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The Bureau comprises the Institute for Basic Standards, the Institute for Materials Research, the Institute for Applied Technology, and the Center for Radiation Research.

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THE CENTER FOR RADIATION RESEARCH engages in research, measurement, and application of radiation to the solution of Bureau mission problems and the problems of other agencies and institutions. The Center for Radiation Research consists of the following divisions:


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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.
MISCELLANEOUS STRUCTURAL COMPUTER PROGRAMS

Modified for IBM 1130
by
E. F. Carpenter

for: The Construction Research Division
Post Office Department

IMPORTANT NOTICE
Approved for public release by the director of the National Institute of Standards and Technology (NIST) on October 9, 2015

NATIONAL BUREAU OF STANDARDS
U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS
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SAMPLE INPUT FORMS

PROGRAM LISTS WITH SAMPLE OUTPUT

ACKNOWLEDGEMENT
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.
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:

\[
\Delta x = \frac{wx^2}{24EI} (L - x)^2
\]

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

\[
\Delta x = \frac{wx}{A_0 \delta EI} \left( \frac{3L^3}{8} - 3Lx^2 + 2x^4 \right)
\]
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 negligible 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-flexure 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 shear 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

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
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<td>1. Concrete</td>
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<tr>
<td>X</td>
<td>2. Steel</td>
</tr>
</tbody>
</table>

B. TYPE OF STRUCTURE

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<thead>
<tr>
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<tbody>
<tr>
<td>X</td>
<td>1. Beams and Girders</td>
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<tr>
<td></td>
<td>2. Columns</td>
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<tr>
<td></td>
<td>3. Composite Beams</td>
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<tr>
<td></td>
<td>4. Foundations</td>
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<tr>
<td></td>
<td>5. Frames and Tunnels</td>
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<tr>
<td></td>
<td>6. Prestress Construction</td>
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<td></td>
<td>7. Shells</td>
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<td>8. Slabs</td>
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C. REFERENCE CODES

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<td>3. A.A.S.H.O.</td>
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D. TYPE OF ANALYSIS

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<td>3. Working Strength Design</td>
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<td>4. Ultimate Strength Design</td>
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E. REMARKS
Program Name: Deflection of Continuous Beams With Uniform Load

A. Type of Material

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B. Type of Structure

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<td>3. Composite Beams</td>
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<td>4. Foundations</td>
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<td>5. Frames and Tunnels</td>
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C. Reference Codes

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D. Type of Analysis

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<td>2. Plastic Analysis</td>
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<td>3. Working Strength Design</td>
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<td>4. Ultimate Strength Design</td>
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</table>

E. Remarks

18
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
PROGRAM NAME:

Concrete Frame Analysis (Part I)

A. TYPE OF MATERIAL
   1. Concrete
   2. Steel

B. TYPE OF STRUCTURE
   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
   1. A.C.I.
   2. A.I.S.C.
   3. A.A.S.H.O.

D. TYPE OF ANALYSIS
   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

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### B. TYPE OF STRUCTURE

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### D. TYPE OF ANALYSIS

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### 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

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### B. TYPE OF STRUCTURE

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|   | 2. Columns  
|   | 3. Composite Beams  
|   | 4. Foundations  
| X | 5. Frames and Tunnels  
|   | 6. Prestress Construction  
|   | 7. Shells  
|   | 8. Slabs  

### C. REFERENCE CODES

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|   | 2. A.I.S.C.  
|   | 3. A.A.S.H.O.  

### D. TYPE OF ANALYSIS

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|   | 3. Working Strength Design  
|   | 4. Ultimate Strength Design  

### E. REMARKS

Requires input from 2.B.2
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<td>09.50 04.75 02.78 25 01.00 1.0 0.00 13.40 0.33 3</td>
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LISTING AND SAMPLE OUTPUT
for
PROGRAM 2.A.1. - DEFLECTION OF CANTILEVER
CANTILEVER DEFORMATION PROGRAM

CONTINUE

WRITE (3,36)
WRITE (3,36)
READ (2,34) SPAN,UL,XP,YP
WRITE (3,36)
WRITE (3,36)
WRITE (3,36)
READ (2,34) XI(1),XI(2),XI(3),XI(4),XI(5)
READ (2,34) XI(6),XI(7),XI(8),XI(9),XI(10)
WRITE (3,34) XI(1),XI(2),XI(3),XI(4),XI(5)
WRITE (3,34) XI(6),XI(7),XI(8),XI(9),XI(10)
WRITE (3,36)
WRITE (3,34)
READ (2,34) XL(1),XL(2),XL(3),XL(4),XL(5)
READ (2,34) XL(6),XL(7),XL(8),XL(9),XL(10)
WRITE (3,34) XL(1),XL(2),XL(3),XL(4),XL(5)
WRITE (3,34) XL(6),XL(7),XL(8),XL(9),XL(10)
WRITE (3,36)
SPAN=SPAN+12.0
UL=UL*1000.0/12.0
AP=XP*12.0
RP=UL*0.0
E=E+1000.0
U0=U0+11.0

2
XL(N)=XL(N)*12.0
UL=SPAN/200.0

6
DE=DISTANCE PROM END OF CANTILEVER
E=XL(1)+XL(2)+XL(3)+XL(4)+XL(5)
U0 = .01,1,200
IF (N>1) 3,34

3
DE(N)=AL*U.5
U0 TO 5

4
K=1

5
DE(N)=DE(N)+AL
CONTINUE

IF (DE(N)>AL(10)) STOP

0
AX(1)=XI(1)
U0 TO 24

7
IF (XI(N)-AL(10)-XL(9)) 0,8,9

8
AX(N)=XL(9)
U0 TO 24

9
IF (XI(N)-AL(10)-XL(9)-XL(8)) 10,10,11

A(N)=XX(1)
U0 TO 24

11
IF (XI(N)-AL(10)-XL(9)-XL(8)-XL(7)) 12,12,13

12
AX(N)=XX(7)
U0 TO 24

13
IF (XI(N)-AL(10)-XL(9)-XL(8)-XL(7)-XL(6)) 14,15,15

14
AX(N)=XX(6)
U0 TO 24

15
IF (XI(N)-AL(10)-XL(9)-XL(8)-XL(7)-AL(6))-12,15,15

16
AX(N)=XX(5)
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<tr>
<th>SPAN (FT)</th>
<th>UDL (K/FT)</th>
<th>XP (FEET)</th>
<th>P (KIPS)</th>
<th>E (KSI)</th>
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Moments of Inertia (ft•ft^4) from fixed to free end

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Length of constant I segments from fixed to free end

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Output

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<td>.00427005</td>
<td>.76860419</td>
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LISTING AND SAMPLE OUTPUT

for

PROGRAM 2.A.2 - DEFLECTION OF CONTINUOUS BEAM
// JOB 1
// FOR
*IUCS (CARD) 1132PRINTER+DISK
*LIST ALL
C
POD STRUCTURAL PROGRAM SLD-7
C
DEFORMATION BY CONJUGATE-BEAM METHOD
I
REAL (5,4) AL,SM,Ai,AM,AL,E1,AL,ZNUM
X=ZNUM*AL
Y=ZNUM
WRITE (3,5)
2
AE=Y**2
B=Y**3
C=Y**4
D=Y**5
SK=550.10*1+Y4.24*A-1299.04*B+8.640.41*C+2.23*D
AK=497.31*1-330.56*A-967.65*B+1277.11*C-470.01*D
BK=320.01*1-271.09*A+543.99*B-1653.24*C+462.97*D
DEF=(AL**2/(E*AL))*((SM*SK+AM*AK+BM*BK))
WRITE (3,6) X,DEF
Y=V+ZNUM
X=X+(ZNUM*AL)
IF (X=AL) 2,3,5
3
CONTINUE
C
4
FORMAT (F5.0,F8.0,F8.0,F8.0,F8.0,E9.1,E8.1,E3.2)
5
FORMAT (A16,'DISPLACEMENTS')
O
FORMAT (F7.2,F8.4)
END
// UOP
*STORE WS UA M2A2
// XM2A2

2.A.2 - 1
LISTING AND SAMPLE OUTPUT
FOR PROGRAM 2.A.3
FIXED-END BEAM DEFLECTIONS
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<tr>
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<tr>
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<td>STAGE (FT)</td>
<td>DEFLECTION (IN)</td>
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LISTING AND SAMPLE PROBLEM
FOR PROGRAM 2.B.1
CONCRETE FRAME ANALYSIS - PART I
// JOB 1
// FOR
*IVCS(LAST,13,PRINT,0,0)
*LST ALL
C POP STRUCTURAL PROGRAM SUB=5-1
C SHEAR AND MOMENT ANALYSIS FOR PER-2 OR 3-CELL CONDUITS OR
C MEMBERS WITHOUT SLIDESHAFT - PART 1
C DIMENSION S(20); m(20); R(20); a(20); DM(20); SR(20)
C DIMENSION COFA(20); COF(20); OF(20); SM(20); DAL(20)

1 DO 1021=0
C IN THE FOLLOWING STATEMENT, THE SYMBOL S REPRESENTS THE CLEAR SPAN.
C IN FEET, SR IS THE THICKNESS OF MEMBER IN FEET; COF IS THE HAAUNCH
C DEPTH IN FEET; A1 IS THE RELATIVE MOMENT OF INERTIA; RAL IS THE
C DEPTH TO THE CENTER OF STEEL FROM TENSILE FACE; AND BM IS THE
C SLOPE OF THE HAUNCH.
C READ (246) S(1),SR(1),COF(1),A1(1),R(1),BM(1),RAL(1)
C IN THE NEXT TWELVE STATEMENTS, THE SYMBOL OF REPRESENTS THE WIDTH
C OF THE ADJACENT MEMBER AT POSITION 1, (1 AS IN INDEX.)
C DF(1)=SR(10)
C DF(2)=SR(17)
C DF(3)=SR(17)
C DF(4)=SR(20)
C DF(5)=SR(20)
C DF(6)=SR(7)
C DF(7)=SR(7)
C DF(8)=SR(9)
C DF(9)=SR(9)
C DF(10)=SR(19)
C DF(11)=SR(19)
C DF(12)=SR(18)
C DF(13)=SR(18)
C DF(14)=SR(15)
C DF(15)=SR(14)
C DF(16)=SR(11)
C DF(17)=SR(12)
C DF(18)=SR(13)
C DF(19)=SR(13)
C DF(20)=SR(5)

C IN THE NEXT TWELVE STATEMENTS, THE SYMBOL COFA REPRESENTS THE
C LENGTH OF THE HAUNCH IN FEET.
C COFA(1)=COF(16)
C COFA(2)=COF(17)
C COFA(3)=COF(17)
C COFA(4)=COF(20)
C COFA(5)=COF(20)
C COFA(6)=COF(7)
C COFA(7)=COF(7)
C COFA(8)=COF(9)
C COFA(9)=COF(10)
C COFA(10)=COF(14)
C COFA(11)=COF(19)
C COFA(12)=COF(16)
C COFA(13)=COF(16)
C COFA(14)=COF(15)
C COFA(15)=COF(14)
C COFA(16)=COF(1)
C COFA(17)=COF(2)
C COFA(18)=COF(13)
C COFA(19)=COF(10)
C COFA(20)=COF(5)
DO 1 I=1,20
3 R(1) = SK(1) * UF(1) + U(I) * COF(1) * COF(I) / (£. * SK(I))
DO 4 I=1,20
4 WRITE (2,45) SK(I), COF(I), UF(I), A(I), COFA(I), DAL(I)
DO 5 I=1,20
5 C IN THE NEXT TWO STATEMENTS, THE SYMBOL S IS RE-DEFINED TO REPRESENT
C THE DISTANCE BETWEEN POINTS OF 1 - INFINITY.
C 6
C 7
C 8
C 9
C 10
C 11
C 12
C 13
C 14
C 15
C 16
2B1
2B1
2B1
2B1
2B1
2B1
2B1
2B1
2B1
2B1
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2B1
2B1
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2B1
2B1
2B1
2B1
2B1
2B1
2B1
C IR = 0.
GO TO 11
10 DO 10 I = 1, N
C IN THE NEXT STATEMENTS, BAL REPRESENTS BALANCE AND UM IS THE
C DISTRIBUTIVE MOUNT. ALL RATHER CONFUSING, BUT NECESSARY.
BAL(1) = SUM(1) * (U1 - SUM(1))
11 UM(1) = SK(1) + BAL(1)
12 DO 20 J = 1, M
13 I = I + 1
14 UM(1) = DF(1) * (U1 - SUM(1))
15 UM(1) = UM(1) + SK(1) + BAL(1)
16 DFF = 0.
17 UM(1) = UM(1)
18 IF (UM(1)) 20, 4, 8
19 Z = 0, UM(1)
GO TO 9
20 Z = DF(1)
21 IF (SK(1)) 24, 2, 30
22 X = UM - SK(1)
GO TO 31
23 X = SK(1)
24 IF (UM(1)) 26, 2, 53
25 Y = UM - BAL(1)
GO TO 34
26 Y = BAL(1)
27 DFF = X - Y
IF (DFF) 29, 2, 53
28 DIFF = 0, DFF
29 DFF = 0, DIFF
30 DFF = 0, DIFF - 0000*Z
IF (DIFF - LDIFF) 38, 07, 30
31 DIFF = LDIFF
32 CONTINUE
33 IF (UDIFF) 23, 2, 19
34 WRITE (3, 50)
DU 40, L = 1, 0, 12
C IN THE NEXT TWO STATEMENTS, S IS RE-DEFINED TO REPRESENT THE
C DISTANCE BETWEEN CENTERLINES OF MEMBERS.
S(1) = S(1) + A(1) + A(1+1)
35 S(1+1) = S(1)
36 DU 44, L = 1, 0, 12
37 W(I) = 0, W(I)
38 WRITE (3, 51) UM(I)
39 IF (W(I)) 42, 0.44, 44
40 UM(I) = UM - UM(I)
41 WRITE (2, 47) S(I), UM(I), W(I)
CALL EX1
C
42 FORMAT (F7.3,F7.4,F7.3,F7.4,F7.3,F7.4,F7.3)
43 FORMAT (F7.3,F7.4,F7.3)
44 FORMAT (L3X3F4.3,L3X3F4.3)
45 FORMAT (F7.3)
46 FORMAT (F7.3)
47 FORMAT (F7.3)
48 FORMAT (F7.3)
49 FORMAT (L3X3F4.3)

2.B.1 - 3
49  FORMAT (F19.3,F10.3,F10.4,F10.4)
50  FORMAT (/12X2NUM/)
51  FORMAT (F11,3)

// LDPR
*STORE  WS UA M201
// A0T A2H1
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DM

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LISTING AND SAMPLE OUTPUT
FOR PROGRAM 2.B.2
CONCRETE FRAME ANALYSIS - PART II
/* ISC(d) INTERPRETER */
/* LIST ALL */
C SHEAR AND MOMENT ANALYSIS FOR 1-, 2-, OR 3-CELL CONDUITS OR
C CULVERTS COMPOSED OF UNIFORMLY LOADED PRISMATIC AND/OR HAUNCHED
C MEMBERS, WITHOUT SIDEWAY - PART 2
C DIMENSION S(20); A(20); I(20); COF(20); UM(20); UF(20); WI(20)
C DIMENSION V(20); VF(20); VA(20); C(20); COFA(20)
1 DO 2 I=1,20
2 READ (2,9) T(I),I,COF(I),UF(I),A(I),COFA(I),C(I)
DO 3 I=1,20
3 READ (2,30) S(I),UM(I),VF(I)
DO 4 I=1,20
4 CALL DATSW (1, NSS1)
GO TO (500), NSS1
5 WRITE (3,51)
GO TO 7
6 WRITE (3,52)
7 DO 14 l=1,20
WRITE (2,37) UM(I),VF(I),A(I),COFA(I),C(I),I(1),S(I)
8 IN THE NEXT STATEMENT, VA REPRESENTS THE DIFFERENCE BETWEEN
C MOMENTS AT OPPOSITE ENDS OF MEMBER.
C VA(I)=UM(I)-UM(I+1)
C V(I)=W(I)*S(I)/2+(VF(I)/S(I))
4 V(I+1)=V(I)*S(I)/2-(VF(I)/S(I))
CALL DATSW (1, NSS1)
GO TO (500), NSS1
9 WRITE (3,53)
GO TO 7
10 WRITE (3,54)
7 DO 14 l=1,20
WRITE (2,37) UM(I),VF(I),A(I),COFA(I),C(I),I(1),S(I)
8 IN THE NEXT STATEMENT, VA REPRESENTS SHEAR AT END OF MEMBER.
C CENTER OF STEEL, C REPRESENTS SHEAR AT END OF HAUNCH.
C VF REPRESENTS SHEAR AT FACE; VA REPRESENTS SHEAR AT POINT OF
C INFINITE I. A: WHAT SHEAR BETWEEN VA AND SHEAR AT END OF
C THE HAUNCH. (CALLED WHEN DURING PRINT-OUT.)
C I(1)=I(1)-C(1)
CVF(I)=VF(I)-(A(I)*DF(I)/2)
C VA(I)=VF(I)-(A(I)*A(I))
C C(I)=VF(I)-(VF(I)/2)+COFA(I)
C A(I)=VA(I)+C(I)/2
IF (A(I)<0) GO To 8
8 IN THE FOLLOWING STATEMENT, S Represents THE QUANTITY UNDER RADICAL.
C OF THE NUMERICAL EQUATION.
6 S(I)=V(I)*2-(2.*UM(I)*W(I))
IF (S(I) 10.0 GO To 8
9 IN THE NEXT STATEMENT, S BECOMES THE DISTANCE TO ZERO MOMENT.
9 S(I)=V(I)-UM(S(I))/W(I)
UM(I) NOW BECOMES VF (SHEAR AT POINT OF CONTRAFLEXURE).
UM(I)=VF(I)-(A(I)*S(I))
GO TO 11
10 S(I)=0.
UM(I)=0.
11 WRITE (2,36) V(I),VF(I),VA(I),C(I),S(I)
CALL DATSW (1, NSS1)
GO TO (16,13), NSS1
12 WRITE (3,60) V(I),VF(I),UM(I)
GO TO 14
13 WRITE (3,60) V(I),VA(I),C(I),I(1),UM(I)
6 IN THE NEXT STATEMENT, V BECOMES DISTANCE TO ZERO MOMENT.
14 V(I)=S(I)
CALL DATSW (2, NSS2)
GO TO (20,15), NSS2
15 CALL DATSW (1, NSS1)
GO TO (10, 17), NSS1
16 WRITE (3,60)
GO TO 18

2.B.2 - 1
WRITE (3,59)

UO 27 121=0

C IN THE NEXT TWO STATEMENTS, S BECOMES DEPTH TO CENTER OF STEEL

C AT FACE, AND VF BECOMES UNIT SHEAR AT U/2 FROM FACE.

S(1) = T(1)*CUB(1)

VF(1) = VF(1) - (1.0 + S(1)*144.) /

C IN THE NEXT FOUR STATEMENTS, S IS RE-DEFINED TO REPRESENT DEPTH

C TO CENTER OF STEEL AT POINT OF INFINITE I, VA BECOMES USA.

C THE SYMBOL A BECOMES USUAL: C BECOMES USED, AND WE ARE GETTING

C PRETTY MIXED UP OURSELVES.

S(1) = S(1) + (VF(1)*CUB(1) + (1.0 - (VF(1)*T(1)*2.0)))

C THE NEXT S REPRESENTS HALF THE WIDTH OF ADJACENT MEMBER.

S(1) = (VF(1)/2.)

C IN THIS CASE, YOU ARE STILL READING.

S(1) = S(1) - S(1)

C GO TO 24

S(1) = S(1)

C GO TO 29

C GO TO 25

C GO TO 26

C GO TO 27

C GO TO 28

C GO TO 29

C GO TO 30

C GO TO 31

C GO TO 32

C GO TO 33

C GO TO 34

C GO TO 35

C GO TO 36

C GO TO 37

C GO TO 38

C GO TO 39

C GO TO 40

// UDIF

*STORE 45 UA M2B2

// X9T M2B2
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2.B.2 - 3
LISTING AND SAMPLE OUTPUT
FOR PROGRAM 2.B.3
CONCRETE FRAME ANALYSIS - PART III
In the next four statements, Vf represents moment at face i, representing moment at a distance to MAX positive moment at end of channel.
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