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PRESTRESSED CONCRETE BRIDGE GIRDER DESIGN PROGRAM

by

Leonard L. Ingram
Engineering Research Associate
Texas Transportation Institute

and

H. D. Butler
Designing Engineer
Texas Highway Department

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Prestressed Concrete Girder Design

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ABSTRACT

A computer program has been developed in this study to perform iterative type calculations necessary for the design of simple span I-shaped beams of pretensioned prestressed concrete for use in highway and railroad bridges. Specifications for the designs produced are those that are currently acceptable by the Texas Highway Department.

A complete listing of the computer program, detailed flow charts, definitions of terms used in the program, and descriptions of the input and output forms are presented.

The opinions, findings, and conclusions expressed in this report are those of the authors and not necessarily those of the Federal Highway Administration.

SUMMARY

Automated design procedures are very beneficial in the design of structural members which require iterative types of calculations. The prestressed concrete beam, as an element in a structural system, is one member which requires such calculations.

As a part of this study, a computer program to perform the necessary calculations for the design of simple span I-shaped beams of pretensioned prestressed concrete for use in highway and railroad bridges has been developed. A detailed explanation of the program and its usage are presented.

RECOMMENDATION FOR IMPLEMENTATION

A computer program was developed in this study to make iterative type calculations for the design of pretensioned prestressed concrete beams.

This program is being used by the Texas Highway Department, and its continued use is recommended.

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I. INTRODUCTION

Automated design procedures are very beneficial in the design of structural members which require iterative types of calculations. The prestressed concrete beam, as an element in a structural system, is one member which requires such calculations. The different structural layouts, geometric and material properties of the member, and service requirements make it necessary to make several trial designs before the most desirable one is accepted. The digital computer can be programmed to perform the requisite calculations for the best design of such a structural member.

In this study a computer program has been developed to perform the necessary calculations for the design of simple span beams of pretensioned prestressed concrete for use in highway and railroad bridges. The purpose of this report is to describe that program so that the method will be understood, and to make it readily applicable to problems of design. Definitions of terms, flow diagrams, and a complete listing are included with example problems which illustrate the uses of the program.

II. COMPUTER PROGRAM

The Prestressed Concrete Beam Design Program is written in FORTRAN IV language for IBM 360/50 and 360/65 computers. The program is comprised of one main calling routine, twenty-three subroutines, and one Block Data set. Compile time for a FORTRAN version of the program is approximately three minutes and the required storage is approximately 100,000 bytes.

Two types of data input forms are provided for use with this program which is written so that these forms may be used independently or together. One form is for use when a "standard" beam is to be designed while the other is to be used when a "non-standard" beam is to be designed. A "standard" beam is defined as one having the properties and dimensions shown in Table I and is designed using the design criteria shown in Table II. Any beam not in this category is considered to ba a "non-standard" beam.

All the data in Tables I and II are contained in the Block Data set and Subroutine Indata; therefore additions and/or modifications to the "standard" beams may be made quite easily.

Two types of output are also provided for users of this program. One is a brief, one-page output, which contains input data and details of the designed beam. The other type is a multi-page output which contains all the above information plus summaries of moments, shears, stresses, etc., tabulated at various points along the beam for the different stages of loading.

TABLE I. PROPERTIES AND DIMENSIONS FOR STANDARD BEAMS

					Section Dimensions						
Beam Type	Moment of Inertia (in.^{4})	Area in.^{2}	y_b in.	y_t in.	Depth in.	B in.	C in.	E in.	WD in.	A in.	H in.
A	22,658	275.44	12.61	15.39	28	16.0	5.0	5.0	6.0	12.0	4.0
B	43,177	360.31	14.93	19.07	34	18.0	6.0	5.75	6.5	12.0	5.5
C	82,602	494.94	17.09	22.91	40	22.0	7.0	7.5	7.0	14.0	6.0
48	101,950	403.44	22.87	25.13	48	14.0	7.0	4.0	6.0	14.0	3.5
54	164,022	493.44	25.53	28.47	54	16.0	8.0	5.0	6.0	16.0	4.0
60	255,319	628.44	28.41	31.59	60	18.0	9.0	5.5	7.0	18.0	4.5
66	374,688	740.94	31.07	34.93	66	20.0	10.0	6.5	7.0	20.0	5.0
72	532,060	863.44	33.73	38.27	72	22.0	11.0	7.5	7.0	22.0	5.5
IV	260,403	788.44	24.75	29.25	54	26.0	8.0	9.0	8.0	20.0	8.0
V	521,180	1013.00	31.96	31.04	63	28.0	8.0	10.0	8.0	42.0	5.0
VI	733,320	1085.00	36.38	35.62	72	28.0	8.0	10.0	8.0	42.0	5.0

Beam Types A - 72 - THD standard beams

Types IV, V, VI - AASHO standard beams

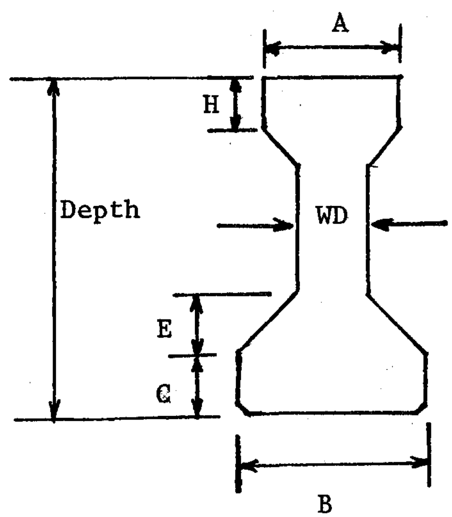

TABLE I. PROPERTIES AND DIMENSIONS FOR STANDARD BEAMS

Beam Type	Moment of Inertia (in.^{4})	Area in.^{2}	y_b in.	y_t in.	Depth in.	B in.	C in.	E in.	WD in.	A in.	H in.
						Section Dimensions					
A	22,658	275.44	12.61	15.39	28	16.0	5.0	5.0	6.0	12.0	4.0
B	43,177	360.31	14.93	19.07	34	18.0	6.0	5.75	6.5	12.0	5.5
C	82,602	494.94	17.09	22.91	40	22.0	7.0	7.5	7.0	14.0	6.0
48	101,950	403.44	22.87	25.13	48	14.0	7.0	4.0	6.0	14.0	3.5
54	164,022	493.44	25.53	28.47	54	16.0	8.0	5.0	6.0	16.0	4.0
60	255,319	628.44	28.41	31.59	60	18.0	9.0	5.5	7.0	18.0	4.5
66	374,688	740.94	31.07	34.93	66	20.0	10.0	6.5	7.0	20.0	5.0
72	532,060	863.44	33.73	38.27	72	22.0	11.0	7.5	7.0	22.0	5.5
IV	260,403	788.44	24.75	29.25	54	26.0	8.0	9.0	8.0	20.0	8.0
V	521,180	1013.00	31.96	31.04	63	28.0	8.0	10.0	8.0	42.0	5.0
VI	733,320	1085.00	36.38	35.62	72	28.0	8.0	10.0	8.0	42.0	5.0

Beam Types A - 72 - THD standard beams

Types IV, V, VI - AASHO standard beams

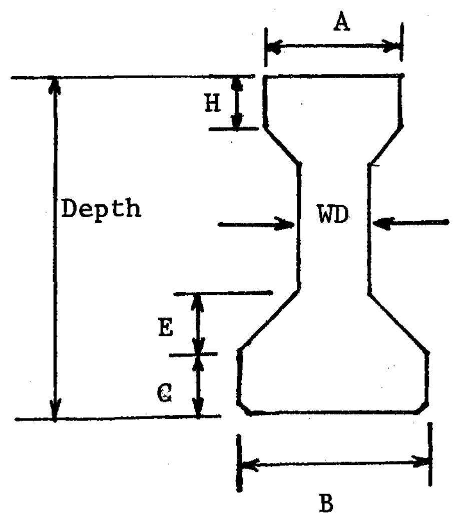

TABLE II. DESIGN CRITERIA FOR STANDARD BEAMS

1. Live load distribution factor = beam spacing ÷ 11
2. Strand diameter = 1/2 in.
3. Strand area = 0.153 sq. in.
4. Unit weight of beam and slab = 150 pcf
5. Compressive strength of slab concrete = 3,600 psi
6. Modulus of elasticity for beam and slab concrete = 5×10^6 psi
7. Modulus of elasticity for steel = 28×10^6 psi
8. Ultimate strength of strand = 270,000 psi
9. Yield point stress for web reinforcement = 40,000 psi
10. Dead load applied to the composite section = zero
11. Number of strands to be draped in the web = 2 (A design for three strands in the web is also provided for AASHO IV beams.)

A section entitled INPUT/OUTPUT is included later in this report which contains instructions for completing both types of input forms, discussion of both types of output, and examples of each.

Use of this program is limited to simply-supported I-shaped beams which are similar in shape to the Texas Highway Department and AASHO standard sections. By use of the appropriate type of output, the following information may be obtained from this program:

1. Vertical shears, moments, and stresses at tenth points and hold-down points in the beam.
2. Maximum ultimate horizontal shear between slab and girders at tenth points.
3. Stirrup spacing, based on ACI Specifications, at tenth points.
4. Stirrup spacing, based on AASHO Specifications, at midspan and quarter points.
5. Ultimate moment required for design loads and provided by the designed section.
6. Dead load deflections at midspan and quarter points due to slab and diaphragms.
7. Predicted maximum camber.
8. Predicted loss of prestress.
9. Arrangement of prestressing strands at ends and center line of beam.
10. Required concrete strengths (release and 28-day).

In outline form, the basic steps of the program are:

1. Read in input data.
2. Determine composite and noncomposite section properties.
3. Calculate moments and shears due to all loads.
4. Calculate dead load deflections.
5. Determine allowable stresses.
6. Calculate stresses due to all loads.
7. Determine number and location of prestressing strands.
8. Calculate required web reinforcement.
9. Calculate ultimate moments (required and provided).
10. Print out results.

III. DESIGN CONSIDERATIONS

Procedures and Specifications

The designs produced by this computer program are based on currently acceptable design procedures as used by the Texas Highway Department and the following specifications:

1. 1969 AASHO Specifications for Highway Bridges (1).*
2. 1968 American Railway Engineering Association Specifications (2).
3. 1963 American Standard Building Code Requirements for Reinforced Concrete, ACI (318-63)(3).

Concrete strengths

The required concrete release strength is determined from the midspan bottom fiber stress conditions at the time of release. The required 28-day concrete strength is determined from the midspan top fiber stress conditions under full working loads.

Number of Strands

The number of prestressing strands is dependent upon the algebraic sum of the allowable tension in the concrete and the bottom fiber stress at midspan due to all loads. A trial design is made assuming the midspan eccentricity equal to the distance from the centroid of the beam to the bottom fiber. The initial trial temporary prestressing force, which is subject to change later, and the corresponding number of strands are found from Equations 1 and 2, respectively.

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*Numbers in parentheses refer to corresponding items in the list of references.

$$PF = \frac{f_b}{\frac{1}{A} + \frac{e_{c.l.}}{Z_b}} \qquad \text{(Eq. 1)}$$

$$NS = \frac{PF}{P} \qquad \text{(Eq. 2)}$$

where PF = trial prestressing force

f_b = stress in the bottom fiber due to all loads plus allowable tensile stress divided by (1 - prestress loss)

P = prestressing force per strand

NS = number of strands

$e_{c.l.}$ = eccentricity of steel at midspan

A = gross cross-sectional area of the beam

Z_b = section modulus at bottom of beam

The minimum number of strands is given by Equation 3.

$$NS = \frac{0.003 \times A}{A_s} \qquad \text{(Eq. 3)}$$

where NS = minimum number of strands

A = gross cross-sectional area of the beam

A_s = cross-sectional area of one prestressing strand

The larger number of strands calculated by Equation 2 or Equation 3 is selected for the first trial. If the midspan bottom fiber stress produced by prestress is less than f_b, the number of strands is increased in increments of two.

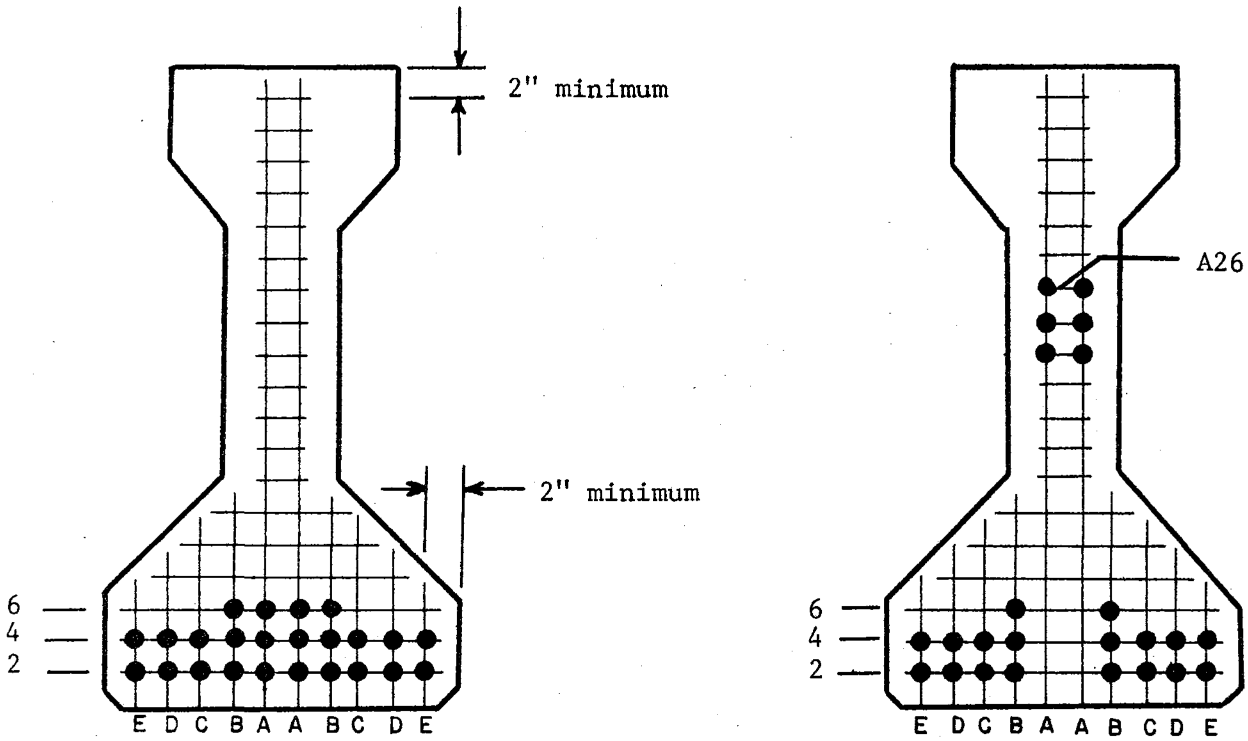
Location and Placement of Strands

Figure 1 shows typical grid systems for placement of the prestressing strands. The strands are placed as low as possible on this grid beginning in row 2, then proceeding to row 4, then to row 6, etc., beginning each row in the "A" position and working outward until the required number of strands is reached.

Strand Pattern Modification

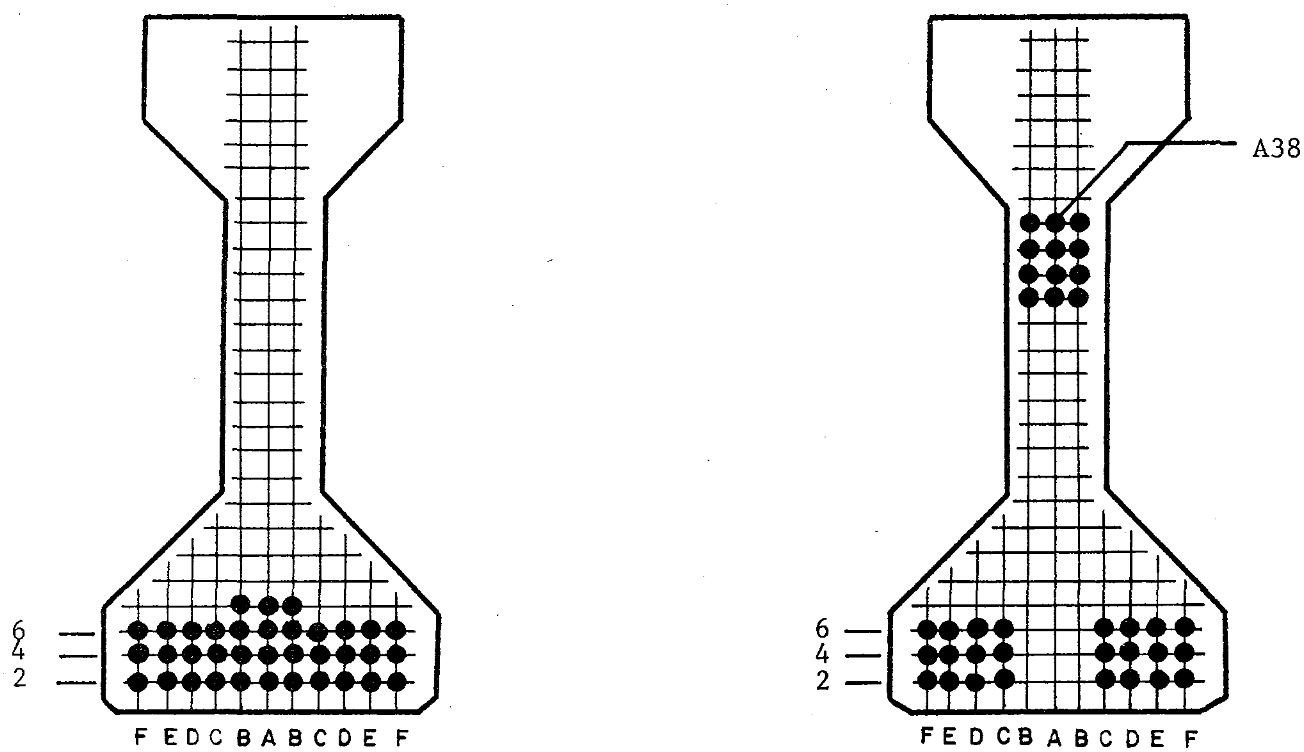
Modifications to the trial pattern are made when required by moments or stresses. Such situation is one in which top fiber tension at midspan exceeds the allowable, although bottom fiber stress is satisfactory. The modification is made by moving strands from a lower level to a higher level, thus reducing the midspan eccentricity and top tensile stress.

By way of illustration, consider a beam and loading conditions that require ten prestressing strands to satisfy the bottom fiber stress at midspan. The strand arrangement for the illustration uses six strands to fill the bottom layer, and the remaining four strands are positioned in the next, second, layer. The midspan eccentricity for this strand pattern may cause the midspan top fiber stress to exceed the allowable stress for concrete in tension. For this case, two strands from the bottom layer would be moved to form a third layer since the number of strands in the bottom layer is greater than the four used in the second layer. The strand pattern then would be four strands in the first layer, four strands in the second layer, and two



Center Line End

Typical 2-Strand Drape Pattern



Center Line End

Typical 3-Strand Drape Pattern

Figure 1. Typical 2-inch Grid Systems

strands in the third layer. The top fiber stress would be recomputed using the eccentricity of the revised pattern of strands to determine if that stress falls within the allowable limits. If the top fiber stress still exceeds the allowable stress, two strands from the second layer would be moved up to make a fourth layer since it is the next layer below the third layer containing more strands than the third layer. The strand pattern then would be four strands in the first layer and two strands in each of the remaining three layers. The top fiber stress would be recomputed using the revised pattern of strands to determine if that stress falls within the allowable limits.

End Eccentricity

The required end eccentricity is determined from the top and bottom fiber stress conditions in the end of the beam at the time of release. This eccentricity is obtained by draping all of the strands in the two middle columns of strands, or, in the case of a three strand web design, the three central columns of strands in each horizontal row to a position that will furnish the required end eccentricity. The maximum position to which these strands can be raised is one that provides a minimum of two inches of cover to the center of the top strands.

If the end eccentricity required to accommodate the midspan release strength necessitates placement of the strands above the maximum position allowed, the program will place the strands at the maximum position and a beam design with release strength based on this end eccentricity will be printed out.

Ultimate Moment

The ultimate moments, required and provided, are determined in accordance with AASHO specifications for highway beams or in accordance with AREA specifications for railway beams. If the ultimate resisting moment is less than that required, additional prestressed strands are added in increments of two until required resistance is attained.

Camber and Prestress Loss

Maximum camber and prestress loss are predicted by the hyperbolic function method developed by Sinno (4). However, the prestress loss actually used in the program is 20 percent of the initial stress.

Hold-down Locations

Strand hold-down points are located as follows:

1. Five feet on each side of midspan for beam lengths less than 120 feet.
2. Six feet on each side of midspan for beam lengths equal to or greater than 120 feet and less than 140 feet.
3. Seven feet on each side of midspan for beam lengths equal to or greater than 140 feet and less than 160 feet.
4. Eight feet on each side of midspan for beam lengths equal to 160 feet and less than 180 feet.

No provisions are made for beam lengths of 180 feet or longer.

Diaphragm Location

For "standard" beams, interior diaphragms are located as follows:

1. One located at midspan for span lengths less than or equal to 50 feet.
2. Two located at one-third points for span lengths between 50.01 and 90.00 feet.
3. Three located at one-fourth points for span lengths between 90.01 and 130.00 feet.
4. Four located at one-fifth points for span lengths between 130.01 and 170.00 feet.

For "nonstandard" beams interior diaphragms must be entered as concentrated static loads applied to the composite section.

No provisions are made for span lengths greater than 170.00 feet.

IV. INPUT/OUTPUT

Input Form for "Standard" Beams

As previously discussed in the section describing the computer program (Section II), this input form is to be used when a "standard" beam is to be designed. The first three cards of this form are for information purposes and must be filled in one time, and one time only, for each run of the program. These cards are programmed for any alphameric information; therefore, data may be arranged in any form convenient to the user.

The three information cards are followed by one card for each beam to be designed. Data required for this card are: type of beam (any type shown in Table I), span length (between centers of bearing), beam spacing, type of live loading (H-15, H-20, HS-20, or Cooper's E loadings). The two columns headed Span Designation and Beam Designation are for beam identification purposes only and may be left blank if desired.

There is no limit on the number of beams that may be stacked and run at one time. The program continues execution until design of the last beam is completed.

Input Form for "Nonstandard" Beams

As previously discussed, this form is to be used for beams which do not fit in the "standard" beam category. When this form is used all problem data must be input by the user.

This form may be used in lieu of, or in conjunction with, the form for "standard" beams. When used in conjunction with the form for "standard" beams, only one set of identification cards is to be used.

In addition to three identification cards, which may or may not be required, the input data set for the design of a "nonstandard" beam is made up of nine cards, all of which must be included for each problem. The first three cards of this set contain the design requirements, section properties of the beam being designed, and the physical properties of the concrete and prestressing steel being used. Note that Beam Type on this form must be designated NS. If a live loading other than the standard AASHO and Railroad loadings is used, the columns headed AASHO L.L. and R.R. L.L. should be left blank. The live loading must then be entered on card type 5, i.e., cards with the numbers 05 in columns 1 and 2. Note that only concentrated live loads may be entered on these cards.

The next six cards are used to describe concentrated loads which can be applied to the beam being designed. All these cards must be included in the data set with the card types punched in Columns 1 and 2, even if no further data appears on the cards. Card type 03 is used to describe concentrated static loads applied to a noncomposite section, card type 04 is used to describe concentrated static loads applied to a composite section, and card type 05 is used to describe a concentrated live load pattern applied to a composite section which is moved across the beam to determine the maximum stress conditions at the previously discussed locations.

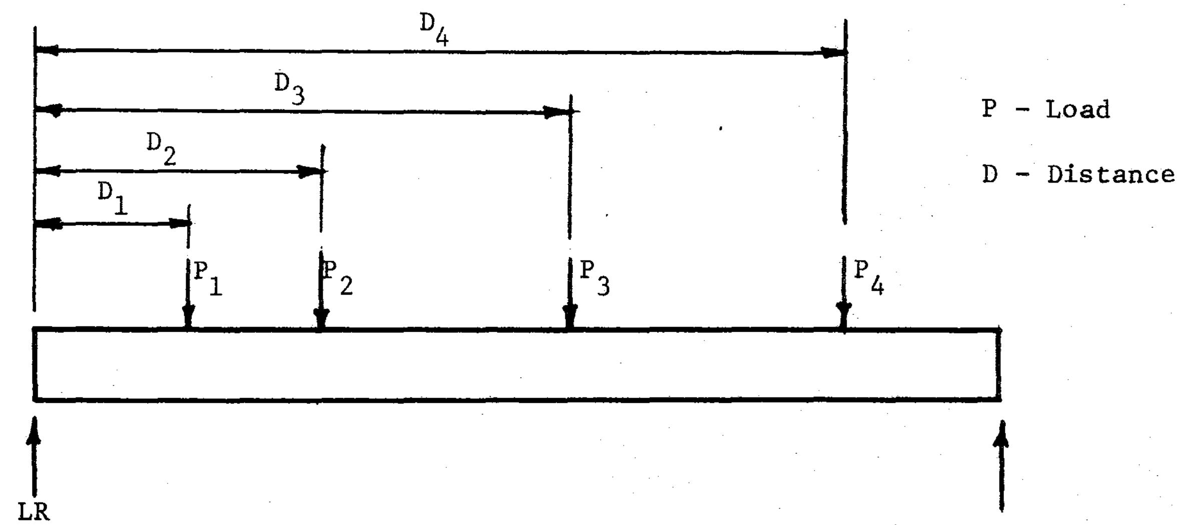
Whenever a load is input on a load card it must be accompanied by a corresponding distance on the distance card of the same card type which immediately follows the load card. For static loads the number of distances is equal to the number of loads, however for live loads, the number of distances is one less than the number of loads. This is illustrated in Figure 2.

If there is an inconsistency between the number of loads and the number of distances input, execution of the problem is stopped, an error message is printed out, and execution of the next problem begins.

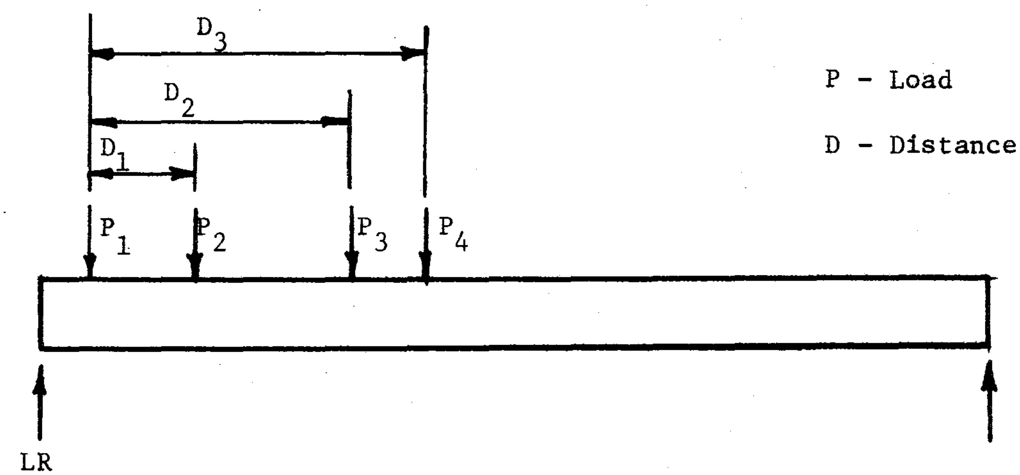
Program Output

Users of this program may choose between a brief one-page output which contains only input data and details of the designed beam and an extended multipage form which contains the above information plus summaries of moments, shears, stresses, etc., tabulated at various points along the beam for the different stages of loading.

There are two informative messages output in conjunction with the ultimate moments. The first tells whether the section used for calculating the ultimate moment provided is flanged or rectangular. The second message tells whether the output beam design is based on stress requirements or ultimate moment requirements.



a. Static Loads



b. Live Loads

Figure 2. Typical Concentrated Loads and Required Distances

When the topmost draped strands are placed in the maximum upper allowable position and the release strength, based on center-line conditions, is not adequate, a message is printed out indicating that the concrete release strength shown was calculated from end eccentricity based on that maximum draped position.

When the beam being designed is an AASHO IV beam, designs for both 2 and 3 strands in the web of the beam will be made and the results printed out.

Examples of the input and output forms are shown in Figures 3, 4, 5, and 6, respectively.

TEXAS HIGHWAY DEPARTMENT
BRIDGE DIVISION

PRESTRESSED CONCRETE BEAM DESIGN PROGRAM

(STANDARD BEAM)

SHEET___OF___BY__________
DATE__________CONTROL__________
DISTRICT__________IPE__________
COUNTY__________PROB. NO.__________

GENERAL INFORMATION

DISTRICT (1–8)	14 (10–11)	TRAVIS (15–27)	COUNTY (29–34)	HIGHWAY NO. (38–48)	IH 35 (50–55)	SUBMITTED BY (59–70)	HDB (72–80)
CONTROL NO. (1–11)	476-219 (13–19)	IPE (23–25)	675 (27–29)	DATE (33–36)	NOVEMBER 1970 (38–55)		
DESCRIPTION (1–11)	SAMPLE INPUT (13–80)						

BEAM TYPE	SPAN (C-C BRG) (FT)	BEAM SPACING (FT)	SLAB THICKNESS (IN.)	AASHO L.L.	R.R. L.L.	SPAN DESIGNATION	BEAM DESIGNATION	ENTER "I" FOR EXTENDED OUTPUT	REMARKS
A	34.00	6.75	7.50	H-15		14R	10-15	I	
B	64.00	5.50	7.00	HS-20					
C	70.00	8.00	7.25	H-20		12-19	2R-3L		
48	75.41	7.33	7.00	HS-20					
54	64.25	2.67	9.00	-	72	ALL	ALL	I	Coopers E-72 Loading
60	90.87	6.75	7.33	HS-20					
66	93.42	7.33	7.25	-					
72	102.50	6.75	6.75	-					
IV	110.25	7.33	7.25	-				I	AASHO Beams
V	109.75	7.75	6.75	-					" "
VI	125.18	7.00	7.00	HS-20		ALL	ALL		" "
3 4	7 11	14 17	20 23	26 30	33 35	40 44	47 51	54	

Figure 3. Input Form for "Standard" Beam

PRESTRESSED CONCRETE BEAM DESIGN PROGRAM (NON-STANDARD BEAMS)

TEXAS HIGHWAY DEPARTMENT
BRIDGE DIVISION

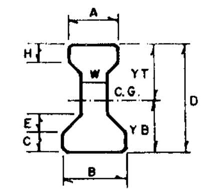
SHEET __ OF __ BY __ DATE __ CONTROL __
DISTRICT __ IPE __ COUNTY __ PROB NO __

DISTRICT 12 HARRIS COUNTY HIGHWAY NO. US 290

CONTROL NO. 214-876 IPE 694 SUBMITTED BY HDB

GENERAL INFORMATION

DESCRIPTION SAMPLE INPUT



BEAM TYPE	SPAN L (FT) C-C BRG	BEAM SPACING (FT)	SLAB THICK. (IN)	AASHO L.L.	R.R. L.L.	SPAN DESIGNATION	BEAM DESIGNATION	ENTER "1" FOR EXTENDED OUTPUT
NS	118.75	7.00	7.25	HS-20		120	4	1

	INERTIA (IN^4)	AREA (IN^2)	D (IN.)	YB (IN.)	YT (IN.)	B (IN.)	W (IN.)	C (IN.)	E (IN.)	A (IN.)	H (IN.)	STRANDS IN WEB
01	216836.00	709.00	54.00	25.98	28.02	20.00	10.00	8.00	5.00	20.00	4.00	2

	STRAND SIZE (3/8---9/16)	ULT STGTH OF STRAND (KSI)	UNIT WT (LBS/CU FT) BEAM	UNIT WT (LBS/CU FT) SLAB	SLAB CONC. 28-DAY ST. (PSI)	MODULUS OF ELASTICITY (10^6 PSI) BEAM CONC.	SLAB CONC.	STEEL	WIDTH COMP SLAB (FT)	UNIF. D.L. ON COMP. SEC. (K/FT)	L.L. DIST. FACTOR
02	1/2	270.00	150.00	150.00	3600.00	5.00	5.00	28.00	7.00		.636

CONCENTRATED STATIC LOAD APPLIED TO NON-COMPOSITE SECTION

03	2.00	2.00	2.00								LOADS (KIPS)
03	29.38	59.38	89.38								DISTANCE FROM LEFT SUPPORT (FT)

CONCENTRATED STATIC LOADS APPLIED TO COMPOSITE SECTION

04											LOADS (KIPS)
04											DISTANCE FROM LEFT SUPPORT (FT.)

CONCENTRATED LIVE LOADS APPLIED TO COMPOSITE SECTION

05											LOADS (KIPS)
05											DISTANCE FROM LEFT LOAD (FT.)

BEAM TYPE	SPAN L (FT) C-C BRG.	BEAM SPACING (FT)	SLAB THICK. (IN)	AASHO L.L.	R.R. L.L.	SPAN DESIGNATION	BEAM DESIGNATION	ENTER "1" FOR EXTENDED OUTPUT
NS	126.42	7.00	7.25	—		14-F	2 L-R	

	INERTIA (IN^4)	AREA (IN^2)	D (IN.)	YB (IN)	YT (IN.)	B (IN.)	W (IN.)	C (IN.)	E (IN.)	A (IN.)	H (IN.)	STRANDS IN WEB
01	243178.00	817.00	54.00	26.11	27.89	22.00	12.00	8.00	5.00	22.00	4.00	3

	STRAND SIZE (3/8---9/16)	ULT. STGTH. OF STRAND (KSI)	UNIT WT. (LBS/CU FT) BEAM	UNIT WT. (LBS/CU FT) SLAB	SLAB CONC. 28-DAY ST. (PSI)	MODULUS OF ELASTICITY (10^6 PSI) BEAM CONC.	SLAB CONC.	STEEL	WIDTH COMP SLAB (FT)	UNIF. D.L. ON COMP. SEC. (K/FT)	L.L. DIST. FACTOR
02	9/16	270.00	150.00	112.00	3600.00	5.00	5.00	28.00	7.00		.636

CONCENTRATED STATIC LOAD APPLIED TO NON-COMPOSITE SECTION

03	2.00	2.00	2.00								LOADS (KIPS)
03	31.60	63.20	94.80								DISTANCE FROM LEFT SUPPORT (FT.)

CONCENTRATED STATIC LOADS APPLIED TO COMPOSITE SECTION

04											LOADS (KIPS)
04											DISTANCE FROM LEFT SUPPORT (FT.)

CONCENTRATED LIVE LOADS APPLIED TO COMPOSITE SECTION

05	4.00	16.00	16.00								LOADS (KIPS)
05	14.00	28.00									DISTANCE FROM LEFT LOAD (FT.)

Figure 4. Input Form for "Non-Standard" Beam

```
DISTRICT 14          TRAVIS COUNTY   HIGHWAY NO. LP 275   SUBMITTED BY BR WINN
CONTROL NO. 151-6     IPE 228   DATE NOV 2 1970

                  LOOP 275 OVERPASS US 183   SPANS NO 1-6

                          SPAN    1   BEAM    1


**** INPUT DATA ****

BEAM TYPE          =   54          UNIT WT. BEAM CONC.     =  150.   PCF          L.L. DIST. FACTOR =       0.69
SPAN LENGTH        =  77.25 FT     UNIT WT. SLAB CONC.     =  150.   PCF          COMP. SLAB WIDTH  =         90.48 IN
BEAM SPACING       =   7.54 FT     28-DAY ST.(SLAB CONC.) = 3600.   PSI          COMP. DEAD LOAD   =       0.0  KLF
SLAB THICKNESS     =   7.50 IN     E(BM.CONC.)            =    5.00 E(06)PSI     BEAM INERTIA      = 164023.   IN4
STRAND SIZE        =   1/2  IN     E(SLB.CONC.)           =    5.00 E(06)PSI     BEAM AREA         =    493.44 IN2
STRAND ULT. STR.   =   270K        E(PSRR. STL.)          =   28.00 E(06)PSI     BEAM DEPTH        =     54.00 IN
NO.OF WEB STRNS.   =    2          AASHO L.L.             =   HS-20              BEAM YB           =     25.53 IN
GRID SIZE          =   2.   IN     RAILROAD L.L.          =    E- 0.             BEAM YT           =     28.47 IN

*** BEAM DESIGN ***


TYPE OF BEAM               =   54           D.L. DEFLECTION AT MID-SPAN =  0.058 FT (SLAB)     0.007 FT (DIAF)
NO. OF STRANDS             =   22.          D.L. DEFLECTION AT 1/4 PT.  =  0.041 FT (SLAB)     0.005 FT (DIAF)
SIZE OF STRANDS            =   1/2
TYPE OF STRANDS            =   270K         ULTIMATE MOMENT REQUIRED = 3806. FT-KIPS
ECCENTRICITY AT C.L.       =   20.80 IN     ULT. MOMENT PROVIDED =     4161. FT-KIPS  UNDER REINF. RECT. SECT.
ECCENTRICITY AT END        =   13.53 IN
NO. OF DEPRESSED STRANDS   =    8           STIRRUP SPAC. (MIDDLE 1/2 SPAN) = NO. 4 AT 24.00 IN
DEPRESS TOP 2 STRANDS TO POSITION A-28      STIRRUP SPAC. (EXT. 1/4 SPAN)   = NO. 4 AT 16.43 IN
CONCRETE RELEASE STRENGTH = 4425.   PSI
CONCRETE 28-DAY STRENGTH  =   5000.    PSI   TOP FIBER DESIGN STRESS (C.L.)    = 2231. PSI
                                             BOTTOM FIBER DESIGN STRESS (C.L.) = 2869. PSI

                                             MAXIMUM CAMBER =  1.80 IN
                                             PRESTRESS LOSS = 17.16 PERCENT

*** STRAND PATTERN ***
    (C.L. OF BEAM)

ROW  1 HAS  6. STRANDS
ROW  2 HAS  6. STRANDS
ROW  3 HAS  6. STRANDS
ROW  4 HAS  4. STRANDS
```

Figure 5. Typical Output, One-Page

DISTRICT 14 TRAVIS COUNTY HIGHWAY NO. LP 275 SUBMITTED BY BR WINN
CONTROL NO. 151-6 IPE 228 DATE NOV 2 1970

LOOP 275 OVERPASS US 183 SPANS NO 1-6

SPAN 5 BEAM NO. ALL

INPUT DATA

BEAM TYPE	= 54	UNIT WT. BEAM CONC.	= 150. PCF	L.L. DIST. FACTOR	= 0.58
SPAN LENGTH	= 96.42 FT	UNIT WT. SLAB CONC.	= 150. PCF	COMP. SLAB WIDTH	= 75.96 IN
BEAM SPACING	= 6.33 FT	28-DAY ST.(SLAB CONC.)	= 3600. PSI	COMP. DEAD LOAD	= 0.0 KLF
SLAB THICKNESS	= 7.25 IN	E(BM. CONC.)	= 5.00 E(06)PSI	BEAM INERTIA	= 164023. IN4
STRAND SIZE	= 1/2 IN	E(SLB. CONC.)	= 5.00 E(06)PSI	BEAM AREA	= 493.44 IN2
STRAND ULT. STR.	= 270K	E(PSTR. STL.)	= 28.00 E(06)PSI	BEAM DEPTH	= 54.00 IN
NO. OF WEB STRNS.	= 2	AASHO L.L.	= HS-20	BEAM YB	= 25.53 IN
GRID SIZE	= 2. IN	RAILROAD L.L.	= E- 0.	BEAM YT	= 28.47 IN

	MOMENT SUMMARY (FT-KIPS)			SHEAR SUMMARY (KIPS)		
SECTION	DEAD LOAD	L.L.+I.	TOTAL	DEAD LOAD	L.L.+I.	TOTAL
0	0.0	0.0	0.0	55.3	45.9	101.2
1	479.7	393.3	873.1	44.2	40.8	85.0
2	852.9	688.7	1541.6	33.2	35.7	68.9
3	1119.4	886.2	2005.6	22.1	30.6	52.8
4	1279.3	1001.5	2280.8	11.1	25.6	36.6
5	1332.6	1C26.8	2359.4	-0.0	20.5	20.5
6	1279.3	1001.5	2280.8	11.1	25.6	36.6
7	1119.4	886.2	2005.6	22.1	30.6	52.8
8	852.9	688.7	1541.6	33.2	35.7	68.9
9	479.7	393.3	873.1	44.2	40.8	85.0
10	0.0	0.0	0.0	55.3	45.9	101.2
HOLD-DOWN	1318.3	1C25.9	2344.1	5.7	18.0	23.7

LOOP 275 OVERPASS US 183 SPANS NO 1-6

STRESSES IN EXTREME FIBERS DUE TO EXTERNAL LOADS (LBS PER SQ. IN.)

SECTION	BEAM		SLAB		TOTAL D.L. NCN-COMP SEC.		DEAD LOAD COMP SEC.		LIVE LOAD PLUS IMPACT		TOTAL	
	TOP	BOT	TOP	BOT	TOP	BOT	TOP	BOT	TOP	BOT	TOP	BOT
0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	448.	402.	551.	494.	999.	896.	0.	0.	125.	461.	1125.	1357.
2	796.	714.	980.	879.	1776.	1593.	0.	0.	220.	808.	1996.	2401.
3	1045.	937.	1286.	1154.	2332.	2091.	0.	0.	292.	1039.	2614.	3130.
4	1194.	1071.	1470.	1318.	2665.	2389.	0.	0.	319.	1174.	2984.	3564.
5	1244.	1116.	1532.	1373.	2776.	2489.	0.	0.	327.	1204.	3103.	3693.
6	1194.	1071.	1470.	1318.	2665.	2389.	0.	0.	319.	1174.	2984.	3564.
7	1045.	937.	1286.	1154.	2332.	2091.	0.	0.	282.	1039.	2614.	3130.
8	796.	714.	980.	879.	1776.	1593.	0.	0.	220.	808.	1996.	2401.
9	448.	402.	551.	494.	999.	896.	0.	0.	125.	461.	1125.	1357.
10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
HOLD-DOWN	1231.	1104.	1515.	1359.	2746.	2462.	0.	0.	327.	1203.	3073.	3665.

STRESSES DUE TO EXTERNAL LOADS PLUS PRESTRESS (LBS PER SQ. IN.)

	INITIAL PREST.		BEAM PLUS INITIAL PREST.		FINAL PREST. PLUS TOT. D.L.(N/C SEC.)		ALL LOADS PLUS FINAL PREST.	
	TOP	BOT	TOP	BOT	TOP	BOT	TOP	BOT
0	164.	3210.	164.	3210.	131.	2568.	131.	2568.
1	-134.	3477.	314.	3075.	892.	1885.	1017.	1424.
2	-432.	3744.	365.	3029.	1431.	1402.	1651.	594.
3	-729.	4010.	316.	3073.	1748.	1118.	2031.	79.
4	-1027.	4277.	167.	3206.	1843.	1032.	2162.	-142.
5	-1170.	4406.	74.	3290.	1839.	1036.	2167.	-168.
6	-1027.	4277.	167.	3206.	1843.	1032.	2162.	-142.
7	-729.	4010.	316.	3073.	1748.	1118.	2031.	79.
8	-432.	3744.	365.	3029.	1431.	1402.	1651.	594.
9	-134.	3477.	314.	3075.	892.	1985.	1017.	1424.
10	164.	3210.	164.	3210.	131.	2568.	131.	2568.
HOLD-DOWN	-1170.	4406.	61.	3302.	1810.	1062.	2137.	-141.

Figure 6. Typical Output, Multi-page

LOOP 275 OVERPASS US 183   SPANS NO 1-6

STIRRUP SPACING IN EXTERIOR 1/4 SPAN (AASHO SPECS.)   NO. 4 AT 16.8 IN.

STIRRUP SPACING IN MIDDLE 1/2 SPAN (AASHO SPECS.)   NO. 4 AT 24.0 IN.

STIRRUP SPACING BASED ON ACI SPECS.

SECTION	
0	NO. 4 AT 4.6 IN.
1	NO. 4 AT 17.4 IN.
2	NO. 4 AT 16.7 IN.
3	NO. 4 AT 17.0 IN.
4	NO. 4 AT 17.4 IN.
5	NO. 4 AT 17.4 IN.
6	NO. 4 AT 17.4 IN.
7	NO. 4 AT 17.0 IN.
8	NO. 4 AT 16.7 IN.
9	NO. 4 AT 17.4 IN.
10	NO. 4 AT 4.6 IN.

MAXIMUM ULTIMATE HORIZONTAL SHEAR BETWEEN SLAB AND GIRDER FLANGE (VQ/I)

SECTION	
0	223.2 PSI
1	188.0 PSI
2	152.8 PSI
3	117.6 PSI
4	82.4 PSI
5	61.5 PSI
6	82.4 PSI
7	117.6 PSI
8	152.8 PSI
9	188.0 PSI
10	223.2 PSI

LOOP 275 OVERPASS US 183   SPANS NO 1-6

ULTIMATE MOMENT REQUIRED = 4565.8 FT-KIPS
ULTIMATE MOMENT PROVIDED = 5396.9 FT-KIPS   UNDER REINFORCED RECTANGULAR SECTION
DESIGN BASED ON STRESSES

DEAD LOAD DEFLECTIONS	SLAB	DIAPHRAM	COMP DEAD LOAD
MIDSPAN	0.113 FT	0.016 FT	0.0 FT
QUARTER POINT	0.081 FT	0.011 FT	0.0 FT

MAXIMUM CAMBER = 2.85 IN.
PRESTRESS LOSS = 19.22 PERCENT

TYPE OF BEAM	=	54
NO. OF STRANDS	=	30.
SIZE OF STRANDS	=	1/2
ULT. STRENGTH OF STRANDS	=	270K
ECCENTRICITY AT C.L.	=	19.40 IN.
ECCENTRICITY AT END	=	10.60 IN.
CONCRETE RELEASE STRENGTH	=	5490. PSI
CONCRETE 28-DAY STRENGTH	=	5490. PSI
NUMBER OF DRAPED STRANDS	=	12

DEPRESS TOP STRANDS TO POSITION A-34

STRAND PATTERN AT CENTERLINE OF BEAM

ROW 1 HAS 6 STRANDS

ROW 2 HAS 6 STRANDS

ROW 3 HAS 6 STRANDS

ROW 4 HAS 6 STRANDS

ROW 5 HAS 4 STRANDS

ROW 6 HAS 2 STRANDS

Figure 6, cont'd.

REFERENCES

1. Standard Specifications for Highway Bridges adapted by The American Association of State Highway Officials, 1969.

2. American Railway Engineering Association Engineering Division, AAR, 1968.

3. ACI Standard Building Code Requirements for Reinforced Concrete ACI (318-63), American Concrete Institute, Detroit, Michigan, 1963.

4. Raouf Sinno, The Time Dependent Deflections of Prestressed Concrete Bridge Beams, Ph.D. Dissertation, Texas A&M University, College Station, Texas, January 1968.

APPENDIX A

Summaries, Definitions, Flow Charts

A summary of steps, definitions of terms, and flow charts, in that order, are presented.

Routine: BLOCK DATA

Subroutine BLOCK DATA stores properties of the 11 standard beams and zeros out arrays.

Definition of Terms:

AR	- array of beam cross-sectional areas (in.^{2})
BB	- array of bottom flange widths (in.) (see sketch)
BEAM	- list of 11 beam sections
BPRIME	- array of web thicknesses (in.) (see sketch)
CC	- array of depths of the bottom flanges (see sketch)
DI	- array of beam depths (in.)
EE	- array of vertical depths of the sloped portion of the bottom flanges (in.) (see sketch)
HH	- array of depths of the top flanges (in.) (see sketches)
IBI	- array of beam moments of inertia (in.^{4})
WTFI	- array of widths of the top flanges (in.) (see sketch)
YBI	- array of the distances for the sections from the cg to the bottom of the beam (in.)
YTI	- array of the distances for the sections from the cg to the top of the beam (in.)

Routine: MAIN

A summary of the steps for routine MAIN is divided into two parts. The parts consist of steps pertaining to the input form for "standard" beams or to the input form for "nonstandard" beams.

Steps for input form for "standard" beams are:

a. Call INPUT1

b. Call REREAD

c. Read input data

d. Call INDATA to complete the input data set

e. Define LTYPE

f. Define KODE

g. Call PROPTY

h. Call HELP

i. Call PSTRES

j. Call LOPUT or SHPUT to print results

k. If BTYPE = IV change the number of strands lifted from each row to three, call CHANGE, and repeat steps h, i, and j.

Steps for input form for "nonstandard" beams are:

a. Call INPUT1

b. Call REREAD

c. Read input data and check for inconsistencies in data. If inconsistencies are found, the data set will be destroyed, an error message printed, and the next set of data initiated.

d. Define LTYPE

e. Define KODE

f. Call PROPTY

g. Call HELP

h. Call PSTRES

i. Call LOPUT or SHPUT to print results

j. If BTYPE = IV change the number of strands lifted from each row to three, call CHANGE, and repeat steps h, i, and j.

Definition of Terms:

A - see sketch

AREA - beam cross-sectional area (in.^{2})

ASTRN - defined as SAREA1 or SAREA2

B - see sketch

BLANKA___ , VBLANK - stored data for comparative purposes to eliminate confusion when using beam types A, B, C, and V

BNSTD - term defined as 'NS' to compare with BTYPE

BSPAC - beam spacing (ft)

BTYPE - beam designation such as B, C, 54, etc.

C - see sketch

CCD(I) - distance(s) from left reaction to location of CCP(I) beginning with the CCD(2). CCD(k) is set to zero internally.

CCP(I) - concentrated live load(s) applied to the composite section to simulate truck loads (kips)

CNCD(I) - distance(s) from left reaction to the location of the concentrated load(s) (ft)

CNCP(I) - concentrated static load(s) applied to the noncomposite section (kips)

D - beam depth (in.)

DIA - nominal strand diameter (1/2..., etc.)

DIA1 - stored sizes of prestressing strands

DFACT - live load distribution factor

E - see sketch

EC, ECSL - elastic modulii of beam concrete, slab concrete, and prestressing steel, respectively (10^6 psi)

EFW - effective flange width (ft)

ES - elastic modulii of beam concrete, slab concrete, and prestressing steel, respectively (10^6 psi)

FPS - ultimate strength of prestressing strand (ksi)

H - see sketch

IB - beam moment of inertia (in.^4)

IBMNO - number of the beam

ICARD(I) - alphameric array that contains design data that can later be read using specified format

IOPUT - designates the type of output selected. The number 1 gives the extended output; the number 0 gives the short output.

IW - number of parallel strands in the web

KODE - number of diaphragms as a function of the span length

LTYPE - indicator of the type live load selected and used for direction to the proper routine to generate live shears and moments

NCDL - uniformly distributed dead load applied to the composite section (kips/ft)

NTYPE - term that determines the direction of the routine when the long input form is used

RROAD - magnitude of Cooper's E-loading selected (E-72, etc.)

SAREA1, SAREA2 - cross-sectional area corresponding to the input diameter and 270k or 250k prestressing strand

SCNCD(I) - distance from left reaction to location of SCNCP(I) (ft)

SCNCP(I) - concentrated static load(s) applied to the composite section (kips)

SFPC - compressive strength of slab concrete (psi)

SMBOL1 - combination of numbers and letters to designate the type of highway loading ('HS-2', 'H-1')

SMBOL2 - the last number that completes SMBOL1

SPAN1, SPAN2 - terms for span identification

SPANL - span length (ft)

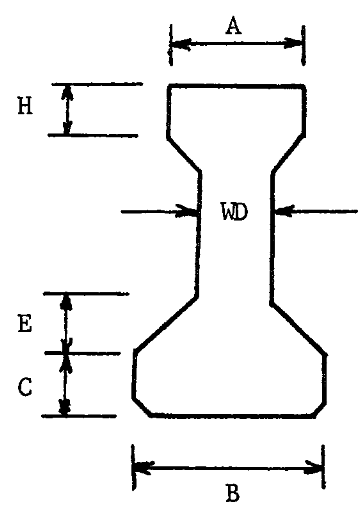
TS - slab thickness (in.)

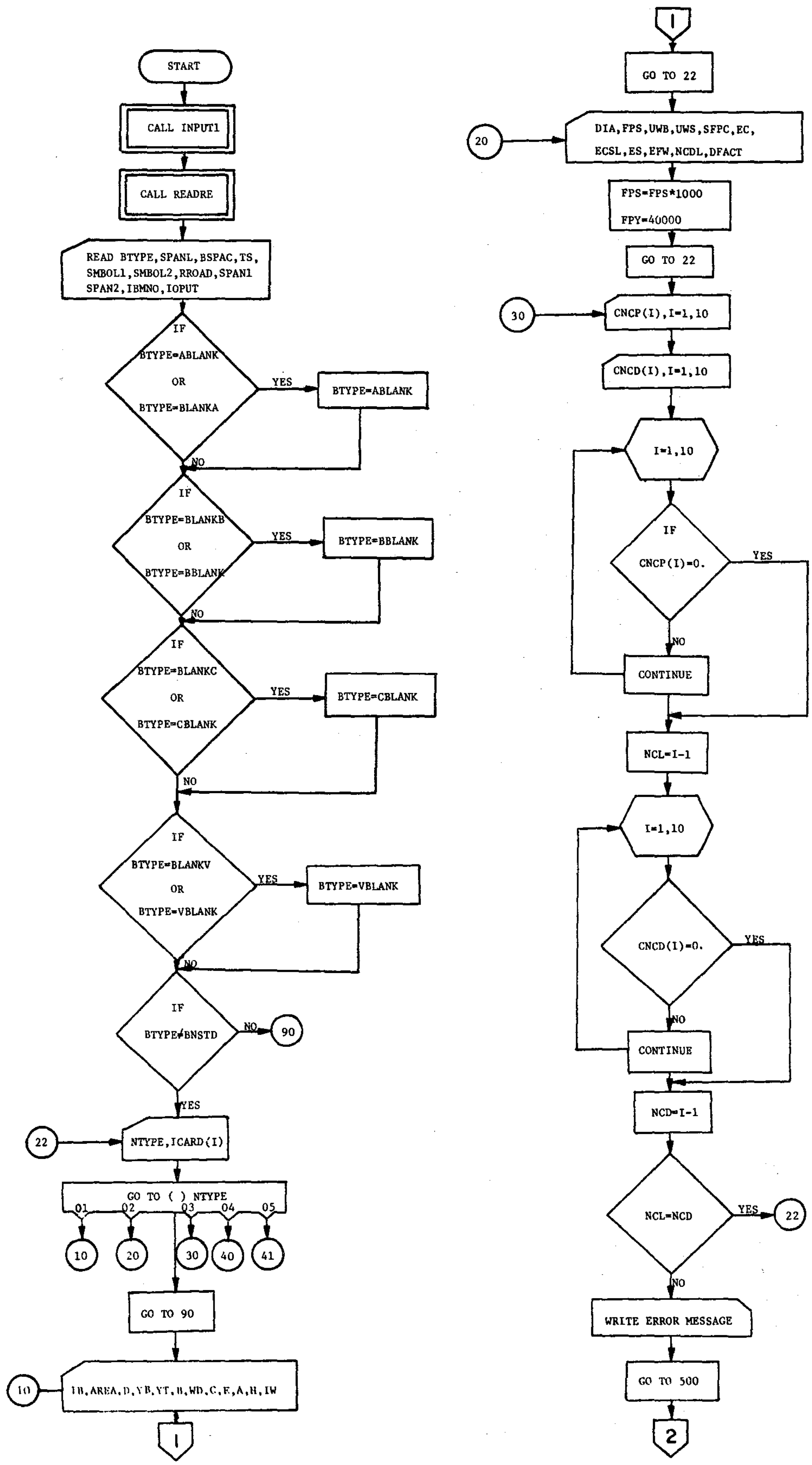
UWB, UWS - unit weight of beam and slab concrete, respectively (lb/ft^3)

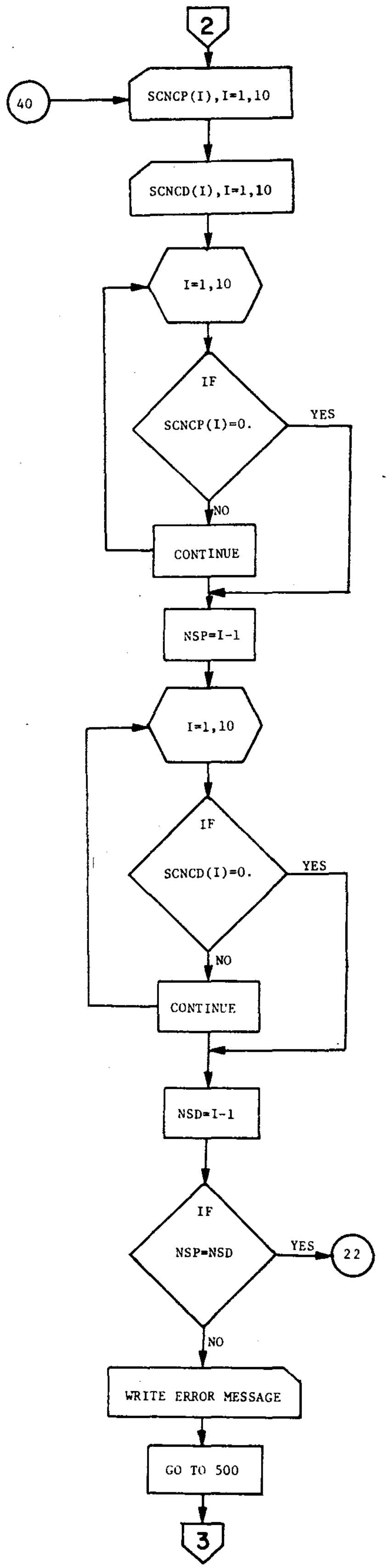
WD - see sketch

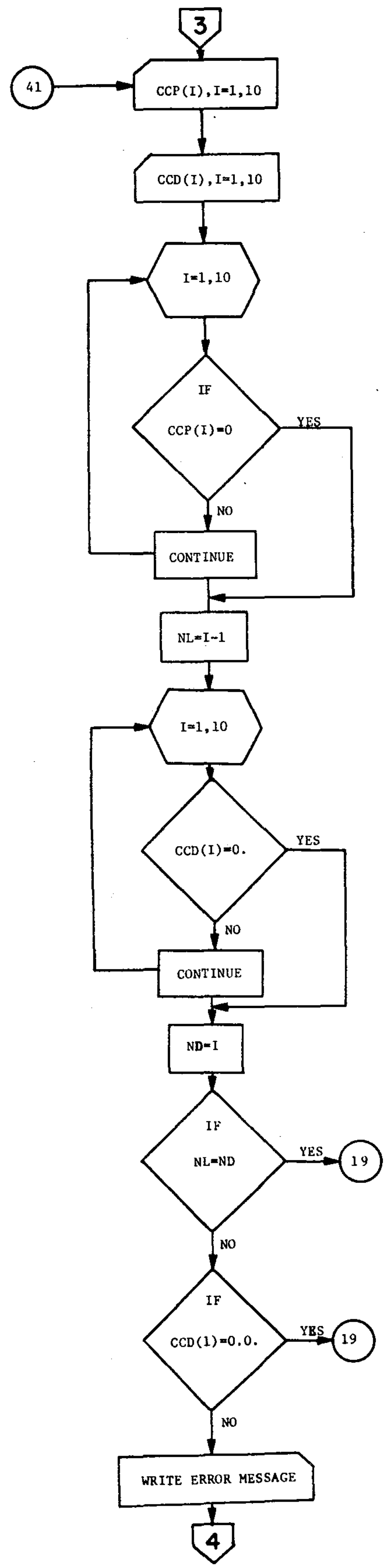
YB - distance from cgc to bottom of beam (in.)

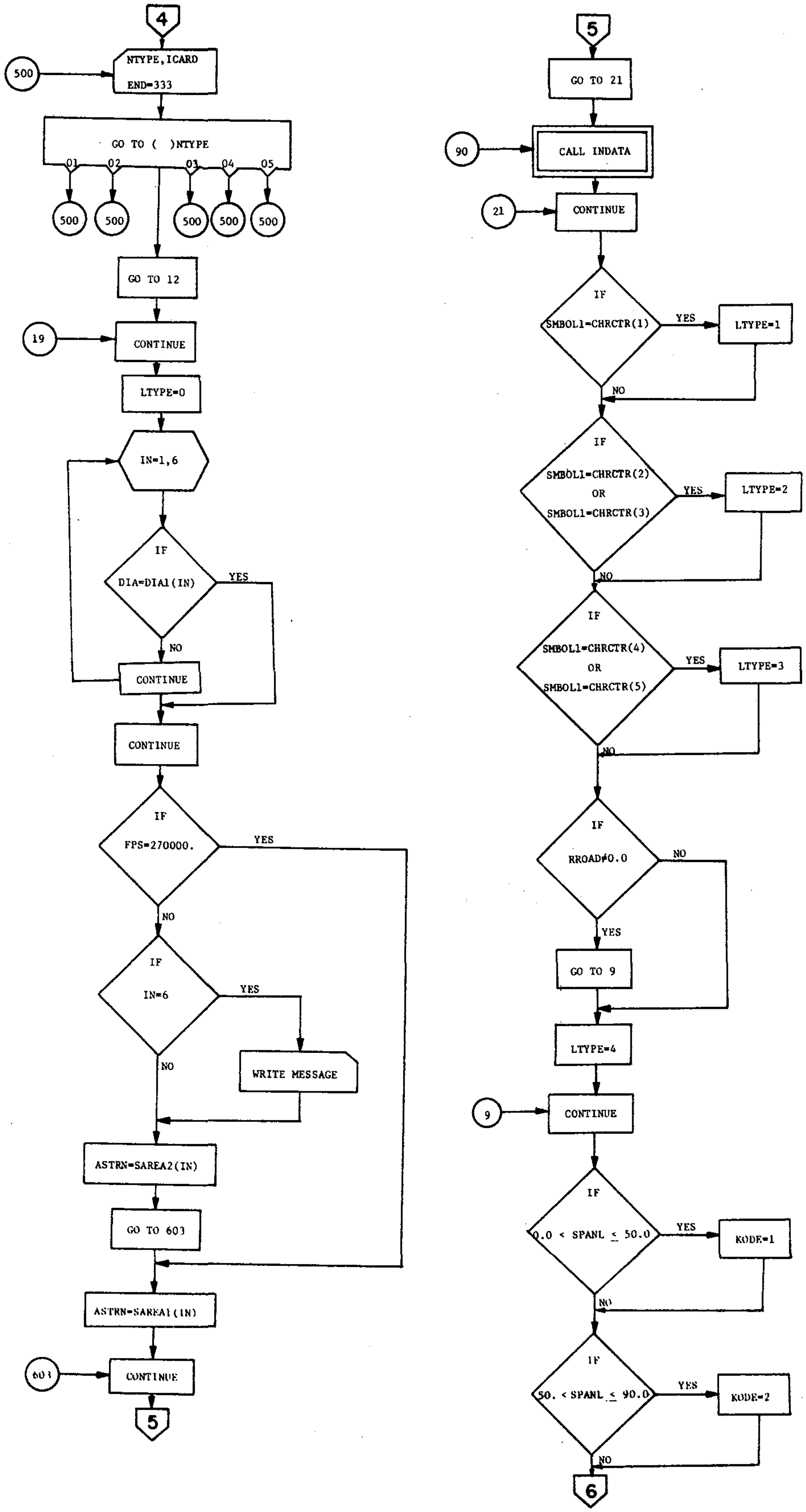
YT - distance from cgc to top of beam (in.)

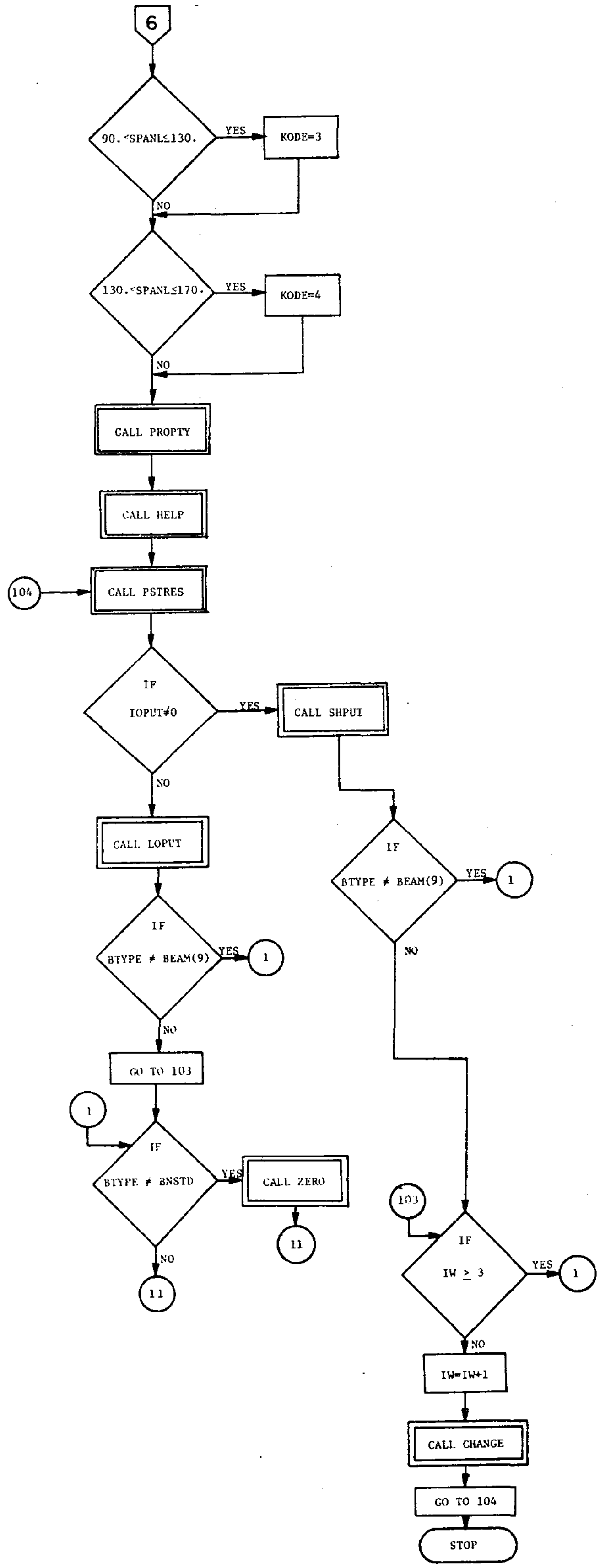



START
CALL INPUT1
CALL READRE
READ BTYPE,SPANL,BSPAC,TS,
SMBOL1,SMBOL2,RROAD,SPAN1
SPAN2,IBMNO,IOPUT
IF
BTYPE=ABLANK
OR
BTYPE=BLANKA
YES
BTYPE=ABLANK
NO
IF
BTYPE=BLANKB
OR
BTYPE=BBLANK
YES
BTYPE=BBLANK
NO
IF
BTYPE=BLANKC
OR
BTYPE=CBLANK
YES
BTYPE=CBLANK
NO
IF
BTYPE=BLANKV
OR
BTYPE=VBLANK
YES
BTYPE=VBLANK
NO
IF
BTYPE≠BNSTD
NO
90
YES
22
NTYPE,ICARD(I)
GO TO ( ) NTYPE
01
02
03
04
05
10
20
30
40
41
GO TO 90
10
IB,AREA,D,YB,YT,B,WD,C,E,A,H,IW
1
1
GO TO 22
20
DIA,FPS,UWB,UWS,SFPC,EC,
ECSL,ES,EFW,NCDL,DFACT
FPS=FPS*1000
FPY=40000
GO TO 22
30
CNCP(I),I=1,10
CNCD(I),I=1,10
I=1,10
IF
CNCP(I)=0.
YES
NO
CONTINUE
NCL=I-1
I=1,10
CNCD(I)=0.
YES
NO
CONTINUE
NCD=I-1
NCL=NCD
YES
22
NO
WRITE ERROR MESSAGE
GO TO 500
2


2
40
SCNCP(I),I=1,10
SCNCD(I),I=1,10
I=1,10
IF
SCNCP(I)=0.
YES
NO
CONTINUE
NSP=I-1
I=1,10
IF
SCNCD(I)=0.
YES
NO
CONTINUE
NSD=I-1
IF
NSP=NSD
YES
22
NO
WRITE ERROR MESSAGE
GO TO 500
3


3
41
CCP(I),I=1,10
CCD(I),I=1,10
I=1,10
IF
CCP(I)=0
YES
NO
CONTINUE
NL=I-1
I=1,10
CCD(I)=0.
YES
NO
CONTINUE
ND=I
IF
NL=ND
YES
19
NO
IF
CCD(1)=0.0.
YES
19
NO
WRITE ERROR MESSAGE
4


4
500
NTYPE,ICARD
END=333
GO TO ( )NTYPE
01
02
03
04
05
500
GO TO 12
19
CONTINUE
LTYPE=0
IN=1,6
IF
DIA=DIA1(IN)
YES
NO
CONTINUE
CONTINUE
IF
FPS=270000.
YES
NO
IF
IN=6
YES
WRITE MESSAGE
NO
ASTRN=SAREA2(IN)
GO TO 603
ASTRN=SAREA1(IN)
603
CONTINUE
5
5
GO TO 21
90
CALL INDATA
21
CONTINUE
IF
SMBOL1=CHRCTR(1)
YES
LTYPE=1
NO
IF
SMBOL1=CHRCTR(2)
OR
SMBOL1=CHRCTR(3)
YES
LTYPE=2
NO
IF
SMBOL1=CHRCTR(4)
OR
SMBOL1=CHRCTR(5)
YES
LTYPE=3
NO
IF
RROAD≠0.0
NO
YES
GO TO 9
LTYPE=4
9
CONTINUE
IF
0.0 < SPANL ≤ 50.0
YES
KODE=1
NO
IF
50. < SPANL ≤ 90.0
YES
KODE=2
NO
6


6
90.<SPANL≤130.
YES
KODE=3
NO
130.<SPANL≤170.
YES
KODE=4
NO
CALL PROPTY
CALL HELP
104
CALL PSTRES
IF
IOPUT≠0
YES
CALL SHPUT
NO
CALL LOPUT
IF
BTYPE ≠ BEAM(9)
YES
1
NO
GO TO 103
1
IF
BTYPE ≠ BNSTD
YES
CALL ZERO
11
NO
11
IF
BTYPE ≠ BEAM(9)
YES
1
NO
103
IF
IW ≥ 3
YES
1
NO
IW=IW+1
CALL CHANGE
GO TO 104
STOP

Subroutine: PSTRES

A summary of steps for subroutine PSTRES is:

a. Set minimum concrete strengths

b. Call ALLOW to calculate allowable stresses

c. Calculate stresses due to loads

d. Calculate the bottom fiber stress at midspan to be overcome by prestress

e. Determine a temporary prestress force and eccentricity

f. Call MILLER to place strands at midspan

g. Calculate midspan eccentricity

h. Calculate stresses in extreme fibers at midspan due to prestress

i. Compare the bottom fiber stress of step h to that of step d. If the stress from step d is greater than that from step h, increase the number of strands by two and repeat steps f, g, h, and i.

j. Calculate extreme fiber stresses at midspan before and after losses

k. Determine concrete release strength required. If the required release is greater than 4000 psi, call ALLOW to define allowable stresses and repeat steps d, i, j, and k.

l. Compare the midspan release stress in the top fibers to the allowable stress. If the allowable is exceeded, call STRMOD to modify the midspan strand pattern and repeat steps d, g, h, i, j, k, and l.

m. Compare the midspan top fiber stress after losses to the allowable. If the allowable is exceeded, redefine f'_c, call ALLOW to define allowable stresses, and repeat steps d, i, j, k, l, and m.

n. Call MOMENT to determine ultimate and resisting moments. If the resisting moment is less than the ultimate moment required, define MSTATE equal to two, increase the number of strands by two, and repeat steps d, f, g, h, i, j, k, l, m, and n.

o. Determine the maximum end eccentricity permitted.

p. Call ECCEND to determine the position of the topmost draped strands and determine the end eccentricity. If IWCH is greater than one, calculate a release strength using the eccentricity calculated when the topmost strands are placed two inches below the top surface. This release strength is controlled by the initial top or bottom fiber tension.

q. Calculate stresses at the tenth points.

r. Call CAMBER

s. Call SHEAR

Definition of Terms:

DECC - vertical distance from the end eccentricity to the cgs of the strand pattern (in.)

E(I) - eccentricity at 1/10 points along beam (in.)

ECC - temporary eccentricity. Used as a starting point to determine the required number of strands (in.)

ECCL - eccentricity of the strand pattern at the center line of the beam measured from the cg (in.)

END1, END2 - possible maximum allowable end eccentricities (in.)

ENDMAX - maximum allowable end eccentricity (in.)

FB(I) - stress at tenth points in bottom fibers of the beam due to prestress plus all loads (psi)

FBBM(I) - stress at tenth points in the bottom fibers of the beam due to beam weight (psi)

FBDL(I) - stress at tenth points in the bottom fibers of the beam due to beam plus slab weights (psi)

FBFIN - final stress in the bottom of the beam at midspan due to all loads plus prestress (psi)

FBFOG - stress in the bottom of the beam at midspan due to prestress plus beam weight (psi)

FBI(I) - stress at tenth points in bottom fibers of the beam due to initial prestress (psi)

FBIB(I) - stress at tenth points in bottom fibers of the beam due to initial prestress plus beam weight (psi)

FBIBSN(I) - stress at tenth points in bottom fibers of the beam due to prestress plus all dead load (psi)

FBLL(I) - stress at tenth points in bottom fibers of the beam due to live load (psi)

FBNCDL(I) - stress at tenth points in bottom fibers of the beam due to noncomposite dead load, NCDL (psi)

FBP - stress due to prestress in the bottom of the beam at midspan (psi)

FBSL(I) - stress at tenth points in bottom fibers of the beam due to slab weight (psi)

FO - total initial prestressing force (lbs)

FPC - minimum 28-day concrete strength (psi)

FPCI - minimum release strength for concrete (psi)

FPCI1, FPCI2 - possible release strengths (psi)

FT(I) - stress at tenth points in top fibers of the beam due to prestress plus all loads (psi)

FTBM(I) - stress in top fibers of the beam due to beam weight (psi)

FTDL(I) - stress in top fibers of the beam due to beam plus slab weights (psi)

FTFIN - final stress in the top of the beam at midspan due to all loads plus prestress (psi)

FTFOG - stress in the top of the beam at midspan due to prestress plus beam weight (psi)

FTI(I) - stress at tenth points in top fibers of the beam due to initial prestress (psi)

FTIB(I) - stress at tenth points in the top fibers of the beam due to initial prestress plus beam weight (psi)

FTIBSN(I) - stress at tenth points in top fibers of the beam due to prestress plus all dead load (psi)

FTLL(I) - stress at tenth points in top fibers of the beam due to live load (psi)

FTNCDL(I) - stress at tenth points in top fibers of the beam due to noncomposite dead load, NCDL (psi)

FTPR - stress due to prestress in the top of the beam at midspan (psi)

FTSL(I) - stress at tenth points in top fibers of the beam due to slab weight (psi)

NMSTN, NNSTN, NSTN - terms which round down the required number of strands to a whole number

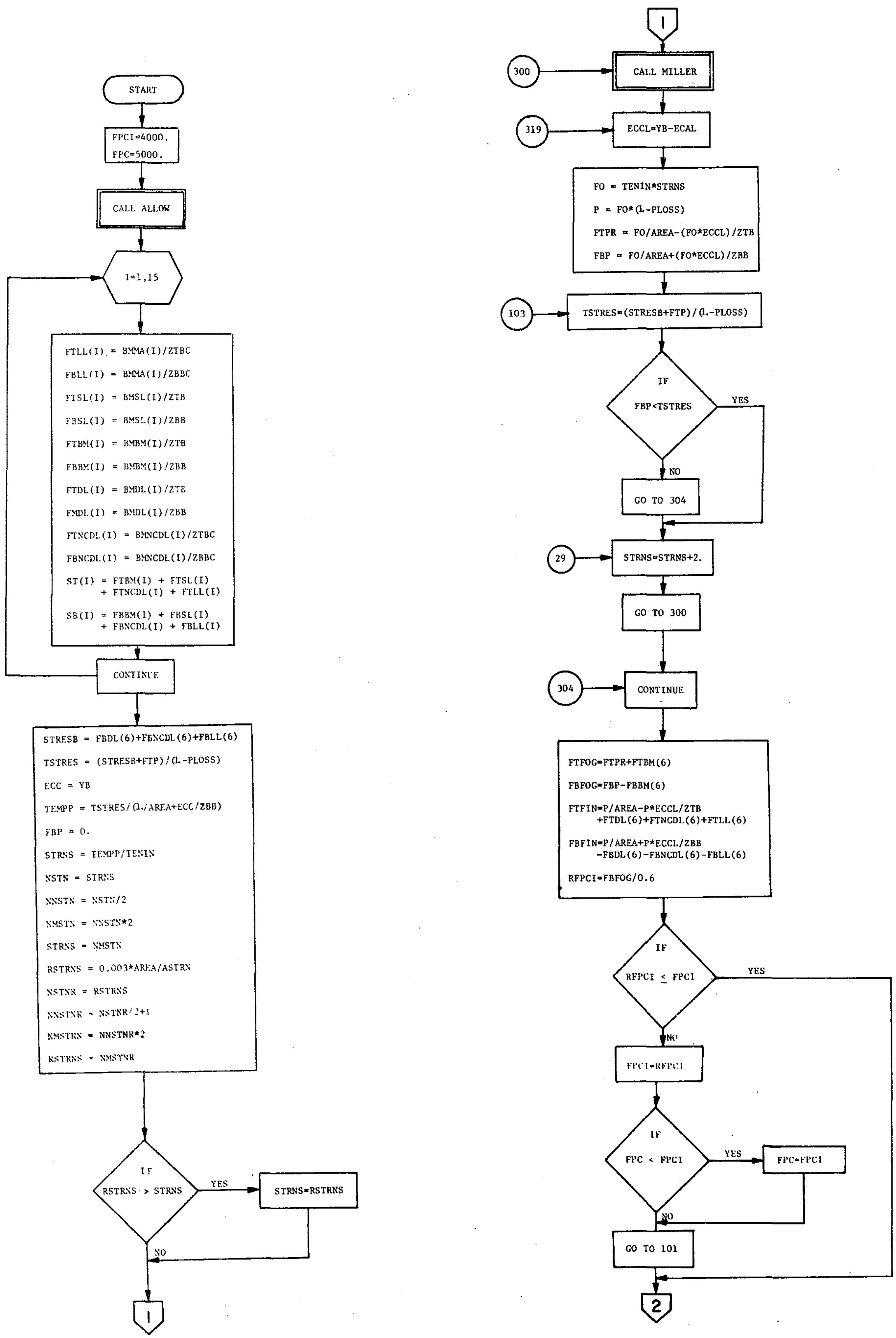
NSTNR, NNSTNR, NMSTNR - terms which round up the minimum number of strands to a whole number

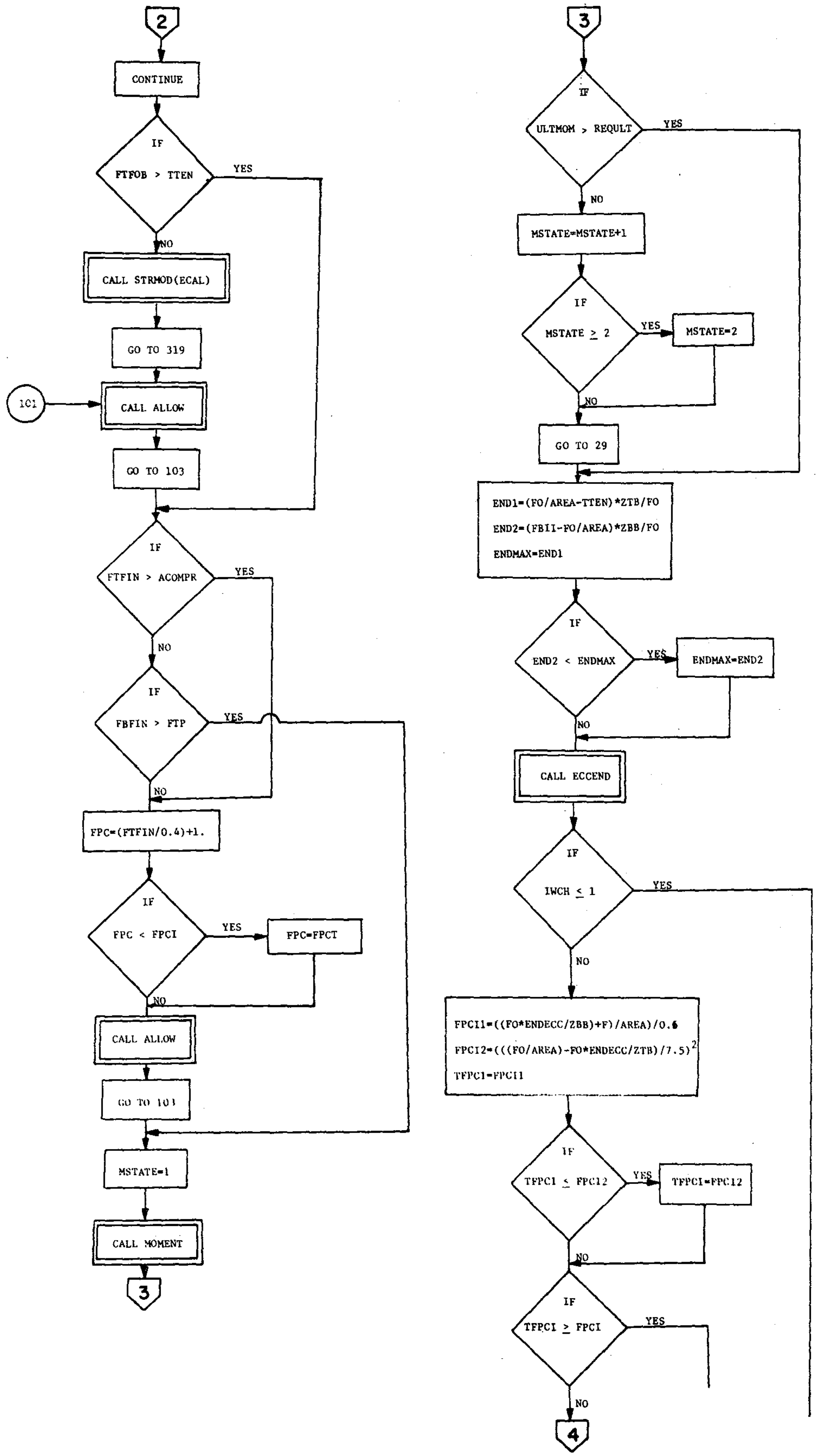
P - total prestressing force after losses (lbs)

RFPC - required 28-day strength, f'_c (psi)

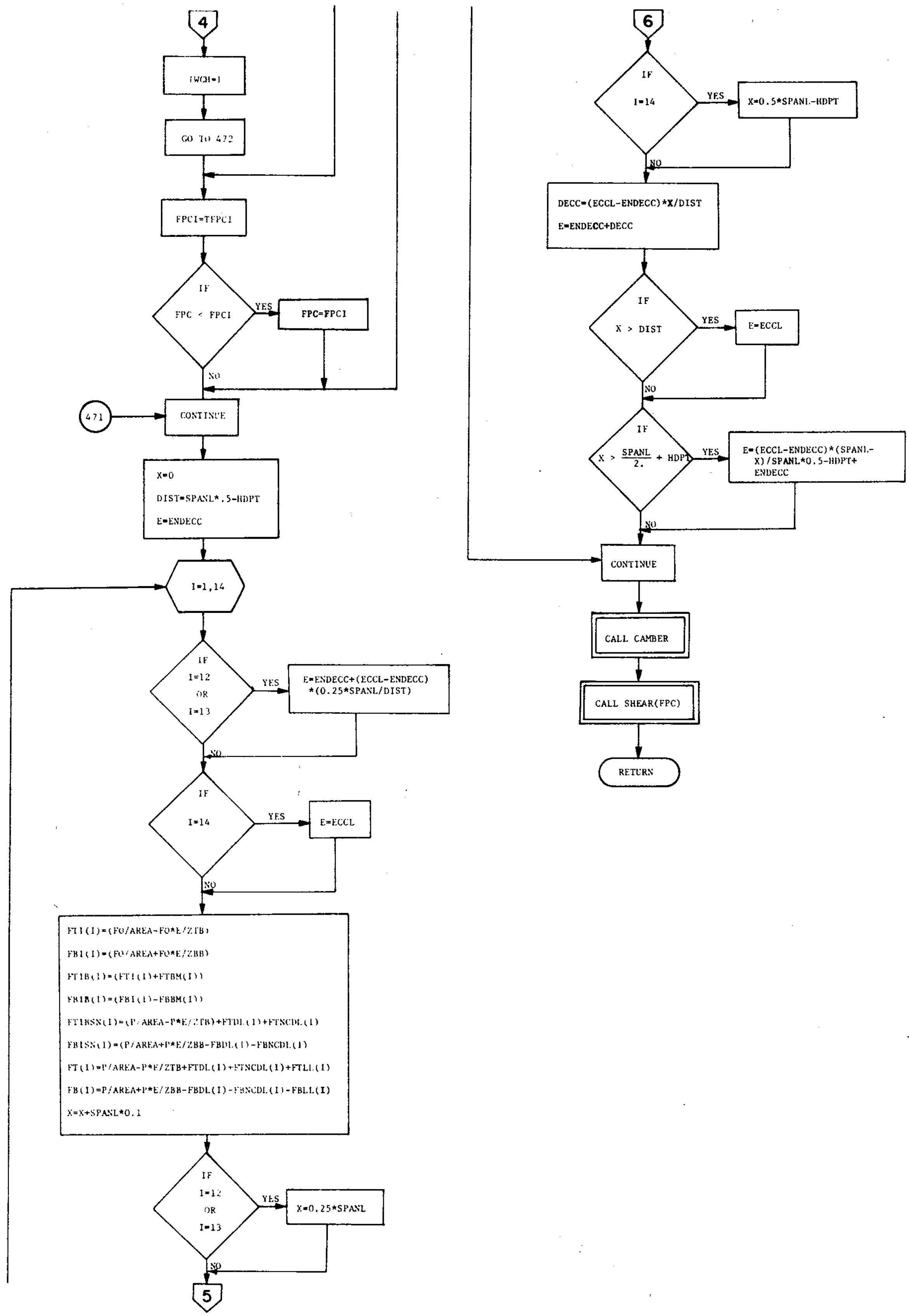
RFPCI - required release strength, f'_{ci} (psi)

RSTRNS	- minimum number of prestressing strands
SB(I)	- stress at tenth points in bottom fibers of the beam due to all external loads (psi)
ST(I)	- stress at tenth points in top fibers of the beam due to all external loads (psi)
STRESB	- stress in bottom of the beam at the center line due to dead plus live loads (psi)
STRNS	- number of prestressing strands
TEMPP	- temporary prestressing force coupled with ECC (lbs)
TFPCI	- larger value of FPCI1 or FPCI2 (psi)
TSTRES	- stress in bottom of the beam which must be overcome by prestress (psi)
X	- incremental length of span (ft)


START
FPCI=4000.
FPC=5000.
CALL ALLOW
I=1,15
FTLL(I) = BMMA(I)/ZTBC
FBLL(I) = BMMA(I)/ZBBC
FTSL(I) = BMSL(I)/ZTB
FBSL(I) = BMSL(I)/ZBB
FTBM(I) = BMBM(I)/ZTB
FBBM(I) = BMBM(I)/ZBB
FTDL(I) = BMDL(I)/ZTB
FMDL(I) = BMDL(I)/ZBB
FTNCDL(I) = BMNCDL(I)/ZTBC
FBNCDL(I) = BMNCDL(I)/ZBBC
ST(I) = FTBM(I) + FTSL(I) + FTNCDL(I) + FTLL(I)
SB(I) = FBBM(I) + FBSL(I) + FBNCDL(I) + FBLL(I)
CONTINUE
STRESB = FBDL(6)+FBNCDL(6)+FBLL(6)
TSTRES = (STRESB+FTP)/(1.-PLOSS)
ECC = YB
TEMPP = TSTRES/(1./AREA+ECC/ZBB)
FBP = 0.
STRNS = TEMPP/TENIN
NSTN = STRNS
NNSTN = NSTN/2
NMSTN = NNSTN*2
STRNS = NMSTN
RSTRNS = 0.003*AREA/ASTRN
NSTNR = RSTRNS
NNSTNR = NSTNR/2+1
NMSTNR = NNSTNR*2
RSTRNS = NMSTNR
IF
RSTRNS > STRNS
YES
STRNS=RSTRNS
NO
1
1
300
CALL MILLER
319
ECCL=YB-ECAL
FO = TENIN*STRNS
P = FO*(1.-PLOSS)
FTPR = FO/AREA-(FO*ECCL)/ZTB
FBP = FO/AREA+(FO*ECCL)/ZBB
103
TSTRES=(STRESB+FTP)/(1.-PLOSS)
IF
FBP<TSTRES
YES
NO
GO TO 304
29
STRNS=STRNS+2.
GO TO 300
304
CONTINUE
FTFOG=FTPR+FTBM(6)
FBFOG=FBP-FBBM(6)
FTFIN=P/AREA-P*ECCL/ZTB +FTDL(6)+FTNCDL(6)+FTLL(6)
FBFIN=P/AREA+P*ECCL/ZBB -FBDL(6)-FBNCDL(6)-FBLL(6)
RFPCI=FBFOG/0.6
IF
RFPCI ≤ FPCI
YES
NO
FPCI=RFPCI
IF
FPC < FPCI
YES
FPC=FPCI
NO
GO TO 101
2



2
CONTINUE
IF
FTFOB > TTEN
YES
NO
CALL STRMOD(ECAL)
GO TO 319
101
CALL ALLOW
GO TO 103
IF
FTFIN > ACOMPR
YES
NO
IF
FBFIN > FTP
YES
NO
FPC=(FTFIN/0.4)+1.
IF
FPC < FPCI
YES
FPC=FPCT
NO
CALL ALLOW
GO TO 103
MSTATE=1
CALL MOMENT
3
3
IF
ULTMOM > REQULT
YES
NO
MSTATE=MSTATE+1
IF
MSTATE ≥ 2
YES
MSTATE=2
NO
GO TO 29
END1=(FO/AREA-TTEN)*ZTB/FO
END2=(FBII-FO/AREA)*ZBB/FO
ENDMAX=END1
IF
END2 < ENDMAX
YES
ENDMAX=END2
NO
CALL ECCEND
IF
IWCH ≤ 1
YES
NO
FPCI1=((FO*ENDECC/ZBB)+F)/AREA)/0.6
FPCI2=(((FO/AREA)-FO*ENDECC/ZTB)/7.5)^2
TFPCI=FPCI1
IF
TFPCI ≤ FPCI2
YES
TFPCI=FPCI2
NO
IF
TFPCI ≥ FPCI
YES
NO
4


4
IWCH=1
GO TO 472
FPCI=TFPCI
IF
FPC < FPCI
YES
FPC=FPCI
NO
471
CONTINUE
X=0
DIST=SPANL*.5-HDPT
E=ENDECC
I=1,14
IF
I=12
OR
I=13
YES
E=ENDECC+(ECCL-ENDECC)
*(0.25*SPANL/DIST)
NO
IF
I=14
YES
E=ECCL
NO
FT1(I)=(FO/AREA-FO*E/ZTB)
FB1(I)=(FO/AREA+FO*E/ZBB)
FT1B(I)=(FT1(I)+FTBM(I))
FB1B(I)=(FB1(I)-FBBM(I))
FT1BSN(I)=(P/AREA-P*E/ZTB)+FTDL(I)+FTNCDL(I)
FB1SN(I)=(P/AREA+P*E/ZBB-FBDL(I)-FBNCDL(I)
FT(I)=P/AREA-P*E/ZTB+FTDL(I)+FTNCDL(I)+FTLL(I)
FB(I)=P/AREA+P*E/ZBB-FBDL(I)-FBNCDL(I)-FBLL(I)
X=X+SPANL*0.1
IF
I=12
OR
I=13
YES
X=0.25*SPANL
NO
5
6
IF
I=14
YES
X=0.5*SPANL-HDPT
NO
DECC=(ECCL-ENDECC)*X/DIST
E=ENDECC+DECC
IF
X > DIST
YES
E=ECCL
NO
IF
X > SPANL/2. + HDPT
YES
E=(ECCL-ENDECC)*(SPANL-X)/SPANL*0.5-HDPT+ENDECC
NO
CONTINUE
CALL CAMBER
CALL SHEAR(FPC)
RETURN

Subroutine: HELP

A summary of steps for subroutine HELP is:

Steps for "Standard" Beam Input Form

a. Define location of inspection points, tenth, quarter, and hold-down.

b. Calculate deflections at quarter-span and midspan due to slab weight and due to uniform load on the composite section

c. Calculate deflections due to diaphragms.

d. Calculate shears and moments at the inspection points due to slab weight, beam weight, and uniform load on the composite section.

e. Call TYPELD to determine live load shears and moments.

f. Sum the dead plus live load shears and moments at the inspection points.

Steps for "Nonstandard" Beam Input Form

a. Define location of inspection points, tenth, quarter, and hold-down.

b. Calculate deflections at quarter-span and midspan due to slab weight and uniform load on the composite section.

c. Calculate deflections at quarter-span and midspan due to concentrated loads on the noncomposite section.

d. Calculate shears and moments due to all concentrated loads, slab weight, and beam at the inspection points.

e. Call TYPELD to determine live load shears and moments.

f. Sum the dead plus live load shears and moments at the inspection points.

Definition of Terms:

AREA - cross-sectional area of beam (in.^{2})

BM - temporary summation for bending moment (in.-lbs)

BMBM(I) - stored value for bending moment at Ith inspection point due to weight of beam (in.-lbs)

BMDL(I) - stored value for bending moment at Ith inspection point due to composite dead loads (in.-lbs)

BMM(I) - stored value for bending moment at Ith inspection point due to $CNCP_m$ (lb-in.)

BMMS(I) - stored value for bending moment at Ith inspection point due to $SCNCP_m$ (lb-ft)

BMNCDL(I) - stored value for bending moment at Ith inspection point due to noncomposite dead load (in.-lbs)

BMREAC - left reaction due to beam weight (lbs)

BMSL(I) - stored value for bending moment at Ith inspection point due to weight of slab (in.-lbs)

BMSUM(I) - stored value for bending moment at Ith inspection point due to all loads (in.-lbs)

BSPAC - beam spacing (ft)

CBAR - distance between left reaction and center of gravity of loads applied to beam (ft)

CNCD(I) - distance(s) from left reaction to the location of the concentrated load(s) (ft)

CNCP(I) - concentrated static load(s) applied to the noncomposite section (kips)

CONST1 - constants used to determine diaphragm weights

CP - weight of one diaphragm (lbs)

DEFK1 - deflection at 1/4 SPAN due to slab weight (in.)

DEFK2	-	deflection at 1/2 SPAN due to slab weight (in.)
DEFL12	-	deflection at 1/2 SPAN due to diaphragms (in.)
DEFL14	-	deflection at 1/4 SPAN due to diaphragms (in.)
DNCDL1	-	deflection at 1/4 SPAN due to uniform load on the composite section (in.)
DNCDL2	-	deflection at 1/2 SPAN due to uniform load on the composite section
DX	-	distance from left support to position of concentrated load, CNCP(I) (in.)
DX2	-	$[DX]^2$
EC	-	modulus of elasticity of concrete (psi)
ECI	-	IB * EC
ECI6	-	6 * ECS
ECSI6	-	6 * ECSI
IB	-	area moment of inertia ($in.^4$)
INA	-	composite area moment of inertia ($in.^4$)
N2	-	counter
NCDL	-	uniform load on the composite section (kips/ft)
NN	-	counter
P		
P12	-	CNCP(I) * SPANN/2
P14	-	CNCP(I) * SPANN/4
PDL	-	CNCP(I)
PDX	-	moment of CNCP about left support (lb-in.)
REACT1	-	left reaction due to static loads applied to the composite section (lbs)
REACTN	-	left reaction due to slab, beam, and diaphragms (lbs)

RNCDL	- left reaction due to uniform load on the composite section (lbs)
SCNCD(I)	- distance from left support to the location of SCNCP(I) (ft)
SCNCP(I)	- concentrated static load(s) applied to the composite section (lbs)
SLREAC	- left reaction due to weight of slab and diaphragms (lbs)
SPANN	- span length (in.)
SUBTND	- constants used to determine diaphragm weights
SUMW	- temporary summation of weights on beam (lbs)
SUMWC	- temporary summation of moments (in.-lbs)
TS	- slab thickness (ft)
UWB	- unit weight of beam (lbs/ft^3)
UWS	- unit weight of slab (lbs/ft^3)
VCAY	- constants used to determine diaphragm weights
VDL(I)	- stored value for shear at I^{th} inspection point due to composite dead loads (lbs)
VM	- temporary value for shear (lbs)
VMM(I)	- stored value for shear at I^{th} inspection point due to CNCP(I) (lbs)
VMMS(I)	- stored value for shear at I^{th} inspection point due to SCNCP(I) (lbs)
VNCDL(I)	- stored value for shear at I^{th} inspection point due to noncomposite dead loads (lbs)
VOL(K)	- constants used to determine diaphragm weights
VSUM(I)	- stored value for shear at I^{th} inspection point due to all loads (lbs)
W	- WS + WB = unit composite dead load
W	- counter
WB	- weight of beam (lbs/ft)

WCP - diaphragm weights considered as a uniform load; use only for "standard" beams (lbs/ft)

WI - unit composite dead load (lbs/in.)

WS - unit weight of slab (lb/ft)

X - distance to inspection point from left reaction (ft)

X12 - SPANN/2

X14 - SPANN/4

X122 - $[SPANN/2]^2$

X142 - $[SPANN/4]^2$

X12L - $[SPANN]^2/2$

X14L - $[SPANN]^2/4$

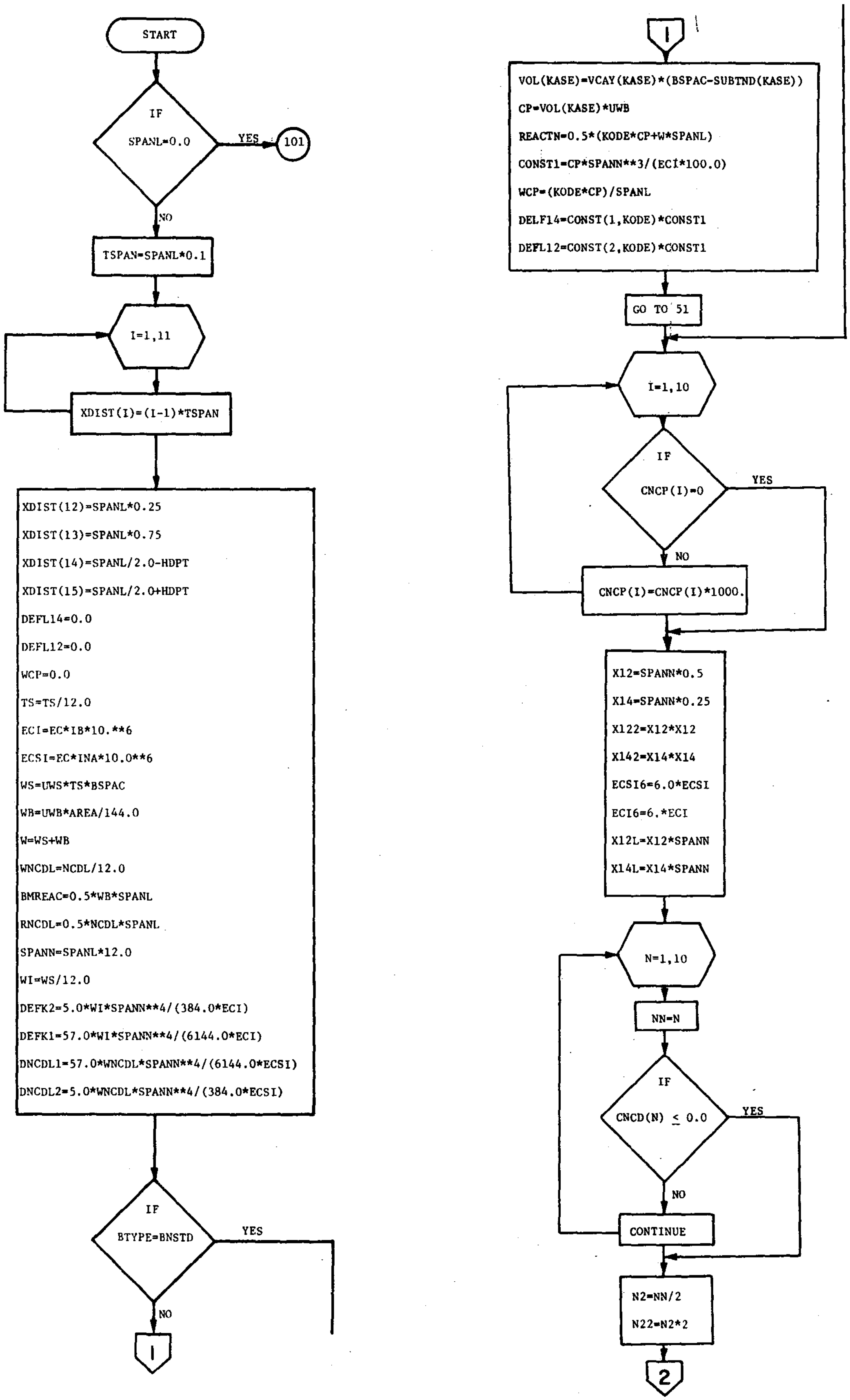
XDIST(M) - fraction of span length (ft)
for M = 1, 11

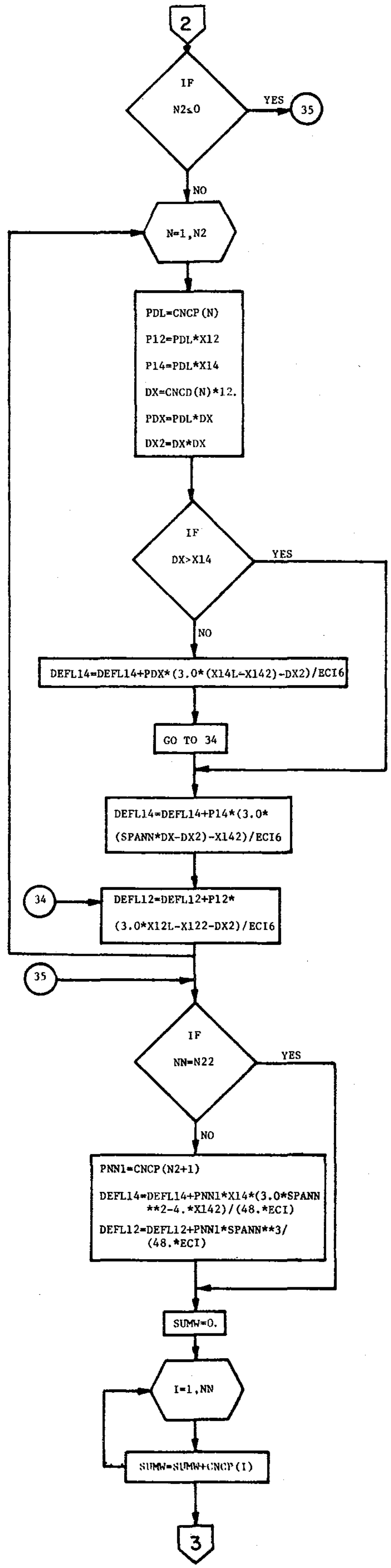
$$XDIST(M) = \left(\frac{M-1}{10}\right) \times SPANL$$

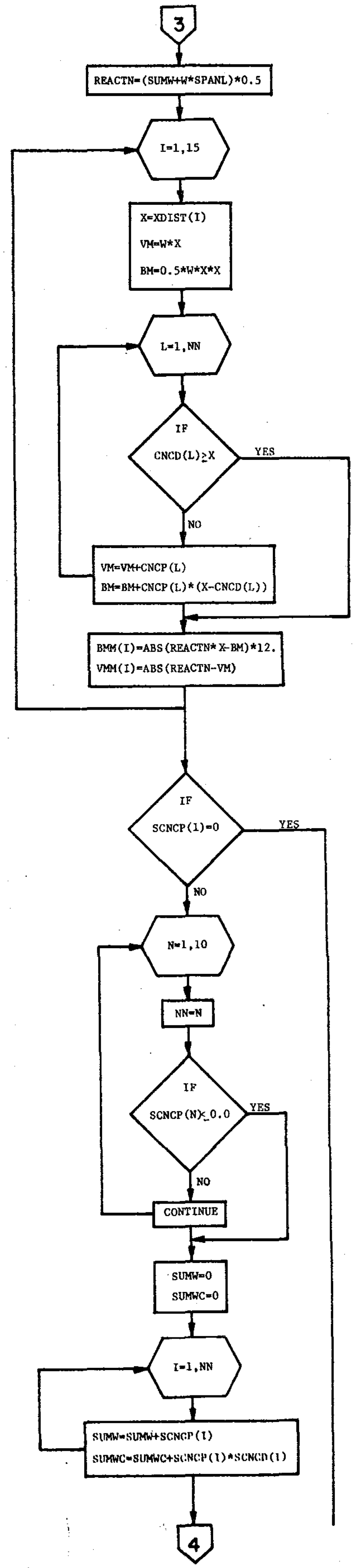
M = 12, 15

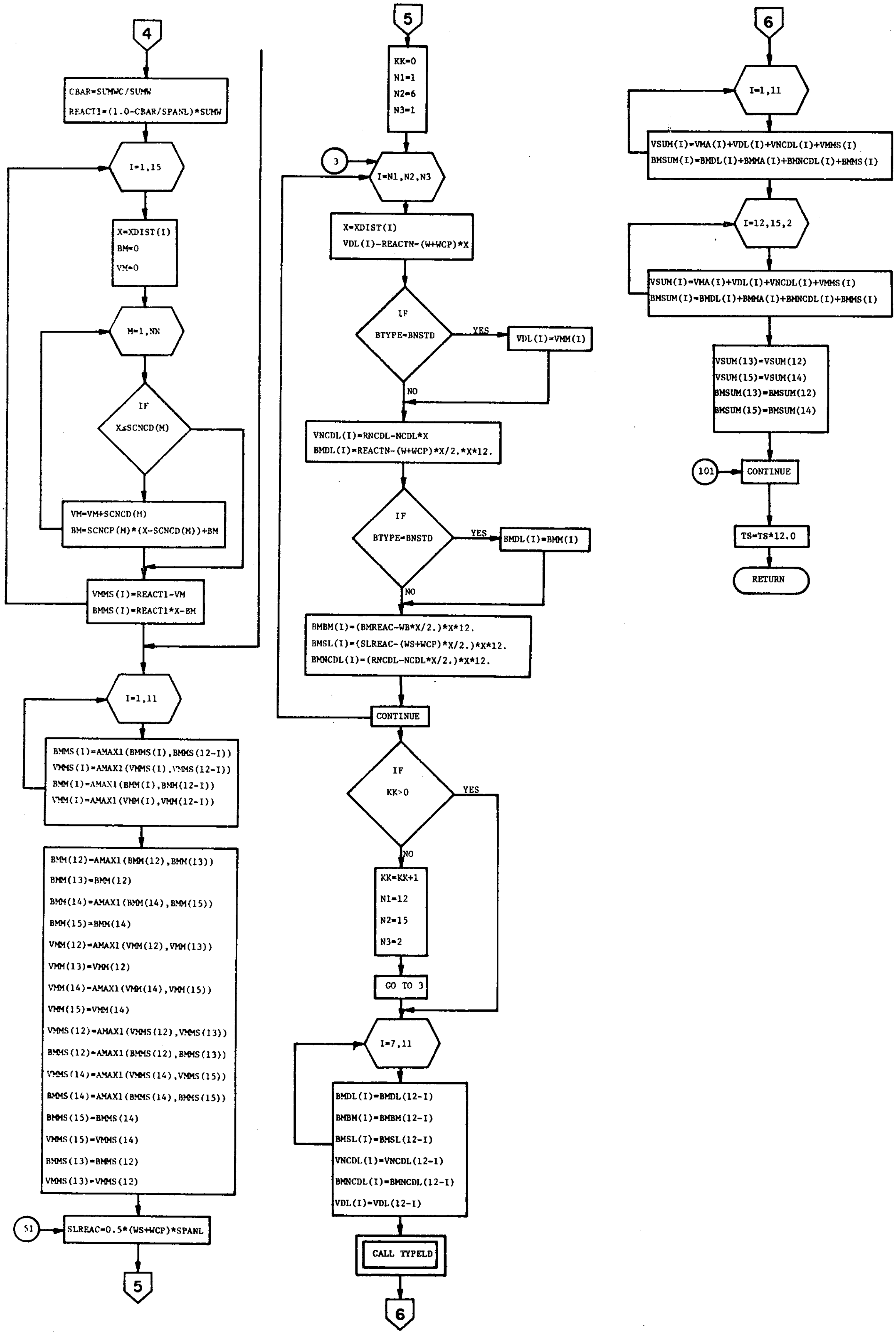
M = 12, 13 XDIST(M) = distance from the support to a quarter point (ft)

M = 14, 15 XDIST(M) = distance from the support to hold-down position (ft)


START
IF
SPANL=0.0
YES
101
NO
TSPAN=SPANL*0.1
I=1,11
XDIST(I)=(I-1)*TSPAN
XDIST(12)=SPANL*0.25
XDIST(13)=SPANL*0.75
XDIST(14)=SPANL/2.0-HDPT
XDIST(15)=SPANL/2.0+HDPT
DEFL14=0.0
DEFL12=0.0
WCP=0.0
TS=TS/12.0
ECI=EC*IB*10.**6
ECSI=EC*INA*10.0**6
WS=UWS*TS*BSPAC
WB=UWB*AREA/144.0
W=WS+WB
WNCDL=NCDL/12.0
BMREAC=0.5*WB*SPANL
RNCDL=0.5*NCDL*SPANL
SPANN=SPANL*12.0
WI=WS/12.0
DEFK2=5.0*WI*SPANN**4/(384.0*ECI)
DEFK1=57.0*WI*SPANN**4/(6144.0*ECI)
DNCDL1=57.0*WNCDL*SPANN**4/(6144.0*ECSI)
DNCDL2=5.0*WNCDL*SPANN**4/(384.0*ECSI)
IF
BTYPE=BNSTD
YES
NO
1
1
VOL(KASE)=VCAY(KASE)*(BSPAC-SUBTND(KASE))
CP=VOL(KASE)*UWB
REACTN=0.5*(KODE*CP+W*SPANL)
CONST1=CP*SPANN**3/(ECI*100.0)
WCP=(KODE*CP)/SPANL
DELF14=CONST(1,KODE)*CONST1
DEFL12=CONST(2,KODE)*CONST1
GO TO 51
I=1,10
IF
CNCP(I)=0
YES
NO
CNCP(I)=CNCP(I)*1000.
X12=SPANN*0.5
X14=SPANN*0.25
X122=X12*X12
X142=X14*X14
ECSI6=6.0*ECSI
ECI6=6.*ECI
X12L=X12*SPANN
X14L=X14*SPANN
N=1,10
NN=N
IF
CNCD(N) ≤ 0.0
YES
NO
CONTINUE
N2=NN/2
N22=N2*2
2


2
IF
N2≤0
YES
35
NO
N=1,N2
PDL=CNCP(N)
P12=PDL*X12
P14=PDL*X14
DX=CNCD(N)*12.
PDX=PDL*DX
DX2=DX*DX
IF
DX>X14
YES
NO
DEFL14=DEFL14+PDX*(3.0*(X14L-X142)-DX2)/ECI6
GO TO 34
DEFL14=DEFL14+P14*(3.0*
(SPANN*DX-DX2)-X142)/ECI6
34
DEFL12=DEFL12+P12*
(3.0*X12L-X122-DX2)/ECI6
35
IF
NN=N22
YES
NO
PNN1=CNCP(N2+1)
DEFL14=DEFL14+PNN1*X14*(3.0*SPANN
**2-4.*X142)/(48.*ECI)
DEFL12=DEFL12+PNN1*SPANN**3/
(48.*ECI)
SUMW=0.
I=1,NN
SUMW=SUMW+CNCP(I)
3


3
REACTN=(SUMW+W*SPANL)*0.5
I=1,15
X=XDIST(I)
VM=W*X
BM=0.5*W*X*X
L=1,NN
IF
CNCD(L)≥X
YES
NO
VM=VM+CNCP(L)
BM=BM+CNCP(L)*(X-CNCD(L))
BMM(I)=ABS(REACTN*X-BM)*12.
VMM(I)=ABS(REACTN-VM)
IF
SCNCP(1)=0
YES
NO
N=1,10
NN=N
IF
SCNCP(N)≤0.0
YES
NO
CONTINUE
SUMW=0
SUMWC=0
I=1,NN
SUMW=SUMW+SCNCP(I)
SUMWC=SUMWC+SCNCP(I)*SCNCD(I)
4


4
CBAR=SUMWC/SUMW
REACT1=(1.0-CBAR/SPANL)*SUMW
I=1,15
X=XDIST(I)
BM=0
VM=0
M=1,NN
IF
X≤SCNCD(M)
VM=VM+SCNCD(M)
BM=SCNCP(M)*(X-SCNCD(M))+BM
VMMS(I)=REACT1-VM
BMMS(I)=REACT1*X-BM
I=1,11
BMMS(I)=AMAX1(BMMS(I),BMMS(12-I))
VMMS(I)=AMAX1(VMMS(I),VMMS(12-I))
BMM(I)=AMAX1(BMM(I),BMM(12-I))
VMM(I)=AMAX1(VMM(I),VMM(12-I))
BMM(12)=AMAX1(BMM(12),BMM(13))
BMM(13)=BMM(12)
BMM(14)=AMAX1(BMM(14),BMM(15))
BMM(15)=BMM(14)
VMM(12)=AMAX1(VMM(12),VMM(13))
VMM(13)=VMM(12)
VMM(14)=AMAX1(VMM(14),VMM(15))
VMM(15)=VMM(14)
VMMS(12)=AMAX1(VMMS(12),VMMS(13))
BMMS(12)=AMAX1(BMMS(12),BMMS(13))
VMMS(14)=AMAX1(VMMS(14),VMMS(15))
BMMS(14)=AMAX1(BMMS(14),BMMS(15))
BMMS(15)=BMMS(14)
VMMS(15)=VMMS(14)
BMMS(13)=BMMS(12)
VMMS(13)=VMMS(12)
51
SLREAC=0.5*(WS+WCP)*SPANL
5
5
KK=0
N1=1
N2=6
N3=1
3
I=N1,N2,N3
X=XDIST(I)
VDL(I)-REACTN=(W+WCP)*X
IF
BTYPE=BNSTD
YES
VDL(I)=VMM(I)
NO
VNCDL(I)=RNCDL-NCDL*X
BMDL(I)=REACTN-(W+WCP)*X/2.*X*12.
IF
BTYPE=BNSTD
YES
BMDL(I)=BMM(I)
NO
BMBM(I)=(BMREAC-WB*X/2.)*X*12.
BMSL(I)=(SLREAC-(WS+WCP)*X/2.)*X*12.
BMNCDL(I)=(RNCDL-NCDL*X/2.)*X*12.
CONTINUE
IF
KK>0
YES
NO
KK=KK+1
N1=12
N2=15
N3=2
GO TO 3
I=7,11
BMDL(I)=BMDL(12-I)
BMBM(I)=BMBM(12-I)
BMSL(I)=BMSL(12-I)
VNCDL(I)=VNCDL(12-I)
BMNCDL(I)=BMNCDL(12-I)
VDL(I)=VDL(12-I)
CALL TYPELD
6
6
I=1,11
VSUM(I)=VMA(I)+VDL(I)+VNCDL(I)+VMMS(I)
BMSUM(I)=BMDL(I)+BMMA(I)+BMNCDL(I)+BMMS(I)
I=12,15,2
VSUM(I)=VMA(I)+VDL(I)+VNCDL(I)+VMMS(I)
BMSUM(I)=BMDL(I)+BMMA(I)+BMNCDL(I)+BMMS(I)
VSUM(13)=VSUM(12)
VSUM(15)=VSUM(14)
BMSUM(13)=BMSUM(12)
BMSUM(15)=BMSUM(14)
101
CONTINUE
TS=TS*12.0
RETURN

Subroutine: ZERO

Subroutine ZERO zeroes out arrays for static dead loads, static live loads, shears, and for moments. This operation is necessary when "Standard" and "nonstandard" beams are designed in one execution of the program.

A comparison of shears and moments is made in subroutine TYPELD to determine the maximum values. It is possible for the loading conditions of two different beams to be compared especially when a "standard" beam follows a "nonstandard" beam. This possibility is eliminated with the use of subroutine ZERO.

Definition of Terms:

BMDL(I) - stored value for bending moment at I^{th} inspection point due to composite dead loads (in.-lbs)

BMMA(I) - stored maximum value of bending moment at I^{th} inspection point due to live load (in.-lbs)

BMNCDL(I) - stored value for bending moment at I^{th} inspection point due to noncomposite dead load (in.-lbs)

BMSUM(I) - stored value for bending moment at I^{th} inspection point due to all loads (in.-lbs)

CCD(I) - distance between concentrated live load I and CCP(1) (ft)

CCP(I) - concentrated live load I (lbs)

CNCD(I) - distance(s) from left reaction to the location of the concentrated load(s) (ft)

CNCP(I) - concentrated static load(s) applied to the noncomposite section (kips)

SCNCD(I) - distance from left reaction to location of SCNCP(I) (ft)

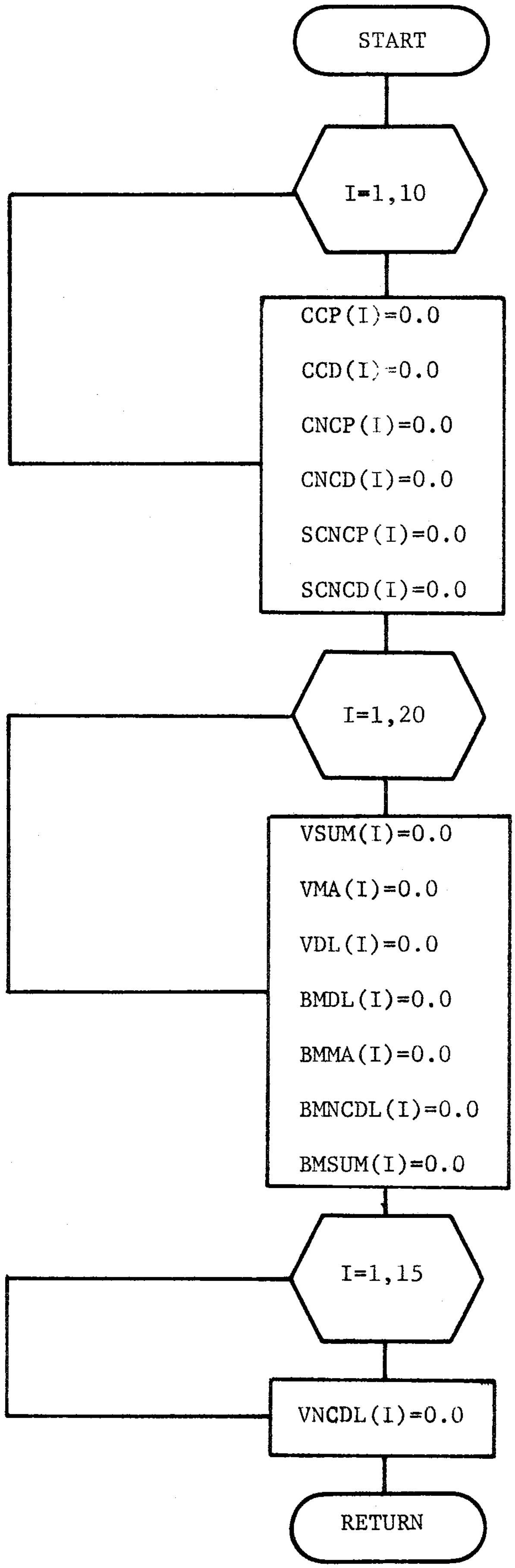
SCNCP(I) - concentrated static load(s) applied to the composite section (kips)

VDL(I) - stored value for shear at I^{th} inspection point due to composite dead loads (lbs)

VMA(I) - stored maximum value of shear at I^{th} inspection point due to live load (lbs)

VNCDL(I) - stored value for shear at I^{th} inspection point due to noncomposite dead loads (lbs)

VSUM(I) - stored value for shear at I^{th} inspection point due to all loads (lbs)


START
I=1,10
CCP(I)=0.0
CCD(I)=0.0
CNCP(I)=0.0
CNCD(I)=0.0
SCNCP(I)=0.0
SCNCD(I)=0.0
I=1,20
VSUM(I)=0.0
VMA(I)=0.0
VDL(I)=0.0
BMDL(I)=0.0
BMMA(I)=0.0
BMNCDL(I)=0.0
BMSUM(I)=0.0
I=1,15
VNCDL(I)=0.0
RETURN

Subroutine: MILLER

A summary of steps for subroutine MILLER is:

a. Determine the number of strands that can be placed in the bottom row. Checks are provided to maintain proper edge distances.

b. Place strands in the bottom row. If the number of strands is less than the maximum number of strands, control is transferred to the call MILLER position in PSTRES.

c. Check the next row to see if the same number of strands as the previous row can be placed. Place strands in the row until the row is filled unless the number of remaining strands is less than the number that can be placed in the row, then transfer control to the call MILLER position in PSTRES.

d. Repeat step c until all strands have been placed.

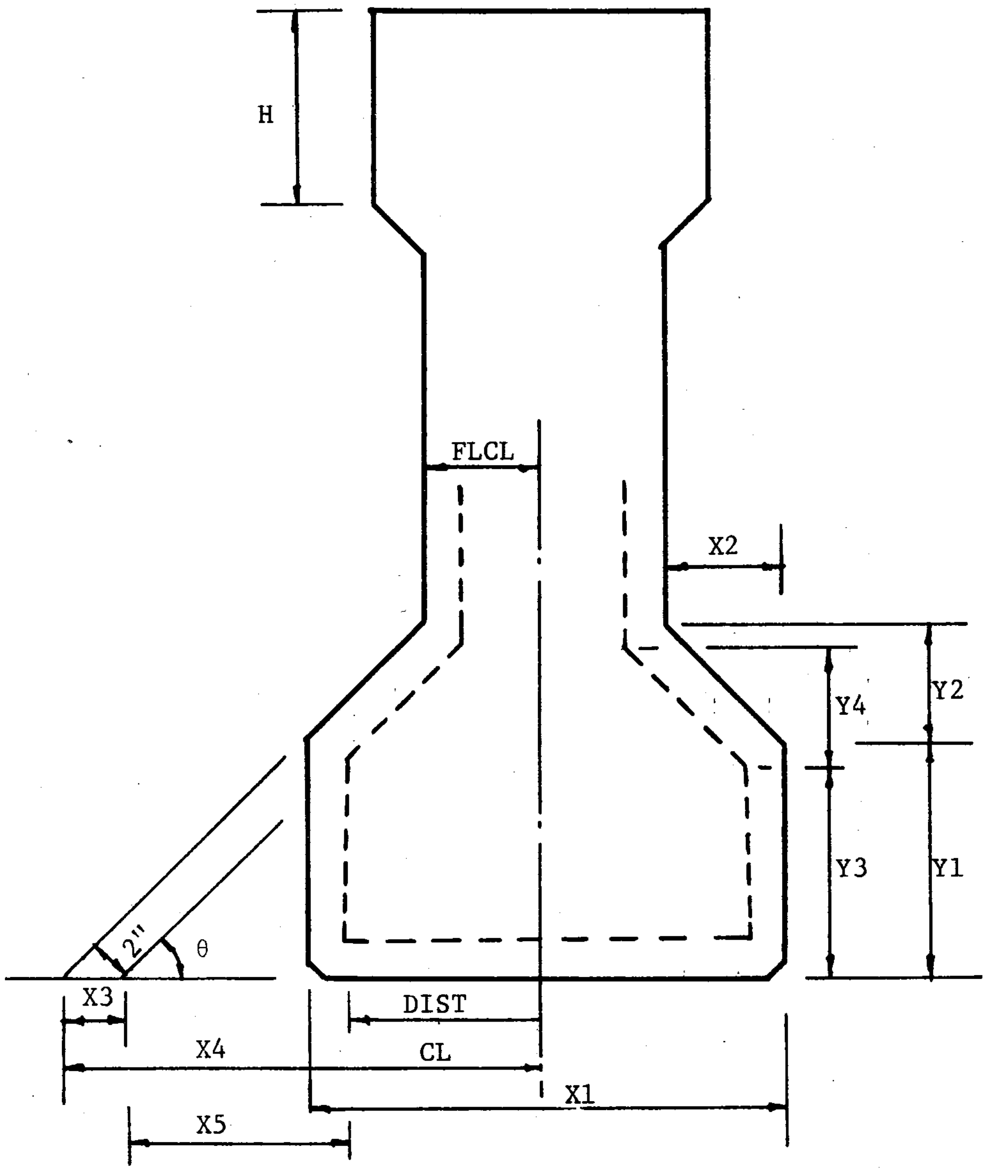
e. Determine the position of the cgs with reference to the bottom of the beam.

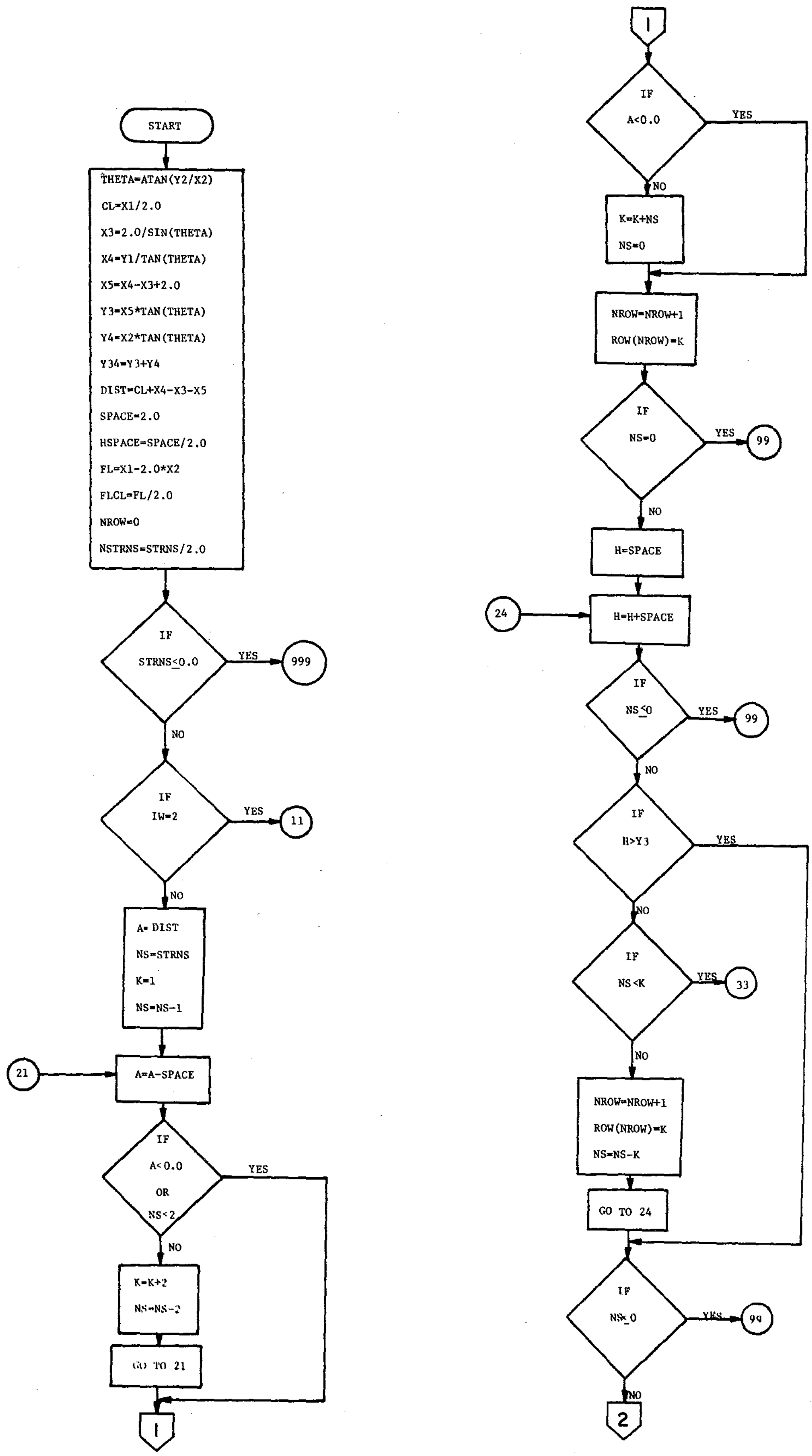
Definition of Terms:

A	- temporary dimension to locate a strand
CL	- 1/2 the width of the section. Note that this distance changes along the sloped portion of the section.
DIST	- CL minus the cover distance. Note that this distance changes along the sloped portion of the section.
ECAL	- distance between bottom of beam and cgs of strands
FLCL	- FL/2.0 or 1/2 thickness of web (in.)
H	- vertical distance between rows of strands (in.)

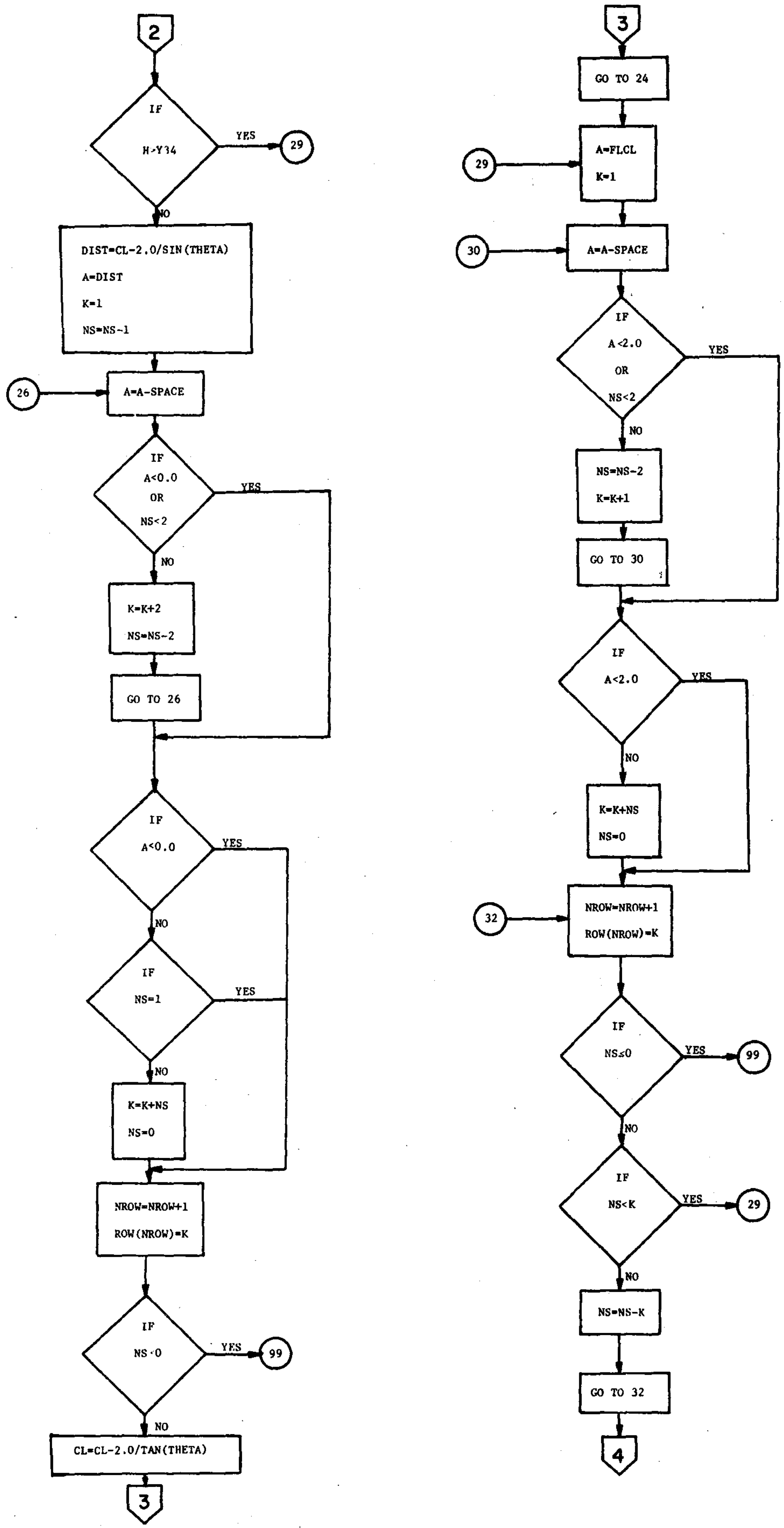
K	- counter -- number of strands placed
NROW	- counter -- identifies each row
NS	- counter -- remaining number of strands
NSTRNS	- 1/2 STRNS
ROW(NROW)	- number of strands placed in each row
SPACE	- horizontal distance between strands (in.)
STRNS	- number of strands to be placed
SUMMST	- area moment of strands used to find the cgs
SUMSTR	- temporary sum of strands
UPRLMT	- distance from the bottom of the beam to the point of maximum allowable end eccentricity (in.)

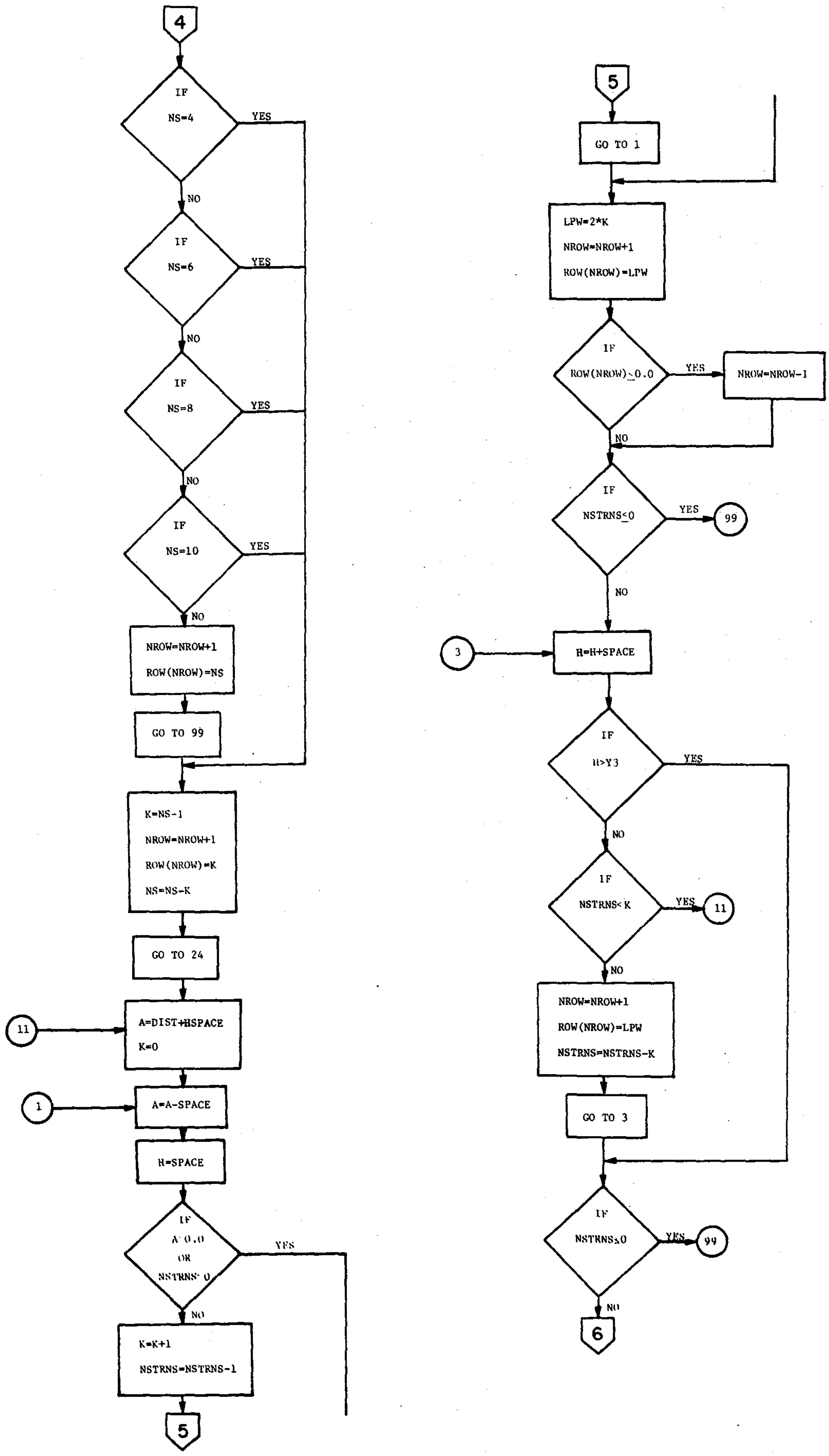
X1, X2, X3, X4,
X5, Y1, Y2, Y3, Y4 - see sketch

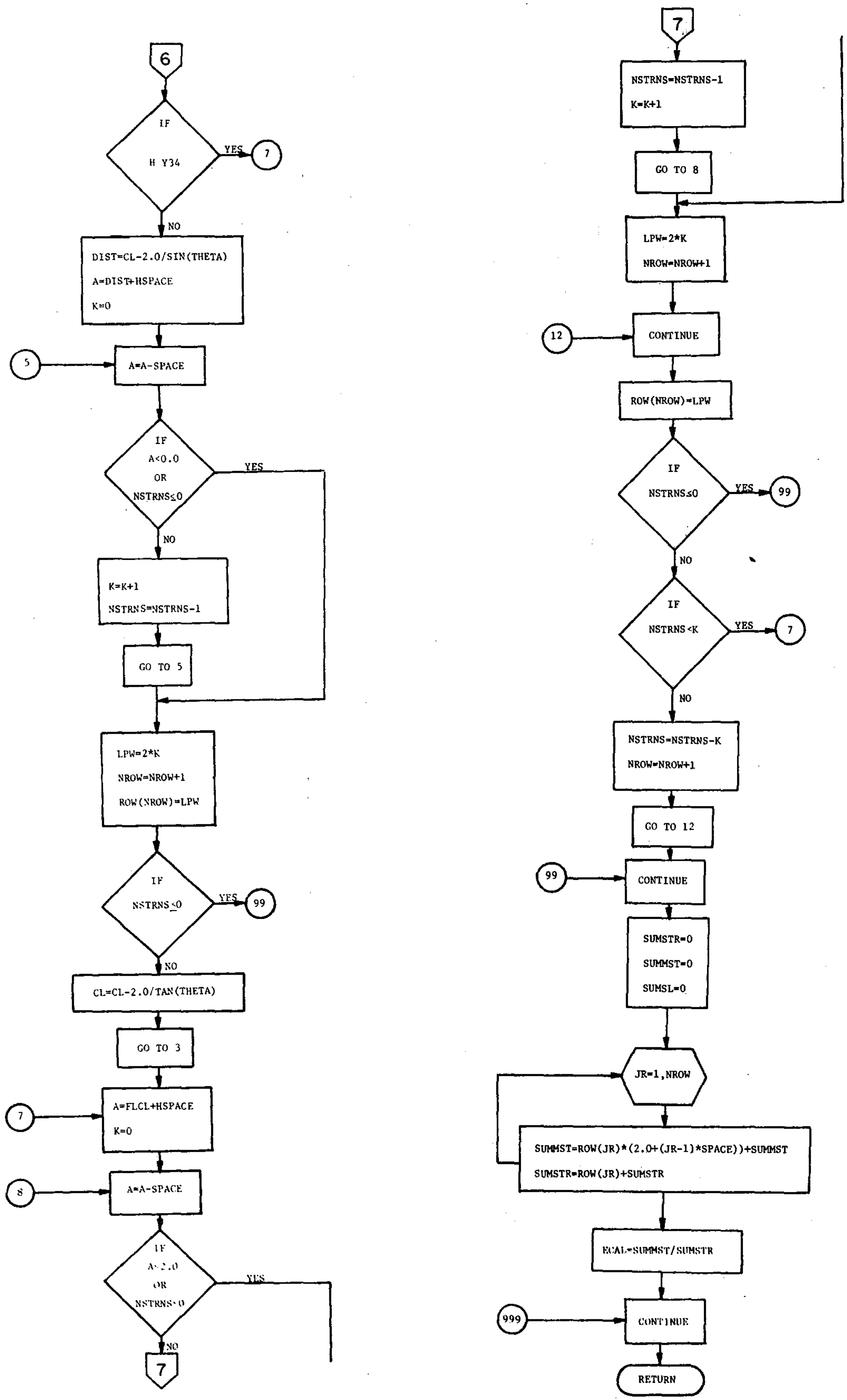

H
FLCL
X2
Y4
Y2
Y3
Y1
2"
θ
X3
DIST
X4
CL
X1
X5



START
THETA=ATAN(Y2/X2)
CL=X1/2.0
X3=2.0/SIN(THETA)
X4=Y1/TAN(THETA)
X5=X4-X3+2.0
Y3=X5*TAN(THETA)
Y4=X2*TAN(THETA)
Y34=Y3+Y4
DIST=CL+X4-X3-X5
SPACE=2.0
HSPACE=SPACE/2.0
FL=X1-2.0*X2
FLCL=FL/2.0
NROW=0
NSTRNS=STRNS/2.0
IF STRNS≤0.0
YES
999
NO
IF IW=2
YES
11
NO
A= DIST
NS=STRNS
K=1
NS=NS-1
21
A=A-SPACE
IF A<0.0 OR NS<2
YES
NO
K=K+2
NS=NS-2
GO TO 21
1
1
IF A<0.0
YES
NO
K=K+NS
NS=0
NROW=NROW+1
ROW(NROW)=K
IF NS=0
YES
99
NO
H=SPACE
24
H=H+SPACE
IF NS≤0
YES
99
NO
IF H>Y3
YES
NO
IF NS<K
YES
33
NO
NROW=NROW+1
ROW(NROW)=K
NS=NS-K
GO TO 24
IF NS≤0
YES
99
NO
2

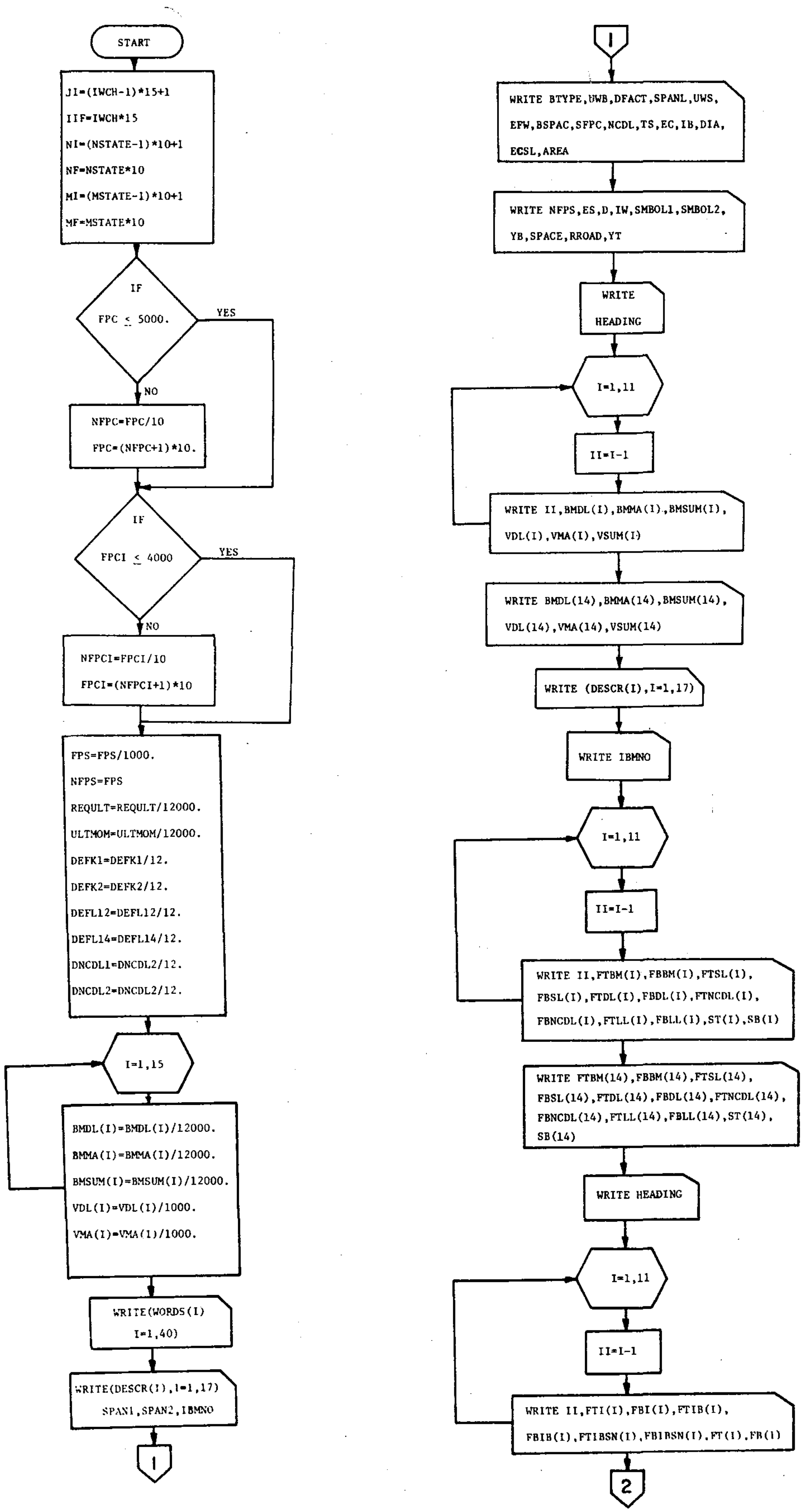

2
IF
H>Y34
YES
29
NO
DIST=CL-2.0/SIN(THETA)
A=DIST
K=1
NS=NS-1
26
A=A-SPACE
IF
A<0.0
OR
NS<2
YES
NO
K=K+2
NS=NS-2
GO TO 26
IF
A<0.0
YES
NO
IF
NS=1
YES
NO
K=K+NS
NS=0
NROW=NROW+1
ROW(NROW)=K
IF
NS≤0
YES
99
NO
CL=CL-2.0/TAN(THETA)
3
3
GO TO 24
29
A=FLCL
K=1
30
A=A-SPACE
IF
A<2.0
OR
NS<2
YES
NO
NS=NS-2
K=K+1
GO TO 30
IF
A<2.0
YES
NO
K=K+NS
NS=0
32
NROW=NROW+1
ROW(NROW)=K
IF
NS≤0
YES
99
NO
IF
NS<K
YES
29
NO
NS=NS-K
GO TO 32
4

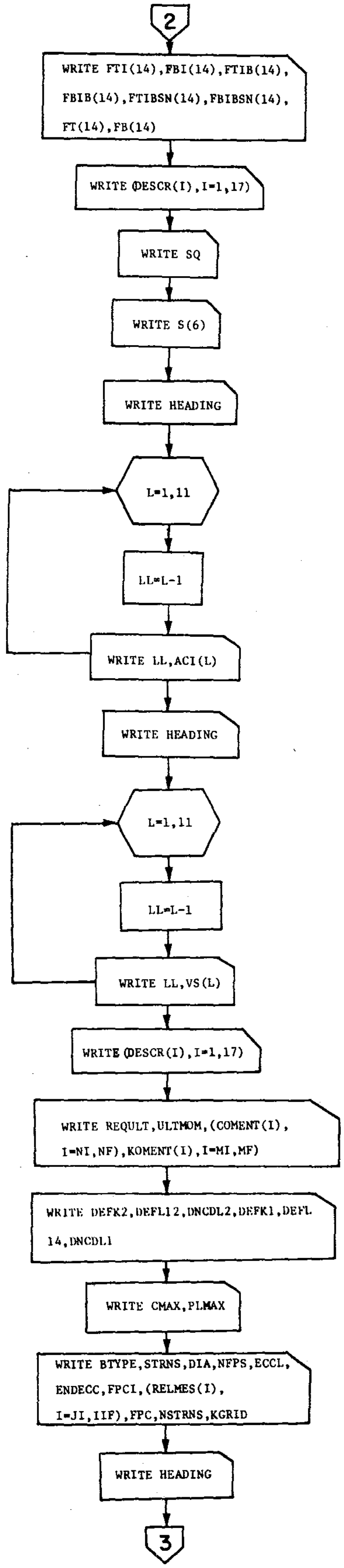

4
IF NS=4
YES
NO
IF NS=6
YES
NO
IF NS=8
YES
NO
IF NS=10
YES
NO
NROW=NROW+1
ROW(NROW)=NS
GO TO 99
K=NS-1
NROW=NROW+1
ROW(NROW)=K
NS=NS-K
GO TO 24
11
A=DIST+HSPACE
K=0
1
A=A-SPACE
H=SPACE
IF
A 0.0
OR
NSTRNS 0
YES
NO
K=K+1
NSTRNS=NSTRNS-1
5
5
GO TO 1
LPW=2*K
NROW=NROW+1
ROW(NROW)=LPW
IF ROW(NROW)≤0.0
YES
NROW=NROW-1
NO
IF NSTRNS≤0
YES
99
NO
3
H=H+SPACE
IF H>Y3
YES
NO
IF NSTRNS< K
YES
11
NO
NROW=NROW+1
ROW(NROW)=LPW
NSTRNS=NSTRNS-K
GO TO 3
IF NSTRNS≤0
YES
99
NO
6

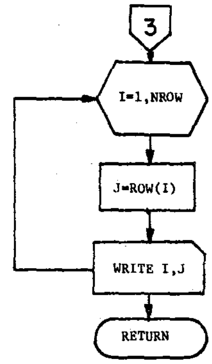

6
IF
H Y34
YES
7
NO
DIST=CL-2.0/SIN(THETA)
A=DIST+HSPACE
K=0
5
A=A-SPACE
IF
A<0.0
OR
NSTRNS≤0
YES
NO
K=K+1
NSTRNS=NSTRNS-1
GO TO 5
LPW=2*K
NROW=NROW+1
ROW(NROW)=LPW
IF
NSTRNS≤0
YES
99
NO
CL=CL-2.0/TAN(THETA)
GO TO 3
7
A=FLCL+HSPACE
K=0
8
A=A-SPACE
IF
OR
YES
NO
7
7
NSTRNS=NSTRNS-1
K=K+1
GO TO 8
LPW=2*K
NROW=NROW+1
12
CONTINUE
ROW(NROW)=LPW
IF
NSTRNS≤0
YES
99
NO
IF
NSTRNS<K
YES
7
NO
NSTRNS=NSTRNS-K
NROW=NROW+1
GO TO 12
99
CONTINUE
SUMSTR=0
SUMMST=0
SUMSL=0
JR=1,NROW
SUMMST=ROW(JR)*(2.0+(JR-1)*SPACE))+SUMMST
SUMSTR=ROW(JR)+SUMSTR
ECAL=SUMMST/SUMSTR
999
CONTINUE
RETURN

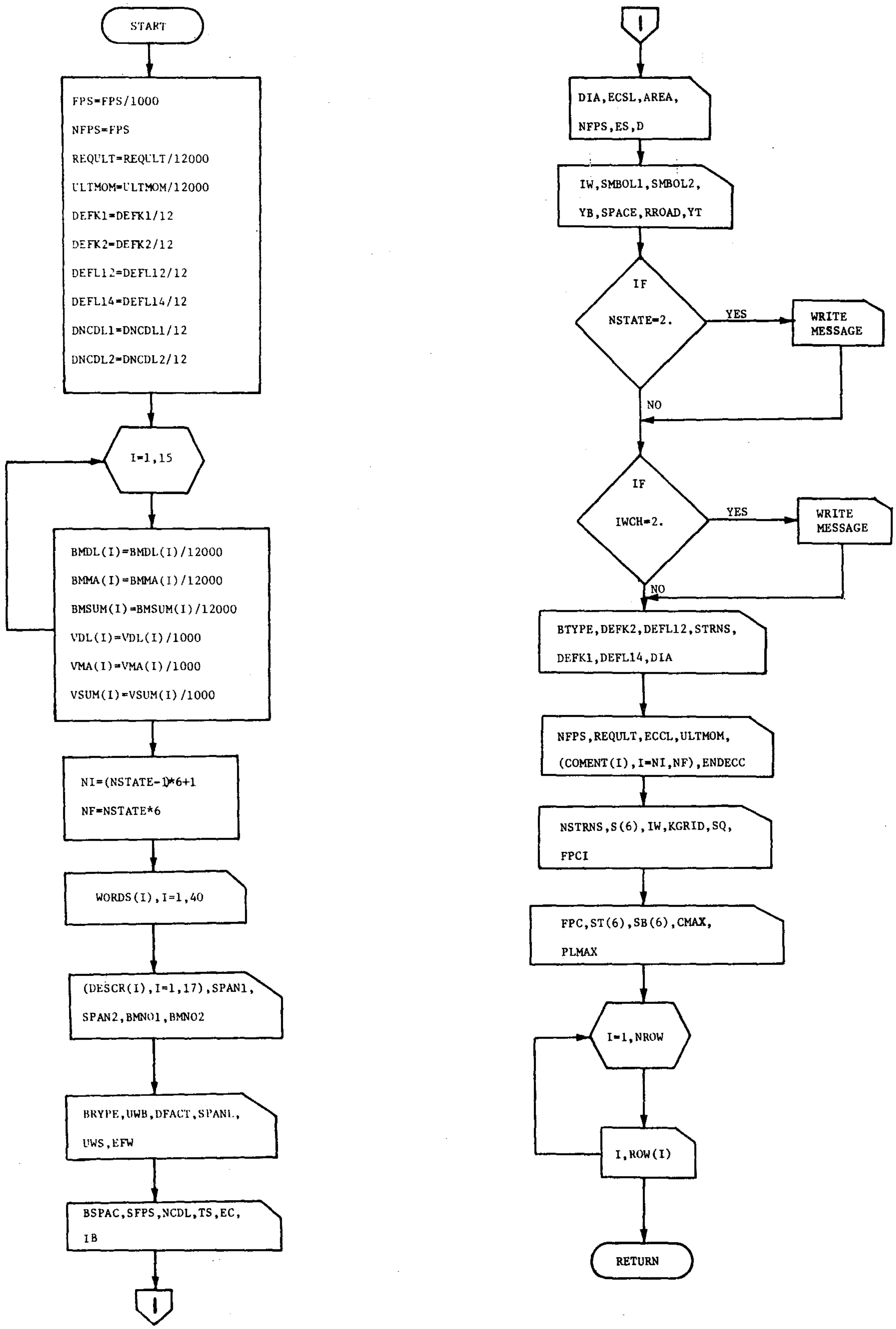
Subroutines: LOPUT and SHPUT

Function: Print design information by the extended multipage form, LOPUT, or by the brief one-page form, SHPUT


START
JI=(IWCH-1)*15+1
IIF=IWCH*15
NI=(NSTATE-1)*10+1
NF=NSTATE*10
MI=(MSTATE-1)*10+1
MF=MSTATE*10
IF
FPC ≤ 5000.
YES
NO
NFPC=FPC/10
FPC=(NFPC+1)*10.
IF
FPCI ≤ 4000
YES
NO
NFPCI=FPCI/10
FPCI=(NFPCI+1)*10
FPS=FPS/1000.
NFPS=FPS
REQULT=REQULT/12000.
ULTMOM=ULTMOM/12000.
DEFK1=DEFK1/12.
DEFK2=DEFK2/12.
DEFL12=DEFL12/12.
DEFL14=DEFL14/12.
DNCDL1=DNCDL2/12.
DNCDL2=DNCDL2/12.
I=1,15
BMDL(I)=BMDL(I)/12000.
BMMA(I)=BMMA(I)/12000.
BMSUM(I)=BMSUM(I)/12000.
VDL(I)=VDL(I)/1000.
VMA(I)=VMA(I)/1000.
WRITE(WORDS(I)
I=1,40)
WRITE(DESCR(I),I=1,17)
SPAN1,SPAN2,IBMNO
1
1
WRITE BTYPE,UWB,DFACT,SPANL,UWS,
EFW,BSPAC,SFPC,NCDL,TS,EC,IB,DIA,
ECSL,AREA
WRITE NFPS,ES,D,IW,SMBOL1,SMBOL2,
YB,SPACE,RROAD,YT
WRITE
HEADING
I=1,11
II=I-1
WRITE II,BMDL(I),BMMA(I),BMSUM(I),
VDL(I),VMA(I),VSUM(I)
WRITE BMDL(14),BMMA(14),BMSUM(14),
VDL(14),VMA(14),VSUM(14)
WRITE (DESCR(I),I=1,17)
WRITE IBMNO
I=1,11
II=I-1
WRITE II,FTBM(I),FBBM(I),FTSL(I),
FBSL(I),FTDL(I),FBDL(I),FTNCDL(I),
FBNCDL(I),FTLL(I),FBLL(I),ST(I),SB(I)
WRITE FTBM(14),FBBM(14),FTSL(14),
FBSL(14),FTDL(14),FBDL(14),FTNCDL(14),
FBNCDL(14),FTLL(14),FBLL(14),ST(14),
SB(14)
WRITE HEADING
I=1,11
II=I-1
WRITE II,FTI(I),FBI(I),FTIB(I),
FBIB(I),FTIBSN(I),FBIBSN(I),FT(I),FB(I)
2


2
WRITE FTI(14),FBI(14),FTIB(14),
FBIB(14),FTIBSN(14),FBIBSN(14),
FT(14),FB(14)
WRITE (DESCR(I),I=1,17)
WRITE SQ
WRITE S(6)
WRITE HEADING
L=1,11
LL=L-1
WRITE LL,ACI(L)
WRITE HEADING
L=1,11
LL=L-1
WRITE LL,VS(L)
WRITE (DESCR(I),I=1,17)
WRITE REQULT,ULTMOM,(COMENT(I),
I=NI,NF),KOMENT(I),I=MI,MF)
WRITE DEFK2,DEFL12,DNCDL2,DEFK1,DEFL
14,DNCDL1
WRITE CMAX,PLMAX
WRITE BTYPE,STRNS,DIA,NFPS,ECCL,
ENDECC,FPCI,(RELMES(I),
I=JI,IIF),FPC,NSTRNS,KGRID
WRITE HEADING
3


3
I=1,NROW
J=ROW(I)
WRITE I,J
RETURN


START
FPS=FPS/1000
NFPS=FPS
REQULT=REQULT/12000
ULTMOM=ULTMOM/12000
DEFK1=DEFK1/12
DEFK2=DEFK2/12
DEFL12=DEFL12/12
DEFL14=DEFL14/12
DNCDL1=DNCDL1/12
DNCDL2=DNCDL2/12
I=1,15
BMDL(I)=BMDL(I)/12000
BMMA(I)=BMMA(I)/12000
BMSUM(I)=BMSUM(I)/12000
VDL(I)=VDL(I)/1000
VMA(I)=VMA(I)/1000
VSUM(I)=VSUM(I)/1000
NI=(NSTATE-1)*6+1
NF=NSTATE*6
WORDS(I),I=1,40
(DESCR(I),I=1,17),SPAN1,
SPAN2,BMNO1,BMNO2
BRYPE,UWB,DFACT,SPANL,
UWS,EFW
BSPAC,SFPS,NCDL,TS,EC,
IB
1
1
DIA,ECSL,AREA,
NFPS,ES,D
IW,SMBOL1,SMBOL2,
YB,SPACE,RROAD,YT
IF
NSTATE=2.
YES
WRITE MESSAGE
NO
IF
IWCH=2.
YES
WRITE MESSAGE
NO
BTYPE,DEFK2,DEFL12,STRNS,
DEFK1,DEFL14,DIA
NFPS,REQULT,ECCL,ULTMOM,
(COMENT(I),I=NI,NF),ENDECC
NSTRNS,S(6),IW,KGRID,SQ,
FPCI
FPC,ST(6),SB(6),CMAX,
PLMAX
I=1,NROW
I,ROW(I)
RETURN

Subroutine: PROPTY

A summary of steps for subroutine PROPTY is:

a. Define beam section properties

b. Determine the effective flange width

c. Compute composite section properties

d. Determine the hold-down position

Definition of Terms:

AR - array of beam cross-sectional areas (in.^{2})

AREAC - total area of the composite section (in.^{2})

ASL - effective area of slab for computing composite section properties (in.^{2})

BB(I) - width of the bottom flange (in.)

BEAM(I) - list of stored letters and numbers corresponding to 11 stored beam sections

BPRIME - web thickness (in.)

CC(I) - depth of the bottom flange (in.)

D1(I) - depth of the beam (in.)

EE(I) - vertical depth of the sloped portion of the bottom flange (in.)

H - depth of the top flange (in.)

HH(I) - depth of the top flange (in.)

HDPT - distance from the center line of the beam to the hold-down point (ft)

IB1(I) - beam moment of inertia (in.^{4})

IBSL - moment of inertia of ASL about a horizontal axis at mid-depth of the slab (in.^{4})

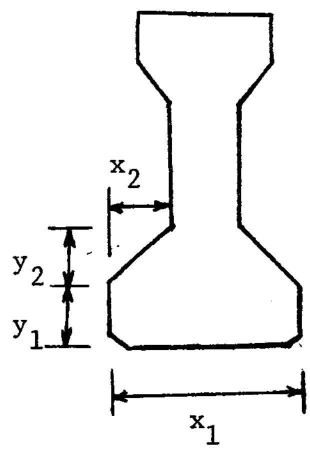
INA - composite moment of inertia (in.^{4})

KASE - number between 1 and 11 in the stored list of stored beams that indicates the type of beam selected

WTF - width of the top flange (in.)

WTF1(I) - width of the top flange (in.)

X1, X2, Y1, Y2 - terms to describe beam section for purposes of placing prestressing strands in the section (in.) (see sketch)



YB1(I) - distance from cgc to the bottom of the beam (in.)

YBC - distance from the composite cgc to the bottom of the beam (in.)

YT1(I) - distance from the cgc to the top of the beam (in.)

YTC - distance from the composite cgc to the top of the beam (in.)

YTCSL - distance from the composite cgc to the top of the slab (in.)

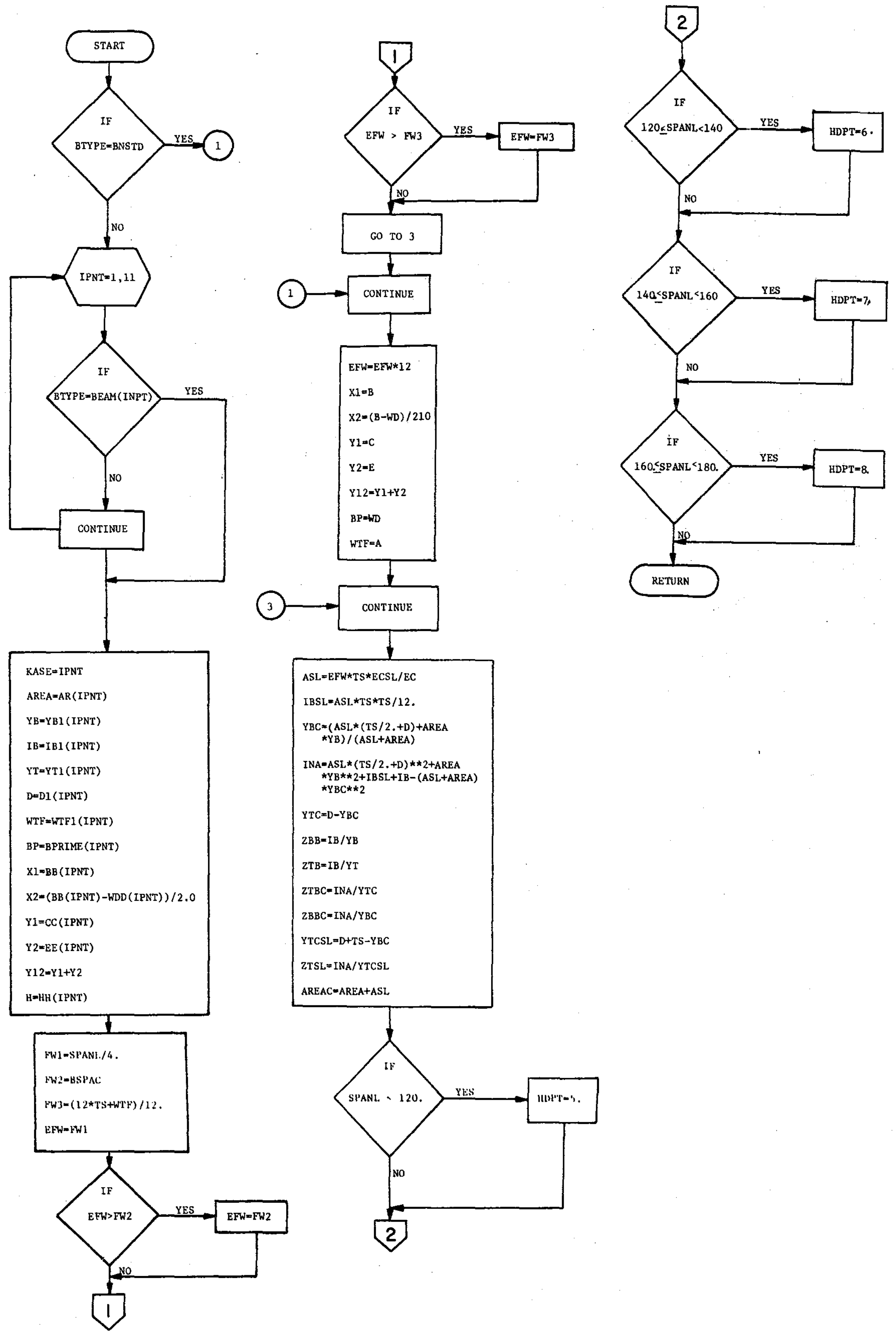
ZBB - section modulus for bottom of beam ($in.^3$)

ZBBC - composite section modulus for bottom of beam ($in.^3$)

ZTB - section modulus for top of beam ($in.^3$)

ZTBC - composite section modulus for top of beam ($in.^3$)

ZTSL - composite section modulus for top of slab ($in.^3$)


START
IF BTYPE=BNSTD
YES
1
NO
IPNT=1,11
IF BTYPE=BEAM(INPT)
YES
NO
CONTINUE
KASE=IPNT
AREA=AR(IPNT)
YB=YB1(IPNT)
IB=IB1(IPNT)
YT=YT1(IPNT)
D=D1(IPNT)
WTF=WTF1(IPNT)
BP=BPRIME(IPNT)
X1=BB(IPNT)
X2=(BB(IPNT)-WDD(IPNT))/2.0
Y1=CC(IPNT)
Y2=EE(IPNT)
Y12=Y1+Y2
H=HH(IPNT)
FW1=SPANL/4.
FW2=BSPAC
FW3=(12*TS+WTF)/12.
EFW=FW1
IF EFW>FW2
YES
EFW=FW2
NO
1
1
IF EFW > FW3
YES
EFW=FW3
NO
GO TO 3
1
CONTINUE
EFW=EFW*12
X1=B
X2=(B-WD)/210
Y1=C
Y2=E
Y12=Y1+Y2
BP=WD
WTF=A
3
CONTINUE
ASL=EFW*TS*ECSL/EC
IBSL=ASL*TS*TS/12.
YBC=(ASL*(TS/2.+D)+AREA *YB)/(ASL+AREA)
INA=ASL*(TS/2.+D)**2+AREA *YB**2+IBSL+IB-(ASL+AREA) *YBC**2
YTC=D-YBC
ZBB=IB/YB
ZTB=IB/YT
ZTBC=INA/YTC
ZBBC=INA/YBC
YTCSL=D+TS-YBC
ZTSL=INA/YTCSL
AREAC=AREA+ASL
IF SPANL < 120.
YES
HDPT=5.
NO
2
2
IF 120≤SPANL<140
YES
HDPT=6.
NO
IF 140≤SPANL<160
YES
HDPT=7.
NO
IF 160≤SPANL<180.
YES
HDPT=8.
NO
RETURN

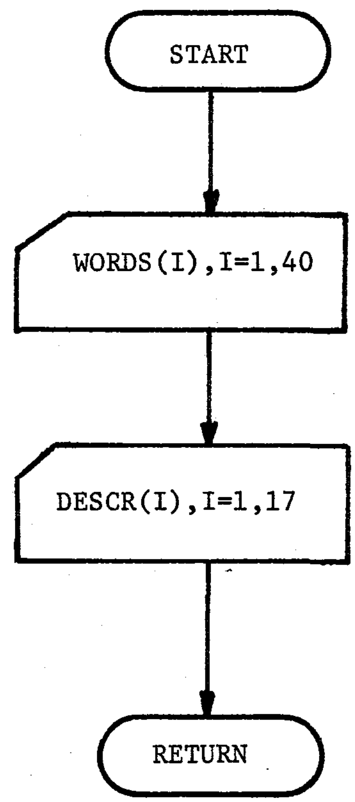
Subroutine: INPUT1

Subroutine INPUT1 reads in descriptive data for the problem set:

Definition of Terms:

DESCR(I) - array that contains descriptive data on the third header card for the problem set

WORDS(I) - array that contains the descriptive data on the first two header cards for the problem set


START
WORDS(I),I=1,40
DESCR(I),I=1,17
RETURN

Subroutine: INDATA

Subroutine INDATA defines terms that complete the data set used with the input form for "standard" beams.

Definition of Terms:

ASTRN - area of prestressing strand (in.^{2})

DFACT - live load distribution factor

DIA - diameter of the prestressing strand (in.)

DIAB - diameter of a 1/2 in. prestressing strand (in.)

EC, ECSL, ES - elastic modulii for beam concrete, slab concrete, and prestressing steel, respectively (10^6 psi)

FPS - ultimate stress for prestressing strand (psi)

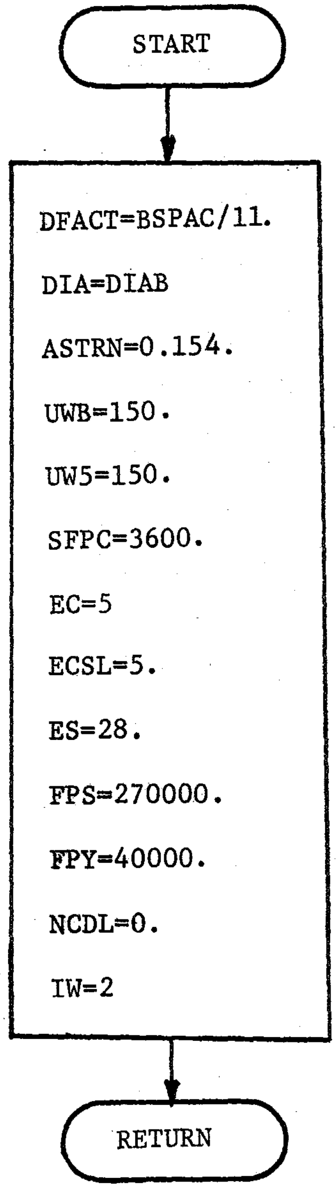
FPY - yield point stress for nonprestressed reinforcement (psi)

IW - number of parallel strands in the web

NCDL - uniform load on the composite section (kips/ft)

SFPC - compressive strength of slab concrete (psi)

UWB, UWS - unit weights of beam and slab, respectively (pcf)


START
DFACT=BSPAC/11.
DIA=DIAB
ASTRN=0.154.
UWB=150.
UW5=150.
SFPC=3600.
EC=5
ECSL=5.
ES=28.
FPS=270000.
FPY=40000.
NCDL=0.
IW=2
RETURN

Subroutine: ALLOW

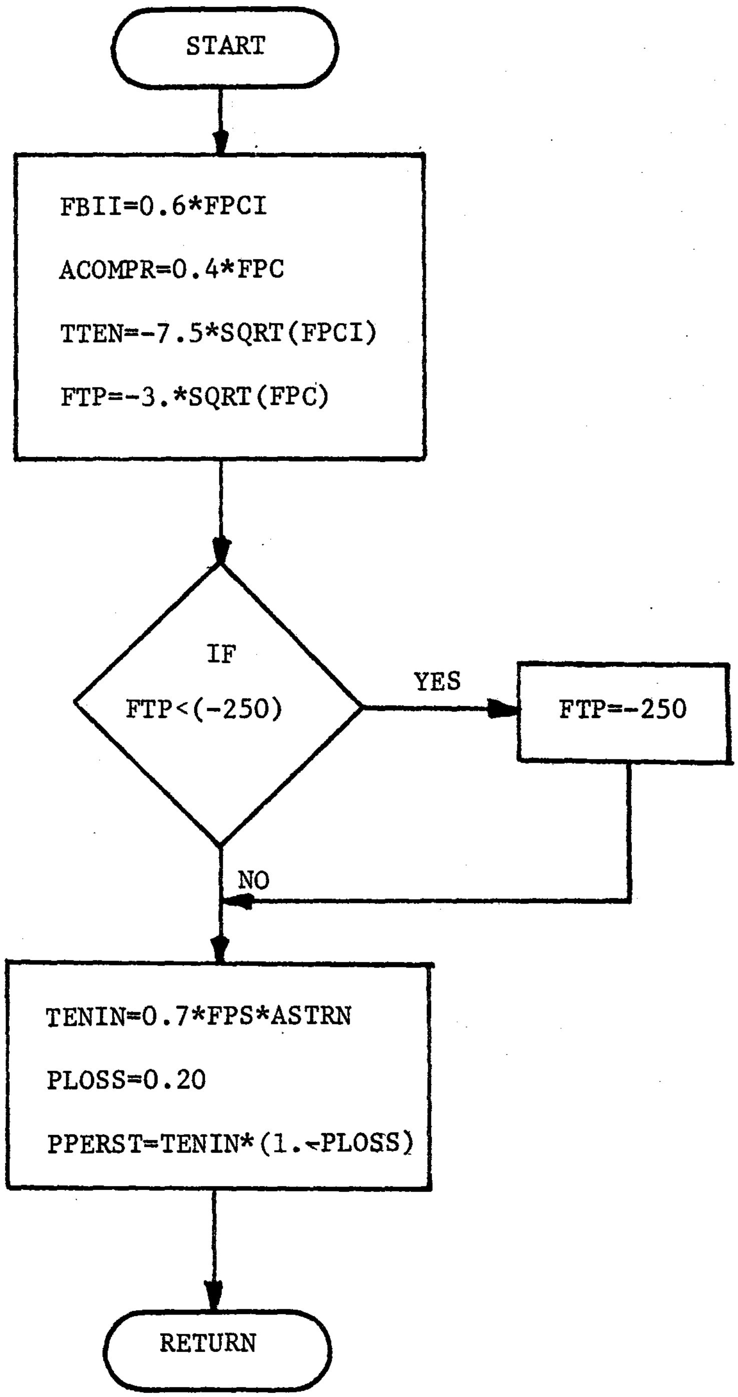
A summary of steps for subroutine ALLOW is:

a. Define allowable stresses.

b. Calculate prestressing force before and after losses.

Definition of Terms:

ACOMPR	- allowable compressive stress at design load after losses (psi)
FBII	- temporary allowable stress before losses due to creep and shrinkage (psi)
FTB	- allowable tensile stress at working loads (psi)
PLOSS	- 20% loss of prestress
PPERST	- force per strand after losses (lbs)
TENIN	- initial force per strand (lbs)
TTEN	- maximum allowable initial tensile stress (with auxiliary reinforcement) (psi)


START
FBII=0.6*FPCI
ACOMPR=0.4*FPC
TTEN=-7.5*SQRT(FPCI)
FTP=-3.*SQRT(FPC)
IF
FTP<(-250)
YES
FTP=-250
NO
TENIN=0.7*FPS*ASTRN
PLOSS=0.20
PPERST=TENIN*(1.-PLOSS)
RETURN

Subroutine: ECCEND

A summary of steps for subroutine ECCEND is:

a. Determine the number of strands to remain straight and the number of strands to be draped per row.

b. Sum the product of the number of straight strands times the distance to the bottom of the beam for each row.

c. Sum the product of the number of draped strands times the distance to the bottom of the beam for each row.

d. Determine the cgs of the strands with respect to the bottom of the beam.

e. Determine the minimum distance allowed from the bottom of the beam to the cgs.

f. Compare steps d and e. If the value from step d is less than the value from step 3, increment the value from step d by two.

g. Determine the position of the topmost draped strands. If that position is below two inches from the top surface, repeat steps d, e, f, and g until the value from step d is just greater than the value from step e. If the position of the topmost draped strands is two inches below the top surface, set IWCH equal to two and calculate the end eccentricity.

h. Calculate the end eccentricity.

Definition of Terms:

CGT - distance from the bottom of the beam to the cgs of the strand pattern (in.)

CGTLMT - minimum allowable distance from the bottom of the beam to the cgs of the strand pattern (in.)

DROW(I) - number of draped strands from the I^{th} row

ENDECC - eccentricity of the strand pattern at the end of the beam measured from the cgc of the beam (in.)

IWCH - term that indicates whether or not the maximum drape position has been reached

KGRID - position of the topmost draped strands

KS - counter

NSTRNS - total number of draped strands

SROW(I) - number of strands in the I^{th} row after removal of the draped strands

SUMD1 - sum of the strands that remain straight

SUMD2 - sum of the draped strands

SUMDW1 - sum of SUMD1 times the distance from the bottom of the beam

SUMDW2 - sum of SUMD2 times the distance from the bottom of the beam

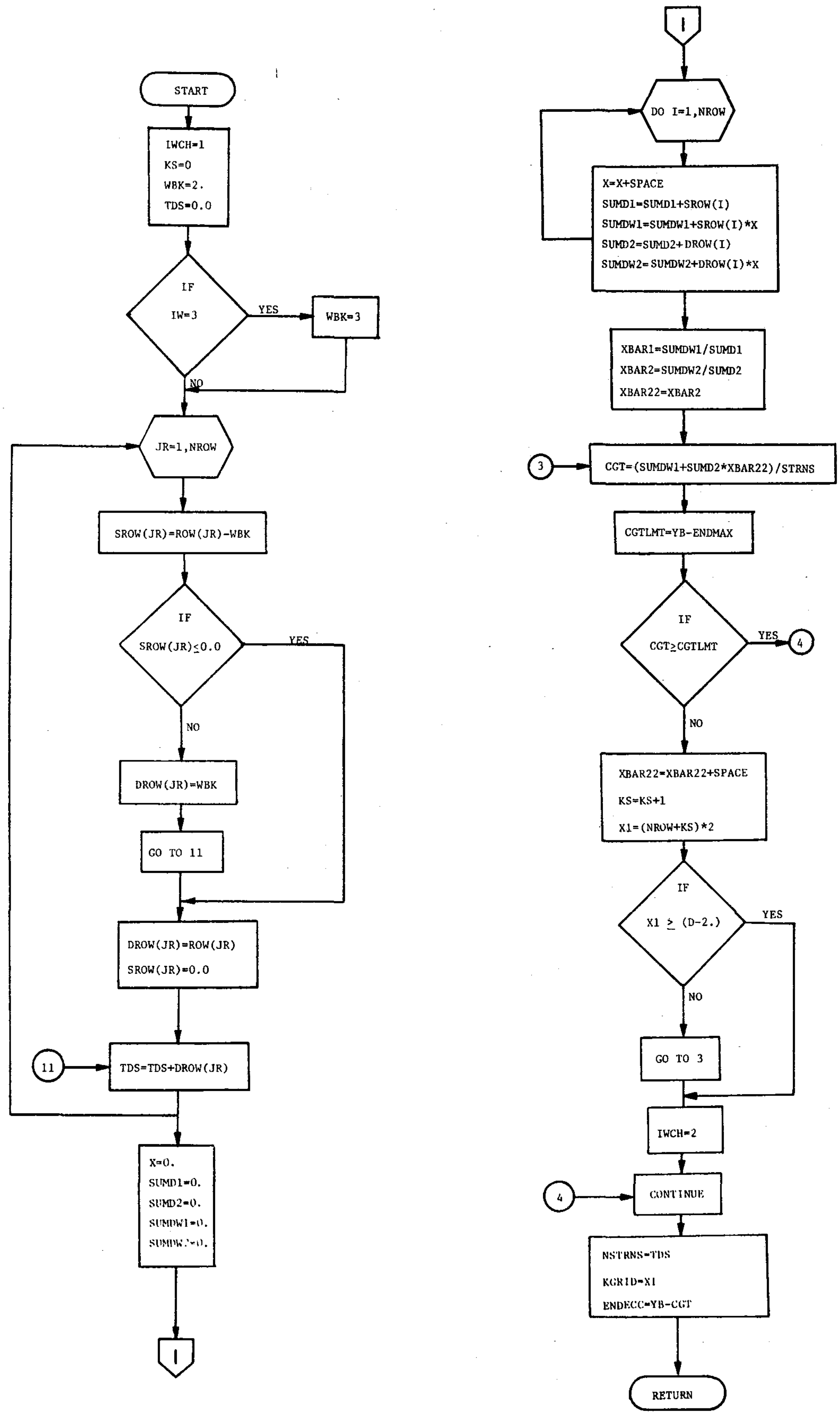
TDS - sum of the draped strands

X - distance from the bottom of the beam to the I^{th} row of strands (in.)

X1 - position of the topmost draped strands with reference to the bottom of the beam (in.)

XBAR1 - distance from the bottom of the beam to the cgs of the straight strands (in.)

XBAR2 - distance from the bottom of the beam to the cgs of the draped strands


START
IWCH=1
KS=0
WBK=2.
TDS=0.0
IF
IW=3
YES
WBK=3
NO
JR=1,NROW
SROW(JR)=ROW(JR)-WBK
IF
SROW(JR)≤0.0
YES
NO
DROW(JR)=WBK
GO TO 11
DROW(JR)=ROW(JR)
SROW(JR)=0.0
11
TDS=TDS+DROW(JR)
X=0.
SUMD1=0.
SUMD2=0.
SUMDW1=0.
SUMDW2=0.
1
1
DO I=1,NROW
X=X+SPACE
SUMD1=SUMD1+SROW(I)
SUMDW1=SUMDW1+SROW(I)*X
SUMD2=SUMD2+DROW(I)
SUMDW2=SUMDW2+DROW(I)*X
XBAR1=SUMDW1/SUMD1
XBAR2=SUMDW2/SUMD2
XBAR22=XBAR2
3
CGT=(SUMDW1+SUMD2*XBAR22)/STRNS
CGTLMT=YB-ENDMAX
IF
CGT≥CGTLMT
YES
4
NO
XBAR22=XBAR22+SPACE
KS=KS+1
X1=(NROW+KS)*2
IF
X1 ≥ (D-2.)
YES
NO
GO TO 3
IWCH=2
4
CONTINUE
NSTRNS=TDS
KGRID=X1
ENDECC=YB-CGT
RETURN

Subroutine: MOMENT

A summary of steps for subroutine MOMENT is:

a. Calculate the required ultimate moment capacity.

b. Determine whether the section is rectangular or flanged.

c. Calculate the resisting moment capacity for the section using the appropriate equation.

d. Determine the actual steel percentage and compare that percentage with the maximum allowable percentage. If the allowable is exceeded, calculate the resisting moment capacity using the appropriate equation for flanged or rectangular section. A check for minimum steel percentage is made in subroutine PSTRES in determining the number of strands for the initial trial.

The term NSTATE is defined as a number between 1 and 4 and is used as an indicator for printing messages along with the required and resisting moment capacities.

Definition of Terms:

ASF - steel area required to develop the ultimate strength of the overhanging portions of the flange (in.^{2})

ASR - steel area required to develop the ultimate compressive strength of the web of a flange section (in.^{2})

ASTEEL - total area of prestressing strands (in.^{2})

CHECK - check for a rectangular to determine if the percentage of steel is such that $P \frac{fsu}{f'c} < .30$

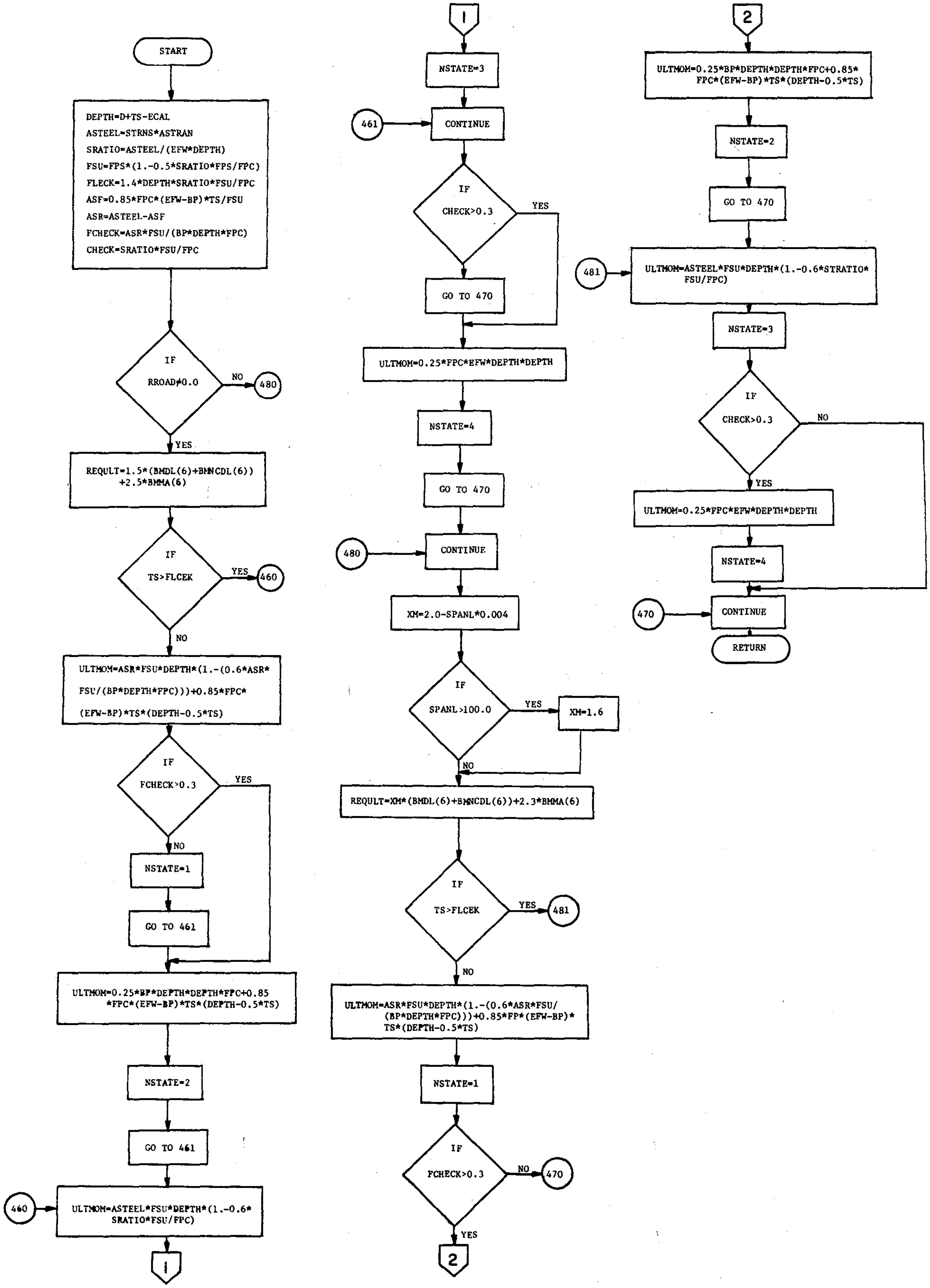
DEPTH - distance from top of slab to cgs at midspan (in.)

FCHECK - check for a flanged section to determine if the percentage of steel is such that $A_{sr} \frac{fsu}{b'df'c} < 0.3$

FLCEK - check on flange thickness

FSU - average stress in prestressing steel at ultimate load (psi)

NSTATE	- indicator that determines which one of four messages will be printed along with the ultimate moments
REQULT	- required ultimate moment (in.-lbs)
SRATIO	- steel ratio
ULTMOM	- ultimate moment provided by the section (in.-lbs)
XM	- load factor for railroad loading


START
DEPTH=D+TS-ECAL
ASTEEL=STRNS*ASTRAN
SRATIO=ASTEEL/(EFW*DEPTH)
FSU=FPS*(1.-0.5*SRATIO*FPS/FPC)
FLECK=1.4*DEPTH*SRATIO*FSU/FPC
ASF=0.85*FPC*(EFW-BP)*TS/FSU
ASR=ASTEEL-ASF
FCHECK=ASR*FSU/(BP*DEPTH*FPC)
CHECK=SRATIO*FSU/FPC
IF RROAD≠0.0
NO
480
YES
REQULT=1.5*(BMDL(6)+BMNCDL(6)) +2.5*BMMA(6)
IF TS>FLCEK
YES
460
NO
ULTMOM=ASR*FSU*DEPTH*(1.-(0.6*ASR* FSU/(BP*DEPTH*FPC)))+0.85*FPC* (EFW-BP)*TS*(DEPTH-0.5*TS)
IF FCHECK>0.3
YES
NO
NSTATE=1
GO TO 461
ULTMOM=0.25*BP*DEPTH*DEPTH*FPC+0.85 *FPC*(EFW-BP)*TS*(DEPTH-0.5*TS)
NSTATE=2
GO TO 461
460
ULTMOM=ASTEEL*FSU*DEPTH*(1.-0.6* SRATIO*FSU/FPC)
1
1
NSTATE=3
461
CONTINUE
IF CHECK>0.3
YES
GO TO 470
ULTMOM=0.25*FPC*EFW*DEPTH*DEPTH
NSTATE=4
GO TO 470
480
CONTINUE
XM=2.0-SPANL*0.004
IF SPANL>100.0
YES
XM=1.6
NO
REQULT=XM*(BMDL(6)+BMNCDL(6))+2.3*BMMA(6)
IF TS>FLCEK
YES
481
NO
ULTMOM=ASR*FSU*DEPTH*(1.-(0.6*ASR*FSU/ (BP*DEPTH*FPC)))+0.85*FP*(EFW-BP)* TS*(DEPTH-0.5*TS)
NSTATE=1
IF FCHECK>0.3
NO
470
YES
2
2
ULTMOM=0.25*BP*DEPTH*DEPTH*FPC+0.85* FPC*(EFW-BP)*TS*(DEPTH-0.5*TS)
NSTATE=2
GO TO 470
481
ULTMOM=ASTEEL*FSU*DEPTH*(1.-0.6*STRATIO* FSU/FPC)
NSTATE=3
IF CHECK>0.3
NO
YES
ULTMOM=0.25*FPC*EFW*DEPTH*DEPTH
NSTATE=4
470
CONTINUE
RETURN

Subroutines CONLD, JMLOAD, RRLOAD, and SPCL are similar in that the loads are numbered from left to right while the load configuration is moved from right to left. A summary of steps for the above subroutines is:

a. Place first load in the configuration at an inspection point, inspection points being tenth, quarter, and hold-down positions.

b. Check the number of the last load to come onto the beam. Determine the centroid of the load and the left end reaction.

c. Calculate moment and shear at the inspection point.

d. Place next load at the inspection point. Check the position of the first load to see if it remains on the beam.

e. Repeat steps b, c, and d until all loads have been positioned at the inspection point.

f. Repeat the above steps for each inspection point.

g. Determine maximum shears and moments by selecting larger values of the first ninth, second and eighth, third and seventh, fourth and sixth, ... points.

Subroutine CONLD calculates shears and moments at tenth points due to concentrated live loads, CCP(I).

Subroutine JMLOAD calculates shears and moments at tenth points due to HS-20 live loading.

Subroutine RRLOAD calculates shears and moments at tenth points due to Cooper's E-loading.

Subroutine SPCL calculates shears and moments at tenth points due to H-20 or H-15 live loading.

Subroutine: CONLD

Definition of Terms:

BMM(I) - temporary maximum value of bending moment at I^{th} inspection point due to live load (in.-lbs)

BMMA(I) - stored maximum value of bending moment at I^{th} inspection point due to live load (in.-lbs)

BMW(M) - bending moment at a given inspection point as wheel M approaches it (in.-lbs)

CCD(I) - distance between concentrated live load I and CCP(1) (ft)

CCP(I) - concentrated live load I (lbs)

LW - last wheel in live load configuration

SUBM - temporary summation of moments (in.-lbs)

SUBW - temporary summation of weights (lbs)

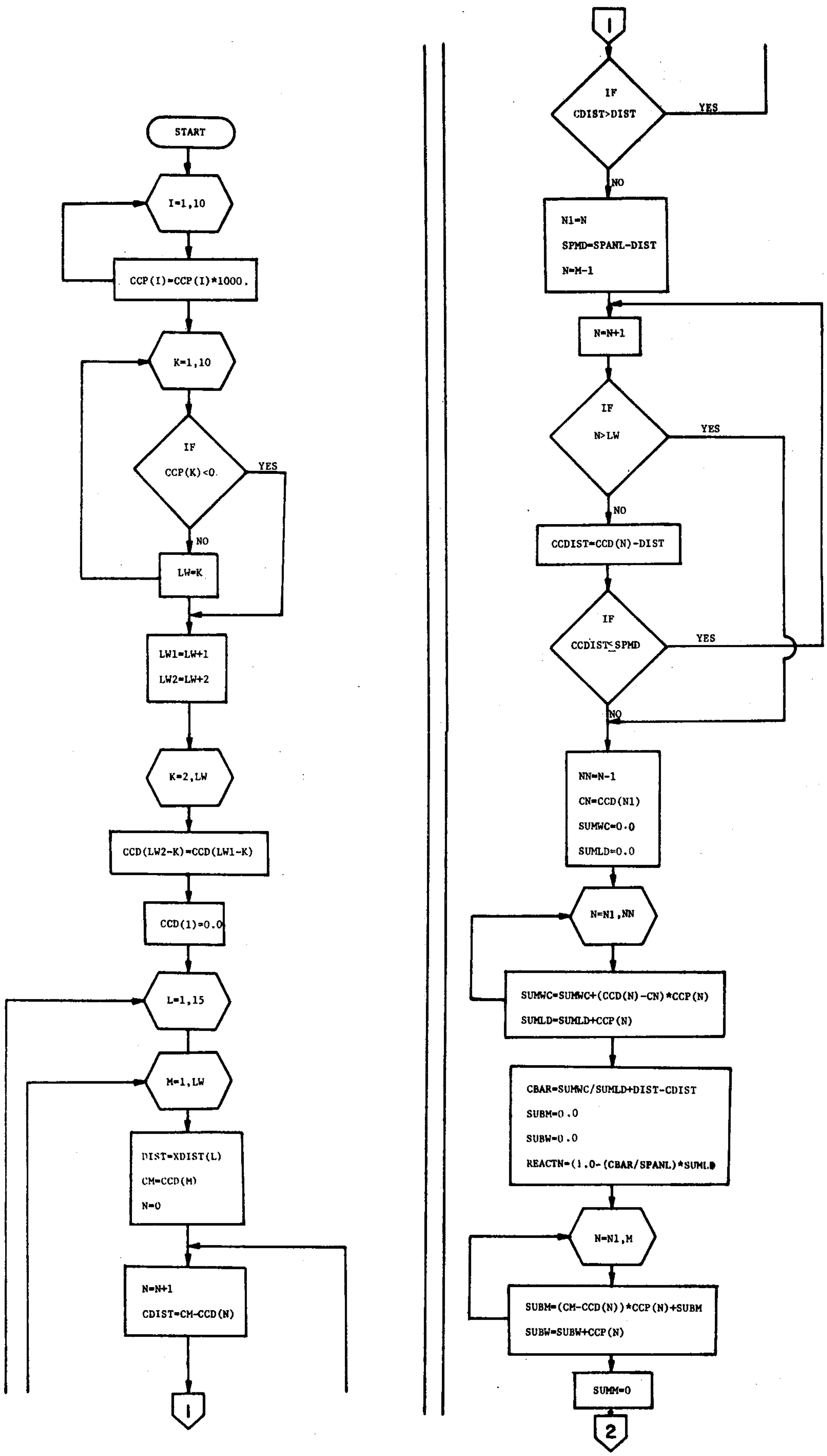
V1 - temporary value of shear (lbs)

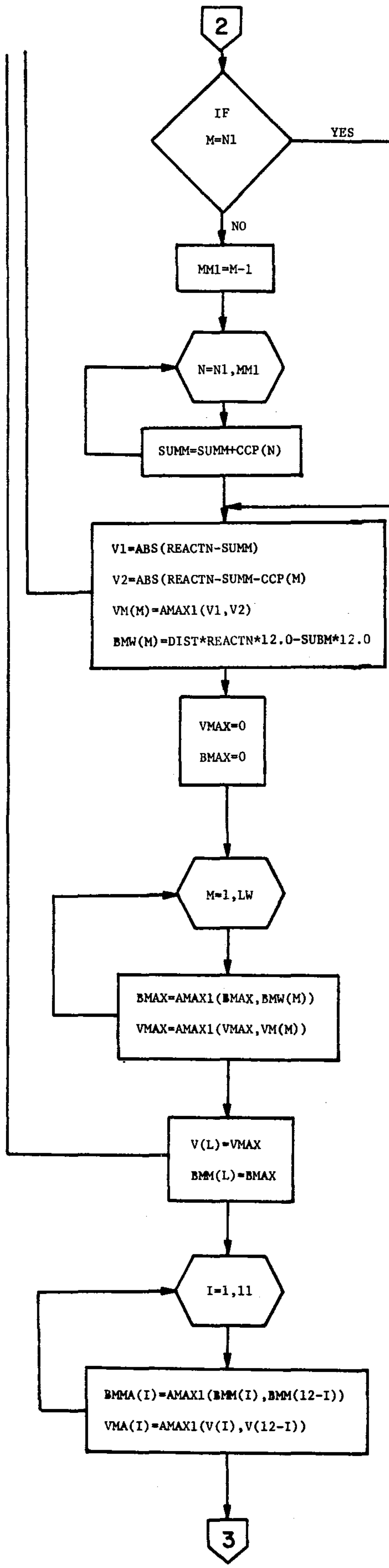
V2 - temporary value of shear (lbs)

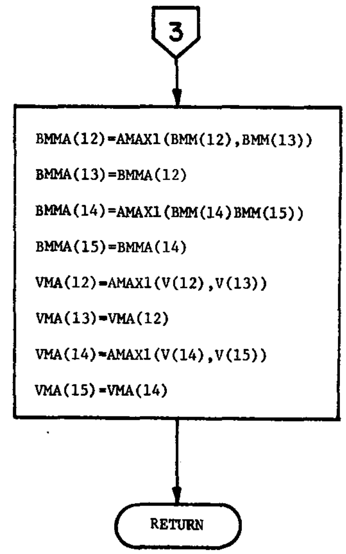
V(I) - temporary maximum value of shear at I^{th} inspection point due to live load (lbs)

VMA(I) - stored maximum value of shear at I^{th} inspection point due to live load (lbs)

VM(M) - shear at a given inspection point as wheel M approaches it (lbs)


START
I=1,10
CCP(I)=CCP(I)*1000.
K=1,10
IF
CCP(K)<0.
YES
NO
LW=K
LW1=LW+1
LW2=LW+2
K=2,LW
CCD(LW2-K)=CCD(LW1-K)
CCD(1)=0.0
L=1,15
M=1,LW
DIST=XDIST(L)
CM=CCD(M)
N=0
N=N+1
CDIST=CM-CCD(N)
1
1
IF
CDIST>DIST
YES
NO
N1=N
SPMD=SPANL-DIST
N=M-1
N=N+1
IF
N>LW
YES
NO
CCDIST=CCD(N)-DIST
IF
CCDIST≤SPMD
YES
NO
NN=N-1
CN=CCD(N1)
SUMWC=0.0
SUMLD=0.0
N=N1,NN
SUMWC=SUMWC+(CCD(N)-CN)*CCP(N)
SUMLD=SUMLD+CCP(N)
CBAR=SUMWC/SUMLD+DIST-CDIST
SUBM=0.0
SUBW=0.0
REACTN=(1.0-(CBAR/SPANL)*SUMLD
N=N1,M
SUBM=(CM-CCD(N))*CCP(N)+SUBM
SUBW=SUBW+CCP(N)
SUMM=0
2


2
IF
M=N1
YES
NO
MM1=M-1
N=N1,MM1
SUMM=SUMM+CCP(N)
V1=ABS(REACTN-SUMM)
V2=ABS(REACTN-SUMM-CCP(M)
VM(M)=AMAX1(V1,V2)
BMW(M)=DIST*REACTN*12.0-SUBM*12.0
VMAX=0
BMAX=0
M=1,LW
BMAX=AMAX1(BMAX,BMW(M))
VMAX=AMAX1(VMAX,VM(M))
V(L)=VMAX
BMM(L)=BMAX
I=1,11
BMMA(I)=AMAX1(BMM(I),BMM(12-I))
VMA(I)=AMAX1(V(I),V(12-I))
3


3
BMMA(12)=AMAX1(BMM(12),BMM(13))
BMMA(13)=BMMA(12)
BMMA(14)=AMAX1(BMM(14)BMM(15))
BMMA(15)=BMMA(14)
VMA(12)=AMAX1(V(12),V(13))
VMA(13)=VMA(12)
VMA(14)=AMAX1(V(14),V(15))
VMA(15)=VMA(14)
RETURN

Subroutine: JMLOAD

Definition of Terms:

BM - temporary summation for bending moment (in.-lbs)

BMHS(I) - stored maximum value for bending moment due to HS-20 loading at I^{th} inspection point (in.-lbs)

BMW - temporary value for bending moment (in.-lbs)

CBAR - distance between left reaction and center of gravity of loads applied to beam (ft)

C(I) - distance between I^{th} axle and first axle

CL - SPAN/2.0

DFSTW - temporary distance between left reaction and first axle load on span for a given position of configuration (ft)

DLSTW - temporary distance between left reaction and last axle load on span for a given position of configuration (ft)

KACE - a constant which denotes the arrangement of an HS-20 loading configuration on the span

KACE describes the loading situation used to obtain either a maximum shear or a maximum bending moment at an inspection point.

KACE - 1 truck direction right to left
place middle wheel at inspection point

KACE - 2 truck direction right to left
first wheel is off beam, second wheel is at inspection point

KACE - 3 truck direction left to right
first two wheels are on span and second wheel is at inspection point

KACE - 4 span is too short for more than one axle (heavy) which is at inspection point

KACE - 5 truck direction right to left
third wheel is at inspection point

KACE - 6 truck direction right to left
first wheel is off span, third wheel is at inspection point

PT - distance on beam used to check for maximum bending moment (ft)

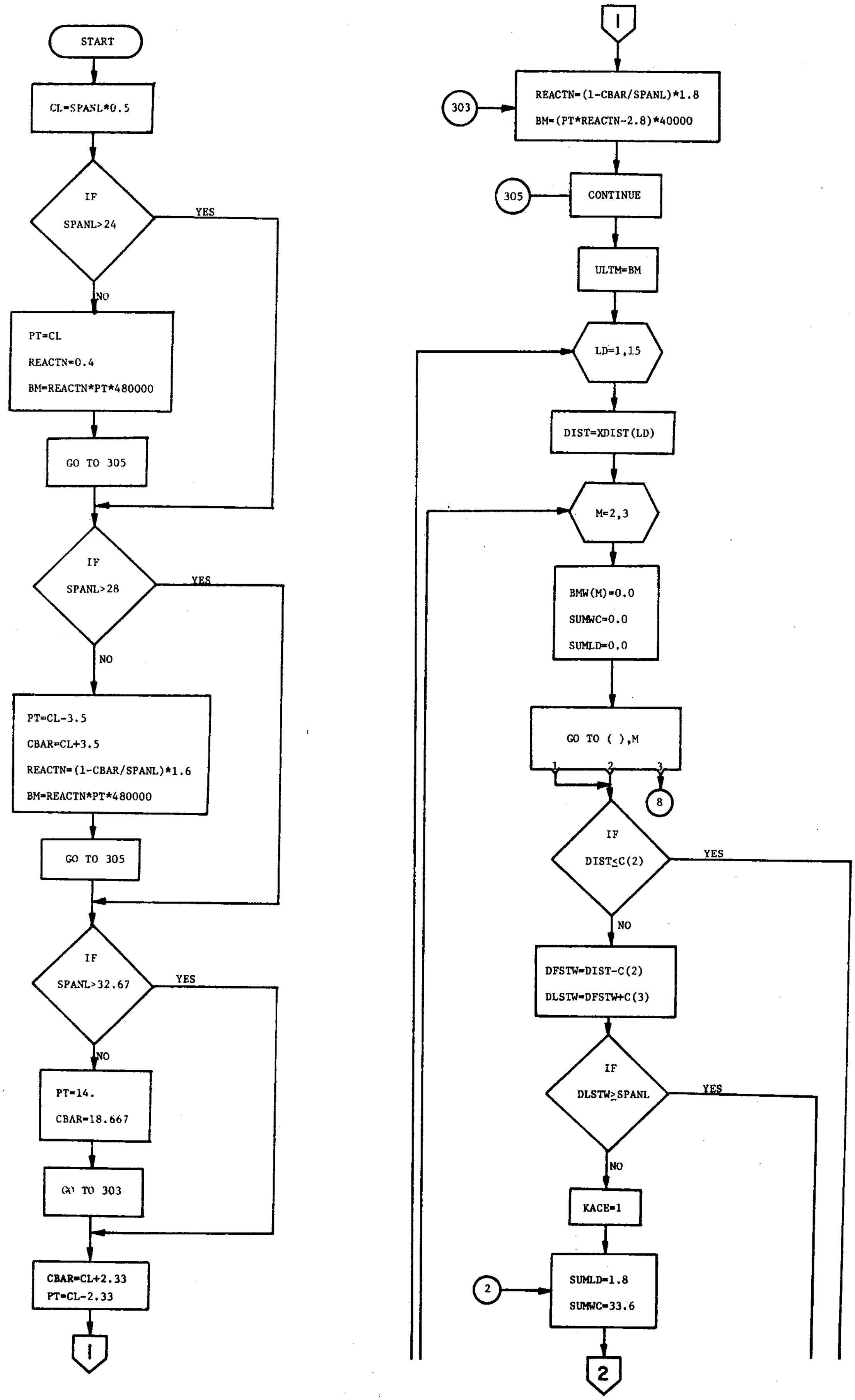
REACTN - reaction at left end of beam due to HS-20 live loads

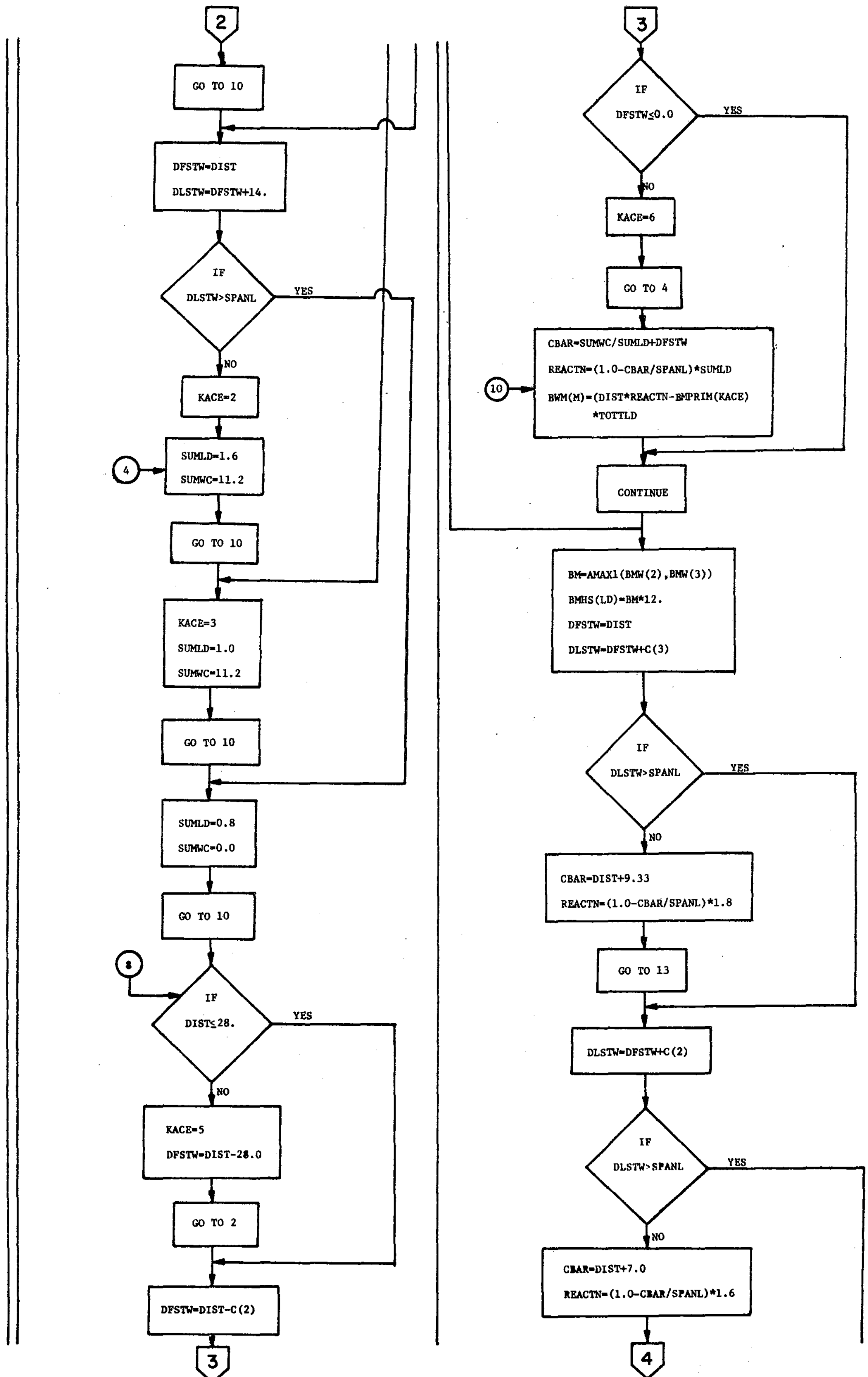
SUMLD - the sum of the weights of the axles

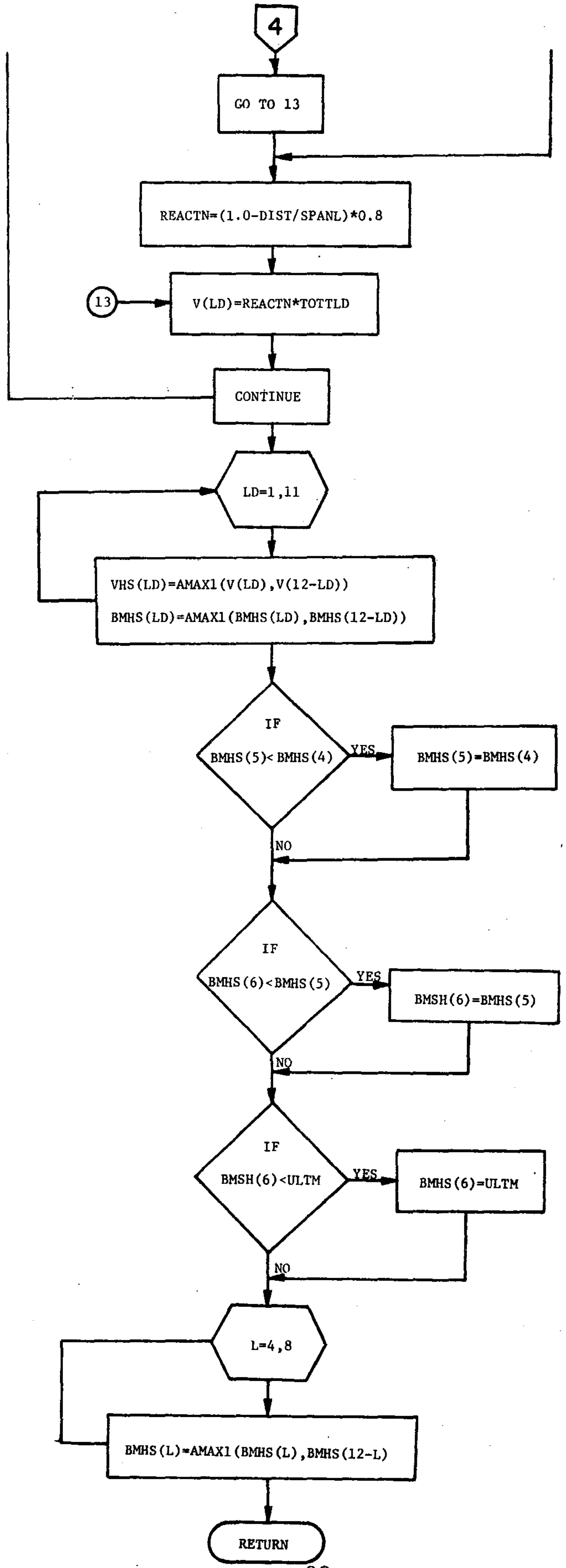
SUMW - temporary summation of weights on beam (lbs)

SUMWC - the sum of the products of the axles and their moment arms where the arm is the distance between the axle and the first axle on the span

VHS(I) - stored maximum value for shear due to HS-20 loading at I^{th} inspection point (lbs)


START
CL=SPANL*0.5
IF SPANL>24
YES
NO
PT=CL
REACTN=0.4
BM=REACTN*PT*480000
GO TO 305
IF SPANL>28
YES
NO
PT=CL-3.5
CBAR=CL+3.5
REACTN=(1-CBAR/SPANL)*1.6
BM=REACTN*PT*480000
GO TO 305
IF SPANL>32.67
YES
NO
PT=14.
CBAR=18.667
GO TO 303
CBAR=CL+2.33
PT=CL-2.33
1
1
303
REACTN=(1-CBAR/SPANL)*1.8
BM=(PT*REACTN-2.8)*40000
305
CONTINUE
ULTM=BM
LD=1,15
DIST=XDIST(LD)
M=2,3
BMW(M)=0.0
SUMWC=0.0
SUMLD=0.0
GO TO ( ),M
1
2
3
8
IF DIST≤C(2)
YES
NO
DFSTW=DIST-C(2)
DLSTW=DFSTW+C(3)
IF DLSTW≥SPANL
YES
NO
KACE=1
2
SUMLD=1.8
SUMWC=33.6
2


2
GO TO 10
DFSTW=DIST
DLSTW=DFSTW+14.
IF
DLSTW>SPANL
YES
NO
KACE=2
4
SUMLD=1.6
SUMWC=11.2
GO TO 10
KACE=3
SUMLD=1.0
SUMWC=11.2
GO TO 10
SUMLD=0.8
SUMWC=0.0
GO TO 10
8
IF
DIST≤28.
YES
NO
KACE=5
DFSTW=DIST-28.0
GO TO 2
DFSTW=DIST-C(2)
3
3
IF
DFSTW≤0.0
YES
NO
KACE=6
GO TO 4
10
CBAR=SUMWC/SUMLD+DFSTW
REACTN=(1.0-CBAR/SPANL)*SUMLD
BWM(M)=(DIST*REACTN-BMPRIM(KACE)
*TOTTLD
CONTINUE
BM=AMAX1(BMW(2),BMW(3))
BMHS(LD)=BM*12.
DFSTW=DIST
DLSTW=DFSTW+C(3)
IF
DLSTW>SPANL
YES
NO
CBAR=DIST+9.33
REACTN=(1.0-CBAR/SPANL)*1.8
GO TO 13
DLSTW=DFSTW+C(2)
IF
DLSTW>SPANL
YES
NO
CBAR=DIST+7.0
REACTN=(1.0-CBAR/SPANL)*1.6
4


4
GO TO 13
REACTN=(1.0-DIST/SPANL)*0.8
13
V(LD)=REACTN*TOTTLD
CONTINUE
LD=1,11
VHS(LD)=AMAX1(V(LD),V(12-LD))
BMHS(LD)=AMAX1(BMHS(LD),BMHS(12-LD))
IF
BMHS(5)< BMHS(4)
YES
BMHS(5)=BMHS(4)
NO
IF
BMHS(6)<BMHS(5)
YES
BMSH(6)=BMHS(5)
NO
IF
BMSH(6)<ULTM
YES
BMHS(6)=ULTM
NO
L=4,8
BMHS(L)=AMAX1(BMHS(L),BMHS(12-L)
RETURN

Subroutine: RRLOAD

Definition of Terms:

BM	- temporary summation for bending moment (in.-lbs)
BMLL	- temporary value for bending moment (in.-lbs)
BMMA(I)	- stored maximum value for bending moment at I^{th} inspection point due to railroad loading (in.-lbs)
BMMAX	- temporary maximum bending moment (in.-lbs)
C(M)	- distance between wheel M and wheel 1 C(1) = 0.0
DFSTW	- temporary distance between left reaction and first axle load on span for a given position of configuration (ft)
DISTWU	- length of uniform live load on span (ft)
DSTRN	- total length of live load configuration on span (ft)
FRACT	- live load distribution factor FRACT = 1.35 - $(SPAN^2)/50{,}000$
IC	- counter -- denotes number of first wheel on span
JLM	- counter -- denotes number of last wheel on span
REACTN	- reaction at left end of beam (lbs)
SUMLD	- the sum of the weights of the wheel loads (lbs)
SUMWC	- the sum of the products of the wheel loads and their moment arms where the arm is the distance between the wheel load and the first wheel load on the span
TOTTLD	- for Cooper's E-40 loading TOTTLD = 40 Cooper's E-72 loading TOTTLD = 72
V	- live load shear (lbs)
VMA(I)	- stored maximum value for shear at I^{th} inspection points (lbs)
VMAX	- temporary maximum shear (lbs)

VSUB - temporary summation of shears (lbs)

W(M) - weight of wheel M (lbs)

WU - uniform liveload for Cooper's E loading (lbs/ft)

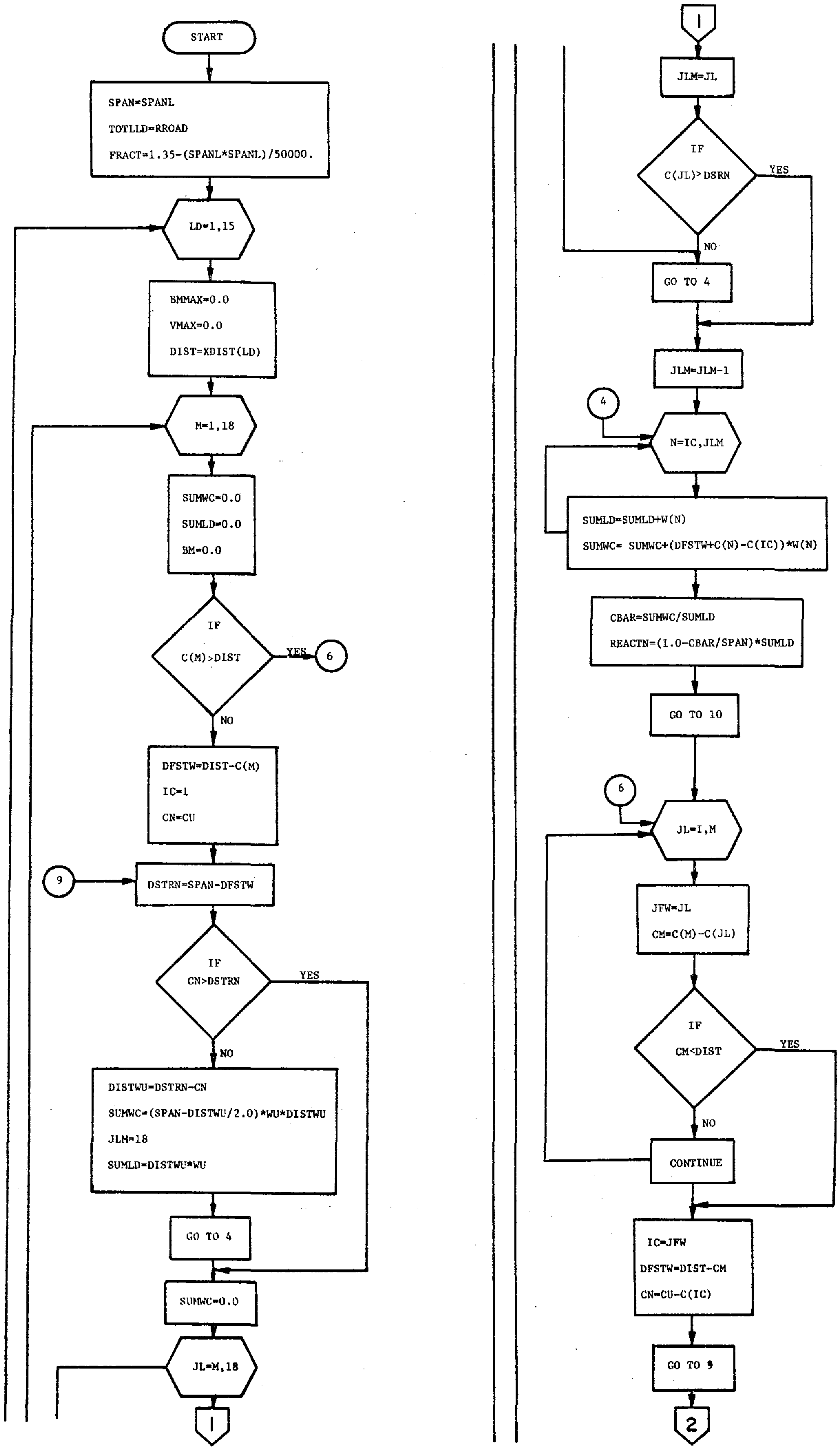
XDIST(M) - fraction of span length (ft) for M = 1,11

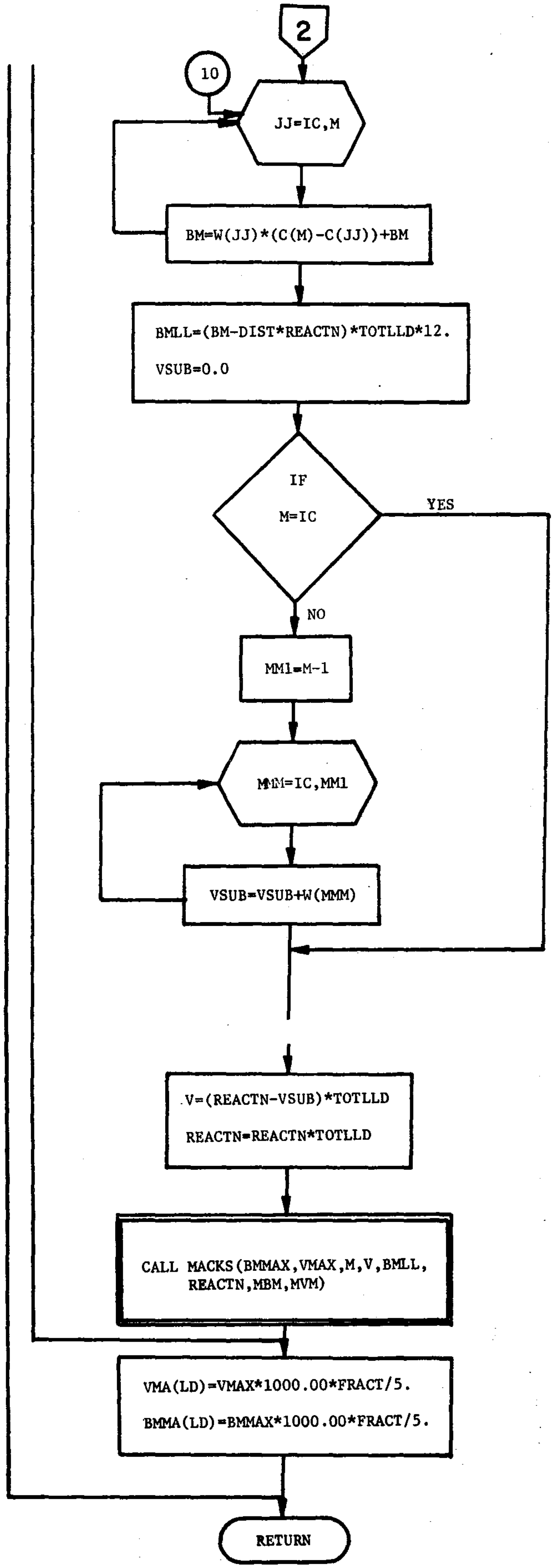
$$XDIST(M) = \left(\frac{M-1}{10}\right) \times SPANL$$

M = 12,15

M = 12,13 XDIST(M) = distance from the support to a quarter point (ft)

M = 14,15 XDIST(M) = distance from the support to a hold-down position (ft)

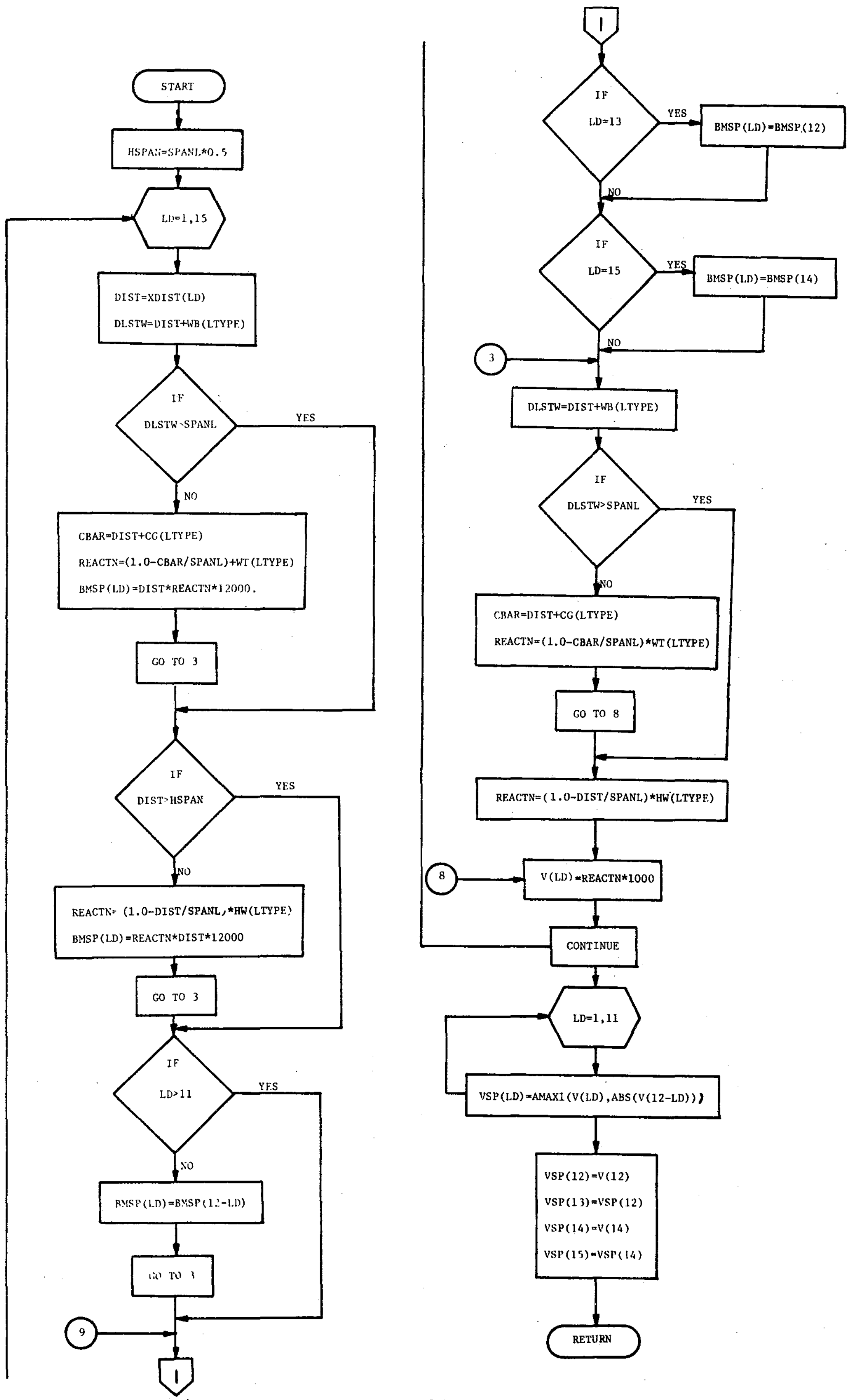

START
SPAN=SPANL
TOTLLD=RROAD
FRACT=1.35-(SPANL*SPANL)/50000.
LD=1,15
BMMAX=0.0
VMAX=0.0
DIST=XDIST(LD)
M=1,18
SUMWC=0.0
SUMLD=0.0
BM=0.0
IF
C(M)>DIST
YES
6
NO
DFSTW=DIST-C(M)
IC=1
CN=CU
9
DSTRN=SPAN-DFSTW
IF
CN>DSTRN
YES
NO
DISTWU=DSTRN-CN
SUMWC=(SPAN-DISTWU/2.0)*WU*DISTWU
JLM=18
SUMLD=DISTWU*WU
GO TO 4
SUMWC=0.0
JL=M,18
1
1
JLM=JL
IF
C(JL)>DSRN
YES
NO
GO TO 4
JLM=JLM-1
4
N=IC,JLM
SUMLD=SUMLD+W(N)
SUMWC= SUMWC+(DFSTW+C(N)-C(IC))*W(N)
CBAR=SUMWC/SUMLD
REACTN=(1.0-CBAR/SPAN)*SUMLD
GO TO 10
6
JL=I,M
JFW=JL
CM=C(M)-C(JL)
IF
CM<DIST
YES
NO
CONTINUE
IC=JFW
DFSTW=DIST-CM
CN=CU-C(IC)
GO TO 9
2


2
10
JJ=IC,M
BM=W(JJ)*(C(M)-C(JJ))+BM
BMLL=(BM-DIST*REACTN)*TOTLLD*12.
VSUB=0.0
IF
M=IC
YES
NO
MM1=M-1
MMM=IC,MM1
VSUB=VSUB+W(MMM)
V=(REACTN-VSUB)*TOTLLD
REACTN=REACTN*TOTLLD
CALL MACKS(BMMAX,VMAX,M,V,BMLL,
REACTN,MBM,MVM)
VMA(LD)=VMAX*1000.00*FRACT/5.
BMMA(LD)=BMMAX*1000.00*FRACT/5.
RETURN

Subroutine: SPCL

Definition of Terms:

BMSP(I)	- stored maximum value of bending moment at I^{th} inspection point for H-20 or H-15 loading (in.-lbs)
CBAR	- distance between left reaction and center of gravity of loads applied to beam (ft)
CG	- constant dimension for a given load type distance between first wheel load and centroid of mass for that configuration
DFSTW	- temporary distance between left reaction and first axle load on span for a given position of configuration (ft)
DLSTW	- temporary distance between left reaction and last axle load on span for a given position of configuration (ft)
HSPAN	- span length divided by two (ft)
VSP(I)	- stored max value of shear at I^{th} inspection point for H-20 or H-15 loading (lbs)


START
HSPAN=SPANL*0.5
LD=1,15
DIST=XDIST(LD)
DLSTW=DIST+WB(LTYPE)
IF
DLSTW>SPANL
YES
NO
CBAR=DIST+CG(LTYPE)
REACTN=(1.0-CBAR/SPANL)*WT(LTYPE)
BMSP(LD)=DIST*REACTN*12000.
GO TO 3
IF
DIST>HSPAN
YES
NO
REACTN=(1.0-DIST/SPANL)*HW(LTYPE)
BMSP(LD)=REACTN*DIST*12000
GO TO 3
IF
LD>11
YES
NO
BMSP(LD)=BMSP(12-LD)
GO TO 3
9
1
1
IF
LD=13
YES
BMSP(LD)=BMSP(12)
NO
IF
LD=15
YES
BMSP(LD)=BMSP(14)
NO
3
DLSTW=DIST+WB(LTYPE)
IF
DLSTW>SPANL
YES
NO
CBAR=DIST+CG(LTYPE)
REACTN=(1.0-CBAR/SPANL)*WT(LTYPE)
GO TO 8
REACTN=(1.0-DIST/SPANL)*HW(LTYPE)
8
V(LD)=REACTN*1000
CONTINUE
LD=1,11
VSP(LD)=AMAX1(V(LD),ABS(V(12-LD)))
VSP(12)=V(12)
VSP(13)=VSP(12)
VSP(14)=V(14)
VSP(15)=VSP(14)
RETURN

Subroutine: TYPELD

A summary of steps for subroutine TYPELD is:

a. Calculate the live load impact factor.

b. Call the subroutine(s) to determine live load shears and moments.

c. Apply the impact and distribution factors.

Definition of Terms:

DFACT - live load distribution factor
DFACT = BSPAC/11.0

FRACT - fraction of impact for highway loads with a maximum of 30%

$$\text{FRACT} = \frac{50}{\text{Span Length} + 125}$$

LTYPE - designates type of load

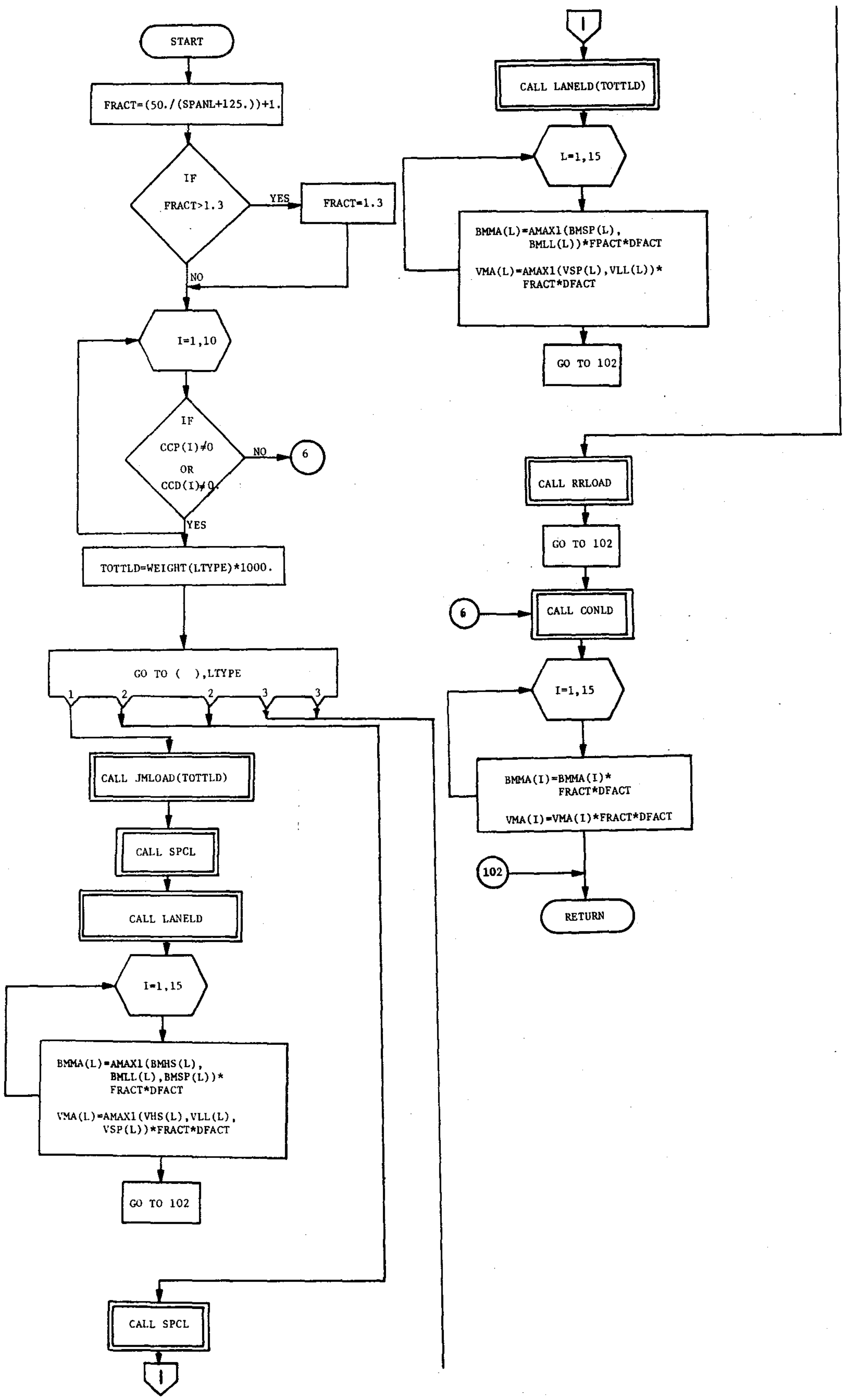
= 1 HS-20

= 2 H-20

= 3 H-15

= 4 Cooper's Loading

TOTTLD - Designation of total weight of truck load; for
HS-20 total load = 40k x axle fraction (axle fr. = 1.8)
H-20 total load = 40k x axle fraction (axle fr. = 1.0)


START
FRACT=(50./(SPANL+125.))+1.
IF FRACT>1.3
YES
FRACT=1.3
NO
I=1,10
IF CCP(I)≠0 OR CCD(I)≠0.
NO
6
YES
TOTTLD=WEIGHT(LTYPE)*1000.
GO TO ( ),LTYPE
1
2
2
3
3
CALL JMLOAD(TOTTLD)
CALL SPCL
CALL LANELD
I=1,15
BMMA(L)=AMAX1(BMHS(L), BMLL(L),BMSP(L))* FRACT*DFACT
VMA(L)=AMAX1(VHS(L),VLL(L), VSP(L))*FRACT*DFACT
GO TO 102
CALL SPCL
1
1
CALL LANELD(TOTTLD)
L=1,15
BMMA(L)=AMAX1(BMSP(L), BMLL(L))*FPACT*DFACT
VMA(L)=AMAX1(VSP(L),VLL(L))* FRACT*DFACT
GO TO 102
CALL RRLOAD
GO TO 102
6
CALL CONLD
I=1,15
BMMA(I)=BMMA(I)* FRACT*DFACT
VMA(I)=VMA(I)*FRACT*DFACT
102
RETURN

Subroutine: LANELD

A summary of steps for subroutine LANELD is:

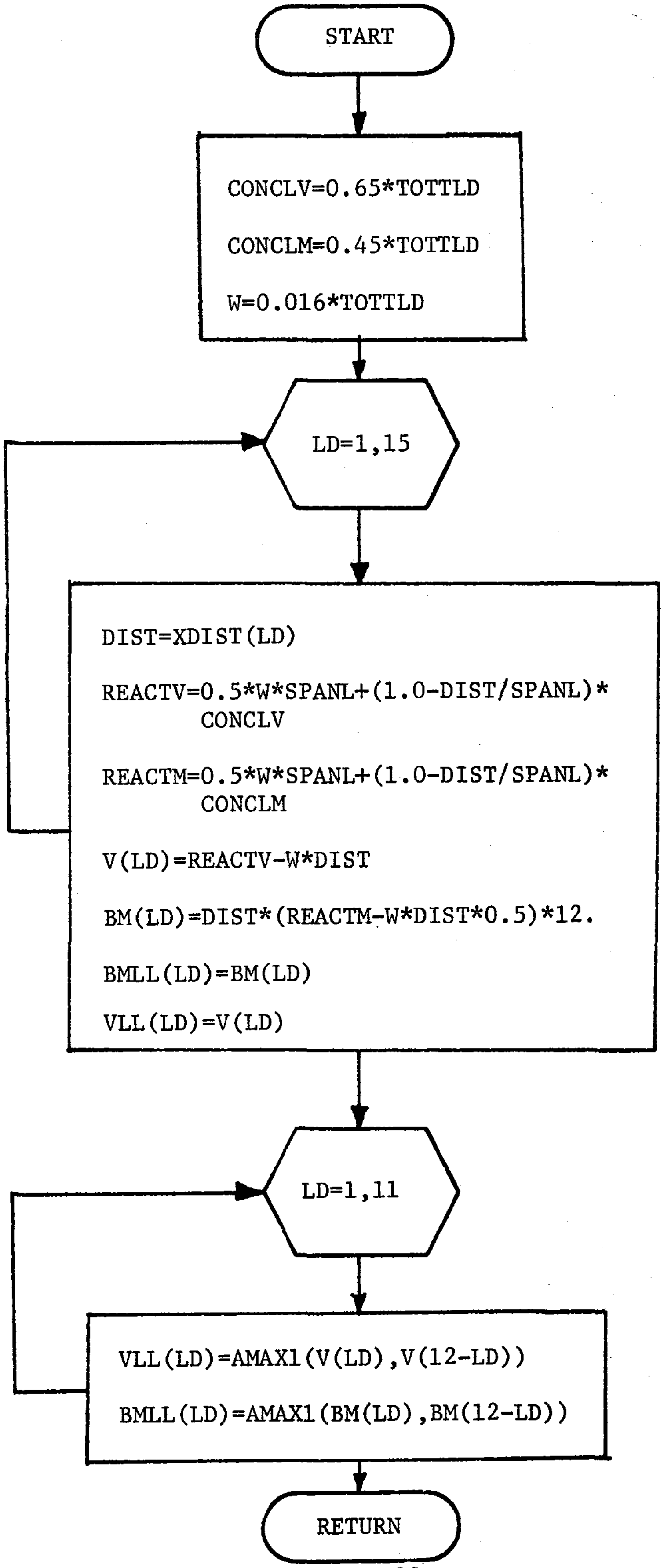
a. Calculate concentrated and uniformly distributed loads

b. Calculate shears and moments at tenth points

c. Select maximum shears and moments by choosing the larger of 1st and 9th tenth points, 2nd and 8th tenth points, . . . etc.

Definition of Terms:

BM(LD)	- bending moment due to uniformly distributed load plus the concentrated load for moment (in.-lbs)
BMLL(LD)	- live load bending moment (in.-lbs)
CONCLM	- concentrated load for moment (lbs)
CONCLV	- concentrated load for shear (lbs)
DIST	- distance from left reaction to inspection point (ft)
REACTM	- reaction due to uniformly distributed load plus the concentrated load for moment (lbs)
REACTV	- reaction due to uniformly distributed load plus the concentrated load for shear((lbs)
V(LD)	- shear due to uniformly distributed load plus the concentrated load for shear (lbs)
VLL(LD)	- live load shear (lbs)
W	- uniformly distributed load (lb/ft)


START
CONCLV=0.65*TOTTLD
CONCLM=0.45*TOTTLD
W=0.016*TOTTLD
LD=1,15
DIST=XDIST(LD)
REACTV=0.5*W*SPANL+(1.0-DIST/SPANL)*CONCLV
REACTM=0.5*W*SPANL+(1.0-DIST/SPANL)*CONCLM
V(LD)=REACTV-W*DIST
BM(LD)=DIST*(REACTM-W*DIST*0.5)*12.
BMLL(LD)=BM(LD)
VLL(LD)=V(LD)
LD=1,11
VLL(LD)=AMAX1(V(LD),V(12-LD))
BMLL(LD)=AMAX1(BM(LD),BM(12-LD))
RETURN

Subroutine: STRMOD

A summary of steps for subroutine STRMOD is:

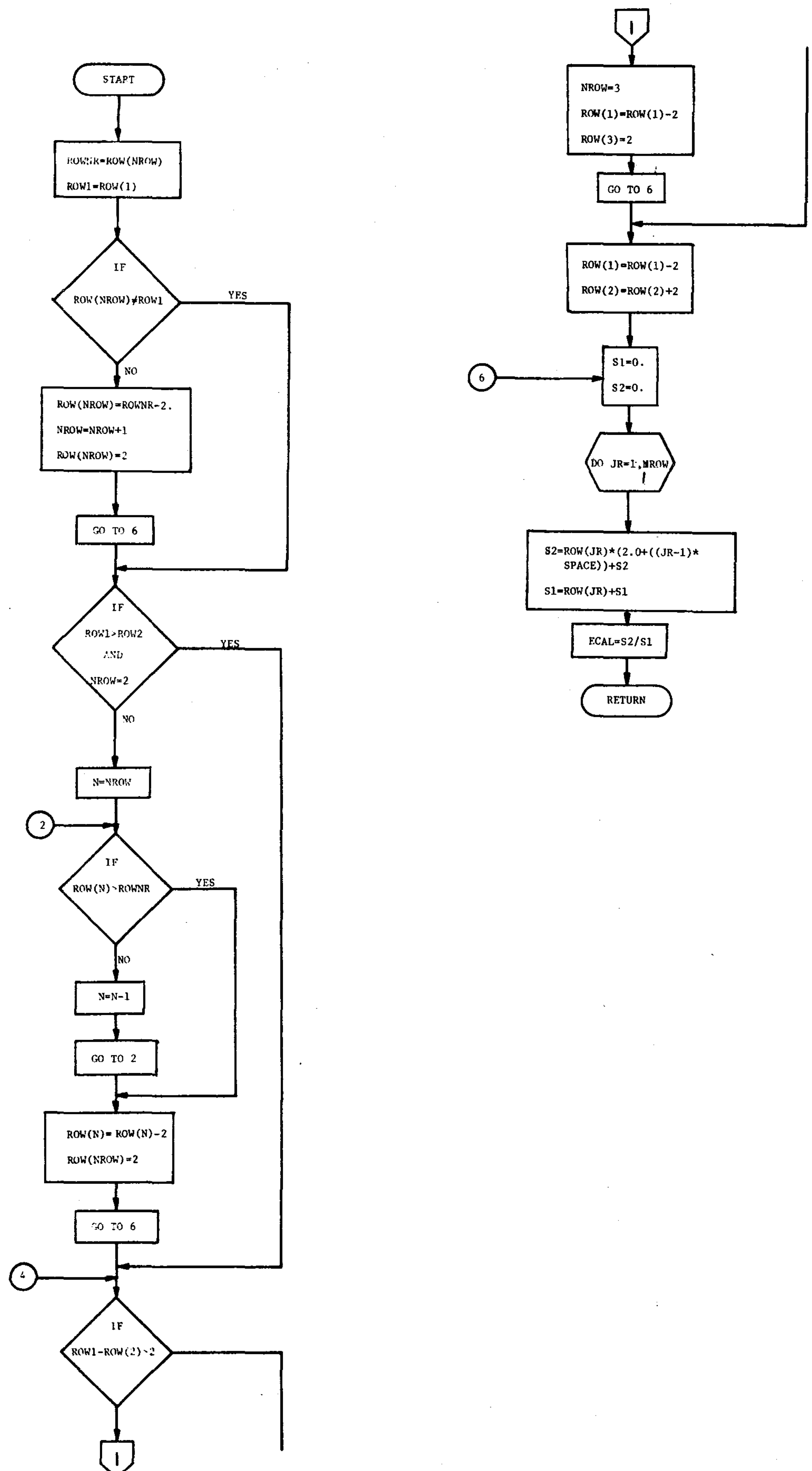
a. Determine whether or not all rows have the same number of strands. If so create another row with two strands from the top row.

b. Should there be only two rows and the bottom row has two more strands than the top row, create a third row with two strands from the bottom row. Should the number of strands in the bottom row exceed the number in the top row by more than two, move two strands from the bottom row to the top row.

c. Should there be more than two rows, determine the highest row from the bottom of the beam that has more strands than the top row and create a new row with two strands from that row.

Definition of Terms:

ECAL	- distance between bottom of beam and cgs of strands
N	- counter
ROW1	- number of strands in row number 1
ROWNR	- number of strands in last row
S1	- temporary sum number of strands
S2	- temporary sum of strand areas times their moment arms

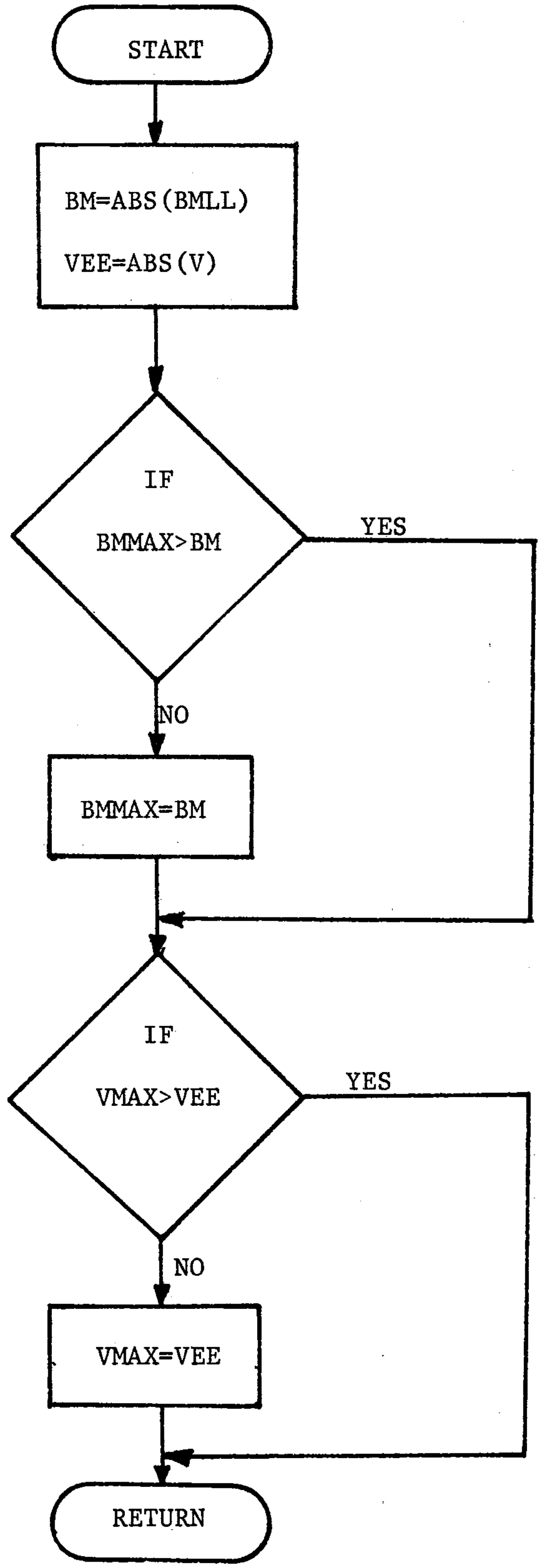

START
ROWNR=ROW(NROW)
ROW1=ROW(1)
IF
ROW(NROW)≠ROW1
YES
NO
ROW(NROW)=ROWNR-2.
NROW=NROW+1
ROW(NROW)=2
GO TO 6
IF
ROW1>ROW2
AND
NROW=2
YES
NO
N=NROW
2
IF
ROW(N)>ROWNR
YES
NO
N=N-1
GO TO 2
ROW(N)= ROW(N)-2
ROW(NROW)=2
GO TO 6
4
IF
ROW1-ROW(2)>2
1
1
NROW=3
ROW(1)=ROW(1)-2
ROW(3)=2
GO TO 6
ROW(1)=ROW(1)-2
ROW(2)=ROW(2)+2
6
S1=0.
S2=0.
DO JR=1,NROW
S2=ROW(JR)*(2.0+((JR-1)*SPACE))+S2
S1=ROW(JR)+S1
ECAL=S2/S1
RETURN

Subroutine: MACKS

Subroutine MACKS determines maximum shears and bending moments for RRLOAD.

Definition of Terms:

BM	- absolute value of bending moment (in.-lbs)
BMLL	- live load moment (in.-lbs)
BMMAX	- maximum bending moment (in.-lbs)
V	- live load shear (lbs)
VEE	- absolute value of shear (lbs)
VMAX	- maximum shear (lbs)


START
BM=ABS(BMLL)
VEE=ABS(V)
IF
BMMAX>BM
YES
NO
BMMAX=BM
IF
VMAX>VEE
YES
NO
VMAX=VEE
RETURN

Subroutine: CAMBER

A summary of steps for subroutine CAMBER is:

a. Define values for hyperbolic functions.

b. Calculate the release force.

c. Calculate the predicted initial prestress loss.

d. Calculate the predicted infinite prestress loss.

e. Calculate the predicted maximum camber.

Definition of Terms:

ACR - unit creep at time infinity (in./in./psi)

ASH - shrinkage at time infinity (in./in.)

AST - total area of prestressing strands (in.^{2})

BCR - time at which one-half ACR is reached (days)

BSH - time at which one-half ASH is reached (days)

C4 - deflection due to weight of beam (in.)

CCONST - constant equal to 1/EI (1/lb-in.^{2})

CI - camber at release (in.)

CI1+CI2+CI3 - deflection due to initial prestress equal to the moment of the area of the M/EI diagram about the support (in.)

CMAS - total camber (in.)

CONST - constant used to evaluate FCSO (1/in.^{2})

DFCS, DFCS1 - change in stress due to a change in strain (psi)

DLM - moment at midspan due to weight of beam (lb-in.)

FGSO - stress in concrete just after release (psi)

FR - total prestressing force just after release (lbs)

HSPAN - one-half span length (ft)

PLI - initial prestress loss (%)

PLINF - time dependent prestress loss (%)

PLMAX - total prestress loss (%)

RN - ratio of steel modulus to concrete modulus

STRAIN - strain in concrete at release (in./in.)

STRN1, STRN2, STRN4, STRN5, STRN6, STRN7 - steps to arrive at the strain in concrete after losses due to creep plus shrinkage

TEMP - constant used to evaluate FR

W - weight of beam (lb/ft)

```
START

ASH=0.000325
BSH=10.
ACRR=0.000225
BCR=15.
ACR=ACRR*.001

RN=ES/EC
AST=ASTRN*STRNS
W=UWB*AREA/144
DLM=(W*SPANL^2/8)*12
TEMP=1+(RN*AST/AREA)+
      (RN*AST*ECCL^2/IB)
FR=FO/TEMP+(DLM*ECCL*RN*AST/
    (IB*TEMP))

PLI=((FO-FR)/FO)*100

CONST=1./AREA+ECCL^2/IB
FCSO=FR*CONST-(DLM*ECCL/IB)
STRN1=ACR*FCSO+ASH
STRN2=STRN1-STRN1*RN*AST*CONST
DFCS=STRN2*ES*AST*CONST*10^6
STRN4=ACR*(FCO-DFCS/2.)+ASH
STRN5=STRN4-STRN4*RN*AST*CONST
DFCS1=STRN5*ES*AST*CONST*10^6
STRN6=ACR*(FCSO-DFCS1/2.)+ASH
STRN7=STRN6-STRN6*RN*AST*CONST
PLINF=(STRN7*ES*AST*10^6/FO)*100.
PLMAX=PLINF+PLI

CCONST=1./(EC*IB*10^6)
HSPAN=SPANL/2.
CI1=CCONST*FR*ENDECC*HSPAN^2*0.5*144.
CI2=CCONST*FR*(ECCL-ENDECC)*(HSPAN-HDPT)
     *0.5*0.67*(HSPAN-HDPT)*144.
CI3=CCONST*FR*(ECCL-ENDECC)*HDPT
     *(HSPAN-HDPT/2.)*144.
CI4=CCONST*(5./384.)*W*SPANL^4*12^3
CI=CI1+CI2+CI3-CI4
STRAIN=FCSO/(EC*10^6)
CMAX=CI* (ACR*(FCSO-(DFCS/2.))
      +STRAIN)/STRAIN)*(.-(PLINF/100.))

RETURN
```

Subroutine SHEAR

A summary of steps for subroutine SHEAR is:

a. Apply load factors by 1965 AASHO to dead and live loads at the tenth points.

b. Define the distances from extreme compressive fiber to centroid of prestressing steel at the tenth points.

c. Define the cosine of the angle between the cgs and a horizontal plane through the end eccentricity position, ratio of distance between centroid of compression and centroid of tension to the depth d, and shear carried by concrete.

d. Define the vertical component of prestressing force.

e. Calculate the spacing of web reinforcement at the tenth points.

f. Calculate values for design of horizontal shear connections at the tenth points.

g. Repeat steps a, b, c, d, and e using quarter points instead of tenth points.

h. Apply load factors by 1963 ACI at the tenth points.

i. Calculate the distance between the cgc and cgs at the tenth points.

j. Define distance from extreme compressive fiber to centroid of prestressing steel, compressive stress in concrete due to prestress only, after all losses, stress due to dead load, net flexural cracking moment, and vertical component of prestress at the tenth points.

k. Define at the tenth points the shear that corresponds to the minimum web reinforcement; shear at diagonal cracking due to all loads, when such cracking is the result of combined shear and moment; shear at diagonal cracking due to all loads, when such cracking is the result of excessive principal tension stresses in the web; and the minimum shear at diagonal cracking due to all loads, when such cracking is the result of combined shear and moment.

1. Calculate the spacing of web reinforcement at the tenth points.

Definition of Terms:

ACI	- web reinforcement spacing (in.)
AS	- total area of prestressing steel (in.^{2})
AV	- area of web reinforcement (in.^{2})
AVM	- minimum area of web reinforcement permitted (in.^{2})
AVMQ	- minimum area at the quarter point (in.^{2})
CTHETA	- cosine of the angle θ (see diagram for θ)
DD	- distance from extreme compressive fiber to centroid of the prestressing force (in.)
DDQ	- DD at the quarter point (in.)
DM	- depth of member (in.)
E	- vertical distance between eccentricity at the end of the beam and the cgs (in.)
FD	- stress due to dead load, at the extreme fiber of a section at which tension stresses are caused by applied loads (psi)
FPCC	- compressive stress in the concrete after all prestress losses have occurred, at the centroid of the cross section resisting the applied loads (psi)
FPE	- compressive stress in concrete due to prestress only, after all losses, at the extreme fiber of a section at which tension stresses are caused by applied loads (psi)
HSPAN	- one half the span length (ft)
MCR	- net flexural cracking moment (in.-lb)
MU	- ultimate moment (in.-lbs)

MUVU - ratio of bending moment to shear

PHIVC - lesser of PHIVCI or PHIVCW

PHIVCI - ϕ factor times VCI

PHIVCW - ϕ factor times VCW

PHIVPU - ϕ factor times VPU

Q - static moment of cross section area, above or below the level investigated for shear, about the centroid

QMU - ultimate moment at quarter point (in.-lbs)

RJ - ratio of distance between centroid of compression and centroid of tension to the depth DD

RJQ - RJ at the quarter point

S - spacing of web reinforcement (in.)

SG - limit maximum spacing to .75 times DM

SGQ - SG at quarter point

SMAX - maximum spacing allowed when stirrups are used as vertical ties (in.)

SQ - S at the quarter point

STHETA - sine of angle θ

TTHETA - tangent of angle θ

VC - shear carried by concrete (psi)

VCG - maximum for VC

VCGQ - maximum for V_C at the quarter point

VCI - shear at diagonal cracking due to all loads when such cracking is the result of combined shear and moment (lbs)

VCIM - ϕ times minimum VCI allowed

VCW - shear force at diagonal cracking due to all loads, when such cracking is the result of excessive principal stresses in the web (lbs)

VCQ - V_C at the quarter point (psi)

VP - vertical component of the effective prestress force at section considered (lbs)

VPR - vertical component of the prestressing force (lbs)

VPU - shear resisting ability that corresponds to a minimum amount of web reinforcement (lbs)

VS - shear at the connections of slab and beam (bond stress)

VU - shear due to ultimate load and effect of prestressing (lbs)

VULT - ultimate shear (1.5 DL + 1.8 LL) (lbs)

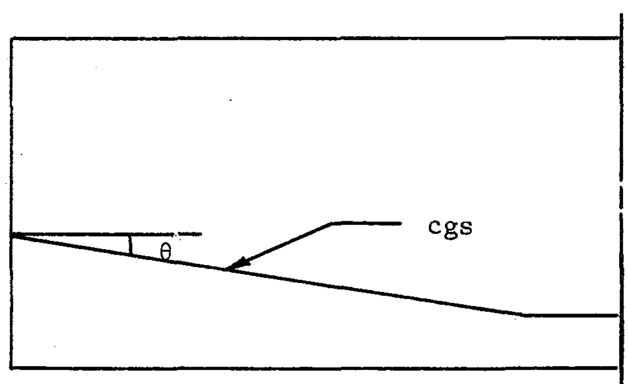
VUQ - V_u at the quarter point (lbs)

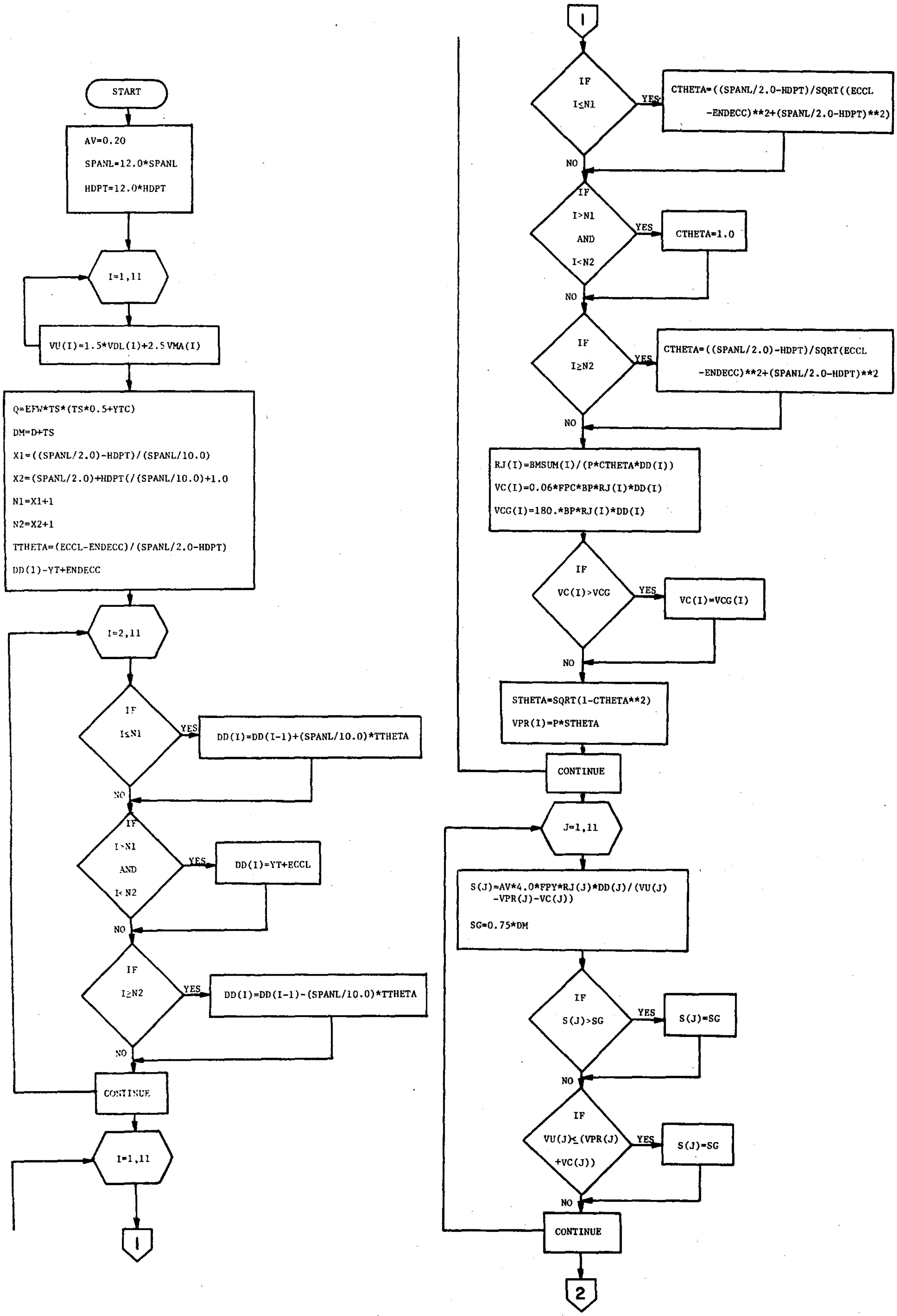
VUVPU - ultimate shear minus the shear resisting ability of the minimum web reinforcement (lbs)

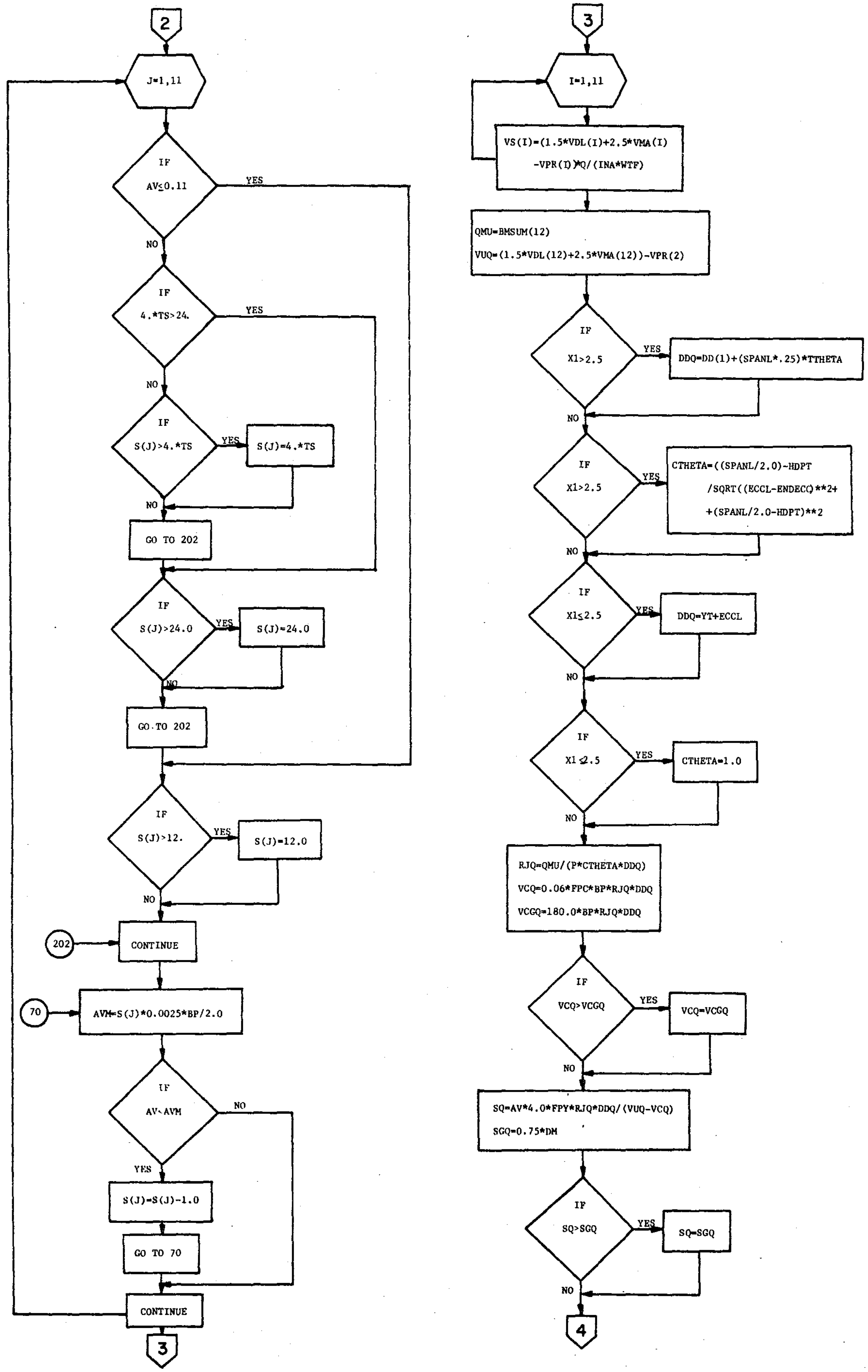
X - incremental length along beam (ft)

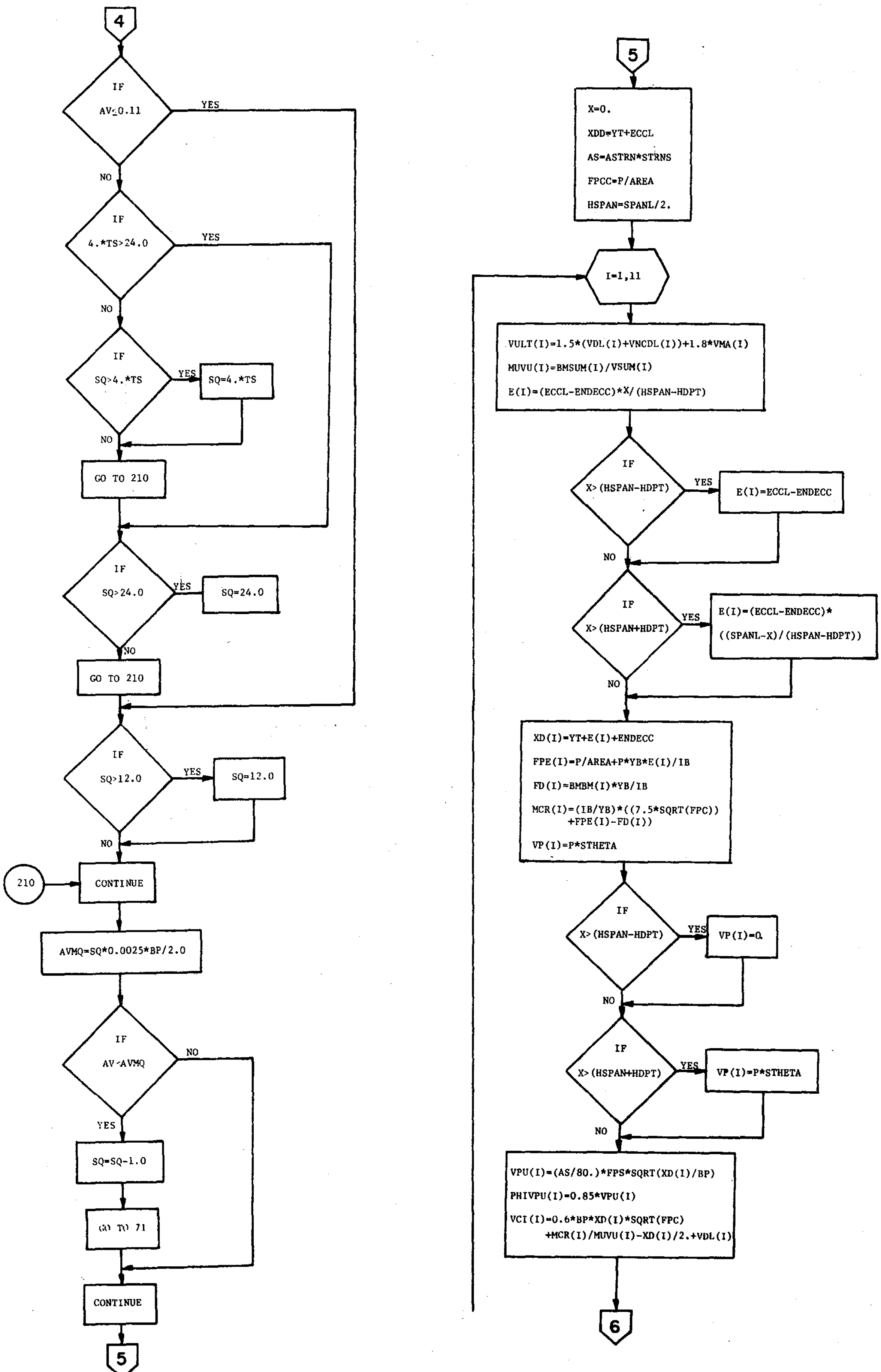
XD - distance from extreme compression fiber to centroid of the prestressing tendons (in.)

XDD - effective depth at section of maximum moment (in.)

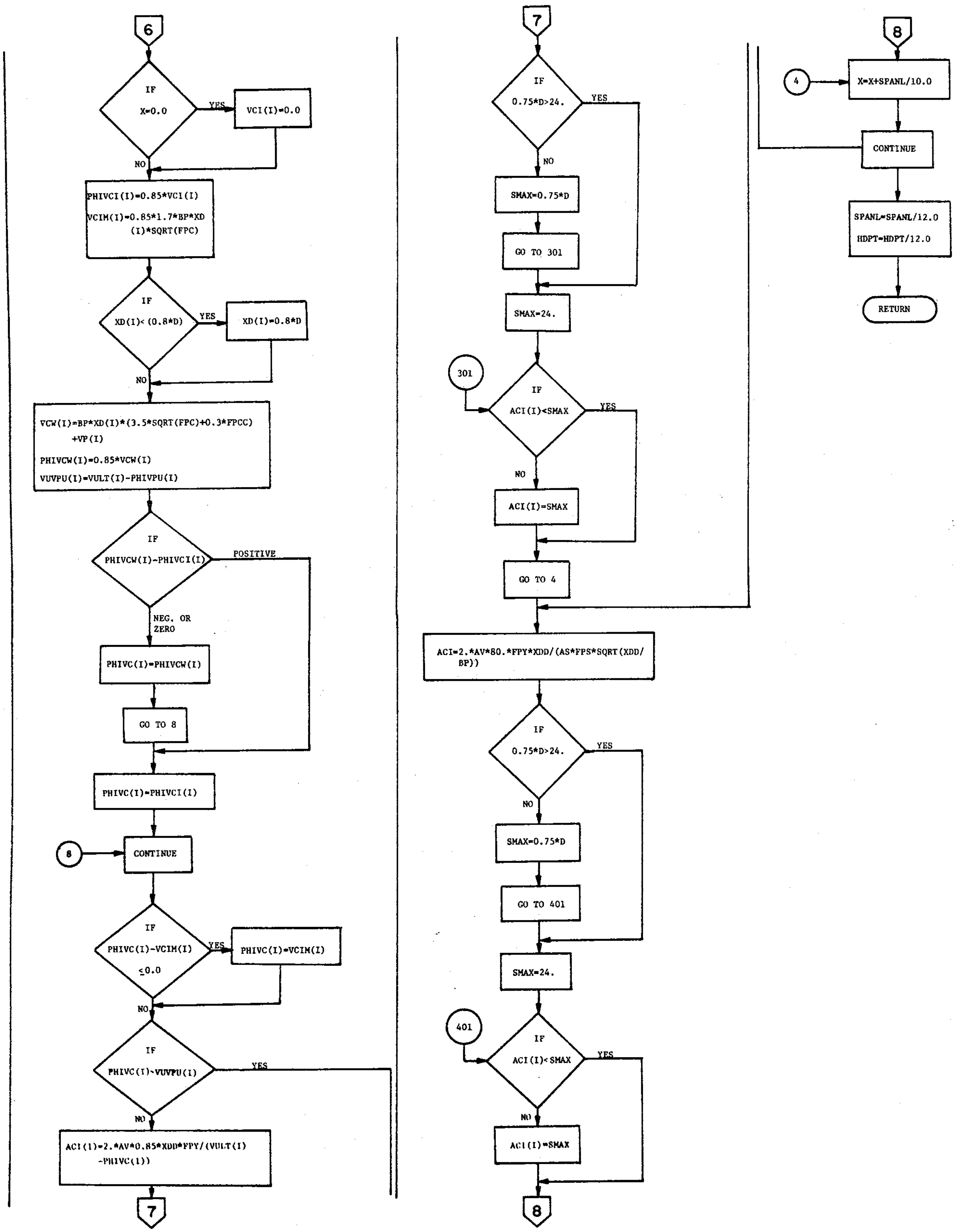



START
AV=0.20
SPANL=12.0*SPANL
HDPT=12.0*HDPT
I=1,11
VU(I)=1.5*VDL(I)+2.5VMA(I)
Q=EFW*TS*(TS*0.5+YTC)
DM=D+TS
X1=((SPANL/2.0)-HDPT)/(SPANL/10.0)
X2=(SPANL/2.0)+HDPT(/(SPANL/10.0)+1.0
N1=X1+1
N2=X2+1
TTHETA=(ECCL-ENDECC)/(SPANL/2.0-HDPT)
DD(1)-YT+ENDECC
I=2,11
IF I≤N1
YES
DD(I)=DD(I-1)+(SPANL/10.0)*TTHETA
NO
IF I>N1 AND I<N2
YES
DD(I)=YT+ECCL
NO
IF I≥N2
YES
DD(I)=DD(I-1)-(SPANL/10.0)*TTHETA
NO
CONTINUE
I=1,11
1
1
IF I≤N1
YES
CTHETA=((SPANL/2.0-HDPT)/SQRT((ECCL -ENDECC)**2+(SPANL/2.0-HDPT)**2)
NO
IF I>N1 AND I<N2
YES
CTHETA=1.0
NO
IF I≥N2
YES
CTHETA=((SPANL/2.0)-HDPT)/SQRT(ECCL -ENDECC)**2+(SPANL/2.0-HDPT)**2
NO
RJ(I)=BMSUM(I)/(P*CTHETA*DD(I))
VC(I)=0.06*FPC*BP*RJ(I)*DD(I)
VCG(I)=180.*BP*RJ(I)*DD(I)
IF VC(I)>VCG
YES
VC(I)=VCG(I)
NO
STHETA=SQRT(1-CTHETA**2)
VPR(I)=P*STHETA
CONTINUE
J=1,11
S(J)=AV*4.0*FPY*RJ(J)*DD(J)/(VU(J) -VPR(J)-VC(J))
SG=0.75*DM
IF S(J)>SG
YES
S(J)=SG
NO
IF VU(J)≤(VPR(J) +VC(J))
YES
S(J)=SG
NO
CONTINUE
2


2
J=1,11
IF
AV≤0.11
YES
NO
IF
4.*TS>24.
YES
NO
IF
S(J)>4.*TS
YES
S(J)=4.*TS
NO
GO TO 202
IF
S(J)>24.0
YES
S(J)=24.0
NO
GO TO 202
IF
S(J)>12.
YES
S(J)=12.0
NO
202
CONTINUE
70
AVM=S(J)*0.0025*BP/2.0
IF
AV<AVM
NO
YES
S(J)=S(J)-1.0
GO TO 70
CONTINUE
3
3
I=1,11
VS(I)=(1.5*VDL(I)+2.5*VMA(I)
-VPR(I))*Q/(INA*WTF)
QMU=BMSUM(12)
VUQ=(1.5*VDL(12)+2.5*VMA(12))-VPR(2)
IF
X1>2.5
YES
DDQ=DD(1)+(SPANL*.25)*TTHETA
NO
IF
X1>2.5
YES
CTHETA=((SPANL/2.0)-HDPT
/SQRT((ECCL-ENDECC)**2+
+(SPANL/2.0-HDPT)**2
NO
IF
X1≤2.5
YES
DDQ=YT+ECCL
NO
IF
X1≤2.5
YES
CTHETA=1.0
NO
RJQ=QMU/(P*CTHETA*DDQ)
VCQ=0.06*FPC*BP*RJQ*DDQ
VCGQ=180.0*BP*RJQ*DDQ
IF
VCQ>VCGQ
YES
VCQ=VCGQ
NO
SQ=AV*4.0*FPY*RJQ*DDQ/(VUQ-VCQ)
SGQ=0.75*DM
IF
SQ>SGQ
YES
SQ=SGQ
NO
4



4
IF
AV≤0.11
YES
NO
IF
4.*TS>24.0
YES
NO
IF
SQ>4.*TS
YES
SQ=4.*TS
NO
GO TO 210
IF
SQ>24.0
YES
SQ=24.0
NO
GO TO 210
IF
SQ>12.0
YES
SQ=12.0
NO
210
CONTINUE
AVMQ=SQ*0.0025*BP/2.0
IF
AV<AVMQ
NO
YES
SQ=SQ-1.0
GO TO 71
CONTINUE
5
5
X=0.
XDD=YT+ECCL
AS=ASTRN*STRNS
FPCC=P/AREA
HSPAN=SPANL/2.
I=1,11
VULT(I)=1.5*(VDL(I)+VNCDL(I))+1.8*VMA(I)
MUVU(I)=BMSUM(I)/VSUM(I)
E(I)=(ECCL-ENDECC)*X/(HSPAN-HDPT)
IF
X>(HSPAN-HDPT)
YES
E(I)=ECCL-ENDECC
NO
IF
X>(HSPAN+HDPT)
YES
E(I)=(ECCL-ENDECC)*
((SPANL-X)/(HSPAN-HDPT))
NO
XD(I)=YT+E(I)+ENDECC
FPE(I)=P/AREA+P*YB*E(I)/IB
FD(I)=BMBM(I)*YB/IB
MCR(I)=(IB/YB)*((7.5*SQRT(FPC))
+FPE(I)-FD(I))
VP(I)=P*STHETA
IF
X>(HSPAN-HDPT)
YES
VP(I)=0.
NO
IF
X>(HSPAN+HDPT)
YES
VP(I)=P*STHETA
NO
VPU(I)=(AS/80.)*FPS*SQRT(XD(I)/BP)
PHIVPU(I)=0.85*VPU(I)
VCI(I)=0.6*BP*XD(I)*SQRT(FPC)
+MCR(I)/MUVU(I)-XD(I)/2.+VDL(I)
6


6
IF X=0.0
YES
VCI(I)=0.0
NO
PHIVCI(I)=0.85*VCI(I)
VCIM(I)=0.85*1.7*BP*XD(I)*SQRT(FPC)
IF XD(I)<(0.8*D)
YES
XD(I)=0.8*D
NO
VCW(I)=BP*XD(I)*(3.5*SQRT(FPC)+0.3*FPCC)+VP(I)
PHIVCW(I)=0.85*VCW(I)
VUVPU(I)=VULT(I)-PHIVPU(I)
IF PHIVCW(I)-PHIVCI(I)
POSITIVE
NEG. OR ZERO
PHIVC(I)=PHIVCW(I)
GO TO 8
PHIVC(I)=PHIVCI(I)
8
CONTINUE
IF PHIVC(I)-VCIM(I) ≤0.0
YES
PHIVC(I)=VCIM(I)
NO
IF PHIVC(I)-VUVPU(I)
YES
NO
ACI(I)=2.*AV*0.85*XDD*FPY/(VULT(I)-PHIVC(I))
7
7
IF 0.75*D>24.
YES
NO
SMAX=0.75*D
GO TO 301
SMAX=24.
301
IF ACI(I)<SMAX
YES
NO
ACI(I)=SMAX
GO TO 4
ACI=2.*AV*80.*FPY*XDD/(AS*FPS*SQRT(XDD/BP))
IF 0.75*D>24.
YES
NO
SMAX=0.75*D
GO TO 401
SMAX=24.
401
IF ACI(I)<SMAX
YES
NO
ACI(I)=SMAX
8
8
4
X=X+SPANL/10.0
CONTINUE
SPANL=SPANL/12.0
HDPT=HDPT/12.0
RETURN

Subroutine: CHANGE

Subroutine CHANGE converts units of deflections, moments, shears, and ultimate strand strength from kips and feet to pounds and inches. This conversion is necessary when a problem is repeated draping three strands in the web instead of two.

Definition of Terms:

BMDL(I) - strand value for bending moment at I^{th} inspection point due to composite dead loads

BMMA(I) - stored maximum value for bending moment at I^{th} inspection point due to railroad loading

BMSUM(I) - stored value for bending moment at I^{th} inspection point due to all loads

DEFK1 - deflection at 1/4 span due to slab weight

DEFK2 - deflection at 1/2 span due to slab weight

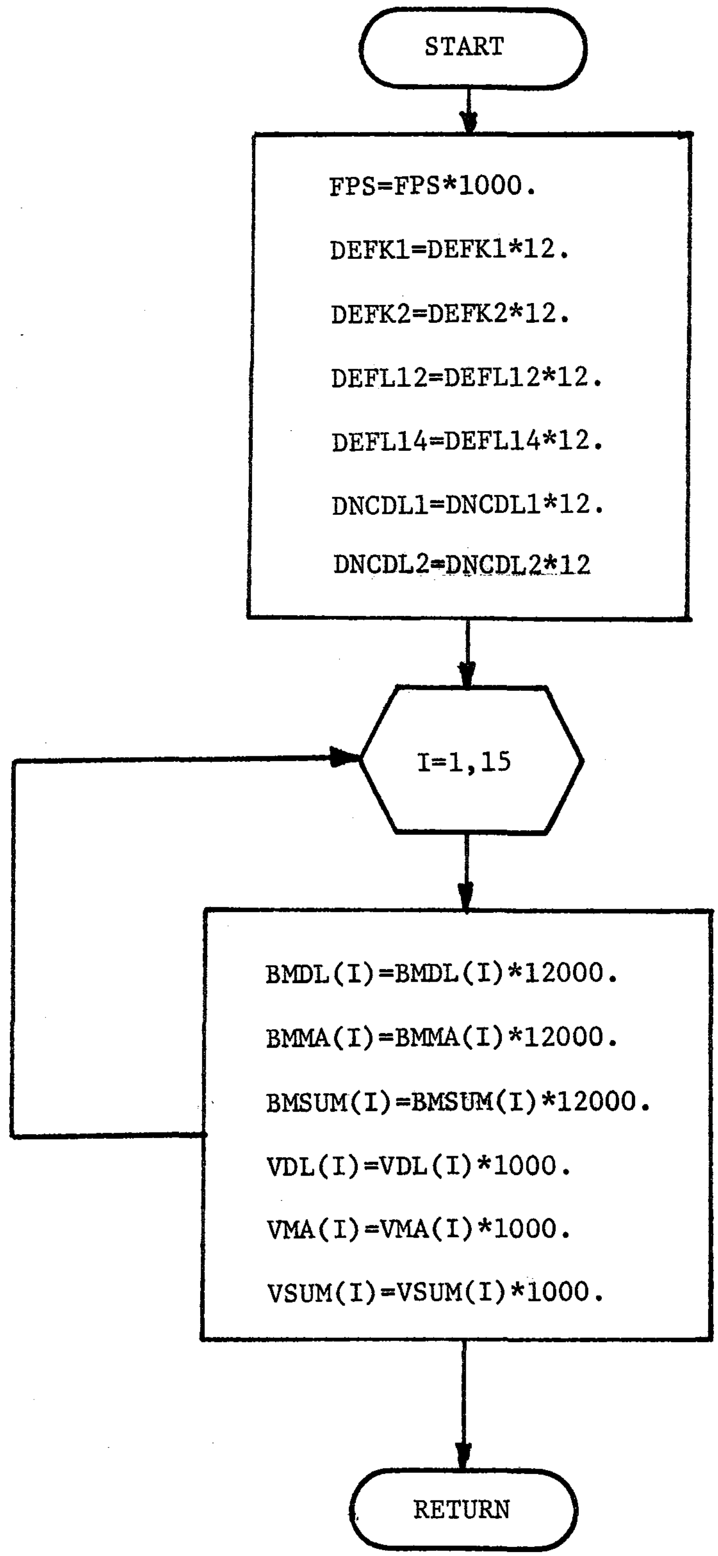
DEFL12 - deflection at 1/2 span due to diaphragms

DEFL14 - deflection at 1/4 span due to diaphragms

DNCDL1 - deflection at 1/4 span due to noncomposite dead load

DNCDL2 - deflection at 1/2 span due to noncomposite dead load

FPS - ultimate strength of prestressing strand


START
FPS=FPS*1000.
DEFK1=DEFK1*12.
DEFK2=DEFK2*12.
DEFL12=DEFL12*12.
DEFL14=DEFL14*12.
DNCDL1=DNCDL1*12.
DNCDL2=DNCDL2*12
I=1,15
BMDL(I)=BMDL(I)*12000.
BMMA(I)=BMMA(I)*12000.
BMSUM(I)=BMSUM(I)*12000.
VDL(I)=VDL(I)*1000.
VMA(I)=VMA(I)*1000.
VSUM(I)=VSUM(I)*1000.
RETURN

APPENDIX B

FORTRAN IV, Program Listing

The listing that follows is as used by the Bridge Division, Texas Highway Department

```
C
C
      REAL IB,IB1,INA,NCDL,MNCDL,MS,IBSL
      COMMON/KI/ ASL,IBSL,INA,YTC,YBC,YTCSL,ZTSL,YBCSL,ZBSL,AREAC,ECCL,
     1ENDMAX,TENIN,SPANL,BSPAC,BTYPE,TS, EFW ,UWB,UWS,EC,ECSL,ES,ASTRN,
     2FPS,NCDL,ZTB,ZBB,YT,AREA,D,IB,ZBBC,STRNS,ECAL,YB,ZTBC,WTF,BP,AV
     3,FPY,LTYPE,KASE,KODE,RROAD,SFPC,DFACT,DIA
      COMMON/TJH/ B,WD,C,E,A
      COMMON/LI/BEAM(11),AR(11),YB1(11),YT1(11),D1(11),IB1(11),WTF1(11),
     1BPRIME(11),HH(11)
      COMMON/BNS/ BNSTD
      COMMON/MM/ROW(20),NROW,SROW(20),SPACE,IW,DROW(20)
      COMMON/ELL/BMNO1,BMNO2,WORDS(40),SMBOL1,SMBOL2,SPAN1,SPAN2,
     1DESCR(17)
      COMMON/CONC/ CNCP(10),CNCD(10),CCP(10),CCD(10),SCNCP(10),SCNCD(10)
      COMMON/FYB/KGRID,NSTRNS,ENDECC,IWCH
      COMMON/JWM/ VMA(20),VDL(20),XDIST(15),DEFK2,DEFL12,DEFK1,DEFL14,
     1DNCDL2,DNCDL1
      DIMENSION CHRCTR(5)
      DIMENSION ICARD(26)
      DIMENSION DIA1(6),SAREA1(6),SAREA2(5)
      DATA DIA1/' 3/8','3/8 ','7/16',' 1/2','1/2 ','9/15'/
      DATA SAREA1/0.085,0.085,0.116,0.154,0.154,0.193/
      DATA SAREA2/0.080,0.080,0.109,0.144,0.144/
      DATA BLANKA,ABLANK,BLANKB,BBLANK,BLANKC,CBLANK,BLANKV,VBLANK/' A',
     1'A ',' B','B ',' C','C ',' V','V '/
      DATA CHRCTR/'HS-2',' H-2','H -2',' H-1','H -1'/
C
C
      CALL INPUT1
      CALL REREAD                                                       MAIN  25
   11 READ(5,2,END=333) BTYPE,SPANL,BSPAC,TS,SMBOL1,SMBOL2,RROAD,
     1SPAN1,SPAN2,BMNO1,BMNO2,IOPUT
    2 FORMAT(2X,A2,2X,F5.2,2(2X,F4.2),2X,A4,A1,2X,F3.0,4X,A4,A1,2X,A4,
     1A1,2X,I1)
   12 IF(BTYPE.EQ.BLANKA.OR.BTYPE.EQ.ABLANK)BTYPE=ABLANK
      IF(BTYPE.EQ.BLANKB.OR.BTYPE.EQ.BBLANK)BTYPE=BBLANK
      IF(BTYPE.EQ.BLANKC.OR.BTYPE.EQ.CBLANK)BTYPE=CBLANK
      IF(BTYPE.EQ.BLANKV.OR.BTYPE.EQ.VBLANK)BTYPE=VBLANK
      IF(BTYPE.NE.BNSTD)GO TO 90
   22 READ(5,3)NTYPE,(ICARD(I),I=1,26)
    3 FORMAT(I2,26A3)
      GO TO (10,20,30,40,41),NTYPE
      GO TO 90
   10 READ(99,4) IB,AREA,D,YB,YT,B,WD,C,E,A,H,IW
    4 FORMAT(4X,F8.2,2X,F6.2 ,2X,F5.2,7(2X,F4.2),2X,F4.2,2X,I1)
    6 FORMAT(3X,10(1X,F5.2))
      GO TO 22
```



```
   20 READ(99,5) DIA   ,FPS,UWB,UWS,SFPC,EC,ECSL,ES,EFW,NCDL,DFACT
    5 FORMAT(4X,A4   ,3X,F5.2,2(2X,F5.2),2X,F6.2,5(2X,F4.2),2X,F5.3)
      FPS=FPS*1000.
      FPY = 40000.0
      GO TO 22
   30 READ(99,6)(CNCP(I),I=1,10)
      READ(5,6)(CNCD(I),I=1,10)
      DO 50 I=1,10
      IF(CNCP(I).EQ.0.0) GO TO 60
   50 CONTINUE
   60 NCL=I-1
      DO 70 I=1,10
      IF(CNCD(I).EQ.0.0) GO TO 80
   70 CONTINUE
   80 NCD=I-1
      IF(NCL.EQ.NCD) GO TO 22
      WRITE(6,8)
    8 FORMAT(T30,'ERROR IN CONCENTRATED LOAD INPUT')
      GO TO 500
   40 READ(99,6) (SCNCP(I),I=1,10)
      READ(5,6) (SCNCD(I),I=1,10)
      DO 121 I=1,10
      IF(SCNCP(I).EQ.0.0) GO TO 122
  121 CONTINUE
  122 NSP = I-1
      DO 123 I=1,10
      IF(SCNCD(I).EQ.0.0) GO TO 124
  123 CONTINUE
  124 NSD = I-1
      IF(NSP.EQ.NSD) GO TO 19
      WRITE(6,8)
      GO TO 500
   41 READ(99,6)(CCP(I),I=1,10)
      READ(5,6)(CCD(I),I=1,10)
      DO 120 I=1,10
      IF(CCP(I).EQ.0.0) GO TO 130
  120 CONTINUE
  130 NL=I-1
      DO 140 I=1,10
      IF(NL.EQ.ND) GO TO 19
      IF(CCD(I).EQ.0.0) GO TO 150
  140 CONTINUE
  150 ND = I
      IF(CCD(1).EQ.0.0) GO TO 19
      WRITE(6,8)
  500 READ(5,3,END=333) NTYPE,ICARD
      GO TO (500,500,500,500,500),NTYPE
      READ(5,2,END=333) BTYPE,SPANL,BSPAC,TS,SMBOL1,SMBOL2,RROAD,
```

```
     1SPAN1,SPAN2,BMNO1,BMNO2,IOPUT
      GO TO 12
   19 CONTINUE
      LTYPE=0
      DO 600 IN = 1,6
      IF(DIA.EQ.DIA1(IN)) GO TO 601
  600 CONTINUE
  601 CONTINUE
      IF(FPS.EQ.270000.) GO TO 602
      IF (IN.EQ.6) WRITE(6,604)
      ASTRN = SAREA2(IN)
      GO TO 603
  602 ASTRN = SAREA1(IN)
  603 CONTINUE
  604 FORMAT(1H1,/////,T25,'THE REQUESTED 9/16 IN 250K STRAND IS NOT',
     1'AVAILABLE')
      GO TO 21
   90 CALL INDATA
   21 CONTINUE
      IF(SMBOL1.EQ.CHRCTR(1)) LTYPE = 1
      IF(SMBOL1.EQ.CHRCTR(2).OR.SMBOL1.EQ.CHRCTR(3)) LTYPE = 2
      IF(SMBOL1.EQ.CHRCTR(4).OR.SMBOL1.EQ.CHRCTR(5)) LTYPE = 3
      IF(RROAD.NE.0.0) GO TO 100
      GO TO 9
  100 CONTINUE
      LTYPE = 4
    9 CONTINUE
      IF(SPANL.GT.0.00.AND.SPANL.LE.50.0) KODE = 1
      IF(SPANL.GT.50.0.AND.SPANL.LE.90.0) KODE = 2
      IF(SPANL.GT.90.0.AND.SPANL.LE.130.) KODE = 3
      IF(SPANL.GT.130..AND.SPANL.LE.170.) KODE = 4
      CALL PROPTY
      CALL HELP
  104 CALL PSTRES
      IF(IOPUT.NE.0) GO TO 102
      CALL SHPUT
      IF(BTYPE.NE.BEAM(9)) GO TO 1

      GO TO 103
  102 CALL LOPUT
      IF(BTYPE.NE.BEAM(9)) GO TO 1
      GO TO 103
    1 IF(BTYPE.NE.BNSTD) GO TO 11
      CALL ZERO
      GO TO 11
  103 IF(IW.GE.3) GO TO 1
      IW = IW + 1
      CALL CHANGE
```



```
      GO TO 104
  333 STOP
      END
```

```
      SUBROUTINE PROPTY
C
      REAL IB,IB1,INA,NCDL,MNCDL,MS,IBSL
      COMMON/TJH/ B,WD,C,E,A
      COMMON/HLF/ X1,X2,Y1,Y2,Y12
      COMMON/JJJ/ BB(11),WDD(11),CC(11),EE(11)
      COMMON/MMM/ FO,HDPT,P
      COMMON/BNS/ BNSTD
      COMMON/KI/ ASL,IBSL,INA,YTC,YBC,YTCSL,ZTSL,YBCSL,ZBSL,AREAC,ECCL,
     1ENDMAX,TENIN,SPANL,BSPAC,BTYPE,TS, EFW ,UWB,UWS,EC,ECSL,ES,ASTRN,
     2FPS,NCDL,ZTB,ZBB,YT,AREA,D,IB,ZBBC,STRNS,ECAL,YB,ZTBC,WTF,BP,AV
     3,FPY,LTYPE,KASE,KODE,RROAD,SFPC,DFACT,DIA
      COMMON/LI/BEAM(11),AR(11),YB1(11),YT1(11),D1(11),IB1(11),WTF1(11),
     1BPRIME(11),HH(11)
C
C
      IF(BTYPE.EQ.BNSTD) GO TO 1
      DO 4 IPNT = 1,11
      IF(BTYPE.EQ.BEAM(IPNT)) GO TO 5
    4 CONTINUE
    5 CONTINUE
      KASE = IPNT
      AREA = AR(IPNT)
      YB = YB1(IPNT)
      IB = IB1(IPNT)
      YT = YT1(IPNT)
      D = D1(IPNT)
      WTF = WTF1(IPNT)
      BP=BPRIME(IPNT)
      X1 = BB(IPNT)
      X2 = (BB(IPNT) - WDD(IPNT))/2.0
      Y1 = CC(IPNT)
      Y2 = EE(IPNT)
      Y12 = Y1 + Y2
      H = HH(IPNT)
C
C     DETERMINE EFFECTIVE FLANGE WIDTH
C
      FW1 = SPANL/4.
      FW2 = BSPAC
      FW3 = (12.*TS + WTF ) / 12.
      EFW = FW1
      IF(EFW.GT.FW2) EFW = FW2
      IF(EFW.GT.FW3) EFW = FW3
      EFW = EFW * 12.
      GO TO 3
    1 CONTINUE
      EFW = EFW * 12.
```



```
      X1 = B
      X2 = (B - WD ) / 2.0
      Y1 = C
      Y2 = E
      Y12 = Y1 + Y2
      BP = WD
      WTF = A
    3 CONTINUE
      ASL = EFW * TS * ECSL / EC
      IBSL = ASL*TS*TS/12.
      YBC = (ASL*(TS/2.+D)+AREA*YB)/(ASL+AREA)
      INA = ASL*(TS/2.+D)**2+AREA*YB**2+IBSL+IB-(ASL+AREA)*YBC**2
      YTC = D - YBC
      ZBB=IB/YB
      ZTB=IB/YT
      ZTBC = INA / YTC
      ZBBC = INA/YBC
      YTCSL = D + TS - YBC
      ZTSL = INA/YTCSL
      AREAC = AREA+ASL
    2 CONTINUE
      IF(SPANL.LT.120.) HDPT = 5.
      IF(SPANL.GE.120.0.AND.SPANL.LT.140.) HDPT = 6.
      IF(SPANL.GE.140.0.AND.SPANL.LT.160.) HDPT = 7.
      IF(SPANL.GE.160.0.AND.SPANL.LT.180.) HDPT = 8.
      RETURN
      END
```

```
      SUBROUTINE MILLER
C
      REAL IB,IB1,INA,NCOL,MNCOL,MS,IBSL
      COMMON/HLF/ X1,X2,Y1,Y2,Y12
      COMMON/KI/ ASL,IBSL,INA,YTC,YBC,YTCSL,ZTSL,YBCSL,ZBSL,AREAC,ECCL,
     1ENDMAX,TENIN,SPANL,BSPAC,BTYPE,TS, EFW ,UWB,UWS,EC,ECSL,ES,ASTRN,
     2FPS,NCOL,ZTB,ZBB,YT,AREA,D,IB,ZBBC,STRNS,ECAL,YB,ZTBC,WTF,BP,AV
     3,FPY,LTYPE,KASE,KODE,RROAD,SFPC,DFACT,DIA
      COMMON/MM/ROW(20),NROW,SROW(20),SPACE,IW,DROW(20)
      COMMON/LI/BEAM(11),AR(11),YB1(11),YT1(11),D1(11),IB1(11),WTF1(11),
     1BPRIME(11),HH(11)
C   SPACE - DISTANCE BETWEEN STRANDS
C
C
      THETA = ATAN(Y2/X2)
      CL = X1/2.0
      X3 = 2.0 / SIN(THETA)
      X4 = Y1 / TAN(THETA)
      X5 = X4 - X3 + 2.0
      Y3 = X5 * TAN(THETA)
      Y4 = X2 * TAN(THETA)
      Y34 = Y3 + Y4
      SPACE = 2.0
      HSPACE = SPACE/2.0
      FL = X1 - 2.0* X2
      FLCL = FL/2.0
      IF(STRNS.LE.0.0) GO TO 999
      DIST = CL + X4 - X3 - X5
      NROW = 0
      NSTRNS = STRNS/2.0
      IF(IW.EQ.2) GO TO 11
      A = DIST
      NS = STRNS
      K=1
      NS=NS-1
   21 A=A-SPACE
      IF(A.LT.-0.001.OR.NS.LT.2) GO TO 22
      K=K+2
      NS = NS - 2
      GO TO 21
   22 IF(A.LT.-0.001) GO TO 23
      K=K+NS
      NS=0
   23 NROW=NROW+1
      ROW(NROW)=K
      IF(NS.EQ.0)GO TO 99
      H=SPACE
   24 H=H+SPACE
```



```
      IF(NS.LE.0) GO TO 99
      IF(H.GT.Y3) GO TO 25
      IF(NS.LT.K) GO TO 33
      NROW=NROW+1
      ROW(NROW)=K
      NS=NS-K
      GO TO 24
   25 IF(NS.LE.0) GO TO 99
      IF(H.GT.Y34) GO TO 29
      DIST = CL - 2.0 / SIN(THETA)
      A = DIST
      K=1
      NS = NS - 1
   26 A=A-SPACE
      IF(A.LT.-0.001.OR.NS.LT.2) GO TO 27
      K=K+2
      NS=NS-2
      GO TO 26
   27 IF(A.LT.-0.001) GO TO 28
      IF(NS.EQ.1) GO TO 28
      K=K+NS
      NS=0
   28 NROW=NROW+1
      ROW(NROW)=K
      IF(NS.LE.0) GO TO 99
      CL = CL - 2.0 / TAN(THETA)
      GO TO 24
   29 A=FLCL
      K=1
   30 A=A-SPACE
      IF(A.LT.2.0.OR.NS.LT.2) GO TO 31
      NS=NS-2
      K=K+1
      GO TO 30
   31 IF(A.LT.2.0) GO TO 32
      K=K+NS
      NS=0
   32 NROW=NROW+1
      ROW(NROW)=K
      IF(NS.LE.0) GO TO 99
      IF(NS.LT.K) GO TO 29
      NS=NS-K
      GO TO 32
   33 IF(NS.EQ.4) GO TO 34
      IF(NS.EQ.6) GO TO 34
      IF(NS.EQ.8) GO TO 34
      IF(NS.EQ.10) GO TO 34
      NROW = NROW + 1
```

```
            ROW(NROW) = NS
            GO TO 99
         34 K = NS - 1
            NROW = NROW + 1
            ROW(NROW) = K
            NS = NS - K
            GO TO 24
         11 A = DIST + HSPACE
            K = 0
            H = SPACE
          1 A = A-SPACE
            IF(A.LT.-0.001.OR.NSTRNS.LE.0) GO TO 2
            K = K+1
            NSTRNS = NSTRNS - 1
            GO TO 1
          2 LPW = 2 * K
            NROW = NROW + 1
            ROW(NROW) = LPW
            IF(ROW(NROW).LE.0.0) NROW = NROW - 1
            IF(NSTRNS.LE.0) GO TO 99
          3 H = H + SPACE
            IF(H.GT.Y3) GO TO 4
            IF(NSTRNS.LT.K) GO TO 11
            NROW = NROW + 1
            ROW(NROW) = LPW
            NSTRNS = NSTRNS -K
            GO TO 3
          4 CONTINUE
            IF(NSTRNS.LE.0) GO TO 99
            IF(H.GT.Y34) GO TO 7
            DIST = CL - 2.0 / SIN(THETA)
            A = DIST + HSPACE
            K = 0
          5 A = A-SPACE
            IF(A.LT.-0.001.OR.NSTRNS.LE.0) GO TO 6
            K = K+1
            NSTRNS = NSTRNS - 1
            GO TO 5
          6 LPW = 2 * K
            NROW = NROW + 1
            ROW(NROW) = LPW
            IF(NSTRNS.LE.0) GO TO 99
            CL = CL - 2.0 / TAN(THETA)
            GO TO 3
          7 A = FLCL+HSPACE
            K = 0
          8 A = A-SPACE
            IF(A.LT.2.0.OR.NSTRNS.LE.0) GO TO 9
```



```
            NSTRNS = NSTRNS - 1
            K = K + 1
            GO TO 8
          9 LPW = 2 * K
            NROW = NROW + 1
         12 CONTINUE
            ROW(NROW) = LPW
            IF(NSTRNS.LE.0) GO TO 99
            IF(NSTRNS.LT.K) GO TO 7
            NSTRNS = NSTRNS - K
            NROW = NROW + 1
            GO TO 12
         99 CONTINUE
            SUMSTR = 0
            SUMMST = 0
            SUMSL = 0
            DO 13 JR = 1,NROW
            SUMMST = ROW(JR) * (2.0 + ((JR - 1) *SPACE)) + SUMMST
         13 SUMSTR = ROW(JR) + SUMSTR
            ECAL= SUMMST / SUMSTR
        999 CONTINUE
            RETURN
            END
```

```
      SUBROUTINE HELP
      COMMON/CONC/ CNCP(10),CNCD(10),CCP(10),CCD(10),SCNCP(10),SCNCD(10)
      COMMON/MMM/ FD,HDPT,P
      COMMON/BNS/ BNSTD
      COMMON/LLI/ BMMA(20),BMDL(20),BMSUM(20),BMBM(20),BMNCDL(20),VSUM(2
     10),BMSL(20)
      COMMON/KI/ ASL,IBSL,INA,YTC,YBC,YTCSL,ZTSL,YBCSL,ZBSL,AREAC,ECCL,
     1ENDMAX,TENIN,SPANL,BSPAC,BTYPE,TS, EFW ,UWB,UWS,EC,ECSL,ES,ASTRN,
     2FPS,NCDL,ZTB,ZBB,YT,AREA,D,IB,ZBBC,STRNS,ECAL,YB,ZTBC,WTF,BP,AV
     3,FPY,LTYPE,KASE,KODE,RROAD,SFPC,DFACT,DIA
      COMMON/JWM/ VMA(20),VDL(20),XDIST(15),DEFK2,DEFL12,DEFK1,DEFL14,
     1DNCDL2,DNCDL1
      COMMON/KAP/ W,WCP
      COMMON/MSC/ VNCDL(15)
      REAL NCDL,IB,INA
      DIMENSION VOL(11)
      DIMENSION CAY(11),FACTOR(11),VCAY(11),SUBTND(11)
      DIMENSION CONST(2,4),        POINT(4)
      DIMENSION VMM(15),BMM(15) ,BMMS(15),VMMS(15)
      DATA VMM,BMM,BMMS,VMMS/60*0.0/
      DATA CONST/1.4322,2.0833,2.5174,3.5494,3.5156,5.4598,3.9333,6.300/
      DATA VCAY/0.9445,1.1667,1.3889,2.000,2.2223,2.4445,2.6668,2.8890,2
     1.0000,2.4446,2.8890/
      DATA SUBTND/0.6656,0.69169,0.76419,0.6005,0.6354,0.7344,0.7696,0.8
     1057,0.9622,1.1381,0.9631/
C
C
      NCDL = NCDL*1000.
      IF(SPANL.EQ.0.0) GO TO 101
      TSPAN = SPANL * 0.1
      DO 5 I = 1,11
    5 XDIST(I) = (I - 1) * TSPAN
      XDIST(12) = SPANL * 0.25
      XDIST(13) = SPANL * 0.75
      XDIST(14) = SPANL / 2.0 - HDPT
      XDIST(15) = SPANL / 2.0 + HDPT
      DEFL14 = 0.0
      DEFL12 = 0.0
      WCP = 0.0
      TS = TS/12.
      ECI = EC * IB * 10. **6
      ECSI = EC*INA*10.0**6
      WS = UWS * TS * BSPAC
      WB = UWB * AREA / 144.0
      W = WS + WB
      WNCDL = NCDL/12.0
      BMREAC = 0.5*WB*SPANL
      RNCDL = 0.5*NCDL*SPANL
```



```
      SPANN = SPANL * 12.0
      WI = WS/12.
      DEFK2   =    5.0* WI* SPANN ** 4/( 384.0*ECI)
      DEFK1   =   57.0* WI* SPANN ** 4/(6144.0*ECI)
      DNCDL1 = 57.0*WNCDL*SPANN**4/(6144.0*ECSI)
      DNCDL2 = 5.0*WNCDL*SPANN**4/(384.0*ECSI)
      IF(BTYPE.EQ.BNSTD) GO TO 50
      VOL(KASE) =VCAY(KASE) * (BSPAC - SUBTND(KASE))
      CP= VOL(KASE) * UWB
      REACTN = 0.5*(KODE *CP + W * SPANL)
      CONST1 =CP * SPANN ** 3 / (ECI * 100.0)
      WCP = (KODE*CP)/SPANL
      DEFL14 = CONST(1,KODE)*CONST1
      DEFL12 = CONST(2,KODE)*CONST1
      GO TO 51
   50 DO 55 I = 1,10
      IF(CNCP(I).EQ.0.0) GO TO 56
   55 CNCP(I) = CNCP(I) * 1000.
   56 CONTINUE
      X12 = SPANN * 0.5
      X14 = SPANN * 0.25
      X122 = X12 * X12
      X142 = X14 * X14
      ECSI6 = 6.0*ECSI
      ECI6 = 6. * ECI
      X12L = X12 * SPANN
      X14L = X14 * SPANN
      DO 30 N = 1,10
      NN = N
      IF(CNCD(N).LE.0.0) GO TO 31
   30 CONTINUE
   31 N2 = NN/2
      N22 = N2 * 2
C     X - DISTANCE FROM LEFT REACTION TO INSPECTION POINT
C     X14 = QUARTER POINT
C     X12 = HALF POINT
C     X142 = DISTANCE TO QUARTER POINT SQUARED
C     X122 = DISTANCE TO HALF POINT SQUARED
C     CNCP(N) = WEIGHT OF CONCENTRATED DEADLOAD N
C     CNCD(N) = DISTANCE FROM LEFT REACTION TO THE NTH DEADLOAD
      IF(N2.LE.0) GO TO 35
      DO 34 N = 1,N2
      PDL = CNCP(N)
      P12 = PDL * X12
      P14 = PDL * X14
      DX = CNCD(N) *12.
      PDX = PDL * DX
      DX2 = DX * DX
```

```
      IF (DX.GT.X14) GO TO 33
      DEFL14 = DEFL14 + PDX * (3.0*(X14L-X142)-DX2)/ECI6
      GO TO 34
   33 DEFL14 = DEFL14 + P14 * (3.0*(SPANN*DX-DX2) - X142)/ECI6
   34 DEFL12 = DEFL12 + P12 * (3.0*X12L-X122-DX2)/ECI6
   35 IF(NN.EQ.N22)  GO TO 36
      PNN1 = CNCP(N2+1)
      DEFL14 = DEFL14 + PNN1*X14*(3.0*SPANN**2-4.*X142)/(48.*ECI)
      DEFL12 = DEFL12 + PNN1*SPANN**3/(48.*ECI)
   36 CONTINUE
      SUMW = 0.
      DO 37 I = 1,NN
   37 SUMW = SUMW + CNCP(I)
      REACTN = (SUMW + W * SPANL ) * 0.5
      DO 39 I = 1,15
      X = XDIST(I)
      VM = W * X
      BM = 0.5 * W * X*X
      DO 38 L = 1,NN
      IF(CNCD(L).GE.X) GO TO 87
      VM = VM + CNCP(L)
   38 BM = BM + CNCP(L) * (X-CNCD(L))
   87 BMM(I) = ABS(REACTN*X-BM)  * 12.
      VMM(I) = ABS(REACTN-VM)
   39 CONTINUE
      SDEF12 = 0
      SDEF14 = 0
C     SCNCP(N) = WEIGHT OF STATIC CONC DEADLOAD N
C     SCNCD(N) = DISTANCE FROM  LEFT REACTION TO THE NTH LOAD
      IF(SCNCP(1).EQ.0) GO TO 86
      DO 80 N = 1,10
      NN = N
      IF(SCNCP(N).LE.0.0) GO TO 81
   80 CONTINUE
   81 SUMW = 0
      SUMWC = 0
      DO 82 I = 1,NN
      SUMW = SUMW + SCNCP(I)
   82 SUMWC = SUMWC + SCNCP(I) * SCNCD(I)
      CBAR = SUMWC / SUMW
      REACT1 = (1.0 - CBAR/SPANL) * SUMW
      DO 85 I = 1,15
      X = XDIST(I)
      BM = 0
      VM = 0
      DO 83 M = 1,NN
      IF(X.LE.SCNCD(M)) GO TO 84
      VM = VM + SCNCD(M)
```



```
   83 BM = SCNCP(M) * (X-SCNCD(M)) + BM
   84 VMMS(I) = REACT1 - VM
   85 BMMS(I)= REACT1 * X - BM
   86 CONTINUE
      DO 40 I = 1,11
      BMMS(I) = AMAX1(BMMS(I),BMMS(12-I))
      VMMS(I) = AMAX1(VMMS(I),VMMS(12-I))
      BMM(I) = AMAX1(BMM(I),BMM(12-I))
   40 VMM(I) = AMAX1(VMM(I),VMM(12-I))
      BMM(12) = AMAX1(BMM(12),BMM(13))
      BMM(13) = BMM(12)
      BMM(14) = AMAX1(BMM(14),BMM(15))
      BMM(15) = BMM(14)
      VMM(12) = AMAX1(VMM(12),VMM(13))
      VMM(13) = VMM(12)
      VMM(14) = AMAX1(VMM(14),VMM(15))
      VMM(15) = VMM(14)
      VMMS(12) = AMAX1(VMMS(12),VMMS(13))
      BMMS(12) = AMAX1(BMMS(12),BMMS(13))
      VMMS(14) = AMAX1(VMMS(14),VMMS(15))
      BMMS(14) = AMAX1(BMMS(14),BMMS(15))
      BMMS(15) = BMMS(14)
      VMMS(15) = VMMS(14)
      BMMS(13) = BMMS(12)
      VMMS(13) = VMMS(12)
   51 SLREAC = 0.5 * (WS + WCP ) * SPANL
      KK = 0
      N1 = 1
      N2 = 6
      N3 =1
    3 DO 15 I = N1,N2,N3
      X = XDIST(I)
      VDL(I) = REACTN -( W + WCP ) * X
      IF(BTYPE.EQ.BNSTD) VDL(I) = VMM(I)
      VNCDL(I) = RNCDL - NCDL*X
      BMDL(I) = (REACTN - (W + WCP)*X/2.)*X*12.
      IF(BTYPE.EQ.BNSTD) BMDL(I) = BMM(I)
      BMBM(I) = (BMREAC-WB*X/2.)*X*12.
      BMSL(I) = (SLREAC -(WS +WCP ) * X/2.) * X * 12.
      BMNCDL(I) = (RNCDL - NCDL*X/2.)*X*12.
   15 CONTINUE
      IF (KK.GT.0) GO TO 17
      KK = KK+1
      N1 = 12
      N2 = 15
      N3 = 2
      GO TO 3
   17 CONTINUE
```

```
      DO 16 I =7,11
      BMDL(I) = BMDL(12-I)
      BMBM(I) = BMBM(12-I)
      BMSL(I) = BMSL(12-I)
      VNCDL(I) = VNCDL(12-I)
      BMNCDL(I) = BMNCDL(12-I)
   16 VDL(I) = VDL(12-I)
      CALL TYPELD
      DO 21 I =1,11
      VSUM(I) = VMA(I) + VDL(I) +VNCDL(I) + VMMS(I)
      BMSUM(I) = BMDL(I) + BMMA(I) + BMNCDL(I) + BMMS(I)
   21 CONTINUE
      DO 23 I = 12,15,2
      VSUM(I) = VMA(I) + VDL(I) + VNCDL(I) + VMMS(I)
      BMSUM(I) = BMDL(I) + BMMA(I) + BMNCDL(I) + BMMS(I)
   23 CONTINUE
      VSUM(13) = VSUM(12)
      VSUM(15) = VSUM(14)
      BMSUM(13) = BMSUM(12)
      BMSUM(15) = BMSUM(14)
  101 CONTINUE
      TS = TS * 12.0
      RETURN
      END
```

```fortran
      SUBROUTINE ZERO
      COMMON/CONC/ CNCP(10),CNCD(10),CCP(10),CCD(10),SCNCP(10),SCNCD(10)
      COMMON/LLI/ BMMA(20),BMDL(20),BMSUM(20),BMBM(20),BMNCDL(20),VSUM(2
     10),BMSL(20)
      COMMON/JWM/ VMA(20),VDL(20),XDIST(15),DEFK2,DEFL12,DEFK1,DEFL14,
     1DNCDL2,DNCDL1
      COMMON/MSC/ VNCDL(15)
C     THIS ROUTINE INITIALIZES ARRAYS
      DO 1 I = 1,10
      CCP(I) = 0.0
      CCD(I) = 0.0
      CNCP(I) = 0.0
      CNCD(I) = 0.0
      SCNCP(I) = 0.0
      SCNCD(I) = 0.0
    1 CONTINUE
      DO 2 I = 1,20
      VSUM(I) = 0.0
      VMA(I) = 0.0
      VDL(I) = 0.0
      BMDL(I) = 0.0
      BMMA(I) = 0.0
      BMNCDL(I) = 0.0
      BMSUM(I) = 0.0
    2 CONTINUE
      DO 3 I = 1,15
      VNCDL(I) = 0.0
    3 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE SHEAR(FPC)
C
      REAL MU(20),VU(20),     MCR(20),MUVU(20)
      REAL IB,IB1,INA,NCDL,MNCDL,MS,IBSL
      COMMON/FYB/KGRID,NSTRNS,ENDECC,IWCH
      COMMON/ELL/ IBMNC,WORDS(40),XD1,XD2,     DESCR(17)
      COMMON/KI/ ASL,IBSL,INA,YTC,YBC,YTCSL,ZTSL,YBCSL,ZBSL,APEAC,ECCL,
     1ENDMAX,TENIN,SPANL,BSPAC,BTYPE,TS, EFW ,UWB,UWS,EC,ECSL,ES,ASTRN,
     2FPS,NCDL,ZTB,ZBB,YT,AREA,D,IB,ZBBC,STRNS,ECAL,YB,ZTBC,WTF,BP,AV
     3,FPY,LTYPE,KASE,KODE,RROAD,SFPC,DFACT,DIA
      COMMON/JWM/ VMA(20),VDL(20),XDIST(15),DEFK2,DEFL12,DEFK1,DEFL14,
     1DNCDL2,DNCDL1
      COMMON/MMM/ FO,HDPT,P
      COMMON/IBM/ ACI(15),VS(20)
      COMMON/LLI/ BMMA(20),BMDL(20),BMSUM(20),BMBM(20),BMNCDL(20),VSUM(2
     10),BMSL(20)
      COMMON/JRR/S(15),SQ
      COMMON/MSC/ VNCDL(15)
      DIMENSION          VC(15),VCG(15),RJ(15),DD(15),VPR(15),VULT(15)
      DIMENSION E(20),XD(20),FPE(20),FO(20),VP(20),VPU(20),VUVPU(20),PHI
     1VC(20), PHIVPU(20),VCI(20),PHIVCI(20),VCIM(20),VCW(20),PHIVCW(20)
      DATA MUVU,E,XD,FPE,FO,MCR,VP,VPU,PHIVPU,VCI,PHIVCI,VCIM,VCW,
     1PHIVCW,VUVPU,PHIVC,VULT/335*0.0/
      DATA VC,VCG,RJ,DD,VPR,VU/95*0.0/
C
C
C
      AV    = 0.20
      SPANL=12.0*SPANL
      HDPT=12.0*HDPT
      DO 996 I = 1,11
      VU(I)=1.5*VDL(I)+2.5*VMA(I)
  996 CONTINUE
      Q = EFW*TS*(TS*0.5 + YTC)
      DM=D+TS
      X1=((SPANL/2.0)-HDPT)/(SPANL/10.0)
      X2=((SPANL/2.0)+HDPT)/(SPANL/10.)+1.0
      N1=X1+1
      N2=X2+1
         TTHETA=(ECCL-ENDECC)/(SPANL/2.0-HDPT)
      DD(1)=YT+ENDECC
      DO 88 I=2,11
      IF(I.LE.N1)DD(I)=DD(I-1)+(SPANL/10.)*TTHETA
      IF(I.GT.N1.AND.I.LT.N2)DD(I)=YT+ECCL
      IF(I.GE.N2)DD(I)=DD(I-1)-(SPANL/10.0)*TTHETA
   88 CONTINUE
      DO 99 I=1,11
      IF(I.LE.N1) CTHETA=((SPANL/2.0)-HDPT)/SQRT((ECCL-ENDECC)**2+(SPANL
```



```
     1/2.0-HDPT)**2)
      IF(I.GT.N1.AND.I.LT.N2)   CTHETA=1.0
      IF(I.GE.N2) CTHETA=((SPANL/2.0)-HDPT)/SQRT((ECCL-ENDECC)**2+(SPANL
     1/2.0-HDPT)**2)
      RJ(I)=BMSUM(I)/(P*CTHETA*DD(I))
      VC(I)=0.06*FPC*BP*RJ(I)*DD(I)
      VCG(I)=180.*BP*PJ(I)*DD(I)
      IF(VC(I).GT.VCG(I))VC(I)=VCG(I)
      STHETA=SQRT(1-CTHETA**2)
      VPR(I)=P*STHETA
   99 CONTINUE
      DO 101 J=1,11
      S(J)=AV*4.0*FPY*RJ(J)*DD(J)/(VU(J)-VPR(J)-VC(J))
      SG=0.75*DM
      IF(S(J).GT.SG) S(J) = SG
      IF(VU(J).LE.(VPR(J)+VC(J))) S(J) = SG
  101 CONTINUE
      DO 244 J=1,11
      IF(AV    .LE.0.11)GO TO 200
      IF(4.*TS.GT.24.0)GO TO 201
      IF(S(J).GT.4.*TS)S(J)=4.*TS
      GO TO 202
  201 IF(S(J).GT.24.0)S(J)=24.0
      GO TO 202
  200 IF(S(J).GT.12.) S(J)=12.0
  202 CONTINUE
   70 AVM=S(J)   *0.0025*BP/2.0
      IF(AV    .LT.AVM)GO TO 1200
      GO TO 1201
 1200 S(J)=S(J)-1.0
      GO TO 70
 1201 CONTINUE
  244 CONTINUE
      DO 500 I=1,11
      VS(I)=(1.5*VDL(I)+2.5*VMA(I)-VPR(I))*Q/(INA*WTF)
  500 CONTINUE
C     SQ-SPACING AT THE QUARTER POINTS
C
C     TO CALCULATE SPACING AT QUARTER POINT
C
      QMU=BMSUM(12)
      VUQ=(1.5*VDL(12)+2.5*VMA(12))-VPR(2)
      IF(X1.GT.2.5)DDQ=DD(1)+(SPANL*.25)*TTHETA
      IF(X1.GT.2.5) CTHETA=((SPANL/2.0)-HDPT)/SQRT((ECCL-ENDECC)**2+(SPA
     1NL/2.0-HDPT)**2)
      IF(X1.LE.2.5)DDQ=YT+ECCL
      IF(X1.LE.2.5)CTHETA=1.0
      RJQ=QMU/(P*CTHETA*DDQ)
```

```
      VCQ=0.06*FPC*BP*RJQ*DDQ
      VCGQ=180.0*BP*RJQ*DDQ
      IF(VCQ.GT.VCGQ)VCQ=VCGQ
      SQ   =AV   *4.0*FPY*RJQ*DDQ/(VUQ-VCQ)
      SGQ=0.75*DM
      IF(SQ   .GT.SGQ)SQ   =SGQ
      IF(AV   .LE.0.11)GO TO 208
      IF(4.*TS.GT.24.0)GO TO 209
      IF(SQ   .GT.4.*TS)SQ   =4.*TS
      GO TO 210
209   IF(SQ   .GT.24.0)SQ   =24.0
      GO TO 210
208   IF(SQ   .GT.12.0)SQ   =12.0
210   CONTINUE
71    AVMQ=SQ   *0.0025*BP/2.0
      IF(AV   .LT.AVMQ)GO TO 1202
      GO TO 1203
1202  SQ   =SQ   -1.0
      GO TO 71
1203  CONTINUE
      X=0.
      XDD=YT+ECCL
      AS = ASTRN * STRNS
      FPCC = P/AREA
      HSPAN = SPANL/2.
      DO 5  I = 1,11
      VULT(I) = 1.5*(VDL(I) + VNCDL(I) ) + 1.8*VMA(I)
      MUVU(I) = BMSUM(I)/VSUM(I)
      E(I) = (ECCL-ENDECC)*X/(HSPAN-HDPT)
      IF(X.GT.(HSPAN-HDPT)) E(I) = ECCL-ENDECC
      IF(X.GT.(HSPAN+HDPT)) E(I) = (ECCL-ENDECC)*((SPANL-X)/(HSPAN-HDPT
     1))
      XD(I) = YT + E(I)  + ENDECC
      FPE(I) = P/AREA + P * YB * E(I)/IB
      FD(I) = BMBM(I) * YB/IB
      MCR(I) = (IB/YB) * ((7.5 * SQRT(FPC)) + FPE(I) - FD(I))
      VP(I) = P * STHETA
      IF( X .GT. (HSPAN - HDPT)) VP(I) = 0.
      IF(X.GT.(HSPAN+HDPT)) VP(I) = P*STHETA
      VPU(I)=(AS/80.)*FPS*SQRT(XD(I)/BP)
      PHIVPU(I) = 0.85 * VPU(I)
      VCI(I) = 0.6 *BP * XD(I) * SQRT(FPC) + MCR(I)/(MUVU(I) - XD(I)/2.
     1) + VDL(I)
      IF(X .EQ. 0.0) VCI(I) = 0.0
      PHIVCI(I) = 0.85 * VCI(I)
      VCIM(I) = 0.85 * 1.7 * BP * XD(I) * SQRT(FPC)
      IF(XD(I).LT.(0.8*D)) XD(I) = 0.8*D
      VCW(I) = BP * XD(I) * (3.5 * SQRT(FPC) + 0.3 * FPCC) + VP(I)
```



```
      PHIVCW(I) = 0.85 * VCW(I)
      VUVPU(I) = VULT(I) - PHIVPU(I)
      IF(PHIVCW(I) - PHIVCI(I)) 6,6,7
    6 PHIVC(I) = PHIVCW(I)
      GO TO 8
    7 PHIVC(I) = PHIVCI(I)
    8 CONTINUE
      IF((PHIVC(I) - VCIM(I)).LE.0.0) PHIVC(I)=VCIM(I)
      IF(PHIVC(I).GT.VUVPU(I)) GO TO 11
      ACI(I)   = 2. * AV    * 0.85 *XDD   * FPY/(VULT(I) - PHIVC(I))
      IF(0.75 * D .GT. 24.) GO TO 300
      SMAX = 0.75 * D
      GO TO 301
  300 SMAX = 24.
  301 IF(ACI(I)    .LT. SMAX) GO TO 14
      ACI(I)    = SMAX
   14 CONTINUE
      GO TO 4
   11 CONTINUE
      ACI(I)    = 2.*AV    *80.*FPY*XDD   /(AS*FPS*SQRT(XDD   /BP))
      IF(0.75 * D .GT. 24.) GO TO 400
      SMAX =0.75 * D
      GO TO 401
  400 SMAX = 24.
  401 IF(ACI(I)    .LT. SMAX) GO TO 18
      ACI(I)    = SMAX
   18 CONTINUE
    4 X = X + SPANL/10.
    5 CONTINUE
      SPANL=SPANL/12.0
      HDPT=HDPT/12.0
      RETURN
      END
```

```
              SUBROUTINE ECCEND
      C
      C
              COMMON/KI/ ASL,IBSL,INA,YTC,YBC,YTCSL,ZTSL,YBCSL,ZBSL,AREAC,ECCL,
             1ENDMAX,TENIN,SPANL,BSPAC,BTYPE,TS, EFW ,UWB,UWS,EC,ECSL,ES,ASTRN,
             2FPS,NCDL,ZTB,ZBB,YT,AREA,D,IB,ZBBC,STRNS,ECAL,YB,ZTBC,WTF,BP,AV
             3,FPY,LTYPE,KASE,KODE,RROAD,SFPC,DFACT,DIA
              COMMON/MM/ROW(20),NROW,SROW(20),SPACE,IW,DROW(20)
              COMMON/FYB/KGRID,NSTRNS,ENDECC,IWCH
      C
      C
              IWCH = 1
              KS = 0
              WBK = 2.
              IF(IW.EQ.3) WBK = 3.0
              TDS = 0.0
              DO 1 JR = 1,NROW
              SROW(JR) = ROW(JR) - WBK
              IF(SROW(JR).LE.0.0) GO TO 12
              DROW(JR) = WBK
              GO TO 11
           12 DROW(JR) = ROW(JR)
              SROW(JR) = 0.0
           11 TDS = TDS + DROW(JR)
            1 CONTINUE
              X = 0.
              SUMD1 = 0.
              SUMD2 = 0.
              SUMDW1 =0.
              SUMDW2 = 0.
              DO 2 I = 1,NROW
              X = X + SPACE
              SUMD1 = SUMD1 + SROW(I)
              SUMDW1 = SUMDW1 + SROW(I)*X
              SUMD2 = SUMD2 + DROW(I)
            2 SUMDW2 = SUMDW2 + DROW(I)*X
              XBAR1 = SUMDW1/SUMD1
              XBAR2 = SUMDW2/SUMD2
              XBAR22 = XBAR2
            3 CGT = (SUMDW1 + SUMD2*XBAR22)/STRNS
              CGTLMT = YB -ENDMAX
              IF(CGT.GE.CGTLMT) GO TO 4
              XBAR22 = XBAR22 + SPACE
              KS = KS + 1
              X1 = (NROW + KS ) * 2
              IF(X1.GE.(D-2.)) GO TO 5
              GO TO 3
            5 IWCH = 2
```



```
            4 CONTINUE
              NSTRNS = TDS
              KGRID = X1
              ENDECC = YB - CGT
              RETURN
              END
```

```
0001          SUBROUTINE LOPUT
0002          REAL IB,IB1,INA,NCDL,MNCDL,MS,IBSL
0003          COMMON/IC/ MSTATE
0004          COMMON/IBM/ ACI(15),VS(20)
0005          COMMON/JWM/ VMA(20),VDL(20),XDIST(15),DEFK2,DEFL12,DEFK1,DEFL14,
             1DNCDL2,DNCDL1
0006          COMMON/ELL/BMNO1,BMNO2,WORDS(40),SMBOL1,SMBOL2,SPAN1,SPAN2,
             1DESCR(17)
0007          COMMON/LOC/PLMAX,CMAX,ACR,BCR,ASH,BSH
0008          COMMON/KI/ ASL,IBSL,INA,YTC,YBC,YTCSL,ZTSL,YBCSL,ZBSL,AREAC,ECCL,
             1ENDMAX,TENIN,SPANL,BSPAC,BTYPE,TS, EFW ,UWB,UWS,EC,ECSL,ES,ASTRN,
             2FPS,NCDL,ZTB,ZBB,YT,AREA,D,IB,ZBBC,STRNS,ECAL,YB,ZTBC,WTF,BP,AV
             3,FPY,LTYPE,KASE,KODE,RROAD,SFPC,DFACT,DIA
0009          COMMON/MMM/ FO,HDPT,P
0010          COMMON/MM/ROW(20),NROW,SROW(20),SPACE,IW,DROW(20)
0011          COMMON/ILL/ REQULT,ULTMOM,FPC,FPCI,NSTATE
0012          COMMON/LLI/ BMMA(20),BMDL(20),BMSUM(20),BMBM(20),BMNCDL(20),VSUM(2
             10),BMSL(20)
0013          COMMON/JDF/ FTLL(20),FBLL(20),FTSL(20),FBSL(20),FTBM(20),
             1FBBM(20),FTDL(20),FBDL(20),FTNCDL(20),FBNCDL(20),ST(20),SB(20)
             2,FT(20),FB(20),FTI(20),FBI(20),FTIB(20),FBIB(20),FTIBSN(20),
             3FBIBSN(20)
0014          COMMON/FYB/KGRID,NSTRNS,ENDECC,IWCH
0015          COMMON/JRR/S(15),SQ
0016          COMMON/KAP/ W,WCP
0017          DIMENSION RELMES(30)
0018          DIMENSION CGMENT(40) ,KOMENT(20)
0019          DATA KOMENT/'DESI','GN B','ASED',' ON ','STRE','SSES','    ','
             1'    ,'    ','    ','DESI','GN B','ASED',' ON ','ULTI','MATE',' MO
             2M','ENT ','    ','    '/
0020          DATA COMENT/'UNDE','R RE','INFC','RCED',' FLA','NGED',' SEC','TION
             1' ,'    ','    ','OVER',' REI','NFOR','CED ','FLAN','GED ','SECT',
             2'ION ','    ','    ','UNDE','R RE','INFO','RCED',' REC','TANG','UL
             3AR',' SEC','TION','    ','OVER',' REI','NFOR','CED ','RECT','ANGU'
             4,'LAR ','SECT','ION ','    '/
0021          DATA RELMES/'    ','    ','    ','    ','    ','    ','    ','
             1','    ','    ','    ','    ','    ','    ','    ','RELE','ASE ','
             2STRE','SS B','ASED',' ON ','MAXI','MUM ','DRAP','E PO','SITI','ON
             3 ','    ','    ','    '/
        C
        C
0022          JI= (IWCH -1) * 15 + 1
0023          IIF = IWCH *15
0024          NI = ( NSTATE - 1 ) * 10 + 1
0025          NF = NSTATE * 10
0026          MI = (MSTATE-1)*10 + 1
0027          MF = MSTATE*10
0028          IF(FPC.LE.5000.) GO TO 300
```



```
0029          NFPC = FPC/10
0030          FPC = (NFPC + 1 ) * 10.
0031          IF(FPCI.LE.4000.) GO TO 300
0032          NFPCI = FPCI/10
0033          FPCI = ( NFPCI + 1 ) * 10.
0034      300 CONTINUE
0035          FPS = FPS / 1000.
0036          NFPS = FPS
0037          REQULT=REQULT/12000.
0038          ULTMOM=ULTMOM/12000.
0039          DEFK1 = DEFK1/12.
0040          DEFK2 = DEFK2/12.
0041          DEFL12 = DEFL12/12.
0042          DEFL14 = DEFL14/12.
0043          DNCDL1 = DNCDL1/12.
0044          DNCDL2 = DNCDL2/12.
0045          DO 293 I = 1,15
0046          BMDL(I) = BMDL(I)/12000.
0047          BMMA(I) = BMMA(I)/12000.
0048          BMSUM(I) =BMSUM(I)/12000.
0049          VDL(I) = VDL(I)/1000.
0050          VMA(I) = VMA(I)/1000.
0051          VSUM(I) = VSUM(I)/1000.
0052      293 CONTINUE
0053          WRITE(6,81)(WORDS(I),I=1,40)
0054       81 FORMAT(1H1,///,2(40X,20A4,/))
0055          WRITE(6,1)(DESCR(I),I=1,17),SPAN1,SPAN2,BMNO1,BMNO2
0056        1 FORMAT(T48,17A4,//,5X,'SPAN',2X,A4,A1,5X,
             1'BEAM NO.',2X,A4,A1,//,T50,'INPUT DATA',//)
0057          WRITE(6,2)BTYPE,UWB,DFACT,SPANL,UWS,EFW,BSPAC,SFPC,NCDL,TS,EC,
             1IB,  DIA,ECSL,AREA
0058        2 FORMAT(5X,'BEAM TYPE',9X,'=   ',A2,13X,'UNIT WT. BEAM CONC.    =',
             1F6.0,'   PCF',13X,'L.L. DIST. FACTOR =',F10.2,/,5X,'SPAN LENGTH',
             27X,'=',F7.2,' FT',8X,'UNIT WT. SLAB CONC.     =',F6.0,'   PCF',13X,
             3'COMP. SLAB WIDTH  =',F10.2,' IN',/,5X,'BEAM SPACING',6X,'=',F7.2,
             4' FT',8X,'28-DAY ST.(SLAB CONC.) =',F6.0,'   PSI',13X,'COMP. DEAD
             5LOAD   =',F10.2,' KLF',/,5X,'SLAB THICKNESS    =',F7.2,' IN',8X,
             6'E(BM. CONC.)',11X,'=',F8.2,' E(06)PSI',8X,'BEAM INERTIA',6X,'=',
             7F8.0,'   IN4',/,5X,'STRAND SIZE',7X,'=   ',A4,' IN',8X,'E(SLB. CON
             8C.)',10X,'=',F8.2,' E(06)PSI',8X,'BEAM AREA',9X,'=',F10.2,' IN2')
0059          WRITE(6,227) NFPS,ES,D,IW,SMBOL1,SMBOL2,YB,SPACE,RROAD,YT
0060      227 FORMAT(5X,'STRAND ULT. STR.  =',I6,'K',11X,'E(PSTR. STL.)',10X,'='
             1,F8.2,' E(06)PSI',8X,'BEAM DEPTH',8X,'=',F10.2,' IN',/,5X,'NO. OF
             2 EB STRNS. =',I5,13X,'AASHO L.L.',13X,'=',3X,A4,A1,17X,'BEAM YB',
             311X,'=',F10.2,' IN',/,5X,'GRID SIZE',9X,'=',F5.0,'    IN',8X,'RAILR
             4OAD L.L.',10X,'=    E-',F3.0,16X,'BEAM YT',11X,'=',F10.2,' IN')
0061          WRITE(6,3)
0062        3 FORMAT(/////T22,'MOMENT  SUMMARY (FT-KIPS)',9X,'SHEAR  SUMMARY (KI
```

```
     1PS)',                  //,5X,'SECTION        DEAD LOAD  L.L.+I.
     2  TOTAL',13X,'DEAD LOAD  L.L.+I.    TOTAL')
      DO 4 I = 1,11
      II = I -1
    4 WRITE(6,5)II,BMDL(I),BMMA(I),BMSUM(I),VDL(I),VMA(I),VSUM(I)
    5 FORMAT(8X,I2,12X,F6.1,3X,F6.1,5X,F6.1,13X,F6.1,4X,F6.1,5X,F6.1,/)
      WRITE(6,24) BMDL(14),BMMA(14),BMSUM(14),VDL(14),VMA(14),VSUM(14)
   24 FORMAT(3X,'HOLD-DOWN',10X,F6.1,3X,F6.1,5X,F6.1,13X,F6.1,4X,F6.1,
     15X,F6.1,/)
   11 FORMAT(1H1,5X,17A4)
      WRITE(6,11)(DESCR(I), I=1,17)
      WRITE(6,6)
    6 FORMAT(////,5X,'STRESSES IN EXTREME FIBERS DUE TO EXTERNAL LOADS (
     1LBS PER SQ. IN.)',//,54X,'TOTAL D.L.',9X,'DEAD LOAD',9X,'LIVE LOAD
     2',/,5X,'SECTION',9X,'BEAM',14X,'SLAB',10X,'NON-COMP SEC.',7X,'COMP
     3 SEC.',7X,'PLUS IMPACT',10X,'TOTAL',/,11X,6(7X,'TOP',5X,'BOT'),/)
      DO 8 I = 1,11
      II = I -1
    8 WRITE(6,7)II,FTBM(I),FBBM(I),FTSL(I),FBSL(I),FTDL(I),FBDL(I),
     1FTNCDL(I),FBNCDL(I),FTLL(I),FBLL(I),ST(I),SB(I)
    7 FORMAT(7X,I2,3X,6(4X,F6.0,2X,F6.0))
      WRITE(6,25) FTBM(14),FBBM(14),FTSL(14),FBSL(14),FTDL(14),FBDL(14),
     1FTNCDL(14),FBNCDL(14),FTLL(14),FBLL(14),ST(14),SB(14)
   25 FORMAT(4X,'HOLD-DOWN',3X,F6.0,2X,F6.0,5(4X,F6.0,2X,F6.0))
      WRITE(6,9)
    9 FORMAT(///,5X,'STRESSES DUE TO EXTERNAL LOADS PLUS PRESTRESS (LBS
     1PER SQ. IN.)',//,40X,'BEAM PLUS',8X,'FINAL PREST. PLUS',6X,'ALL LO
     2ADS PLUS',/,17X,'INITIAL PREST.',7X,'INITIAL PREST.',4X,'TOT. D.L.
     3(N/C SEC.)',6X,'FINAL PREST.',/,8X,4(10X,'TOP',5X,'BOT'),/)
      DO 59 I=1,11
      II = I -1
   59 WRITE(6,821)II,FTI(I),FBI(I),FTIB(I),FBIB(I),FTIBSN(I),FBIBSN(I),
     1FT(I),FB(I)
  821 FORMAT(7X,I2,4(7X,F6.0,2X,F6.0))
      WRITE(6,822) FTI(14),FBI(14),FTIB(14),FBIB(14),FTIBSN(14),
     1FBIBSN(14),FT(14),FB(14)
  822 FORMAT(4X,'HOLD-DOWN',1X,2(2X,F6.0),3(7X,F6.0,2X,F6.0))
      WRITE(6,11)(DESCR(I), I=1,17)
      WRITE(6,12)SQ
   12 FORMAT(///4X,'STIRRUP SPACING IN EXTERIOR 1/4 SPAN (AASHO SPECS.)'
     1,4X,                          'NO. 4 AT',F6.1,' IN.')
      WRITE(6,13) S(6)
   13 FORMAT(//4X,'STIRRUP SPACING IN MIDDLE 1/2 SPAN (AASHO SPECS.)',
     16X,                          'NO. 4 AT',F6.1,' IN.')
      WRITE(6,14)
   14 FORMAT(//4X,'STIRRUP SPACING BASED ON ACI SPECS.',//9X,'SECTION'/)
      DO 15 L=1,11
      LL = L-1
```



```
   15 WRITE(6,16) LL,ACI(L)
   16 FORMAT(11X,I2,6X,'NO. 4 AT',F5.1,' IN.')
      WRITE(6,17)
   17 FORMAT(///4X,'MAXIMUM ULTIMATE HORIZONTAL SHEAR BETWEEN SLAB AND G
     1IRDER FLANGE (VQ/I)',//9X,'SECTION'/)
      DO 18 L=1,11
      LL=L-1
   18 WRITE(6,19) LL,VS(L)
   19 FORMAT(11X,I2,F12.1,' PSI')
      WRITE(6,11)(DESCR(I), I=1,17)
      WRITE(6,20) REQULT,ULTMOM,(COMENT(I),I=NI,NF),(KOMENT(I),I=MI,MF)
   20 FORMAT(     ////,4X,'ULTIMATE MOMENT REQUIRED =',F8.1,' FT-KIPS',/,
     14X,'ULTIMATE MOMENT PROVIDED =',F8.1,' FT-KIPS',10X,10A4,/,56X,
     210A4,///)
      WRITE(6,21) DEFK2,DEFL12,DNCDL2,DEFK1,DEFL14,DNCDL1
   21 FORMAT(//,2X,'DEAD LOAD DEFLECTIONS',5X,'SLAB',5X,'DIAPHRAM',9X,
     1'COMP DEAD LOAD',//,16X,'MIDSPAN',4X,F5.3,' FT',3X,F5.3,' FT',10X,
     2F5.3,' FT',//,10X,'QUARTER POINT',4X,F5.3,' FT',3X,F5.3,' FT',
     310X,F5.3,' FT' )
      WRITE(6,22) CMAX,PLMAX
   22 FORMAT(///4X,'MAXIMUM CAMBER ='F6.2,' IN.'/
     14X,'PRESTRESS LOSS =',F6.2,' PERCENT')
      WRITE(6,23) BTYPE,STRNS,DIA,NFPS,ECCL,ENDECC,FPCI,(RELMES(I),I=JI,
     1IIF),FPC,NSTRNS,KGRID
   23 FORMAT(/////4X,'TYPE OF BEAM',14X,'=',4X,A2/4X,'NO. OF STRANDS',12
     1X,'=',F6.0,/4X,'SIZE OF STRANDS',11X,'=',3X,A4  ,/4X,'ULT. STRENGT
     2H OF STRANDS  =',   I7,'K'     ,/4X,'ECCENTRICITY AT C.L.',6X,'=',
     3F7.2,' IN.'/4X,'ECCENTRICITY AT END',7X,'=',F7.2,' IN.',/4X,'CONCR
     4ETE RELEASE STRENGTH =',F7.0,' PSI',5X,15A4,/,4X,'CONCRETE 28-DAY
     5STRENGTH  =',F7.0,' PSI',
     6       /,4X,'NUMBER OF DRAPED STRANDS  =',I3,/,4X,'DEPRESS TOP STR
     7ANDS TO POSITION A-',I2)
      WRITE(6,27)
   27 FORMAT(/, 4X,'STRAND PATTERN AT CENTERLINE OF BEAM')
      DO 28 I=1,NROW
      J = ROW(I)
   28 WRITE(6,26) I,J
   26 FORMAT(/, 4X,'ROW',I2,' HAS',I3  ,' STRANDS')
      RETURN
      END
```

```
0001          SUBROUTINE SHPUT
        C
        C
0002          REAL IB,IB1,INA,NCDL,MNCDL,MS,IBSL
0003          DIMENSION COMENT(24)
0004          COMMON/IBM/ ACI(15),VS(20)
0005          COMMON/JWM/ VMA(20),VDL(20),XDIST(15),DEFK2,DEFL12,DEFK1,DEFL14,
             1DNCDL2,DNCDL1
0006          COMMON/ELL/BMNO1,BMNO2,WORDS(40),SMBOL1,SMBOL2,SPAN1,SPAN2,
             1DESCR(17)
0007          COMMON/LOC/PLMAX,CMAX,ACR,BCR,ASH,BSH
0008          COMMON/KI/ ASL,IBSL,INA,YTC,YBC,YTCSL,ZTSL,YBCSL,ZBSL,AREAC,ECCL,
             1ENDMAX,TENIN,SPANL,BSPAC,BTYPE,TS, EFW ,UWB,UWS,EC,ECSL,ES,ASTRN,
             2FPS,NCDL,ZTB,ZBB,YT,AREA,D,IB,ZBBC,STRNS,ECAL,YB,ZTBC,WTF,BP,AV
             3,FPY,LTYPE,KASE,KODE,RROAD,SFPC,DFACT,DIA
0009          COMMON/MMM/ FO,HDPT,P
0010          COMMON/MM/ROW(20),NROW,SROW(20),SPACE,IW,DROW(20)
0011          COMMON/ILL/ REQULT,ULTMOM,FPC,FPCI,NSTATE
0012          COMMON/LLI/ BMMA(20),BMDL(20),BMSUM(20),BMBM(20),BMNCDL(20),VSUM(2
             10),BMSL(20)
0013          COMMON/JDF/ FTLL(20),FBLL(20),FTSL(20),FBSL(20),FTBM(20),
             1FBBM(20),FTDL(20),FBDL(20),FTNCDL(20),FBNCDL(20),ST(20),SB(20)
             2,FT(20),FB(20),FTI(20),FBI(20),FTIB(20),FBIB(20),FTIBSN(20),
             3FBIBSN(20)
0014          COMMON/FYB/KGRID,NSTRNS,ENDECC,IWCH
0015          COMMON/JRR/S(15),SQ
0016          DATA COMENT/'UNDE','R RE','INF.',' FLG','D. S','ECT.','OVER',' RET
             1','NF. ','FLGD','. SE','CT. ','UNDE','R RE','INF.',' REC','T. S','
             2ECT.','OVER',' REI','NF. ','RECT','. SE','CT. '/
0017          FPS = FPS/1000.
0018          NFPS = FPS
0019          REQULT = REQULT/12000.
0020          ULTMOM = ULTMOM/12000.
0021          DEFK1 = DEFK1/12.
0022          DEFK2 = DEFK2/12.
0023          DEFL12 = DEFL12/12.
0024          DEFL14 = DEFL14/12.
0025          DNCDL1 = DNCDL1/12.
0026          DNCDL2 = DNCDL2/12.
0027          DO 293 I = 1,15
0028          BMDL(I) = BMDL(I)/12000.
0029          BMMA(I) = BMMA(I)/12000.
0030          BMSUM(I) =BMSUM(I)/12000.
0031          VDL(I) = VDL(I)/1000.
0032          VMA(I) = VMA(I)/1000.
0033          VSUM(I) = VSUM(I)/1000.
0034      293 CONTINUE
0035          NI = (NSTATE - 1) * 6 + 1
```



```
0036          NF = NSTATE * 6
0037        5 FORMAT(  5X,'NOTE----BEAM DESIGN BASED ON ULTIMATE MOMENT REQUIREM
             1ENTS')
0038        6 FORMAT(  5X,'NOTE----RELEASE STRENGTH BASED ON MAXIMUM DRAPED POSI
             1TION OF STRANDS')
0039        7 FORMAT(1H1,///,2(27X,20A4,/))
0040        8 FORMAT(47X,17A4,//,55X,'SPAN ',A4,A1,3X,'BEAM ',A4,A1)
0041       10 FORMAT(///,5X,'**** INPUT DATA **** ',//,5X,'BEAM TYPE',9X,'=    ',
             1A2,13X,'UNIT WT. BEAM CONC.     =',F6.0,'   PCF',13X,'L.L. DIST. FA
             2CTOR =',F10.2,/,5X,'SPAN LENGTH',7X,'=',F7.2,' FT',8X,'UNIT WT. SL
             3AB CONC.     =',F6.0,'   PCF',13X,'COMP. SLAB WIDTH  =',F13.2,' IN'
             4)
0042       11 FORMAT(5X,'BEAM SPACING',6X,'=',F7.2,' FT',8X,'28-DAY ST.(SLAB CON
             1C.) =',F6.0,'   PSI',13X,'COMP. DEAD LOAD   =',F10.2,' KLF',/,5X,
             2'SLAB THICKNESS    =',F7.2,' IN',8X,'E(BM.CONC.)',12X,'=',F8.2,
             3' E(06)PSI',8X, 'BEAM INERTIA',6X,'=',F8.0,'   IN4')
0043       12 FORMAT(5X,'STRAND SIZE',7X,'=    ',A4,' IN',8X,'E(SLB.CONC.)',11X,
             1'=',F8.2,' E(06)PSI',8X,'BEAM AREA',9X,'=',F10.2,' IN2',/,5X,
             2'STRAND ULT. STR.  =',I6,'K',11X,'E(PSRR. STL.)',10X,'=',F8.2,' E(
             306)PSI',8X,'BEAM DEPTH',8X,'=',F10.2,' IN')
0044       13 FORMAT(5X,'NO.OF WEB STRNS.  =',I5,13X,'AASHO L.L.',13X,'=',3X,A4,
             1A1,17X,'BEAM YB',11X,'=',F10.2,' IN',/,5X,'GRID SIZE',9X,'=',F5.0,
             2'   IN',8X,'RAILROAD L.L.',10X,'=    E-',F3.0,16X,'BEAM YT',11X,
             3'=',F10.2,' IN')
0045       14 FORMAT(///,5X,'TYPE OF BEAM',14X,'=',3X,A2,22X,'D.L. DEFLECTION AT
             1 MID-SPAN =',F7.3,' FT (SLAB)',4X,F7.3,' FT (DIAF)',/5X,'NO. OF ST
             2RANDS',12X,'=',F6.0,21X,'D.L. DEFLECTION AT 1/4 PT.  =',F7.3,' FT
             3(SLAB)',4X,F7.3,' FT (DIAF)',/,5X,'SIZE OF STRANDS',11X,'=    ',A4)
0046       15 FORMAT(5X,'TYPE OF STRANDS',11X,'=',I6,'K',20X,'ULTIMATE MOMENT RE
             1QUIRED =',F6.0,' FT-KIPS',/,5X,'ECCENTRICITY AT C.L.',6X,'=',F8.2,
             2' IN',16X,'ULT. MOMENT PROVIDED =',4X,F6.0,' FT-KIPS  ',6A4,
             3          /,5X,'ECCENTRICITY AT END',7X,'=',F8.2,' IN')
0047       16 FORMAT(5X,'NO. OF DEPRESSED STRANDS  =',I5,22X,'STIRRUP SPAC. (MID
             1DLE 1/2 SPAN) = NO. 4 AT',F6.2,' IN',/,5X,'DEPRESS TOP ',I1,' STRA
             2NDS TO POSITION A-',I2,16X,'STIRRUP SPAC. (EXT. 1/4 SPAN)   = NO.
             34 AT',F6.2,' IN',/,5X,'CONCRETE RELEASE STRENGTH =',F6.0,'   PSI')
0048       17 FORMAT(5X,'CONCRETE 28-DAY STRENGTH  =',F8.0,'   PSI',13X,'TOP FIB
             1ER DESIGN STRESS (C.L.)    =',F6.0,' PSI',/59X,'BOTTOM FIBER DESIG
             2N STRESS (C.L.) =',F6.0,' PSI',//,59X,'MAXIMUM CAMBER =',F6.2,' IN
             3',/,59X,'PRESTRESS LOSS =',F6.2,' PERCENT')
0049       18 FORMAT(5X,'*** STRAND PATTERN ***',/,9X,'(C.L. OF BEAM)'/)
0050       20 FORMAT(5X,'ROW',I3,' HAS',F4.0,' STRANDS')
0051       21 FORMAT(//,5X,'*** BEAM DESIGN ***')
0052          WRITE(6,7)(WORDS(I),I = 1,40)
0053          WRITE(6,8)(DESCR(I),I=1,17),SPAN1,SPAN2,BMNO1,BMNO2
0054          WRITE(6,10) BTYPE,UWB,DFACT,SPANL,UWS,EFW
0055          WRITE(6,11) BSPAC ,SFPC,NCDL,TS,EC,IB
0056          WRITE(6,12) DIA,ECSL,AREA,NFPS,ES,D
```

```
                 WRITE(6,13) IW,SMBOL1,SMBOL2,YB,SPACE,RROAD,YT
                 WRITE(6,21)
                 IF(NSTATE.EQ.2) WRITE(6,5)
                 IF(IWCH.EQ.2) WRITE(6,6)
                 WRITE(6,14) BTYPE,DEFK2,DEFL12,STRNS,DEFK1,DEFL14,DIA
                 WRITE(6,15) NFPS,REQULT,ECCL,ULTMOM,(COMENT(I),I = NI,NF),ENDECC
                 WRITE(6,16) NSTRNS,S(6),IW,KGRID,SQ,FPCI
                 WRITE(6,17) FPC,ST(6),SB(6),CMAX,PLMAX
                 WRITE(6,18)
                 DO 19 I = 1,NROW
              19 WRITE(6,20) I,ROW(I)
                 RETURN
                 END
```

```
0001           SUBROUTINE MACKS(BMMAX,VMAX,M,V,BMLL,REACTN,MBM,MVM)
         C
         C
0002           BM = ABS(BMLL)
0003           VEE = ABS(V)
0004           IF(BMMAX.GT.BM) GO TO 1
0005           BMMAX = BM
0006         1 IF(VMAX.GT.VEE) GO TO 2
0007           VMAX = VEE
0008         2 CONTINUE
0009           RETURN
0010           END
```

```
0001            SUBROUTINE LANELD(TOTTLD)
0002            COMMON/JWM/ VMA(20),VOL(20),XDIST(15),DEFK2,DEFL12,DEFK1,DEFL14,
               1DNCOL2,DNCOL1
0003            COMMON/KI/ ASL,IBSL,INA,YTC,YBC,YTCSL,ZTSL,YBCSL,ZBSL,AREAC,ECCL,
               1ENDMAX,TENIN,SPANL,BSPAC,BTYPE,TS, EFW ,UWB,UWS,EC,ECSL,ES,ASTRN,
               2FPS,NCDL,ZTB,ZBB,YT,AREA,D,IB,ZBBC,STRNS,ECAL,YB,ZTBC,WTF,BP,AV
               3,FPY,LTYPE,KASE,KODE,PROAD,SFPC,DFACT
0004            COMMON/J/ BMHS(20),BMSP(20),BMLL(20)       ,VHS(20),VSP(20),VLL(20)
0005            DIMENSION V(20),BM(20)
0006            DATA BM,V/40*0.0/
          C
          C
0007            CONCLV = 0.65 * TOTTLD
0008            CONCLM = 0.45 * TOTTLD
0009            W = 0.016 * TOTTLD
0010            DO 1 LD = 1,15
0011            DIST = XDIST(LD)
0012            REACTV = 0.5*W*SPANL+ (1.0-DIST/SPANL) *CONCLV
0013            REACTM = 0.5*W*SPANL+ (1.0-DIST/SPANL) *CONCLM
0014            V(LD) =  REACTV - W*DIST
0015            BM(LD) = DIST * (REACTM-W*DIST*0.5 )*12.
0016            BMLL(LD) = BM(LD)
0017            VLL(LD) = V(LD)
0018          1 CONTINUE
0019            DO 2 LD = 1,11
0020            VLL(LD) = AMAX1(V(LD),V(12-LD))
0021            BMLL(LD) = AMAX1(BM(LD),BM(12-LD))
0022          2 CONTINUE
0023            RETURN
0024            END
```

```
FORTRAN IV G LEVEL  18                INPUT1            DATE = 70224         00/55/25             PAGE 0001

              SUBROUTINE INPUT1
              COMMON/ELL/ IBMNO,WORDS(40),SMBOL1,SMBOL2,SPAN1,SPAN2,DESCR(17)
              READ(5,14)(WORDS(I),I=1,40)
              READ(5,15)(DESCR(I),I=1,17)
           14 FORMAT(20A4)
           15 FORMAT(12X,17A4)
              RETURN
              END
```

```
FORTRAN IV G LEVEL  18                INDATA            DATE = 70224         00/55/25             PAGE 0001

              SUBROUTINE INDATA
        C
        C
              REAL IB,IB1,INA,NCOL,MNCOL,MS,IBSL
              COMMON/KI/ ASL,IBSL,INA,YTC,YBC,YTCSL,ZTSL,YBCSL,ZBSL,AREAC,ECCL,
             1ENDMAX,TENIN,SPANL,BSPAC,BTYPE,TS, EFW ,UWB,UWS,EC,ECSL,ES,ASTRN,
             2FPS,NCOL,ZTB,ZBB,YT,AREA,D,IB,ZBBC,STRNS,ECAL,YB,ZTBC,WTF,BP,AV
             3,FPY,LTYPE,KASE,KODE,RROAD,SFPC,DFACT,DIA
              COMMON/MM/ROW(20),NROW,SROW(20),SPACE,IW,DROW(20)
              DATA DIAB/'1/2 '/
        C
        C
              DFACT = BSPAC/11.
              DIA = DIAB
              ASTRN = 0.154
              UWB = 150.
              UWS = 150.
              SFPC = 3600.
              EC = 5.
              ECSL = 5.
              ES = 28.
              FPS = 270000.
              FPY = 40000.
              NCOL = 0.
              IW=2
              RETURN
              END
```

```
FORTRAN IV G LEVEL  18                ALLOW             DATE = 70224         00/55/25             PAGE 0001

              SUBROUTINE ALLOW
              COMMON/ALL/ FBII,ACOMPR,TTEN,FTP,PLOSS,PPERST
              COMMON/ILL/ REQULT,ULTMOM,FPC,FPCI,NSTATE
              COMMON/KI/ ASL,IBSL,INA,YTC,YBC,YTCSL,ZTSL,YBCSL,ZBSL,AREAC,ECCL,
             1ENDMAX,TENIN,SPANL,BSPAC,BTYPE,TS, EFW ,UWB,UWS,EC,ECSL,ES,ASTRN,
             2FPS,NCOL,ZTB,ZBB,YT,AREA,D,IB,ZBBC,STRNS,ECAL,YB,ZTBC,WTF,BP,AV
             3,FPY,LTYPE,KASE,KODE,RROAD,SFPC,DFACT,DIA
        C
        C    DETERMINE ALLOWABLE STRESSES
        C
              FBII = 0.6*FPCI
              ACOMPR = 0.4*FPC
              TTEN =-7.5*SQRT(FPCI)
              FTP =-3.*SQRT(FPC )
              IF(FTP.LT.(-250.)) FTP = -250.
              TENIN = 0.7*FPS*ASTRN
              PLOSS = 0.20
              PPERST = TENIN*(1. - PLOSS )
              RETURN
              END
```

```
      SUBROUTINE TYPELD
      COMMON/KI/ ASL,IBSL,INA,YTC,YBC,YTCSL,ZTSL,YBCSL,ZBSL,AREAC,ECCL,
     1ENDMAX,TENIN,SPANL,BSPAC,BTYPE,TS, EFW ,UWB,UWS,EC,ECSL,ES,ASTRN,
     2FPS,NCDL,ZTB,ZBB,YT,AREA,D,IB,ZBBC,STRNS,ECAL,YB,ZTBC,WTF,BP,AV
     3,FPY,LTYPE,KASE,KODE,RROAD,SFPC,DFACT
      COMMON/CONC/ CNCP(10),CNCD(10),CCP(10),CCD(10),SCNCP(10),SCNCD(10)
      COMMON/LLI/ BMMA(20),BMDL(20),BMSUM(20),BMBM(20),BMNCDL(20),VSUM(2
     10),BMSL(20)
      COMMON/J/ BMHS(20),BMSP(20),BMLL(20)       ,VHS(20),VSP(20),VLL(20)
      COMMON/MMM/ FO,HDPT,P
      COMMON/JWM/ VMA(20),VDL(20),XDIST(15),DEFK2,DEFL12,DEFK1,DEFL14,
     1DNCDL2,DNCDL1
      DIMENSION WEIGHT(5)
      DATA WEIGHT/2*40.0,30.0,2*0.0/
C
C
      FRACT = (50./(SPANL + 125.)) + 1.
      IF(FRACT.GT.1.3) FRACT = 1.3
      DO 5 I = 1,10
      IF(CCP(I).NE.0.0.OR.CCD(I).NE.0.0) GO TO 6
    5 CONTINUE
      TOTTLD = WEIGHT(LTYPE)*1000.
      GO TO(1,2,2,3,3),LTYPE
    1 CALL JMLOAD(TOTTLD)
      CALL SPCL
      CALL LANELD(TOTTLD)
      DO 100 L = 1,15
      BMMA(L) = AMAX1(BMHS(L),BMLL(L),BMSP(L))*FRACT*DFACT
      VMA(L) = AMAX1(VHS(L),VLL(L),VSP(L))*FRACT*DFACT
  100 CONTINUE
      GO TO 102
    2 CALL SPCL
      CALL LANELD(TOTTLD)
      DO 101 L = 1,15
      BMMA(L) = AMAX1(BMSP(L),BMLL(L))*FRACT*DFACT
      VMA(L) = AMAX1(VSP(L),VLL(L))*FRACT*DFACT
  101 CONTINUE
      GO TO 102
    3 CALL RRLOAD
      GO TO 102
    6 CALL CONLD
      DO 7 I = 1,15
      BMMA(I) = BMMA(I)*FRACT*DFACT
    7 VMA(I) = VMA(I)*FRACT*DFACT
  102 RETURN
      END
```

```
      SUBROUTINE MOMENT
      COMMON/KI/ ASL,IBSL,INA,YTC,YBC,YTCSL,ZTSL,YBCSL,ZBSL,AREAC,ECCL,
     1ENDMAX,TENIN,SPANL,BSPAC,BTYPE,TS, EFW ,UWB,UWS,EC,ECSL,ES,ASTRN,
     2FPS,NCDL,ZTB,ZBB,YT,AREA,D,IB,ZBBC,STRNS,ECAL,YB,ZTBC,WTF,BP,AV
     3,FPY,LTYPE,KASE,KODE,RROAD,SFPC,DFACT,DIA
      COMMON/LLI/ BMMA(20),BMDL(20),BMSUM(20),BMBM(20),BMNCDL(20),VSUM(2
     10),BMSL(20)
      COMMON/ILL/ REQULT,ULTMCM,FPC,FPCI,NSTATE
C
C
      DEPTH = D + TS - ECAL
      ASTEEL = STRNS * ASTRN
      SRATIO = ASTEEL / (EFW * DEPTH)
      FSU = FPS*(1.- 0.5*SRATIO*FPS/FPC    )
      FLCEK = 1.4*DEPTH*SRATIO*FSU/FPC
      ASF = 0.85*FPC*(EFW-BP)*TS/FSU
      ASR = ASTEEL - ASF
      FCHECK = ASR*FSU/(BP*DEPTH*FPC)
      CHECK = SRATIO*FSU/FPC
      IF(RROAD.NE.0.0) GO TO 480
    2 REQULT = 1.5*(BMDL(6) + BMNCDL(6)) + 2.5*BMMA(6)
      IF(TS.GT.FLCEK) GO TO 460
      ULTMOM = ASR*FSU*DEPTH*(1.-(0.6*ASR*FSU/(BP*DEPTH*FPC))) + 0.85*FP
     1C*(EFW-BP)*TS*(DEPTH-0.5*TS)
      IF(FCHECK.GT.0.3) GO TO 467
      NSTATE = 1
      GO TO 461
  467 ULTMOM = 0.25*BP*DEPTH*DEPTH*FPC + 0.85*FPC*(EFW-BP)*TS*(DEPTH-0.5
     1*TS)
      NSTATE = 2
      GO TO 461
  460 ULTMOM = ASTEEL*FSU*DEPTH*(1.-0.6*SRATIO*FSU/FPC    )
      NSTATE = 3
  461 CONTINUE
      IF(CHECK.GT.0.3) GO TO 463
      GO TO 470
  463 ULTMOM = 0.25*FPC*EFW*DEPTH*DEPTH
      NSTATE = 4
      GO TO 470
  480 CONTINUE
      XM = 2.0 - SPANL * 0.004
      IF(SPANL.GT.100.0) XM = 1.6
      REQULT = XM*(BMDL(6) + BMNCDL(6)) + 2.3*BMMA(6)
      IF(TS.GT.FLCEK) GO TO 481
      ULTMOM = ASR*FSU*DEPTH*(1.-(0.6*ASR*FSU/(BP*DEPTH*FPC))) + 0.85*FP
     1C*(EFW-BP)*TS*(DEPTH-0.5*TS)
      NSTATE = 1
      IF(FCHECK.GT.0.3) GO TO 482
```



```
      GO TO 470
  482 ULTMOM = 0.25*BP*DEPTH*DEPTH*FPC + 0.85*FPC*(EFW-BP)*TS*(DEPTH-0.5
     1*TS)
      NSTATE = 2
      GO TO 470
  481 ULTMOM = ASTEEL*FSU*DEPTH*(1.-0.6*SRATIO*FSU/FPC    )
      NSTATE = 3
      IF(CHECK.GT.0.3) GO TO 483
      GO TO 470
  483 ULTMOM = 0.25*FPC*EFW*DEPTH*DEPTH
      NSTATE = 4
  470 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE PSTRES
      REAL IB,IB1,INA,NCDL,MNCDL,MS,IBSL
C
      CCMMON/IC/ MSTATE
      COMMON/KI/ ASL,IBSL,INA,YTC,YBC,YTCSL,ZTSL,YBCSL,ZBSL,AREAC,ECCL,
     1ENDMAX,TENIN,SPANL,BSPAC,BTYPE,TS, EFW ,UWB,UWS,EC,ECSL,ES,ASTRN,
     2FPS,NCDL,ZTB,ZBB,YT,AREA,D,IB,ZBBC,STRNS,ECAL,YB,ZTBC,WTF,BP,AV
     3,FPY,LTYPE,KASE,KODE,RROAD,SFPC,DFACT,DIA
      COMMON/MMM/ FO,HDPT,P
      COMMON/ALL/ FBII,ACOMPR,TTEN,FTP,PLOSS,PPERST
      COMMON/FYB/KGRID,NSTRNS,ENDECC,IWCH
      CCMMON/MM/ROW(20),NROW,SROW(20),SPACE,IW,DROW(20)
      COMMON/ILL/ REQULT,ULTMOM,FPC,FPCI,NSTATE
      COMMON/LLI/ BMMA(20),BMDL(20),BMSUM(20),BMBM(20),BMNCDL(20),VSUM(2
     10),BMSL(20)
      COMMON/JDF/ FTLL(20),FBLL(20),FTSL(20),FBSL(20),FTBM(20),
     1FBBM(20),FTDL(20),FBDL(20),FTNCDL(20),FBNCDL(20),ST(20),SB(20)
     2,FT(20),FB(20),FTI(20),FBI(20),FTIB(20),FBIB(20),FTIBSN(20),
     3FBIBSN(20)
C
C
      FPCI=4000.
      FPC = 5000.
      CALL ALLOW
C
C     CACULATE STRESSES
C
      DO 47 I=1,15
      FTLL(I)=BMMA(I)/ZTBC
      FBLL(I)=BMMA(I)/ZBBC
      FTSL(I)=BMSL(I)/ZTB
      FBSL(I)=BMSL(I)/ZBB
      FTBM(I)=  BMBM(I)/ZTB
      FBBM(I)=BMBM(I)/ZBB
      FTDL(I)=BMDL(I)/ZTB
      FBDL(I)=BMDL(I)/ZBB
      FTNCDL(I)=BMNCDL(I)/ZTBC
      FBNCDL(I)=BMNCDL(I)/ZBBC
      ST(I) = FTDL(I) + FTNCDL(I) + FTLL(I)
      SB(I) = FBDL(I) + FBNCDL(I) + FBLL(I)
   47 CONTINUE
      STRESB = FBDL(6) + FBNCDL(6) + FBLL(6)
C
C     DETERMINE STRESS TO BE OVERCOME BY PRESTRESS
C
      TSTRES = (STRESB + FTP ) / ( 1. - PLOSS )
C
C     OBTAIN INITIAL NUMBER OF STRANDS AND ECCENTRICITY OF THE PATTERN
```



```
C     AT MIDSPAN
C
      ECC  = YB
      TEMPP = TSTRES/(1./AREA + ECC /ZBB)
      FBP = 0.
  401 STRNS = TEMPP/TENIN
      NSTN = STRNS
      NNSTN = NSTN/2
      NMSTN = NNSTN*2
      STRNS = NMSTN
      RSTRNS = 0.003 * AREA / ASTRN
      NSTNR = RSTRNS
      NNSTNR = NSTNR/2 + 1
      NMSTNR = NNSTNR * 2
      RSTRNS = NMSTNR
      IF(RSTRNS.GT.STRNS) STRNS = RSTRNS
  300 CALL MILLER
  319 ECCL  = YB - ECAL
C
C     DETERMINE PRESTRESSING FORCES, INITIAL AND EFFECTIVE
C
      FO = TENIN*STRNS
      P = FO*(1. - PLOSS)
      FTPR = FO/AREA  -(FO *ECCL )/ZTB
      FBP = FO/AREA +(FO *ECCL )/ZBB
  103 TSTRES = (STRESB + FTP ) / ( 1. - PLOSS )
  407 IF(FBP.LT.TSTRES) GO TO 301
      GO TO 304
  301 CONTINUE
   29 STRNS = STRNS + 2.
      GO TO 300
  304 CONTINUE
      FTFOG = FTPR + FTBM(6)
      FBFOG = FBP  -FBBM(6)
      FTFIN = P/AREA - P* ECCL/ZTB  + FTDL(6)+ FTNCDL(6) + FTLL(6)
      FBFIN = P/AREA + P * ECCL / ZBB  -FBDL(6) - FBNCDL(5) -FBLL(6)
      RFPCI = FBFOG/0.6
      IF(RFPCI.LE.FPCI) GO TO 1
      FPCI = RFPCI
      IF(FPC.LT.FPCI) FPC = FPCI
      GO TO 101
    1 CONTINUE
      IF(FTFOG.GT.TTEN) GO TO 320
      CALL STRMOD(ECAL)
      GO TO 319
  101 CALL ALLOW
      GO TO 103
  320 IF(FTFIN.GT.ACOMPR) GO TO 30
```

```
      IF(FBFIN.GT.FTP) GO TO 408
   30 FPC =(FTFIN/0.4) + 1.
      IF(FPC.LT.FPCI) FPC = FPCI
      CALL ALLOW
      GO TO 103
  408 CONTINUE
      MSTATE = 1
      CALL MOMENT
      IF(ULTMOM.GT.REQULT) GO TO 470
      MSTATE = MSTATE + 1
      IF(MSTATE.GE.2) MSTATE = 2
      GO TO 29
  470 END1 = (FO/AREA - TTEN)*ZTB/FO
      END2 = (FBII - FO/AREA)*ZBB/FO
      ENDMAX = END1
      IF(END2.LT.ENDMAX) ENDMAX = END2
      CALL ECCEND
      IF (IWCH.LE.1) GO TO 471
      FPCI1 = ((FO * ENDECC/ZBB) + FO/AREA)/0.6
      FPCI2 = (((FO/AREA) - FO*ENDECC/ZTB)/7.5)**2
      TFPCI = FPCI1
      IF(TFPCI.LT.FPCI2) TFPCI = FPCI2
      IF(TFPCI.GT.FPCI) GO TO 472
      IWCH = 1
      GO TO 471
  472 FPCI = TFPCI
      IF(FPC.LT.FPCI) FPC = FPCI
  471 CONTINUE
      X = 0.
      DIST = SPANL* .5-HDPT
      E = ENDECC
      DO 501 I = 1,14
      IF(I.EQ.12.OR.I.EQ.13) E = ENDECC+(ECCL-ENDECC)*(0.25*SPANL/DIST)
      IF(I.EQ.14) E = ECCL
      FTI(I)=(FO/AREA-FO*E/ZTB)
      FBI(I)=(FO/AREA+FO*E/ZBB)
      FTIB(I)=(FTI(I)+FTBM(I))
      FBIB(I)=(FBI(I)-FBBM(I))
      FTIBSN(I) = (P/AREA-P*E/ZTB) + FTDL(I) + FTNCDL(I)
      FBIBSN(I) = (P/AREA+P*E/ZBB) - FBDL(I) - FBNCDL(I)
      FT(I) = (P/AREA-P*E/ZTB) + FTDL(I) + FTLL(I) +FTNCDL(I)
      FB(I)=(P/AREA+P*E/ZBB) - FBDL(I) - FBLL(I) -FBNCDL(I)
      X = X + SPANL*0.1
      IF(I.EQ.12.OR.I.EQ.13) X = 0.25*SPANL
      IF(I.EQ.14) X = 0.5*SPANL - HDPT
      DECC = (ECCL-ENDECC)*X/DIST
      E = ENDECC + DECC
      IF(X.GT.DIST) E = ECCL
```



```
      IF(X.GT.(SPANL/2. + HDPT)) E = (ECCL - ENDECC ) * (SPANL-X)/(SPANL
     1*0.5-HDPT) +ENDECC
  501 CONTINUE
      CALL CAMBER
      CALL SHEAR(FPC)
      RETURN
      END
```

```
      SUBROUTINE CONLD
      COMMCN/CONC/ CNCP(10),CNCD(10),CCP(10),CCD(10),SCNCP(10),SCNCD(10)
      COMMON/JWM/ VMA(20),VDL(20),XDIST(15),DEFK2,DEFL12,DEFK1,DEFL14,
     1DNCDL2,DNCDL1
      COMMON/LLI/ BMMA(20),BMDL(20),BMSUM(20),BMBM(20),BMNCDL(20),VSUM(2
     10),BMSL(20)
      COMMON/KI/ ASL,IBSL,INA,YTC,YBC,YTCSL,ZTSL,YBCSL,ZBSL,AREAC,ECCL,
     1ENDMAX,TENIN,SPANL,BSPAC,BTYPE,TS, EFW ,UWB,UWS,EC,ECSL,ES,ASTRN,
     2FPS,NCDL,ZTB,ZBB,YT,AREA,D,IB,ZBBC,STRNS,ECAL,YB,ZTBC,WTF,BP,AV
     3,FPY,LTYPE,KASE,KODE,RROAD,SFPC,DFACT
      COMMON/MMM/ FO,HCPT,P
      DIMENSION          V(15), BMM(15)
      DIMENSION VW(20),BMW(20)
      DO 36 I = 1,10
      CCP(I) = CCP(I) * 1000.
   36 CONTINUE
      DO 101 K = 1,10
      IF(CCP(K).LE.0.0) GO TO 102
      LW = K
  101 CONTINUE
  102 LW1 = LW + 1
      LW2 = LW + 2
      DO 103 K = 2,LW
  103 CCD(LW2 - K) = CCD(LW1 - K)
      CCD(1) = 0.0
      DO 10 L = 1,15
      DO 9 M = 1,LW
      DIST = XDIST(L)
      CM = CCD(M)
      N = 0
    4 N = N + 1
      CDIST = CM - CCD(N)
      IF(CDIST.GT.DIST) GO TO 4
      N1 = N
      SPMD = SPANL - DIST
      N = M - 1
    5 N = N + 1
      IF(N.GT.LW) GO TO 6
      CCDIST = CCD(N) - DIST
      IF(CCDIST.LE.SPMD) GO TO 5
    6 NN = N - 1
      CN = CCD(N1)
      SUMWC = 0.0
      SUMLD = 0.0
      DO 7 N = N1,NN
      SUMWC = SUMWC + (CCD(N) - CN) * CCP(N)
    7 SUMLD = SUMLD + CCP(N)
      CBAR = SUMWC / SUMLD + DIST - CDIST
```



```
      SUBM = 0.0
      SUBW = 0.0
      REACTN = (1.0 - CBAR/SPANL) * SUMLD
      DO 8 N = N1,M
      SUBM = (CM - CCD(N)) * CCP(N) + SUBM
    8 SUBW = SUBW + CCP(N)
      SUMM = 0
      IF(M.EQ.N1) GO TO 3
      MM1 = M - 1
      DO 2 N = N1,MM1
    2 SUMM = SUMM + CCP(N)
    3 V1 = ABS(REACTN - SUMM)
      V2 = ABS(REACTN - SUMM - CCP(M))
      VW(M) = AMAX1(V1,V2)
    9 BMW(M) = DIST * REACTN * 12.0 - SUBM * 12.0
      VMAX = 0
      BMAX = 0
      DO 11 M = 1,LW
      BMAX   = AMAX1(BMAX,BMW(M))
      VMAX = AMAX1(VMAX,VW(M))
   11 CONTINUE
      V  (L) = VMAX
      BMM (L) = BMAX
   10 CONTINUE
      DO 35 I = 1,11
      BMMA(I) = AMAX1(BMM(I),BMM(12-I))
      VMA(I) = AMAX1(V(I),V(12-I))
   35 CONTINUE
      BMMA(12) = AMAX1(BMM(12),BMM(13))
      BMMA(13) = BMMA(12)
      BMMA(14) = AMAX1(BMM(14),BMM(15))
      BMMA(15) = BMMA(14)
      VMA(12) = AMAX1(V(12),V(13))
      VMA(13) = VMA(12)
      VMA(14) = AMAX1(V(14),V(15))
      VMA(15) = VMA(14)
      RETURN
      END
```

```
0001              SUBROUTINE JMLOAD(TOTTLD)
0002              COMMON/JWM/ VMA(20),VDL(20),XDIST(15),DEFK2,DEFL12,DEFK1,DEFL14,
                 1DNCDL2,DNCDL1
0003              COMMON/KI/ ASL,IBSL,INA,YTC,YBC,YTCSL,ZTSL,YBCSL,ZBSL,ARFAC,ECCL,
                 1ENDMAX,TENIN,SPANL,BSPAC,BTYPE,TS, EFW ,UWB,UWS,EC,ECSL,ES,ASTRN,
                 2FPS,NCDL,ZTB,ZBB,YT,AREA,D,IB,ZBBC,STRNS,ECAL,YB,ZTBC,WTF,BP,AV
                 3,FPY,LTYPE,KASE,KODE,RROAD,SFPC,DFACT
0004              COMMON/LLI/ BMMA(20),BMDL(20),BMSUM(20),BMBM(20),BMNCDL(20),VSUM(2
                 10),BMSL(20)
0005              DIMENSION      C(3)
0006              DIMENSION BMPRIM(6)
0007              DIMENSION BMW(3)
0008              DIMENSION V(20)
0009              COMMON/J/ BMHS(20),BMSP(20),BMLL(20)      ,VHS(20),VSP(20),VLL(20)
0010              DATA BMPRIM/2.8,0.0,2.8,0.0,16.8,11.2/
0011              DATA C/0.0,14.0,28.0/
0012              DATA V/20*0.0/
            C
            C
0013              CL = SPANL * 0.5
0014              IF(SPANL.GT.24) GO TO 300
0015              PT = CL
0016              REACTN = 0.4
0017              BM = REACTN * PT * 480000
0018              GO TO 305
0019          300 IF(SPANL.GT.28) GO TO 301
0020              PT = CL - 3.5
0021              CBAR = CL + 3.5
0022              REACTN = (1-CBAR/SPANL)*1.6
0023              BM = REACTN * PT * 480000
0024              GO TO 305
0025          301 IF(SPANL.GT.32.67) GO TO 302
0026              PT = 14.0
0027              CBAR = 18.667
0028              GO TO 303
0029          302 PT = CL - 2.33
0030              CBAR = CL + 2.33
0031          303 REACTN = (1-CBAR/SPANL) * 1.8
0032          304 BM = (PT * REACTN - 2.8) * 40000
0033          305 CONTINUE
0034              ULTM = BM
0035              DO 18 LD = 1,15
0036              DIST = XDIST(LD)
0037              DO 17 M = 2,3
0038              BMW(M) = 0.0
0039              SUMWC = 0.0
0040              SUMLD = 0.0
0041              GO TO (1,1,8),M
```



```
0042            1 IF(DIST.LE.C(2)) GO TO 3
0043              DFSTW = DIST - C(2)
0044              DLSTW = DFSTW + C(3)
0045              IF(DLSTW.GE.SPANL) GO TO 5
0046              KACE = 1
0047            2 SUMLD = 1.8
0048              SUMWC = 33.6
0049              GO TO 10
0050            3 DFSTW = DIST
0051              DLSTW = DFSTW + 14.0
0052              IF(DLSTW.GT.SPANL) GO TO 7
0053              KACE = 2
0054            4 SUMLD = 1.6
0055              SUMWC = 11.2
0056              GO TO 10
0057            5 KACE = 3
0058            6 SUMLD = 1.0
0059              SUMWC = 11.2
0060              GO TO 10
0061            7 SUMLD = 0.8
0062              SUMWC = 0.0
0063              GO TO 10
0064            8 IF(DIST.LE.28.0) GO TO 9
0065              KACE = 5
0066              DFSTW = DIST - 28.0
0067              GO TO 2
0068            9 DFSTW = DIST - C(2)
0069              IF(DFSTW.LE.0.0) GO TO 16
0070              KACE = 6
0071              GO TO 4
0072           10 CBAR = SUMWC/SUMLD + DFSTW
0073              REACTN = (1.0 - CBAR/SPANL) * SUMLD
0074              BMW(M)=(DIST * REACTN - BMPRIM(KACE)) * TOTTLD
0075           16 CONTINUE
0076           17 CONTINUE
0077              BM    = AMAX1(BMW(2),BMW(3))
0078              BMHS(LD) = BM*12.
0079              DFSTW = DIST
0080              DLSTW = DFSTW + C(3)
0081              IF(DLSTW.GT.SPANL) GO TO 11
0082              CBAR = DIST + 9.33
0083              REACTN = (1.0 - CBAR/SPANL) * 1.8
0084              GO TO 13
0085           11 DLSTW = DFSTW + C(2)
0086              IF(DLSTW.GT.SPANL) GO TO 12
0087              CBAR = DIST + 7.0
0088              REACTN = (1.0 - CBAR/SPANL) * 1.6
0089              GO TO 13
```

```
      12 REACTN = (1.0 - DIST/SPANL) * 0.8
      13 V(LD) = REACTN * TOTTLD
      18 CONTINUE
         DO 20 LD = 1,11
         VHS(LD) = AMAX1(V(LD),V(12-LD))
      20 BMHS(LD) = AMAX1(BMHS(LD),BMHS(12-LD))
      19 CONTINUE
         IF(BMHS(5).LT.BMHS(4)) BMHS(5) = BMHS(4)
         IF(BMHS(6).LT.BMHS(5)) BMHS(6) = BMHS(5)
         IF(BMHS(6).LT.ULTM) BMHS(6) = ULTM
         DO 21 L = 4,8
      21 BMHS(L) = AMAX1(BMHS(L),BMHS(12-L))
         RETURN
         END
```

```
            SUBROUTINE RRLOAD
            COMMON/KI/ ASL,IBSL,INA,YTC,YBC,YTCSL,ZTSL,YBCSL,ZBSL,AREAC,ECCL,
           1ENDMAX,TENIN,SPANL,BSPAC,BTYPE,TS, EFW ,UWB,UWS,EC,ECSL,ES,ASTRN,
           2FPS,NCDL,ZTB,ZBB,YT,AREA,D,IB,ZBBC,STRNS,ECAL,YB,ZTBC,WTF,BP,AV
           3,FPY,LTYPE,KASE,KODE,RROAD,SFPC,DFACT
            COMMON/JWM/ VMA(20),VDL(20),XDIST(15),DEFK2,DEFL12,DEFK1,DEFL14,
           1DNCDL2,DNCDL1
            COMMON/LLI/ BMMA(20),BMDL(20),BMSUM(20),BMBM(20),BMNCDL(20),VSUM(2
           10),BMSL(20)
            DIMENSION W(18),C(18),POINT(9)
            DATA W/0.5,4*1.0,4*0.65,0.5,4*1.0,4*0.65/
            DATA C/0.0,8.0,13.0,18.0,23.0,32.0,37.0,43.0,48.0,56.0,64.0,69.0,7
           14.0,79.0,88.0,93.0,99.0,104.0/
            DATA WU,CU/0.1,109.0/
C
C
            SPAN=SPANL
            TOTLLD = RROAD
            FRACT = 1.35 - (SPANL*SPANL)/50000.
            DO 13 LD = 1,15
            BMMAX = 0.0
            VMAX = 0.0
            DIST = XDIST(LD)
            DO 12 M = 1,18
            SUMWC = 0.0
            SUMLD = 0.0
            BM = 0.0
C              CHECK WHEEL POSITIONS FOR MAX. MOMENT
            IF(C(M).GT.DIST) GO TO 6
            DFSTW = DIST - C(M)
            IC = 1
            CN = CU
          9 DSTRN = SPAN - DFSTW
            IF(CN.GT.DSTRN) GO TO 1
            DISTWU = DSTRN - CN
            SUMWC =(SPAN-DISTWU/2.0)*WU*DISTWU
            JLM = 18
            SUMLD = DISTWU * WU
            GO TO 4
          1 SUMWC = 0.0
            DO 2 JL = M , 18
            JLM = JL
            IF(C(JL).GE.DSTRN) GO TO 3
          2 CONTINUE
            GO TO 4
          3 JLM = JLM - 1
          4 DO 5 N = IC,JLM
            SUMLD = SUMLD + W(N)
```



```
          5 SUMWC = SUMWC + (DFSTW + C(N)- C(IC))*W(N)
            CBAR = SUMWC/SUMLD
            REACTN = (1.0 - CBAR/SPAN) * SUMLD
            GO TO 10
          6 DO 7 JL = 1,M
            JFW = JL
            CM = C(M) - C(JL)
            IF(CM.LT.DIST) GO TO 8
          7 CONTINUE
          8 IC = JFW
            DFSTW = DIST - CM
            CN = CU - C(IC)
            GO TO 9
         10 DO 11 JJ = IC,M
         11 BM = W(JJ)*(C(M)-C(JJ)) + BM
            BMLL = (BM-DIST*REACTN)*TOTLLD*12.
            VSUB = 0.0
            IF(M.EQ.IC) GO TO 15
            MM1 = M - 1
            DO 14 MMM = IC,MM1
         14 VSUB = VSUB + W(MMM)
         15 V = (REACTN - VSUB) * TOTLLD
            REACTN = REACTN * TOTLLD
            CALL MACKS(BMMAX,VMAX,M,V,BMLL,REACTN,MBM,MVM)
         12 CONTINUE
            VMA(LD)=VMAX*1000.00 *FRACT/5.
            BMMA(LD)=BMMAX*1000.00      * FRACT/5.
         13 CONTINUE
            RETURN
            END
```

```
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0001               SUBROUTINE SPCL
0002               COMMON/JWM/ VMA(20),VDL(20),XDIST(15),DEFK2,DEFL12,DEFK1,DEFL14,
                  1DNCDL2,DNCDL1
0003               COMMON/KI/ ASL,IBSL,INA,YTC,YBC,YTCSL,ZTSL,YBCSL,ZBSL,AREAC,ECCL,
                  1ENDMAX,TENIN,SPANL,BSPAC,BTYPE,TS, EFW ,UWB,UWS,EC,ECSL,ES,ASTRN,
                  2FPS,NCDL,ZTB,ZBB,YT,AREA,D,IB,ZBBC,STRNS,ECAL,YB,ZTBC,WTF,BP,AV
                  3,FPY,LTYPE,KASE,KODE,RROAD,SFPC,DFACT
0004               COMMON/J/ BMHS(20),BMSP(20),BMLL(20)      ,VHS(20),VSP(20),VLL(20)
0005               DIMENSION V(20)
0006               DIMENSION CG(3),WB(3),WT(3),HW(3)
0007               DATA CG,WB,WT,HW/2.0,2*2.8,4.0,2*14.0,48.0,40.0,30.0,24.0,32.0,24.
                  10/
0008               DATA V/20*0.0/
            C
            C
0009               HSPAN = SPANL * 0.5
0010               DO 4 LD = 1,15
0011               DIST = XDIST(LD)
0012               DLSTW = DIST + WB(LTYPE)
0013               IF(DLSTW.GT.SPANL) GO TO 1
0014               CBAR = DIST + CG(LTYPE)
0015               REACTN = (1.0 - CBAR/SPANL) * WT(LTYPE)
0016               BMSP(LD)= DIST * REACTN*12000.
0017               GO TO 3
0018             1 IF(DIST.GT.HSPAN) GO TO 2
0019               REACTN = (1.0- DIST/SPANL) * HW(LTYPE)
0020               BMSP(LD)= REACTN * DIST*12000.
0021               GO TO 3
0022             2 IF(LD.GT.11) GO TO 9
0023               BMSP(LD) = BMSP(12-LD)
0024               GO TO 3
0025             9 IF(LD.EQ.13) BMSP(LD) = BMSP(12)
0026               IF(LD.EQ.15) BMSP(LD) = BMSP(14)
0027             3 CONTINUE
0028               DLSTW = DIST + WB(LTYPE)
0029               IF(DLSTW.GT.SPANL) GO TO 7
0030               CBAR = DIST + CG(LTYPE)
0031             6 REACTN = (1.0 - CBAR/SPANL) * WT(LTYPE)
0032               GO TO 8
0033             7 REACTN = (1.0 - DIST/SPANL) * HW(LTYPE)
0034             8 V(LD) = REACTN*1000.
0035             4 CONTINUE
0036               DO 5 LD = 1,11
0037               VSP(LD) = AMAX1(V(LD),ABS(V(12-LD)))
0038             5 CONTINUE
0039               VSP(12) = V(12)
0040               VSP(13) = VSP(12)
0041               VSP(14) = V(14)

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0042               VSP(15) = VSP(14)
0043               WRITE(6,600)(BMHS(I),I = 1,11)
0044           600 FORMAT(1H1,////6X,'JMLOAD MOMENTS',//(2X,F8.0))
0045               RETURN
0046               END
```

```
      SUBROUTINE CHANGE
      CCMMON/LLI/ BMMA(20),BMDL(20),BMSUM(20),BMBM(20),BMNCDL(20),VSUM(2
     10),BMSL(20)
      COMMON/JWM/ VMA(20),VDL(20),XDIST(15),DEFK2,DEFL12,DEFK1,DEFL14,
     1DNCDL2,DNCDL1
      COMMON/KI/ ASL,IBSL,INA,YTC,YBC,YTCSL,ZTSL,YBCSL,ZBSL,AREAC,ECCL,
     1ENDMAX,TENIN,SPANL,BSPAC,BTYPE,TS, EFW ,UWB,UWS,EC,ECSL,ES,ASTRN,
     2FPS,NCDL,ZTB,ZBB,YT,AREA,D,IB,ZBBC,STRNS,ECAL,YB,ZTBC,WTF,BP,AV
     3,FPY,LTYPE,KASE,KODE,RROAD,SFPC,DFACT,DIA
C     CHANGE UNITS FOR RERUN WITH 3-STRAND PATTERN
C
      DEFK1 = DEFK1 * 12.
      DEFK2 = DEFK2 * 12.
      DEFL12 = DEFL12 * 12.
      DEFL14 = DEFL14 * 12.
      DNCDL1 = DNCDL1 * 12.
      DNCDL2 = DNCDL2 * 12.
      DO 294 I = 1,15
      BMDL(I) = BMDL(I) * 12000.
      BMMA(I) = BMMA(I) * 12000.
      BMSUM(I) = BMSUM(I) * 12000.
      VDL(I) = VDL(I) * 1000.
      VMA(I) = VMA(I) * 1000.
  294 VSUM(I) = VSUM(I) * 1000.
      FPS= FPS * 1000.
      RETURN
      END
```

```
      SUBROUTINE STRMOD(ECAL)
C
C
      COMMON/MM/ROW(20),NROW,SROW(20),SPACE,IW,DROW(20)
C
C
      ROWNR = ROW(NROW)
      ROW1 = ROW(1)
      IF(ROW(NROW).NE.ROW1) GO TO 1
      ROW(NROW) = ROWNR -2
      NROW = NROW + 1
      ROW(NROW) = 2
      GO TO 6
    1 IF(ROW1.GT.ROW(2).AND.NROW.EQ.2) GO TO 4
      N = NROW
    2 IF(ROW(N).GT.ROWNR) GO TO 3
      N = N - 1
      GO TO 2
    3 ROW(N) = ROW(N) - 2
      NROW = NROW + 1
      ROW(NROW) = 2
      GO TO 6
    4 IF(ROW1-ROW(2).GT.2) GO TO 5
      NROW = 3
      ROW(1) = ROW(1) - 2
      ROW(3) = 2
      GO TO 6
    5 ROW(1) = ROW(1) - 2
      ROW(2) = ROW(2) + 2
    6 S1 = 0.
      S2 = 0.
      DO 8 JR = 1,NROW
      S2 = ROW(JR) * (2.0 + ((JR-1)*SPACE)) + S2
    8 S1 = ROW(JR) + S1
      ECAL = S2/S1
      RETURN
      END
```

```
FORTRAN IV G LEVEL  18                CAMBER              DATE = 70224           00/55/25              PAGE 0001

0001                SUBROUTINE CAMBER
              C
0002                REAL IB,IB1,INA,NCDL,MNCDL,MS,IBSL
0003                COMMON/FYB/KGRID,NSTRNS,ENDECC,IWCH
0004                COMMON/LOC/PLMAX,CMAX,ACR,BCR,ASH,BSH
0005                COMMON/MMM/ FO,HDPT,P
0006                COMMON/KI/ ASL,IBSL,INA,YTC,YBC,YTCSL,ZTSL,YBCSL,ZBSL,AREAC,ECCL,
                   1ENDMAX,TENIN,SPANL,BSPAC,BTYPE,TS, EFW ,UWB,UWS,EC,ECSL,ES,ASTRN,
                   2FPS,NCDL,ZTB,ZBB,YT,AREA,D,IB,ZBBC,STRNS,ECAL,YB,ZTBC,WTF,BP,AV
                   3,FPY,LTYPE,KASE,KODE,RROAD,SFPC,DFACT
              C
              C
              C     CAMBER AND STRESS LOSS CALCULATIONS
              C
              C
0007                ASH = 0.000325
0008                BSH = 10.
0009                ACRR = 0.000225
0010                BCR = 15.
0011                ACR = ACRR*0.001
0012                RN = ES/EC
0013                AST = ASTRN*STRNS
0014                W = UWB*AREA/144.
0015                DLM = (W*SPANL*SPANL/8.)*12.
0016                TEMP = 1.+(RN*AST/AREA )+(RN*AST*ECCL*ECCL/IB)
0017                FR = FO/TEMP         +(DLM*ECCL*RN*AST/(IB*TEMP))
0018                PLI = ((FO-FR)/FO)*100.
0019                CONST = (1./AREA)+(ECCL*ECCL/IB)
0020                FCSO = FR*CONST-(DLM*ECCL/IB)
0021                STRN1 = ACR*FCSO+ASH
0022                STRN2 = STRN1-STRN1*(RN*AST*CONST)
0023                DFCS = STRN2*ES*AST*CONST * 10.0 ** 6
0024                STRN4 = ACR*(FCSO-DFCS/2.)+ASH
0025                STRN5 = STRN4-STRN4*RN*AST*CONST
0026                DFCS1 = STRN5*ES*AST*CONST * 10.0 ** 6
0027                STRN6 = ACR*(FCSO-DFCS1/2.)+ASH
0028                STRN7 = STRN6-STRN6*RN*AST*CONST
0029                PLINF = (STRN7*ES*AST*10.0**6/FO)*100.
0030                PLMAX = PLINF+PLI
0031                CCONST = 1./(EC*IB*10.**6)
0032                HSPAN = SPANL/2.
0033                CI1 = CCONST*(FR*ENDECC*HSPAN*0.5*HSPAN*144.)
0034                CI2 = CCONST*(FR*(ECCL-ENDECC)*(HSPAN-HDPT)*0.5*0.67*(HSPAN-HDPT)*
                   2144.)
0035                CI3 = CCONST*(FR*(ECCL-ENDECC)*HDPT*(HSPAN-HDPT/2.)*144.)
0036                CI4 = CCONST*((5./384.)*(W*SPANL*SPANL*SPANL*SPANL*12.*12.*12.))
0037                CI = CI1 +CI2 +CI3 -CI4
0038                STRAIN=FCSO/(EC*10.**6)


FORTRAN IV G LEVEL  18                CAMBER              DATE = 70224           00/55/25              PAGE 0002

0039                CMAX = CI*((ACR*(FCSO-(DFCS/2.))+STRAIN)/STRAIN)*(1.-(PLINF/100.))
0040                RETURN
0041                END
```

```
0001          BLOCK DATA
0002          REAL  IB1
0003          COMMON/JJJ/ BB(11),WDD(11),CC(11),EE(11)
0004          COMMON/BNS/ BNSTD
0005          COMMON/CONC/ CNCP(10),CNCD(10),CCP(10),CCD(10),SCNCP(10),SCNCD(10)
0006          COMMON/LI/BEAM(11),AR(11),YB1(11),YT1(11),D1(11),IB1(11),WTF1(11),
             1BPRIME(11),HH(11)
0007          COMMON/J/ BMHS(20),BMSP(20),BMLL(20)       ,VHS(20),VSP(20),VLL(20)
0008          COMMON/IBM/ ACI(15),VS(20)
0009          COMMON/JWM/ VMA(20),VDL(20),XDIST(15),DEFK2,DEFL12,DEFK1,DEFL14,
             1DNCDL2,DNCDL1
0010          COMMON/ELL/ IBMNC,WORDS(40),SMBOL1,SMBOL2,SPAN1,SPAN2,DFSCR(17)
0011          COMMON/MM/ROW(20),NROW,SROW(20),SPACE,IW,DROW(20)
0012          COMMON/LLI/ BMMA(20),BMDL(20),BMSUM(20),BMBM(20),BMNCDL(20),VSUM(2
             10),BMSL(20)
0013          COMMON/JDF/ FTLL(20),FBLL(20),FTSL(20),FBSL(20),FTBM(20),
             1FBBM(20),FTDL(20),FBDL(20),FTNCDL(20),FBNCDL(20),ST(20),SB(20)
             2,FT(20),FB(20),FTI(20),FBI(20),FTIB(20),FBIB(20),FTIBSN(20),
             3FBIBSN(20)
0014          COMMON/JRR/ S(15),SQ
0015          COMMON/MSC/ VNCDL(15)
0016          DATA VNCDL/15*0.0/
0017          DATA BMHS,BMSP,BMLL,VHS,VSP,VLL/120*0.0/
0018          DATA BNSTD/'NS'/
0019          DATA ACI,VS,VMA,VDL,     XDIST,WORDS,ROW,SROW,BMMA,BMDL,BMSUM,BMBM,
             1BMNCDL,VSUM,BMSL,FTLL,FBLL,FTSL,FBSL,FTBM,FBBM,FTDL,FBDL,FTNCDL,
             2FBNCDL,ST,SB,FT,FB,FTI,FBI,FTIB,FBIB,FTIBSN,FBIBSN,S/725*0.0/
0020          DATA BEAM /'A','B','C','48','54','60','66','72','IV','V','VI'/
0021          DATA AR/275.44,360.31,494.94,403.44,493.44,628.44,740.94,863.44,78
             18.44,1013.,1085./
0022          DATA YB1/12.61,14.93,17.09,22.87,25.53,28.41,31.07,33.73,24.75,31.
             796,36.38/
0023          DATA YT1/15.38,19.07,22.91,25.13,28.47,31.59,34.93,38.27,29.25,31.
             804,35.62/
0024          DATA D1/28.,34.,40.,48.,54.,60.,66.,72.,54.,63.,72./
0025          DATA IB1/22658.,43177.,82602.,101950.,164023.,255319.,374688.,5320
             960.,260403.,521180.,733320./
0026          DATA WTF1/12.0,12.0,14.0,14.0,16.0,18.0,20.0,22.0,20.0,42.0,42.0/
0027          DATA BPRIME/6.,6.5,7.,6.,6.,7.,7.,7.,8.,8.,8./
0028          DATA CNCP,CNCD,CCP,CCD,SCNCP,SCNCD/60*0.0/
0029          DATA WDD/6.0,6.5,7.0,6.0,6.0,7.0,7.0,7.0,8.0,8.0,8.0/
0030          DATA BB/16.0,18.0,22.0,14.0,16.0,18.0,20.0,22.0,26.0,28.0,28.0/
0031          DATA CC/5.0,6.0,7.0,7.0,8.0,9.0,10.0,11.0,8.0,8.0,8.0/
0032          DATA EE/5.0,5.75,7.5,4.0,5.0,5.5,6.5,7.5,9.0,10.0,10.0/
0033          DATA HH/4.0,5.5,6.0,3.5,4.0,4.5,5.0,5.5,8.0,5.0,5.0/
0034          END
```

APPENDIX C

Following are some example design outpust from the computer program:

Type 54 Beam	One-page Output
Type AASHO IV	Multi-page Output
Type AASHO IV	Multi-page Output
Type 54 Beam	Multi-page Output
Type AASHO IV	One-page Output
Type AASHO IV	One-page Output

```
DISTRICT 14          TRAVIS COUNTY   HIGHWAY NO. LP 275   SUBMITTED BY BR WINN
CONTROL NO. 151-6     IPE 228    DATE NOV 2 1970

                     LOOP 275 OVERPASS US 183   SPANS NO 1-6

                           SPAN     2   BEAM     1


**** INPUT DATA ****

BEAM TYPE          =   54           UNIT WT. BEAM CONC.     =  150.   PCF          L.L. DIST. FACTOR =       0.69
SPAN LENGTH        =  75.75 FT      UNIT WT. SLAB CONC.     =  150.   PCF          COMP. SLAB WIDTH  =        90.48 IN
BEAM SPACING       =   7.54 FT      28-DAY ST.(SLAB CONC.) = 3600.   PSI          COMP. DEAD LOAD   =      0.0  KLF
SLAB THICKNESS     =   7.50 IN      E(BM.CONC.)             =     5.00 E(06)PSI    BEAM INERTIA      = 164023.   IN4
STRAND SIZE        =   1/2  IN      E(SLB.CONC.)            =     5.00 E(06)PSI    BEAM AREA         =    493.44 IN2
STRAND ULT. STR.   =  270K          E(PSRR. STL.)           =    28.00 E(06)PSI    BEAM DEPTH        =     54.00 IN
NO.OF WEB STRNS.   =   2            AASHO L.L.              =   HS-20              BEAM YB           =     25.53 IN
GRID SIZE          =   2.   IN      RAILROAD L.L.           =     E- 0.            BEAM YT           =     28.47 IN

*** BEAM DESIGN ***


TYPE OF BEAM                 =   54              D.L. DEFLECTION AT MID-SPAN =  0.053 FT (SLAB)      0.006 FT (DIAF)
NO. OF STRANDS               =   22.             D.L. DEFLECTION AT 1/4 PT.  =  0.038 FT (SLAB)      0.004 FT (DIAF)
SIZE OF STRANDS              =   1/2
TYPE OF STRANDS              =   270K            ULTIMATE MOMENT REQUIRED = 3698. FT-KIPS
ECCENTRICITY AT C.L.         =   20.80 IN        ULT. MOMENT PROVIDED =     4161. FT-KIPS  UNDER REINF. RECT. SECT.
ECCENTRICITY AT END          =   13.53 IN
NO. OF DEPRESSED STRANDS     =    8              STIRRUP SPAC. (MIDDLE 1/2 SPAN) = NO. 4 AT 24.00 IN
DEPRESS TOP 2 STRANDS TO POSITION A-28           STIRRUP SPAC. (EXT. 1/4 SPAN)   = NO. 4 AT 15.88 IN
CONCRETE RELEASE STRENGTH = 4471.    PSI
CONCRETE 28-DAY STRENGTH  =   5000.    PSI       TOP FIBER DESIGN STRESS (C.L.)    = 2150. PSI
                                                 BOTTOM FIBER DESIGN STRESS (C.L.) = 2778. PSI

                                                 MAXIMUM CAMBER =  1.76 IN
                                                 PRESTRESS LOSS = 17.28 PERCENT
*** STRAND PATTERN ***
    (C.L. OF BEAM)

ROW  1 HAS   6. STRANDS
ROW  2 HAS   6. STRANDS
ROW  3 HAS   6. STRANDS
ROW  4 HAS   4. STRANDS
```

DISTRICT 14 TRAVIS COUNTY HIGHWAY NO. LP 275 SUBMITTED BY BR WINN
CONTROL NO. 151-6 IPE 228 DATE NOV 2 1970

LOOP 275 OVERPASS US 183 SPANS NO 1-6

SPAN TEST BEAM NO. TEST

INPUT DATA

BEAM TYPE	= IV	UNIT WT. BEAM CONC.	= 150. PCF	L.L. DIST. FACTOR	= 0.66
SPAN LENGTH	= 75.00 FT	UNIT WT. SLAB CONC.	= 150. PCF	COMP. SLAB WIDTH	= 87.00 IN
BEAM SPACING	= 7.25 FT	28-DAY ST.(SLAB CONC.)	= 3600. PSI	COMP. DEAD LOAD	= 0.0 KLF
SLAB THICKNESS	= 6.75 IN	E(BM. CONC.)	= 5.00 E(06)PSI	BEAM INERTIA	= 260403. IN4
STRAND SIZE	= 1/2 IN	E(SLB. CONC.)	= 5.00 E(06)PSI	BEAM AREA	= 788.44 IN2
STRAND ULT. STR.	= 270K	E(PSTR. STL.)	= 28.00 E(06)PSI	BEAM DEPTH	= 54.00 IN
NO. OF WEB STRNS.	= 2	AASHO L.L.	= HS-20	BEAM YB	= 24.75 IN
GRID SIZE	= 2. IN	RAILROAD L.L.	= E- 0.	BEAM YT	= 29.25 IN

SECTION	MOMENT SUMMARY (FT-KIPS) DEAD LOAD	L.L.+I.	TOTAL	SHEAR SUMMARY (KIPS) DEAD LOAD	L.L.+I.	TOTAL
0	0.0	0.0	0.0	55.6	51.9	107.6
1	375.5	345.0	720.5	44.5	46.0	90.5
2	667.5	601.1	1268.6	33.4	40.1	73.4
3	876.1	768.2	1644.2	22.2	34.1	56.4
4	1001.2	864.7	1866.0	11.1	28.2	39.3
5	1043.0	881.5	1924.5	-0.0	22.3	22.3
6	1001.2	864.7	1866.0	11.1	28.2	39.3
7	876.1	768.2	1644.2	22.2	34.1	56.4
8	667.5	601.1	1268.6	33.4	40.1	73.4
9	375.5	345.0	720.5	44.5	46.0	90.5
10	0.0	0.0	0.0	55.6	51.9	107.6
HOLD-DOWN	1024.4	880.2	1904.6	7.4	21.4	28.8

LOOP 275 OVERPASS US 183 SPANS NO 1-6

STRESSES IN EXTREME FIBERS DUE TO EXTERNAL LOADS (LBS PER SQ. IN.)

SECTION	BEAM		SLAB		TOTAL D.L. NCN-COMP SEC.		DEAD LOAD COMP SEC.		LIVE LOAD PLUS IMPACT		TOTAL	
	TOP	BOT	TOP	BOT	TOP	BOT	TOP	BOT	TOP	BOT	TOP	BOT
0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	280.	237.	226.	191.	506.	428.	0.	0.	102.	258.	608.	686.
2	498.	422.	402.	340.	900.	761.	0.	0.	178.	449.	1078.	1211.
3	654.	553.	527.	446.	1181.	999.	0.	0.	228.	574.	1408.	1573.
4	747.	632.	602.	510.	1350.	1142.	0.	0.	256.	646.	1606.	1788.
5	778.	659.	627.	531.	1406.	1190.	0.	0.	261.	659.	1667.	1849.
6	747.	632.	602.	510.	1350.	1142.	0.	0.	256.	646.	1606.	1788.
7	654.	553.	527.	446.	1181.	999.	0.	0.	228.	574.	1408.	1573.
8	498.	422.	402.	340.	900.	761.	0.	0.	178.	449.	1078.	1211.
9	280.	237.	226.	191.	506.	428.	0.	0.	102.	258.	608.	686.
10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
HOLD-DOWN	765.	647.	616.	521.	1381.	1168.	0.	0.	261.	658.	1642.	1826.

STRESSES DUE TO EXTERNAL LOADS PLUS PRESTRESS (LBS PER SQ. IN.)

	INITIAL PREST.		BEAM PLUS INITIAL PREST.		FINAL PREST. PLUS TOT. D.L.(N/C SEC.)		ALL LOADS PLUS FINAL PREST.	
	TOP	BOT	TOP	BOT	TOP	BOT	TOP	BOT
0	-471.	1898.	-471.	1898.	-377.	1518.	-377.	1518.
1	-537.	1954.	-257.	1717.	76.	1135.	178.	877.
2	-604.	2010.	-106.	1589.	417.	847.	595.	398.
3	-670.	2066.	-16.	1513.	645.	654.	872.	80.
4	-737.	2123.	11.	1490.	760.	556.	1016.	-90.
5	-759.	2141.	20.	1483.	799.	524.	1060.	-135.
6	-737.	2123.	11.	1490.	760.	556.	1016.	-90.
7	-670.	2066.	-16.	1513.	645.	654.	872.	80.
8	-604.	2010.	-106.	1589.	417.	847.	595.	398.
9	-537.	1954.	-257.	1717.	76.	1135.	178.	877.
10	-471.	1898.	-471.	1898.	-377.	1518.	-377.	1518.
HOLD-DOWN	-759.	2141.	6.	1494.	774.	545.	1034.	-113.

DISTRICT 14 TRAVIS COUNTY HIGHWAY NO. LP 275 SUBMITTED BY BR WINN
CONTROL NO. 151-6 IPE 228 DATE NOV 2 1970

LOOP 275 OVERPASS US 183 SPANS NO 1-6

SPAN TEST BEAM NO. TEST

INPUT DATA

BEAM TYPE	= IV	UNIT WT. BEAM CONC.	= 150. PCF	L.L. DIST. FACTOR	= 0.66
SPAN LENGTH	= 75.00 FT	UNIT WT. SLAB CONC.	= 150. PCF	COMP. SLAB WIDTH	= 87.00 IN
BEAM SPACING	= 7.25 FT	28-DAY ST.(SLAB CONC.)	= 3600. PSI	COMP. DEAD LOAD	= 0.0 KLF
SLAB THICKNESS	= 6.75 IN	E(BM. CONC.)	= 5.00 E(06)PSI	BEAM INERTIA	= 260403. IN4
STRAND SIZE	= 1/2 IN	E(SLB. CONC.)	= 5.00 E(06)PSI	BEAM AREA	= 788.44 IN2
STRAND ULT. STR.	= 270K	E(PSTR. STL.)	= 28.00 E(06)PSI	BEAM DEPTH	= 54.00 IN
NO. OF WEB STRNS.	= 2	AASHO L.L.	= HS-20	BEAM YB	= 24.75 IN
GRID SIZE	= 2. IN	RAILROAD L.L.	= E- 0.	BEAM YT	= 29.25 IN

	MOMENT SUMMARY (FT-KIPS)			SHEAR SUMMARY (KIPS)		
SECTION	DEAD LOAD	L.L.+I.	TOTAL	DEAD LOAD	L.L.+I.	TOTAL
0	0.0	0.0	0.0	55.6	51.9	107.6
1	375.5	345.0	720.5	44.5	46.0	90.5
2	667.5	601.1	1268.6	33.4	40.1	73.4
3	876.1	768.2	1644.2	22.2	34.1	56.4
4	1001.2	864.7	1866.0	11.1	28.2	39.3
5	1043.0	881.5	1924.5	-0.0	22.3	22.3
6	1001.2	864.7	1866.0	11.1	28.2	39.3
7	876.1	768.2	1644.2	22.2	34.1	56.4
8	667.5	601.1	1268.6	33.4	40.1	73.4
9	375.5	345.0	720.5	44.5	46.0	90.5
10	0.0	0.0	0.0	55.6	51.9	107.6
HOLD-DOWN	1024.4	880.2	1904.6	7.4	21.4	28.8

LOOP 275 OVERPASS US 183 SPANS NO 1-6

STRESSES IN EXTREME FIBERS DUE TO EXTERNAL LOADS (LBS PER SQ. IN.)

SECTION	BEAM		SLAB		TOTAL D.L. NCN-COMP SEC.		DEAD LOAD COMP SEC.		LIVE LOAD PLUS IMPACT		TOTAL	
	TOP	BOT	TOP	BOT	TOP	BOT	TOP	BOT	TOP	BOT	TOP	BOT
0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	280.	237.	226.	191.	506.	428.	0.	0.	102.	258.	608.	686.
2	498.	422.	402.	340.	900.	761.	0.	0.	178.	449.	1078.	1211.
3	654.	553.	527.	446.	1181.	999.	0.	0.	228.	574.	1408.	1573.
4	747.	632.	602.	510.	1350.	1142.	0.	0.	256.	646.	1606.	1788.
5	778.	659.	627.	531.	1406.	1190.	0.	0.	261.	659.	1667.	1849.
6	747.	632.	602.	510.	1350.	1142.	0.	0.	256.	646.	1606.	1788.
7	654.	553.	527.	446.	1181.	999.	0.	0.	228.	574.	1408.	1573.
8	498.	422.	402.	340.	900.	761.	0.	0.	178.	449.	1078.	1211.
9	280.	237.	226.	191.	506.	428.	0.	0.	102.	258.	608.	686.
10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
HOLD-DOWN	765.	647.	616.	521.	1381.	1168.	0.	0.	261.	658.	1642.	1826.

STRESSES DUE TO EXTERNAL LOADS PLUS PRESTRESS (LBS PER SQ. IN.)

	INITIAL PREST.		BEAM PLUS INITIAL PREST.		FINAL PREST. PLUS TOT. D.L.(N/C SEC.)		ALL LOADS PLUS FINAL PREST.	
	TOP	BOT	TOP	BOT	TOP	BOT	TOP	BOT
0	-471.	1898.	-471.	1898.	-377.	1518.	-377.	1518.
1	-537.	1954.	-257.	1717.	76.	1135.	178.	877.
2	-604.	2010.	-106.	1589.	417.	847.	595.	398.
3	-670.	2066.	-16.	1513.	645.	654.	872.	80.
4	-737.	2123.	11.	1490.	760.	556.	1016.	-90.
5	-759.	2141.	20.	1483.	799.	524.	1060.	-135.
6	-737.	2123.	11.	1490.	760.	556.	1016.	-90.
7	-670.	2066.	-16.	1513.	645.	654.	872.	80.
8	-604.	2010.	-106.	1589.	417.	847.	595.	398.
9	-537.	1954.	-257.	1717.	76.	1135.	178.	877.
10	-471.	1898.	-471.	1898.	-377.	1518.	-377.	1518.
HOLD-DOWN	-759.	2141.	6.	1494.	774.	545.	1034.	-113.

LOOP 275 OVERPASS US 183   SPANS NO 1-6

STIRRUP SPACING IN EXTERIOR 1/4 SPAN (AASHO SPECS.)   NO. 4 AT 13.5 IN.

STIRRUP SPACING IN MIDDLE 1/2 SPAN (AASHO SPECS.)   NO. 4 AT 20.0 IN.

STIRRUP SPACING BASED ON ACI SPECS.

SECTION	
0	NO. 4 AT 5.0 IN.
1	NO. 4 AT 24.0 IN.
2	NO. 4 AT 18.2 IN.
3	NO. 4 AT 17.1 IN.
4	NO. 4 AT 24.0 IN.
5	NO. 4 AT 24.0 IN.
6	NO. 4 AT 24.0 IN.
7	NO. 4 AT 17.1 IN.
8	NO. 4 AT 18.2 IN.
9	NO. 4 AT 24.0 IN.
10	NO. 4 AT 5.0 IN.

MAXIMUM ULTIMATE HORIZONTAL SHEAR BETWEEN SLAB AND GIRDER FLANGE (VQ/I)

SECTION	
0	184.0 PSI
1	156.1 PSI
2	128.2 PSI
3	100.3 PSI
4	72.5 PSI
5	49.3 PSI
6	72.5 PSI
7	100.3 PSI
8	128.2 PSI
9	156.1 PSI
10	184.0 PSI

LOOP 275 OVERPASS US 183   SPANS NO 1-6

ULTIMATE MOMENT REQUIRED = 3768.3 FT-KIPS
ULTIMATE MOMENT PROVIDED = 4236.3 FT-KIPS   UNDER REINFORCED RECTANGULAR SECTION
DESIGN BASED ON STRESSES

DEAD LOAD DEFLECTIONS	SLAB	DIAPHRAM	COMP DEAD LOAD
MIDSPAN	0.028 FT	0.003 FT	0.0 FT
QUARTER POINT	0.020 FT	0.002 FT	0.0 FT

MAXIMUM CAMBER = 1.03 IN.
PRESTRESS LOSS = 12.36 PERCENT

TYPE OF BEAM	=	IV
NO. OF STRANDS	=	22.
SIZE OF STRANDS	=	1/2
ULT. STRENGTH OF STRANDS	=	270K
ECCENTRICITY AT C.L.	=	21.84 IN.
ECCENTRICITY AT END	=	17.84 IN.
CONCRETE RELEASE STRENGTH	=	4000. PSI
CONCRETE 28-DAY STRENGTH	=	5000. PSI
NUMBER OF DRAPED STRANDS	=	4

DEPRESS TOP STRANDS TO POSITION A-26

STRAND PATTERN AT CENTERLINE OF BEAM

ROW 1 HAS 12 STRANDS

ROW 2 HAS 10 STRANDS

DISTRICT 14 TRAVIS COUNTY HIGHWAY NO. LP 275 SUBMITTED BY BR WINN
CONTROL NO. 151-6 IPE 228 DATE NOV 2 1970

LOOP 275 OVERPASS US 183 SPANS NO 1-6

SPAN TEST BEAM NO. TEST

INPUT DATA

BEAM TYPE	= IV	UNIT WT. BEAM CONC.	= 150. PCF	L.L. DIST. FACTOR	= 0.66
SPAN LENGTH	= 75.00 FT	UNIT WT. SLAB CONC.	= 150. PCF	COMP. SLAB WIDTH	= 87.00 IN
BEAM SPACING	= 7.25 FT	28-DAY ST.(SLAB CONC.)	= 3600. PSI	COMP. DEAD LOAD	= 0.0 KLF
SLAB THICKNESS	= 6.75 IN	E(BM. CONC.)	= 5.00 E(06)PSI	BEAM INERTIA	= 260403. IN4
STRAND SIZE	= 1/2 IN	E(SLB. CONC.)	= 5.00 E(06)PSI	BEAM AREA	= 788.44 IN2
STRAND ULT. STR.	= 270K	E(PSTR. STL.)	= 28.00 E(06)PSI	BEAM DEPTH	= 54.00 IN
NO. OF WEB STRNS.	= 3	AASHO L.L.	= HS-20	BEAM YB	= 24.75 IN
GRID SIZE	= 2. IN	RAILROAD L.L.	= E- 0.	BEAM YT	= 29.25 IN

	MOMENT SUMMARY (FT-KIPS)			SHEAR SUMMARY (KIPS)		
SECTION	DEAD LOAD	L.L.+I.	TOTAL	DEAD LOAD	L.L.+I.	TOTAL
0	0.0	0.0	0.0	55.6	51.9	107.6
1	375.5	345.0	720.5	44.5	46.0	90.5
2	667.5	601.1	1268.6	33.4	40.1	73.4
3	876.1	768.2	1644.2	22.2	34.1	56.4
4	1001.2	864.7	1866.0	11.1	28.2	39.3
5	1043.0	881.5	1924.5	-0.0	22.3	22.3
6	1001.2	864.7	1866.0	11.1	28.2	39.3
7	876.1	768.2	1644.2	22.2	34.1	56.4
8	667.5	601.1	1268.6	33.4	40.1	73.4
9	375.5	345.0	720.5	44.5	46.0	90.5
10	0.0	0.0	0.0	55.6	51.9	107.6
HOLD-DOWN	1024.4	880.2	1904.6	7.4	21.4	28.8

LOOP 275 OVERPASS US 183 SPANS NO 1-6

STRESSES IN EXTREME FIBERS DUE TO EXTERNAL LOADS (LBS PER SQ. IN.)

SECTION	BEAM		SLAB		TOTAL D.L. NON-COMP SEC.		DEAD LOAD COMP SEC.		LIVE LOAD PLUS IMPACT		TOTAL	
	TOP	BOT	TOP	BOT	TOP	BOT	TOP	BOT	TOP	BOT	TOP	BOT
0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	280.	237.	226.	191.	506.	428.	0.	0.	102.	258.	608.	686.
2	498.	422.	402.	340.	900.	761.	0.	0.	178.	449.	1078.	1211.
3	654.	553.	527.	446.	1181.	999.	0.	0.	228.	574.	1408.	1573.
4	747.	632.	602.	510.	1350.	1142.	0.	0.	256.	646.	1606.	1798.
5	778.	659.	627.	531.	1406.	1190.	0.	0.	261.	659.	1667.	1849.
6	747.	632.	602.	510.	1350.	1142.	0.	0.	256.	646.	1606.	1788.
7	654.	553.	527.	446.	1181.	999.	0.	0.	228.	574.	1408.	1573.
8	498.	422.	402.	340.	900.	761.	0.	0.	178.	449.	1078.	1211.
9	280.	237.	226.	191.	506.	428.	0.	0.	102.	258.	608.	686.
10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
HOLD-DOWN	765.	647.	616.	521.	1391.	1168.	0.	0.	261.	658.	1642.	1826.

STRESSES DUE TO EXTERNAL LOADS PLUS PRESTRESS (LBS PER SQ. IN.)

	INITIAL PREST.		BEAM PLUS INITIAL PREST.		FINAL PREST. PLUS TOT. D.L.(N/C SEC.)		ALL LOADS PLUS FINAL PREST.	
	TOP	BOT	TOP	BOT	TOP	BOT	TOP	BOT
0	-438.	1870.	-438.	1870.	-351.	1496.	-351.	1496.
1	-511.	1932.	-231.	1694.	97.	1117.	200.	859.
2	-583.	1993.	-85.	1571.	433.	833.	611.	384.
3	-656.	2054.	-2.	1501.	656.	644.	884.	70.
4	-728.	2115.	19.	1483.	767.	550.	1023.	-96.
5	-752.	2136.	26.	1477.	804.	519.	1065.	-140.
6	-728.	2115.	19.	1483.	767.	550.	1023.	-96.
7	-656.	2054.	-2.	1501.	656.	644.	884.	70.
8	-583.	1993.	-85.	1571.	433.	833.	611.	384.
9	-511.	1932.	-231.	1694.	97.	1117.	200.	859.
10	-438.	1870.	-438.	1870.	-351.	1496.	-351.	1496.
HOLD-DOWN	-752.	2136.	12.	1489.	779.	540.	1040.	-118.

LOOP 275 OVERPASS US 183   SPANS NO 1-6

STIRRUP SPACING IN EXTERIOR 1/4 SPAN (AASHO SPECS.)   NO. 4 AT 18.7 IN.

STIRRUP SPACING IN MIDDLE 1/2 SPAN (AASHO SPECS.)   NO. 4 AT 20.0 IN.

STIRRUP SPACING BASED ON ACI SPECS.

SECTION	
0	NO. 4 AT 5.0 IN.
1	NO. 4 AT 6.3 IN.
2	NO. 4 AT 8.4 IN.
3	NO. 4 AT 24.0 IN.
4	NO. 4 AT 24.0 IN.
5	NO. 4 AT 24.0 IN.
6	NO. 4 AT 24.0 IN.
7	NO. 4 AT 24.0 IN.
8	NO. 4 AT 8.4 IN.
9	NO. 4 AT 6.3 IN.
10	NO. 4 AT 5.0 IN.

MAXIMUM ULTIMATE HORIZONTAL SHEAR BETWEEN SLAB AND GIRDER FLANGE (VQ/I)

SECTION	
0	183.5 PSI
1	155.7 PSI
2	127.8 PSI
3	99.9 PSI
4	72.1 PSI
5	49.3 PSI
6	72.1 PSI
7	99.9 PSI
8	127.8 PSI
9	155.7 PSI
10	183.5 PSI

LOOP 275 OVERPASS US 183   SPANS NO 1-6

ULTIMATE MOMENT REQUIRED = 3768.3 FT-KIPS
ULTIMATE MOMENT PROVIDED = 4229.4 FT-KIPS   UNDER REINFORCED RECTANGULAR SECTION
DESIGN BASED ON STRESSES

DEAD LOAD DEFLECTIONS	SLAB	DIAPHRAM	CCMP DEAD LOAD
MIDSPAN	0.028 FT	0.003 FT	0.0 FT
QUARTER POINT	0.020 FT	0.002 FT	0.0 FT

MAXIMUM CAMBER = 1.01 IN.
PRESTRESS LOSS = 12.32 PERCENT

TYPE OF BEAM	=	IV
NO. OF STRANDS	=	22.
SIZE OF STRANDS	=	1/2
ULT. STRENGTH OF STRANDS	=	270K
ECCENTRICITY AT C.L.	=	21.75 IN.
ECCENTRICITY AT END	=	17.39 IN.
CONCRETE RELEASE STRENGTH	=	4000. PSI
CONCRETE 28-DAY STRENGTH	=	5000. PSI
NUMBER OF DRAPED STRANDS	=	6

DEPRESS TOP STRANDS TO POSITION A-20

STRAND PATTERN AT CENTERLINE OF BEAM

ROW 1 HAS 11 STRANDS

ROW 2 HAS 11 STRANDS

DISTRICT 14 TRAVIS COUNTY HIGHWAY NO. LP 275 SUBMITTED BY BR WINN
CONTROL NO. 151-6 IPE 228 DATE NOV 2 1970

LOOP 275 OVERPASS US 183 SPANS NO 1-6

SPAN 5 BEAM NO. ALL

INPUT DATA

BEAM TYPE	= 54	UNIT WT. BEAM CONC.	= 150. PCF	L.L. DIST. FACTOR	= 0.58
SPAN LENGTH	= 96.42 FT	UNIT WT. SLAB CONC.	= 150. PCF	COMP. SLAB WIDTH	= 75.96 IN
BEAM SPACING	= 6.33 FT	28-DAY ST.(SLAB CONC.)	= 3600. PSI	COMP. DEAD LOAD	= 0.0 KLF
SLAB THICKNESS	= 7.25 IN	E(BM. CONC.)	= 5.00 E(06)PSI	BEAM INERTIA	= 164023. IN4
STRAND SIZE	= 1/2 IN	E(SLB. CONC.)	= 5.00 E(06)PSI	BEAM AREA	= 493.44 IN2
STRAND ULT. STR.	= 270K	E(PSTR. STL.)	= 28.00 E(06)PSI	BEAM DEPTH	= 54.00 IN
NO. OF WEB STRNS.	= 2	AASHO L.L.	= HS-20	BEAM YB	= 25.53 IN
GRID SIZE	= 2. IN	RAILROAD L.L.	= E- 0.	BEAM YT	= 28.47 IN

	MOMENT SUMMARY (FT-KIPS)			SHEAR SUMMARY (KIPS)		
SECTION	DEAD LOAD	L.L.+I.	TOTAL	DEAD LOAD	L.L.+I.	TOTAL
0	0.0	0.0	0.0	55.3	45.9	101.2
1	479.7	393.3	873.1	44.2	40.8	85.0
2	852.9	688.7	1541.6	33.2	35.7	68.9
3	1119.4	886.2	2005.6	22.1	30.6	52.8
4	1279.3	1001.5	2280.8	11.1	25.6	36.6
5	1332.6	1026.8	2359.4	-0.0	20.5	20.5
6	1279.3	1001.5	2280.8	11.1	25.6	36.6
7	1119.4	886.2	2005.6	22.1	30.6	52.8
8	852.9	688.7	1541.6	33.2	35.7	68.9
9	479.7	393.3	873.1	44.2	40.8	85.0
10	0.0	0.0	0.0	55.3	45.9	101.2
HOLD-DOWN	1318.3	1025.9	2344.1	5.7	18.0	23.7

LOOP 275 OVERPASS US 183 SPANS NO 1-6

STRESSES IN EXTREME FIBERS DUE TO EXTERNAL LOADS (LBS PER SQ. IN.)

SECTION	BEAM		SLAB		TOTAL D.L. NON-COMP SEC.		DEAD LOAD COMP SEC.		LIVE LOAD PLUS IMPACT		TOTAL	
	TOP	BOT	TOP	BOT	TOP	BOT	TOP	BOT	TOP	BOT	TOP	BOT
0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	448.	402.	551.	494.	999.	896.	0.	0.	125.	461.	1125.	1357.
2	796.	714.	980.	879.	1776.	1593.	0.	0.	220.	808.	1996.	2401.
3	1045.	937.	1286.	1154.	2332.	2091.	0.	0.	282.	1039.	2614.	3130.
4	1194.	1071.	1470.	1318.	2665.	2389.	0.	0.	319.	1174.	2984.	3564.
5	1244.	1116.	1532.	1373.	2776.	2489.	0.	0.	327.	1204.	3103.	3693.
6	1194.	1071.	1470.	1318.	2665.	2389.	0.	0.	319.	1174.	2984.	3564.
7	1045.	937.	1286.	1154.	2332.	2091.	0.	0.	282.	1039.	2614.	3130.
8	796.	714.	980.	879.	1776.	1593.	0.	0.	220.	808.	1996.	2401.
9	448.	402.	551.	494.	999.	896.	0.	0.	125.	461.	1125.	1357.
10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
HOLD-DOWN	1231.	1104.	1515.	1359.	2746.	2462.	0.	0.	327.	1203.	3073.	3665.

STRESSES DUE TO EXTERNAL LOADS PLUS PRESTRESS (LBS PER SQ. IN.)

	INITIAL PREST.		BEAM PLUS INITIAL PREST.		FINAL PREST. PLUS TOT. D.L.(N/C SEC.)		ALL LOADS PLUS FINAL PREST.	
	TOP	BOT	TOP	BOT	TOP	BOT	TOP	BOT
0	164.	3210.	164.	3210.	131.	2568.	131.	2568.
1	-134.	3477.	314.	3075.	892.	1885.	1017.	1424.
2	-432.	3744.	365.	3029.	1431.	1402.	1651.	584.
3	-729.	4010.	316.	3073.	1748.	1118.	2031.	79.
4	-1027.	4277.	167.	3206.	1843.	1032.	2162.	-142.
5	-1170.	4406.	74.	3290.	1839.	1036.	2167.	-168.
6	-1027.	4277.	167.	3206.	1843.	1032.	2162.	-142.
7	-729.	4010.	316.	3073.	1748.	1118.	2031.	79.
8	-432.	3744.	365.	3029.	1431.	1402.	1651.	594.
9	-134.	3477.	314.	3075.	892.	1885.	1017.	1424.
10	164.	3210.	164.	3210.	131.	2568.	131.	2568.
HOLD-DOWN	-1170.	4406.	61.	3302.	1810.	1062.	2137.	-141.

LOOP 275 OVERPASS US 183   SPANS NO 1-6

STIRRUP SPACING IN EXTERIOR 1/4 SPAN (AASHO SPECS.)   NO. 4 AT 16.8 IN.

STIRRUP SPACING IN MIDDLE 1/2 SPAN (AASHO SPECS.)   NO. 4 AT 24.0 IN.

STIRRUP SPACING BASED ON ACI SPECS.

SECTION	
0	NO. 4 AT 4.6 IN.
1	NO. 4 AT 17.4 IN.
2	NO. 4 AT 16.7 IN.
3	NO. 4 AT 17.0 IN.
4	NO. 4 AT 17.4 IN.
5	NO. 4 AT 17.4 IN.
6	NO. 4 AT 17.4 IN.
7	NO. 4 AT 17.0 IN.
8	NO. 4 AT 16.7 IN.
9	NO. 4 AT 17.4 IN.
10	NO. 4 AT 4.6 IN.

MAXIMUM ULTIMATE HORIZONTAL SHEAR BETWEEN SLAB AND GIRDER FLANGE (VQ/I)

SECTION	
0	223.2 PSI
1	188.0 PSI
2	152.8 PSI
3	117.6 PSI
4	82.4 PSI
5	61.5 PSI
6	82.4 PSI
7	117.6 PSI
8	152.8 PSI
9	188.0 PSI
10	223.2 PSI

LOOP 275 OVERPASS US 183   SPANS NO 1-6

ULTIMATE MOMENT REQUIRED = 4565.8 FT-KIPS
ULTIMATE MOMENT PROVIDED = 5396.9 FT-KIPS

UNDER REINFORCED RECTANGULAR SECTION
DESIGN BASED ON STRESSES

DEAD LOAD DEFLECTIONS	SLAB	DIAPHRAM	COMP DEAD LOAD
MIDSPAN	0.113 FT	0.016 FT	0.0 FT
QUARTER POINT	0.081 FT	0.011 FT	0.0 FT

MAXIMUM CAMBER = 2.85 IN.
PRESTRESS LOSS = 19.22 PERCENT

TYPE OF BEAM	= 54
NO. OF STRANDS	= 30.
SIZE OF STRANDS	= 1/2
ULT. STRENGTH OF STRANDS	= 270K
ECCENTRICITY AT C.L.	= 19.40 IN.
ECCENTRICITY AT END	= 10.60 IN.
CONCRETE RELEASE STRENGTH	= 5490. PSI
CONCRETE 28-DAY STRENGTH	= 5490. PSI
NUMBER OF DRAPED STRANDS	= 12

DEPRESS TOP STRANDS TO POSITION A-34

STRAND PATTERN AT CENTERLINE OF BEAM

ROW 1 HAS 6 STRANDS

ROW 2 HAS 6 STRANDS

ROW 3 HAS 6 STRANDS

ROW 4 HAS 6 STRANDS

ROW 5 HAS 4 STRANDS

ROW 6 HAS 2 STRANDS

DISTRICT 14 TRAVIS COUNTY HIGHWAY NO. LP 275 SUBMITTED BY BR WINN
CONTROL NO. 151-6 IPE 228 DATE NOV 2 1970

LOOP 275 OVERPASS US 183 SPANS NO 1-6

SPAN 3 BEAM 16

**** INPUT DATA ****

BEAM TYPE	= IV	UNIT WT. BEAM CONC.	= 150. PCF	L.L. DIST. FACTOR	= 0.49
SPAN LENGTH	= 124.35 FT	UNIT WT. SLAB CONC.	= 150. PCF	COMP. SLAB WIDTH	= 65.28 IN
BEAM SPACING	= 5.44 FT	28-DAY ST.(SLAB CONC.)	= 3600. PSI	COMP. DEAD LOAD	= 0.0 KLF
SLAB THICKNESS	= 7.50 IN	E(BM.CONC.)	= 5.00 E(06)PSI	BEAM INERTIA	= 260403. IN4
STRAND SIZE	= 1/2 IN	E(SLB.CONC.)	= 5.00 E(06)PSI	BEAM AREA	= 788.44 IN2
STRAND ULT. STR.	= 270K	E(PSRR. STL.)	= 28.00 E(06)PSI	BEAM DEPTH	= 54.00 IN
NO.OF WEB STRNS.	= 2	AASHO L.L.	= HS-20	BEAM YB	= 24.75 IN
GRID SIZE	= 2. IN	RAILROAD L.L.	= E- 0.	BEAM YT	= 29.25 IN

*** BEAM DESIGN ***
NOTE----RELEASE STRENGTH BASED ON MAXIMUM DRAPED POSITION OF STRANDS

TYPE OF BEAM = IV
NO. OF STRANDS = 52.
SIZE OF STRANDS = 1/2
TYPE OF STRANDS = 270K
ECCENTRICITY AT C.L. = 19.29 IN
ECCENTRICITY AT END = 11.60 IN
NO. OF DEPRESSED STRANDS = 10
DEPRESS TOP 2 STRANDS TO PCSITION A-52
CONCRETE RELEASE STRENGTH = 5980. PSI
CONCRETE 28-CAY STRENGTH = 7143. PSI

D.L. DEFLECTION AT MID-SPAN = 0.176 FT (SLAB) 0.016 FT (DIAF)
D.L. DEFLECTION AT 1/4 PT. = 0.125 FT (SLAB) 0.010 FT (DIAF)

ULTIMATE MOMENT REQUIRED = 6860. FT-KIPS
ULT. MOMENT PROVIDED = 9219. FT-KIPS UNDER REINF. RECT. SECT.

STIRRUP SPAC. (MIDDLE 1/2 SPAN) = NO. 4 AT 20.00 IN
STIRRUP SPAC. (EXT. 1/4 SPAN) = NO. 4 AT 13.43 IN

TOP FIBER DESIGN STRESS (C.L.) = 3945. PSI
BOTTOM FIBER DESIGN STRESS (C.L.) = 3888. PSI

MAXIMUM CAMBER = 3.22 IN
PRESTRESS LOSS = 17.64 PERCENT

*** STRAND PATTERN ***
(C.L. OF BEAM)

ROW 1 HAS 12. STRANDS
ROW 2 HAS 12. STRANDS
ROW 3 HAS 12. STRANDS
ROW 4 HAS 10. STRANDS
ROW 5 HAS 6. STRANDS

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DISTRICT 14          TRAVIS COUNTY   HIGHWAY NO. LP 275   SUBMITTED BY BR WINN
CONTRCL NO. 151-6     IPE 228    DATE NOV 2 1970

                         LOOP 275 OVERPASS US 183   SPANS NO 1-6

                                SPAN     3   BEAM     16
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**** INPUT DATA ****

BEAM TYPE	= IV	UNIT WT. BEAM CONC.	= 150. PCF	L.L. DIST. FACTOR	= 0.49
SPAN LENGTH	= 124.35 FT	UNIT WT. SLAB CONC.	= 150. PCF	COMP. SLAB WIDTH	= 65.28 IN
BEAM SPACING	= 5.44 FT	28-DAY ST.(SLAB CONC.)	= 3600. PSI	COMP. DEAD LOAD	= 0.0 KLF
SLAB THICKNESS	= 7.50 IN	E(BM.CONC.)	= 5.00 E(06)PSI	BEAM INERTIA	= 260403. IN4
STRAND SIZE	= 1/2 IN	E(SLB.CONC.)	= 5.00 E(06)PSI	BEAM AREA	= 788.44 IN2
STRAND ULT. STR.	= 270K	E(PSRR. STL.)	= 28.00 E(06)PSI	BEAM DEPTH	= 54.00 IN
NO.OF WEB STRNS.	= 3	AASHO L.L.	= HS-20	BEAM YB	= 24.75 IN
GRID SIZE	= 2. IN	RAILROAD L.L.	= E- 0.	BEAM YT	= 29.25 IN

*** BEAM DESIGN ***
NOTE----RELEASE STRENGTH BASED ON MAXIMUM DRAPED POSITION OF STRANDS

```
TYPE OF BEAM                 =    IV
NO. OF STRANDS               =    52.
SIZE OF STRANDS              =    1/2
TYPE OF STRANDS              =    270K
ECCENTRICITY AT C.L.         =    18.94 IN
ECCENTRICITY AT END          =     7.25 IN
NO. OF DEPRESSED STRANDS     =    16
DEPRESS TOP 3 STRANDS TO POSITION A-52
CONCRETE RELEASE STRENGTH = 8393.   PSI
CONCRETE 28-DAY STRENGTH  =   8393.    PSI

D.L. DEFLECTION AT MID-SPAN =  0.176 FT (SLAB)      0.016 FT (DIAF)
D.L. DEFLECTION AT 1/4 PT.  =  0.125 FT (SLAB)      0.010 FT (DIAF)

ULTIMATE MOMENT REQUIRED = 6860. FT-KIPS
ULT. MOMENT PROVIDED =       9170. FT-KIPS  UNDER REINF. RECT. SECT.

STIRRUP SPAC. (MIDDLE 1/2 SPAN) = NO. 4 AT 20.00 IN
STIRRUP SPAC. (EXT. 1/4 SPAN)   = NO. 4 AT 15.03 IN

TOP FIBER DESIGN STRESS (C.L.)    = 3945. PSI
BOTTOM FIBER DESIGN STRESS (C.L.) = 3888. PSI

MAXIMUM CAMBER =  2.46 IN
PRESTRESS LOSS = 17.44 PERCENT
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*** STRAND PATTERN ***
(C.L. OF BEAM)

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ROW  1 HAS 11. STRANDS
ROW  2 HAS 11. STRANDS
ROW  3 HAS 11. STRANDS
ROW  4 HAS 11. STRANDS
ROW  5 HAS  7. STRANDS
ROW  6 HAS  1. STRANDS
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