input data.

Slope and deflection for the free end of the cantilever are printed, deflection being in inches.

The input and output features of this program can be easily modified by an individual familiar with FORTRAN, to provide a job-stacking capability, or more comprehensive input-output formatting procedures.

3. PROGRAM 2.A.2 - CONTINUOUS BEAM DEFLECTIONS

3.1. Purpose

The purpose of this program is to calculate the deflections at any desired spacing along the length of a uniformly loaded beam, having a constant moment of inertia, and given the moments at the supports.

3.2. Theoretical Basis

The conjugate-beam method is used in the manner described in an article appearing in the September 1961 issue of *Civil Engineering*, entitled "Deflection Calculated by the Conjugate-Beam Method," written by Jack I. Mann.

The conjugate beam is constructed by loading a simple beam with the M/EI diagram of the real beam. The reactions of the conjugate beam represent the slopes on the ends of the real beam, and, since the supports of the real beam are assumed not to deflect, there is no moment at the end of the conjugate beam. The basic design equation is:

3.3. Input

Input is very simple and requires only one card per beam.

This card has seven parameters, which are as follows:

```
Card 1    AL - length of beam in feet
          SM - simple beam moment in kip-ft.
          AM - moment at support A in kip-ft.
          BM - moment at support B in kip-ft.
          E - modulus of elasticity in KSI
          AI - moment of inertia in inches to the fourth power
          ZNUM - percentage of span indicating points
                 at which deflection is to be computed
                 (i.e., .1 would be 1/10 points)
```

3.4. Output

Output is simply two columns of numbers, the first column being the distance from end A, and the second column being deflection at that point in inches.

PROGRAM 2.A.3 - DEFLECTION OF FIXED-END BEAMS

4.1. Purpose

This program computes the deflections at tenth points of a beam with both ends fixed, and with one end fixed and one end free.

4.2. Theoretical Basis

The formula used to calculate deflections of the beam with both ends fixed is as follows:

$$\Delta x = \frac{w x^2}{24 EI} (L - x)^2$$

The formula used to calculate deflections for a beam with one end fixed and one end free is as follows:

$$\Delta x = \frac{w x}{48 EI} (L^3 - 3Lx^2 + 2x^2)$$

4.3. Input

The input for this program consists of one card per beam. The card contains the following parameters:

Card 1
- AL - length of span in feet
- E - modulus of elasticity in KSI
- AI - moment of inertia in inches to the fourth power
- W - uniform load in kips per foot

4.4. Output

The output consists of three columns, the first being the location of the deflection relative to the left end, or free end for the unsymmetrical beam. The second column gives the deflection for the beam with both ends fixed. The third column gives the deflection in inches for the beam with one end free.

This program can be used for more than one beam at a time and serves as a convenient method to compare the effects of fixity on deflection.

5. PROGRAM 2.B.1 - CONCRETE FRAME ANALYSIS - PART I

5.1. Purpose

This program provides an analysis of reinforced concrete structures, including concrete conduits or culverts under high fill. The program is limited to the analysis of uniformly loaded haunched-end or prismatic members which are not subjected to conditions of side-sway. However, assumed side-sway moment distribution can be accomplished separately with the program, and the results combined manually. The program has been divided into three parts, this first part of which computes fixed-end moments, distribution factors, carry-over factors, distributed moments, and that point on the member where the moment of inertia is no longer assumed equal to infinity. Part I also produces the punched data deck for input to the second part (2.B.2).

5.2. Theoretical Basis

The conduit analysis assumes a rectangular or box shape for the exterior of the structure, with either square or simulated-round interior barrels. The simulated-round barrel is represented by an octagonal cross-section, thus utilizing a haunched-member assumption.

The basic situation is a three-celled structure with each member represented by dual numbers. This numerical designation for the numbers is necessarily applied to all situations, and for each situation, twenty sets of input data must be entered. The values entered typify the particular structure being analyzed. For prismatic members, the input format is filled by entering zeros in the positions allocated to length of haunch and slope of haunch. By entering zeros exclusively in the positions allocated to loading, and by entering zeros or ones in the positions designated for moments of inertia, certain members are virtually eliminated from consideration, thus providing for the analysis of a variety of structures.

5.3. Input

Only one type of input card is required; however, twenty of these cards are used for every problem. Each of the twenty cards provides the data for the twenty positions shown in the following figure:

Each of the twenty cards requires numeration of the following parameters:

Card 1 S - the 20 numbers in the figure above can be thought of as beam ends. S is the span length of the beam associated with each particular number.
- SK - this is the thickness of each member in feet
- COF - this is the haunched depth in feet (if any)
- AI - this is the relative moment of inertia
- DM - slope of the haunch
- W - uniform load in kips per foot
- BAL - depth to center of steel from tensile face in feet

It should be remembered that the program expects to find three cells consisting of twenty members. In the event that fewer cells or members are desired, the programmer should insert artificial members that have negligable effect on the analysis: i.e., small moment of inertia, small thickness, and small uniform load.

5.4. Output

This first phase of the concrete frame program computes fixed-end moments, distribution factors, carry-over factors, distributed moments, and that point on the member where the moment of inertia is no longer assumed equal to infinity. The output from this first phase consists of a set of punched cards for input to the second program, 2.B.2, and printed results of five factors for each member. These factors are as follows:

FEM - Fixed-end moments in kip-ft.;

A - Flexibility coefficient times length;

DF - Distribution factor;

COF - Haunch depth in feet;

DM - Distributed moment in kip-ft.

6. PROGRAM 2.B.2 - CONCRETE FRAME ANALYSIS - Part II

6.1. Purpose

The objective of this second phase of the three-part program is to compute values of shear and unit shear at various points along the members, and to produce punched data for input to the third part. The theoretical basis is as described in Program 2.B.1.

6.2. Input and Output

The input for this phase of the program consists of the forty cards prepared by 2.B.1. The first twenty of these cards each contain six numbers representing the various programming coefficients. The second set of twenty cards each contains three coefficients.

The output of Program 2.B.2 can be varied by using Switch 1 and Switch 2. The normal output with both switches off consists of the following:

V - this is the end-sheer in kips;

VA - shear at point of infinite I in kips;

VAEH - this is the change in shear from location of VA to the end of the haunch;

VEH - shear at the end of the haunch in kips;

VPC - shear at the point of counter-flexture in kips;

USA - unit shear for VA in KSI;

USAEH - unit shear for VAEH in KSI;

USEH - unit shear for VEH in KSI;

USPC - unit sheer for VPC in KSI.

In addition to the printed output, this program punches cards for input to the third phase of the system.

7. PROGRAM 2.B.3 - CONCRETE FRAME ANALYSIS - Part III

7.1. Purpose

Program 2.B.3 is the third part of a three-step analysis of concrete frames or rings, such as culverts and tunnels. This part computes the distance to various points along the members, together with the respective moments found at these positions. A moment correction factor is also computed. This can be used, if necessary, in accordance with the description contained in "Continuity in Concrete Building Frames," Fourth edition, Portland Cement Association.

7.2. Input-Output

The input of Program 2.B.3 consists of forty cards punched by Program 2.B.2. The first twenty cards contain eight coefficients. The second twenty each contain five coefficients.

The output with Data Switch 1 off, consists of the following:

S - span length in feet;

XF - distance to face of member in feet;

A - distance to infinite inertia in feet;

XEH - distance to end of haunch in feet;

XMVER - distance to point of counter-flecture in feet;

XMPOS - distance to maximum positive moment in feet;

DM, DMF, DMA, DMEH, DMPOS - these are the moments in kip-ft. at the positions indicated above, the face, the point of infinite inertia, the end of haunch, and the maximum positive moment;

DMCOR - this is the moment distribution correction factor previously referenced.

SUMMARY SHEET FOR PROGRAM NO. 2.A.1

PROGRAM NAME: Deflection of Cantilever Beams

A. TYPE OF MATERIAL

x	1.	Concrete
x	2.	Steel

B. TYPE OF STRUCTURE

x	1.	Beams and Girders
	2.	Columns
	3.	Composite Beams
	4.	Foundations
	5.	Frames and Tunnels
	6.	Prestress Construction
	7.	Shells
	8.	Slabs

C. REFERENCE CODES

N/A	1.	A.C.I.
	2.	A.I.S.C.
	3.	A.A.S.H.O.

D. TYPE OF ANALYSIS

x	1.	Elastic Analysis
	2.	Plastic Analysis
	3.	Working Strength Design
	4.	Ultimate Strength Design

E. REMARKS

SUMMARY SHEET FOR PROGRAM NO. 2.A.2

PROGRAM NAME: Deflection of Continuous Beams With Uniform Load

A. TYPE OF MATERIAL

x 1. Concrete
x 2. Steel

B. TYPE OF STRUCTURE

x 1. Beams and Girders
___ 2. Columns
___ 3. Composite Beams
___ 4. Foundations
___ 5. Frames and Tunnels
___ 6. Prestress Construction
___ 7. Shells
___ 8. Slabs

C. REFERENCE CODES

N/A 1. A.C.I.
___ 2. A.I.S.C.
___ 3. A.A.S.H.O.

D. TYPE OF ANALYSIS

x 1. Elastic Analysis
___ 2. Plastic Analysis
___ 3. Working Strength Design
___ 4. Ultimate Strength Design

E. REMARKS

SUMMARY SHEET FOR PROGRAM NO. 2.A.3

PROGRAM NAME: Fixed-End Beam Deflections

A. TYPE OF MATERIAL

x	1. Concrete
x	2. Steel

B. TYPE OF STRUCTURE

x	1. Beams and Girders
	2. Columns
	3. Composite Beams
	4. Foundations
	5. Frames and Tunnels
	6. Prestress Construction
	7. Shells
	8. Slabs

C. REFERENCE CODES

N/A	1. A.C.I.
	2. A.I.S.C.
	3. A.A.S.H.O.

D. TYPE OF ANALYSIS

x	1. Elastic Analysis
	2. Plastic Analysis
	3. Working Strength Design
	4. Ultimate Strength Design

E. REMARKS

SUMMARY SHEET FOR PROGRAM NO. 2.B.1

PROGRAM NAME: Concrete Frame Analysis (Part I)

A. TYPE OF MATERIAL

- x 1. Concrete
- ___ 2. Steel

B. TYPE OF STRUCTURE

- ___ 1. Beams and Girders
- ___ 2. Columns
- ___ 3. Composite Beams
- ___ 4. Foundations
- x 5. Frames and Tunnels
- ___ 6. Prestress Construction
- ___ 7. Shells
- ___ 8. Slabs

C. REFERENCE CODES

- x 1. A.C.I.
- ___ 2. A.I.S.C.
- ___ 3. A.A.S.H.O.

D. TYPE OF ANALYSIS

- x 1. Elastic Analysis
- ___ 2. Plastic Analysis
- ___ 3. Working Strength Design
- ___ 4. Ultimate Strength Design

E. REMARKS

Particularly well suited to tunnel design.

SUMMARY SHEET FOR PROGRAM NO. 2.B.2

PROGRAM NAME:

Concrete Frame Analysis (Part II)

A. TYPE OF MATERIAL

x 1. Concrete
__ 2. Steel

B. TYPE OF STRUCTURE

__ 1. Beams and Girders
__ 2. Columns
__ 3. Composite Beams
__ 4. Foundations
x 5. Frames and Tunnels
__ 6. Prestress Construction
__ 7. Shells
__ 8. Slabs

C. REFERENCE CODES

x 1. A.C.I.
__ 2. A.I.S.C.
__ 3. A.A.S.H.O.

D. TYPE OF ANALYSIS

x 1. Elastic Analysis
__ 2. Plastic Analysis
__ 3. Working Strength Design
__ 4. Ultimate Strength Design

E. REMARKS

Requires input from 2.B.1

SUMMARY SHEET FOR PROGRAM NO. 2.B.3

PROGRAM NAME: Concrete Frame Analysis (Part III)

A. TYPE OF MATERIAL

x 1. Concrete
__ 2. Steel

B. TYPE OF STRUCTURE

__ 1. Beams and Girders
__ 2. Columns
__ 3. Composite Beams
__ 4. Foundations
x 5. Frames and Tunnels
__ 6. Prestress Construction
__ 7. Shells
__ 8. Slabs

C. REFERENCE CODES

x 1. A.C.I.
__ 2. A.I.S.C.
__ 3. A.A.S.H.O.

D. TYPE OF ANALYSIS

x 1. Elastic Analysis
__ 2. Plastic Analysis
__ 3. Working Strength Design
__ 4. Ultimate Strength Design

E. REMARKS

Requires input from 2.B.2

IBM

FORTRAN CODING FORM

Program 2.A.1
Coded By E.F.C.
Checked By

Date May 9/69
Page 1 of 1

Identification 73–80

C FOR COMMENT

FORTRAN STATEMENT

```
20.          10.          0.            0.          30000.
14928.

20.
```

IBM

FORTRAN CODING FORM

Printed in U.S.A

Program 2.A.2

Coded By ESC

Checked By

Date MAY 9/69

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Identification 73 – 80

C FOR COMMENT

STATEMENT NUMBER (1–5)	Cont. (6)	FORTRAN STATEMENT (7–72)
0140.	0	002870.-001922.-001922. 30.0E 03 1.0E 05.10

IBM

FORTRAN CODING FORM

Program 2.A.3
Coded By EFC
Checked By

Date May 9/69
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Identification 73 – 80

C FOR COMMENT

STATEMENT NUMBER (1–5)	Cont. (6)	FORTRAN STATEMENT (7–72)
40.		30000000. 14988. 833.

IBM

FORTRAN CODING FORM

Form X25 · · · Printed in U.S.A.

Program 2.B.1
Coded By EFC
Checked By

Date May 9/69
Page 1 of 1

Identification 73 — 80

Statement Number (1–5)	Cont. (6)	FORTRAN Statement (7–72)
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09.50	0	4.7502.782501.001.0000-40.200.333 CARD #2
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		SAME AS CARD #2
		SAME AS CARD #1
		SAME AS CARD #2
09.50	0	4.7502.782501.001.0000 13.400.333 CARD #3
09.50	0	4.7502.782501.001.0000-13.400.333 CARD #4
		SAME AS CARD #1
		SAME AS CARD #2
		SAME AS CARD #1
		SAME AS CARD #2
		SAME AS CARD #1
		SAME AS CARD #2
		SAME AS CARD #3
		SAME AS CARD #4
09.50	0	4.7502.782501.001.0000 00.000.333 CARD #5
		SAME AS CARD #5
		SAME AS CARD #5
		SAME AS CARD #5

LISTING AND SAMPLE OUTPUT

for

PROGRAM 2.A.1. - DEFLECTION OF CANTILEVER

```
// JOB
// FOR
*IOCS(CARD,1132PRINTER,DISK)
*LIST ALL
C       CANTILEVER DEFLECTION PROGRAM                                      2A1
        DIMENSION XI(10), XL(10), DE(211), XXI(211), XM(211), SLOPE(211)   2A1
        DIMENSION DEFL(211)                                                2A1
1       CONTINUE                                                           2A1
        WRITE (3,35)                                                       2A1
        WRITE (3,36)                                                       2A1
        READ (2,34) SPAN,UDL,XP,P,E                                        2A1
        WRITE (3,38)                                                       2A1
        WRITE (3,35)                                                       2A1
        WRITE (3,36)                                                       2A1
        WRITE (3,34) SPAN,UDL,XP,P,E                                       2A1
        WRITE (3,38)                                                       2A1
        WRITE (3,37)                                                       2A1
        READ (2,34) XI(1),XI(2),XI(3),XI(4),XI(5)                          2A1
        READ (2,34) XI(6),XI(7),XI(8),XI(9),XI(10)                         2A1
        WRITE (3,34) XI(1),XI(2),XI(3),XI(4),XI(5)                         2A1
        WRITE (3,34) XI(6),XI(7),XI(8),XI(9),XI(10)                        2A1
        WRITE (3,38)                                                       2A1
        WRITE (3,40)                                                       2A1
        READ (2,34) XL(1),XL(2),XL(3),XL(4),XL(5)                          2A1
        READ (2,34) XL(6),XL(7),XL(8),XL(9),XL(10)                         2A1
        WRITE (3,34) XL(1),XL(2),XL(3),XL(4),XL(5)                         2A1
        WRITE (3,34) XL(6),XL(7),XL(8),XL(9),XL(10)                        2A1
        WRITE (3,38)                                                       2A1
        SPAN=SPAN*12.0                                                     2A1
        UDL=UDL*1000.0/12.0                                                2A1
        XP=XP*12.0                                                         2A1
        P=P*1000.0                                                         2A1
        E=E*1000.0                                                         2A1
        DO 2 N=1,10                                                        2A1
2       XL(N)=XL(N)*12.0                                                   2A1
        AL=SPAN/200.0                                                      2A1
C       DE = DISTANCE FROM END OF CANTILEVER                               2A1
        Z=XL(10)+XL(9)+XL(8)+XL(7)+XL(6)+XL(5)                             2A1
        DO 25 N=1,200                                                      2A1
        IF (N-1) 3,3,4                                                     2A1
3       DE(N)=AL*0.5                                                       2A1
        GO TO 5                                                            2A1
4       K=N-1                                                              2A1
        DE(N)=DE(K)+AL                                                     2A1
5       CONTINUE                                                           2A1
        IF (DE(N)-XL(10)) 6,6,7                                            2A1
6       XXI(N)=XI(10)                                                      2A1
        GO TO 24                                                           2A1
7       IF (DE(N)-XL(10)-XL(9)) 8,8,9                                      2A1
8       XXI(N)=XI(9)                                                       2A1
        GO TO 24                                                           2A1
9       IF (DE(N)-XL(10)-XL(9)-XL(8)) 10,10,11                             2A1
10      XXI(N)=XI(8)                                                       2A1
        GO TO 24                                                           2A1
11      IF (DE(N)-XL(10)-XL(9)-XL(8)-XL(7)) 12,12,13                       2A1
12      XXI(N)=XI(7)                                                       2A1
        GO TO 24                                                           2A1
13      IF (DE(N)-XL(10)-XL(9)-XL(8)-XL(7)-XL(6)) 14,15,15                 2A1
14      XXI(N)=XI(6)                                                       2A1
        GO TO 24                                                           2A1
15      IF (DE(N)-XL(10)-XL(9)-XL(8)-XL(7)-XL(6)-XL(5)) 16,17,17           2A1
16      XXI(N)=XI(5)                                                       2A1
```

```
      GO TO 24                                                          2A1
17    IF (DE(N)-Z-XL(4)) 18,19,19                                       2A1
18    XXI(N)=XI(4)                                                      2A1
      GO TO 24                                                          2A1
19    IF (DE(N)-Z-XL(4)-XL(3)) 20,20,21                                 2A1
20    XXI(N)=XI(3)                                                      2A1
      GO TO 24                                                          2A1
21    IF (DE(N)-Z-XL(4)-XL(3)-XL(2)) 22,22,23                           2A1
22    XXI(N)=XI(2)                                                      2A1
      GO TO 24                                                          2A1
23    XXI(N)=XI(1)                                                      2A1
24    CONTINUE                                                          2A1
25    CONTINUE                                                          2A1
      DO 28 N=1,200                                                     2A1
      XM(N)=DE(N)*UDL*DE(N)*0.5                                         2A1
      IF (DE(N)+XP-SPAN) 27,27,26                                       2A1
26    XM(N)=XM(N)+(DE(N)+XP-SPAN)*P                                     2A1
27    CONTINUE                                                          2A1
28    CONTINUE                                                          2A1
      DO 32 N=1,200                                                     2A1
      IF (N-1) 29,29,30                                                 2A1
29    SLOPE(N)=AL*XM(N)/(E*XXI(N))                                      2A1
      DEFL(N)=AL*XM(N)*DE(N)/(E*XXI(N))                                 2A1
      GO TO 31                                                          2A1
30    L=N-1                                                             2A1
      SLOPE(N)=SLOPE(L)+(AL*XM(N)/(E*XXI(N)))                           2A1
      DEFL(N)=DEFL(L)+(AL*XM(N)*DE(N)/(E*XXI(N)))                       2A1
31    CONTINUE                                                          2A1
32    CONTINUE                                                          2A1
      WRITE (3,38)                                                      2A1
      WRITE (3,41)                                                      2A1
      WRITE (3,38)                                                      2A1
      WRITE (3,38)                                                      2A1
      WRITE (3,43)                                                      2A1
      WRITE (3,42) SLOPE(200),DEFL(200)                                 2A1
      WRITE (3,39)                                                      2A1
      GO TO 1                                                           2A1
C                                                                       2A1
33    FORMAT (18X,21HCANTILEVER DEFLECTION)                             2A1
34    FORMAT (1X,6F12.3)                                                2A1
35    FORMAT (6X,4HSPAN,9X,3HUDL,9X,2HXP,10X,1HP,12X,1HE)               2A1
36    FORMAT (7X,2HFT,10X,4HK/FT,8X,4HFEET,8X,4HKIPS,8X,3HKSI)          2A1
37    FORMAT (7X,49HMOMENTS OF INERTIA (IN**4) FROM FIXED TO FREE END)  2A1
38    FORMAT (1H )                                                      2A1
39    FORMAT (1H1)                                                      2A1
40    FORMAT (7X,52HLENGTH OF CONSTANT I SEGMENTS FROM FIXED TO FREE END2A1
     1)                                                                 2A1
41    FORMAT (18X,10HOUTPUT    )                                        2A1
42    FORMAT (13X,F16.8,8X,F16.8)                                       2A1
43    FORMAT (18X,5HSLOPE,19X,10HDEFLECTION)                            2A1
      END                                                               2A1
// DUP
*STORE      WS  UA  M2A1
// XQT M2A1
```

CANTILEVER DEFLECTION

SPAN	UDL	XP	P	E
FT	K/FT	FEET	KIPS	KSI
20.000	10.000	.000	.000	30000.000

MOMENTS OF INERTIA (FT**4) FROM FIXED TO FREE END

14988.000	.000	.000	.000	.000
.000	.000	.000	.000	.000

LENGTH OF CONSTANT I SEGMENTS FROM FIXED TO FREE END

20.000	.000	.000	.000	.000
.000	.000	.000	.000	.000

OUTPUT

SLOPE	DEFLECTION
.00427005	.76860419

LISTING AND SAMPLE OUTPUT

for

PROGRAM 2.A.2 - DEFLECTION OF CONTINUOUS BEAM

```
// JOB T
// FOR
*IOCS(CARD,1132PRINTER,DISK)
*LIST ALL
C       POD STRUCTURAL PROGRAM SCD-7                                     2A2
C       DEFLECTION BY CONJUGATE-BEAM METHOD                              2A2
1       READ (2,4) AL,SM,AM,BM,E,AI,ZNUM                                 2A2
        X=ZNUM*AL                                                        2A2
        Y=ZNUM                                                           2A2
        WRITE (3,5)                                                      2A2
2       A=Y**2                                                           2A2
        B=Y**3                                                           2A2
        C=Y**4                                                           2A2
        D=Y**5                                                           2A2
        SK=556.15*Y+94.29*A-1299.04*B+646.41*C+2.23*D                    2A2
        AK=497.31*Y-336.54*A-967.65*B+1277.11*C-470.01*D                 2A2
        BK=320.01*Y-271.69*A+543.99*B-1055.24*C+462.97*D                 2A2
        DEF=(AL**2/(E*AI))*(SM*SK+AM*AK+BM*BK)                           2A2
        WRITE (3,6) X,DEF                                                2A2
        Y=Y+ZNUM                                                         2A2
        X=X+(ZNUM*AL)                                                    2A2
        IF (X-AL) 2,3,3                                                  2A2
3       CONTINUE                                                         2A2
C                                                                        2A2
4       FORMAT (F5.0,F8.0,F8.0,F8.0,E9.1,E8.1,F3.2)                      2A2
5       FORMAT (1H1,'DISTDEFL(INS)')                                     2A2
6       FORMAT (F7.2,F8.4)                                               2A2
        END                                                              2A2
// DUP
*STORE      WS   UA   M2A2
// XQT M2A2
```

DIST.	[DEFL(INS)]
14.00	.0924
28.00	.2719
42.00	.4580
56.00	.5930
70.00	.6421
84.00	.5934
98.00	.4583
112.00	.2716
126.00	.0914
140.00	-.0004

LISTING AND SAMPLE OUTPUT
FOR PROGRAM 2.A.3
FIXED-END BEAM DEFLECTIONS

```
// JOB T
// FOR
*IOCS(CARD,1132PRINTER,DISK)
*LIST ALL
C       STRUCTURAL PROGRAM SCP-8                                                2A3
C       DEFLECTION AT TENTH-POINTS OF A FIXED-END BEAM                          2A3
1       READ (2,6) AL,E,AI,W                                                    2A3
        AL=12.*AL                                                               2A3
        X=.1*AL                                                                 2A3
        WRITE (3,7)                                                             2A3
        WRITE (3,8)                                                             2A3
2       A=X**2.                                                                 2A3
        B=W*A                                                                   2A3
        C=B/24.                                                                 2A3
        D=C/E                                                                   2A3
        F=D/AI                                                                  2A3
        G=AL-X                                                                  2A3
        R=G**2.                                                                 2A3
        S=F*R                                                                   2A3
        T=.1*AL                                                                 2A3
        XX=X/12.                                                                2A3
        WRITE (3,9) XX,S                                                        2A3
        X=X+T                                                                   2A3
        XY=X-AL                                                                 2A3
        IF (XY) 2,3,3                                                           2A3
3       CONTINUE                                                                2A3
C       MOD STRUCTURAL PROGRAM SCP-9                                            2A3
C       DEFLECTION AT TENTH-POINTS OF A BM FIXED AT                             2A3
C       ONE END AND SIMPLY SUPPORTED AT THE OTHER                               2A3
        X=.1*AL                                                                 2A3
        WRITE (3,10)                                                            2A3
        WRITE (3,8)                                                             2A3
4       A=X**2.                                                                 2A3
        B=X**3.                                                                 2A3
        C=AL**3.                                                                2A3
        D=W*X                                                                   2A3
        F=D/48.                                                                 2A3
        G=F/E                                                                   2A3
        R=G/AI                                                                  2A3
        S=3.*AL                                                                 2A3
        T=S*A                                                                   2A3
        U=2.*B                                                                  2A3
        V=T-U                                                                   2A3
        Y=V-C                                                                   2A3
        DEF=Y*R                                                                 2A3
        DEF=0.-DEF                                                              2A3
        AB=.1*AL                                                                2A3
        XX=X/12.                                                                2A3
        WRITE (3,9) XX,DEF                                                      2A3
        X=X+AB                                                                  2A3
        XY=X-AL                                                                 2A3
        IF (XY) 4,5,5                                                           2A3
5       CALL EXIT                                                               2A3
C                                                                               2A3
6       FORMAT (6F10.0)                                                         2A3
7       FORMAT (1H1,'FIXED-ENDBEAM')                                            2A3
8       FORMAT ('DISTANCE(FT)DEFLECTION(IN)')                                   2A3
9       FORMAT (2F16.4)                                                         2A3
10      FORMAT (1H1,'ONEENDSIMPLYSUPPORTED')                                    2A3
        END                                                                     2A3
// DUP
*STORE        WS  UA  M2A3
```

FIXED-END BEAM

DISTANCE(FT)	DEFLECTION(IN)
4.00	.03
8.00	.10
12.00	.18
16.00	.24
20.00	.26
24.00	.24
28.00	.18
32.00	.10
36.00	.03
40.00	.00

ONE END SIMPLY SUPPORTED

ISTANCE(FT)	DEFLECTION(IN)
4.00	.20
8.00	.37
12.00	.48
16.00	.53
20.00	.51
24.00	.43
28.00	.31
32.00	.17
36.00	.05
40.00	.00

LISTING AND SAMPLE PROBLEM
FOR PROGRAM 2.B.1
CONCRETE FRAME ANALYSIS - PART I

```
// JOB 1
// FOR
*IOCS(CARD,1132PRINTER,DISK)
*LIST ALL
C       POP STRUCTURAL PROGRAM SCP-5-1                                    2B1
C       SHEAR AND MOMENT ANALYIS FOR 1-,2-, OR 3-CELL CONDUITS OR         2B1
C       CULVERTS COMPOSED OF UNIFORMLY LOADED PRISMATIC AND/OR HAUNCHED   2B1
C       MEMBERS, WITHOUT SIDESWAY - PART1.                                2B1
        DIMENSION S(20), W(20), A(20), B(20), A1(20), DM(20), SK(20)      2B1
        DIMENSION COFA(20), COF(20), DF(20), SUM(20), BAL(20)             2B1
1       DO 2 I=1,20                                                       2B1
C       IN THE FOLLOWING STATEMENT, THE SYMBOL S REPRESENTS THE CLEAR SPAN2B1
C       IN FEET, SK IS THE THICKNESS OF MEMBER IN FEET, COF IS THE HAUNCH 2B1
C       DEPTH IN FEET, A1 IS THE RELATIVE MOMENT OF INERTIA, BAL IS THE   2B1
C       DEPTH TO THE CENTER OF STEEL FROM TENSILE FACE, AND DM IS THE     2B1
C       SLOPE OF THE HAUNCH.                                              2B1
2       READ (2,46) S(I),SK(I),COF(I),A1(I),DM(I),W(I),BAL(I)             2B1
C       IN THE NEXT TWENTY STATEMENTS, THE SYMBOL DF REPRESENTS THE WIDTH 2B1
C       OF THE ADJACENT MEMBER AT POSITION I.  (I AS IN INDEX.)           2B1
        DF(1)=SK(16)                                                      2B1
        DF(2)=SK(17)                                                      2B1
        DF(3)=SK(17)                                                      2B1
        DF(4)=SK(20)                                                      2B1
        DF(5)=SK(20)                                                      2B1
        DF(6)=SK(7)                                                       2B1
        DF(7)=SK(6)                                                       2B1
        DF(8)=SK(9)                                                       2B1
        DF(9)=SK(8)                                                       2B1
        DF(10)=SK(19)                                                     2B1
        DF(11)=SK(19)                                                     2B1
        DF(12)=SK(18)                                                     2B1
        DF(13)=SK(18)                                                     2B1
        DF(14)=SK(15)                                                     2B1
        DF(15)=SK(14)                                                     2B1
        DF(16)=SK(1)                                                      2B1
        DF(17)=SK(2)                                                      2B1
        DF(18)=SK(13)                                                     2B1
        DF(19)=SK(10)                                                     2B1
        DF(20)=SK(5)                                                      2B1
C       IN THE NEXT TWENTY STATEMENTS, THE SYMBOL COFA REPRESENTS THE     2B1
C       IN LENGTH OF THE HAUNCH IN FEET.                                  2B1
        COFA(1)=COF(16)                                                   2B1
        COFA(2)=COF(17)                                                   2B1
        COFA(3)=COF(17)                                                   2B1
        COFA(4)=COF(20)                                                   2B1
        COFA(5)=COF(20)                                                   2B1
        COFA(6)=COF(7)                                                    2B1
        COFA(7)=COF(6)                                                    2B1
        COFA(8)=COF(9)                                                    2B1
        COFA(9)=COF(8)                                                    2B1
        COFA(10)=COF(19)                                                  2B1
        COFA(11)=COF(19)                                                  2B1
        COFA(12)=COF(18)                                                  2B1
        COFA(13)=COF(18)                                                  2B1
        COFA(14)=COF(15)                                                  2B1
        COFA(15)=COF(14)                                                  2B1
        COFA(16)=COF(1)                                                   2B1
        COFA(17)=COF(2)                                                   2B1
        COFA(18)=COF(13)                                                  2B1
        COFA(19)=COF(10)                                                  2B1
        COFA(20)=COF(5)                                                   2B1
```

```
      DO 3 I=1,20                                                       2B1
3     A(I)=(SK(I)*DF(I)+DM(I)*COF(I)*COF(I))/(2.*SK(I))                 2B1
      DO 4 I=1,20                                                       2B1
4     WRITE (2,45) SK(I),COF(I),DF(I),A(I),,COFA(I),BAL(I)              2B1
      DO 5 L=1,20,2                                                     2B1
C     IN THE NEXT TWO STATEMENTS, THE SYMBOL S IS RE-DEFINED TO REPRESEN2B1
C     THE DISTANCE BETWEEN POINTS OF I - INFINITY.                      2B1
      S(L)=S(L)-A(L)-A(L+1)+((DF(L)+DF(L+1))/2.)                        2B1
5     S(L+1)=S(L)                                                       2B1
      DO 6 I=1,20                                                       2B1
      B(I)=A(I)/S(I)                                                    2B1
C     IN THE FOLLOWING STATEMENT, THE SYMBOL SK IS RE-DEFINED TO REPRESE2B1
C     STIFFNESS. HOPE YOU ARE WITH US, THERE IS WORSE TO COME.          2B1
6     SK(I)=(1.+12.*((.5+B(I))**2))*AI(I)/S(I)                          2B1
      DO 10 I=1,20                                                      2B1
      DO 7 L=1,21,2                                                     2B1
      IF (I-L) 9,8,7                                                    2B1
7     CONTINUE                                                          2B1
C     IN STATEMENTS IMMEDIATELY FOLLOWING, THE SYMBOL COF IS RE-DEFINED 2B1
C     TO REPRESENT THE CARRYOVER FACTOR, OF ALL THINGS.                 2B1
8     COF(I)=0.-(1.-12.*(.5+B(I))*(.5+B(I+1)))/(1.+12.*((.5+B(I))**2))  2B1
      GO TO 10                                                          2B1
9     COF(I)=0.-(1.-12.*(.5+B(I))*(.5+B(I-1)))/(1.+12.*((.5+B(I))**2))  2B1
10    CONTINUE                                                          2B1
      CTR=1.                                                            2B1
C     THE NEXT TWENTY CODED INSTRUCTIONS ARE EXECUTED THREE TIMES. ON   2B1
C     THE FIRST TRIP THROUGH (CTR = 1.), THE SYMBOL SK STILL REPRESENTS 2B1
C     STIFFNESS. ON THE SECOND TIME THROUGH (CTR = 0.), SK IS RE-DEFINED2B1
C     TO REPRESENT THE FIXED END MOMENT, AND DURING THE THIRD AND FINAL 2B1
C     RUN (CTR = 2.), IT IS AGAIN RE-DEFINED TO REPRESENT CARRYOVER.    2B1
11    SUM(1)=SK(1)+SK(16)                                               2B1
      SUM(2)=SK(2)+SK(3)+SK(17)                                         2B1
      SUM(3)=SUM(2)                                                     2B1
      SUM(4)=SK(4)+SK(5)+SK(20)                                         2B1
      SUM(5)=SUM(4)                                                     2B1
      SUM(6)=SK(6)+SK(7)                                                2B1
      SUM(7)=SUM(6)                                                     2B1
      SUM(8)=SK(8)+SK(9)                                                2B1
      SUM(9)=SUM(8)                                                     2B1
      SUM(10)=SK(10)+SK(11)+SK(19)                                      2B1
      SUM(11)=SUM(10)                                                   2B1
      SUM(12)=SK(12)+SK(13)+SK(18)                                      2B1
      SUM(13)=SUM(12)                                                   2B1
      SUM(14)=SK(14)+SK(15)                                             2B1
      SUM(15)=SUM(14)                                                   2B1
      SUM(16)=SUM(1)                                                    2B1
      SUM(17)=SUM(2)                                                    2B1
      SUM(18)=SUM(12)                                                   2B1
      SUM(19)=SUM(10)                                                   2B1
      SUM(20)=SUM(4)                                                    2B1
      IF (CTR-1.) 17,12,24                                              2B1
12    DO 15 I=1,20                                                      2B1
      IF (SUM(I)) 14,13,14                                              2B1
C     IN STATEMENTS 207 AND 208 DF IS THE DISTRIBUTION FACTOR.U         2B1
13    DF(I)=0.                                                          2B1
      GO TO 15                                                          2B1
14    DF(I)=SK(I)/SUM(I)                                                2B1
C     THE NEXT STATEMENT IS WHERE SK BECOMES FEM.                       2B1
15    SK(I)=W(I)*S(I)*S(I)*(1.+6.*B(I)+6.*B(I)*B(I))/12.                2B1
      WRITE (3,48)                                                      2B1
      DO 16 I=1,20                                                      2B1
16    WRITE (3,49) SK(I),A(I),DF(I),COF(I)                              2B1
```

```
      CTR=0.                                                          2B1
      GO TO 11                                                        2B1
17    DO 18 I=1,20                                                    2B1
C     IN THE NEXT STATEMENTS, BAL REPRESENTS BALANCE AND DM IS THE    2B1
C     DISTRIBUTED MOMENT. ALL RATHER CONFUSING, BUT NECESSARY.        2B1
      BAL(I)=DF(I)*(0.-SUM(I))                                        2B1
18    DM(I)=SK(I)+BAL(I)                                              2B1
19    DO 25 I=1,20                                                    2B1
      DO 20 L=1,21,2                                                  2B1
      IF (I-L) 22,21,20                                               2B1
20    CONTINUE                                                        2B1
C     THE NEXT STATEMENT IS WHERE SK BECOMES CARRYOVER.               2B1
21    SK(I)=BAL(I+1)*COF(I+1)                                         2B1
      GO TO 23                                                        2B1
22    SK(I)=BAL(I-1)*COF(I-1)                                         2B1
23    CONTINUE                                                        2B1
      CTR=2.                                                          2B1
      GO TO 11                                                        2B1
24    DO 25 I=1,20                                                    2B1
      BAL(I)=DF(I)*(0.-SUM(I))                                        2B1
25    DM(I)=DM(I)+SK(I)+BAL(I)                                        2B1
      DIFFM=0.                                                        2B1
      DO 38 I=1,20                                                    2B1
      IF (DM(I)) 26,27,27                                             2B1
26    Z=0.-DM(I)                                                      2B1
      GO TO 28                                                        2B1
27    Z=DM(I)                                                         2B1
28    IF (SK(I)) 29,30,30                                             2B1
29    X=0.-SK(I)                                                      2B1
      GO TO 31                                                        2B1
30    X=SK(I)                                                         2B1
31    IF (BAL(I)) 32,33,33                                            2B1
32    Y=0.-BAL(I)                                                     2B1
      GO TO 34                                                        2B1
33    Y=BAL(I)                                                        2B1
34    DIFF=X-Y                                                        2B1
      IF (DIFF) 35,36,36                                              2B1
35    DIFF=0.-DIFF                                                    2B1
36    EDIFF=DIFF-.0005*Z                                              2B1
      IF (DIFFM-EDIFF) 37,37,38                                       2B1
37    DIFFM=EDIFF                                                     2B1
38    CONTINUE                                                        2B1
      IF (DIFFM) 39,39,19                                             2B1
39    WRITE (3,50)                                                    2B1
      DO 40 I=1,20,2                                                  2B1
C     IN THE NEXT TWO STATEMENTS, S IS RE-DEFINED TO REPRESENT THE    2B1
C     DISTANCE BETWEEN CENTERLINES OF MEMBERS.                        2B1
      S(I)=S(I)+A(I)+A(I+1)                                           2B1
40    S(I+1)=S(I)                                                     2B1
      DO 44 I=1,20                                                    2B1
      IF (W(I)) 41,42,42                                              2B1
41    W(I)=0.-W(I)                                                    2B1
42    WRITE (3,51) DM(I)                                              2B1
      IF (DM(I)) 43,44,44                                             2B1
43    DM(I)=0.-DM(I)                                                  2B1
44    WRITE (2,47) S(I),DM(I),W(I)                                    2B1
      CALL EXIT                                                       2B1
C                                                                     2B1
45    FORMAT (F7.3,F7.4,F7.3,F6.3,F7.4,F5.3)                          2B1
46    FORMAT (F6.3,F5.3,F6.4,F5.2,F6.4,F7.3,F4.3)                     2B1
47    FORMAT (F7.3,F9.3,F7.3)                                         2B1
48    FORMAT (13X3HFEM9X1HA9X2HDF7X3HCOF/)                            2B1
```

```
49      FORMAT (F19.3,F10.3,F10.4,F10.4)                                2B1
50      FORMAT (/12X2HUM/)                                              2B1
51      FORMAT (F17.3)                                                  2B1
        END                                                             2B1
// DUP
*STORE          WS  UA  M2B1
// XQT M2B1
```

FEM	A	DF	COF
916.644	3.190	.5000	.8154
-916.644	3.190	.3333	.8154
916.644	3.190	.3333	.8154
-916.644	3.190	.3333	.8154
916.644	3.190	.3333	.8154
-916.644	3.190	.5000	.8154
305.548	3.190	.5000	.8154
-305.548	3.190	.5000	.8154
916.644	3.190	.5000	.8154
-916.644	3.190	.3333	.8154
916.644	3.190	.3333	.8154
-916.644	3.190	.3333	.8154
916.644	3.190	.3333	.8154
-916.644	3.190	.5000	.8154
305.548	3.190	.5000	.8154
-305.548	3.190	.5000	.8154
.000	3.190	.3333	.8154
.000	3.190	.3333	.8154
.000	3.190	.3333	.8154
.000	3.190	.3333	.8154

DM
466.934
-1108.859
1012.751
-1012.751
1108.859
-466.934
466.934
-466.934
466.934
-1108.859
1012.751
-1012.751
1108.859
-466.934
466.934
-466.934
96.108
-96.108
96.108
-96.108

LISTING AND SAMPLE OUTPUT

FOR PROGRAM 2.B.2

CONCRETE FRAME ANALYSIS - PART II

```
// JOB T
// FOR
*IOCS(CARD,1132PRINTER,DISK)
*LIST ALL
C      SHEAR AND MOMENT ANALYSIS FOR 1-, 2-, OR 3-CELL CONDUITS OR          2B2
C      CULVERTS COMPOSED OF UNIFORMLY LOADED PRISMATIC AND/OR HAUNCHED      2B2
C      MEMBERS, WITHOUT SIDEWAY - PART 2.                                   2B2
       DIMENSION S(20), A(20), T(20), COF(20), DM(20), DF(20), W(20)        2B2
       DIMENSION V(20), VF(20), VA(20), C(20), COFA(20)                     2B2
1      DO 2 I=1,20                                                          2B2
2      READ (2,29) T(I),COF(I),DF(I),A(I),COFA(I),C(I)                      2B2
       DO 3 I=1,20                                                          2B2
3      READ (2,30) S(I),DM(I),W(I)                                          2B2
       DO 4 I=1,20,2                                                        2B2
C      IN THE NEXT STATEMENT, VA REPRESENTS THE DIFFERENCE BETWEEN          2B2
C      MOMENTS AT OPPOSITE ENDS OF MEMBER.                                  2B2
       VA(I)=DM(I)-DM(I+1)                                                  2B2
       V(I)=W(I)*S(I)/2.+(VA(I)/S(I))                                       2B2
4      V(I+1)=W(I)*S(I)/2.-(VA(I)/S(I))                                     2B2
       CALL DATSW (1,NSS1)                                                  2B2
       GO TO (5,6), NSS1                                                    2B2
5      WRITE (3,31)                                                         2B2
       GO TO 7                                                              2B2
6      WRITE (3,33)                                                         2B2
7      DO 14 I=1,20                                                         2B2
       WRITE (2,37) DM(I),DF(I),A(I),COFA(I),W(I),C(I),T(I),S(I)            2B2
C      IN THE FIVE STATMENTS FOLLOWING, T REPRESENTS DEPTH TO THE           2B2
C      CENTER OF STEEL, C REPRESENTS SHEAR AT END OF HAUNCH,                2B2
C      VF REPRESENTS SHEAR AT FACE, VA REPRESENTS SHEAR AT POINT OF         2B2
C      INFINITE I, AND A REPRESENTS SHEAR BETWEEN VA AND SHEAR AT END OF 2B2
C      THE HAUNCH.  (CALLED VAEH DURING PRINT-OUT.)                         2B2
       T(I)=T(I)-C(I)                                                       2B2
       VF(I)=V(I)-(W(I)*DF(I)/2.)                                           2B2
       VA(I)=V(I)-(W(I)*A(I))                                               2B2
       C(I)=V(I)-(W(I)*((DF(I)/2.)+COFA(I)))                                2B2
       A(I)=(VA(I)+C(I))/2.                                                 2B2
       IF (W(I)) 8,10,8                                                     2B2
C      IN THE FOLLOWING STATEMENT, S REPRESENTS THE QUANTITY UNDER RADICA2B2
C      OF THE QUADRATIC EQUATION.                                           2B2
8      S(I)=V(I)**2-(2.*DM(I)*W(I))                                         2B2
       IF (S(I)) 10,9,9                                                     2B2
C      IN THE NEXT STATEMENT, S BECOMES THE DISTANCE TO ZERO MOMENT.        2B2
9      S(I)=(V(I)-SQRT(S(I)))/W(I)                                          2B2
C      DM NOW BECOMES VPC (SHEAR AT POINT OF CONTRAFLEXURE).                2B2
       DM(I)=V(I)-(W(I)*S(I))                                               2B2
       GO TO 11                                                             2B2
10     S(I)=0.                                                              2B2
       DM(I)=0.                                                             2B2
11     WRITE (2,38) V(I),VF(I),VA(I),C(I),S(I)                              2B2
       CALL DATSW (1,NSS1)                                                  2B2
       GO TO (12,13), NSS1                                                  2B2
12     WRITE (3,32) V(I),VF(I),DM(I)                                        2B2
       GO TO 14                                                             2B2
13     WRITE (3,34) V(I),VA(I),A(I),C(I),DM(I)                              2B2
C      IN THE NEXT STATEMENT, V BECOMES DISTANCE TO ZERO MOMENT.            2B2
14     V(I)=S(I)                                                            2B2
       CALL DATSW (2,NSS2)                                                  2B2
       GO TO (26,15), NSS2                                                  2B2
15     CALL DATSW (1,NSS1)                                                  2B2
       GO TO (16,17), NSS1                                                  2B2
16     WRITE (3,35)                                                         2B2
       GO TO 18                                                             2B2
```

```
17    WRITE (3,39)                                                              2B2
18    DO 27 I=1,20                                                              2B2
C     IN THE NEXT TWO STATEMENTS, S BECOMES DEPTH TO CENTER OF STEEL            2B2
C     AT FACE, AND VF BECOMES UNIT SHEAR AT D/2 FROM FACE.                      2B2
      S(I)=T(I)+COF(I)                                                          2B2
      VF(I)=(VF(I)-W(I)*S(I)/2.)/(S(I)*144.)                                    2B2
C     IN THE NEXT FOUR STATEMENTS, S IS RE-DEFINED TO REPRESENT DEPTH           2B2
C     TO CENTER OF STEEL AT POINT OF INFINITE I, VA BECOMES USA,                2B2
C     THE SYMBOL A BECOMES USAEH, C BECOMES USEH, AND WE ARE GETTING            2B2
C     PRETTY MIXED UP OURSELVES.                                                2B2
      S(I)=T(I)+(COF(I)*(1.-(COF(I)/(T(I)*2.))))                                2B2
      VA(I)=VA(I)/(144.*S(I))                                                   2B2
      A(I)=A(I)*2./((T(I)+S(I))*144.)                                           2B2
      C(I)=C(I)/(144.*(T(I)))                                                   2B2
C     THE NEXT S REPRESENTS HALF THE WIDTH OF ADJACENT MEMBER.                  2B2
      S(I)=DF(I)/2.                                                             2B2
      IF (V(I)-S(I)) 19,19,20                                                   2B2
19    DM(I)=0.                                                                  2B2
      GO TO 24                                                                  2B2
C     THE NEXT S BECOMES THE DIFFERENCE BETWEEN DISTANCE TO ZERO MOMENT         2B2
C     AND PREVIOUSLY RE-DEFINED S, IN CASE YOU ARE STILL READING.               2B2
20    S(I)=V(I)-S(I)                                                            2B2
      IF (COFA(I)-S(I)) 22,22,21                                                2B2
C     THE NEXT S IS NOTHING MORE THAN PARTIAL HAUNCH DEPTH.                     2B2
21    S(I)=(COFA(I)-V(I)+(DF(I)*.5))*COF(I)/COFA(I)                             2B2
C     THE NEXT S, HOWEVER, BECOMES DEPTH TO STEEL AT P.C. WITHIN THE            2B2
C     HAUNCH, AND THE ONE AFTER THAT BECOMES THE DEPTH TO STEEL OUT-            2B2
C     SIDE THE HAUNCH AT P.C., BUT FORTUNATELY NONE OF THE OTHER                2B2
C     VARIABLES ARE MAKING ESSES OF THEMSELVES.                                 2B2
      S(I)=T(I)+S(I)                                                            2B2
      GO TO 23                                                                  2B2
22    S(I)=T(I)                                                                 2B2
23    DM(I)=DM(I)/(144.*S(I))                                                   2B2
24    CALL DATSW (1,NSS1)                                                       2B2
      GO TO (25,26), NSS1                                                       2B2
25    WRITE (3,36) VF(I),DM(I)                                                  2B2
      GO TO 27                                                                  2B2
26    WRITE (3,40) VA(I),A(I),C(I),DM(I)                                        2B2
27    CONTINUE                                                                  2B2
      GO TO 1                                                                   2B2
28    CONTINUE                                                                  2B2
C                                                                               2B2
29    FORMAT (F7.3,F7.4,F7.3,F6.3,F7.4,F5.3)                                    2B2
30    FORMAT (F7.3,F9.3,F7.3)                                                   2B2
31    FORMAT (25X1HV10X2HVF10X3HVPC/)                                           2B2
32    FORMAT (F29.3,F12.3,F12.3)                                                2B2
33    FORMAT (13X1HV10X2HVA9X4HVAEH9X3HVEH9X3HVPC/)                             2B2
34    FORMAT (F17.3,F12.3,F12.3,F12.3,F12.3)                                    2B2
35    FORMAT (/29X5HUSD2F6X4HUSPC/)                                             2B2
36    FORMAT (F34.3,F10.3)                                                      2B2
37    FORMAT (F9.3,F7.3,F6.3,F7.4,F7.3,F5.3,F7.3,F7.3)                          2B2
38    FORMAT (F9.3,F9.3,F9.3,F9.3,F7.3)                                         2B2
39    FORMAT (/20X3HUSA6X5HUSAEH6X4HUSEH6X4HUSPC/)                              2B2
40    FORMAT (F24.3,F10.3,F10.3,F10.3)                                          2B2
      END                                                                       2B2
// DUP
*STORE      WS   UA   M2B2
// XQT M2B2
```

V	VA	VAEH	VEH	VPC
241.378	113.140	73.593	34.046	143.950
331.472	203.234	163.688	124.141	143.950
286.425	158.187	118.640	79.093	24.781
286.425	158.187	118.640	79.093	24.781
331.472	203.234	163.688	124.141	143.950
241.378	113.140	73.593	34.046	143.950
95.475	52.729	39.547	26.365	.000
95.475	52.729	39.547	26.365	.000
241.378	113.140	73.593	34.046	143.950
331.472	203.234	163.688	124.141	143.950
286.425	158.187	118.640	79.093	24.781
286.425	158.187	118.640	79.093	24.781
331.472	203.234	163.688	124.141	143.950
241.378	113.140	73.593	34.046	143.950
95.475	52.729	39.547	26.365	.000
95.475	52.729	39.547	26.365	.000
.000	.000	.000	.000	.000
.000	.000	.000	.000	.000
.000	.000	.000	.000	.000
.000	.000	.000	.000	.000

USA	USAEH	USEH	USPC
.124	.095	.054	.140
.223	.212	.195	.204
.174	.153	.124	.039
.174	.153	.124	.039
.223	.212	.195	.204
.124	.095	.054	.140
.058	.051	.041	.000
.058	.051	.041	.000
.124	.095	.054	.140
.223	.212	.195	.204
.174	.153	.124	.039
.174	.153	.124	.039
.223	.212	.195	.204
.124	.095	.054	.140
.058	.051	.041	.000
.058	.051	.041	.000
.000	.000	.000	.000
.000	.000	.000	.000
.000	.000	.000	.000
.000	.000	.000	.000

LISTING AND SAMPLE OUTPUT

FOR PROGRAM 2.B.3

CONCRETE FRAME ANALYSIS - PART III

```
// JOB T
// FOR
*IOCS(CARD,1132PRINTER,DISK)
*LIST ALL
C      POD STRUCTURAL PROGRAM SCP-5-3                                      2B3
C      SHEAR AND MOMENT ANALYSIS FOR 1-, 2-, OR 3-CELL CONDUITS OR         2B3
C      CULVERTS COMPOSED OF UNIFORMLY LOADED PRISMATIC AND/OR HAUNCHED     2B3
C      MEMBERS, WITHOUT SIDESWAY - PART 3.                                 2B3
       DIMENSION DM(20), XF(20), A(20), XEH(20), W(20), C(20), XMPOS(20),2B3
      1 S(20)                                                              2B3
       DIMENSION V(20), VF(20), VA(20), VEH(20), XMZER(20), T(20)          2B3
1      DO 4 I=1,20                                                         2B3
C      XF NOW BECOMES DISTANCE TO FACE, AND XEH BECOMES                    2B3
       READ (2,21) DM(I),XF(I),A(I),XEH(I),W(I),C(I),T(I),S(I)             2B3
       READ (2,22) V(I),VF(I),VA(I),VEH(I),XMZER(I)                        2B3
C      DISTANCE TO END OF HAUNCH.                                          2B3
       XF(I)=XF(I)/2.                                                      2B3
       XEH(I)=XF(I)+XEH(I)                                                 2B3
       IF (W(I)) 2,3,2                                                     2B3
2      XMPOS(I)=V(I)/W(I)                                                  2B3
       GO TO 4                                                             2B3
3      XMPOS(I)=0.                                                         2B3
4      CONTINUE                                                            2B3
       CALL DATSW (1,NSS1)                                                 2B3
       GO TO (5,6), NSS1                                                   2B3
5      WRITE (3,27)                                                        2B3
       GO TO 7                                                             2B3
6      WRITE (3,23)                                                        2B3
7      DO 11 I=1,20                                                        2B3
       CALL DATSW (1,NSS1)                                                 2B3
       GO TO (8,9), NSS1                                                   2B3
8      WRITE (3,28) S(I),XF(I),XMZER(I),XMPOS(I)                           2B3
       GO TO 10                                                            2B3
9      WRITE (3,24) S(I),XF(I),A(I),XEH(I),XMZER(I),XMPOS(I)               2B3
C      IN THE NEXT FOUR STATEMENTS, VF REPRESENTS MOMENT CORRECTION,       2B3
C      XF REPRESENTS MOMENT AT FACE, A REPRESENTS MOMENT AT A,             2B3
C      AND XEH REPRESENTS MOMENT AT END OF HAUNCH.                         2B3
10     VF(I)=XF(I)*(V(I)+VF(I))/6.                                         2B3
       XF(I)=DM(I)-VF(I)*3.                                                2B3
       A(I)=DM(I)-(((V(I)+VA(I))/2.)*A(I))                                 2B3
11     XEH(I)=DM(I)-(((V(I)+VEH(I))/2.)*XEH(I))                            2B3
       DO 14 I=1,20,2                                                      2B3
       IF (W(I)) 12,13,12                                                  2B3
C      FROM HERE ON OUT, XMPOS REPRESENTS DISTANCE TO MAX POSITIVE MOMENT2B3
12     XMPOS(I)=DM(I)-((V(I)*V(I))/(2.*W(I)))                              2B3
       GO TO 14                                                            2B3
13     XMPOS(I)=0.                                                         2B3
14     XMPOS(I+1)=XMPOS(I)                                                 2B3
       CALL DATSW (1,NSS1)                                                 2B3
       GO TO (15,16), NSS1                                                 2B3
15     WRITE (3,29)                                                        2B3
       GO TO 17                                                            2B3
16     WRITE (3,25)                                                        2B3
17     DO 20 I=1,20                                                        2B3
       CALL DATSW (1,NSS1)                                                 2B3
       GO TO (18,19), NSS1                                                 2B3
18     WRITE (3,30) DM(I),XF(I),XMPOS(I),VF(I)                             2B3
       GO TO 20                                                            2B3
19     WRITE (3,26) DM(I),XF(I),A(I),XEH(I),XMPOS(I),VF(I)                 2B3
20     CONTINUE                                                            2B3
       GO TO 1                                                             2B3
C                                                                          2B3
```

```
21     FORMAT (F9.3,F7.3,F6.3,F7.4,F7.3,F5.3,F7.3,F7.3)                              2B3
22     FORMAT (F9.3,F9.3,F9.3,F9.3,F7.3)                                             2B3
23     FORMAT (11X1HS9X2HXF8X1HA9X3HXEH6X5HXMZER5X5HXMPOS/)                          2B3
24     FORMAT (F15.3,F10.3,F10.3,F10.3,F10.3,F10.3)                                  2B3
25     FORMAT (/11X2HDM9X3HDMF8X3HDMA8X4HDMEH6X5HDMPOS6X5HDMCOR/)                    2B3
26     FORMAT (F16.3,F11.3,F11.3,F11.3,F11.3,F11.3)                                  2B3
27     FORMAT (21X1HS9X2HXF7X5HXMZER5X5HXMPOS/)                                      2B3
28     FORMAT (F25.3,F10.3,F10.3,F10.3)                                              2B3
29     FORMAT (/14X2HDM10X3HDMF8X5HDMPOS7X5HDMCOR/)                                  2B3
30     FORMAT (F19.3,F12.3,F12.3,F12.3)                                              2B3
       END                                                                           2B3
// DUP
*STORE       WS   UA   M2B3
// XQT M2B3
```

S	XF	A	XEH	XMZER	XMPOS
14.250	2.375	3.190	5.157	2.424	6.004
14.250	2.375	3.190	5.157	4.665	8.246
14.250	2.375	3.190	5.157	6.509	7.125
14.250	2.375	3.190	5.157	6.509	7.125
14.250	2.375	3.190	5.157	4.665	8.246
14.250	2.375	3.190	5.157	2.424	6.004
14.250	2.375	3.190	5.157	.000	7.125
14.250	2.375	3.190	5.157	.000	7.125
14.250	2.375	3.190	5.157	2.424	6.004
14.250	2.375	3.190	5.157	4.665	8.246
14.250	2.375	3.190	5.157	6.509	7.125
14.250	2.375	3.190	5.157	6.509	7.125
14.250	2.375	3.190	5.157	4.665	8.246
14.250	2.375	3.190	5.157	2.424	6.004
14.250	2.375	3.190	5.157	.000	7.125
14.250	2.375	3.190	5.157	.000	7.125
14.250	2.375	3.190	5.157	.000	.000
14.250	2.375	3.190	5.157	.000	.000
14.250	2.375	3.190	5.157	.000	.000
14.250	2.375	3.190	5.157	.000	.000

DM	DMF	DMA	DMEH	DMPOS	DMCOR
466.934	7.038	-98.522	-243.316	-257.734	153.299
1108.859	434.990	256.003	-66.053	-257.734	224.623
1012.751	445.868	303.595	70.171	-7.638	188.961
1012.751	445.868	303.595	70.171	-7.638	188.961
1108.859	434.990	256.003	-66.053	-257.729	224.623
466.934	7.038	-98.522	-243.316	-257.729	153.299
466.934	277.973	230.549	152.739	126.804	62.987
466.934	277.973	230.549	152.739	126.804	62.987
466.934	7.038	-98.522	-243.316	-257.734	153.299
1108.859	434.990	256.003	-66.053	-257.734	224.623
1012.751	445.868	303.595	70.171	-7.638	188.961
1012.751	445.868	303.595	70.171	-7.638	188.961
1108.859	434.990	256.003	-66.053	-257.729	224.623
466.934	7.038	-98.522	-243.316	-257.729	153.299
466.934	277.973	230.549	152.739	126.804	62.987
466.934	277.973	230.549	152.739	126.804	62.987
96.108	96.108	96.108	96.108	.000	.000
96.108	96.108	96.108	96.108	.000	.000
96.108	96.108	96.108	96.108	.000	.000
96.108	96.108	96.108	96.108	.000	.000

ACKNOWLEDGEMENT

PROGRAM	ORIGINATOR
2.B.1	J.J. Miller and
2.B.2	H.H. Sharp, U.S.
2.B.3	Army Corp of Engineers
	P.O. Box 1538
	Albuquerque, New Mexico