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16. Abstract

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This volume of the report contains a description of the computer program, instructions for its use and information on its structure and operation.

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AUTOMATED DESIGN OF CONTINUOUS BRIDGES WITH PRECAST PRESTRESSED CONCRETE BEAMS

VOLUME II: PROGRAM DOCUMENTATION

by

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Research Report Number 22-1(F)

Volume II
Automated Design of Prestressed Concrete Beams
Made Continuous for Live Load

Research Study Number 2-5-73-22

Sponsored by

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Texas A&M University
College Station, Texas

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ABSTRACT

A computer program has been developed in this study to perform the calculations for the design of continuous prestressed concrete bridge girders. The continuous girder is constructed from simple span precast concrete I-shaped beams made continuous by supplementary reinforcing in the deck and the ends of the precast beams. Specifications for the designs produced are those currently accepted by the State Department of Highways and Public Transportation.

This volume of the report contains a description of the computer program, instructions for its use and information on its structure and operation.

SUMMARY

This report describes the operation and use of a computer program for the design of continuous prestressed concrete bridge girders. The continuous girder is constructed from simple span precast prestressed concrete I-shaped beams made continuous by supplemental reinforcing in the deck and the ends of the beam. The program is limited to continuous girders in which precast beams in all spans are of identical cross section. The program considers live loads produced by standard AASHTO trucks and lane loadings, by an "axle train" of up to 15 axles of arbitrary weight and spacing and by a uniform distributed load on the continuous beam. Dead load due to beam weight, diaphragms and slab weight is also included. Provisions are made to treat cases where a portion of the deck over interior supports is cast first to establish continuity and the remaining deck weight is carried by the continuous beam.

The program computes for each span of the girder the number of prestressing strands and their placement, the area of conventional reinforcing required in the deck to resist negative moment, the area of reinforcing required at interior supports to resist positive moment and the spacing of stirrups.

RECOMMENDATION FOR IMPLEMENTATION

A computer program was developed in this study to carry out the necessary calculations for the design of continuous bridge girders constructed from simple span precast prestressed concrete I-shaped beams.

This program is being used by the State Department of Highways and Public Transportation and its continued use is recommended.

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I. INTRODUCTION

This report contains user's instructions and a description of the computer program for the automated design of continuous bridges, constructed with precast, prestressed concrete beams. The program is written in FORTRAN IV for IBM 360 and 370 series computers and requires approximately 190,000 bytes of core in source form. The program is structured around a main program and two functional modules which are called and executed sequentially. If core space must be reduced, this structure permits a significant reduction in core requirements through an overlay process. The program is capable of processing an unlimited number of beam designs during a single run.

The basic function of the program is to determine the following information for each span in a continuous beam:

(i) centerline strand pattern,

(ii) strand pattern eccentricity at each end,

(iii) minimum release and 28 day concrete strengths,

(iv) area of conventional reinforcing required in the deck to resist negative moments at each tenth point of the span,

(v) areas of conventional reinforcing required for continuity connection,

(vi) spacing of stirrups.

Beam cross sections must be I-shaped and the same section must be used for all spans (maximum of 10 spans). Standard THD and AASHTO beams may be designed with minimal program data input. Design live loadings available include AASHTO standard truck and lane, a vehicle of up to 15 arbitrarily spaced axles and a uniformly distributed load. Forces resulting from dead load are included automatically, while forces produced by creep and shrinkage restraint may be included or excluded at the user's option.

The remainder of this report is devoted to instructions for the use of the program and a description of its subroutines and their functions. Section II gives a detailed description of program input and output, while Section III gives details of program operation. The Appendices contain program variable definitions, subroutine descriptions, and a program listing.

II. PROGRAM INPUT/OUTPUT

Two types of program input are available, each utilizing a different input form for preparation of data. The first, referred to as a "standard beam", is intended to minimize data input, and is therefore limited to a number of standard conditions defined below. The "non-standard beam" input option is more lengthy but affords the user the full range of program options.

2.1 Standard Beam Input

Figure 1 shows the input form used with data preparation for standard designs. The standard input option is limited to cases where

(i) the beam section used is one of the standard THD or AASHTO shapes listed in Table 1,

(ii) AASHTO standard loading and/or uniformly distributed load on composite section,

(iii) no partial continuity for slab dead load,

(iv) two strands in the beam web,

(v) strand grid spacing of 2.0 in.,

(vi) 1/2 in. diameter grade 270 k strands,

(vii) normal weight slab and beam concrete (.150 kips/ft.^{3}),

(viii) slab concrete with 28 day strength of 3.6 ksi.,

(ix) strand eccentricities at each end of a beam may be different,

(x) standard weight diaphragms listed in Table 2.

2.1.1 Title Cards - The first three input cards are the title cards shown in Fig. 1. The information preprinted on the form in various

Beam Type	D (in.)	B (in.)	W (in.)	A (in.)	C (in.)	E (in.)	G (in.)	H (in.)	F (in.)	Q (in.)	O (in.)	P (in.)
A	28.0	16.0	6.0	12.0	5.0	5.0	3.0	4.0	0	0	0	0
B	34.0	18.0	6.5	12.0	6.0	5.75	2.75	5.5	0	0	0	0
C	40.0	22.0	7.0	14.0	7.0	7.5	3.5	6.0	0	0	0	0
48	48.0	14.0	6.0	14.0	7.0	4.0	4.0	3.5	0	0	0	0
54	54.0	16.0	6.0	16.0	8.0	5.0	5.0	4.0	0	0	0	0
5M	54.0	22.0	12.0	22.0	8.0	5.0	5.0	4.0	0	0	0	0
60	60.0	18.0	7.0	18.0	9.0	5.5	5.5	4.5	0	0	0	0
66	66.0	20.0	7.0	20.0	10.0	6.5	6.5	5.0	0	0	0	0
72	72.0	22.0	7.0	22.0	11.0	7.5	7.5	5.5	0	0	0	0
IV	54.0	26.0	8.0	20.0	8.0	9.0	6.0	8.0	0	0	0	0
V	63.0	28.0	8.0	42.0	8.0	10.0	3.0	5.0	0	0	4.0	4.0
VI	72.0	28.0	8.0	42.0	8.0	10.0	3.0	5.0	0	0	4.0	4.0

Beam Types A through 72 - THD standard beams

Beam Types IV, V, VI, - AASHTO standard beams

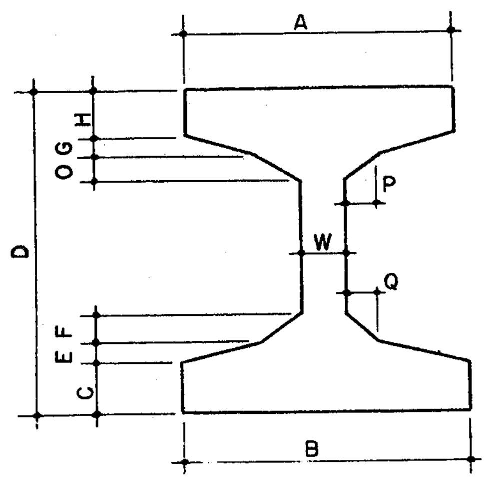


TABLE 1. DIMENSIONS OF STANDARD BEAMS

Diaphragm Weight (kips) = $C_1 (S - C_2) W$

where S = beam spacing in ft.,
W = unit weight of beam concrete (k/ft^3), and

Beam Type	C_1	C_2
A	1.0000	.6516
B	1.2221	.6850
C	1.4445	.7572
48	2.0556	.5978
54	2.2779	.6321
5M	2.2779	1.2189
60	2.5001	.7310
66	2.7223	.7658
72	2.9445	.8015
IV	2.0555	.9542
V	2.5001	1.1277
VI	2.9445	.9575

TABLE 2. COMPUTATION OF STANDARD DIAPHRAGM WEIGHTS

columns need not be punched on the data cards - it will be printed out automatically during output. The information on these cards is optional. These cards should be entered only once per problem run.

2.1.2 Load & Span Card - The information on the 4th line of the form constitutes the load and span card. The first column of this card must contain the letter "L". Standard AASHTO loadings (H-15, HS-15, H-20, and HS-20) and uniformly distributed load on the composite section (kips/ft.) are entered in the appropriate columns. Span lengths (in ft.) are entered in the columns indicated.

2.1.3 Beam Cards - The remaining lines on the input form specify the properties of the beam to be used. Columns 5 through 9 are for symbols to identify the beam. The beam type is input in columns 13 - 14 and must be selected from among those listed in Table 1. Columns 18 through 21 and 25 through 28 contain the lateral spacing of beams (in ft.) and the slab thickness (in in.), respectively. The minimum 28-day strength of beam concrete for all spans (in ksi) is entered in columns 32 through 35. If this field is left blank, 5.0 ksi is automatically assumed. Column 39 permits the user to delete consideration of creep and shrinkage forces during design by leaving this column blank. Columns 43 through 45 allow the user to specify the lateral distribution factor to be applied to AASHTO loadings. If this field is left blank, a factor of S/11 applied to axle loads (where S = beam spacing in ft.) is automatically assumed. The number of interior diaphragms to be used in each span are specified in columns 55 through 64. The user may choose an abbreviated output format by leaving column 68 blank. If a more extensive list of output information is desired, a "1" must be entered in this column (see Section 2.6).

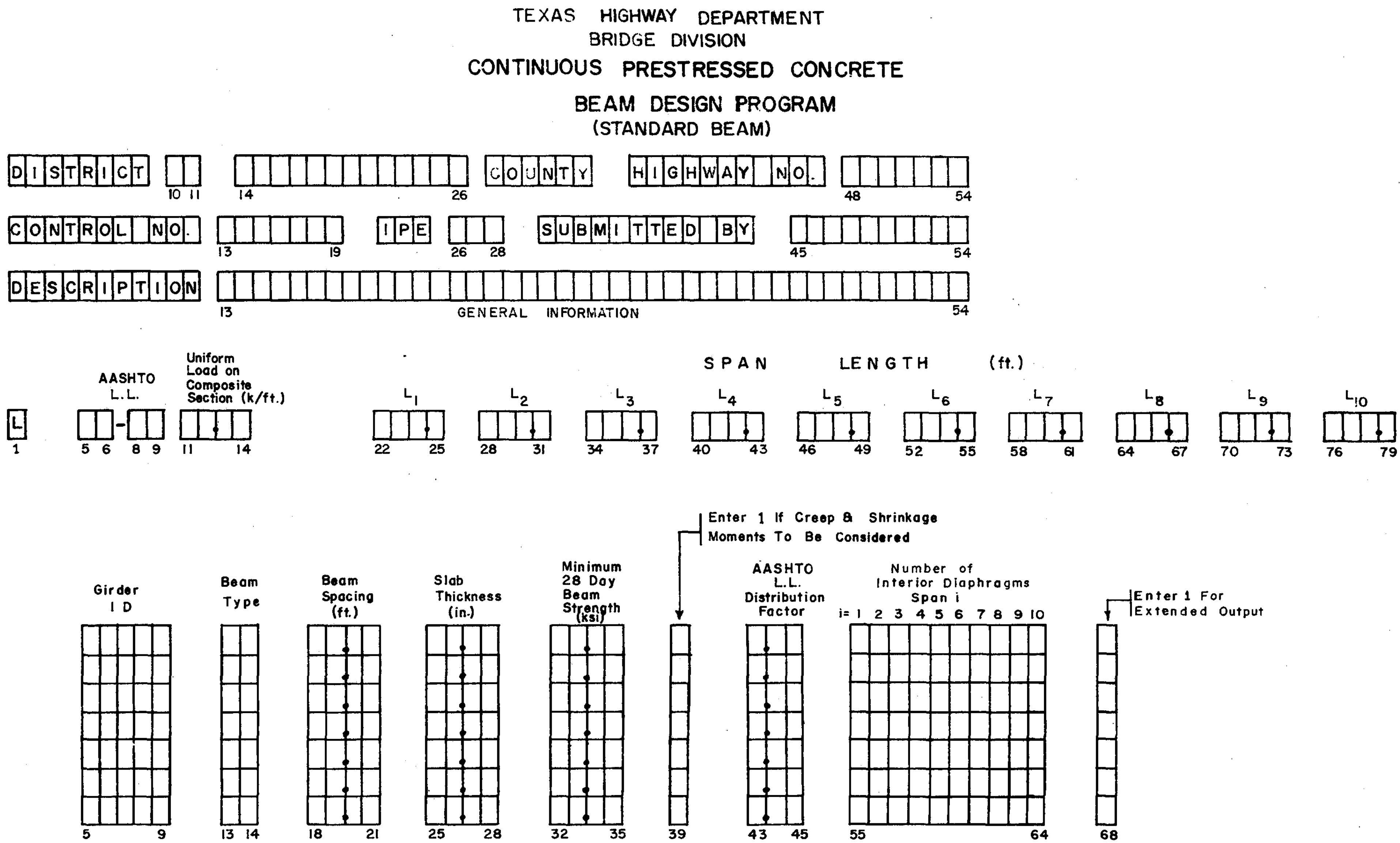


FIGURE 1. STANDARD INPUT FORM

The user may enter as many beam cards as he desires. However, each beam must have the same span lengths and loading conditions as specified on the preceding load and span card.

2.1.4 Multiple Beam Runs - The user may, during a single computer run, treat more than one loading or span length condition. This is accomplished by entering a new load and span card for each new condition and following it with one or more beam cards.

2.2 Non-Standard Beam Input

Figure 2 shows the two part non-standard input form to be used when one or more of the standard conditions stated in Section 2.1 are not met. As explained below, not all cards shown on the non-standard form must be used.

2.2.1 Title Cards - The first three input cards for any computer run must be the title cards described in Section 2.1.1. As in the standard input option, not all the information shown need be entered on the form.

2.2.2 Load & Span Card - The load and span card for non-standard input is identical in form to that used for standard input, with the exception of two additional entries. If an axle train loading is to be used, a "1" should be entered in column 17, and the 6th and 7th lines of Part 1 of the form which describes the vehicle must be included in the data set. If a partial slab continuity pour is to be utilized, enter a "1" in column 19, and complete the 1st line of Part 2 of the input form which describes the extent of the continuity pours. As with standard input, an "L" must be entered in column 1 of the load and span card.

PART 1 of 2

TEXAS HIGHWAY DEPARTMENT
BRIDGE DIVISION

CONTINUOUS PRESTRESSED CONCRETE BEAM DESIGN PROGRAM

(NON-STANDARD BEAM)

DISTRICT [10–11] [14–26] COUNTY HIGHWAY NO. [48–54]

CONTROL NO. [13–19] IPE [26–28] SUBMITTED BY [45–54]

DESCRIPTION [13–54] GENERAL INFORMATION

L [1]

AASHTO L.L. [5 6 – 8 9]

Uniform Load on Composite Section (k/ft) [11–14]

Enter 1 For Axle Train [17]

Enter 1 For D.L. Partial Continuity [19]

SPAN LENGTHS (ft.)

L_1 [22–25] L_2 [28–31] L_3 [34–37] L_4 [40–43] L_5 [46–49] L_6 [52–55] L_7 [58–61] L_8 [64–67] L_9 [70–73] L_{10} [76–79]

Girder ID [5–9]

Beam Type [13 14]

Beam Spacing (ft.) [18–21]

Slab Thickness (in.) [25–28]

Minimum 28 Day Beam Strength (ksi) [32–35]

Enter 1 If Creep & Shrinkage Moments To Be Considered [39]

AASHTO L.L. Distribution Factor [43–45]

Axle Train Distribution Factor [49–51]

Number of Interior Diaphragms Span i — i = 1 2 3 4 5 6 7 8 9 10 [55–64]

Enter 1 for Extended Output [68]

Diaphragm Wt. (Kips) [72–75]

AXLE TRAIN

Axle 1 [5–7]

Axle 2 [9–11] i = 2
Axle 3 [13–15] i = 3
Axle 4 [17–19] i = 4
Axle 5 [21–23] i = 5
Axle 6 [25–27] i = 6
Axle 7 [29–31] i = 7
Axle 8 [33–35] i = 8
Axle 9 [37–39] i = 9
Axle 10 [41–43] i = 10
Axle 11 [45–47] i = 11
Axle 12 [49–51] i = 12
Axle 13 [53–55] i = 13
Axle 14 [57–59] i = 14
Axle 15 [61–63] i = 15

Axle Load (Kips)
Dist. From Axle 1 To Axle i (ft.)

FIGURE 2. NON-STANDARD INPUT FORM

PART 2 of 2

PARTIAL CONTINUITY FOR D.L.

a_1	b_1	a_2	b_2	a_3	b_3	a_4	b_4	a_5	b_5	a_6	b_6	a_7	b_7	a_8	b_8	a_9	b_9	a_{10}	b_{10}
5 6	8 9	12 13	15 16	19 20	22 23	26 27	29 30	33 34	36 37	40 41	43 44	47 48	50 51	54 55	57 58	61 62	64 65	68 69	71 72

Enter Standard Beam ID If Modified Standard Beam	D(in)	B(in)	W(in)	A(in)	C(in)	E(in)	G(in)	H(in)	F(in)	Q(in)	O(in)	P(in)	Number Web Strands	Grid Spacing (in)
5 6	8 11	13 16	18 21	23 26	28 31	33 36	38 41	43 46	48 51	53 56	58 61	63 66	69	72 75

M	Strand Area (in)	Strand Ultimate Strength (ksi)	Unit Weight Beam Conc. (kip/ft^3)	Unit Weight Slab Conc. (kip/ft^3)	28 Day Strength Slab (ksi)	Enter 1 For Equal End Eccentricties
1	5 8	11 14	17 20	23 26	29 32	35

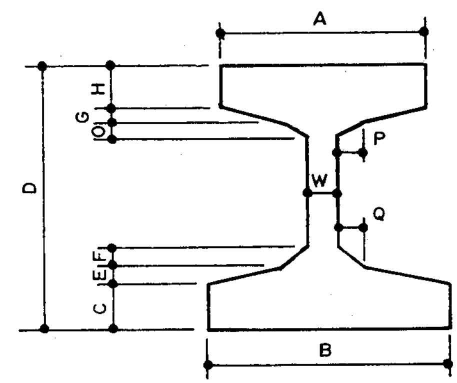


FIGURE 2. (CONTINUED)

2.2.3 Beam Card - This card is similar in form to that used for standard input. If a standard beam is to be used, enter the beam type in Columns 13 and 14, and omit the beam dimensions card (Section 2.2.7). If a non-standard beam is used, enter "NS" in columns 13 and 14. The user may specify a lateral distribution factor (fraction of an axle) for axle train loadings by entering this factor in columns 49 through 51. If this field is left blank, a factor of 1.0 is assumed. The number of interior diaphragms in each span are entered in columns 55 through 64. The diaphragm weight is entered in columns 72 through 75.

2.2.4 Axle Train Cards - (Use only when column 17 of the span and load card contains "1") - The 6th line contains the weight (in kips) of each axle in the axle train. The 7th line contains axle spacing information. The distance between the 1st axle and each of the other axles is entered on line 7. Axle spacings are specified to the nearest foot.

2.2.5 Continuity Card - (Use only when column 19 of the span and load card contains "1") - The coefficients a_i and b_i on line 1 of Part 2 of the form denote the fraction of span length L_i covered by the slab continuity pour. a_i pertains to the left end and b_i to the right end of the span, respectively. For example, if a two span beam with span lengths of 60 and 80 ft. were to have a continuity pour extending over 1/4 of each span on either side of the interior support, $a_1 = .00$ (or left blank), $b_1 = .25$, $a_2 = .25$, and $b_2 = .00$ (or blank). If the continuity pour were to extend 10 ft. on either side of the interior support, $a_1 = .00$, $b_1 = .17$, $a_2 = .13$, $b_2 = .00$.

2.2.6 Beam Dimensions Card - This card must be included in non-standard input if columns 13 and 14 of the beam card contain "NS". If a beam cross section, which is basically a standard shape, is to be used but with some dimensions modified, the standard beam identification should be entered in columns 5 and 6. Otherwise, enter "NS" or leave blank. For a modified standard beam, only those dimensions which differ from those shown in Table 1 need be entered. For example, if a type C beam were to be widened by spreading the forms in order to gain an additional web strand, "C" would be entered in column 6, and the new flange and web widths would be entered in Columns 13 through 16, 23 through 26, and 18 through 21. The program would then automatically retrieve the other beam dimensions listed in Table 1. The dimensions F, Q, O, P shown on the beam section on the form pertain only to sections with two tapers in flange thickness (AASHTO V & VI). For sections with only one taper, these fields should be left blank.

Column 69 is for specification of the number of strands in the web. If this column is left blank, two strands are assumed. Columns 72 through 75 specify the grid spacing of the strand pattern. If the field is left blank, 2.0 in. is assumed.

2.2.7 Miscellaneous Information Card - This card allows the user to specify strand area (columns 5 through 8), strand ultimate strength (columns 11 through 14), unit weight of beam and slab concrete (columns 17 through 20 and 23 through 26), and 28 day slab concrete strength (columns 29 through 32). If the eccentricities of the strands at each end of the beam must be equal, enter "1" in column 35. If any field is left blank, the standard values listed in Section 2.1 are assumed. If standard values are to be used for all quantities, this card should be omitted. When the card is used, an "M" must be entered in column 1.

2.3 Mixed Standard and Non-Standard Runs

Both standard and non-standard input may be used during one program run. The program will automatically sort out the input data. However, only one set of title cards should be used in a single run, and the load/span card and beam card sequence must be maintained for each data set. An example of this type of input is given in the next section.

2.4 Superposition of Load Effects

The maximum and minimum live load moments and shears determined at each design point (tenth point) are those creating the greatest effect from (i) standard AASHTO trucks, or (ii) standard AASHTO lane load, or (iii) axle train. Impact factors are applied only to AASHTO loadings. For ultimate strength calculations, a load factor of

$$\frac{1.30}{\phi}\left[D.L. + \frac{5}{3}(L.L. + I)\right] \qquad (1)$$

is applied, where ϕ = 1.0 for moment and 0.9 for shear. Dead load consists of the sum of the effects due to (i) slab weight, (ii) beam weight, (iii) diaphragm weight, and (iv) uniform load on continuous beam.

2.5 Sample Input

Described below are three example problems demonstrating the use of standard and non-standard input forms.

2.5.1 Example Problem 1 - This problem consists of a two span bridge, with each span being 40.0 ft. The loading is AASHTO HS-20. Three girders are to be designed. The first two are type B beams, on 10 ft. centers with 8 in. slab. In the first design, creep and shrinkage restraint moments are to be ignored. The second design includes restraint moments. The third design is a type A beam, on 6 ft. centers with a 6.5 in. slab. The input form used for this example is shown in Fig. 3, and the program output for the first two designs is shown in Figs. 4 and 5.

2.5.2 Example Problem 2 - This design consists of three spans of 117 ft., 134 ft., and 105 ft. The designer wishes to utilize a partial continuity pour of 1/10th of each span (see Fig. 6). A single diaphragm located at center span is to be used. The computed weight of a diaphragm is 1.8 kips. Since the beam is an interior beam, it will carry the full diaphragm weight (1/2 a diaphragm on each side) and 1.8 is entered on the form. The bridge is to contain a concrete median curb weighing 100 lbs. per foot. Three designs are considered: the first is a type IV beam, the second a 66 in. beam, and the third a 54 in. beam. Because of the loading options chosen, a non-standard form must be used. Since only the loading is non-standard, the standard beam identification is entered on the beam card and the beam dimensions card is omitted. The axle train and miscellaneous properties cards are omitted. The second and third designs are also for standard beams. These are entered using only the beam card on the non-standard form (3rd and 4th sheets, Fig. 7). The results of the first design are shown in Fig. 8.

2.5.3 Example Problem 3 - A two span, 60 ft. - 60 ft. bridge is to sustain the 9-axle vehicle shown in Fig. 9. A non-standard beam cross

TEXAS HIGHWAY DEPARTMENT
BRIDGE DIVISION

CONTINUOUS PRESTRESSED CONCRETE

BEAM DESIGN PROGRAM

(STANDARD BEAM)

DISTRICT **14** (10 11) **TRAVIS** (14 26) COUNTY HIGHWAY NO. **IH 35** (48 54)

CONTROL NO. **476-219** (13 19) IPE **675** (26 28) SUBMITTED BY **HLJ** (45 54)

DESCRIPTION **EXAMPLE PROBLEM NO. 1** (13 54)

GENERAL INFORMATION

	AASHTO L.L.	Uniform Load on Composite Section (k/ft.)	SPAN LENGTH (ft.) L_1	L_2	L_3	L_4	L_5	L_6	L_7	L_8	L_9	L_{10}
L	HS-20	.	40.	40.	.	.	.	.	.	.	.	.
1	5 6 8 9	11 14	22 25	28 31	34 37	40 43	46 49	52 55	58 61	64 67	70 73	76 79

Enter 1 If Creep & Shrinkage Moments To Be Considered

Enter 1 For Extended Output

Girder ID	Beam Type	Beam Spacing (ft.)	Slab Thickness (in.)	Minimum 28 Day Beam Strength (ksi)	Creep & Shrinkage	AASHTO L.L. Distribution Factor	Number of Interior Diaphragms Span i (i= 1 2 3 4 5 6 7 8 9 10)	Extended Output
DSN 1	B	10.	875	.		.	1 1	1
DSN 2	B	10.	875	.	1	.	1 1	1
DSN 3	A	6.	65	.	1	.	1 1	1
5 9	13 14	18 21	25 28	32 35	39	43 45	55 64	68

FIGURE 3. INPUT FORM FOR EXAMPLE PROBLEM 1

```
                              DISTRICT 14          TRAVIS COUNTY  HIGHWAY NO.    IH 35
                              CONTROL NO. 476-219  IPE 675  SUBMITTED BY HLJ
                              DESCRIPTION EXAMPLE PROBLEM NO. 1
                   ***BRIDGE IS SYMMETRICAL - ONLY INFORMATION ON 1/2 OF BRIDGE OUTPUT***
                                          *****************
                                          *BEAM I.D.  DSN 1*
                                          *****************
******************************************************************************************************
BEAM TYPE             = B              NO. WEB STRANDS     =  2                 CREEP AND SHRINKAGE FORCES CONSIDERED =  NO
BEAM SPACING          =10.00(FT)       AASHTO L.L.         =HS-20               PARTIAL D.L. CONTINUITY               =  NO
SLAB THICKNESS        = 8.75(IN)       L.L. DIST           =0.91                AXLE TRAIN DIST. FACTOR               =1.00
28 DAY ST.(SLAB)      = 3.60(KSI)      BEAM INERTIA        =  43177.(IN**4)     UNIF. LOAD ON CONTINUOUS BEAM         = 0.00
UNIT WT. BEAM CONC.=0.150(K/FT**3)     BEAM AREA           = 360.3(IN**2)       TOTAL STIRRUP AREA                    =0.22(IN**2
UNIT WT. SLAB CONC.=0.150(K/FT**3)     BEAM YB             = 14.93(IN)
STRAND AREA           =0.153(IN**2)    BEAM YT             = 19.07(IN)
STRAND ULT. STRGTH.=270.0(KSI)         BEAM ZB             =  2891.9(IN**3)
GRID SIZE             = 2.00(IN)       BEAM ZT             =  2264.1(IN**3)
******************************************************************************************************
*NON-STANDARD DIAPHRAMS*SPAN  1*SPAN  2*SPAN  3*SPAN  4*SPAN  5*SPAN  6*SPAN  7*SPAN  8*SPAN  9*SPAN 10*
*NO. DIAPHRAMS PER SPAN*   1   *
*DIAP. WT.=  1.71(KIPS)*
******************************************************************************************************
*COMP. PROPERTIES *  SPAN 1  *  SPAN 2  *  SPAN 3  *  SPAN 4  *  SPAN 5  *  SPAN 6  *  SPAN 7  *  SPAN 8  *  SPAN 9  *  SPAN 10*
******************************************************************************************************
SPAN LENGTH(FT)   *     40.0  *     40.0  *
AREA(IN**2)       *   1279.1  *   1279.1  *
INERTIA(IN**4)    *  191298.  *  191298.  *
YB(IN)            *    31.77  *    31.77  *
YT(IN)            *     2.23  *     2.23  *
******************************************************************************************************
*STRAND AND CONCRETE PROPERTIES*SPAN  1*SPAN  2*SPAN  3*SPAN  4*SPAN  5*SPAN  6*SPAN  7*SPAN  8*SPAN  9*SPAN 10*
******************************************************************************************************
RELEASE STRENGTH(KSI)             *  4.00 *
28  DAY STRENGTH(KSI)             *  4.11 *
LEFT ECCENTRICITY(IN)             *  7.60 *
 LEFT END-RAISE TOP STRANDS TO *ROW   7 *
RIGHT ECCENTRICITY(IN)            *  7.60 *
RIGHT END-RAISE TOP STRANDS TO *ROW   7 *
CENTER ECCENTRICITY(IN)           * 12.26 *
TOTAL NUMBER OF STRANDS           *  12   *
NO. OF DEPRESSED STRANDS          *   4   *
NO. STRANDS IN ROW  2             *   4   *
NO. STRANDS IN ROW  1             *   8   *
******************************************************************************************************
*(-)M REINF. (IN**2/FT) * 0/10* 1/10* 2/10* 3/10* 4/10* 5/10* 6/10* 7/10* 8/10* 9/10*10/10**(+M) CONT. REINF.(IN**2)* 0/10*10/10
******************************************************************************************************
                SPAN  1* 0.00* 0.03* 0.16* 0.34* 0.42* 0.45* 0.43* 0.36* 0.24* 0.27* 0.37*               SPAN  1* 0.00* 0.00
******************************************************************************************
*AASHTO STIRRUP SPACING(IN)*0/4-1/4*1/4-3/4*3/4-4/4**********ACI STIRRUP SPACING(IN)*0/4-1/4*1/4-3/4*3/4-4/4*
                  SPAN  1*  7.17 *  9.40 *  5.32 **********                SPAN  1*  7.71 * 16.47 *  4.98 *
******************************************************************************************************
*ULTIMATE MOMENT SUMMARY(KIP-FT)*   SPAN  1  *   SPAN  2  *   SPAN  3  *   SPAN  4  *   SPAN  5  *
*******************************************************************************************
                      REQUIRED* 0.13014E 04*
                      SUPPLIED* 0.16045E 04*
******************************************************************************************************
*      PRESTRESS LOSS(PERCENT)  *SPAN  1*SPAN  2*SPAN  3*SPAN  4*SPAN  5*SPAN  6*SPAN  7*SPAN  8*SPAN  9*  SPAN 10*
******************************************************************************************************
                       RELEASE*  9.56*
```

FIGURE 4. OUTPUT FOR FIRST DESIGN - EXAMRLE PROBLEM 1

FINAL* 23.49*

MOMENT SUMMARY(KIP-FT)

SPAN	POINT	LIVE LOAD MAXIMUM	LIVE LOAD MINIMUM	DEAD LOAD NON-COMP SECTION	DEAD LOAD COMP SECTION	CREEP RESTRAINT	AASHTO ULTIMATE SHEAR
1	0/10	0.0	0.0	0.0	0.0	0.0	172.5
1	1/10	206.9	-25.6	109.2	0.0	0.0	143.7
1	2/10	339.0	-51.2	194.9	0.0	0.0	115.8
1	3/10	402.9	-76.8	257.0	0.0	0.0	89.1
1	4/10	423.3	-102.4	295.7	0.0	0.0	63.9
1	5/10	410.2	-127.9	310.9	0.0	0.0	65.0
1	6/10	380.1	-153.5	295.7	0.0	0.0	91.0
1	7/10	300.7	-179.1	257.0	0.0	0.0	116.5
1	8/10	182.6	-204.7	194.9	0.0	0.0	142.2
1	9/10	51.3	-230.3	109.2	0.0	0.0	166.9
1	10/10	0.0	-314.6	0.0	0.0	0.0	189.7

RELEASE STRESSES(KSI)

	SPAN 1	SPAN 2	SPAN 3	SPAN 4	SPAN 5	SPAN 6	SPAN 7	SPAN 8	SPAN 9	SPAN 10
LEFT END(TOP)	-0.369									
LEFT END(BOT)	1.850									
HOLD DOWN(TOP)	-0.460									
HOLD DOWN(BOT)	1.922									
RIGHT END(TOP)	-0.369									
RIGHT END(BOT)	1.850									

SERVICE LOAD STRESSES(KSI)

SPAN	POINT	L.L. MAXIMUM DEAD LOAD (+)CREEP RESTNT TOP	L.L. MAXIMUM DEAD LOAD (+)CREEP RESTNT BOT	L.L. MINIMUM DEAD LOAD (-)CREEP RESTNT TOP	L.L. MINIMUM DEAD LOAD (-)CREEP RESTNT BOT
1	0/10	-0.310	1.557	-0.310	1.557
1	1/10	0.193	0.773	0.161	1.236
1	2/10	0.561	0.236	0.507	1.013
1	3/10	0.796	-0.068	0.729	0.888
1	4/10	0.925	-0.208	0.852	0.840
1	5/10	1.004	-0.245	0.929	0.828
1	6/10	0.919	-0.122	0.845	0.942
1	7/10	0.781	0.136	0.714	1.092
1	8/10	0.540	0.547	0.495	1.319
1	9/10	0.171	1.083	0.132	1.644
1	10/10	-0.310	1.557	-0.354	2.184

MAXIMUM TENSION STRESS TOP OF SLAB(KSI)

	0/10	1/10	2/10	3/10	4/10	5/10	6/10	7/10	8/10	9/10	10/10
SPAN 1	0.000	0.018	0.035	0.053	0.070	0.088	0.106	0.123	0.141	0.159	0.217

FIGURE 4. (CONTINUED)

```
                              DISTRICT 14          TRAVIS COUNTY  HIGHWAY NO.    IH 35
                              CONTROL NO. 476-219  IPE 675  SUBMITTED BY HLJ
                              DESCRIPTION EXAMPLE PROBLEM NO. 1
                    ***BRIDGE IS SYMMETRICAL - ONLY INFORMATION ON 1/2 OF BRIDGE OUTPUT***
                                             ******************
                                             *BEAM I.D.  DSN 2*
                                             ******************
***************************************************************************************************************
BEAM TYPE             = B              NO. WEB STRANDS      =  2           CREEP AND SHRINKAGE FORCES CONSIDERED =  YES
BEAM SPACING          =10.00(FT)       AASHTO L.L.          =HS-20         PARTIAL D.L. CONTINUITY               =  NO
SLAB THICKNESS        = 8.75(IN)       L.L. DIST            =0.91          AXLE TRAIN DIST. FACTOR               =1.00
28 DAY ST.(SLAB)      = 3.60(KSI)      BEAM INERTIA         =  43177.(IN**4)  UNIF. LOAD ON CONTINUOUS BEAM      = 0.00
UNIT WT. BEAM CONC.=0.150(K/FT**3)     BEAM AREA            = 360.3(IN**2)    TOTAL STIRRUP AREA                 =0.22(IN*
UNIT WT. SLAB CONC.=0.150(K/FT**3)     BEAM YB              = 14.93(IN)
STRAND AREA           =0.153(IN**2)    BEAM YT              = 19.07(IN)
STRAND ULT. STRGTH.=270.0(KSI)         BEAM ZB              =   2891.9(IN**3)
GRID SIZE             = 2.00(IN)       BEAM ZT              =   2264.1(IN**3)
***************************************************************************************************************
*NON-STANDARD DIAPHRAMS*SPAN  1*SPAN  2*SPAN  3*SPAN  4*SPAN  5*SPAN  6*SPAN  7*SPAN  8*SPAN  9*SPAN 10*
*NO. DIAPHRAMS PER SPAN*   1    *
*DIAP. WT.=  1.71(KIPS)*
***************************************************************************************************************
*COMP. PROPERTIES *  SPAN 1  *  SPAN 2  *  SPAN 3  *  SPAN 4  *  SPAN 5  *  SPAN 6  *  SPAN 7  *  SPAN 8  *  SPAN 9  *  SPAN 1
***************************************************************************************************************
SPAN LENGTH(FT)    *    40.0  *    40.0  *
AREA(IN**2)        *  1279.1  *  1279.1  *
INERTIA(IN**4)     * 191298.  * 191298.  *
YB(IN)             *    31.77 *    31.77 *
YT(IN)             *     2.23 *     2.23 *
***************************************************************************************************************
*STRAND AND CONCRETE PROPERTIES*SPAN  1*SPAN  2*SPAN  3*SPAN  4*SPAN  5*SPAN  6*SPAN  7*SPAN  8*SPAN  9*SPAN 10*
***************************************************************************************************************
RELEASE STRENGTH(KSI)              *  4.00 *
28  DAY STRENGTH(KSI)              *  6.50 *
LEFT ECCENTRICITY(IN)              *  8.26 *
 LEFT END-RAISE TOP STRANDS TO *ROW  6 *
RIGHT ECCENTRICITY(IN)             *  1.60 *
RIGHT END-RAISE TOP STRANDS TO *ROW 16 *
CENTER ECCENTRICITY(IN)            * 12.26 *
TOTAL NUMBER OF STRANDS            *  12   *
NO. OF DEPRESSED STRANDS           *   4   *
NO. STRANDS IN ROW  2              *   4   *
NO. STRANDS IN ROW  1              *   8   *
***************************************************************************************************************
*(-)M REINF. (IN**2/FT) * 0/10* 1/10* 2/10* 3/10* 4/10* 5/10* 6/10* 7/10* 8/10* 9/10*10/10**(+M) CONT. REINF.(IN**2)* 0/10*10/1
***************************************************************************************************************
                SPAN  1* 0.00* 0.08* 0.16* 0.34* 0.43* 0.46* 0.50* 0.58* 0.67* 0.76* 0.93*              SPAN  1* 0.00* 0.0
****************************************************************************************************
*AASHTO STIRRUP SPACING(IN)*0/4-1/4*1/4-3/4*3/4-4/4**********ACI STIRRUP SPACING(IN)*0/4-1/4*1/4-3/4*3/4-4/4*
                   SPAN  1*  7.12 * 10.23 *  5.62 **********              SPAN  1* 10.50 * 24.00 *  6.81 *
***************************************************************************************************************
*ULTIMATE MOMENT SUMMARY(KIP-FT)*   SPAN  1  *   SPAN  2  *   SPAN  3  *   SPAN  4  *   SPAN  5  *
*********************************************************************************************
                      REQUIRED* 0.13014E 04*
                      SUPPLIED* 0.16045E 04*
***************************************************************************************************************
*      PRESTRESS LOSS(PERCENT)  *SPAN  1*SPAN  2*SPAN  3*SPAN  4*SPAN  5*SPAN  6*SPAN  7*SPAN  8*SPAN  9*  SPAN 10*
***************************************************************************************************************
                       RELEASE*  9.56*
```

FIGURE 5. OUTPUT FOR SECOND DESIGN - EXAMPLE PROBLEM 1

FINAL* 23.49*

MOMENT SUMMARY (KIP-FT)

SPAN	POINT	LIVE LOAD MAXIMUM	LIVE LOAD MINIMUM	DEAD LOAD NON-COMP SECTION	DEAD LOAD COMP SECTION	CREEP RESTRAINT	AASHTO ULTIMATE SHEAR
1	0/10	0.0	0.0	0.0	0.0	0.0	172.5
1	1/10	206.9	-25.6	109.2	0.0	-74.5	143.7
1	2/10	339.0	-51.2	194.9	0.0	-149.0	115.8
1	3/10	402.9	-76.8	257.0	0.0	-223.5	89.1
1	4/10	423.3	-102.4	295.7	0.0	-297.9	63.9
1	5/10	410.2	-127.9	310.9	0.0	-372.4	65.0
1	6/10	380.1	-153.5	295.7	0.0	-446.9	91.0
1	7/10	300.7	-179.1	257.0	0.0	-521.4	116.5
1	8/10	182.6	-204.7	194.9	0.0	-595.9	142.2
1	9/10	51.3	-230.3	109.2	0.0	-670.4	166.9
1	10/10	0.0	-314.6	0.0	0.0	-744.9	189.7

RELEASE STRESSES (KSI)

RELEASE STRESSES (KSI)	SPAN 1	SPAN 2	SPAN 3	SPAN 4	SPAN 5	SPAN 6	SPAN 7	SPAN 8	SPAN 9	SPAN 10
LEFT END(TOP)	-0.462									
LEFT END(BOT)	1.923									
HOLD DOWN(TOP)	-0.460									
HOLD DOWN(BOT)	1.922									
RIGHT END(TOP)	0.467									
RIGHT END(BOT)	1.196									

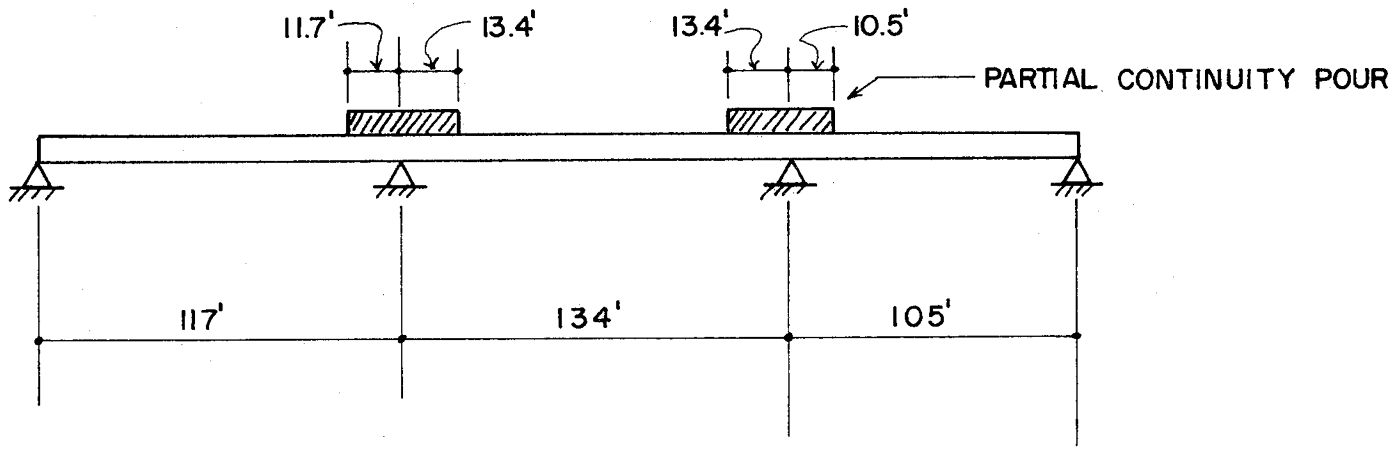
SERVICE LOAD STRESSES (KSI)

SPAN	POINT	L.L. MAXIMUM DEAD LOAD (+)CREEP RESTNT TOP	L.L. MAXIMUM DEAD LOAD (+)CREEP RESTNT BOT	L.L. MINIMUM DEAD LOAD (-)CREEP RESTNT TOP	L.L. MINIMUM DEAD LOAD (-)CREEP RESTNT BOT
1	0/10	-0.388	1.618	-0.388	1.618
1	1/10	0.136	0.818	0.103	1.281
1	2/10	0.525	0.264	0.470	1.042
1	3/10	0.780	-0.056	0.713	0.900
1	4/10	0.925	-0.208	0.852	0.840
1	5/10	1.004	-0.245	0.929	0.828
1	6/10	0.919	-0.122	0.845	0.942
1	7/10	0.922	0.025	0.855	0.982
1	8/10	0.868	0.290	0.814	1.062
1	9/10	0.687	0.679	0.648	1.240
1	10/10	0.393	1.006	0.349	1.633

MAXIMUM TENSION STRESS TOP OF SLAB (KSI)

	0/10	1/10	2/10	3/10	4/10	5/10	6/10	7/10	8/10	9/10	10/10
SPAN 1	0.000	0.069	0.138	0.207	0.276	0.345	0.414	0.482	0.551	0.620	0.730

FIGURE 5. (CONTINUED)



$$a_1 = \frac{0}{117} = 0.00 \qquad a_2 = \frac{13.4}{134} = 0.10 \qquad a_3 = \frac{10.5}{105} = 0.10$$

$$b_1 = \frac{11.7}{117} = 0.10 \qquad b_2 = \frac{13.4}{134} = 0.10 \qquad b_3 = \frac{0}{105} = 0.00$$

FIGURE 6 PARTIAL SLAB CONTINUITY POUR-EXAMPLE PROBLEM 2

PART 1 of 2

TEXAS HIGHWAY DEPARTMENT
BRIDGE DIVISION

CONTINUOUS PRESTRESSED CONCRETE

BEAM DESIGN PROGRAM
(NON-STANDARD BEAM)

DISTRICT 14 (10 11) | TRAVIS (14–26) COUNTY | HIGHWAY NO. IH 35 (48–54)

CONTROL NO. 476-219 (13–19) | IPE 675 (26 28) | SUBMITTED BY HLJ (45–54)

DESCRIPTION EXAMPLE PROBLEM NO. 2 (13–54)

GENERAL INFORMATION

Field	Columns	Entry
L	1	L
AASHTO L.L.	5 6 8 9	HS-20
Uniform Load on Composite Section (k/ft)	11–14	.10
Enter 1 For Axle Train	17	
Enter 1 For D.L. Partial Continuity	19	1

SPAN LENGTHS (ft.)

L_1	L_2	L_3	L_4	L_5	L_6	L_7	L_8	L_9	L_{10}
22–25	28–31	34–37	40–43	46–49	52–55	58–61	64–67	70–73	76–79
117.	134.	105.							

Field	Columns	Entry
Girder ID	5–9	DSN 1
Beam Type	13 14	IV
Beam Spacing (ft.)	18–21	6.9
Slab Thickness (in.)	25–28	7.25
Minimum 28 Day Beam Strength (ksi)	32–35	
Enter 1 If Creep & Shrinkage Moments To Be Considered	39	
AASHTO L.L. Distribution Factor	43–45	
Axle Train Distribution Factor	49–51	
Number of Interior Diaphragms Span i (i = 1 2 3 4 5 6 7 8 9 10)	55–64	1 1 1
Enter 1 for Extended Output	68	1
Diaphragm Wt. (Kips)	72–75	1.8

AXLE TRAIN

Axle	Columns	i
Axle 1	5 7	
Axle 2	9 11	i = 2
Axle 3	13 15	i = 3
Axle 4	17 19	i = 4
Axle 5	21 23	i = 5
Axle 6	25 27	i = 6
Axle 7	29 31	i = 7
Axle 8	33 35	i = 8
Axle 9	37 39	i = 9
Axle 10	41 43	i = 10
Axle 11	45 47	i = 11
Axle 12	49 51	i = 12
Axle 13	53 55	i = 13
Axle 14	57 59	i = 14
Axle 15	61 63	i = 15

Axle Load (Kips)

Dist. From Axle 1 To Axle i (ft.)

FIGURE 7. INPUT FOR EXAMPLE PROBLEM 2

PART 2 of 2

PARTIAL CONTINUITY FOR D.L.

Field	Entry	Columns
a_1		5 6
b_1	10	8 9
a_2	10	12 13
b_2	10	15 16
a_3	10	19 20
b_3		22 23
a_4		26 27
b_4		29 30
a_5		33 34
b_5		36 37
a_6		40 41
b_6		43 44
a_7		47 48
b_7		50 51
a_8		54 55
b_8		57 58
a_9		61 62
b_9		64 65
a_{10}		68 69
b_{10}		71 72

Field	Columns
Enter Standard Beam ID If Modified Standard Beam	5 6
D(in)	8 11
B(in)	13 16
W(in)	18 21
A(in)	23 26
C(in)	28 31
E(in)	33 36
G(in)	38 41
H(in)	43 46
F(in)	48 51
Q(in)	53 56
O(in)	58 61
P(in)	63 66
Number Web Strands	69
Grid Spacing (in)	72 75

Field	Columns
M	1
Strand Area (in)	5 8
Strand Ultimate Strength (ksi)	11 14
Unit Weight Beam Conc. (kip/ft^3)	17 20
Unit Weight Slab Conc. (kip/ft^3)	23 26
28 Day Strength Slab (ksi)	29 32
Enter 1 For Equal End Eccentricties	35

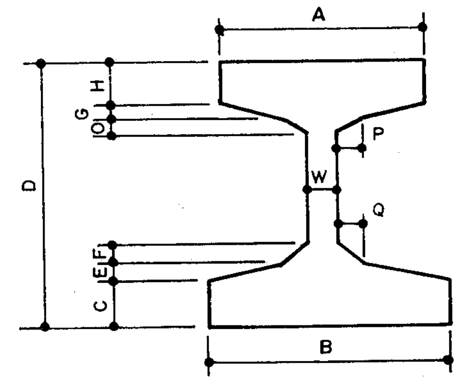


FIGURE 7. (CONTINUED)

PART 1 of 2

TEXAS HIGHWAY DEPARTMENT
BRIDGE DIVISION
CONTINUOUS PRESTRESSED CONCRETE
BEAM DESIGN PROGRAM
(NON-STANDARD BEAM)

DISTRICT [10–11] [14–26] COUNTY HIGHWAY NO. [48–54]

CONTROL NO. [13–19] IPE [26–28] SUBMITTED BY [45–54]

DESCRIPTION [13–54] GENERAL INFORMATION

Enter 1 For Axle Train

Enter 1 For D.L. Partial Continuity

SPAN LENGTHS (ft.)

Field	Columns
L	1
AASHTO L.L.	5 6 – 8 9
Uniform Load on Composite Section (k/ft)	11–14
Enter 1 For Axle Train	17
Enter 1 For D.L. Partial Continuity	19
L_1	22–25
L_2	28–31
L_3	34–37
L_4	40–43
L_5	46–49
L_6	52–55
L_7	58–61
L_8	64–67
L_9	70–73
L_{10}	76–79

Enter 1 If Creep & Shrinkage Moments To Be Considered

Enter 1 for Extended Output

Field	Entry	Columns
Girder ID	DSN 2	5–9
Beam Type	66	13 14
Beam Spacing (ft.)	6.9	18–21
Slab Thickness (in.)	7.25	25–28
Minimum 28 Day Beam Strength (ksi)		32–35
Enter 1 If Creep & Shrinkage Moments To Be Considered		39
AASHTO L.L. Distribution Factor		43–45
Axle Train Distribution Factor		49–51
Number of Interior Diaphragms Span i (i = 1 2 3 4 5 6 7 8 9 10)	111	55–64
Enter 1 for Extended Output	1	68
Diaphragm Wt. (Kips)	1.8	72–75

AXLE TRAIN

Axle Load (Kips)

Dist. From Axle 1 To Axle i (ft.)

Axle	Columns	i
Axle 1	5–7	
Axle 2	9–11	i = 2
Axle 3	13–15	i = 3
Axle 4	17–19	i = 4
Axle 5	21–23	i = 5
Axle 6	25–27	i = 6
Axle 7	29–31	i = 7
Axle 8	33–35	i = 8
Axle 9	37–39	i = 9
Axle 10	41–43	i = 10
Axle 11	45–47	i = 11
Axle 12	49–51	i = 12
Axle 13	53–55	i = 13
Axle 14	57–59	i = 14
Axle 15	61–63	i = 15

FIGURE 7. (CONTINUED)

TEXAS HIGHWAY DEPARTMENT
BRIDGE DIVISION

CONTINUOUS PRESTRESSED CONCRETE

BEAM DESIGN PROGRAM
(NON-STANDARD BEAM)

DISTRICT [ ] 10 11 [ ] 14 – 26 COUNTY HIGHWAY NO. [ ] 48 – 54

CONTROL NO. [ ] 13 – 19 IPE [ ] 26 28 SUBMITTED BY [ ] 45 – 54

DESCRIPTION [ ] 13 – 54 GENERAL INFORMATION

Enter 1 For Axle Train

Enter 1 For D.L. Partial Continuity

SPAN LENGTHS (ft.)

L	AASHTO L.L.	Uniform Load on Composite Section (k/ft)	Enter 1 For Axle Train	Enter 1 For D.L. Partial Continuity	L_1	L_2	L_3	L_4	L_5	L_6	L_7	L_8	L_9	L_{10}
1	5 6 – 8 9	11 14	17	19	22 25	28 31	34 37	40 43	46 49	52 55	58 61	64 67	70 73	76 79

Enter 1 If Creep & Shrinkage Moments To Be Considered

Enter 1 for Extended Output

Girder ID	Beam Type	Beam Spacing (ft.)	Slab Thickness (in.)	Minimum 28 Day Beam Strength (ksi)	Enter 1 If Creep & Shrinkage Moments To Be Considered	AASHTO L.L. Distribution Factor	Axle Train Distribution Factor	Number of Interior Diaphragms Span i (i= 1 2 3 4 5 6 7 8 9 10)	Enter 1 for Extended Output	Diaphragm Wt. (Kips)
DSN 3	54	5	6.75					1 1 1	1	1.8
5 9	13 14	18 21	25 28	32 35	39	43 45	49 51	55 64	68	72 75

AXLE TRAIN

	Axle 1	Axle 2	Axle 3	Axle 4	Axle 5	Axle 6	Axle 7	Axle 8	Axle 9	Axle 10	Axle 11	Axle 12	Axle 13	Axle 14	Axle 15
Axle Load (Kips) / Dist. From Axle 1 To Axle i (ft.)	5 7	9 11	13 15	17 19	21 23	25 27	29 31	33 35	37 39	41 43	45 47	49 51	53 55	57 59	61 63
		i = 2	i = 3	i = 4	i = 5	i = 6	i = 7	i = 8	i = 9	i = 10	i = 11	i = 12	i = 13	i = 14	i = 15

FIGURE 7. (CONTINUED)

```
                                     DISTRICT 14          TR      COUNTY HIGHWAY NO.    IH 35
                                     CONTROL NO. 476-219  IPE        SUBMITTED BY HLJ
                                     DESCRIPTION EXAMPLE PROBLEM NO. 2
                                                        *****************
                                                        *BEAM I.D.  DSN 1*
                                                        *****************
************************************************************************************************************************
BEAM TYPE              =IV                NO. WEB STRANDS      =  2                CREEP AND SHRINKAGE FORCES CONSIDERED =  NO
BEAM SPACING           = 6.90(FT)         AASHTO L.L.          =HS-20              PARTIAL D.L. CONTINUITY               =  YES
SLAB THICKNESS         = 7.25(IN)         L.L. DIST            =0.63               AXLE TRAIN DIST. FACTOR               =1.00
28 DAY ST.(SLAB)       = 3.60(KSI)        BEAM INERTIA         = 260404.(IN**4)    UNIF. LOAD ON CONTINUOUS BEAM         = 0.10
UNIT WT. BEAM CONC.=0.150(K/FT**3)        BEAM AREA            = 788.4(IN**2)      TOTAL STIRRUP AREA                    =0.22(IN**
UNIT WT. SLAB CONC.=0.150(K/FT**3)        BEAM YB              = 24.75(IN)
STRAND AREA            =0.153(IN**2)      BEAM YT              = 29.25(IN)
STRAND ULT. STRGTH.=270.0(KSI)            BEAM ZB              = 10520.8(IN**3)
GRID SIZE              = 2.00(IN)         BEAM ZT              =  8903.1(IN**3)
************************************************************************************************************************
*PARTIAL D.L.*
***CONTINUITY*A(1)*B(1)*A(2)*B(2)*A(3)*B(3)*A(4)*B(4)*A(5)*B(5)*A(6)*B(6)*A(7)*B(7)*A(8)*B(8)*A(9)*B(9)*A(10)*B(10)*
******FACTORS*0.00*0.10*0.10*0.10*0.10*0.00*
************************************************************************************************************************
*NON-STANDARD DIAPHRAMS*SPAN  1*SPAN  2*SPAN  3*SPAN  4*SPAN  5*SPAN  6*SPAN  7*SPAN  8*SPAN  9*SPAN 10*
*NO. DIAPHRAMS PER SPAN*   1    *   1    *   1    *
*DIAP. WT.=  1.80(KIPS)*
************************************************************************************************************************
*COMP. PROPERTIES *  SPAN 1  *  SPAN 2  *  SPAN 3  *  SPAN 4  *  SPAN 5  *  SPAN 6  *  SPAN 7  *  SPAN 8  *  SPAN 9  *  SPAN  10
************************************************************************************************************************
SPAN LENGTH(FT)     *    117.0  *    134.0  *    105.0  *
AREA(IN**2)         *   1388.7  *   1388.7  *   1388.7  *
INERTIA(IN**4)      *  631342.  *  631342.  *  631342.  *
YB(IN)              *     38.96 *     38.96 *     38.96 *
YT(IN)              *     15.04 *     15.04 *     15.04 *
************************************************************************************************************************
*STRAND AND CONCRETE PROPERTIES*SPAN  1*SPAN  2*SPAN  3*SPAN  4*SPAN  5*SPAN  6*SPAN  7*SPAN  8*SPAN  9*SPAN 10*
************************************************************************************************************************
RELEASE STRENGTH(KSI)                *  4.00 *  5.27 *  4.00 *
28  DAY STRENGTH(KSI)                * 17.20 *  8.25 *  8.86 *
LEFT ECCENTRICITY(IN)                * 13.81 *  9.49 *  9.52 *
 LEFT END-RAISE TOP STRANDS TO       *ROW 20 *ROW 26 *ROW 26 *
RIGHT ECCENTRICITY(IN)               * 11.69 *  9.49 * 15.98 *
RIGHT END-RAISE TOP STRANDS TO       *ROW 26 *ROW 26 *ROW 12 *
CENTER ECCENTRICITY(IN)              * 20.87 * 19.12 * 21.52 *
TOTAL NUMBER OF STRANDS              *  34   *  54   *  26   *
NO. OF DEPRESSED STRANDS             *   6   *  10   *   6   *
NO. STRANDS IN ROW  5                *   0   *   8   *   0   *
NO. STRANDS IN ROW  4                *   0   *  10   *   0   *
NO. STRANDS IN ROW  3                *  10   *  12   *   2   *
NO. STRANDS IN ROW  2                *  12   *  12   *  12   *
NO. STRANDS IN ROW  1                *  12   *  12   *  12   *
************************************************************************************************************************
*(-)M REINF. (IN**2/FT) * 0/10* 1/10* 2/10* 3/10* 4/10* 5/10* 6/10* 7/10* 8/10* 9/10*10/10**(+M) CONT. REINF.(IN**2)* 0/10*10/10
************************************************************************************************************************
                   SPAN  1* 0.00* 0.04* 0.00* 0.00* 0.00* 0.00* 0.00* 0.36* 0.67* 1.21* 2.07*              SPAN  1* 0.00* 0.00
                   SPAN  2* 2.12* 1.17* 0.56* 0.30* 0.00* 0.00* 0.00* 0.19* 0.43* 0.99* 1.92*              SPAN  2* 0.00* 0.00
                   SPAN  3* 1.90* 1.14* 0.70* 0.42* 0.21* 0.00* 0.00* 0.00* 0.00* 0.00* 0.00*              SPAN  3* 0.00* 0.00
****************************************************************************************************
*AASHTO STIRRUP SPACING(IN)*0/4-1/4*1/4-3/4*3/4-4/4*********ACI STIRRUP SPACING(IN)*0/4-1/4*1/4-3/4*3/4-4/4*
                   SPAN  1*  9.76 * 12.00 *  6.78 *********           SPAN  1* 24.00 * 24.00 * 15.03 *
                   SPAN  2*  6.62 * 12.00 *  6.78 *********           SPAN  2*  9.24 * 24.00 * 12.12 *
```

FIGURE 8. OUTPUT FOR FIRST DESIGN - EXAMPLE PROBLEM 2

SPAN 3* 7.56 * 12.00 * 10.46 ********** SPAN 3* 14.46 * 24.00 * 24.00 *

ULTIMATE MOMENT SUMMARY(KIP-FT)	SPAN 1	SPAN 2	SPAN 3	SPAN 4	SPAN 5
REQUIRED	0.51996E 04	0.54497E 04	0.43841E 04		
SUPPLIED	0.11109E 05	0.96726E 04	0.10223E 05		

PRESTRESS LOSS(PERCENT)	SPAN 1	SPAN 2	SPAN 3	SPAN 4	SPAN 5	SPAN 6	SPAN 7	SPAN 8	SPAN 9	SPAN 10
RELEASE	10.01	11.05	9.36							
FINAL	18.74	29.49	17.61							

MOMENT SUMMARY(KIP-FT)

SPAN	POINT	LIVE LOAD MAXIMUM	LIVE LOAD MINIMUM	DEAD LOAD NON-COMP SECTION	DEAD LOAD COMP SECTION	CREEP RESTRAINT	AASHTO ULTIMATE SHEAR
1	0/10	0.0	0.0	0.0	0.0	0.0	212.3
1	1/10	506.3	-61.6	811.2	46.4	0.0	174.4
1	2/10	828.2	-118.1	929.0	554.0	0.0	138.9
1	3/10	1034.7	-179.7	1224.9	690.7	0.0	101.5
1	4/10	1121.4	-241.4	1409.4	723.0	0.0	64.5
1	5/10	1100.5	-297.8	1479.4	660.8	0.0	75.5
1	6/10	986.7	-359.4	1416.9	492.8	0.0	112.2
1	7/10	771.5	-421.0	1242.0	220.5	0.0	147.6
1	8/10	480.6	-483.4	954.7	-156.3	0.0	181.7
1	9/10	202.1	-705.9	555.0	-593.5	0.0	213.8
1	10/10	134.8	-1169.5	-0.0	-1125.4	0.0	251.2
2	0/10	133.2	-1169.5	0.0	-1125.4	0.0	257.0
2	1/10	197.9	-675.6	731.8	-594.4	0.0	215.0
2	2/10	558.3	-443.3	1260.0	-102.6	0.0	172.9
2	3/10	818.2	-400.8	1640.8	276.7	0.0	134.4
2	4/10	987.4	-383.7	1874.0	444.2	0.0	93.1
2	5/10	1028.3	-367.7	1959.8	519.0	0.0	52.1
2	6/10	978.5	-353.3	1874.0	471.1	0.0	91.8
2	7/10	800.3	-336.1	1640.8	282.5	0.0	133.0
2	8/10	537.2	-375.4	1260.0	-19.9	0.0	171.4
2	9/10	194.9	-598.7	731.8	-482.3	0.0	210.7
2	10/10	166.5	-1091.8	-0.0	-978.3	0.0	252.6
3	0/10	169.9	-1091.8	0.0	-978.3	0.0	234.2
3	1/10	226.3	-692.2	447.9	-528.9	0.0	201.3
3	2/10	453.7	-515.8	770.9	-168.0	0.0	172.2
3	3/10	717.0	-448.4	1003.2	145.2	0.0	139.8
3	4/10	892.6	-387.0	1145.0	353.8	0.0	108.3
3	5/10	991.8	-319.2	1196.3	499.5	0.0	71.2
3	6/10	1007.4	-257.9	1138.2	555.7	0.0	62.9
3	7/10	921.5	-190.4	989.4	533.0	0.0	98.0
3	8/10	750.5	-129.0	750.2	437.8	0.0	131.2
3	9/10	391.6	-61.4	420.4	248.4	0.0	167.1
3	10/10	0.0	0.0	0.0	0.0	0.0	200.7

RELEASE STRESSES(KSI)	SPAN 1	SPAN 2	SPAN 3	SPAN 4	SPAN 5	SPAN 6	SPAN 7	SPAN 8	SPAN 9	SPAN 10
LEFT END(TOP)	-0.351	0.165	0.029							
LEFT END(BOT)	2.345	3.113	1.541							
HOLD DOWN(TOP)	0.940	1.243	0.743							
HOLD DOWN(BOT)	1.253	2.200	0.937							
RIGHT END(TOP)	-0.143	0.165	-0.456							

FIGURE 8. (CONTINUED)

RIGHT END(BOT)* 2.169* 3.113* 1.952*

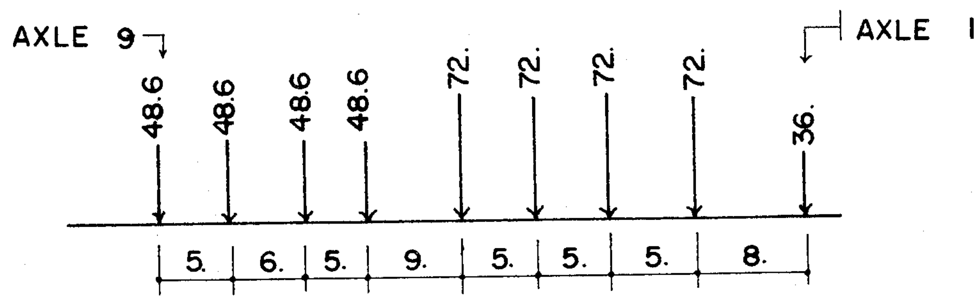
SERVICE LOAD STRESSES(KSI)

SPAN	POINT	L.L. MAXIMUM DEAD LOAD (+)CREEP RESTNT TOP	L.L. MAXIMUM DEAD LOAD (+)CREEP RESTNT BOT	L.L. MINIMUM DEAD LOAD (-)CREEP RESTNT TOP	L.L. MINIMUM DEAD LOAD (-)CREEP RESTNT BOT
1	0/10	-0.321	2.143	-0.321	2.143
1	1/10	0.813	0.908	0.650	1.328
1	2/10	1.091	0.259	0.820	0.959
1	3/10	1.470	-0.233	1.123	0.666
1	4/10	1.633	-0.431	1.244	0.578
1	5/10	1.638	-0.393	1.238	0.642
1	6/10	1.565	-0.191	1.190	0.806
1	7/10	1.349	0.235	1.008	1.118
1	8/10	0.930	0.922	0.654	1.636
1	9/10	0.346	1.773	0.086	2.446
1	10/10	-0.414	2.715	-0.787	3.681
2	0/10	-0.153	3.202	-0.525	4.167
2	1/10	0.763	2.131	0.513	2.777
2	2/10	1.477	1.101	1.190	1.843
2	3/10	1.917	0.435	1.568	1.338
2	4/10	2.100	0.087	1.708	1.103
2	5/10	2.116	0.016	1.716	1.050
2	6/10	2.105	0.074	1.725	1.060
2	7/10	1.928	0.407	1.603	1.249
2	8/10	1.494	1.056	1.233	1.732
2	9/10	0.794	2.050	0.567	2.638
2	10/10	-0.101	3.069	-0.461	4.000
3	0/10	-0.204	2.026	-0.565	2.961
3	1/10	0.381	1.279	0.118	1.959
3	2/10	0.821	0.613	0.544	1.331
3	3/10	1.136	0.059	0.803	0.922
3	4/10	1.273	-0.249	0.908	0.699
3	5/10	1.327	-0.416	0.952	0.555
3	6/10	1.303	-0.431	0.941	0.506
3	7/10	1.135	-0.236	0.817	0.588
3	8/10	0.800	0.181	0.549	0.832
3	9/10	0.263	0.909	0.133	1.244
3	10/10	-0.423	1.808	-0.423	1.808

MAXIMUM TENSION STRESS TOP OF SLAB(KSI)

	0/10	1/10	2/10	3/10	4/10	5/10	6/10	7/10	8/10	9/10	10/10
SPAN 1	0.000	0.006	0.000	0.000	0.000	0.000	0.000	0.085	0.271	0.550	0.972
SPAN 2	0.972	0.538	0.231	0.074	0.000	0.000	0.000	0.023	0.167	0.458	0.877
SPAN 3	0.877	0.517	0.290	0.128	0.014	0.000	0.000	0.000	0.000	0.000	0.000

FIGURE 8. (CONTINUED)



VEHICLE CONFIGURATION - LOADS IN KIPS, AXLE SPACING IN FT.

DISTANCE FROM WHEEL 1 TO WHEEL i

i	DISTANCE
2	8.
3	13.
4	18.
5	23.
6	32.
7	37.
8	43.
9	48

FIGURE 9 AXLE TRAIN CONFIGURATION FOR EXAMPLE PROBLEM 3

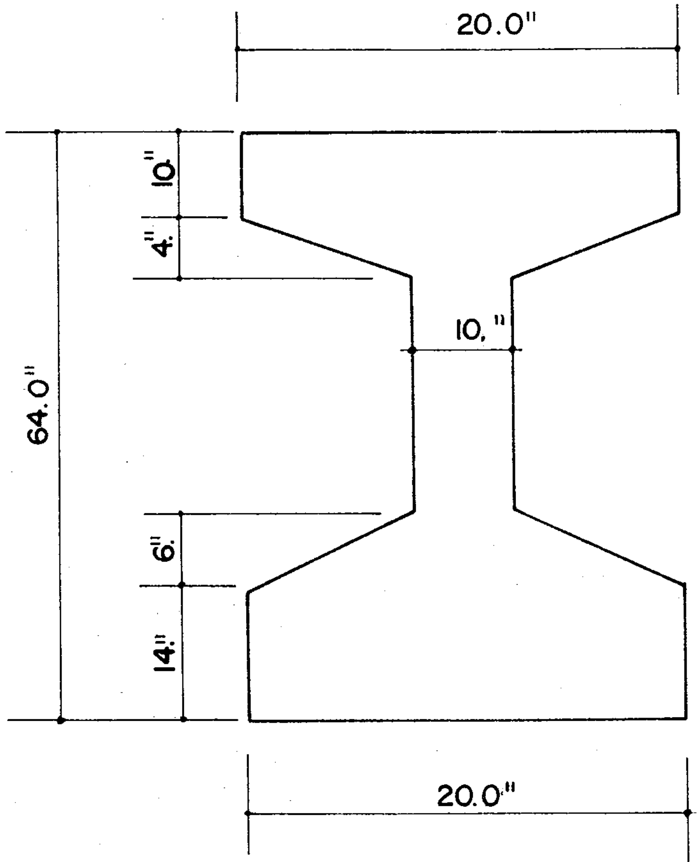


FIGURE 10 BEAM CROSS SECTION FOR EXAMPLE PROBLEM 3

TEXAS HIGHWAY DEPARTMENT
BRIDGE DIVISION

CONTINUOUS PRESTRESSED CONCRETE

BEAM DESIGN PROGRAM
(NON-STANDARD BEAM)

DISTRICT 14 (10 11) | TRAVIS (14–26) COUNTY | HIGHWAY NO. IH 35 (48–54)

CONTROL NO. 467-219 (13–19) | IPE 675 (26–28) | SUBMITTED BY HLJ (45–54)

DESCRIPTION EXAMPE PROBLEM NO. 3 (13–54)

GENERAL INFORMATION

Field	Columns	Entry
L	1	L
AASHTO L.L.	5 6 – 8 9	
Uniform Load on Composite Section (k/ft)	11–14	
Enter 1 For Axle Train	17	1
Enter 1 For D.L. Partial Continuity	19	

SPAN LENGTHS (ft.)

Span	Columns	Entry
L_1	22–25	60.
L_2	28–31	60.
L_3	34–37	
L_4	40–43	
L_5	46–49	
L_6	52–55	
L_7	58–61	
L_8	64–67	
L_9	70–73	
L_{10}	76–79	

Field	Columns	Entry
Girder ID	5–9	DSN 1
Beam Type	13 14	NS
Beam Spacing (ft.)	18–21	2.5
Slab Thickness (in.)	25–28	6.
Minimum 28 Day Beam Strength (ksi)	32–35	
Enter 1 If Creep & Shrinkage Moments To Be Considered	39	
AASHTO L.L. Distribution Factor	43 45	
Axle Train Distribution Factor	49 51	.23
Number of Interior Diaphragms Span i (i = 1 2 3 4 5 6 7 8 9 10)	55–64	
Enter 1 for Extended Output	68	1
Diaphragm Wt. (Kips)	72 75	

AXLE TRAIN

Axle	Axle Load (Kips)	Columns	Dist. From Axle 1 To Axle i (ft.)	i
Axle 1	36.	5 7		
Axle 2	72.	9 11	8.	i = 2
Axle 3	72.	13 15	13.	i = 3
Axle 4	72.	17 19	18.	i = 4
Axle 5	72.	21 23	23.	i = 5
Axle 6	48.6	25 27	32.	i = 6
Axle 7	48.6	29 31	37.	i = 7
Axle 8	48.6	33 35	43.	i = 8
Axle 9	48.6	37 39	48.	i = 9
Axle 10		41 43		i = 10
Axle 11		45 47		i = 11
Axle 12		49 51		i = 12
Axle 13		53 55		i = 13
Axle 14		57 59		i = 14
Axle 15		61 63		i = 15

FIGURE 11. INPUT FORM FOR EXAMPLE PROBLEM 3

PART 2 of 2

PARTIAL CONTINUITY FOR D.L.

a_1	b_1	a_2	b_2	a_3	b_3	a_4	b_4	a_5	b_5	a_6	b_6	a_7	b_7	a_8	b_8	a_9	b_9	a_{10}	b_{10}
5 6	8 9	12 13	15 16	19 20	22 23	26 27	29 30	33 34	36 37	40 41	43 44	47 48	50 51	54 55	57 58	61 62	64 65	68 69	71 72

Enter Standard Beam ID If Modified Standard Beam	D(in)	B(in)	W(in)	A(in)	C(in)	E(in)	G(in)	H(in)	F(in)	Q(in)	O(in)	P(in)	Number Web Strands	Grid Spacing (in)
	64	20	10	20	14	6	4	10					3	
5 6	8 11	13 16	18 21	23 26	28 31	33 36	38 41	43 46	48 51	53 56	58 61	63 66	69	72 75

M	Strand Area (in)	Strand Ultimate Strength (ksi)	Unit Weight Beam Conc. (kip/ft^3)	Unit Weight Slab Conc. (kip/ft^3)	28 Day Strength Slab (ksi)	Enter 1 For Equal End Eccentricties
1	5 8	11 14	17 20	23 26	29 32	35

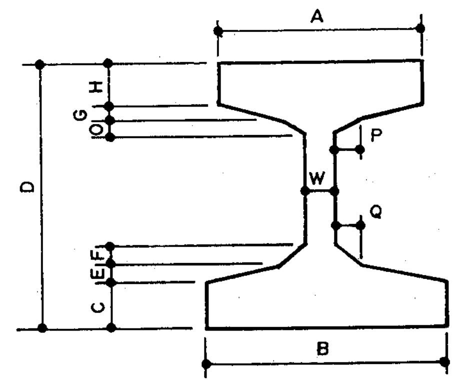


FIGURE 11. (CONTINUED)

```
                                   DISTRICT 14          TRAVIS COUNTY  HIGHWAY NO.    IH 35
                                   CONTROL NO. 467-219  IPE 675  SUBMITTED BY HLJ
                                   DESCRIPTION EXAMPLE PROBLEM NO. 3
                         ***BRIDGE IS SYMMETRICAL - ONLY INFORMATION ON 1/2 OF BRIDGE OUTPUT***
                                                 ******************
                                                 *BEAM I.D.  DSN 1*
                                                 ******************
*************************************************************************************************************************************
BEAM TYPE            =NS                NO. WEB STRANDS       =  3                     CREEP AND SHRINKAGE FORCES CONSIDERED =  NO
BEAM SPACING         = 2.50(FT)         AASHTO L.L.           =  -                     PARTIAL D.L. CONTINUITY               =  NO
SLAB THICKNESS       = 6.00(IN)         L.L. DIST             =0.23                    AXLE TRAIN DIST. FACTOR               =0.23
28 DAY ST.(SLAB)     = 3.60(KSI)        BEAM INERTIA          = 396932.(IN**4)         UNIF. LOAD ON CONTINUOUS BEAM         = 0.00
UNIT WT. BEAM CONC.=0.150(K/FT**3)      BEAM AREA             = 929.4(IN**2)           TOTAL STIRRUP AREA                    =0.22(IN*
UNIT WT. SLAB CONC.=0.150(K/FT**3)      BEAM YB               = 31.09(IN)
STRAND AREA          =0.153(IN**2)      BEAM YT               = 32.91(IN)
STRAND ULT. STRGTH.=270.0(KSI)          BEAM ZB               = 12768.5(IN**3)
GRID SIZE            = 2.00(IN)         BEAM ZT               = 12059.9(IN**3)
*************************************************************************************************************************************
*BEAM DIMENSIONS(IN)*  D  *  B  *  W  *  A  *  C  *  E  *  G  *  H  *  F  *  O  *  Q  *  P  *
*********************64.00*20.00*10.00*20.00*14.00* 6.00* 4.00*10.00* 0.00* 0.00* 0.00* 0.00*
*************************************************************************************************************************************
                                   *AX  1*AX  2*AX  3*AX  4*AX  5*AX  6*AX  7*AX  8*AX  9*AX 10*AX 11*AX 12*AX 13*AX 14*AX 15*
*AXLE TRAIN AXLE  LOADS(KIPS) * 36.0* 72.0* 72.0* 72.0* 72.0* 48.6* 48.6* 48.6* 48.6*
*DIST. FROM AX.1 TO AX. I (FT)*     *  8.0* 13.0* 18.0* 23.0* 32.0* 37.0* 43.0* 48.0*
*************************************************************************************************************************************
*NON-STANDARD DIAPHRAMS*SPAN  1*SPAN  2*SPAN  3*SPAN  4*SPAN  5*SPAN  6*SPAN  7*SPAN  8*SPAN  9*SPAN 10*
*NO. DIAPHRAMS PER SPAN*    0    *
*DIAP. WT.=  0.00(KIPS)*
************************************************************************************************************************************
*COMP. PROPERTIES *  SPAN 1  *  SPAN 2  *  SPAN 3  *  SPAN 4  *  SPAN 5  *  SPAN 6  *  SPAN 7  *  SPAN 8  *  SPAN 9  *  SPAN 1
************************************************************************************************************************************
SPAN LENGTH(FT)    *     60.0  *    60.0  *
AREA(IN**2)        *   1109.4  *  1109.4  *
INERTIA(IN**4)     * 591963.   * 591963.  *
YB(IN)             *     36.91 *    36.91 *
YT(IN)             *     27.09 *    27.09 *
************************************************************************************************************************************
*STRAND AND CONCRETE PROPERTIES*SPAN  1*SPAN  2*SPAN  3*SPAN  4*SPAN  5*SPAN  6*SPAN  7*SPAN  8*SPAN  9*SPAN 10*
************************************************************************************************************************************
RELEASE STRENGTH(KSI)            *  4.00 *
28  DAY STRENGTH(KSI)            *  4.95 *
LEFT ECCENTRICITY(IN)            * 23.72 *
 LEFT END-RAISE TOP STRANDS TO   *ROW  7 *
RIGHT ECCENTRICITY(IN)           * 18.67 *
RIGHT END-RAISE TOP STRANDS TO   *ROW 15 *
CENTER ECCENTRICITY(IN)          * 28.14 *
TOTAL NUMBER OF STRANDS          *  19   *
NO. OF DEPRESSED STRANDS         *   6   *
NO. STRANDS IN ROW  2            *   9   *
NO. STRANDS IN ROW  1            *  10   *
************************************************************************************************************************************
*(-)M REINF. (IN**2/FT) * 0/10* 1/10* 2/10* 3/10* 4/10* 5/10* 6/10* 7/10* 8/10* 9/10*10/10**(+M) CONT. REINF.(IN**2)* 0/10*10/1
************************************************************************************************************************************
                  SPAN  1* 0.00* 0.14* 0.27* 0.41* 0.55* 0.69* 0.82* 0.96* 1.13* 1.26* 1.40*                    SPAN  1* 0.00* 0.0
************************************************************************************************************
*AASHTO STIRRUP SPACING(IN)*0/4-1/4*1/4-3/4*3/4-4/4**********ACI STIRRUP SPACING(IN)*0/4-1/4*1/4-3/4*3/4-4/4*
                  SPAN  1* 12.00 * 12.00 * 11.03 **********              SPAN  1* 24.00 * 24.00 * 24.00 *
*************************************************************************************************************************************
*ULTIMATE MOMENT SUMMARY(KIP-FT)*   SPAN  1  *   SPAN  2  *   SPAN  3  *   SPAN  4  *   SPAN  5  *
```


FIGURE 12. OUTPUT FOR EXAMPLE PROBLEM 3

REQUIRED* 0.24859E 04*
SUPPLIED* 0.53366E 04*

PRESTRESS LOSS(PERCENT)	SPAN 1	SPAN 2	SPAN 3	SPAN 4	SPAN 5	SPAN 6	SPAN 7	SPAN 8	SPAN 9	SPAN 10
RELEASE	9.23									
FINAL	22.19									

MOMENT SUMMARY(KIP-FT) SPAN	POINT	LIVE LOAD MAXIMUM	LIVE LOAD MINIMUM	DEAD LOAD NON-COMP SECTION	DEAD LOAD COMP SECTION	CREEP RESTRAINT	AASHTO ULTIMATE SHEAR
1	0/10	0.0	0.0	0.0	0.0	0.0	202.7
1	1/10	361.6	-52.4	187.2	0.0	0.0	166.6
1	2/10	616.1	-104.8	332.8	0.0	0.0	130.4
1	3/10	780.5	-157.2	436.8	0.0	0.0	95.3
1	4/10	848.0	-209.5	499.2	0.0	0.0	62.3
1	5/10	813.0	-261.9	520.0	0.0	0.0	63.7
1	6/10	738.1	-314.3	499.2	0.0	0.0	96.7
1	7/10	565.6	-366.7	436.8	0.0	0.0	131.9
1	8/10	305.0	-419.1	332.8	0.0	0.0	167.4
1	9/10	0.0	-471.5	187.2	0.0	0.0	200.8
1	10/10	0.0	-523.9	0.0	0.0	0.0	231.8

RELEASE STRESSES(KSI)	SPAN 1	SPAN 2	SPAN 3	SPAN 4	SPAN 5	SPAN 6	SPAN 7	SPAN 8	SPAN 9	SPAN 10
LEFT END(TOP)	-0.469									
LEFT END(BOT)	1.483									
HOLD DOWN(TOP)	-0.204									
HOLD DOWN(BOT)	1.232									
RIGHT END(TOP)	-0.156									
RIGHT END(BOT)	1.188									

SERVICE LOAD STRESSES(KSI) SPAN	POINT	L.L. MAXIMUM DEAD LOAD (+)CREEP RESTNT TOP	L.L. MAXIMUM DEAD LOAD (+)CREEP RESTNT BOT	L.L. MINIMUM DEAD LOAD (-)CREEP RESTNT TOP	L.L. MINIMUM DEAD LOAD (-)CREEP RESTNT BOT
1	0/10	-0.403	1.275	-0.403	1.275
1	1/10	-0.051	0.859	-0.278	1.169
1	2/10	0.202	0.562	-0.194	1.102
1	3/10	0.363	0.372	-0.152	1.074
1	4/10	0.430	0.293	-0.150	1.085
1	5/10	0.426	0.305	-0.164	1.109
1	6/10	0.381	0.365	-0.197	1.153
1	7/10	0.321	0.462	-0.191	1.159
1	8/10	0.171	0.663	-0.227	1.205
1	9/10	-0.045	0.937	-0.304	1.290
1	10/10	-0.135	1.022	-0.422	1.414

MAXIMUM TENSION STRESS TOP OF SLAB(KSI)

	0/10	1/10	2/10	3/10	4/10	5/10	6/10	7/10	8/10	9/10	10/10
SPAN 1	0.000	0.035	0.070	0.105	0.141	0.176	0.211	0.246	0.281	0.316	0.351

FIGURE 12. (CONTINUED)

section (Fig. 10) is to be used. The web is to contain three strands. Diaphragm weight is neglected. A slab thickness of 6.0 in. and beam spacing of 2.5 ft. is specified. A lateral distribution factor for axle train loads is specified as .23 (axle loads shown in Fig. 9 are scaled by this factor). The input form is shown in Fig. 11 and the output in Fig. 12.

2.6 Program Output Options

Two levels of output are available. The default level lists information pertaining to the loading, material properties, section properties, and the final design. If a "1" is entered on the beam card in column 68, the above information is displayed, together with moment and stress summaries. The moment summary table lists maximum moments produced by live load (AASHTO or axle train), minimum moments produced by live load, total dead load moment carrier by non-composite beam (beam weight, diaphragms, continuity pour and completion slab pour for sections outside the limits of the continuity pour), total dead load moment on the composite beam (uniformly distributed load and slab completion pour for sections within the limits of the initial continuity pour), creep restraint moments, and shears used in AASHTO stirrup design.

Release stresses are displayed for top and bottom of the beam at each end and at the hold down. These stresses are produced by beam weight and prestress force. Service load stresses are displayed at tenth points of each span for top and bottom points. Two sets of stresses are given. First set results from prestress, dead load, maximum live load moment, and creep restraint moments if they are positive. The second set results from the same dead loads, minimum live load moment and includes creep restraint moments if they are negative. Thus, these two sets of stresses are the largest tension and compression stresses that will exist under service load conditions during the life of the structure. In all cases, tension stresses have negative signs, while compressive stresses are positive.

Maximum tension stresses in the top of the deck under service loads are computed and displayed at tenth points. The moments used to compute these stresses are from (i) dead load on the composite section, (ii) maximum negative live load and (iii) creep restraint moment, if negative. If a tension stress is never attained at a tenth point, zero is printed.

2.7 Interpretation of Program Output

If several beams are to be designed, each is assumed to be subjected to the same loadings specified on the load and span card (Section 2.2.2). For example, if a standard AASHTO truck and an axle train are indicated on the load and span card, each beam design which follows is based on moments from these live loadings, scaled by the distribution factors specified on the beam card (Section 2.2.3). When both AASHTO and axle train loadings are specified, the beam is designed to withstand the larger of the moments produced by these two loading conditions.

The deck reinforcing for negative moment is the total area of reinforcement per foot width of slab required. The area of reinforcing indicated for positive moment continuity reinforcement is the total area of steel required in the bottom of beams over interior supports.

The moment summary table displayed with the extended output option consists of the following moments; (i) live load maximum - the greater of the moments produced by standard AASHTO loading and axle train, (ii) live load minimum - the larger negative moment resulting from standard AASHTO loading and axle train, (iii) dead load on non-composite section - moments from beam weight, diaphragms and the initial portion of a continuity pour. At tenth points outside the limits of the initial portion of the continuity pour, the moments produced by the completion segment of the continuity pour, (iv) dead load on composite section - the moments resulting from the uniformly distributed load for tenth points within the limits of the initial portion of the continuity pour, the moment produced by the completion segment of the continuity pour. All moments are for service load conditions.

The computed ultimate moment capacity for each span is for a section between drape points. The required ultimate moment capacity output is the greatest positive ultimate moment existing at the tenth points of that span. Creep restraint moments are included in the computation of the required deck and positive moment support reinforcing when their consideration is specified on the input form.

III. PROGRAM STRUCTURE AND OPERATION

The computer program is divided into three segments that operate independently and sequentially. The controlling segment is the MAIN program which contains program input and output, and performs set-up calculations for the other two segments. The second segment is subroutine ANALYZ and supporting subroutines that compute the design moments and shears. The third segment performs the actual design of the girders. This section of the report describes the operation of these segments and the interface between them.

3.1 Control Segment - MAIN PROGRAM

A flow chart for this segment is contained in Appendix A, together with a definition of variable names used. The first portion of MAIN reads input data and computes and stores quantities used in other segments. The MAIN utilizes REREAD statements which permit checking of data cards as they are read. If an incorrect data card is encountered, the program skips over the remainder of the current data set and attempts to continue with the next data set. An error message identifying the data set skipped is printed out. In addition to MAIN, a BLOCK DATA subroutine is used to define standard quantities used by the program. These quantities are stored in labeled common blocks /PASBK1/ and /PASBK2/, and the variable names used are defined in Appendix A.1.

After the necessary input data have been processed, subroutine ANALYZ is called. This subroutine computes moments and shears at tenth points of each span produced by live and dead loads. Effects from AASHTO and lane loads and from the axle train are computed using the full axle load (lateral distribution factor equal to 1.0). Dead load effects are computed using unit loads. After return from ANALYZ, the moments and shears are scaled by factors specified on the beam card or computed from information contained on this card. This arrangement permits the design of a series of beams all having the same loading conditions and span lengths from a single analysis.

The remainder of the data cards for a single design are then read and processed, and subroutine DESIGN is called to complete the design. Control is then transferred back to the MAIN program, where the results of the design are printed out.

3.2 Analysis Segment - Subroutine ANALYZ

Communications between MAIN and subroutine ANALYZ are established through labeled common blocks /PASAN1/ and PASAN2/ (see Appendix A.1). ANALYZ calls subroutines SORTAX, SORTIL, SORTHS, REACTN, INFLNE, IMPACT and MATINV, which are describes in Appendix A.2. A common core area is reserved in /DUMP/ for use in intermediate calculations in ANALYZ as well as in other parts of the program. Subroutine ANALYZ is an adaptation of a shear and moment envelope program (Volume III, this report). The routine determines the extreme values for moment and shear at tenth points of each span of a continuous beam. Loading conditions include standard AASHTO truck and lane loads, axle train (up to 15 arbitrarily spaced axles), uniform dead load on simple beam, uniform load on end sections of a simple beam (to represent the effect of a continuity slab casting), and uniform load in the central section of continuous beams (to represent the effect of the completion slab casting). The resulting shears and moments are computed for full live loads (lateral distribution factor of 1.0 for AASHTO and axle train loadings) and unit dead loads. The forces are stored in the arrays contained in COMMON/PASAN1/.

3.3 Design Segment - Subroutine DESIGN

Communications between MAIN and subroutine DESIGN are through labeled commons /PASDN/ and /DUMP/. The common /DUMP/ contains scratch work from the analysis segment on return to the MAIN program. Quantities required by the design segment are then computed in MAIN and stored in the first portion of /DUMP/ for communication to DESIGN. The latter portion of /DUMP/ is used for intermediate storage needed independently and sequentially by MAIN and DESIGN. Subroutine DESIGN calls subroutine subprograms SLOPED, MATINV, DCKSTL, PLOSS, ULTMO, SHEAR, ADDIT and function subprograms ECC, FPRIMC and BRACK.

The release and 28 day concrete strengths, the strand pattern and the end draping of strands for each span are determined in subroutine DESIGN. After these quantities are known, DESIGN calls subroutine DCKSTL to compute the negative moment steel required in the deck and the positive support moment steel and subroutine SHEAR to compute stirrup requirements.

Subroutine DESIGN has four principal sections; (1) selection of midspan strand pattern, (2) determination of minimum end eccentricity to preserve the release strength established during strand pattern selection, (3) determination of end eccentricities and 28 day concrete strength, and (4) computation of creep restraint moments. Selection of midspan strand pattern for a particular span is based on release and 28 day concrete strength necessary to sustain the stresses at the strand holddown point and those at midspan under full dead and live load. A minimum number of strands NS, computed from

$$NS \geq 0.003 \text{ Area of Beam / Area of strand} \tag{2}$$

are first placed in the beam. Placement of strands is in pairs unless beginning a new row, when the number of strands that can be placed in the web are added. Strand placement begins with the bottom most row (row 1) in the beam. The philosophy followed in identifying satisfactory strand pattern arrangements is that minimum release and 28 day strengths are 4.0 ksi and 5.0 ksi, respectively and that release strengths between 4.0 and 5.0 ksi, and 28 day strengths between 5.0 and 6.0 ksi are nearly equally satisfactory. Release strengths above 5.0 ksi and 28 day strengths in excess of 6.0 ksi become less desirable with increasing values. Required concrete strength is determined from the total stress (from loads and prestress) at a point. The stress in the top and the bottom of a beam must satisfy the inequalities

$$-S_{ci}\, f'_{ci} \leq \sigma_j \leq S_{ti}\sqrt{f'_{ci}} \tag{3}$$

on release and

$$-S_c\, f'_c \leq \sigma_j \leq S_t\sqrt{f'_c} \tag{4}$$

under service load. The allowable stress coefficients S_{ci}, S_{ti}, S_t and S_c are presently set at 0.6, 7.5, 6.0 and 0.4 (except the end of the beam where it is taken as 0.6). These values are initialized in subroutine BLOCK DATA. If concrete strength required at a point along the beam is plotted against the number of prestress strands, a concave curve is obtained with a definite minimum. Strands are added to the beam until the release strength f'_{ci}, based on stresses at the holddown, has reached this minimum. If the minimum is greater than 5.0 ksi, the corresponding strand pattern is designated a trial pattern for later checking. If the minimum f'_{ci} is less than 5.0 ksi and the 28 day strength f'_c required by service load moment at midspan is under 5.0 ksi, the pattern is a trial pattern. If f'_c is greater than 5.0 ksi, strands are added until f'_c reaches a value of 5.0 or a minimum value is obtained for f'_c. Once a trial pattern and corresponding concrete strengths are selected, the cracking and ultimate moment capacities of the section are computed. If the ultimate capacity of the section exceeds that required as well as 1.2 times the cracking capacity, the section is acceptable. If the section is unacceptable, strands are added until an acceptable section is achieved. The geometry of many beam cross sections is such that release strength is controlled by tension in the top of the beam. If this situation occurs, and the current f'_{ci} is less than 4.2 ksi, a new trial pattern is obtained from the previous one to reduce the pattern eccentricity. Concrete strengths for this pattern are computed and compared with previous values. If f'_{ci} is reduced and f'_c is not increased beyond 6.0 ksi, the new pattern is used.

The strand pattern selected will generally lead to overstress at the end of the beam on release. The second phase of subroutine DESIGN determines the amount by which the drapable strands must be raised at the end of the beam in order to preserve the release strength computed from stresses at the holddown. In some instances, no amount of draping will produce an f'_{ci} less than or equal to that required at the holddown. When this occurs, the strands are raised to the top-most row to reduce f'_{ci} as much as possible and a new, higher release strength calculated.

The third section of the subroutine makes the final selection of draping at each end of the beam. The process begins with strands raised at each end to the minimum eccentricity just computed. The strands are then raised one row at each end. With the new strand position, the 28 day strength is computed from the greater of the values required to sustain the top and bottom stresses at each 10th point under full service load plus creep restraint moments (if considered). If this f'_c is greater than that required by the previous position, the process is terminated. If different eccentricities are permitted at the two ends, the above process is applied separately to the left and right halves of the beam.

When secondary moments due to creep and shrinkage of beam and deck concretes (creep restraint moments) are considered, they are included in an iterative fashion. The magnitude of these moments depends on the strand pattern and concrete strengths in each span. After these values have been determined, the restraint moments at tenth points are computed in the fourth section of DESIGN. If the restraint moments from the preceeding iteration are all algebraically greater than for the current iteration, the design is satisfactory. If this criteria is not met, but the change in moment does not require an increase in f'_c of more than 100 psi, the design is satisfactory. When a design is found unsatisfactory, another iteration is initiated by updating the creep restraint moments and returning to third segment of the subroutine to recompute required concrete strengths.

Final prestress losses used in calculations are computed from the equations of the 1974 AASHTO Interim Specifications. Release losses are taken as those due to elastic shortening plus one half of the strand relaxation loss.

3.4 Subroutine BLOCK DATA

This subroutine defines the cross sectional dimensions of standard beams and certain quantities related to the properties of the reinforcing and creep and shrinkage properties of the concrete. The user may change concrete, reinforcing, or creep and shrinkage properties by changing values of variables defined in this subroutine. Variable names and definitions may be found in Appendix A.1 under labeled common blocks /PASBK1/ and /PASBK2/.

APPENDIX A.1

LABELED COMMON BLOCKS USED IN

INTERSEGMENT COMMUNICATIONS

Defined below are variables used in labeled common blocks which transmit information between the MAIN program and subroutines ANALYZ, DESIGN and BLOCK DATA.

<u>COMMON/PASAN1/</u>

LLMASP(I, J) - maximum positive live load moment at the (I-1) tenth point of span J produced by AASHTO truck or lane loading without lateral distribution factor (ft. - kips)

LLMASN(I, J) - maximum negative live load moment at the (I-1) tenth point of span J produced by AASHTO truck or lane loading without lateral distribution factor (ft. - kips)

LLSASP(I, J) - maximum positive live load shear at the (I-1) tenth point of span J produced by AASHTO truck or lane loading without lateral distribution factor (ft. - kips)

LLSASN(I, J) - maximum negative live load shear at the (I-1) tenth point of span J produced by AASHTO truck or lane loading without lateral distribution factor (ft. - kips)

LLMAXP(I, J) - maximum positive live load moment at the (I-1) tenth point of span J produced by axle train without lateral distribution factor (ft. - kips)

LLMAXN(I, J) - maximum negative live load moment at the (I-1) tenth point of span J produced by axle train without lateral distribution factor (ft. - kips)

LLSAXP(I, J) - maximum positive live load shear at the (I-1) tenth point of span J produced by axle train without lateral distribution factor (ft. - kips)

LLSAXN(I, J) - maximum negative live load shear at the (I-1) tenth point of span J produced by axle train without lateral distribution factor (ft. - kips)

DLMUNF(I, J) - moment at (I-1) tenth point, span J, produced by uniformly distributed load of 1.0 kips/ft. acting on continuous beam (ft. - kips)

DLSUNF(I, J) - shear at (I-1) tenth point, span J, produced by uniformly distributed load of 1.0 kips/ft. acting on continuous beam (ft. - kips)

DLMBM(I, J) - moment at (I-1) tenth point, span J, produced by beam weight of 1.0 kips/ft. acting on simply supported beam (ft. - kips)

DLSBM(I, J) - shear at (I-1) tenth point, span J, produced by beam weight of 1.0 kips/ft. acting on simply supported beam (ft. - kips)

DLMSLS(I, J) - moment at (I-1) tenth point, span J, produced by partial continuity pour with slab weight of 1.0 kips/ft. acting on simple beam (ft. - kips). If no continuity pour is used, this array contains the moments produced by the entire slab (with weight of 1.0 kips/ft.) acting on the simple beam

DLSSLS(I, J) - shear at (I-1) tenth point, span J, produced by partial continuity pour with slab weight of 1.0 kips/ft. acting on simple beam (ft. - kips). If no continuity pour is used, this array contains the moments produced by the entire slab (with weight of 1.0 kips/ft.) acting on the simple beam

DLMSLC(I, J) - moment at (I-1) tenth point, span J, produced by casting of remainder of slab (with weight of 1.0 kips/ft.) on continuous beam. If no continuity pour is used, this array contains zeros

DLSSLC(I, J) - shear at (I-1) tenth point, span J, produced by casting of remainder of slab (with weight of 1.0 kips/ft.) on continuous beam. If no continuity pour is used, this array contains zeros

MSASP(I, J) - moment at (I-1) tenth point, span J, produced by AASHTO truck or lane load that produces the maximum positive shear at this point (no lateral load distribution factor included), (ft. - kips)

MSASN(I, J) - moment at (I-1) tenth point, span J, produced by AASHTO truck or lane load that produces the maximum negative shear at this point (no lateral load distribution factor included), (ft. - kips)

MSAXP(I, J) - moment at (I-1) tenth point, span J, produced by axle train loading that produces maximum positive shear at this point (no lateral load distribution factor included), (ft. - kips)

MSAXN(I, J) - moment at (I-1) tenth point, span J, produced by axle train loading that produces maximum negative shear at this point (no lateral load distribution factor included), (ft. - kips)

IBETA(I, J) - contains number of the node where continuity pour ends for left end of span I (IBETA(I, 1)), and where continuity pour begins at right end of span I (IBETA(I, 2))

SL(I) - (see l_i, Eq. (2), Vol. I)

LODKOD(I) - array containing zeros or ones, indicating which types of live loads are to be considered

PWHEEL(I) - weight of I<u>th</u> wheel in axle train (kips)

BETA(I, J) - (see Fig. 6, this volume, where BETA(I, 1) = a_i and BETA(I, 2) = b_i)

NWHL(I) - distance from wheel 1 to wheel I of axle train (ft.)

L(I) - length of span I (ft.)

<u>COMMON/PASAN2/</u>

SCLHHS - weight of an H or HS axle. For H-15 or HS-15 truck, SCLHHS = 24.0; for H-20 or HS-20, SCLHHS = 32. (kips)

SCLLNE - lane loading. For H-15 or HS-15 loading SCLLNE = .48; for H-20 or HS-20, SCLLNE = .64 (kips/ft.)

SCLCOM - concentrated force used in computing moments for lane loading. For H-15 or HS-15, SCLCOM = 13.5; for H-20 or HS-20, SCLCOM = 18.0 (kips)

SCLCOV - concentrated force used in computing shears for lane loading. For H-15 or HS-15, SCLOCOV = 19.5; for H-20 or HS-20, SCLCOV = 26. (kips)

NWHEEL - number of wheels in axle train

KCONT - equals zero if no partial continuity pour made; equals one if continuity pour used

NSPNS - number of spans to be considered in analysis or design because of beam symmetry

NN - number of spans in bridge

COMMON/DUMP/

YTC(I) - distance from c.g. of composite section, span I, to top of beam (in.)

YBC(I) - distance from c.g. of composite section, span I, to bottom of beam (in.)

ZL(I) - length of span I (ft.)

FPCBM(I) - 28-day concrete strength for beam in span I (ksi.)

FPCRL(I) - release strength for beam concrete in span I (ksi.)

ZTCBM(I) - composite section modulus, span I, used to compute stress at top of beam in composite section ($in.^3$)

ZBCBM(I) - composite section modulus, span I, used to compute stress at bottom of beam in composite section ($in.^3$)

EL(I) - strand row to which top most strands are raised at left end of beam

ER(I) - strand row to which top most strands are raised at right end of beam

DD(I) - distance from c.g. axis of beam to strand row I (in.). DD(I) is positive if row I lies above c.g. axis

ALPH(I) - (see α, Fig. 8, pp. 20, Vol. 1)

NS(I, J) - number of strands in row I of beam in span J

ULTMOM(I) - required ultimate moment capacity for span I (ft. - kips)

ULTMSP(I) - ultimate moment capacity of span I (ft. - kips)

CRPMOM(I, J) - restraint moment at (I-1)th tenth point, span J (ft. - kips)

DLMSIM(I, J) - total dead load moment acting on noncomposite beam, at (I-1)th tenth point, span J (ft. - kips)

DLMCOM(I, J) - total dead load moment acting on composite beam at (I-1)th tenth point, span J (ft. - kips)

MAMOM(I, J) - total maximum positive moment acting at (I-1)th tenth point, span J (ft. - kips)

MIMOM(I, J) - total maximum negative moment acting at (I-1)th tenth point, span J (ft. - kips)

STSRLS(I, J) - array containing release stresses (ksi.)

STSLOD(I, J) - array containing final service load stresses at tenth points of each span (ksi.)

ASNEG(I, J) - area of reinforcing steel required per foot width of deck to resist negative moment at (I-1)th tenth point, span J ($in.^2$)

ASPOS(I) - area of reinforcing steel required to resist positive moment at (I+1)th support

TAUI(I, J) - (see τ_i, Eqs. 35 and 36, pp. 36, Vol. I)

NLIM(I) - limiting number of strands permitted in row I of beam

ZTOPSL(I) - section modulus used to compute bending stress at top of slab in composite section, span I

ULTSHR(I, J) - ultimate shear computed with AASHTO load factors, to be resisted at (I-1)th tenth point, span J (kips)

ULTACI(I, J) - ultimate shear computed with ACI load factors, to be resisted at (I-1)th tenth point, span J (kips)

SMOM(I, J) - moment at (I-1)th tenth point, span J, from loading which produces absolutely largest shear at this point (ft. - kips)

SIGMA(I, J) - temporary storage for stresses at (I-1)th tenth point due to all loads plus creep restraint moments if considered; J = 1, stress top for maximum (+) live load moment; J = 2, stress bottom for maximum (+) live load moment; J = 3, stress top for maximum (-) live load moment; J = 4, stress bottom for maximum (-) live load moment (ksi.)

ZICBM(I) - moment of inertia of composite section, span I ($in.^4$)

ZLOSSR(I) - fraction of initial prestress force lost after release

ZLOSS(I) - fraction of initial prestress force lost after all losses have occurred

SPCAAS(I, J) - spacing required for stirrups in span J from left end to quarter point (I = 1), quarter point to quarter point (I = 2), quarter point to right end (I = 3), computed from the provisions of AASHTO 1973 Specifications (in.)

SPCACI(I, J) - same as SPCAAS(I, J), except computed by ACI 318-71 (in.)

AREACP(I) - area of composite section, span I ($in.^2$)

NDIA(I) - number of interior diaphragms, span I.

. . . . . . (The following variables appear in /DUMP/ only in MAIN) . . . . . .

DLMDIA(I, J) - moment at (I-1)th tenth point of span J due to NDIA (J) diaphragms weighing 1.0 kips positioned in span J (ft. - kips)

DLSPIA(I, J) - shear force corresponding to DLMDIA(I, J) (kips)

HDPT(I) - distance from centerline of beam to strand holddown point (ft.)

KECL(I), KECR(I) - contains the number of the strand row to which the top-most row of strands is raised as the left (right) end of the beam in span I

ECCCL(I) - distance from c.g. of strand pattern at centerline of span I to c.g. of beam (in.)

KTOTSN(I) - total number of strands in beam, span I

KDEPSN(I) - total number of draped strands in beam, span I

ITILT(I, J) - storage for title cards

TTI(I), IDENT(I) - storage for Hollerith constants used in identifications

CD(I) - scratch storage

. . . . . . (The following variables appear in /DUMP/ only in DESIGN). . . . . .

AMSUP(I) - contains creep restraint moment at support I from previous iteration (ft. - kips)

NTOP(I) - highest row at centerline of beam of span I which contains strands

NECCL(I), NECCR(I) - row to which top-most strands in span I are raised at left (right) end of beam

NECMIN(I) - lowest row to which top-most strands in span I must be raised at the ends to preserve release strength computed from stresses at the holddown point

AA(I, J), B(I, J) - work space, passed to subroutine SLOPED

ZMSLN(I) - maximum (-) service load moment at (I-1)th tenth point, for checking service load stress in deck reinforcing (ft. - kips)

ZMSLF(I) - moment at (I-1)th tenth point used to compute cyclic stress in deck reinforcing (ft. - kips)

ZMULN(I) - ultimate (-) moment used to determine area of deck reinforcing at (I-1)th tenth point (ft. - kips)

FEM(I) - fixed end moments at left end (2I-1) and right end (2I) of span I due to creep restraint moments (ft. - kips)

NSOLD(I, J) - storage for NS(I, J) from previous calculations

STORES(I, J) - storage for service load stresses. Contents of this array transferred to STSLOD(I, J) prior to exit from DESIGN

. . . . . . (The following variables appear in /DUMP/ only in ANALYZ) . . . . .

A(I, J) - array used for working storage in subroutine REACTN (see Eqs. (9) & (10), Volume I, this report)

ALPHA(I, J) - (see Eq. (11), Volume I, this report)

REACT(I, J) - reaction force at Ith support (left support is number 1) due to unit load applied at a point J ft. from left end of bridge. Initially contains the vectors $\bar{b}_j$ (Volume I, Eqs. (12) - (15)) and after call to MATINV the ordinates of the reaction influence lines

INFLM(I) - array containing ordinates of the influence line for moment at each nodal point. Nodal points along the beam are spaced at one foot intervals. The left-most support has node number 200. The nodes are numbered consecutively to end of the beam (node number 200 + L, where L is the total length of the bridge in ft.) and carry beyond for 200 nodes. For a bridge of 350 ft. overall length, INFLM(1) through INFLM(199) would contain zeros. INFLM(200) through INFLM(550) would contain computed values and INFLM (551) through INFLM(750) would contain zeros.

INFLV(I) - array containing ordinates of the influence line for shear at each nodal point (see INFLM(I))

LEXTRM(I) - array containing node number of each relative maximum or minimum point on the moment influence line

LEXTRV(I) - array containing node number of each relative maximum or minimum point on the shear influence line

LMMAX(I) - array containing node numbers for position of truck wheels which produces largest positive moment at design print under consideration

LMMIN(I) - array containing node numbers for position of truck wheels which produces largest negative moment at design point under consideration

LVMAX(I) - array containing node numbers for position of truck wheels which produces largest positive shear at design point under consideration

LVMIN(I) - array containing node numbers for position of truck wheels which produces largest negative shear at design point under consideration

NODDSN(I, J) - array containing the number of the node closest to the Ith tenth point, span J

COMMON/PASDN/

NRAV - number of rows in grid pattern for beam

NRFLG - number of strand rows which contain non-drapable strands

NNSPNS - (see NSPNS, /PASAN2/)

THK - slab thickness (in.)

S - beam spacing (ft.)

BMWT - weight per foot of beam (kips/ft.)

SLBWT - weight per foot of slab (kips/ft.)

IITER - trigger used to determine if creep restraint moments considered (IITER ≠ 0) or ignored (IITER = 0) in design

FPCBMN - minimum 28-day concrete strength allowed for the beam (ksi.)

NSWEB - number of web strands

FSTRND - initial strand force, before release (kips)

KODSYM - symmetry code; 0 = no symmetry of span lengths, 1 = symmetrical with even number of spans, 2 = symmetrical with odd number of spans

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

ZTBM - section modulus used to compute stress at the top of the beam (in.^{3})

ZBBM - section modulus used to compute stress at the bottom of the beam (in.^{3})

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

YB - distance from c.g. of beam to bottom of section (in.)

YT - distance from c.g. of beam to top of section (in.)

FPS - ultimate strength of prestress strand (ksi.)

FPL - proportional limit stress of prestress strand (ksi.)

KASE - standard beam case number

UWBM - unit weight of beam concrete (kips/ft.^{3})

STSIZE - cross sectional area of strand (in.^{2})

N - number of spans

ISYM - code indicating whether beams are required to have the same strand drape at both ends (ISYM = 1) or whether the drape at the ends may be different (ISYM = 0)

GRIDS - center-to-center spacing of strands

FPCSLB - 28 day strength of slab concrete (ksi.)

<u>COMMON/PASBK1/</u>

ZD(I),...,ZP(I) - dimensions of beam cross section (see D,...,P Table 1, this Volume)

DIAPSD(I, J) - array of constants used to compute weights of standard diaphragms (see Table 2, this Volume)

BEAMTP(I) - stored standard beam symbols used to identify standard beams from input data

<u>COMMON/PASBK2/</u>

AV - total area of shear reinforcing ($in.^2$)

FSY - yield strength of conventional reinforcing

ECRPUL - ultimate unit creep strain without volume/surface ratio correction (see Eqs. 23 and 25, pp. 23, Vol. I) ($in./in./ksi. \times 10^{-6}$)

ESHSUL - ultimate shrinkage strain, without humidity correction factor (see Eqs. 24 and 29, pp. 23, Vol. I) ($in./in./ \times 10^{-6}$)

TIMCRP - constant in the denominator of hyperbolic expression for unit creep strain function (see Eq. 23, pp. 23, Vol. I) (days)

TIMSHR - constant in the denominator of hyperbolic expression for shrinkage strain function (see Eq. 24, pp. 23, Vol. I)

AGECON - time from casting of beams to casting of first segment of deck (days)

HUMID - relative humidity during substantial portion of beam curing period (percent)

FTNER - factor multiplied times the square root of beam concrete release strength to obtain allowable release tensile stress on concrete

FCOMR - factor multiplied times the beam concrete release strength to obtain allowable release compression stress

FTEN - factor multiplied times the square root of beam concrete 28-day strength to obtain allowable service condition tensile stress

FCOM - factor multiplied times the beam concrete 28-day strength to obtain allowable service condition compressive stress

VOLSUR - volume surface ratio of beam (in.)

COMMON/BLK 1/

NPNTS - number of design points along entire beam (design points are spaced at 1 ft. intervals)

JPNT - tenth point under consideration

JSPAN - span under consideration

N - total number of spans

APPENDIX A.2

DESCRIPTION OF SUBROUTINES

Table of Contents

MAIN PROGRAM

Function

The main program reads and checks input data, computes the necessary quantities required by subroutines ANALYZ and DESIGN, calls these subroutines to process the design and produces the output for each design.

Variable Definition

FACTOR - lateral load distribution factor for AASHTO loadings

IOUT - if blank, normal output option used; if 1, extended output used

KANALY - if equal to zero, subroutine ANALYZ is called; if equal to one, this subroutine call is bypassed

KAXT - if blank, no axle train specified; if 1, axle train to be input

KBMTYP - contains code designation of beam type (see Table 1)

KKONT - if blank, no continuity slab pour used; if 1, continuity pour specified

NN - number of spans

NNSPNS - (see NSPNS, COMMON/PASAN2/)

PERM - perimeter of beam section (in.)

SCLAXT - lateral load distribution factor for axle train

STDIA - diameter of prestressing strand (in.)

UNIFL - magnitude of uniformly distributed load on composite section (kips/ft.)

WTDIA - weight of single diaphragm (kips)

XL(I) - length of span I (ft.)

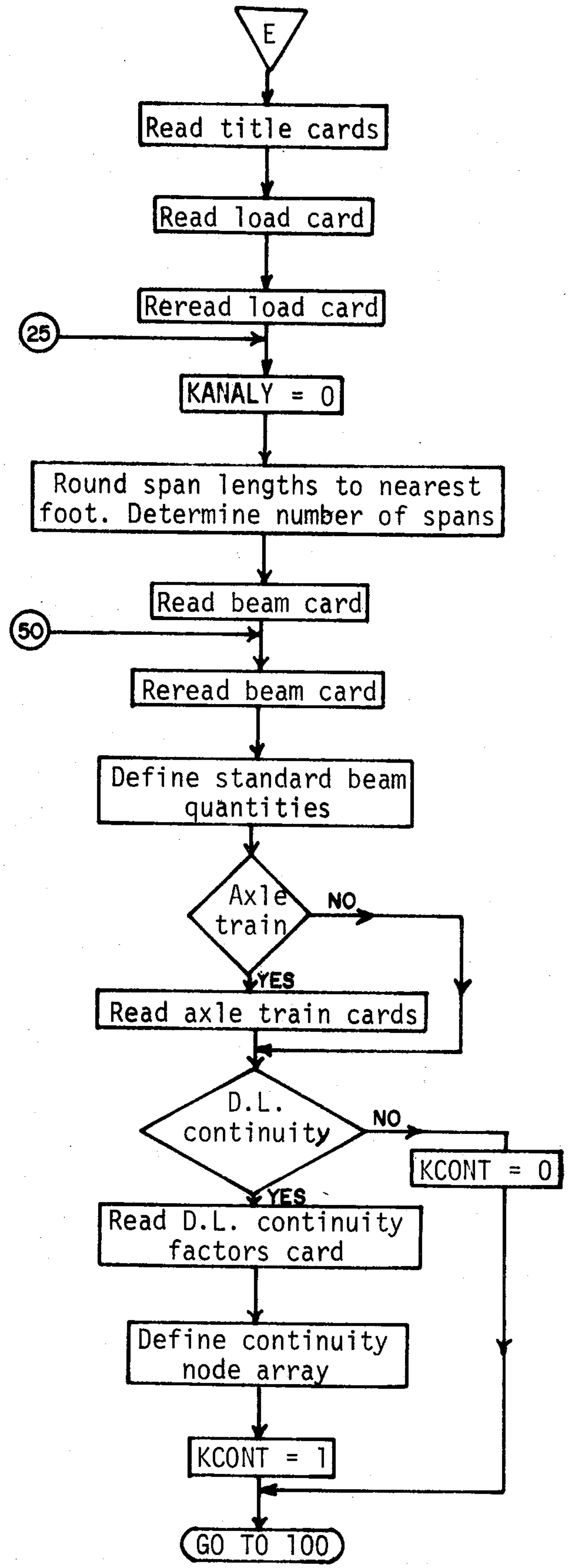


FIGURE A.2-1. FLOW CHART FOR MAIN PROGRAM

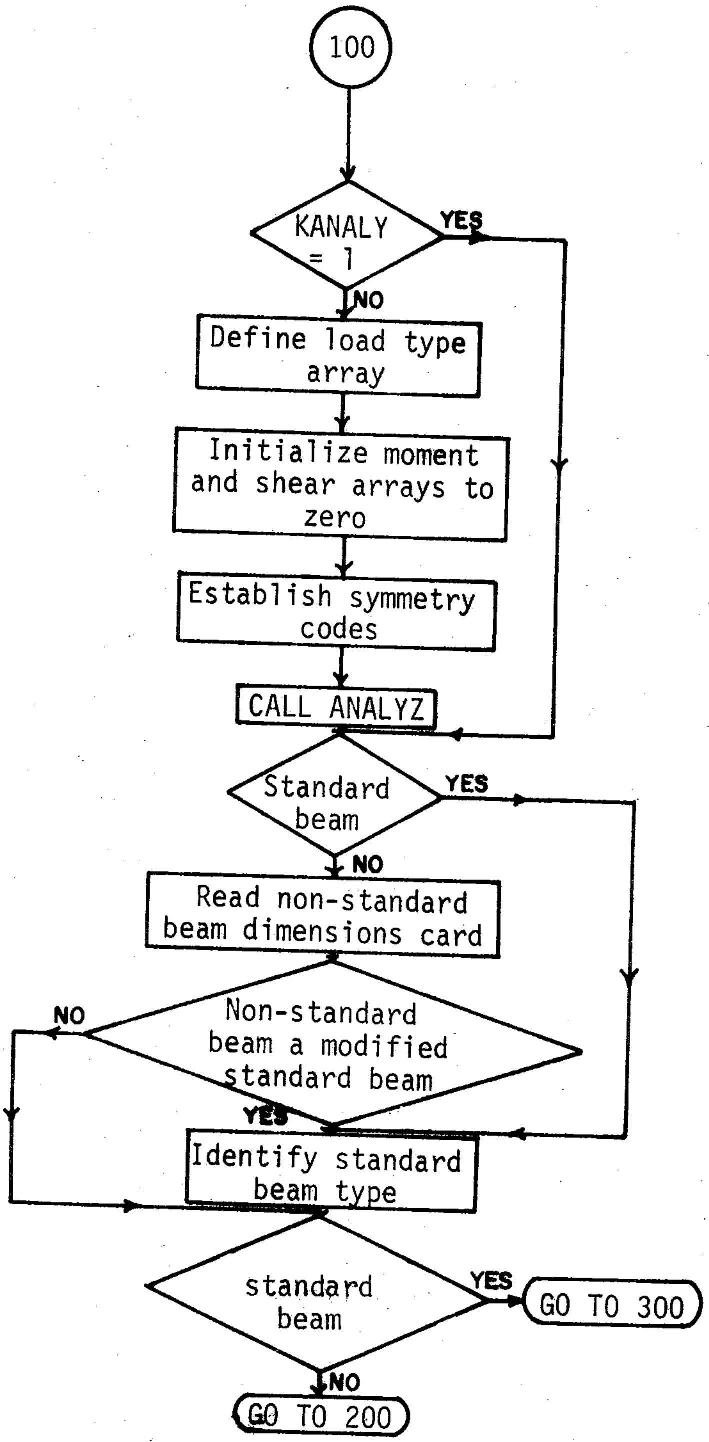


FIGURE A.2-1. (CONTINUED)

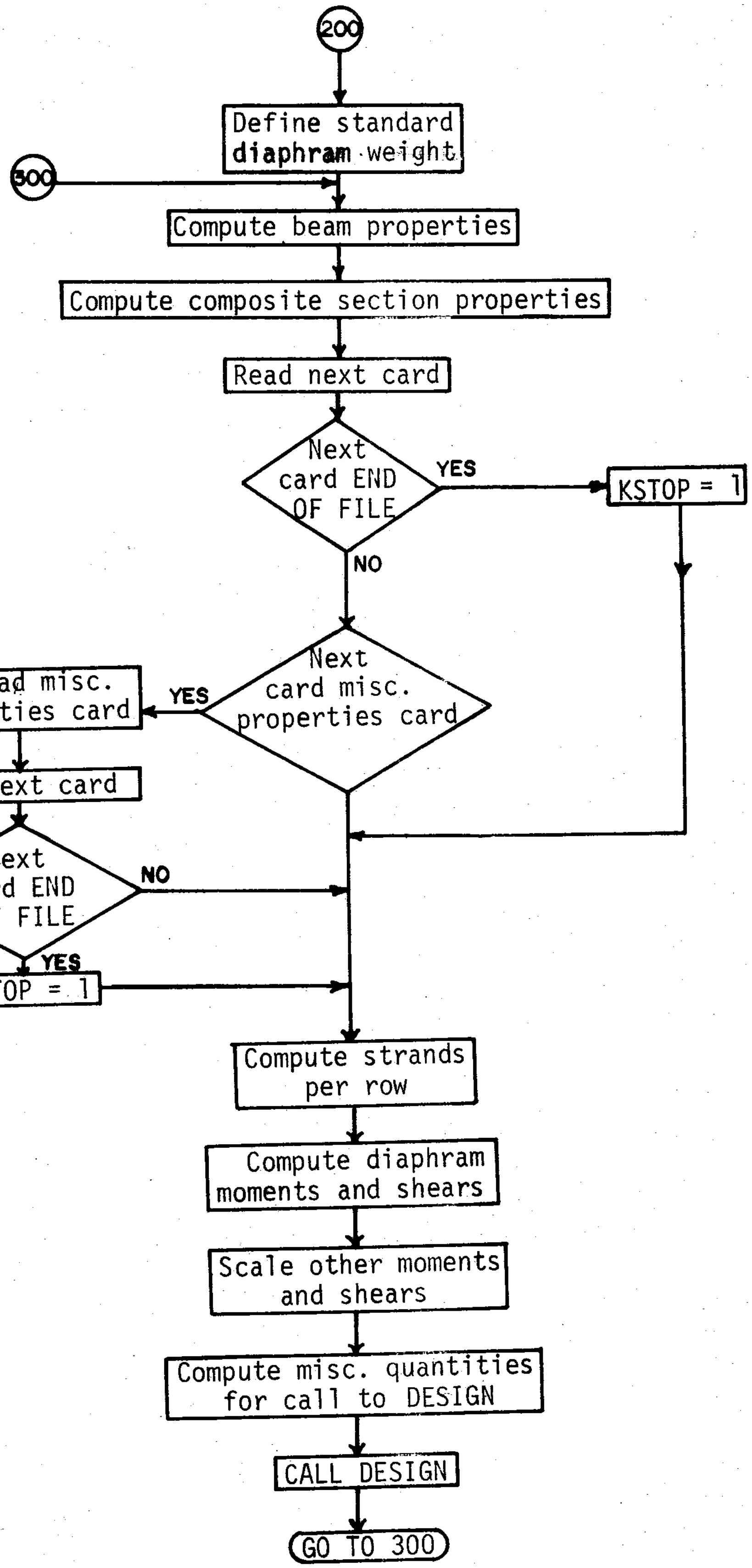


FIGURE A.2-1. (CONTINUED)

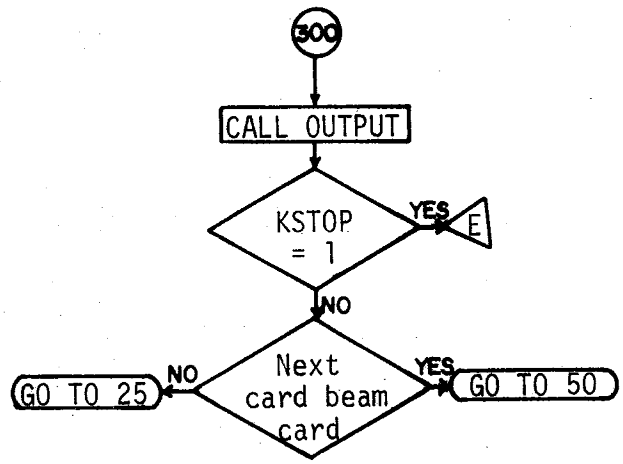


FIGURE A.2-1. (CONTINUED)

SUBROUTINE ANALYZ

Subroutine Function

This subroutine computes moments and shears at tenth points of each span due to live and dead loads. Dead load computations use unit loads, and the final moments and shears are obtained in the MAIN program by scaling with correct dead loads. Moments and shears produced by AASHTO truck and lane loadings are for a single wheel load (24 kips for H or HS-15 and 32 kips for H or HS-20) and half a lane load (.48 kips/ft. for H or HS-15 and .64 kips/ft. for H or HS-20). These moments and shears are then scaled in MAIN by an AASHTO lateral load distribution factor. Moments and shears from axle train loading are computed with the axle loads specified on input and then scaled in MAIN by a lateral distribution factor obtained from input.

Variable Definition

NEXTRM - number of relative maximum and minimum points on the influence line for moment

NEXTRV - number of relative maximum and minimum points on the influence line for shear

JTRIG - = -1, H truck
= +1, HS truck

MAXMOM - currently largest positive moment found at design point under consideration

MAXSHR - currently largest positive shear found at design point under consideration

MINMOM - currently largest negative moment found at design point under consideration

MINSHR - currently largest negative shear found at design point under consideration

NDISC - node number of current design point. This point has a discontinuity in the shear influence line

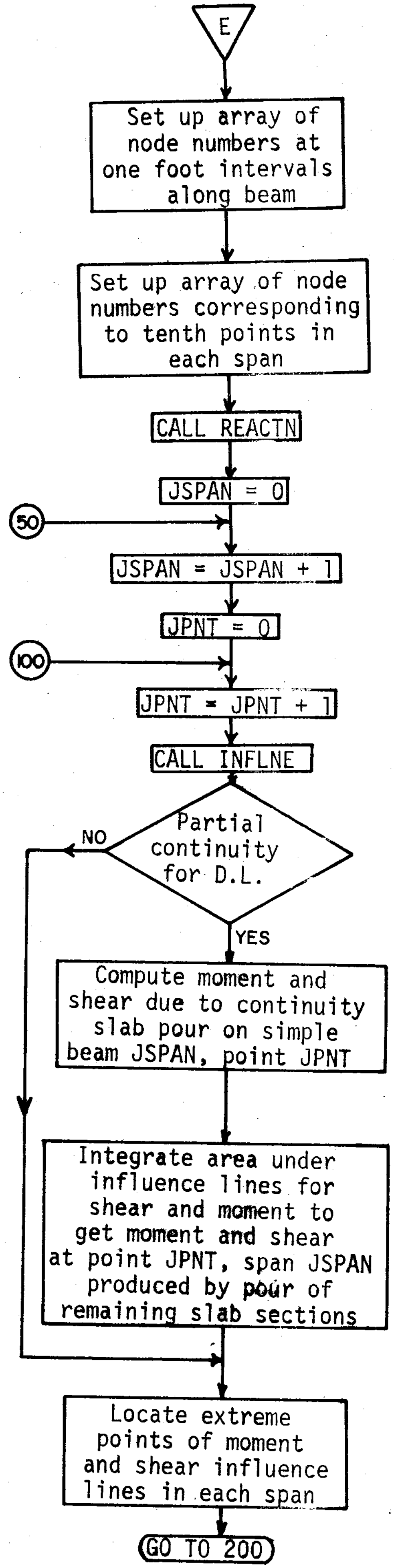


FIGURE A.2-2. FLOW CHART FOR SUBROUTINE ANALYZ

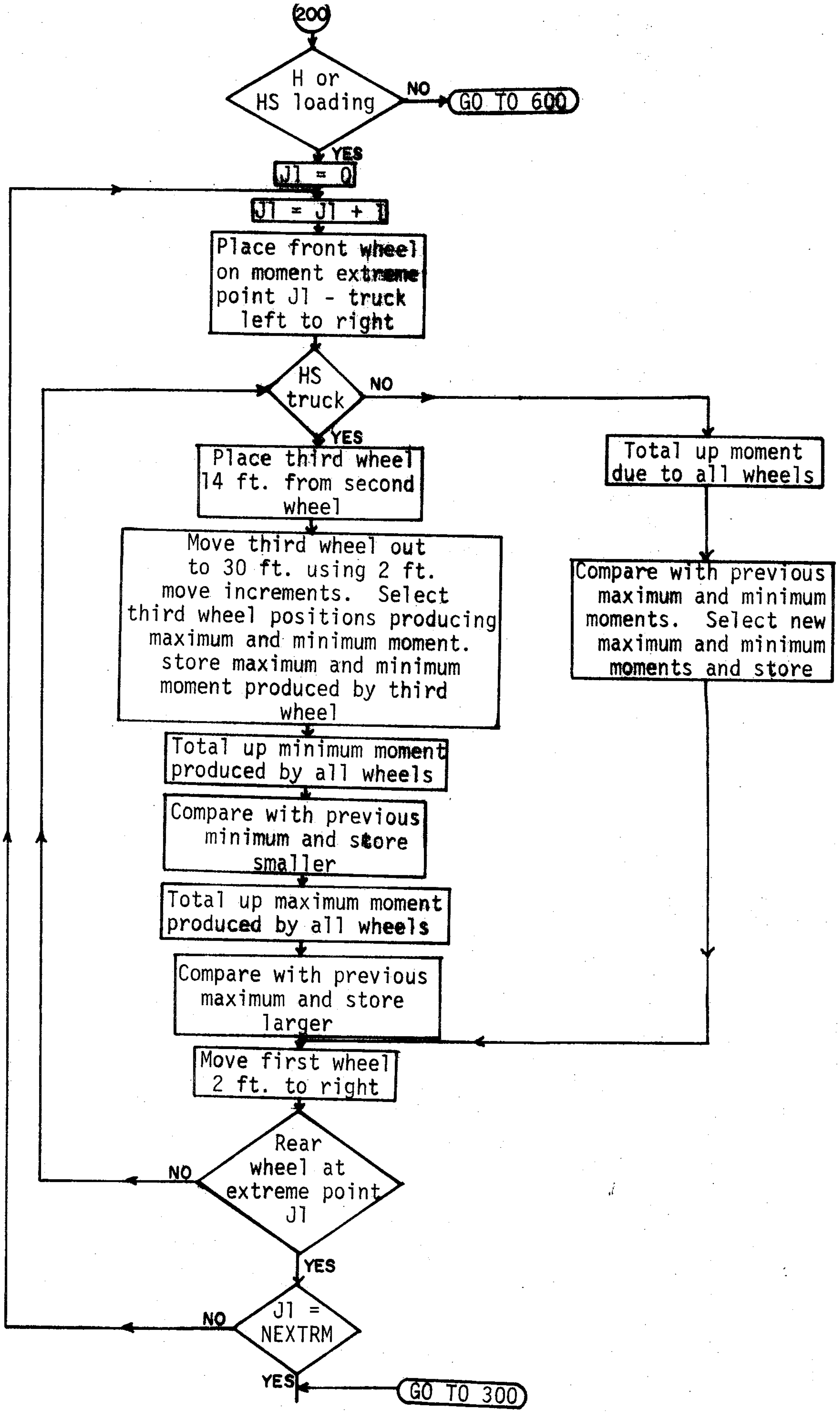


FIGURE A.2-2. (CONTINUED)

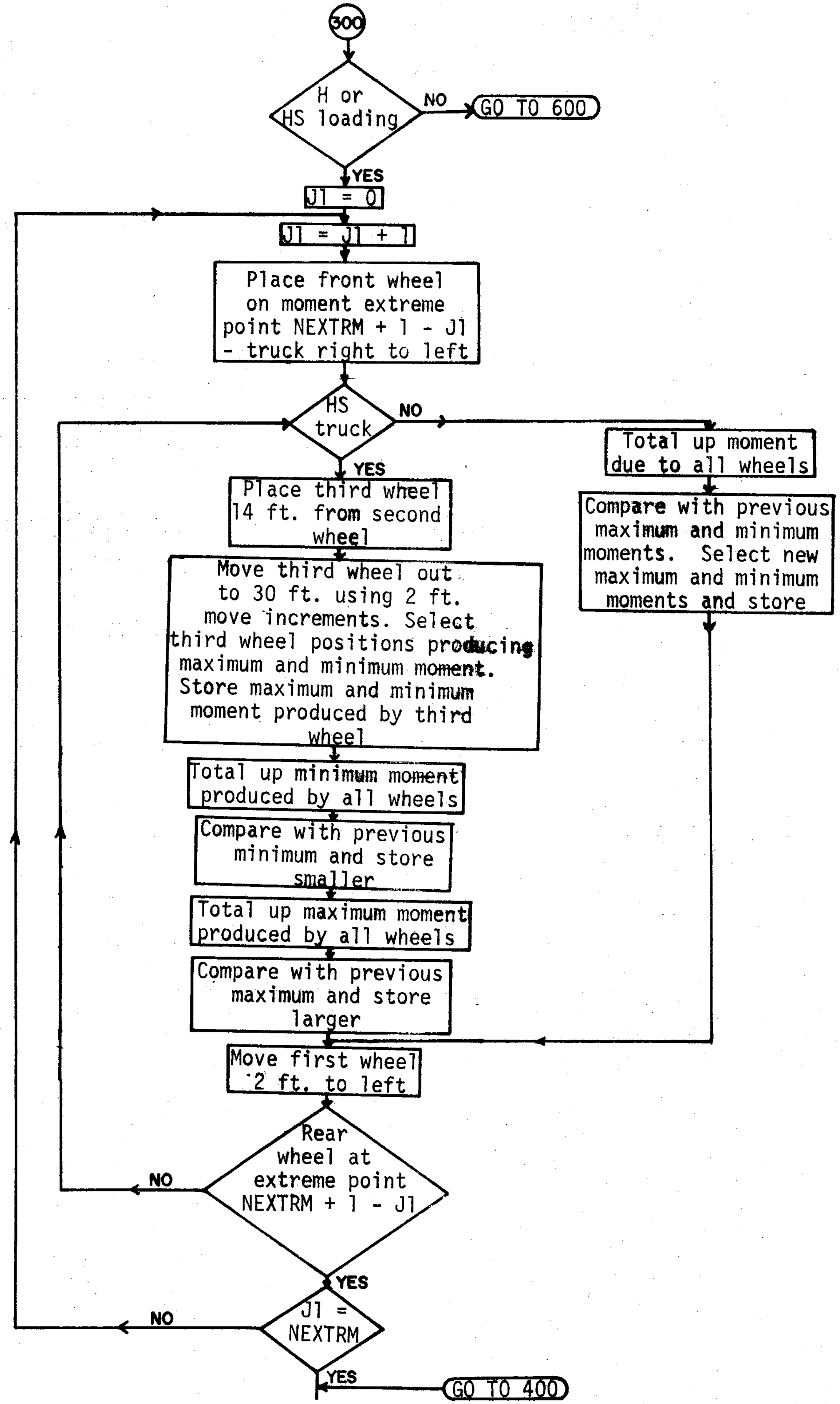


FIGURE A.2-2. (CONTINUED)

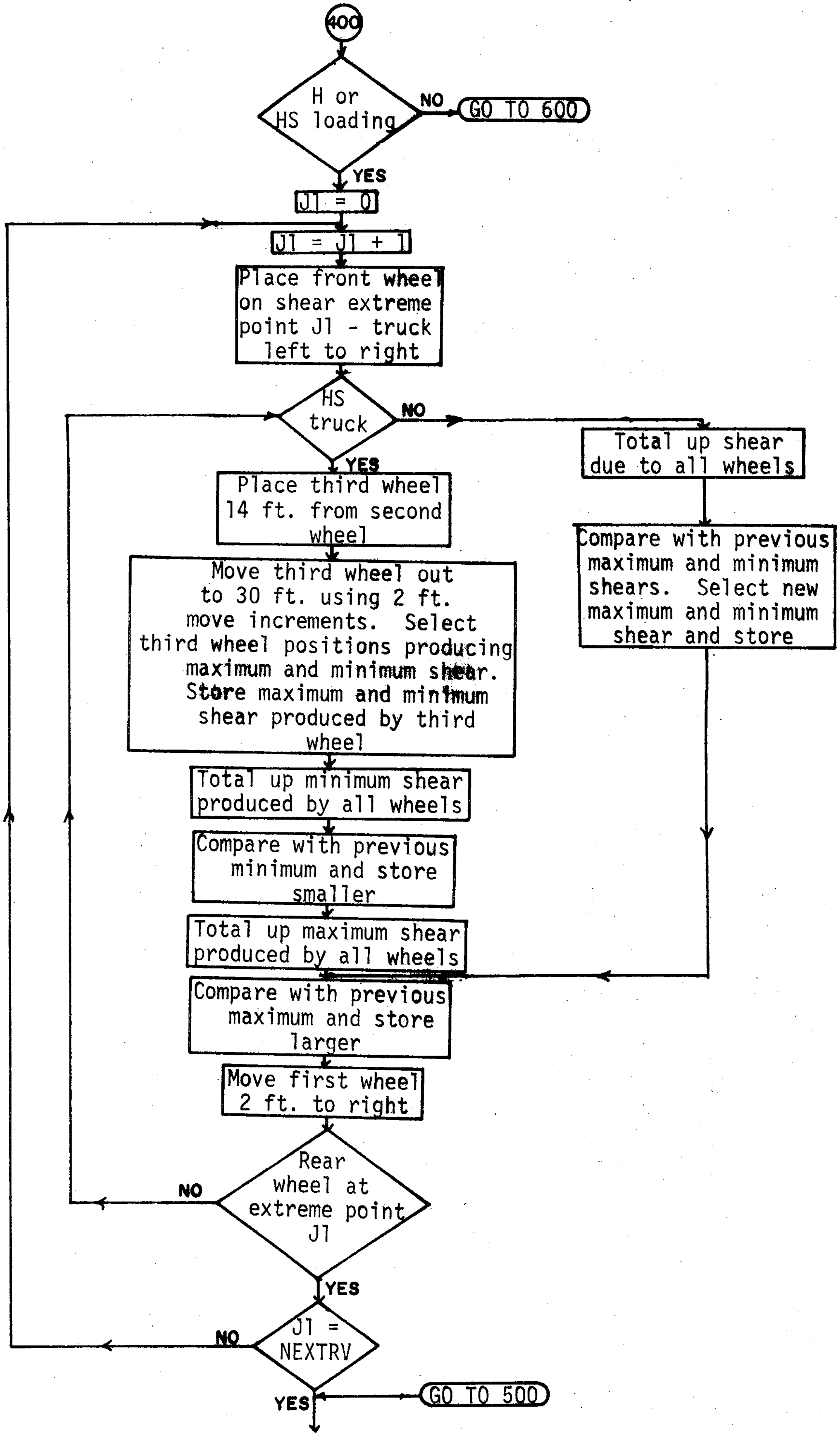


FIGURE A.2-2. (CONTINUED)

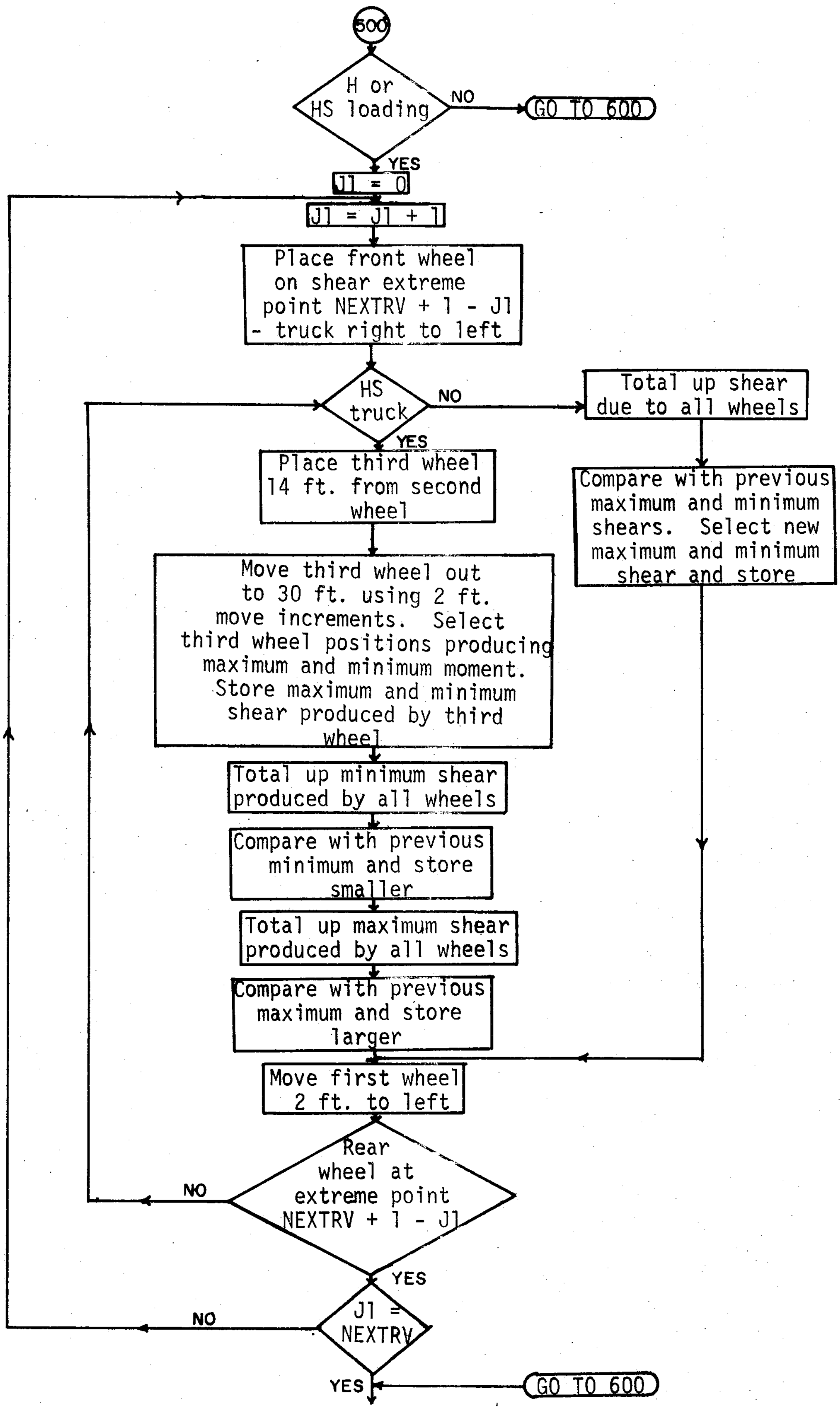


FIGURE A.2-2. (CONTINUED)

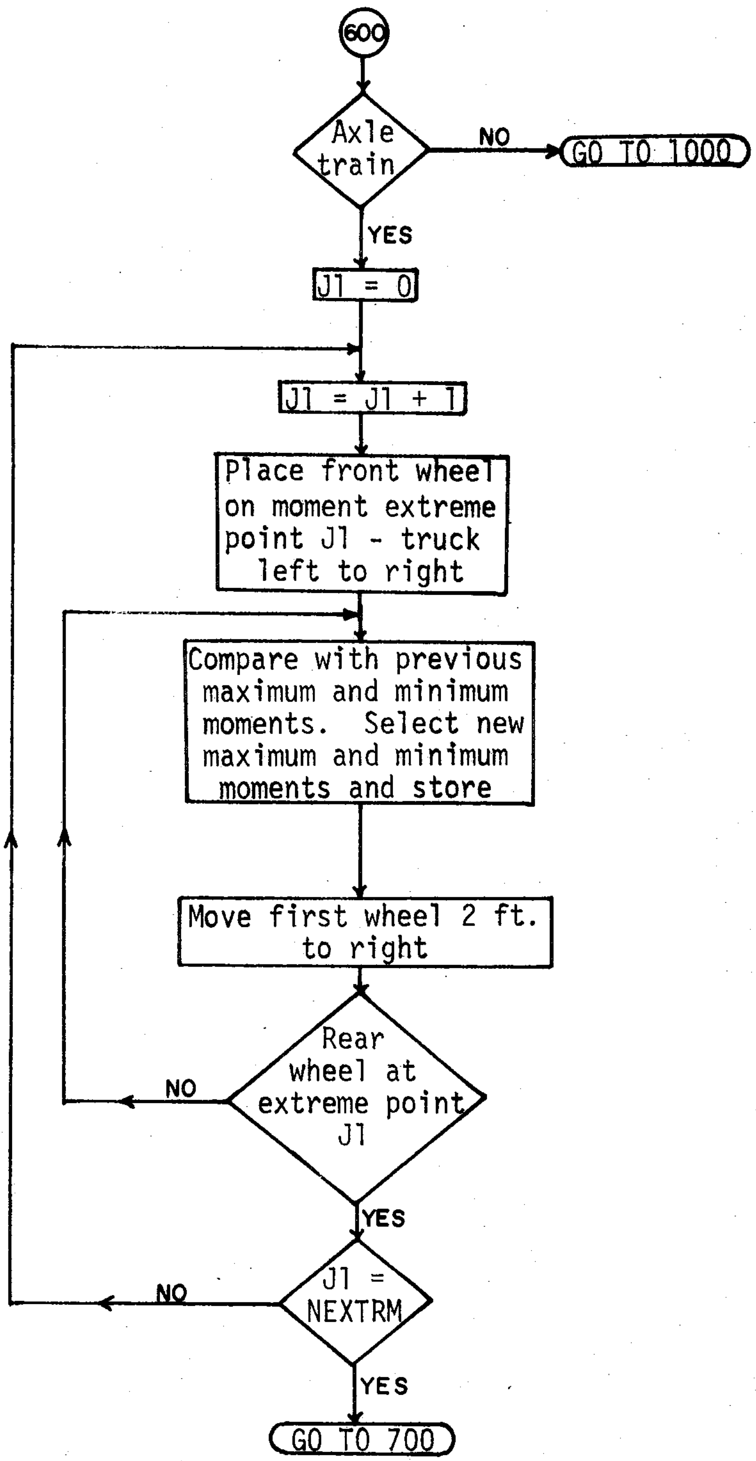


FIGURE A.2-2. (CONTINUED)

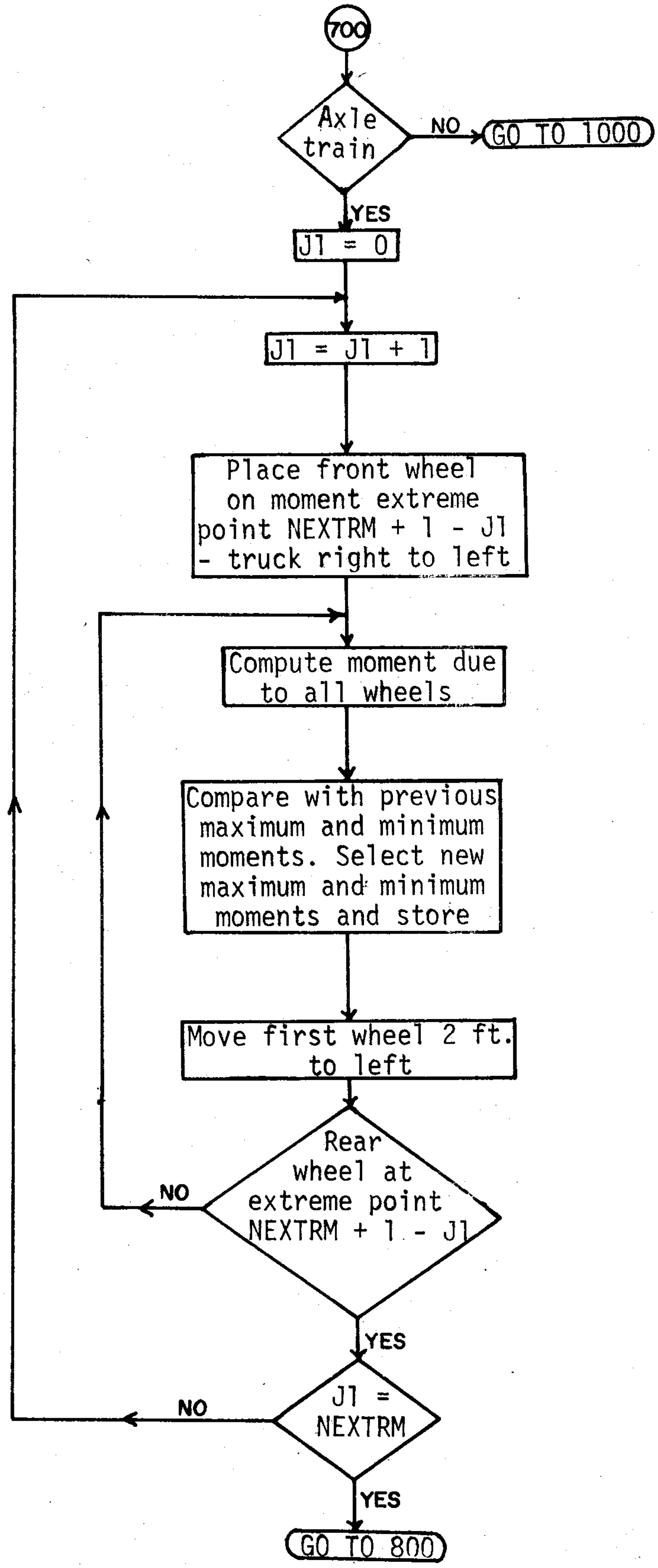


FIGURE A.2-2. (CONTINUED)

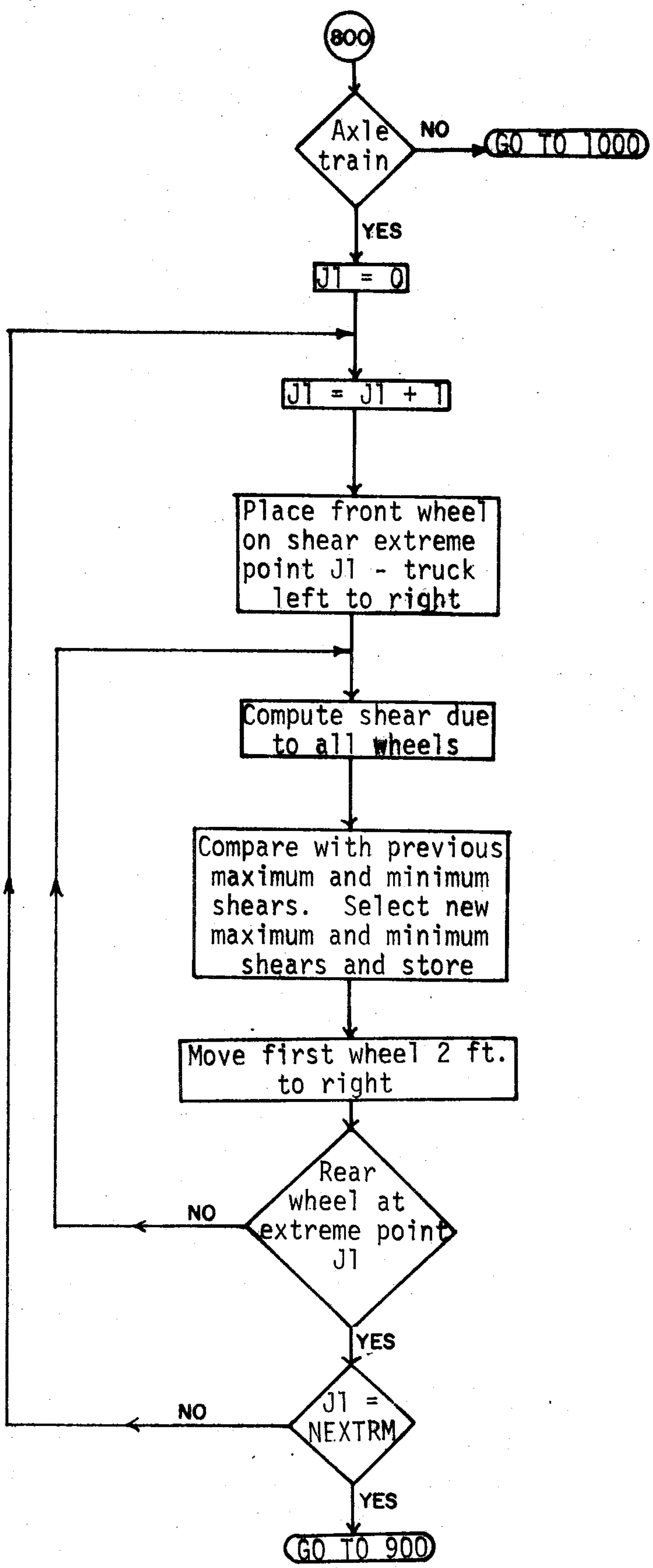


FIGURE A.2-2. (CONTINUED)

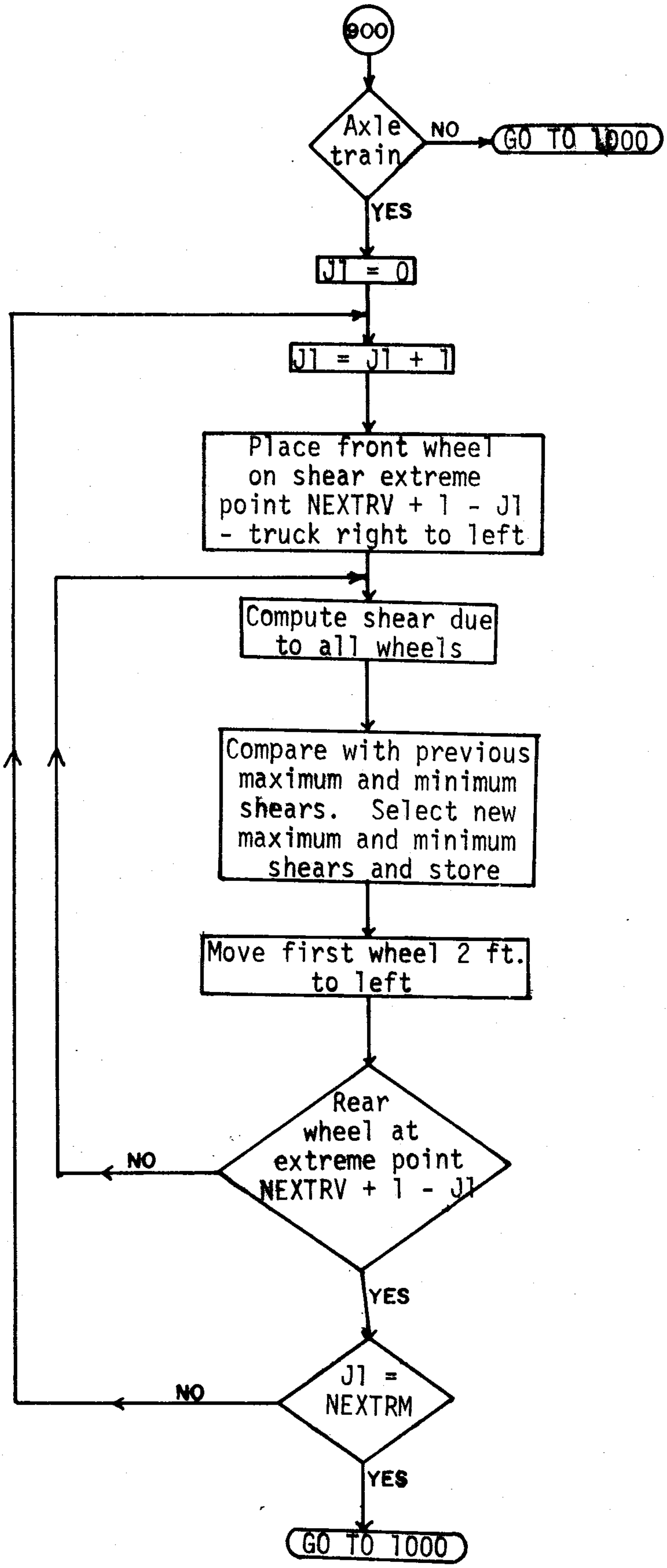


FIGURE A.2-2. (CONTINUED)

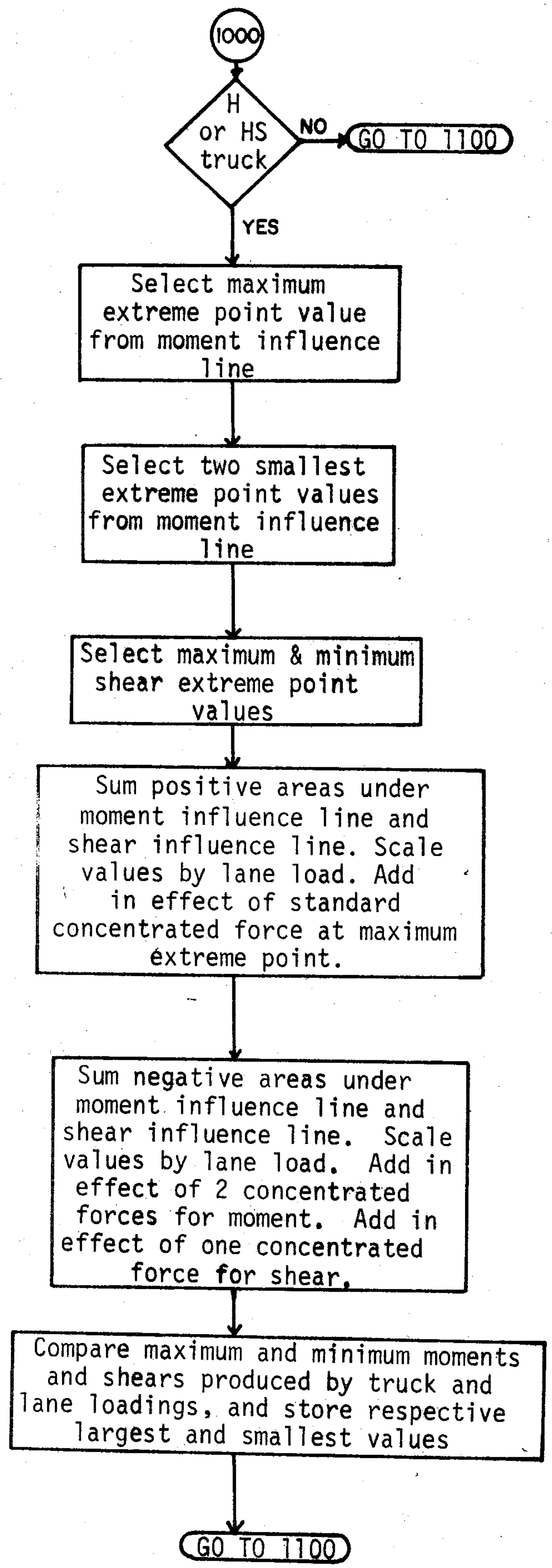


FIGURE A.2-2. (CONTINUED)

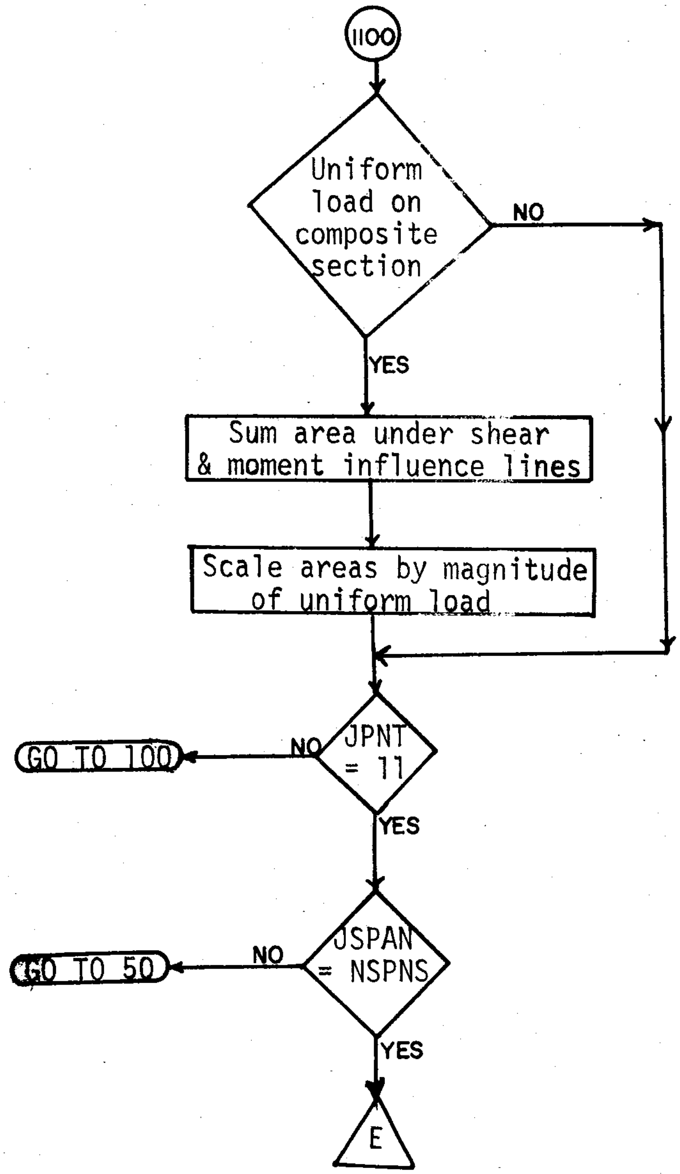


FIGURE A.2-2. (CONTINUED)

SUBROUTINE INFLNE

Subroutine Function

This subroutine computes the ordinates of the influence lines for moment and shear at the current design point. Ordinates are computed at one foot intervals along the beam. Moment and shear influence lines are computed using statics and the previously computed reaction force influence line ordinates (see Eqs. (16) and (17) of Volume I).

Variable Definition

JPNT - tenth point within span JSPAN where influence lines are being constructed

JSPAN - span in which the design point at which influence lines are being constructed

SUBROUTINE IMPACT (ITEST, L, JPNT, JSPAN, RIMP, N)

Subroutine Function

This subroutine computes the impact factor for AASHTO standard loadings. The impact factor RIMP is computed from

$$RIMP = 1. + RI$$

where

$$RI = \frac{50}{RL + 125} \; ; \; RI \leq .30$$

and

RL = For positive moments, the length of the span under consideration (span in which the current design point lies)

RL = For negative moments at design point i, span j, RL is given by

$$i = 0 \qquad RL = \frac{L_j + L_{j+1}}{2}$$

$$1 \leq i \leq 5 \qquad RL = \frac{L_j + L_{j-1}}{2}$$

$$6 \leq i \leq 9 \qquad RL = \frac{L_j + L_{j+1}}{2}$$

$$i = 10 \qquad RL = \frac{L_j + L_{j-1}}{2}$$

RL = For shear at design point i, span j, RL is given by

$$0 \leq i < 5 \qquad RL = L_j(1 - i/10)$$

$$6 \leq i \leq 10 \qquad RL = iL_j/10$$

Variable Definition

ITEST - = 1, compute impact for positive moment

= 2, compute impact for negative moment

= 3, compute impact for shear

JPNT - design point under consideration

JSPAN - number of the span which contains current design point

L - span length (ft.)

N - number of spans

RIMP - contains computed value of impact

SUBROUTINE REACTN

Subroutine Function

This subroutine computes and stores influence line values for support reactions of the beam. Values are stored in REACT(i, j), and (N-1) row by (L+1) column array where N is the number of spans and L is the total length of the beam (rounded to the nearest foot). The subroutine calls subroutine MATINV which solves systems of linear equations. The reader is referred to Volume I, Section 2.1, for a presentation of the equations used in this subroutine.

Variable Definition

SL(I) - (see Eq. (12), Volume I, this report)

SUBROUTINE SORTAX (MAXEFT, ZMAX, MINEFT, ZMIN, J1, KDIRT, NWHL, JW, LMAX, LMIN)

Subroutine Function

This subroutine compares a computed moment (or shear) with maximum and minimum moments (shears) computed previously, for an axle train. If the computed value exceeds the previous maximum, it is stored as the maximum. If the computed value is less than the previous minimum, it is stored as the minimum. The array containing the node numbers at which the wheels of the axle train are positioned is updated if the computed moment (shear) is a new maximum or minimum.

Variable Definition

J1 - node number at which the first wheel of the axle train is currently located

JW - number of wheels in the axle train

KDIRT - 1, if axle train is moving from left to right
-1, if axle train is moving from right to left

LMAX(I) - node numbers locating wheel positions which produce maximum moment (shear)

LMIN(I) - node numbers locating wheel positions which produce minimum moment (shear)

MAXEFT - previous maximum moment (or shear) found for current design point

MINEFT - previous minimum moment (or shear) found for current design point

NWHL(I) - array containing wheel spacings

ZMAX - for moment, contains computed moment at current axle train position. For shear, contains the computed shear at the current axle train position. If one of the wheels of the axle train is at the current design point (where a discontinuity exists in the influence line for shear), the contribution of that wheel to the total shear is computed using the ordinate of the influence line just to the right of the discontinuity (which is a positive value)

ZMIN - for moment, contains computed moment at current axle train position. For shear, contains the computed shear at the current axle train position. If one of the wheels of the axle train is at the current design point, the contribution of that wheel to the total shear is computed using the ordinate of the influence line just to the left of the discontinuity (which is a negative value)

SUBROUTINE SORTIL (ZINF, ZMAX, JMAX, ZMIN, JMIN, KSTRT, KSTOP, JJ)

Subroutine Function

This subroutine selects the maximum and minimum values of influence line ordinates which are within the range of possible positions for the rear wheel of an HS truck, for specified positions of wheels 1 and 2. If the influence line under consideration is for shear, the routine determines if the discontinuity in the shear influence line is within the range of the rear wheel. If it is, the ordinate value immediately to the left of the discontinuity (which is a negative value) is the minimum value.

Variable Definition

JJ - node number corresponding to the point of discontinuity in the shear influence line

JMAX - node number corresponding to ZMAX

JMIN - node number corresponding to ZMIN

KSTRT, KSTOP - node numbers defining the range of possible positions of the rear wheel

ZINF(i) - array containing influence line ordinates

ZMAX - maximum influence line ordinate

ZMIN - minimum influence line ordinate

SUBROUTINE SORTHS (MAXEFT, ZMAX, MINEFT, ZMIN, J1, J2, J3MAX, J3MIN, LMAX, LMIN)

Subroutine Function

This subroutine performs the same operations for H or HS trucks as subroutine SORTAX for an axle train vehicle.

Variable Definition

J1 - node number of front wheel of truck

J2 - node number of second wheel of truck

J3MAX - node number corresponding to the position of the rear wheel which produces the largest moment (or shear) when wheels 1 and 2 are at positions J1 and J2

J3MIN - node number corresponding to the position of the rear wheel which produces the smallest moment (shear) when wheels 1 and 2 are at positions J1 and J2

LMAX(I), LMIN(I) - (see subroutine SORTAX)

MAXEFT, MINEFT - (see subroutine SORTAX)

ZMAX, ZMIN - (see subroutine SORTAX)

SUBROUTINE DESIGN

Subroutine Function

This subroutine carries out the design of each precast unit making up the continuous beam. Design moments, beam section properties and other design information is passed from MAIN to the subroutine through labeled common blocks/PASDN/and/DUMP/. For each span of the continuous beam, the subroutine computes beam release and 28-day concrete strengths, the number and placement of prestressing strands, the reinforcing required in the deck to resist negative moment, the reinforcing required at continuity connections to resist positive moment and the required stirrup spacing. The results are passed back to MAIN for output.

Variable Definition

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

ASPRM - area of compression steel in deck to be considered in ultimate moment capacity calculations (in.^{2})

BEFF - effective flange width of T-beam (in.)

C - prestress loss on release (fraction of initial stress lost)

CRPHI - $\phi/(1 + \phi)$

D - distance from compression face (top of deck) to c.g. of strand pattern at midspan (in.)

DBAR - distance between c.g. of composite and non-composite section (in.)

DCR - one half of deck thickness (in.)

DPTH - depth of beam (in.)

ESD - ultimate differential shrinkage strain between deck and beam concrete (in./in. x 10^{-6})

ESLAB - modulus of elasticity of deck concrete (ksi.)

ETA - final prestress loss (fraction of initial stress lost)

ETC - distance from bottom of beam to c.g. of strand pattern at midspan (in.)

ETCOLD - storage for ETC

FCOMED - allowable compression stress factor used at end of the beam

FPC1 - 28 day concrete strength necessary to sustain stresses at a tenth point under dead load, maximum positive live load moment, creep restraint moments (if positive) and prestress (ksi.)

FPC2 - 28 day concrete strength necessary to sustain stresses at a tenth point under dead load, maximum negative live moment, creep restraint moment (if negative) and prestress (ksi.)

FPCLFT - maximum 28 day strength required by stress conditions at tenth points to the left of midspan (ksi.)

FPCLOD - storage for FPCLFT (ksi.)

FPCNEW - new 28 day strength (ksi.)

FPCOLD - storage for 28 day strength (ksi.)

FPCRGT - same as FPCLFT, but for right side of midspan

FPCRNW - new release strength (ksi.)

FPCROD - storage for FPCRGT (ksi.)

FSCRTH - dummy variable used when function FPRIMC is called only for the purpose of computing stresses top and bottom of the beam

FSTRND - initial strand force (kips)

JR - number of top-most row in strand pattern

JROLD - storage for JR

NMIN - minimum number of strands to be placed in beam

NUM - total number of strands in beam

NUMOLD - storage for NUM

OLDC - prestress loss on release

OLDETA - storage for ETA

PDRP - total force in draped strands (kips)

PHI - the factor ϕ (see Volume I, Eq. (19))

PSTH - total force in straight strands (kips)

RLSBT - same as RLSTP, but at bottom of beam (ksi.)

RLSTP - final stress top of beam at holddown after release, computed in function FPRIMC and passed to MAIN in calling arguement list (ksi.)

SAVEC - storage for C

SHPHI - $1./(1 + \phi)$

SIGB - stress bottom of beam at midspan due to all sources except prestress (ksi.)

SIGBR - stress bottom of beam at holddown due to beam weight (ksi.)

SIGT - stress top of beam at midspan due to all sources except prestress (ksi.)

SIGTR - stress top of beam at holddown due to beam weight (ksi.)

Y1,...,Y4;

Z1,...,Z4 - Dimension used in computing ultimate moment capacity (see subroutine ULTMO)

YYBC - distance from c.g. of composite section to bottom of beam ($in.^2$)

ZIC - composite section moment of inertia ($in.^4$)

ZL - length of span (ft.)

ZMO,...,ZM3 - fixed end moment components for prestress creep restraint (see Volume I, Fig. 8) (ft. - kips)

ZMBW - bending moment at midspan due to beam weight (ft. - kips)

ZMC - dead load moment acting on composite section at midspan (ft. - kips)

ZMDL - fixed end moment for dead load creep restraint (see Volume I, Fig. 7) (ft. - kips)

ZMHD - bending moment due to beam weight, at holddown point (ft. - kips)

ZMNC - dead load moment acting on non-composite beam section at midspan (ft. - kips)

ZMSH - fixed end moment for differential shrinkage (see Volume I, Fig. 9) (ft. - kips)

ZMSLP - positive service load moment to be resisted by continuity connection over support (ft. - kips)

ZMSLPF - service load level alternating moment for fatigue stress check of positive moment continuity connection

ZMULSP - positive ultimate moment to be resisted by continuity connection over support (ft. - kips)

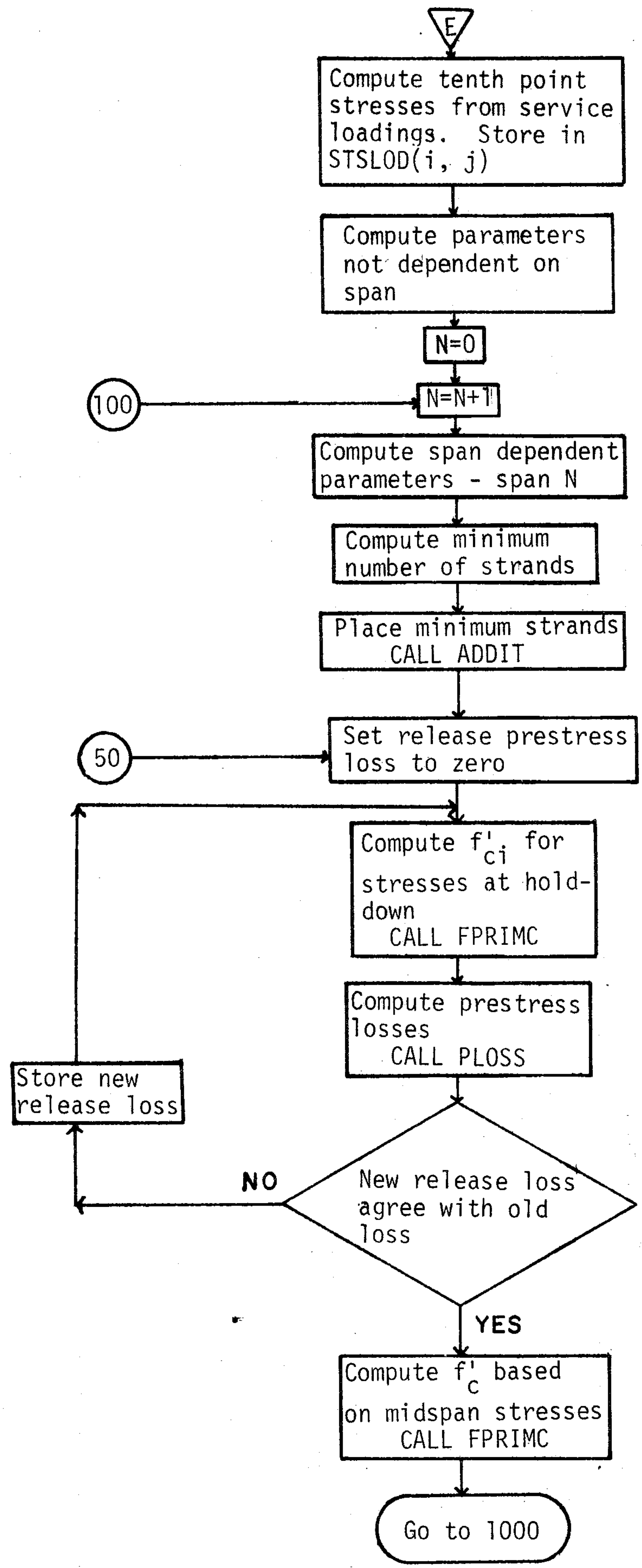


FIGURE A.2-3. FLOW CHART FOR SUBROUTINE DESIGN

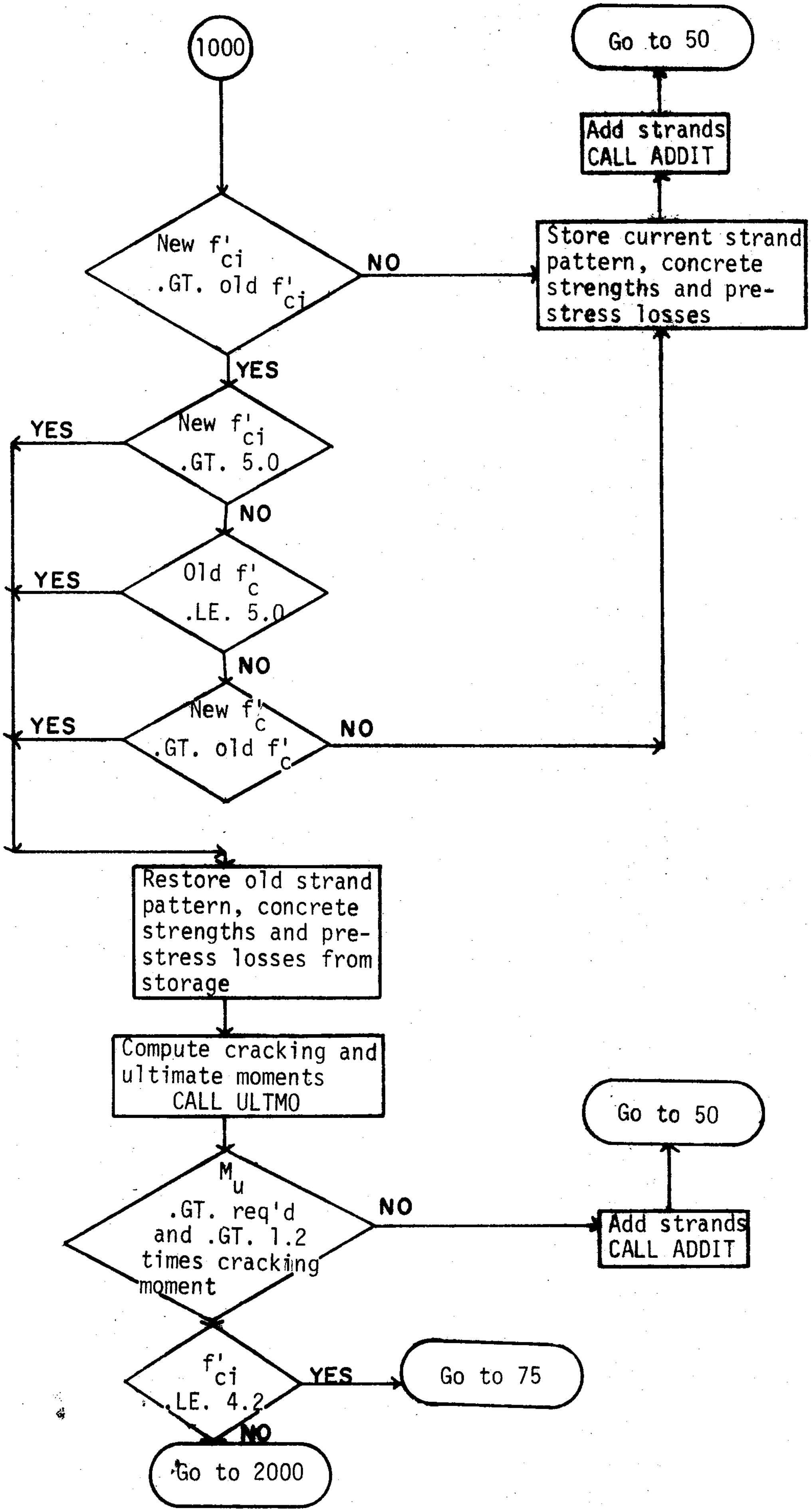


FIGURE A.2-3 (CONTINUED)

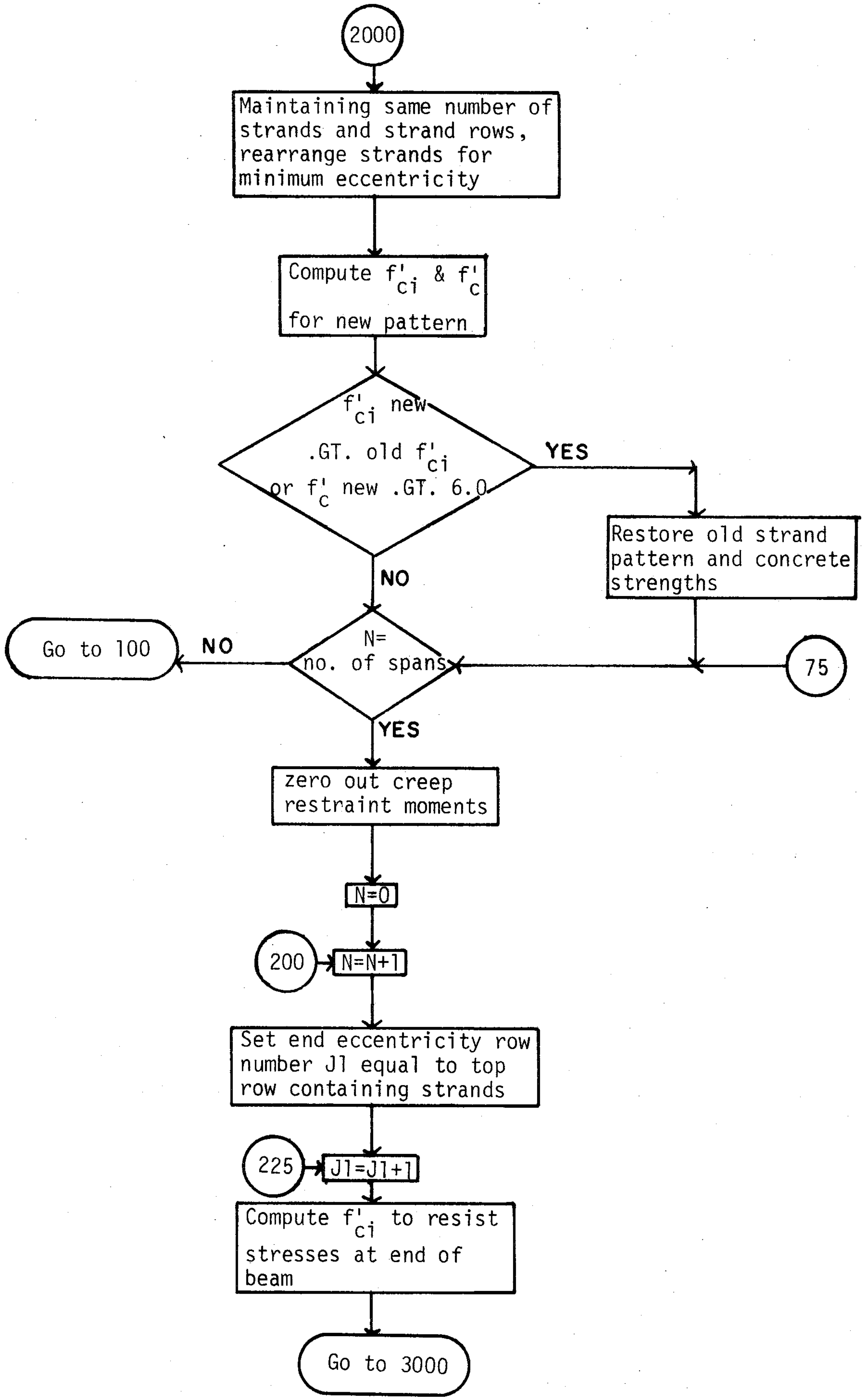


FIGURE A.2-3 (CONTINUED)

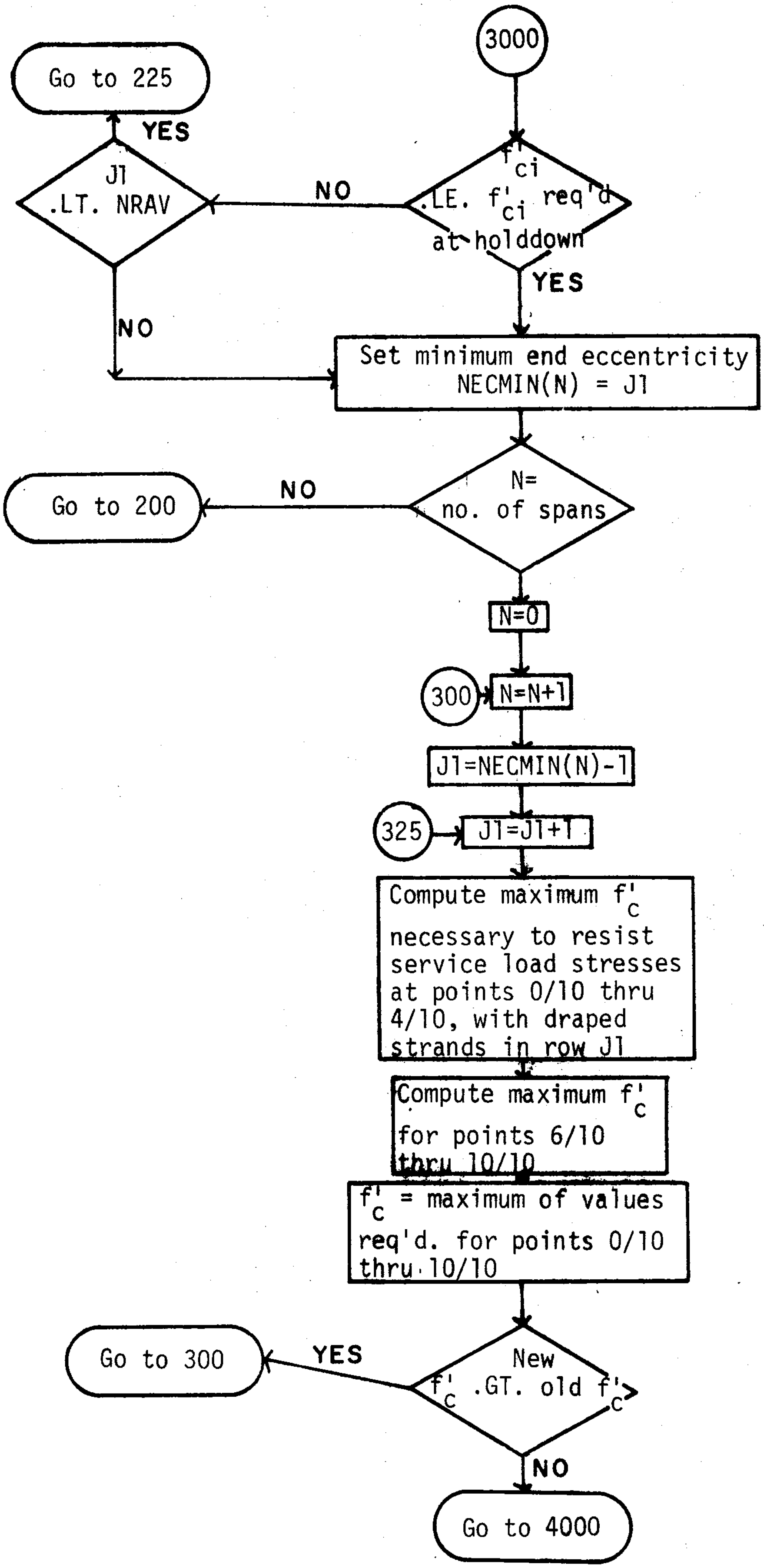


FIGURE A.2-3 (CONTINUED)

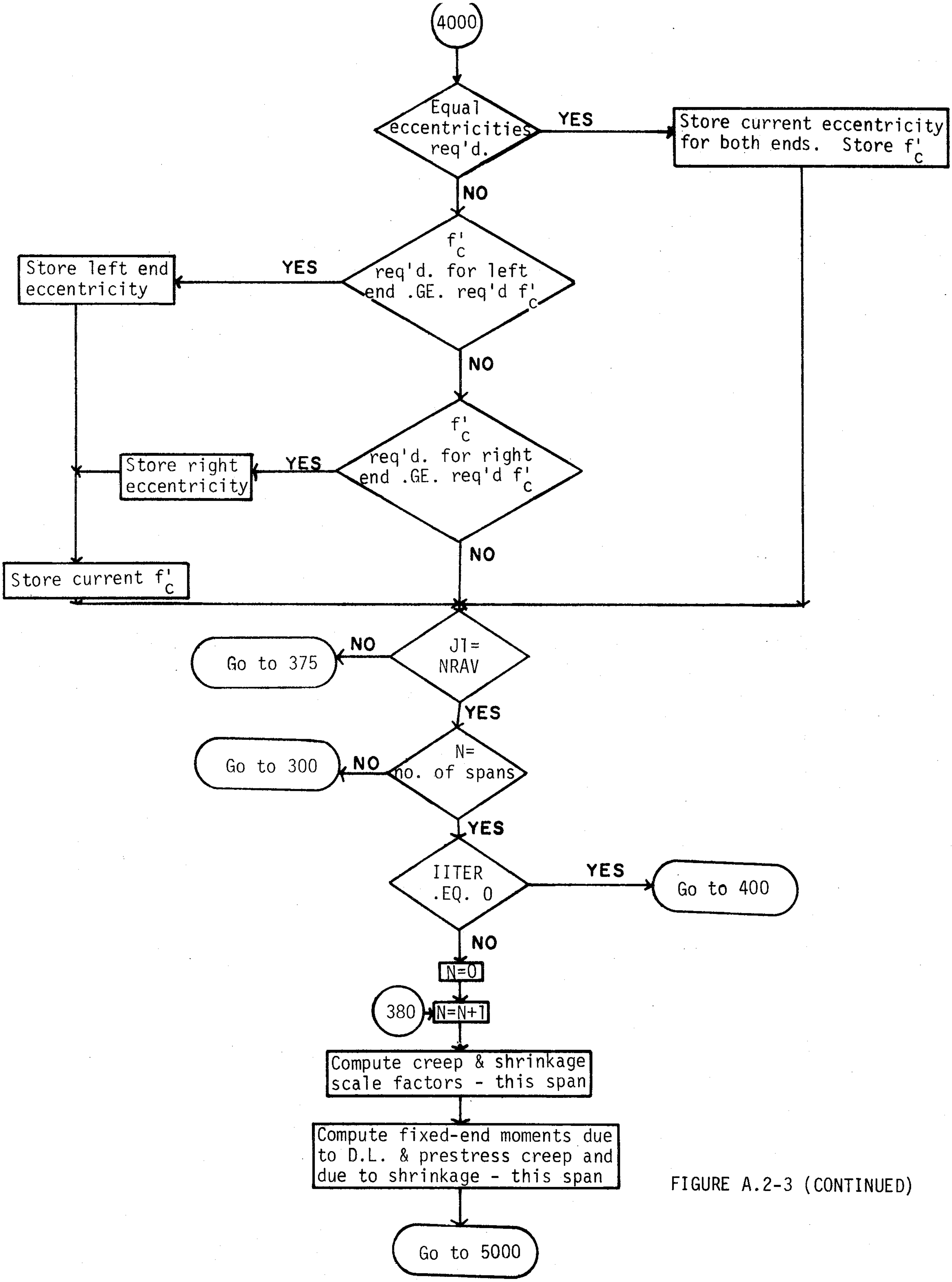


FIGURE A.2-3 (CONTINUED)

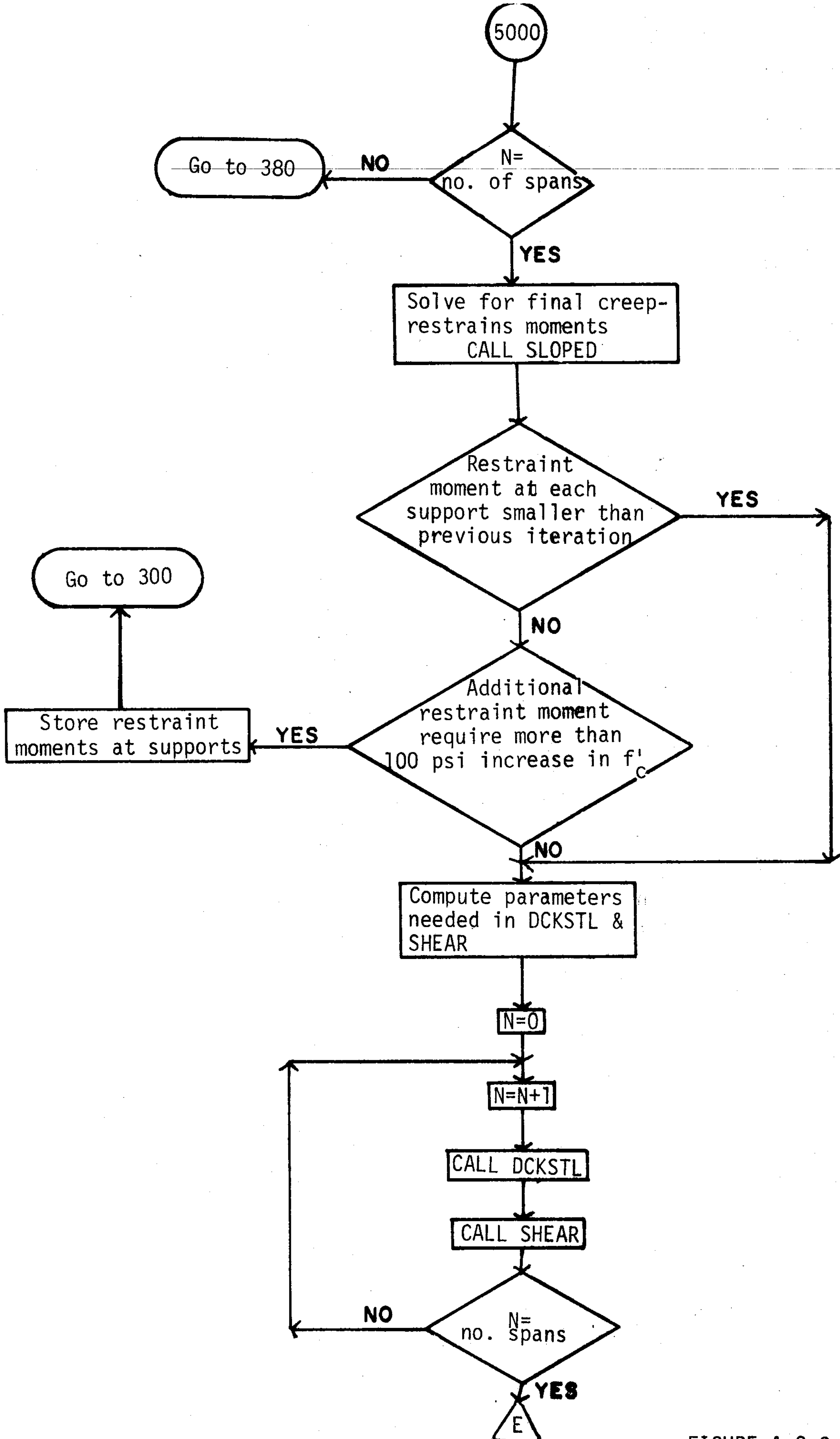


FIGURE A.2-3 (CONTINUED)

SUBROUTINE DCKSTL (Z1, Z2, Z3, Z4, Y1, Y2, Y3, Y4, YB,
THK, YT, ZMSLN, ZMSLF, ZMULN, ZMSLSP,
ZMULSP, ZMSLPF, JSP, FSY, FPC, ZIBM,
BMA, ASNEG, ASPOS, FPCSLB, ZICMP, S)

Subroutine Function

This subroutine determines the area of reinforcing required in the deck at each tenth point of a span to resist negative moment as well as the area of steel required at right end of the beam to resist positive moment over the support. The area of steel in the deck is first computed by ordinary ultimate strength design theory. The effect of strands in the beam are neglected in this calculation. Account is taken of the possible irregular shape of the concrete compression zone. The stress in the reinforcing is then checked under full service load to determine if it is less than 36 ksi and checked under alternating moment (maximum positive live load moment minus maximum negative live load moment) to determine if the alternating stress is less than 21 ksi. If either of the latter stresses are exceeded, the area of deck reinforcing is adjusted accordingly. The same criteria are used to size reinforcing for positive moment at the support. Deck reinforcing steel is assumed located at mid-depth of slab, while positive moment reinforcing at supports is assumed to centered 3 in. above the bottom of the beam.

Variable Definition

ASNEG(I, J) - area of deck reinforcing required at (I-1)th tenth point, span J (in.^{2}/ft. of slab)

ASPOS(I) - area of positive moment reinforcing required at Ith support (in.^{2})

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

C - area of concrete compression zone ($in.^2$)

DBAR - distance from compression face to c.g. of reinforcing (in.)

EST - strain in reinforcing

FPC - 28 day strenght of beam concrete (ksi.)

FPCSLB - 28 day strength of deck concrete (ksi.)

FSY - yield strength of conventional reinforcing (ksi.)

JSP - span number

NMOD - ratio of modulus of elasticity of reinforcing steel to that of the beam concrete

S - lateral spacing of beams (ft.)

SIGSTL - stress in reinforcing steel (ksi.)

SST - stress in reinforcing (ksi.)

THK - thickness of deck slab (in.)

YB - distance from c.g. of beam cross section to bottom of beam (in.)

YC - distance from bottom of beam to c.g. of concrete compression zone (in.)

YSHF - distance between c.g. of beam and c.g. of section consisting of beam plus transformed area of deck reinforcing (in.)

YT - distance from c.g. of beam cross section to top of beam (in.)

YTS - distance from c.g. of section consisting of beam plus transformed reinforcing area, to reinforcing steel (in.)

Z1,...,Z4;

Y1,...,Y4 - cross section dimensions (see Fig. A.2-4) (in.)

ZIBM - moment of inertia of beam section ($in.^4$)

ZICMP - moment of inertia of composite cross section ($in.^4$)

ZMSLF(I) - negative cyclic service load moment at (I-1)th tenth point (ft. - kips)

ZMSLN(I) - maximum service load negative moment at (I-1)th tenth point (ft. - kips)

ZMSLPF - positive cyclic moment at right end of span (ft. - kips)

ZMSLSP - maximum positive service load moment at right end of span (ft. - kips)

ZMULN(I) - ultimate negative moment at (I-1)th tenth point (ft. - kips)

ZMULSP - ultimate positive moment at right end of span (ft. - kips)

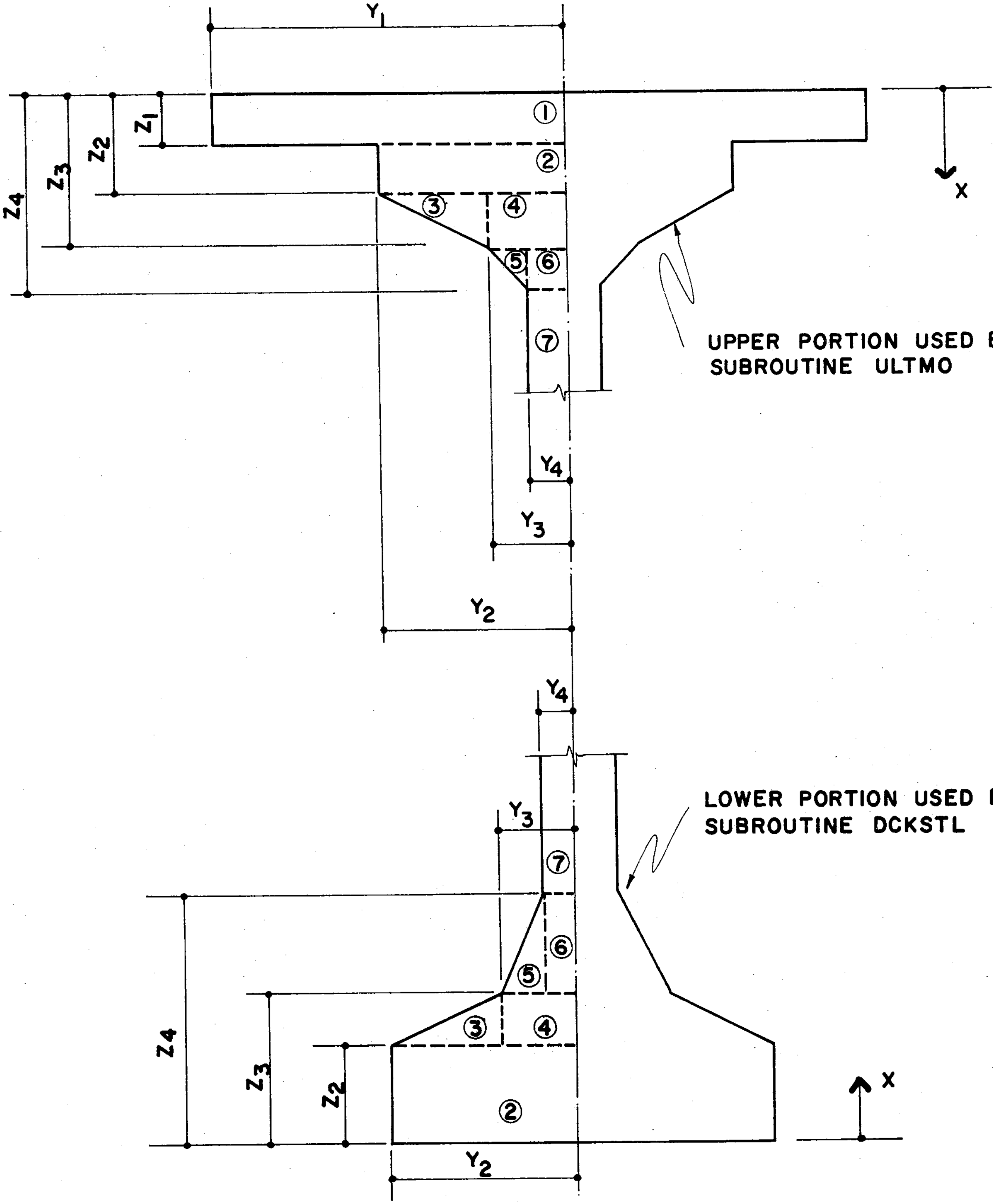


FIGURE A.2-4 COMPONENTS OF AREA USED IN COMPUTING COMPRESSION ZONE PROPERTIES

SUBROUTINE PLOSS (FPCR, ZMBW, ZMC, ZMNC, FSU, AS, AB, ZI, ZIC, YB, YBC, EC, HUM, SPAN, ZLOSS, ZINLOS, UWC)

Subroutine Function

This subroutine computes the fraction of initial prestress strand stress lost immediately after release of strands and after all losses have occurred. The procedure used is that of the 1974 AASHTO Interim Specification.

Variable Definition

- AB - cross sectional area of beam ($in.^2$)
- AS - total strand area ($in.^2$)
- EC - distance from bottom of beam to c.g. of strands (in.)
- FPCR - release strength of beam concrete
- FSU - ultimate strength of strand (ksi.)
- HUM - average relative humidity (%)
- SPAN - span length (ft.)
- UWC - unit weight of beam concrete ($kips/ft.^3$)
- YB - distance from c.g. of beam to bottom of beam (in.)
- YBC - distance from c.g. of composite section to bottom of beam (in.)
- ZI - moment of inertia of beam ($in.^4$)
- ZIC - moment of inertia of composite beam ($in.^4$)
- ZINLOS - fraction of strand stress lost on release
- ZLOSS - fraction of strand stress lost after all losses
- ZMBW - dead load moment due to beam weight at midspan (ft. - kips)
- ZMC - total dead load moment at midspan acting on composite section (ft. - kips)

ZMNC - total dead load moment at midspan (except beam weight) acting on noncomposite section (ft. - kips)

SUBROUTINE SLOPED (FEM, YX, L, N, A, B)

Subroutine Function

This subroutine uses the slope-deflection method of analysis to compute the moments at the supports of the continuous beam produced by shrinkage restraint moments, dead load creep restraint and prestress creep restraint moments. Final moments at tenth points in each span are computed from the final support moments.

Variable Definition

A(I, J) - coefficient matrix (see Eq. 21, Vol. I)

B(I) - array containing fixed end moments (see Eq. 21, Vol. I)

FEM(I) - array containing fixed end moments. Element (2I-1) is the fixed end moment at the left end of span I, and element (2I) is the fixed end moment at the right end of span I (kip-in.)

L(I) - length of span I (ft.)

N - number of spans

YX(I, J) - array containing the final moment at (I-1)th tenth point of span J

ZMSUP(I, J) - contains final support moments at left end (J = 1) and right end (J = 2) of span I

SUBROUTINE ADDIT (NS, NTOP, NSWEB, NRFLG, NLIM, JSP, NUMSTN)

Subroutine Function

This subroutine adds strands to the strand pattern of a beam. It determines which row is the current top-most row, and places 2 strands in that row if it already contains at least NSWEB strands. If the row is full, a new row is started.

Variable Definition

- JSP - span number
- NLIM(I) - one half the number of non-drapable strands that can be placed in row I
- NRFLG - number of rows which contain non-drapable strands
- NS(I, J) - number of strands in row I, span J
- NSWEB - number of drapable strands per row
- NTOP - upon return contains the number of top-most row in strand pattern containing strands
- NUMSTN - upon return contains the total number of strands

SUBROUTINE MATINV (A, N, B, M, DETERM)

Subroutine Function

This subroutine carries two names, each being used in a different segment of the program when an overlay procedure is used. The subroutine solves a system of linear equations using Jordan's method.

Variable Definition

A(I, J) - coefficient matrix

B(I, J) - right-hand side array

DETERM - determinant of coefficient matrix A

INDEX(I, J) - array used to keep track of pivotol operations

IPIVOT(I) - array containing row number in which pivots performed

M - number of vectors in right-hand side array B

N - size of coefficient matrix

PIVOT(I) - array containing pivotal elements

SUBROUTINE SHEAR (L, ALPH, SMOM, BMD, THK, FPCBM, BPRIME, ULTSHR, AV, FSY, DPTH, ULTACI, SPCAAS, SPCACI, JS, SVERTL, SVERTR)

Subroutine Function

This subroutine computes stirrup spacing required by AASHTO and ACI criteria (see Section 4.7, Vol. I).

Variable Definition

ALPH(I) - (see α, Fig. 8, pp. 20, Vol. I)

AV - stirrup area (in.^{2})

BMD - beam depth (in.)

BPRIME - beam web width (in.)

DPTH(I, J) - distance from c.g. axis of beam to c.g. of strands at (I-1)th tenth point, span J (in.)

FPCBM - concrete strength (ksi.)

FSY - yield strength (ksi.)

JS - span number

L(I) - span length of span I (ft.)

SMOM(I, J) - moment at (I-1)th tenth point, span J from loading which produces maximum shear at that point (ft. - kips)

SPCAAS(I, J) - stirrup spacing by AASHTO criteria for left quarter of span (I=1), middle half of span (I=2), and right quarter of span (I=3), for span J (in.)

SPCACI(I, J) - stirrup spacing by ACI criteria (see SPCAAS(I, J)) (in.)

SVERTL - component of total strand force in vertical direction, between left end of beam and holddown point (kips)

SVERTR - component of total strand force in vertical direction, between right end of beam and holddown point (kips)

THK - deck thickness (in.)

ULTACI(I, J) - ultimate shear to be resisted at (I-1)tenth point, span J, using ACI load factors (kips)

ULTSHR(I, J) - ultimate shear to be resisted at (I-1) tenth point, span J, using AASHTO load factors (kips)

ZJD - effective depth used in AASHTO criteria (Vol. I, Eq. (76)) (in.)

SUBROUTINE ULTMO (ASTAR, FPCBM, FPS, ASPRM, FPL, D, DPTH, FSY, DCR, Y1, Y2, Y3, Y4, Z1, Z2, Z3, Z4, CLONG, ZMUL)

Subroutine Function

This subroutine computes the positive ultimate moment capacity of a section between drape points. If the neutral axis is within the deck slab, the equations from the AASHTO 1973 Specifications are used to compute capacity. If the axis is below the slab, the method described in Volume I, Section 4.4 is used.

Variable Definition

ASPRM - area of compression reinforcing in deck (in.^{2})

ASTAR - total area of strands(in.)

BEFF - effective flange width of composite section (in.)

C - total area contained in concrete compression zone (in.^{2})

CC - total compressive force resulting from compression stress in concrete (ksi.)

CLONG - fraction of initial strand force lost after all prestress losses have occurred

CON1, CON2 - constants used in computing stress in prestressing strands from known strain

D - the distance from the c.g. of strands to the top of the deck (in.)

DBAR - distance from c.g. of strands to c.g. of concrete compression zone (in.)

DCR - distance from c.g. of deck reinforcing to top of deck slab (in.)

DPTH - overall depth of composite beam (in.)

ES - strain in strands (in./in.)

ESINI - initial strain in strands (in./in.)

ESP - strain in deck steel (in./in.)

FS - stress in strands (ksi.)

FSUSTR - stress in strands when neutral axis in slab (ksi.)

PSTAR - reinforcement index used in computing positive ultimate moment capacity when neutral axis in slab

SUMFOR - total of forces in the concrete compression zone, strands and deck reinforcing (kips)

T - total force in conventional strands (kips)

X - distance to the location of the neutral axis from top of composite section (in.)

YC - distance from c.g. of compression zone to top of slab (in.)

ZMUL - upon return, contains the positive ultimate moment capacity of the section (ft. - kips)

Z1,...,Z4

Y1,...,Y4 - dimensions describing concrete compression zone (see Figure A.2-4)

FUNCTION BRACK (ZL, X, ZU)

Purpose

This function computes a length used in calculating the area and c.g. of concrete compression zone. It is called from both subroutine ULTMO and DCKSTL. The distance BRACK is defined from

$$BRACK = \begin{cases} 0. & ; X \le ZL \\ (X - ZL) & ; ZL \le X \le ZU \\ (ZU-ZL) & ; X > ZU \end{cases}$$

FUNCTION ECC (NS, DD, NTOP, JSP, NUMSTN)

Purpose

This function subprogram computes the distance between the c.g. of the strand pattern (between drape points) and the c.g. of the beam and returns this value through the function name. In addition, it counts the total number of strands and the top-most strand row, and returns the values in the calling parameter list.

Variable Definition

DD(I) - distance from c.g. of strand row I to c.g. of beam (positive if strand row is above c.g.) (in.)

JSP - span number

NS(I, J) - number of strands in row I of beam in span J

NTOP - upon return, contains the row number of top-most row containing strands

NUMSTN - upon return, contains total number of strands present

FUNCTION FPRIMN (FT, FC, A, ZT, ZB, ZLOS, NS, DD, SIGT, SIGB,
TAU, DRAPE, NTOP, P, JSP, J10TH, G, NW,
STOTTP, STOTBT)

Purpose

This function subprogram computes the required concrete strength to resist stress top and bottom of a beam at a specified point. The value is returned through the function name. In addition, the stresses top and bottom due to applied loads and prestress are returned through the calling parameters.

Variable Definition

A - area of beam (in.^{2})

DD(I) - distance from c.g. of beam to strand row I; positive if strand is above c.g. (in.)

DRAPE - row to which top most strands are raised at the end of the beam

FC - factor for allowable compression stress

FT - factor for allowable tension stress

G - spacing of strand rows (in.)

JSP - span number

J10TH - stresses occur at (J10TH-1) tenth point

NS(I, J) - contains number of strands in row I of beam in span J

NTOP - row number of top-most strand in pattern

NW - number of strands in web

P - initial force in strand (kips)

SIGB - load induced stress in the bottom of the beam at tenth point under consideration (ksi.)

SIGT - load induced stress in the top of the beam (ksi.)

STOTBT - total stress at bottom of beam due to prestress and applied loads, at tenth point under consideration (ksi.)

STOTTP - total stress at top of beam due to prestress and load (ksi.)

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

ZLOSS - fraction of initial prestress force lost

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

APPENDIX A.3

PROGRAM LISTING

```
      REAL*4LLMASP,LLMASN,LLSASP,LLSASN,LLMAXP,LLMAXN,LLSAXP,LLSAXN,
     2L,MAMOM,MIMOM,MSAXN,MSAXP,MSASN,MSASP
      INTEGER*2 ITILT,TT,IDENT,BEAMTP,ID,IDS,IDH,ID1,ID2,BK,KAXT,KKONT,
     1KDIAP,IST,MISC,LL,KBMTYP,SKAXT,SKKONT
      COMMON/PASAN1/LLMASP(11,10),LLMASN(11,10),LLSASP(11,10),LLSASN(11,
     110),LLMAXP(11,10),LLMAXN(11,10),LLSAXP(11,10),LLSAXN(11,10),
     2DLMUNF(11,10),DLSUNF(11,10),DLMBM(11,10),DLMSLS(11,10),DLSSLS(11,1
     30),DLMSLC(11,10),DLSSLC(11,10),MSASP(11,10),MSASN(
     411,10)                  ,MSAXP(11,10),MSAXN(11,10),IBETA(10,2),SL(10)
     5,LODKOD(7),PWHEEL(15),BETA(10,2),NWHL(14),L(10),DLSBM(11,10)
      COMMON/PASAN2/ SCLHHS,SCLLNE,SCLCCM,SCLCOV,NWHEEL,KCONT,NSPNS,NN
      COMMON/DUMP/MAMOM(11,10),MIMOM(11,10),CRPMOM(11,10),DLMCOM(11,10),
     *DLMSIM(11,10),ULTSHR(11,10),ULTACI(11,10),ULTMOM(10),SMOM(11,10),
     *STSLOD(110,4),STSRLS(6,10),ZTCBM(10),ZBCBM(10),ZICBM(10),YTC(10),
     *YBC(10),FPCRL(10),FPCBM(10),ZLOSSR(10),ZLOSS(10),TAUI(10,11),
     *DD(50),ZL(10),ALPH(10),NLIM(20),NS(50,10),EL(10),ER(10),
     *SPCAAS(3,10),SPCACI(3,10),ULTMSP(10),ASPOS(11),ASNEG(11,10),
     *AREACP(10),NDIA(10),
C     REMAINDER OF /DUMP/ IS OVERLAPPED.
     *SIGMA(11,4),DLMDIA(11,10),DLSDIA(11,10),HDPT(10),KECL(10),
     *KECR(10),ECCCL(10),KTOTSN(10),KDEPSN(11),ITILT(3,54),TT(5),
     *IDENT(5),CD(4),ZTOPSL(10)
      COMMON/PASDN/NNSPNS,ZTBM,ZBBM,BMA,ZIBM,YB,YT,S,FPS,FPL,THK,KASE,
     *FPCSLB,BMWT,SLBWT,UWBM,STSIZE,NSWEB,NRFLG,NRAV,FPCBMN,N,ISYM,
     *KODSYM,IITER,GRIDS
      COMMON/PASBK1/ ZD(13),ZB(13),ZW(13),ZA(13),ZC(13),ZE(13),ZG(13),ZH
     1(13),ZF(13),ZQ(13),ZO(13),ZP(13),DIAPSD(12,2),BEAMTP(17)
      COMMON/PASBK2/AV,FSY,ECRPUL,ESHSUL,TIMCRP,TIMSHR,AGECON,
     *HUMID,FTER,FCOMR,FTEN,FCOM,VOLSUR
      DATA IDS,IDH,ID1,ID2,BK,MISC,LL/'S','H','1','2',' ','M','L'/
      INTEGER FORM(9) /'(1H+','.32X','.    ','    ','(1X,','2HA-','.I2,',
     $'2X,1','H*))'/
      INTEGER DIGIT(10)/'1','2','3','4','5','6','7','8','9','10'/
      INTEGER ROW(10)/10*'ROW '/
      DATA KYES,NO /'YES ','NO  '/
C
      CALL REREAD
C
C   READ TITLE CARDS
C
      READ(5,102)(ITILT(1,J2),J2=10,26),(ITILT(1,J2),J2=48,54)
  102 FORMAT(9X,17A1,21X,7A1)
      READ(5,104)(ITILT(2,J2),J2=13,19),(ITILT(2,J2),J2=26,28),
     $(ITILT(2,J2),J2=44,54)
  104 FORMAT(12X,7A1,6X,3A1,16X,11A1)
      READ(5,106)(ITILT(3,J2),J2=13,54)
  106 FORMAT(12X,42A1)
      READ(5,107)ID
  107 FORMAT(A1)
C
C     PICK UP LOADING CARD
C
 1052 READ(99,114) (TT(J2),J2=1,2),(TT(J2),J2=4,5),UNIFL,KAXT,KKONT,
     *(L(J2),J2=1,10)
  114 FORMAT(4X,2A1,1X,2A1,1X,F4.2,2X,A1,1X,A1,2X,9(F4.1,2X),F4.1)
      SKAXT=KAXT
      SKKONT= KKONT
      KANALY=0
```

```
C
C     ROUND SPAN LENGTHS TO NEAREST FOOT
C
      DO 10 J1=1,10
      SS=L(J1)
      S1=AINT(SS)
      IF(L(J1)-S1.GE..5)  L(J1)=S1+1.
      IF(L(J1)-S1.LT..5)  L(J1)=S1
      IF(L(J1).NE.0.) N=J1
   10 ZL(J1)=L(J1)
      NN=N
      SS=0.
      DO 12 J1=1,N
      SS=SS+L(J1)
   12 SL(J1)=SS
C
C     SET PARAMETERS SO THAT ALL SLAB WEIGHT CARRIED BY SIMPLE BEAM -
C     CHANGED LATER IF PARTIAL CONTINUITY POUR INPUT
C
      DO 16 J1=1,N
      BETA(J1,1)=0.5
   16 BETA(J1,2)=0.5
C
C    PICK UP BEAM CARD
C
      READ(5,107)ID
  500 READ(99,120)(IDENT(J1),J1=1,5),KBMTYP,S,THK,FPCBMN,IITER,FACTOR,
     $SCLAXT,(NDIA(J1),J1=1,10),IOUT,WDIA
  120 FORMAT(4X,5A1,3X,A2,3X,F4.2,3X,F4.2,3X,F4.2,3X,I1,3X,F3.2,3X,
     *F3.2,3X,10I1,3X,I1,3X,F4.2)
C
C      DEFINE STANDARD BEAM QUANTITIES
C
      UWSLB=.150
      UWBM=.150
      STSIZE=0.153
      NSWEB=2
      FPS=270.
      FPL=.63*FPS
      FPCSLB=3.6
      GRIDS=2.0
      ISYM=0
      IF(FPCBMN.EQ.0.) FPCBMN=5.0
      IF(SCLAXT.EQ.0.0) SCLAXT=1.0
      IF(SKAXT.EQ.BK) GO TO 24
C
C    READ AXLE TRAIN
C
      READ(5,116)(PWHEEL(J1),J1=1,15)
  116 FORMAT(4X,15(F3.1,1X))
      READ(5,118)(NWHL(J1),J1=1,14)
  118 FORMAT(8X,14(I3,1X))
      DO 22 J1=1,15
      IF(PWHEEL(J1).NE.0.)NWHEEL=J1
   22 CONTINUE
   24 IF(SKKONT.EQ.BK) GO TO 28
C
C     READ PARTIAL CONTINUITY FOR DEAD LOAD
```

```
C
      READ(5,117)(BETA(J2,1),BETA(J2,2),J2=1,10)
  117 FORMAT(4X,10(F2.2,1X,F2.2,2X))
      DO 26 J1=1,N
      IBETA(J1,1)=IFIX(BETA(J1,1)*L(J1)+200+SL(J1)-L(J1))
      TERM=L(J1)-BETA(J1,2)*L(J1)
   26 IBETA(J1,2)=IFIX(TERM)+200+SL(J1)-L(J1)
   28 IF( KKONT.EQ.BK) KCONT=0
      IF( KKONT.NE.BK) KCONT=1
C
C     SET UP FOR CALL TO ANALYSIS
C
   32 IF(KANALY.EQ.1) GO TO 51
      DO 36 J1=1,7
   36 LODKOD(J1)=0
      IF(UNIFL.GT..001) LODKOD(4)=1
      IF(KAXT.NE.BK) LODKOD(3)=1
      IF(TT(1).EQ.BK.AND.TT(4).EQ.BK) GO TO 42
      IF(TT(4).EQ.ID2) GO TO 38
      SCLHHS=24.
      SCLLNE=.480
      SCLCOM=13.5
      SCLCOV=19.5
      GO TO 40
   38 SCLHHS=32.
      SCLLNE=.640
      SCLCOM=18.
      SCLCOV=26.
   40 IF(TT(2).EQ.IDS) LODKOD(2)=1
      IF(TT(2).EQ.BK.OR.TT(2).EQ.IDH) LODKOD(1)=1
      IF(LODKOD(1).EQ.0.OR.LODKOD(2).NE.0) GO TO 42
      WRITE(6,124) TT(1),TT(2),TT(4),TT(5)
  124 FORMAT(////,30X,'*UNRECOGNIZED AASHTO LOAD SPECIFIED*',49X,2A1,
     *'-',2A1)
      KBOMB=1
      GO TO 2000
C
   42 DO 44 I=1,N
      DO 44 J=1,11
      MSASP(J,I)=0.
      MSASN(J,I)=0.
      MSAXP(J,I)=0.
      MSAXN(J,I)=0.
      LLMASP(J,I)=0.
      LLMASN(J,I)=0.
      LLSASP(J,I)=0.
      LLSASN(J,I)=0.
      LLMAXP(J,I)=0.
      LLMAXN(J,I)=0.
      LLSAXP(J,I)=0.
      LLSAXN(J,I)=0.
      DLMUNF(J,I)=0.
      DLSUNF(J,I)=0.
      DLMBM(J,I)=0.
      DLSBM(J,I)=0.
      DLMSLS(J,I)=0.
      DLSSLS(J,I)=0.
      DLMSLC(J,I)=0.
```

```
   44 DLSSLC(J,I)=0.
C
C     CHECK SYMMETRY, KODSYM=0 -NO SYMMETRY, KODSYM=1 -SYMMETRICAL
C     WITH EVEN NUMBER SPANS, KODSYM=3  SYMMETRICAL WITH ODD
C     NUMBER SPANS
      J1=N/2
      KODE=0
      DO 48 J2=1,J1
      IF(KODE.EQ.1) GO TO 48
      S1=L(J2)-L(N+1-J2)
      IF(ABS(S1).GE.1.E-02) GO TO 46
      GO TO 48
   46 KODE=1
   48 CONTINUE
      DO 50 J1=1,N
      NT=N/2
      DO 50 J2=1,NT
      TEST=N-(J2*2)
      IF(TEST.EQ.0) J3=1
      IF(TEST.EQ.1.) J3=0
   50 IF(KODE.EQ.1) KODSYM=0
      IF(KODE.EQ.0.AND.J3.EQ.0) KODSYM=1
      IF(KODE.EQ.0.AND.J3.EQ.1) KODSYM=2
      NSPNS=N
      IF(KODSYM.EQ.1) NSPNS=N/2+1
      IF(KODSYM.EQ.2) NSPNS=N/2
C
C       CHECK FOR SYMMETRY OF PARTIAL CONTINUITY POUR
C
      J6=NSPNS
      IF(KODSYM.EQ.0.OR.KCONT.EQ.0) GO TO 57
      DO 55 J1=1,J6
      IF(BETA(J1,1).NE.BETA(N+1-J1,2)) GO TO 53
      IF(BETA(J1,2).NE.BETA(N+1-J1,1)) GO TO 53
      GO TO 55
   53 NSPNS=N
      KODSYM=0
   55 CONTINUE
   57 CONTINUE
      NNSPNS=NSPNS
C*************************************************************************
      CALL ANALYZ
C*************************************************************************
C
C     READ NON-STANDARD BEAM PROPERTIES
C
   51 IST=KBMTYP
      IF(KBMTYP.NE.BEAMTP(13)) GO TO 52
      READ(5,126) ID,ZD(13),ZB(13),ZW(13),ZA(13),ZC(13),ZE(13),
     $ZG(13),ZH(13),ZF(13),ZQ(13),ZO(13),ZP(13),NSWEB,GRIDS
  126 FORMAT(4X,A2,12(1X,F4.2),2X,I1,2X,F4.2)
      IF(GRIDS.EQ.0.) GRIDS=2.0
      IF(NSWEB.EQ.0) NSWEB=2
      IF(ID.EQ.BK.OR.ID.EQ.BEAMTP(13)) KASE=13
      IF(ID.EQ.BK.OR.ID.EQ.BEAMTP(13)) GO TO 58
      IST=ID
C
C     IDENTIFY STANDARD SECTION
```

```
C
   52 DO 54 J1=1,17
      KASE=J1
      IF(IST.EQ.BEAMTP(J1)) GO TO 56
   54 CONTINUE
      WRITE(6,128) IST
  128 FORMAT(////,30X,'*UNRECOGNIZABLE STANDARD BEAM SPECIFIED*',/,35X,
     $'BEAM SPECIFIED WAS ',A2)
      KBOMB=2
      GO TO 2000
   56 IF(KASE.EQ.14) KASE=1
      IF(KASE.EQ.15) KASE=2
      IF(KASE.EQ.16) KASE=3
      IF(KASE.EQ.17) KASE=4
      IF(KBMTYP.NE.BEAMTP(13)) GO TO 58
      IF(ZD(13).EQ.0.) ZD(13)=ZD(KASE)
      IF(ZB(13).EQ.0.) ZB(13)=ZB(KASE)
      IF(ZW(13).EQ.0.) ZW(13)=ZW(KASE)
      IF(ZA(13).EQ.0.) ZA(13)=ZA(KASE)
      IF(ZC(13).EQ.0.) ZC(13)=ZC(KASE)
      IF(ZE(13).EQ.0.) ZE(13)=ZE(KASE)
      IF(ZG(13).EQ.0.) ZG(13)=ZG(KASE)
      IF(ZH(13).EQ.0.) ZH(13)=ZH(KASE)
      IF(ZF(13).EQ.0.) ZF(13)=ZF(KASE)
      IF(ZQ(13).EQ.0.) ZQ(13)=ZQ(KASE)
      IF(ZO(13).EQ.0.) ZO(13)=ZO(KASE)
      IF(ZP(13).EQ.0.) ZP(13)=ZP(KASE)
      KASE=13
C
C        DEFINE STANDARD DIAPHRAMS
C
   58 IF(WDIA.NE.0.) WTDIA=WDIA
      IF(WDIA.NE.0.) GO TO 61
      WTDIA=0.
      IF(KASE.EQ.13) GO TO 61
      WTDIA=DIAPSD(KASE,1)*(S-DIAPSD(KASE,2))*UWSLB
C
C      COMPUTE BEAM SECTION PROPERTIES
C
   61 J=KASE
      BMD=ZD(KASE)
      REMB=ZB(J)/2.-ZQ(J)-ZW(J)/2.
      REMT=ZA(J)/2.-ZP(J)-ZW(J)/2.
      TI =ZC(J)**3*REMB/12.
      AREA=ZC(J)*(ZB(J)/2.-ZW(J)/2.-ZQ(J))
      XI=TI+AREA*(ZC(J)/2.)**2
      AYB=AREA*ZC(J)/2.
      TI=(REMB*ZE(J)**3)/36.
      TA=.5*ZE(J)*REMB
      AREA=AREA+TA
      XI=TI+TA*(ZE(J)/3.+ZC(J))**2+XI
      AYB=AYB+TA*(ZE(J)/3.+ZC(J))
      TA=.5*ZQ(J)*ZF(J)
      TI=(ZQ(J)*ZF(J)**3)/36.
      AREA=AREA+TA
      XI=XI+TI+TA*(ZF(J)/3.+ZE(J)+ZC(J))**2
      AYB=AYB+TA*(ZF(J)/3.+ZE(J)+ZC(J))
      TA=(ZC(J)+ZE(J))*ZQ(J)
```

```
      TI=(ZQ(J)*(ZC(J)+ZE(J))**3)/12.
      AREA=AREA+TA
      XI=XI+TI+TA*((ZC(J)+ZE(J))/2.)**2
      AYB=AYB+TA*((ZC(J)+ZE(J))/2.)
      TA=ZP(J)*ZO(J)*.5
      TI=(ZP(J)*ZO(J)**3)/36.
      AREA=AREA+TA
      XI=XI+TI+TA*(ZD(J)-ZH(J)-ZG(J)-ZO(J)/3.)**2
      AYB=AYB+TA*(ZD(J)-ZH(J)-ZG(J)-ZO(J)/3.)
      TA=ZG(J)*REMT*.5
      TI=(REMT*ZG(J)**3)/36.
      AREA=AREA+TA
      XI=XI+TI+TA*(ZD(J)-ZH(J)-ZG(J)/3.)**2
      AYB=AYB+TA*(ZD(J)-ZH(J)-ZG(J)/3.)
      TA=ZP(J)*(ZH(J)+ZG(J))
      TI=(ZP(J)*(ZH(J)+ZG(J))**3)/12.
      AREA=AREA+TA
      XI=XI+TI+TA*(ZD(J)-(ZH(J)+ZG(J))/2.)**2
      AYB=AYB+TA*(ZD(J)-(ZH(J)+ZG(J))/2.)
      TA=ZH(J)*REMT
      TI=(REMT*ZH(J)**3)/12.
      AREA=AREA+TA
      XI=XI+TI+TA*(ZD(J)-ZH(J)/2.)**2
      AYB=AYB+TA*(ZD(J)- ZH(J )/2.)
      TA=.5*(.75)**2
      TI=(.75)**4/12.
      AREA=AREA-TA
      XI=XI-TI-TA*(.333*.75)**2
      AYB=AYB-TA*.333*.75
      TA=ZD(J)*ZW(J)/2.
      TI=ZW(J)/2.*ZD(J)**3/12.
      AREA=AREA+TA
      XI=XI+TI+TA*(ZD(J)/2.)**2
      AYB=AYB+TA*ZD(J)/2.
      YB=AYB/AREA
      YT=ZD(J)-YB
      XI=XI-AREA*YB**2
      BMI=XI*2.
      BMA=AREA*2.
      ZTBM=BMI/YT
      ZBBM=BMI/YB
      PERM=(ZD(J)+SQRT(ZE(J)**2+REMB**2)+SQRT(ZF(J)**2
     $+ZQ(J)**2)+SQRT(ZP(J)**2+ZO(J)**2)+SQRT(REMT**2
     $+ZG(J)**2)+ZA(J)/2.+ZB(J)/2.-ZG(J)-ZD(J)-ZF(J)-ZE(J))*2.
      VOLSUR=BMA/PERM
      BMD=ZD(J)
      ZIBM=BMI
C
C     COMPUTE COMPOSITE SECTION PROPERTIES
C
      BPRIME=ZW(KASE)
      DO 72 J1=1,N
      SEFF=S
      IF(SEFF.GT.L(J1)/4.) SEFF=L(J1)/4.
      IF(SEFF.GT.THK+ZW(KASE)/12.) SEFF=THK+ZW(KASE)/12.
      IF(SEFF.GT.THK) SEFF=THK
      ASLB=12.*SEFF*THK
      YBC(J1)=(YB*BMA   +ASLB*(BMD+THK/2.))/(BMA   +ASLB)
```

```
      YTC(J1)=BMD-YBC(J1)
      ZI=BMI+BMA   *(YBC(J1)-YB)**2+SEFF *THK**3+ASLB*(YTC(J1)+THK/2.)**2
      ZICBM(J1)=ZI
      ZTCBM(J1)=-ZI/YTC(J1)
      ZBCBM(J1)=ZI/YBC(J1)
      AREACP(J1)=BMA+ASLB
   72 ZTOPSL(J1)=-ZI/(YTC(J1)+THK)
      READ(5,130,END=76) IST
  130 FORMAT(A1)
      IF(IST.NE.MISC) GO TO 78
C
C     READ MISCELLANEOUS PROPERTIES CARD
C
      READ(99,132) STSIZE,FPS,UWBM,UWSLB,FPCSLB,ISYM
  132 FORMAT(4X,F4.3,2X,F4.1,2(2X,F4.3),2(2X,F4.2),2X,I1)
      IF(STSIZE.EQ.0.) STSIZE=.152
      IF(FPS.EQ.0.) FPS=270.
      FPL=.63*FPS
      IF(UWBM.EQ.0.) UWBM=.150
      IF(UWSLB.EQ.0.) UWSLB=.150
      IF(FPCSLB.EQ.0.) FPCSLB=3.6
      READ(5,134,END=76) IST
  134 FORMAT(A1)
      GO TO 78
   76 KSTOP=1
      GO TO 80
   78 KSTOP=0
   80 CONTINUE
C
C     COMPUTE 1/2 NUMBER OF NON-WEB STRANDS PERMITTED IN EACH STRAND
C     ROW.  CENTERLINE OF ROW 1 IS LOCATED GRIDS ABOVE BOTTOM FACE OF
C     BEAM.  BEAM HAS 3/4 IN. CHAMFER ON OUTSIDE EDGE OF BOTTOM FLANGE.
C     MINIMUM PERMITTED DISTANCE BETWEEN CENTER OF STRAND AND ANY BEAM
C     SURFACE ( EXCEPT BOTTOM ) IS DIM.
      DIM=1.5+0.5*(SQRT(4.*STSIZE*1.292/3.1418))
      DELX=0.5*(ZB(J)-ZW(J)-2.*ZQ(J))
      DELY=ZE(J)
      IF(DELY.LT.1.E-40) DELY=0.01
      THETA=ATAN2(DELY,DELX)
      DELX=ZQ(J)
      DELY=ZF(J)
      IF(DELY.LT.1.E-40) DELY=0.01
      PHI=ATAN2(DELY,DELX)
      AX=DIM
      AY=GRIDS
      BX=DIM
      Z7=3.1418/4.-0.5*THETA
      BY=ZC(J)-DIM*TAN(Z7)
      ZZ=0.5*(PHI+THETA)
      XX=0.5*(PHI-THETA)
      CX=0.5*(ZB(J)-ZW(J)-2.*ZQ(J))+DIM*SIN(ZZ)/COS(XX)
      CY=ZC(J)+ZE(J)-DIM*COS(ZZ)/COS(XX)
      DX=0.5*(ZB(J)-ZW(J))+DIM
      DY=ZC(J)+ZE(J)+ZF(J)+DIM*TAN(Z7)
      EE=(NSWEB-1)*GRIDS/2.
      DO 82 JR=1,200
      NRFLG=JR
      DIST=EE
```

```
      ZY=JR*GRIDS
      NLIM(JR)=0
      DO 74 JC=1,100
      DIST=DIST+GRIDS
      ZX=ZB(J)/2.-DIST
      IF(ZX.LT.DIM) GO TO 81
      IF((CY-BY)*ZX-(CX-BX)*ZY+(BY*CX-CY*BX).GE.0.) GO TO 73
      IF((DY-CY)*ZX-(DX-CX)*ZY+(CY*DX-DY*CX).LT.0.) GO TO 81
   73 IF(ZX.GT.0.5*ZB(J)-EE) GO TO 81
   74 NLIM(JR)=JC
   81 IF(NLIM(JR).EQ.0) GO TO 83
      IF(ZY.GT.ZD(J)-DIM) GO TO 83
   82 CONTINUE
   83 IF(1.414*(0.5*(ZB(J)/2.-EE-NLIM(1)*GRIDS)+.5*GRIDS-.375).LT.DIM)NL
     *IM(1)=NLIM(1)-1
      DO 84 J2=1,200
      IF(ZD(J)-DIM.GE.J2*GRIDS) NRAV=J2
   84 CONTINUE
      DO 85 J2=1,NRAV
   85 DD(J2)=GRIDS*J2-YB
      BMWT=BMA*UWBM/144.
      SLBWT=S*THK*UWSLB/12.
      FSTRND=STSIZE*FPS*0.7
C
C       COMPUTE MOMENTS AND SHEARS DUE TO UNIT WEIGHT DIAPHRAGM
C
      DO 86 J1=1,NSPNS
      DO 86 J2=1,11
      DLMDIA(J2,J1)=0.
   86 DLSDIA(J2,J1)=0.
      DO 91 J1=1,NSPNS
      J4=NDIA(J1)
      IF(J4.EQ.0) GO TO 91
      DO 88 J2=1,J4
   88 CD(J2)=J2*L(J1)/(1+J4)
      DO 90 J2=1,J4
      DO 90 J3=1,6
      Z=(J3-1)*L(J1)*0.1
      DLMDIA(J3,J1)=(CD(J2)*(L(J1)-CD(J2))/L(J1)*Z/CD(J2))
     *+DLMDIA(J3,J1)
   90 DLSDIA(J3,J1)=DLSDIA(J3,J1)+ (L(J1)-CD(J2))/L(J1)
      DO 89 J2=1,6
      DLMDIA(12-J2,J1)=DLMDIA(J2,J1)
   89 DLSDIA (12-J2,J1)=-DLSDIA(J2,J1)
   91 CONTINUE
C
C     SCALE OTHER MOMENTS AND SHEARS
C
      IF(FACTOR.EQ.0.) FACTOR=S/11.0
      IF(SCLAXT.EQ.0.) SCLAXT=1.0
      DO 98 J1=1,NSPNS
      SULT=0.
      DO 96 J2=1,11
      Z1=LLMASP(J2,J1)*FACTOR
      Z2=LLMAXP(J2,J1)*SCLAXT
      MAMOM(J2,J1)=AMAX1(Z1,Z2)
      Z1=LLMASN(J2,J1)*FACTOR
      Z2=LLMAXN(J2,J1)*SCLAXT
```

```
      Z3=0.
      MIMOM(J2,J1)=AMIN1(Z1,Z2,Z3)
      Z1=DLMBM(J2,J1)*BMWT+DLMDIA(J2,J1)*WTDIA+DLMSLS(J2,J1)*SLBWT
      ZDIST=(J2-1)*L(J1)/10.
      IF(BETA(J1,1)*L(J1).LE.ZDIST.AND.ZDIST.LE.BETA(J1,2)*L(J1))Z1=
     *Z1+DLMSLC(J2,J1)*SLBWT
      DLMSIM(J2,J1)=Z1
      Z1=DLMUNF(J2,J1)*UNIFL
      IF(ZDIST.LE.BETA(J1,1)*L(J1).OR.BETA(J1,2)*L(J1).LE.ZDIST) Z1=
     *Z1+DLMSLC(J2,J1)*SLBWT
      DLMCOM(J2,J1)=Z1
      SS=DLSBM(J2,J1)*BMWT+DLSDIA(J2,J1)*WTDIA+(DLSSLS(J2,J1)+DLSSLC(J2,
     *J1))*SLBWT+DLSUNF(J2,J1)*UNIFL
      S1=2.166*LLSAXP(J2,J1)*SCLAXT+1.3*SS
      S1=ABS(S1)
      S2=2.166*LLSAXN(J2,J1)*SCLAXT+1.3*SS
      S2=ABS(S2)
      S3=2.166*LLSASP(J2,J1)*FACTOR+1.3*SS
      S3=ABS(S3)
      S4=2.166*LLSASN(J2,J1)*FACTOR+1.3*SS
      S4=ABS(S4)
      LLTSHR(J2,J1)=AMAX1(S1,S2,S3,S4)
      S1=1.7*LLSAXP(J2,J1)*FACTOR+1.4*SS
      S1=ABS(S1)
      S2=1.7*LLSAXN(J2,J1)*FACTOR+1.4*SS
      S2=ABS(S2)
      S3=1.7*LLSASP(J2,J1)*FACTOR+1.4*SS
      S3=ABS(S3)
      S4=1.7*LLSASN(J2,J1)*FACTOR+1.4*SS
      S4=ABS(S4)
      S5=AMAX1(S1,S2,S3,S4)
      ULTACI(J2,J1)=S5
      S6=1.4*(DLMSIM(J2,J1)+DLMCOM(J2,J1))
      IF(S5.EQ.S1)SMOM(J2,J1)=1.7*MSAXP(J2,J1)*FACTOR+S6
      IF(S5.EQ.S2)SMOM(J2,J1)=1.7*MSAXN(J2,J1)*FACTOR+S6
      IF(S5.EQ.S3)SMOM(J2,J1)=1.7*MSASP(J2,J1)*FACTOR+S6
      IF(S5.EQ.S4)SMOM(J2,J1)=1.7*MSASN(J2,J1)*FACTOR+S6
      SS=2.166*MAMOM(J2,J1)+1.3*(DLMSIM(J2,J1)+DLMCOM(J2,J1))
      IF(SS.GT.SULT) SULT=SS
   96 CONTINUE
   98 ULTMOM(J1)=SULT
C
C     MISC. SETUP FOR CALL TO DESIGN
C
      DO 202 J1=1,NSPNS
      IF(L(J1).LT.120.) HDPT(J1)=5.0
      IF(120.LE.L(J1).AND.L(J1).LT.140.) HDPT(J1)=6.0
      IF(140.LE.L(J1).AND.L(J1).LT.160.) HDPT(J1)=7.0
      IF(L(J1).GE.160.) HDPT(J1)=8.0
      ALP=(L(J1)/2.-HDPT(J1))/L(J1)
      ALPH(J1)=ALP
      DO 202 J2=1,11
      ZIL10=(J2-1)*L(J1)/10.
      IF(ZIL10.LT.ALP*L(J1)) TAUI(J1,J2)=(ALP-(J2-1)/10.)/ALP
      IF(ALP*L(J1).LE.ZIL10.AND.L(J1)*(1.-ALP).GE.ZIL10) TAUI(J1,J2)=0.
      IF(ZIL10.GT.L(J1)*(1.-ALP)) TAUI(J1,J2)=((J2-1)/10.-1.+ALP)/ALP
  202 CONTINUE
      DO 6237 J1=1,N
```

```
 6237 ZL(J1)=L(J1)
C*****************************************************************
      CALL DESIGN
C*****************************************************************
C*********************************************************************
C       OUTPUT SECTION
C*********************************************************************
C
C       COMPUTE END ECCENTRICITY ARRAYS
C
      DO 206 J1=1,NSPNS
      DO 3157 J3=1,11
 3157 ASNEG(J3,J1)=ASNEG(J3,J1)/S
      ZLOSSR(J1)=ZLOSSR(J1)*100.
      ZLOSS(J1)=ZLOSS(J1)*100.
      SUMC=0.
      SUMS=0.
      SUMLD=0.
      NROWDP=0
      SUMRD=0.
      KTOTSN(J1)=0
      DO 204 J2=1,NRAV
      KTOTSN(J1)=KTOTSN(J1)+NS(J2,J1)
      SUMC=SUMC+NS(J2,J1)*DD(J2)
      IF(NS(J2,J1).GT.NSWEB) SUMS=SUMS+(NS(J2,J1)-NSWEB)*DD(J2)
      IF(NS(J2,J1).GT.0) SUMLD=SUMLD+NSWEB*(DD(J2)+EL(J1)*GRIDS)
      IF(NS(J2,J1).GT.0) SUMRD=SUMRD+NSWEB*(DD(J2)+ER(J1)*GRIDS)
      IF(NS(J2,J1).GT.0) NROWDP=J2
  204 CONTINUE
      KECL(J1)=EL(J1)
      KECR(J1)=ER(J1)
      KDEPSN(J1)=NROWDP*NSWEB
      ECCCL(J1)=-SUMC/KTOTSN(J1)
      EL(J1)=-(SUMS+SUMLD)/KTOTSN(J1)
  206 ER(J1)=-(SUMS+SUMRD)/KTOTSN(J1)
      WRITE(6,1098)
      WRITE(6,1011)(ITILT(1,J2),J2=10,26),(ITILT(1,J2),J2=48,54)
      WRITE(6,1020)(ITILT(2,J2),J2=13,19),(ITILT(2,J2),J2=26,28),(ITILT(
     $2,J2),J2=44,54)
      WRITE(6,1030)(ITILT(3,J2),J2=13,54)
      IF(KODSYM.NE.0) WRITE(6,1040)
      WRITE(6,1060)(IDENT(J2),J2=1,5)
      WRITE(6,1000)
      IF(IITER.EQ.0) KT=NO
      IF(IITER.NE.0) KT=KYES
      WRITE(6,1080)KBMTYP,NSWEB,KT
      IF(KCONT.EQ.0) KT=NO
      IF(KCONT.EQ.1) KT=KYES
      WRITE(6,1110)S,(TT(J2),J2=1,2),(TT(J2),J2=4,5),KT
      WRITE(6,1120)THK,FACTOR,SCLAXT
      WRITE(6,1140)FPCSLB,BMI,UNIFL
      WRITE(6,1160)UWBM,BMA,AV
      WRITE(6,1180)UWSLB,YB
      WRITE(6,1200)STSIZE,YT
      WRITE(6,1220)FPS,ZBBM
      WRITE(6,1240)GRIDS,ZTBM
      WRITE(6,1000)
      IF(KBMTYP.NE.BEAMTP(13)) GO TO 1660
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      WRITE(6,1250)
      WRITE(6,1270)ZD(13),ZB(13),ZW(13),ZA(13),ZC(13),ZE(13),ZG(13),
     1ZH(13),ZF(13),ZQ(13),ZO(13),ZP(13)
      WRITE(6,1000)
 1660 CONTINUE
      IF(KAXT.EQ.BK) GO TO 1881
      WRITE(6,1290)(I,I=1,15)
      WRITE(6,1310)(PWHEEL(J2),J2=1,NWHEEL)
      J3=NWHEEL-1
      WRITE(6,1330)(NWHL(J2),J2=1,J3)
      WRITE(6,1000)
 1881 IF(KCONT.EQ.0) GO TO 1999
      WRITE(6,1350)(I,I,I=1,9)
      WRITE(6,1370)(BETA(J1,1),BETA(J1,2),J1=1,NSPNS)
      WRITE(6,1000)
 1999 CONTINUE
      WRITE(6,1390)(I,I=1,10)
      WRITE(6,1410)(NDIA(J1),J1=1,NSPNS)
      WRITE(6,1430)WTDIA
      WRITE(6,1000)
 2199 CONTINUE
      WRITE(6,1260)    (I,I=1,10)
      WRITE(6,1000)
      WRITE(6,1300)(L(J1),J1=1,N)
      WRITE(6,1320)(AREACP(J1),J1=1,N)
      WRITE(6,1340)(ZICBM(J1),J1=1,N)
      WRITE(6,1360)(YBC(J1),J1=1,N)
      WRITE(6,1380)(YTC(J1),J1=1,N)
      WRITE(6,1000)
      WRITE(6,1400)(I,I=1,10)
      WRITE(6,1000)
      WRITE(6,1440)(FPCRL(J1),J1=1,NSPNS)
      WRITE(6,1460)(FPCBM(J1),J1=1,NSPNS)
      WRITE(6,1480)(EL(J1),J1=1,NSPNS)
      WRITE(6,1500) (ROW(J1),KECL(J1),J1=1,NSPNS)
      WRITE(6,1520)(ER(J1),J1=1,NSPNS)
      WRITE(6,1540) (ROW(J1),KECR(J1),J1=1,NSPNS)
      WRITE(6,1560)(ECCCL(J1),J1=1,NSPNS)
      WRITE(6,1580)(KTOTSN(J1),J1=1,NSPNS)
      WRITE(6,1600)(KDEPSN(J1),J1=1,NSPNS)
      DO 2020 I=1,NRAV
      DO 2020 J=1,NSPNS
      IROW=NRAV-(I-1)
      IF(NS(IROW,J).NE.0) GO TO 2299
 2020 CONTINUE
 2299 DO 2499 I=1,IROW
      JROW=IROW-(I-1)
 2499 WRITE(6,1620)JROW,(NS(JROW,J1),J1=1,NSPNS)
      WRITE(6,1000)
      WRITE(6,1720)
      WRITE(6,1000)
      ASPOS(1)=0.
      DO 2699 J1=1,NSPNS
      ZT=ASPOS(J1)
      ZR=ASPOS(J1+1)
 2699 WRITE(6,1760) J1,(ASNEG(J2,J1),J2=1,11),J1,ZT,ZR
      WRITE(6,1006)
      WRITE(6,1780)
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      DO 2700 J1=1,NSPNS
 2700 WRITE(6,1820)  J1,SPCAAS(1,J1),SPCAAS(2,J1),SPCAAS(3,J1),J1,
     1SPCACI(1,J1),SPCACI(2,J1),SPCACI(3,J1)
      WRITE(6,1000)
      WRITE(6,1782) (J1,J1=1,5)
      WRITE(6,1784)
      J2=NSPNS
      IF(J2.GT.5) J2=5
      WRITE(6,1786) (ULTMOM(J3),J3=1,J2)
      WRITE(6,1788) (ULTMSP(J3),J3=1,J2)
      IF(NSPNS.LE.5) GO TO 2790
      J2=NSPNS-J2
      WRITE(6,1790) (J1,J1=6,NSPNS)
      WRITE(6,1786) (ULTMOM(J3),J3=6,NSPNS)
      WRITE(6,1788) (ULTMSP(J3),J3=6,NSPNS)
 2790 CONTINUE
      WRITE(6,1000)
      WRITE(6,2052) (I,I=1,10)
 2052 FORMAT(1X,'*        PRESTRESS LOSS(PERCENT)   ',9('*SPAN',2X,I1),'*
     1SPAN',1X,I2,'*')
      WRITE(6,1000)
      WRITE(6,2053) (ZLOSSR(J3),J3=1,NSPNS)
 2053 FORMAT(26X,'RELEASE*',10(F6.2,'*'))
      WRITE(6,2054) (ZLOSS(J3),J3=1,NSPNS)
 2054 FORMAT(28X,'FINAL*',10(F6.2,'*'))
      IF(IOUT.EQ.0) WRITE(6,1098)
      IF(IOUT.EQ.0) GO TO 2024
      WRITE(6,1000)
      WRITE(6,1840)
      DO 2893 J1=1,NSPNS
      DO 2899 J2=1,11
      J3=J2-1
 2899 WRITE(6,1880)J1,J3,MAMOM(J2,J1), MIMOM(J2,J1),DLMSIM(J2,J1),
     $DLMCOM(J2,J1),CRPMOM(J2,J1),ULTSHR(J2,J1)
 2893 WRITE(6,1860)
      WRITE(6,1002)
      WRITE(6,1890)(I,I=1,10)
      WRITE(6,1002)
      DO 2898 J1=1,NSPNS
      DO 2895 J2=1,6
 2895 STSRLS(J2,J1)=-STSRLS(J2,J1)
      DO 2896 J2=1,11
      DO 2896 J3=1,4
 2896 STSLOD((J1-1)*11+J2,J3)=-STSLOD((J1-1)*11+J2,J3)
 2898 CONTINUE
      WRITE(6,1900)(STSRLS(1,J2),J2=1,NSPNS)
      WRITE(6,1910) (STSRLS(2,J2),J2=1,NSPNS)
      WRITE(6,1920)(STSRLS(3,J2),J2=1,NSPNS)
      WRITE(6,1930) (STSRLS(4,J2),J2=1,NSPNS)
      WRITE(6,1940)(STSRLS(5,J2),J2=1,NSPNS)
      WRITE(6,1950) (STSRLS(6,J2),J2=1,NSPNS)
      WRITE(6,1004)
      WRITE(6,1960)
      WRITE(6,1004)
      DO 3099 J1=1,NSPNS
      DO 3099 J2=1,11
      J3=J2-1
 3099 WRITE(6,1980)J1,J3,(STSLOD((J1-1)*11+J2,J4),J4=1,4)
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      WRITE(6,2010)
      DO 4002 J1=1,NSPNS
      DO 4002 J2=1,11
      ASNEG(J2,J1)=(MIMOM(J2,J1)+DLMCOM(J2,J1))*12./ZTOPSL(J1)
      IF(CRPMOM(J2,J1).LT.0.) ASNEG(J2,J1)=ASNEG(J2,J1)+CRPMOM(J2,J1)*
     *12./ZTOPSL(J1)
      IF(ASNEG(J2,J1).LT.0.) ASNEG(J2,J1)=0.
 4002 CONTINUE
      WRITE(6,1008)
      DO 4003 J1=1,11
 4003 KDEPSN(J1)=J1-1
      WRITE(6,2021) (KDEPSN(J1),J1=1,11)
      DO 4004 J1=1,NSPNS
 4004 WRITE(6,2022) J1,(ASNEG(J2,J1),J2=1,11)
      WRITE(6,1009)
      WRITE(6,1098)
 1000 FORMAT(1X,129(1H*))
 1002 FORMAT(1X,103('*'))
 1004 FORMAT(1X,71('*'))
 1006 FORMAT(1X,109('*'))
 1008 FORMAT(1X,102('*'))
 1009 FORMAT(14X,89('*'))
 1011 FORMAT(39X,'DISTRICT',1X,17A1     ,1X,'COUNTY',2X,'HIGHWAY NO. ',7A
     $1)
 1020 FORMAT(39X,'CONTROL NO. ',7A1,2X,'IPE',1X,3A1,2X,'SUBMITTED BY ',1
     $1A1)
 1030 FORMAT(39X,'DESCRIPTION',1X,42A1)
 1040 FORMAT(27X,'***BRIDGE IS SYMMETRICAL - ONLY INFORMATION ON 1/2 OF
     $BRIDGE OUTPUT***')
 1060 FORMAT(55X,18(1H*),/,55X,'*BEAM I.D.',2X,5A1,'*',/,55X,18(1H*))
 1080 FORMAT(1X,'BEAM TYPE',T21,'=', A2,T40,'NO. WEB STRANDS',T59,'=',I3
     $,T82,'CREEP AND SHRINKAGE FORCES CONSIDERED =',2X,A4)
 1098 FORMAT(1H1)
 1110 FORMAT(1X,'BEAM SPACING',T21,'=',F5.2,'(FT)',T40,'AASHTO L.L.',T59
     $,'=',2A1,'-',2A1,T82,'PARTIAL D.L. CONTINUITY',T120,'=',2X,A4)
 1120 FORMAT(1X,'SLAB THICKNESS',T21,'=',F5.2,'(IN)',T40,'L.L. DIST',T59
     $,'=',F4.2,T82,'AXLE TRAIN DIST. FACTOR',T120,'=',F4.2)
 1140 FORMAT(1X,'28 DAY ST.(SLAB)',3X,'=',F5.2,'(KSI)',T40,'BEAM INERTIA
     $',T59,'=',F8.0,'(IN**4)',T82,'UNIF. LOAD ON CONTINUOUS BEAM',T120,
     $'=',F5.2)
 1160 FORMAT(1X,'UNIT WT. BEAM CONC.=',F5.3,'(K/FT**3)',T40,'BEAM AREA',
     $T59,'=',F6.1,'(IN**2)',T82,'TOTAL STIRRUP AREA',T120,'=',F4.2,'(IN
     $**2)')
 1180 FORMAT(1X,'UNIT WT. SLAB CONC.=',F5.3,'(K/FT**3)',T40,'BEAM YB',
     $T59,'=',F6.2,'(IN)')
 1200 FORMAT(1X,'STRAND AREA',T21,'=',F5.3,'(IN**2)',T40,'BEAM YT',T59,
     $'=',F6.2,'(IN)')
 1220 FORMAT(1X,'STRAND ULT. STRGTH.=',F5.1,'(KSI)',T40,'BEAM ZB',T59,
     $'=',F8.1,'(IN**3)')
 1240 FORMAT(1X,'GRID SIZE',T21,'=',F5.2,'(IN)',T40,'BEAM ZT',T59,'=',
     $F8.1,'(IN**3)')
 1250 FORMAT(1X,'*BEAM DIMENSIONS(IN)*  D  *  B  *  W  *  A  *  C  *  E
     1 *  G  *  H  *  F  *  Q  *  O  *  P  *')
 1260 FORMAT(1X,'*COMP. PROPERTIES ' ,9('*',2X,'SPAN',I2,2X),  '*',2X,'S
     $PAN',2X,I2,'*')
 1270 FORMAT(1X,20('*'),12('*',F5.2),'*')
 1290 FORMAT(31X,15('*AX',I3),'*')
 1300 FORMAT(1X,'SPAN LENGTH(FT)',3X,10('*',3X,F5.1,2X))
```

```
1310 FORMAT(1X,'*AXLE TRAIN AXLE  LOADS(KIPS) *',15(1X,F4.1,'*'))
1320 FORMAT(1X,'AREA(IN**2)',T20,10('*',2X,F6.1,2X))
1330 FORMAT(1X,'*DIST. FROM AX.1 TO AX. I (FT)*',5X,'*',14(I3,'.0*'))
1340 FORMAT(1X,'INERTIA(IN**4)',T20,10('*',F8.0,2X))
1350 FORMAT(1X,'*PARTIAL D.L.*',/,1X,'***CONTINUITY*',9('A(',I1,')*B(',
    *I1,')*'),'A(10)*B(10)*')
1360 FORMAT(1X,'YB(IN)',T20,10('*',2X,F7.2,1X))
1370 FORMAT(1X,'******FACTORS*',9(   F4.2,'*',   F4.2,'*'),1X,F4.2,
    *'*',1X,F4.2,'*')
1380 FORMAT(1X,'YT(IN)',T20,10('*',2X,F7.2,1X))
1390 FORMAT(1X,'*NON-STANDARD DIAPHRAMS*',10('SPAN',I3,'*'))
1400 FORMAT(1X,'*STRAND AND CONCRETE PROPERTIES',8('*SPAN',2X,I1),'*SPA
    $N',2X,I1,'*SPAN',1X,I2,'*')
1410 FORMAT(1X,'*NO. DIAPHRAMS PER SPAN*',10(3X,I1,3X,'*'))
1430 FORMAT(1X,'*DIAP. WT.=',1X,F5.2,'(KIPS)*')
1440 FORMAT(1X,'RELEASE STRENGTH(KSI)'  ,T33,10('*',1X,F5.2,1X))
1460 FORMAT(1X,'28  DAY STRENGTH(KSI)'  ,T33,10('*',1X,F5.2,1X))
1480 FORMAT(1X,'LEFT ECCENTRICITY(IN)',  T33,10('*',1X,F5.2,1X))
1500 FORMAT(1X,' LEFT END-RAISE TOP STRANDS TO *',10(A4,I2,1X,'*'))
1520 FORMAT(1X,'RIGHT ECCENTRICITY(IN)',T33,10('*',1X,F5.2,1X))
1540 FORMAT(1X,'RIGHT END-RAISE TOP STRANDS TO *',10(A4,I2,1X,'*'))
1560 FORMAT(1X,'CENTER ECCENTRICITY(IN)',T33,10('*',1X,F5.2,1X))
1580 FORMAT(1X,'TOTAL NUMBER OF STRANDS',T33,10('*',1X,I3,3X))
1600 FORMAT(1X,'NO. OF DEPRESSED STRANDS',T33,10('*',1X,I3,3X))
1620 FORMAT(1X,'NO. STRANDS IN ROW ',I2,T33,10('*',1X,I3,3X))
1720 FORMAT(1X,'*(-)M REINF. (IN**2/FT) *',1X,'0/10*',1X,'1/10*',1X,
    2'2/10*',1X,'3/10*',1X,'4/10*',1X,'5/10*',1X,'6/10*',1X,'7/10*',
    31X,'8/10*',1X,'9/10*','10/10**(+M) CONT. REINF.(IN**2)* 0/10*10/10
    4*')
1760 FORMAT(T19,'SPAN ',I2,'*',11(   F5.2,'*'),T111,'SPAN',I3,'*',2(F5.
    *2,'*'))
1780 FORMAT(1X,'*AASHTO STIRRUP SPACING(IN)*0/4-1/4*1/4-3/4*3/4-4/4',10
    2(1H*),'ACI STIRRUP SPACING(IN)*0/4-1/4*1/4-3/4*3/4-4/4*')
1782 FORMAT(1X,'*ULTIMATE MOMENT SUMMARY(KIP-FT)*',5(3X,'SPAN',I3,'  *'
    1))
1784 FORMAT(1X,98('*'))
1786 FORMAT(25X,'REQUIRED*',5(E12.5,'*'))
1788 FORMAT(25X,'SUPPLIED*',5(E12.5,'*'))
1790 FORMAT(33X,66('*'),/,33X,'*',5(3X,'SPAN',I3,2X,'*'),/,33X,66('*'))
1820 FORMAT(1X,T22,'SPAN',1X,I2,'*',3(1X,F5.2,1X,'*'),9(1H*),T79,'SPAN'
    $,1X,I2,'*',3(1X,F5.2,1X,'*'))
1840 FORMAT(1X,24('*'),3(10X,'*'),2('DEAD LOAD *'),10X,'*','  AASHTO  '
    1,/,1X,'*MOMENT SUMMARY(KIP-FT)*',10X,'*LIVE LOAD *LIVE LOAD * NON-
    2COMP *   COMP   *  CREEP   * ULTIMATE *',/,1X,23('*'),'*SPAN*POINT
    3*  MAXIMUM *  MINIMUM *  SECTION *  SECTION * RESTRAINT*  SHEAR
    4*',/,1X,101('*'))
1860 FORMAT(T25,78(1H*))
1880 FORMAT(T25,'*',I2,' *',I3,'/10*',10(F10.1,'*'))
1890 FORMAT(1X,'*RELEASE STRESSES(KSI)*',10('SPAN',I3,'*'))
1900 FORMAT(10X,'LEFT END(TOP)*',10(F7.3,'*'))
1910 FORMAT(10X,'LEFT END(BOT)*',10(F7.3,'*'))
1920 FORMAT(9X,'HOLD DOWN(TOP)*',10(F7.3,'*'))
1930 FORMAT(9X,'HOLD DOWN(BOT)*',10(F7.3,'*'))
1940 FORMAT(9X,'RIGHT END(TOP)*',10(F7.3,'*'))
1950 FORMAT(9X,'RIGHT END(BOT)*',10(F7.3,'*'))
1960 FORMAT(1X,27('*'),'*',10X,'*',2X,'L.L. MAXIMUM *  L.L. MINIMUM *',
    1/,1X,27('*'),'*',10X,'*',3X,'DEAD LOAD   *',3X,'DEAD LOAD   *',/,
    21X,'*SERVICE LOAD STRESSES(KSI)*',10X,'*(+)CREEP RESTNT*(-)CREEP R
```

```
     3ESTNT*',/,1X,27('*'),'*SPAN*POINT*  TOP  *  BOT  *  TOP  *  BOT  *
     4')
 1980 FORMAT(T29,'*',I3,1X,'*',I2,'/10*',10(F7.3,'*'))
 2010 FORMAT(T29,44('*'))
 2021 FORMAT(1X,'*MAXIMUM TENSION STRESS TOP OF SLAB(KSI)*',/,1X,102('*'
     1),/,14X,'*',10(2X,I1,'/10 *'),1X,I2,'/10 *',/,14X,89('*'))
 2022 FORMAT(7X,'SPAN',I3,'*',11(F7.3,'*'))
 2024 IF(KSTOP.EQ.1) STOP
      SKAXT=BK
      SKKONT=BK
      IF(IST.EQ.LL) GO TO 1052
      KANALY=1
      GO TO 500
C***********************************************************
C     BOMBED DATA CARD-READ FORWARD TO NEXT DATA SET
C***********************************************************
2000  CONTINUE
      IF(KBOMB.EQ.2) GO TO 3020
 3010 READ(5,3012,END=3034) IST
 3012 FORMAT(A1)
      IF(IST.EQ.LL) GO TO 1052
      GO TO 3010
 3020 READ(5,3014,END=3034) IST,TT(1)
 3014 FORMAT(A1,11X,A2)
      IF(IST.EQ.LL) GO TO 1052
      DO 3016 J1=1,17
      IF(TT(1).EQ.BEAMTP(J1)) GO TO 500
 3016 CONTINUE
      GO TO 3020
 3034 STOP
      END
```

```
      BLOCK DATA
      INTEGER*2 BEAMTP
      COMMON/PASBK1/ ZD(13),ZB(13),ZW(13),ZA(13),ZC(13),ZE(13),ZG(13),ZH
     1(13),ZF(13),ZQ(13),ZO(13),ZP(13),DIAPSD(12,2),BEAMTP(17)
      COMMON/PASBK2/AV,FSY,ECRPUL,ESHSUL,TIMCRP,TIMSHR,AGECON,
     *HUMID,FTENR,FCOMR,FTEN,FCOM,VOLSUR
      DATA BEAMTP/' A',' B',' C','48','54','60','66','72','IV',' V','VI'
     $,'5M','NS','A ','B ','C ','V '/
      DATA ZD/28.,34.,40.,48.,54.,60.,66.,72.,54.,63.,72.,54.,0./
      DATA ZB/16.,18.,22.,14.,16.,18.,20.,22.,26.,28.,28.,22.,0./
      DATA ZW/6.,6.5,7.,6.,6.,7.,7.,7.,8.,8.,8.,12.,0./
      DATA ZA/12.,12.,14.,14.,16.,18.,20., 22.,20.,42.,42.,22.,0./
      DATA ZC/5.,6.,7.,7.,8.,9.,10.,11.,8.,8.,8.,8.,0./
      DATA ZE /5.,5.75,7.5,4.0,5.0,5.5,6.5,7.5,9.,10.,10.,5.,0./
      DATA ZG/3.,2.75,3.5,4.,5.,5.5,6.5,7.5,6.,3.,3.,5.,0./
      DATA ZH/4.,5.5,6.,3.5,4.,4.5,5.,5.5,8.,5.,5.,4.,0./
      DATA ZF/13*0./
      DATA ZQ/13*0./
      DATA ZO/9*0.0,4.,4.,2*0.0/
      DATA ZP/9*0.0,4.,4.,2*0.0/
      DATA DIAPSD/1.0,1.2221,1.4445,2.0556,2.2779,2.2779,2.5001,2.7223,
     *2.9445,2.0555,2.5001,2.9445,.6516,.6850,.7572,.5978,.6321,1.2189,
     *.7310,.7658,.8015,.9542,1.1277,.9575/
      DATA AV,FSY/0.22,60./
      DATA ECRPUL,ESHSUL,TIMCRP,TIMSHR,AGECON,HUMID/425.E-06,525.E-06,
     *34.,20.,90.,60./
      DATA FTENR,FCOMR,FTEN,FCOM/7.5,.6,6.,.4/
      END
```

```
      SUBROUTINE DESIGN
      REAL*4 L,MAMOM,MIMOM
      INTEGER*2 BEAMTP
      COMMON/DUMP/MAMOM(11,10),MIMOM(11,10),CRPMOM(11,10),DLMCOM(11,10),
     *DLMSIM(11,10),ULTSHR(11,10),ULTACI(11,10),ULTMOM(10),SMOM(11,10),
     *STSLOD(110,4),STSRLS(6,10),ZTCBM(10),ZBCBM(10),ZICBM(10),YTC(10),
     *YBC(10),FPCRL(10),FPCBM(10),ZLOSSR(10),ZLOSS(10),TAU(10,11),
     *DD(50),L(10),ALPH(10),NLIM(20),NS(50,10),EL(10),ER(10),
     *SPCAAS(3,10),SPCACI(3,10),ULTMSP(10),ASPOS(11),ASNEG(11,10),
     *AREACP(10),NDIA(10),SIGMA(11,4),
C     REMAONDER OF /DUMP/ IS OVERLAPPED.
     *ZMSUP(11),NTOP(10),NECCL(10),NECCR(10),NECMIN(10),
     *            AA(10,10),B(10,1),ZMSLN(11),ZMSLF(11),ZMULN(11),
     *FEM(20),NSOLD(50,10),STORES(110,4),DEPTH(11,10)
      COMMON/PASDN/NSPNS,ZTBM,ZBBM,BMA,ZIBM,YB,YT,S,FPS,FPL,THK,KASE,
     *FPCSLB,BMWT,SLBWT,UWBM,STSIZE,NSWEB,NRFLG,NRAV,FPCBMN,N,ISYM,
     *KODSYM,IITER,GRIDS
      COMMON/PASBK1/ ZD(13),ZB(13),ZW(13),ZA(13),ZC(13),ZE(13),ZG(13),ZH
     1(13),ZF(13),ZQ(13),ZO(13),ZP(13),DIAPSD(12,2),BEAMTP(17)
      COMMON/PASBK2/AV,FSY,ECRPUL,ESHSUL,TIMCRP,TIMSHR,AGECON,
     *HUMID,FTENR,FCOMR,FTEN,FCOM,VOLSUR
C
C     COMPUTE STRESS TOP AND BOTTOM OF BEAMS DUE TO ALL D.L. AND L.L.
C
      DO 12 J1=1,NSPNS
      DO 12 J2=1,11
      J3=(J1-1)*11+J2
      STSLOD(J3,1)=DLMSIM(J2,J1)*12./(-ZTBM)+(DLMCOM(J2,J1)+MAMOM(J2,J1)
     *)*12./ZTCBM(J1)
      STSLOD(J3,2)=DLMSIM(J2,J1)*12./ZBBM+(DLMCOM(J2,J1)+MAMOM(J2,J1))*
     *12./ZBCBM(J1)
      STSLOD(J3,3)=DLMSIM(J2,J1)*12./(-ZTBM)+(DLMCOM(J2,J1)+MIMOM(J2,J1)
     *)*12./ZTCBM(J1)
      STSLOD(J3,4)=DLMSIM(J2,J1)*12./ZBBM+(DLMCOM(J2,J1)+MIMOM(J2,J1))*
     *12./ZBCBM(J1)
   12 CONTINUE
C
C     COMPUTE UNCHANGING PARAMETERS FOR CALLS TO PLOSS AND
C     ULTMO AND FOR LATER USE
C
C      DEFINE T.D.H.P.T. STANDARD MINIMUM DECK REINFORCING FOR CONSIDERA
C       IN ULTIMATE MOMENT CAPACITY CALCULATIONS
      IF(S.LE.4.999) ASPRM=2.86
      IF(5.LE.S.AND.S.LE.6.839) ASPRM=3.57
      IF(6.84.LE.S.AND.S.LE.8.000) ASPRM=4.08
      IF(S.GT.8.001) ASPRM=4.39
      DCP=THK/2.
      Y2=0.5*ZA(KASE)
      Y3=0.5*(ZP(KASE)+ZW(KASE))
      Y4=0.5*ZW(KASE)
      Z1=THK
      Z2=Z1+ZH(KASE)
      Z3=Z2+ZG(KASE)
      Z4=Z3+ZQ(KASE)
C      ALLOWABLE COMPRESSION STRESS FOR END OF THE BEAM UNDER SERVICE
C      LOAD CONDITIONS
      FCOMED=1.5*FCOM
      FSTRND=0.7*STSIZE*FPS
```

```
      DPTH=ZD(KASE)
      ESLAB=57000.*31.623*SQRT(FPCSLB)/1000.
      ALPHUM=-0.12729E-03*HUMID**2+1.3215
      ESD=ESHSUL*ALPHUM*AGECON/(TIMSHR+AGECON)
      ALPHVS=(0.61823+1.2763/SQRT(VOLSUR)-0.19475/VOLSUR)/1.7
C***********************************************************************
C     SELECT MIDSPAN STRAND PATTERNS
C***********************************************************************
      DO 100 JSP=1,NSPNS
C
C     COMPUTE PARAMETERS WHICH DEPEND ON SPAN
C
      BEFF=0.25*L(JSP)
      IF(BEFF.GT.S) BEFF=S
      IF(BEFF.GT.THK+ZW(KASE)) BEFF=THK+ZW(KASE)
      BEFF=BEFF*12.
      ZMBW=BMWT*L(JSP)**2/8.
      ZMC=DLMCOM(6,JSP)
      ZMNC=DLMSIM(6,JSP)
      ZL=L(JSP)
      ZIC=ZICBM(JSP)
      YYBC=YBC(JSP)
      ZMHD=0.5*BMWT*ALPH(JSP)*L(JSP)**2-0.5*(ALPH(JSP)*L(JSP))**2*BMWT
      DO 14 J1=1,NRAV
      NSOLD(J1,JSP)=0
   14 NS(J1,JSP)=0
      SIGTR=-12.*ZMHD/ZTBM
      SIGBR=12.*ZMHD/ZBBM
      SIGT=STSLOD((JSP-1)*11+6,1)
      SIGB=STSLOD((JSP-1)*11+6,2)
C
C     PLACE MINIMUM NUMBER OF STRANDS
C
      NMIN=0.003*BMA/STSIZE
      FPCRL(JSP)=100.
      FPCBM(JSP)=FPCBMN
C
C     ADD STRANDS
C
      JR=1
   18 CALL ADDIT(NS,JR,NSWEB,NPFLG,NLIM,JSP,NUM)
      NTOP(JSP)=JR
      IF(NUM.LT.NMIN) GO TO 18
C
C     COMPUTE REQUIRED RELEASE STRENGTH
C
      OLDC=0.
      ETC=YB-ECC(NS,DD,JR,JSP,JZ)
      AS=NUM*STSIZE
   32 FPCRNW=FPRIMC(FTENR,FCOMR,BMA,ZTBM,ZBBM,OLDC,NS,DD,SIGTR,SIGBR,
     *TAU,JR,JR,FSTRND,JSP,6,GRIDS,NSWEB,RLSTP,RLSBT)
      CALL PLOSS(FPCRNW,ZMBW,ZMC,ZMNC,EPS,AS,BMA,ZIBM,ZIC,
     *YB,YYBC,ETC,HUMID,ZL,ETA,C,UWBM)
      IF(ABS(C-OLDC).LE.0.01) GO TO 36
      OLDC=C
      GO TO 32
C
C     COMPUTE MIDSPAN 28 DAY STRENGTH
```

```
C
   36 FPCNEW=FPRIMC(FTEN,FCOM,BMA,ZTBM,ZBBM,ETA,NS,DD,SIGT,SIGB,
     *TAU,JR,JR,FSTRND,JSP,6,GRIDS,NSWEB,FNSTP,FNSBT)
C
C     DECIDE WHETHER TO CONTINUE ADDING STRANDS OR TO TERMINATE
C
      IF(FPCRNW.GT.FPCRL(JSP).AND.FPCRNW.GT.5.0) GO TO 38
      IF(FPCRNW.GT.FPCRL(JSP).AND.FPCBM(JSP).LE.5.0) GO TO 38
      IF(FPCRNW.GT.FPCRL(JSP).AND.FPCNEW.GT.FPCBM(JSP)) GO TO 38
C
C     RELEASE STRENGTH STILL DECREASING - CONTINUE TO ADD STRANDS
C
      FPCBM(JSP)=FPCNEW
      FPCRL(JSP)=FPCRNW
      DO 35 J1=1,JR
   35 NSOLD(J1,JSP)=NS(J1,JSP)
      SAVEC=C
      OLDETA=ETA
      NUMOLD=NUM
      JROLD=JR
      ETCOLD=ETC
      STSRLS(3,JSP)=RLSTP
      STSRLS(4,JSP)=RLSBT
      GO TO 18
C
C     SATISFACTORY RELEASE STRENGTH AND 28 DAY STRENGTH FOUND
C     FOR MIDSPAN CONDITION.  CHECK ULTIMATE AND CRACKING
C     MOMENT CAPACITIES.
C
   38 DO 39 J1=1,JR
   39 NS(J1,JSP)=NSOLD(J1,JSP)
      ZLOSSR(JSP)=SAVEC
      ZLOSS(JSP)=OLDETA
      NUM=NUMOLD
      JR=JROLD
C
C     COMPUTE STRESS MIDSPAN DUE TO PRESTRESS AND FULL D.L. - CRACKING
C     MOMENT CALCULATION
C
      SIGB=(DLMSIM(6,JSP)/ZBBM+DLMCOM(6,JSP)/ZBCBM(JSP))*12.
      SCRTH=FPRIMC(FTEN,FCOM,BMA,ZTBM,ZBBM,OLDETA,NS,DD,0.,SIGB,
     *TAU,JR,JR,FSTRND,JSP,6,GRIDS,NSWEB,STOP,SBOT)
      ZMCRK=(7.5*SQRT(1000.*FPCBM(JSP))/1000.-SBOT)*ZBCBM(JSP)/12.
      Y1=(BEFF*FPCSLB/FPCBM(JSP))/2.
      FP=FPCBM(JSP)
      D=THK+ZD(KASE)-ETCOLD
      AS=NUM*STSIZE
      CALL ULTMO(AS,FP,FPS,ASPRM,FPL,D,DPTH,FSY,DCR,Y1,Y2,Y3,Y4,
     *Z1,Z2,Z3,Z4,OLDETA,ZMUL)
      ULTMSP(JSP)=ZMUL
      IF(ZMCRK*1.2.LE.ZMUL.AND.ZMUL.GE.ULTMOM(JSP)) GO TO 45
C
C     ULTIMATE MOMENT CAPACITY.LE. REQUIRED CAPACITY OR
C     ULTIMATE MOMENT CAPACITY .LT.1.2*CRACKING MOMENT - ADD STRANDS
C
      GO TO 18
C
C     INITIAL STRAND PLACEMENT COMPLETE. CRACKING AND ULTIMATE MOMENT
```

```
C     O.K.
C
C
C     RELEASE STRENGTH EXCEEDS 4.0 KSI. HOLD NUMBER OF STRANDS AND
C     NUMBER OF ROWS CONTAINING STRANDS CONSTANT AND REDUCE RELEASE
C     STRENGTH BY RAISING C.G. OF PATTERN IF POSSIBLE
C
   45 IF(FPCRL(JSP).LT.4.0) FPCRL(JSP)=4.0
      IF(FPCRL(JSP).LE.4.2) GO TO 100
      DO 46 J1=1,JR
   46 NS(J1,JSP)=NSWEB
      NTOT=NUM-NSWEB*JR
      NSP=NLIM(1)
      DO 48 J2=1,NSP
      DO 48 J3=1,JR
      IF(NS(J3,JSP).GE.2*NLIM(J3)+NSWEB) GO TO 48
      NS(J3,JSP)=NS(J3,JSP)+2
      NTOT=NTOT-2
      IF(NTOT.LE.0) GO TO 49
   48 CONTINUE
   49 CONTINUE
      NTOP(JSP)=JR
C
C     COMPUTE CONCRETE STRENGTHS FOR NEW PATTERN
C
      OLDC=0.
      ETC=YB-ECC(NS,DD,JR,JSP,NUM)
      AS=NUM*STSIZE
   40 FPCRNW=FPRIMC(FTENR,FCOMR,BMA,ZTBM,ZBBM,OLDC,NS,DD,SIGTR,SIGBR,
     *TAU,JR,JR,FSTRND,JSP,6,GRIDS,NSWEB,RLSTP,RLSBT)
      CALL PLOSS(FPCRNW,ZMBW,ZMC,ZMNC,FPS,AS,BMA,ZIBM,ZIC,
     *YB,YYBC,ETC,HUMID,ZL ,ETA,C,UWBM)
      IF(ABS(C-OLDC).LE.0.01) GO TO 51
      OLDC=C
      GO TO 40
   51 FPCNEW=FPRIMC(FTEN,FCOM,BMA,ZTBM,ZBBM,ETA,NS,DD,SIGT,SIGB,
     *TAU,JR,JR,FSTRND,JSP,6,GRIDS,NSWEB,FNSTP,FNSBT)
C
C     CHECK FOR IMPROVEMENT
C
      IF(FPCRNW.GT.FPCRL(JSP)) GO TO 53
      IF(FPCNEW.GT.6.0) GO TO 53
      FPCRL(JSP)=FPCRNW
      FPCBM(JSP)=FPCNEW
      ZLOSSR(JSP)=OLDC
      ZLOSS(JSP)=ETA
      GO TO 100
   53 DO 55 J1=1,JROLD
   55 NS(J1,JSP)=NSOLD(J1,JSP)
C
C     STRAND PATTERN, IF REQUIRED , HAS BEEN MODIFIED
C**********************************************************************
C     MIDSPAN STRAND PATTERN SELECTION COMPLETE
C**********************************************************************
  100 CONTINUE
C
C      ZERO OUT CREEP RESTRAINT MOMENTS
C
```

```
      DO 54 J1=1,N
      DO 54 J2=1,11
   54 CRPMOM(J2,J1)=0.
      NT2=N*2
      NT11=N*11
      DO 56 J1=1,11
   56 ZMSUP(J1)=0.
C*************************************************************************
C       COMPUTE MINIMUM END ECCENTRICITY TO MAINTAIN CURRENT RELEASE
C       STRENGTH IN EACH SPAN
C*************************************************************************
   64 DO 200 JSP=1,NSPNS
      FPCOLD=100.
      JST=NTOP(JSP)
      DO 68 J1=JST,NRAV
      FPCRNW=FPRIMC(FTENR,FCOMR,BMA,ZTBM,ZBBM,C,NS,DD,0.,0.,
     *TAU,J1,JST,FSTRND,JSP,1,GRIDS,NSWEB,ST,SG)
      IF(J1.EQ.JST) F1=FPCRNW
      IF(J1.EQ.NRAV) FF=FPCRNW
      IF(FPCRNW.LE.FPCRL(JSP)) GO TO 74
   68 CONTINUE
C
C     NO END ECCENTRICITY WILL PERMIT CURRENT RELEASE STRENGTH
C     TO STAND. MUST USE NEW, HIGHER RELEASE STRENGTH
C
      IF(F1.LE.FF) FPCRL(JSP)=F1
      IF(F1.LE.FF) NECCL(JSP)=JST
      IF(F1.LE.FF) NECCR(JSP)=JST
      IF(F1.GT.FF) FPCRL(JSP)=FF
      IF(F1.GT.FF) NECCL(JSP)=NRAV
      IF(F1.GT.FF) NECCR(JSP)=NRAV
      NECMIN(JSP)=NRAV
C
C     COMPUTE NEW PRESTRESS LOSSES
C
      OLDC=0.
      ETC=YB-ECC(NS,DD ,JR,JSP,NUM)
      AS=NUM*STSIZE
      CALL PLOSS(FF,ZMBW,ZMC,ZMNC,FPS,AS,BMA,ZIBM,ZIC,
     *YB,YYBC,ETC,HUMID,ZL,ETA,C,UWBM)
      ZLOSSR(JSP)=C
      ZLOSS(JSP)=ETA
      GO TO 200
C
C     MINIMUM END ECCENTRICITY NECESSARY TO MAINTAIN CURRENT
C     RELEASE STRENGTH FOUND. STORE IT.
C
   74 NECMIN(JSP)=J1
      JJJ=J1
  200 CONTINUE
C*************************************************************************
C       COMPUTATION OF MINIMUM END ECCENTRICITY COMPLETE
C*************************************************************************
C*************************************************************************
C       COMPUTE REQUIRED 28 DAY STRENGTH AND END ECCENTRICITIES
C     FOR EACH SPAN
C*************************************************************************
   77 DO 320 JSP=1,NSPNS
```

```
      FPCLFT=0.
      FPCRGT=0.
C       COMPUTE STRESS UNDER SERVICE LOAD CONDITIONS, FROM ALL
C      SOURCES EXCEPT DRAPED STRANDS
C
      DO 82 J1=1,11
      DO 78 J2=1,4
   78 SIGMA(J1,J2)=STSLOD((JSP-1)*11+J1,J2)
      IF(CRPMOM(J1,JSP).LE.0.) GO TO 80
      SIGMA(J1,1)=SIGMA(J1,1)+12.*CRPMOM(J1,JSP)/ZTCBM(JSP)
      SIGMA(J1,2)=SIGMA(J1,2)+12.*CRPMOM(J1,JSP)/ZBCBM(JSP)
   80 IF(CRPMOM(J1,JSP).GT.0.) GO TO 82
      SIGMA(J1,3)=SIGMA(J1,3)+12.*CRPMOM(J1,JSP)/ZTCBM(JSP)
      SIGMA(J1,4)=SIGMA(J1,4)+12.*CRPMOM(J1,JSP)/ZBCBM(JSP)
   82 CONTINUE
C
C      COMPUTE STRESSES DUE TO BEAM WEIGHT
C
      ZMHD=0.5*BMWT*ALPH(JSP)*L(JSP)**2-0.5*(ALPH(JSP)*L(JSP))**2*BMWT
      SIGBR=12.*ZMHD/ZBBM
      SIGTR=-12.*ZMHD/ZTBM
C
C      FOR EACH END ECCENTRICITY, DETERMINE REQUIRED 28 DAY STRENGTH.
C       SORT OUT BEST ARRANGEMENT
C
      NECCL(JSP)=NECMIN(JSP)
      NECCR(JSP)=NECMIN(JSP)
      FPCLOD=10000.
      FPCROD=10000.
         FPCOLD=10000.
      JST = NECMIN(JSP)
      JR=NTOP(JSP)
      ETA=ZLOSS(JSP)
      DO 102 J1=JST,NRAV
       DO 90  J2=1,2
      IST = 1
      ISP=5
      IF(J2.EQ.2)  IST =7
         IF(J2.EQ.2)  ISP=11
      IF(J2.EQ.1) FPCLFT=0.0
      IF(J2.EQ.2) FPCRGT=0.0
      DO 88 J3=IST,ISP
      SIGT=SIGMA(J3,1)
      SIGB=SIGMA(J3,2)
      FC=FCOM
      IF(J3.EQ.1.OR.J3.EQ.11) FC=FCOMED
      FPC1=FPRIMC(FTEN,FC,BMA,ZTBM,ZBBM,ETA,NS,DD,SIGT,SIGB,
     *TAU,J1,JR,FSTRND,JSP,J3,GRIDS,NSWEB,STS,SBS)
      SIGT=SIGMA(J3,3)
      SIGB=SIGMA(J3,4)
      FPC2=FPRIMC(FTEN,FC,BMA,ZTBM,ZBBM,ETA,NS,DD,SIGT,SIGB,
     *TAU,J1,JR,FSTRND,JSP,J3,GRIDS,NSWEB,STS,SBS)
      FFPC=AMAX1(FPC1,FPC2)
C
C     CHECK COMPRESSION AT ENDS UNDER D.L. AND PRESTRESS
C
      IF(J3.GE.2..AND.J3.LE.10) GO TO 84
      IF(J2.EQ.1) ID=1
```

```
      IF(J2.EQ.2) ID=11
      SIGT=DLMSIM(ID,JSP)*12./(-ZTBM)+DLMCOM(ID,JSP)*12./ZTCBM(JSP)
      SIGB=DLMSIM(ID,JSP)*12./ZBBM+DLMCOM(ID,JSP)*12./ZBCBM(JSP)
      FPC3=FPRIMC(FTEN,FCOM,BMA,ZTBM,ZBBM,ETA,NS,DD,SIGT,SIGB,
     *TAU,J1,JP,FSTRND,JSP,ID,GRIDS,NSWEB,STS,SBS)
      FFPC=AMAX1(FFPC,FPC3)
   84 CONTINUE
      IF(J2.EQ.1.AND.FFPC.GT.FPCLFT) FPCLFT=FFPC
      IF(J2.EQ.2.AND.FFPC.GT.FPCRGT) FPCRGT=FFPC
   88  CONTINUE
   90 CONTINUE
      FPCNEW=AMAX1(FPCLFT,FPCRGT)
C
C      EXIT IF MINIMUM END ECCENTRICITY LEADS TO REQUIRED FPC WHICH
C      IS SMALLER THAN THAT REQUIRED FOR STRESSES AT MIDSPAN
C
      IF(J1.EQ.JST.AND.FPCNEW.LE.FPCBM(JSP)) GO TO 300
C
C     EXIT IF FPC INCREASED FROM LAST POSITION
C
      IF(FPCNEW.GT.FPCOLD) GO TO 300
C
C     FPC DECREASED FROM LAST POSITION
C
      FPCOLD=FPCNEW
      IF(ISYM.EQ.0) GO TO 94
C
C     EQUAL END ECCENTRICITIES REQUIRED
C
      NECCL(JSP)=J1
      NECCR(JSP)=J1
      FPCBM(JSP)=FPCOLD
      IF(FPCNEW.LE.5.0) GO TO 300
      GO TO 102
C
C     UNEQUAL END ECCENTRICITIES PERMITTED
C
   94  IF(FPCLFT.GT.FPCLOD.OR.FPCLFT.NE.FPCNEW) GO TO 96
      NECCL(JSP)=J1
      IF(FPCROD.GT.FPCNEW) NECCR(JSP)=J1
   96   IF(FPCRGT.GT.FPCROD.OR.FPCRGT.NE.FPCNEW) GO TO 98
      NECCR(JSP)=J1
      IF(FPCLOD.GT.FPCNEW) NECCL(JSP)=J1
   98   FPCROD=FPCRGT
       FPCLOD=FPCLFT
      FPCBM(JSP)=FPCOLD
      IF(FPCNEW.LE.5.0) GO TO 300
  102   CONTINUE
  300 CONTINUE
      IF(FPCBM(JSP).LT.FPCRL(JSP)) FPCBM(JSP)=FPCRL(JSP)
C
C     RECOMPUTE MU FOR NEW 28 DAY CONCRETE STRENGTH
C
      Y1=(BEFF*FPCSLB/FPCBM(JSP))/2.
      AS=NUM*STSIZE
      FP=FPCBM(JSP)
      D=THK+ZD(KASE)-(YB-ECC(NS,DD,NTOP(JSP),JSP,NTT))
      CALL ULTMO(AS,FP,FPS,ASPRM,FPL,D,DPTH,FSY,DCR,Y1,Y2,Y3,Y4,
```

```
     *Z1,Z2,Z3,Z4,ETA,ZMUL)
      ULTMSP(JSP)=ZMUL
C
C     COMPUTE FINAL STRESSES FOR OUTPUT
C
      DO 112 J6=1,3
      IF(J6.EQ.1) J10=1
      IF(J6.EQ.1) ST=0.
      IF(J6.EQ.1) SB=0.
      IF(J6.EQ.1) JDRP=NECCL(JSP)
      IF(J6.EQ.2) J10=6
      IF(J6.EQ.2) ST=SIGTR
      IF(J6.EQ.2) SB=SIGBR
      IF(J6.EQ.3) J10=11
      IF(J6.EQ.3) ST=0.
      IF(J6.EQ.3) SB=0.
      IF(J6.EQ.3) JDRP=NECCR(JSP)
      FSCRTH=FPRIMC(FTEN,FCOM,BMA,ZTBM,ZBBM,C ,NS,DD,ST,SB,
     *TAU,JDRP,JR,FSTRND,JSP,J10,GRIDS,NSWEB,STOP,SBOT)
      STSRLS(2*J6-1,JSP)=STOP
  112 STSRLS(2*J6,JSP)=SBOT
      DO 114 J1=1 ,11
      JDRP=NECCL(JSP)
      IF(J1.GE.7) JDRP=NECCR(JSP)
      J5=(JSP-1)*11+J1
      DO 114 J2=1,2
      SIGT=STSLOD(J5,2*J2-1)
      SIGB=STSLOD(J5,2*J2)
      FSCRTH=FPRIMC(FTEN,FCOM,BMA,ZTBM,ZBBM,ETA,NS,DD,SIGT,SIGB,
     *TAU,JDRP,JR,FSTRND,JSP,J1,GRIDS,NSWEB,STOP,SBOT)
      STORES(J5,2*J2-1)=STOP
  114 STORES(J5,2*J2)=SBOT
  320 CONTINUE
C***********************************************************************
C       REQUIRED 28 DAY STRENGTH AND END ECCENTRICITIES CALCULATIONS
C     COMPLETE
C***********************************************************************
       DO 126 J1=1,NSPNS
       EBR=57000.*31.623*SQRT(FPCRL(J1))/1000.
      PHI=ECRPUL*ALPHVS*EBR*(1.-AGECCN/(TIMCRP+AGECON))
      CRPHI=PHI/(1.+PHI)
      SHPHI=1./(1.+PHI)
      NST=0
      DDRP=0.
      DSTH=0.
      EEL=0.
      EER=0.
      JSP=NTOP(J1)
      DO 124 J2=1,JSP
      DDRP=DDRP+(-DD(J2))
      DSTH=DSTH+(NS(J2,J1)-NSWEB)*(-DD(J2))
      EEL=EEL+GRIDS*(NECCL(J1)-2*J2+1)+DD(J2)
      EER=EER+GRIDS*(NECCR(J1)-2*J2+1)+DD(J2)
  124 NST=NST+(NS(J2,J1)-NSWEB)
      DDRP=DDRP/JSP
      DSTH=DSTH/NST
      EEL=EEL/JSP
      EER=EER/JSP
```

```
      NDRP=JSP*NSWEB
      CGC=(DDRP*NDRP+DSTH*NST)/(NDRP+NST)
      CGLE=(DSTH*NST+EEL*NDRP)/(NDRP+NST)
      CGRE=(DSTH*NST+EER*NDRP)/(NDRP+NST)
      DO 127 J3=1,11
      EEND=CGLE
      IF(J3.GT.5) EEND=CGRE
  127 DEPTH(J3,J1)=YT+THK+(1.-TAU(J1,J3))*CGC+TAU(J1,J3)*EEND
      IF(IITER.EQ.0) GO TO 126
      PSTH=(1.-ZLOSS(J1))*FSTRND*NST
      PDRP=(1.-ZLOSS(J1))*FSTRND*NDRP
      DBAR=YT-YTC(J1)
      ZMO=PSTH*(DBAR+DSTH)/12.
      ZM1=PDRP*(DBAR+EEL)/12.
      ZM2=PDRP*(DBAR+DDRP)/12.
      ZM3=PDRP*(DBAR+EER)/12.
      ZMDL=-(BMWT+SLBWT)*L(J1)**2/12.
      ZMSH=-(ESD*THK*12.*S*(YTC(J1)+THK/2.)*ESLAB)/12.
      AL=ALPH(J1)
      FEM(2*J1-1)=(ZMO+AL*(2.-AL)*ZM1+(1.-AL)*ZM2-AL*(1.-AL)*ZM3)*
     *CRPHI     +ZMDL*CRPHI+ZMSH*SHPHI
      FEM(2*J1)=(ZMO-AL*(1.-AL)*ZM1+(1.-AL)*ZM2+AL*(2.-AL)*ZM3)*
     *CRPHI     +ZMDL*CRPHI+ZMSH*SHPHI
  126 CONTINUE
      IF(IITER.EQ.0) GO TO 400
      JR=2*N
      IF(KODSYM.EQ.0) GO TO 130
      IF(KODSYM.EQ.1) JR=(NSPNS-1)*2
      IF(KODSYM.EQ.2) JR=2*NSPNS
      DO 128 J1=1,JR
  128 FEM(2*N+1-J1)=FEM(J1)
  130 CONTINUE
      JJT=JR/2
      CALL SLOPED(FEM,CRPMOM,L,N,AA,B)
C
C     CHECK TO SEE IF RESTRAINT MOMENT AT SUPPORTS DECREASED
C
      DO 132 J1=2,N
      IF(ZMSUP(J1).GE.0..AND.CRPMOM(1,J1).GT.0..AND.ZMSUP(J1).GT.
     *CRPMOM(1,J1)) GO TO 132
      IF(ZMSUP(J1).LT.0..AND.CRPMOM(1,J1).LT.0..AND.ZMSUP(J1).LT.
     *CRPMOM(1,J1)) GO TO 132
      GO TO 134
  132 CONTINUE
C
C     SUPPORT MOMENTS REDUCED THIS ITERATION - TERMINATE
C
      GO TO 400
C
C     NOT ALL SUPPORT MOMENTS REDUCED. CHECK REQUIRED INCREASE IN
C     CONCRETE STRENGTH
C
  134 DO 136 J1=2,N
      ZMOM=CRPMOM(1,J1)
      IF(ZMSUP(J1).GT.0..AND.CRPMOM(1,J1).GT.0.) ZMOM=CRPMOM(1,J1)
     *-ZMSUP(J1)
      IF(ZMSUP(J1).LE.0..AND.CRPMOM(1,J1).LE.0.) ZMOM=CRPMOM(1,J1)
     *-ZMSUP(J1)
```

```
      SIGB=12.*ZMOM/ZBCBM(J1)
      SIGT=12.*ZMOM/ZTCBM(J1)
      IF(SIGB.GE.0.) FPCBT=((1000.*SIGB/FTEN)**2)/1000.
      IF(SIGB.LT.0.) FPCBT=ABS(SIGB)/FCOM
      IF(SIGT.GE.0.) FPCTP=((1000.*SIGT/FTEN)**2)/1000.
      IF(SIGT.LT.0.) FPCTP=ABS(SIGT)/FCOM
      FPCINC=AMAX1(FPCTP,FPCBT)
      IF(FPCINC.GT.0.10) GO TO 138
  136 CONTINUE
C
C     REQUIRED CONCRETE STRENGTH INCREASE LESS THAN 100 PSI
C
      GO TO 400
C
C     TOO MUCH RESTRAINT MOMENT CHANGE - TAKE ANOTHER ITERATION
C
  138 DO 140 J1=2,N
  140 ZMSUP(J1)=CRPMOM(1,J1)
      GO TO 77
C***********************************************************************
C     EVERYTHING SATISFACTORY - COMPLETE THE DESIGN BY COMPUTING
C     OUTPUT QUANTITIES , STIRRUPS AND DECK STEEL
C***********************************************************************
  400 CONTINUE
C
C     COMPUTE UNCHANGING PARAMETERS FOR CALLS TO DCKSTL AND SHEAR
C
      Z1=0.
      Z2=ZC(KASE)
      Z3=Z2+ZE(KASE)
      Z4=Z3+ZF(KASE)
      Y1=0.
      Y2=ZB(KASE)/2.
      Y3=ZW(KASE)/2.+ZQ(KASE)
      Y4=ZW(KASE)/2.
C
C     COMPUTE DECK STEEL AND POSITIVE MOMENT SUPPORT STEEL
C
      DO 144 JSP=1,NSPNS
      J6=(JSP-1)*11
      DO 143 J7=1,11
      DO 143 J8=1,4
  143 STSLOD(J6+J7,J8)=STORES(J6+J7,J8)
      EL(JSP)=NECCL(JSP)
      ER(JSP)=NECCR(JSP)
      FPC=FPCBM(JSP)
      ZIC=ZICBM(JSP)
      DO 142 J2=1,11
      ZMSLN(J2)=DLMCOM(J2,JSP)+MI MOM(J2,JSP)
      IF(CRPMOM(J2,JSP).LT.0.) ZMSLN(J2)=ZMSLN(J2)+CRPMOM(J2,JSP)
      ZMULN(J2)=0.
      IF(ZMSLN(J2).LT.0.) ZMULN(J2)=2.166*MI MOM(J2,JSP)+
     *1.3*DLMCOM(J2,JSP)
      IF(CRPMOM(J2,JSP).LT.0.) ZMULN(J2)=ZMULN(J2)+1.3*CRPMOM(J2,JSP)
  142 ZMSLF(J2)=MAMOM(J2,JSP)-MI MOM(J2,JSP)
      ZMSLP=MAMOM(11,JSP)+DLMCOM(11,JSP)
      IF(CRPMOM(11,JSP).GT.0.) ZMSLP=ZMSLP+CRPMOM(11,JSP)
      IF(ZMSLP.LT.0.) ZMSLP=0.
```

```
      ZMULSP=0.
      IF(ZMSLP.GT.0.) ZMULSP=2.166*MAMOM(11,JSP)+1.3*DLMCOM(11,JSP)
      IF(CRPMOM(11,JSP).GT.0.) ZMULSP=ZMULSP+1.3*CRPMOM(11,JSP)
      ZMSLPF=MAMOM(11,JSP)-MI MOM(11,JSP)
      CALL DCKSTL(Z1,Z2,Z3,Z4,Y1,Y2,Y3,Y4,YB,THK,YT,ZMSLN,ZMSLF,
     *ZMULN,ZMSLP,ZMULSP,ZMSLPF,JSP,FSY,FPC,ZIBM,BMA,ASNEG,ASPOS,
     *FPCSLB,ZIC,S)
      FDRP=FSTRND*NTOP(JSP)*NSWEB*(1.-ZLOSS(JSP))
      VERTR= (NECCR(JSP)-NTOP(JSP))*GRIDS*FDRP/(ALPH(JSP)*L(JSP)*12.)
      VERTL= (NECCL(JSP)-NTOP(JSP))*GRIDS*FDRP/(ALPH(JSP)*L(JSP)*12.)
  144 CALL SHEAR( L,ALPH,SMOM,ZD(KASE),THK,FPCBM(JSP),ZW(KASE),
     *ULTSHR,AV,FSY,DEPTH,ULTACI,SPCAAS,SPCACI,JSP,VERTL,VERTR)
      RETURN
      END
```

```
      SUBROUTINE SLOPED (FEM,YX,L,N,A,B)
      REAL L
      DIMENSION FEM(20),YX(11,10),A(10,10),B(10,1    ),L(10),ZMSUP(10,2)
      NT2=N*2
C      SET UP 'A' MATRIX TO SOLVE FOR THETA
      NP1=N+1
      DO 50 I=1,NP1
      DO 50 J=1,NP1
   50 A(I,J)=0.
      A(1,1)=4./ L(1)
      A(1,2)=A(1,1)/2
      A(N+1,N)=2./ L(N)
      A(N+1,N+1)=4./ L(N)
      DO 13 I=2,N
      A(I,I-1)=2./ L(I-1)
      A(I,I)=4./L(I-1)+4./L(I)
      A(I,I+1)=2./L(I)
   13 CONTINUE
C      SET UP 'B' MATRIX TO SOLVE FOR THETA
C
C      CONVERT FEM TO SLOPE DEFLECTION CONVENTION
C
      DO 15 I=2,NT2,2
   15 FEM(I)=FEM(I)*(-1.)
      B(1,1)=-FEM(1)
      B(NP1,1)=-FEM(NT2)
      NT=N
      DO 14 K=2,NT
      M=(K-1)/2
      B(K,1)=-FEM(K+M)-FEM(K+1+M)
   14 CONTINUE
C      SOLVE FOR THETA
      NP1=N+1
      CALL MATINV (A,NP1,B,1,DETERM,10,1)
C      USE THETA TO COMPUTE SUPPORT MOMENT
      DO 16 I=1,N
      ZMSUP(I,1)=(2/ L(I)     )*(2*B(I,1)+B(I+1,1))+FEM(I*2-1)
      ZMSUP(I,2)=(2/ L(I)     )*(B(I,1)+2*B(I+1,1))+FEM(I*2)
   16 CONTINUE
C
C     CONVERT MSUP FROM SLOPE DEFLECTION TO BEAM CONVENTION
C
      DO 17 I=1,N
      ZMSUP(I,2)=ZMSUP(I,2)*(-1)
   17 CONTINUE
C
C     COMPUTE MOMENTS AT TENTH POINTS
C
      DO 18 J1=1,N
      YX(1,J1)=ZMSUP(J1,1)
      YX(11,J1)=ZMSUP(J1,2)
      DIF=YX(11,J1)-YX(1,J1)
      DO 18 J2=2,10
   18 YX(J2,J1)=YX(1,J1)+0.1*(J2-1)*DIF
      RETURN
      END
```

```
      SUBROUTINE MATINV(A,N,B,M,DETERM,N1,N2)
      DIMENSION IPIVOT(10),A(N1,N1),B(N1,N2),INDEX(10,2),PIVOT(10)
      EQUIVALENCE(IROW,JROW),(ICOLUM,JCOLUM),(AMAX,T,SWAP)
      DETERM=1.0
      DO 20 J=1,N
   20 IPIVOT(J) =0
      DO 550 I=1,N
      AMAX=0.0
      DO 105 J=1,N
      IF (IPIVOT(J) -1) 60,105,60
   60 DO 100 K=1,N
      IF(IPIVOT(K)-1) 80,100,740
   80 IF( ABS(AMAX)- ABS(A(J,K))) 85,85,100
   85 IROW=J
      ICOLUM = K
      AMAX=A(J,K)
  100 CONTINUE
  105 CONTINUE
      IPIVOT(ICOLUM)=IPIVOT(ICOLUM)+1
      IF(IROW-ICOLUM) 140,260,140
  140 DETERM=-DETERM
      DO 200 L=1,N
      SWAP=A(IROW,L)
      A(IROW,L)=A(IC LUM,L)
  200 A(ICOLUM,L)=SWAP
      IF(M) 260,260,210
  210 DO 250 L=1,M
      SWAP=B(IROW,L)
      B(IROW,L)=B(ICOLUM,L)
  250 B(ICOLUM,L)=SWAP
  260 INDEX(I,1)=IROW
      INDEX(I,2)=ICOLUM
      PIVOT(I)=A(ICOLUM,ICOLUM)
      DETERM=DETERM*PIVOT(I)
      IF(PIVOT(I)) 330,720, 330
  330 A(ICOLUM,ICOLUM)=1.0
      DO 350 L=1,N
  350 A(ICOLUM,L)=A(ICOLUM,L)/PIVOT(I)
      IF(M) 380,380,360
  360 DO 370 L=1,M
  370 B(ICOLUM,L)=B(ICOLUM,L)/PIVOT(I)
  380 DO 550 L1=1,N
      IF(L1-ICOLUM) 400,550, 400
  400 T=A(L1,ICOLUM)
      A(L1,ICOLUM)=0.0
      DO 450 L=1,N
  450 A(L1,L)=A(L1,L)-A(ICOLUM,L)*T
      IF(M) 550, 550, 460
  460 DO 500 L=1,M
  500 B(L1,L)=B(L1,L)-B(ICOLUM,L)*T
  550 CONTINUE
      DO 710 I=1,N
      L=N+1-I
      IF (INDEX(L,1)-INDEX(L,2)) 630, 710, 630
  630 JROW=INDEX(L,1)
      JCOLUM = INDEX(L,2)
      DO 705 K=1,N
      SWAP=A(K,JROW)
```

```
      A(K,JROW)=A(K,JCOLUM)
      A(K,JCOLUM)=SWAP
  705 CONTINUE
  710 CONTINUE
      RETURN
  720 WRITE(6,730)
  730 FORMAT(20H MATRIX IS SINGULAR        )
  740 RETURN
      END
```

```
C
      SUBROUTINE SHEAR(L,ALPH,SMOM,BMD,THK,FPCBM,BPRIME,ULTSHR,AV,FSY,
     *DPTH,ULTACI,SPCAAS,SPCACI,JS,SVERTL,SVERTR)
      REAL*4 L
      DIMENSION L(10),ALPH(10),SMOM(11,10),ULTSHR(11,10),DPTH(11,10),
     *ULTACI(11,10),SPCAAS(3,10),SPCACI(3,10)
      DO 14 J1=1,11
   14 IF(SMOM(J1,JS).LT.0.) DPTH(J1,JS)=BMD+THK/2.
      DO 22 J1=1,3
      IF(J1.EQ.1) JSTRT=1
      IF(J1.EQ.1) JSTOP=3
      IF(J1.EQ.2) JSTRT=3
      IF(J1.EQ.2) JSTOP=9
      IF(J1.EQ.3) JSTRT=9
      IF(J1.EQ.3) JSTOP=11
      SAASHO=1000.
      SACI=1000.
      DO 20 J2=JSTRT,JSTOP
      ZX=(J2-1)*L(JS)/10.
      VPR=0.
      IF(ZX.LE.ALPH(JS)*L(JS)) VPR=SVERTL
      IF(ZX.GE.L(JS)*(1.-ALPH(JS))) VPR=SVERTR
C
C      AASHTO
C
      ZJD=0.9*(BMD+THK)
      IF(SMOM(J2,JS).LT.0.) ZJD=0.875*(BMD+THK/2.)
      VC=.06*FPCBM     *BPRIME*ZJD
      VU=ULTSHR(J2,JS)/0.9
      IF(.06*FPCBM     .GT..180) VC=.180*BPRIME*ZJD
      IF(VC+VPR.GE.VU) SST=12.
      IF(VC+VPR.GE.VU) GO TO 16
      SST=AV*2.*FSY*ZJD/(VU-VC-VPR)
      IF(SST.GT.12.) SST=12.
   16 IF(SST.LT.SAASHO) SAASHO=SST
C
C      ACI
C
      IF(SMOM(J2,JS).LT.0.) DTH=BMD+THK/2.
      IF(SMOM(J2,JS).GE.0.) DTH=DPTH(J2,JS)+THK
      IF(ABS(SMOM(J2,JS)).LT.1.E-10) SMOM(J2,JS)=.001
      SS=.7*ULTACI(J2,JS)*DTH/(12.*ABS(SMOM(J2,JS)))
      IF(SS.GT.1) SS=1.
      VC=1.6*SQRT(1000.*FPCBM      )/1000.+SS
      IF(VC.LT.2.*SQRT(1000.*FPCBM      )/1000.) VC=2.*SQRT(1000.*FPCBM
     *)/1000.
      IF(VC.GT.5.*SQRT(1000.*FPCBM      )/1000.) VC=5.*SQRT(1000.*FPCBM
     *)/1000.
      IF(DTH.LT..8*BMD) DTH=.8*BMD
      VU=ULTACI(J2,JS)/(.85*BPRIME*DTH)
      VPR=VPR/(BPRIME*DTH)
      SST=AV*FSY*1000./(50.*BPRIME)
      IF(SST.LT.SACI) SACI=SST
      IF(VC+VPR.GT.VU) GO TO 18
      SST=AV*FSY/((VU-VC-VPR)*BPRIME)
      IF(SST.LT.SACI) SACI=SST
   18 IF(SACI.GT..75*BMD) SACI=.75*BMD
      IF(SACI.GT.24.) SACI=24.
```

```
   20 CONTINUE
      SPCAAS(J1,JS)=SAASHO
   22 SPCACI(J1,JS)=SACI
   24 CONTINUE
      RETURN
      END
```

```
      FUNCTION BRACK(ZL,X,ZU)
      IF(X.LE.ZL) BRACK=0.
      IF(ZL.LT.X.AND.X.LE.ZU) BRACK=X-ZL
      IF(X.GT.ZU) BRACK=ZU-ZL
      RETURN
      END
```

```
      SUBROUTINE DCKSTL(Z1,Z2,Z3,Z4,Y1,Y2,Y3,Y4,YB,THK,YT,ZMSLN,ZMSLF,
     *ZMULN,ZMSLSP,ZMULSP,ZMSLPF,JSP,FSY,FPC,ZIBM,BMA,ASNEG,ASPOS,
     *FPCSLB,ZICMP,S)
      DIMENSION ZMSLN(11),ZMSLF(11),ZMULN(11),ASNEG(11,10),ASPOS(11)
C     ZMULN(I) = ULTIMATE NEGATIVE DESIGN MOMENT AT POINT I (K-FT)
C     ZMSLN(I) = MAXIMUM SERVICE LOAD NEGATIVE MOMENT AT POINT I (K-FT)
C     ZMSLF(I) = MOMENT TO COMPUTE CYCLIC STRESS IN DECK STEEL AT
C     POINT I (K-FT)
C     ZMSLSP = MAXIMUM POSITIVE SERVICE LOAD MOMENT AT RIGHT END
C     OF SPAN (K-FT)
C     ZMULSP V
C     ZMULSP = ULTIMATE POSITIVE MOMENT AT RIGHT END OF SPAN (K-FT)
C     NMOD = MODULAR RATIO
C     ZMSLPF = MOMENT TO COMPUTE CYCLIC STRESS IN (+) M SUPPORT
C     STEEL (K-FT)
C***********************************************************************
C     NEGATIVE MOMENT DECK STEEL
C***********************************************************************
      NMOD=10
      DBAR=YT+YB+THK/2.
      DO 500 J2=1,11
C
C     SELECT STEEL AREA BY USD
C
      ASNEG(J2,JSP)=0.
      IF(ZMSLN(J2).GE.0.) GO TO 18
      ZMM=ABS(ZMULN(J2))
      X=0.
   10 X=X+0.05
      EST=0.003*(DBAR-X)/X
      SST=29.E+03*EST
      IF(SST.GT.FSY) SST=FSY
      C=(Y1*BRACK(0.,X,Z1)+Y2*BRACK(Z1,X,Z2)+0.5*(Y2-Y3)*BRACK(Z2,X,Z3)
     1+Y3*BRACK(Z2,X,Z3)+0.5*(Y3-Y4)*BRACK(Z3,X,Z4)+Y4*BRACK(Z3,X,Z4)
     2+Y4*BRACK(Z4,X,1000.))*2.
      YC=(0.5*Y1*BRACK(0.,X,Z1)**2+Y2*BRACK(Z1,X,Z2)*(Z1+0.5*BRACK(Z1,
     1X,Z2))+0.5*(Y2-Y3)*BRACK(Z2,X,Z3)*(Z2+0.333*BRACK(Z2,X,Z3))
     2+Y3*BRACK(Z2,X,Z3)*(Z2+0.5*BRACK(Z2,X,Z3))+0.5*(Y3-Y4)*BRACK
     3(Z3,X,Z4)*(Z3+0.333*BRACK(Z3,X,Z4))+Y4*BRACK(Z3,X,Z4)*(Z3+0.5*
     4BRACK(Z3,X,Z4))+Y4*BRACK(Z4,X,1000.)*(Z4+0.5*BRACK(Z3,X,1000.)))
     5*2./C
      ZMUL=(DBAR-YC)*C*0.833*FPC/12.
      IF(ZMUL.GE.ZMM) ASNEG(J2,JSP)=C*0.833*FPC/SST
      IF(ZMUL.GE.ZMM) GO TO 12
      GO TO 10
C
C     CHECK TENSION STRESS IN DECK STEEL UNDER FULL SERVICE
C     LOADS, ASSUMING CRACKED DECK AND UNCRACKED BEAM
C
   12 ZMM=ABS(ZMSLN(J2))
   14 YSHF=NMOD*ASNEG(J2,JSP)*(YT+THK/2.)/(NMOD*ASNEG(J2,JSP)+BMA)
      YTS=YT-YSHF+THK/2.
      ZI=ZIBM+BMA*(YSHF)**2+(NMOD*ASNEG(J2,JSP))*(YTS)**2
      SIGSTL=(12.*ZMM*YTS/ZI)*NMOD
      IF(SIGSTL.GT.36.) ASNEG(J2,JSP)=ASNEG(J2,JSP)+0.5
      IF(SIGSTL.GT.36.) GO TO 14
C
C     CHECK FATIGUE STRESS LEVEL
```

```
C
      SIGSTL=12.*ABS(ZMSLF(J2))*(YTS/ZI)*NMOD
      IF(SIGSTL.GT.21.) ASNEG(J2,JSP)=ASNEG(J2,JSP)+0.5
      IF(SIGSTL.GT.21.) GO TO 14
   18 IF(J2.NE.11) GO TO 500
C***********************************************************************
C******POSITIVE MOMENT CONNECTION REINFORCING
C***********************************************************************
      JSPAN=JSP
      ZMM=ZMULSP*12.
      DBAR=YT+YB+THK-3.0
      IF(ZMM.LE.0.) ASPOS(1+JSPAN)=0.
      IF(ZMM.LE.0.) GO TO 24
      BB=-1.666*FPCSLB*S*12.*DBAR/FSY
      CC=1.666*FPCSLB*S*12.*ZMM/FSY**2
      AREA1=(-BB+SQRT(BB**2-4.*CC))/2.
      AREA2=(-BB-SQRT(BB**2-4.*CC))/2.
      IF(AREA1.GT.AREA2) GO TO 20
      IF(AREA1.GE.0.) AREA=AREA1
      IF(AREA1.LT.0.) AREA=AREA2
      GO TO 22
   20 IF(AREA2.GE.0.) AREA=AREA2
      IF(AREA2.LT.0.) AREA=AREA1
   22 CONTINUE
      ASPOS(1+JSPAN)=AREA
C
C     CHECK FATIGUE STRESS
C
      SIGSTL=(12.*ABS(ZMSLF(11))*(YB-3.0)/ZICMP)*NMOD
      IF(SIGSTL.GT.21.) ASPOS(1+JSPAN)=ASPOS(1+JSPAN)*SIGSTL/21.
  500 CONTINUE
   24 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE ULTMO(ASTAR,FPCBM,FPS,ASPRM,FPL,D,DPTH,FSY,DCR,
     *Y1,Y2,Y3,Y4,Z1,Z2,Z3,Z4,CLONG,ZMUL)
      ESINI=0.7*FPS*(1.-CLONG)/28.E+03
      CON1=(FPL/28000.)*(1.+(FPS-FPL)/(FPS-2.*FPL))
      CON2=-(FPL/28000.)*FPL*(FPS-FPL)**2/(FPS-2.*FPL)
C
C       CHECK TO SEE IF N.A. IN SLAB
C
      THK=Z1
      BEFF=Y1*2.
      PSTAR=ASTAR/(BEFF*D)
      FSUSTR=FPS*(1.-0.5*PSTAR*FPS/FPCBM          )
      T=ASTAR*FSUSTR
      CC=.833*FPCBM        *BEFF*THK
      IF(CC.LT.T) GO TO 10
C
C       N.A. IN SLAB
C
      ZMUL           =ASTAR*FSUSTR*D*(1.-0.6*PSTAR*FSUSTR/FPCBM        )/12
      RI=PSTAR*FSUSTR/FPCBM
      IF(RI.GT.0.3)  ZMUL          =0.25*FPCBM        *BEFF*D**2/12.
      RETURN
C*************************************************************************
C****  POSITIVE MOMENT CAPACITY - N.A. BELOW SLAB
C*************************************************************************
C
C       MINIMUM DECK REINF. - THD STANDARD
C
C
C       BEGIN ITERATION TO LOCATE N.A.
C
   10 JCNT=0
      X=0.
   12 X=X+0.25
   13 JCNT=JCNT+1
      IF(X.GT.DPTH) ZMUL=0.
      IF(X.GT.DPTH) RETURN
C
C       COMPUTE STRAND STRAIN AND FORCE IN DECK STEEL
C
      ES=.003*(D-X)/X+ESINI
      ESP=0.003*(X-DCR)/X
      CS=29.E+03*ABS(ESP)
      IF(CS.GT.FSY) CS=FSY
      IF(ESP.LE.0) CS=-CS
      CS=CS*ASPRM
C
C       COMPUTE RESULTANT COMPRESSIVE FORCE ON CONCRETE AND ITS LOCATION
C
      GO TO 1000
   14 DBAR=D-YC
      CC=C*0.833*FPCBM
      CTOT=CS+CC
      GO TO 2000
C
C       COMPUTE STRAND STRESS AND STRAND FORCE
C
   16 T=ASTAR*FS
```

```
      SUMFOR=T-CTOT
      IF(SUMFOR.LT.0.) GO TO 18
      IF(JCNT.EQ.2) GO TO 17
      SAVEF1=SUMFOR
      SAVEX1=X
      GO TO 12
   17 SAVEF2=SUMFOR
      SAVEX2=X
      X=SAVEX1+(SAVEX2-SAVEX1)*SAVEF1/(SAVEF1-SAVEF2)
      IF(X-SAVEX1.LT..25) X=SAVEX1+.25
      JCNT=0
      GO TO 13
   18 ZMUL=(CC*DBAR+CS*(D-DCR))/12.
      GO TO 28
C***********************************************************************
C******THIS SECTION COMPUTES CONCRETE COMPRESSION AREA AND ITS C.G.
C***********************************************************************
 1000 C=(Y1*BRACK(0.,X,Z1)+Y2*BRACK(Z1,X,Z2)+0.5*(Y2-Y3)*BRACK(Z2,X,Z3)
     1+Y3*BRACK(Z2,X,Z3)+0.5*(Y3-Y4)*BRACK(Z3,X,Z4)+Y4*BRACK(Z3,X,Z4)
     2+Y4*BRACK(Z4,X,1000.))*2.
      YC=(0.5*Y1*BRACK(0.,X,Z1)**2+Y2*BRACK(Z1,X,Z2)*(Z1+0.5*BRACK(Z1,
     1X,Z2))+0.5*(Y2-Y3)*BRACK(Z2,X,Z3)*(Z2+0.333*BRACK(Z2,X,Z3))
     2+Y3*BRACK(Z2,X,Z3)*(Z2+0.5*BRACK(Z2,X,Z3))+0.5*(Y3-Y4)*BRACK
     3(Z3,X,Z4)*(Z3+0.333*BRACK(Z3,X,Z4))+Y4*BRACK(Z3,X,Z4)*(Z3+0.5*
     4BRACK(Z3,X,Z4))+Y4*BRACK(Z4,X,1000.)*(Z4+0.5*BRACK(Z3,X,1000.)))
     5*2./C
      GO TO 14
C***********************************************************************
C***** THIS SECTION COMPUTES STRAND STRESS
C***********************************************************************
 2000 FS=ES*28000
      IF(FS.GT.FPL) GO TO 2002
      GO TO 16
 2002 FS=.5*FPS+.5*SQRT(FPS**2-4.*CON2/(ES-CON1))
      GO TO 16
   28 RETURN
      END
```

```
      SUBROUTINE PLOSS(FPCR,ZMBW,ZMC,ZMNC,FSU,AS,AB,ZI,ZIC,YB,YBC,EC,
     *HUM,SPAN,ZLOSS,ZINLOS,UWC)
C
C     THIS SUBROUTINE COMPUTES PRESTRESS LOSS BY 1975 AASHTO
C     INTERIM SPEC.
C
C     FPCR = CONCRETE RELEASE STRENGTH (KSI)
C     ZMBW=D.L. MOMENT DUE TO BEAM WEIGHT AT MIDSPAN(K-FT)
C     ZMC = TOTAL D.L. MOMENT (EXCEPT BEAM WEIGHT) AT MIDSPAN
C           ACTING ON COMPOSITE SECTION(K-FT)
C     ZMNC = TOTAL D.L. MOMENT (EXCEPT BEAM WEIGHT) AT MIDSPAN
C           ACTING ON NONCOMPOSITE SECTION (K-FT)
C     FSU = ULTIMATE STRENGTH OF STRAND (KSI)
C     AS = TOTAL STRAND AREA (IN**2)
C     AB = CROSS SECTIONAL AREA OF BEAM (IN**2)
C     ZI = M. OF I. OF NONCOMPOSITE BEAM (IN**4)
C     ZIC = M. OF I. OF COMPOSITE BEAM (IN**4)
C     YB = DISTANCE FROM C.G. OF BEAM TO BOTTOM FIBER (IN)
C     YBC = DISTANCE FROM C.G. OF COMPOSITE BEAM TO BOTTOM FIBER (IN)
C     EC = DISTANCE FROM BOTTOM OF BEAM TO C.G. OF STRANDS (IN)
C     HUM = RELATIVE HUMIDITY (PERCENT)
C     SPAN = SPAN LENGTH (FT)
C     ZINLOS=FRACTION OF INITIAL STRESS(.7*FSU) LOST (RELEASE)
C     ZLOSS = FRACTION OF INITIAL STRESS (.7*FSU) LOST (SERVICE)
C
C     (COMPRESSION STRESS IS POSITIVE )
C
C     SHRINKAGE LOSS
C
      SH=(17000.-150*HUM)/1000.
C
C     ELASTIC SHORTENING
C
C      A 10 PERCENT LOSS IN STRAND FORCE DUE TO RELAXATION AND ELASTIC
C      SHORTENING PRIOR TO RELEASE IS ASSUMED AT TIME OF RELEASE
C
      FEFF=0.9*0.7*FSU*AS
      FCIR=FEFF/AB+FEFF*(YB-EC)*ABS(YB-EC)/ZI-12.*ZMBW*(YB-EC)/ZI
      ECI=(UWC*1000.)**1.5*33.*SQRT(1000.*FPCR)
      ES=(28E+06*FCIR/ECI)
C
C     CREEP LOSS
C
      FCDS=12.*ZMNC*(YB-EC)/ZI+12.*ZMC*(YBC-EC)/ZIC
      CRC=12.*FCIR-7.*FCDS
C
C     STRAND RELAXATION LOSS
C
      CRS=20.-0.4*ES-0.2*(SH+CRC)
C
C     TOTAL LOSS
C
      DELTFS=SH+ES+CRC+CRS
      DELFSI=ES+0.5*CRS
C
C     LOSS FACTOR
C
      ZLOSS=DELTFS/(.7*FSU)
```

```
      ZINLOS=DELFSI/(.7*FSU)                                            00019130
      RETURN                                                            00019140
      END                                                               00019150
```

```
      FUNCTION FPRIMC(FT,FC,A,ZT,ZB,ZLOS,NS,DD,SIGT,SIGB,TAU,DRAPE,
     *NTOP,P,JSP,J1OTH,G,NW,STOTTP,STOTBT)
      INTEGER DRAPE
      DIMENSION NS(50,10),DD(50),TAU(10,11)
      SIGTP=0.
      SIGBP=0.
      DO 10 J1=1,NTOP
      SIGTP=SIGTP+(1.-ZLOS)*P*NS(J1,JSP)*(-1./A-DD(J1)/ZT)
   10 SIGBP=SIGBP+(1.-ZLOS)*P*NS(J1,JSP)*(-1./A+DD(J1)/ZB)
      TEMP=(1.-ZLOS)*P*G*NTOP*TAU (JSP,J1OTH)*(DRAPE-NTOP)*NW
      SIGTP=SIGTP-TEMP/ZT
      SIGBP=SIGBP+TEMP/ZB
      IF(SIGT+SIGTP.GE.0.) FPCTP=((1000.*(SIGT+SIGTP)/FT)**2)/1000.
      IF(SIGT+SIGTP.LT.0.) FPCTP=ABS(SIGT+SIGTP)/FC
      IF(SIGB+SIGBP.GE.0.) FPCBT=((1000.*(SIGB+SIGBP)/FT)**2)/1000.
      IF(SIGB+SIGBP.LT.0.) FPCBT=ABS(SIGB+SIGBP)/FC
      FPRIMC=AMAX1(FPCTP,FPCBT)
      STOTTP=SIGT+SIGTP
      STOTBT=SIGB+SIGBP
      RETURN
      END
```

```
      FUNCTION ECC(NS,DD,NTOP,JSP,NUMSTN)
      DIMENSION NS(50,10),DD(50)
      NUMSTN=0
      ECC=0.
      DO 8 NTOP=1,1000
      IF(NS(NTOP,JSP).EQ.0) GO TO 9
    8 CONTINUE
    9 NTOP=NTOP-1
      DO 10 J1=1,NTOP
      NUMSTN=NUMSTN+NS(J1,JSP)
   10 ECC=ECC-DD(J1)*NS(J1,JSP)
      ECC=ECC/NUMSTN
      RETURN
      END
```

```
      SUBROUTINE ADDIT(NS,NTOP,NSWEB,NRFLG,NLIM,JSP,NUMSTN)
      DIMENSION NS(50,10),NLIM(20)
      IF(NTOP.GT.NRFLG) GO TO 28
      IF(NS(NTOP,JSP)-NSWEB.LT.2*NLIM(NTOP)) GO TO 30
   28 NTOP=NTOP+1
      NS(NTOP,JSP)=NSWEB
      GO TO 32
   30 NS(NTOP,JSP)=NS(NTOP,JSP)+2
   32 NUMSTN=0
      DO 34 J1=1,NTOP
   34 NUMSTN=NUMSTN+NS(J1,JSP)
      RETURN
      END
```

```
      SUBROUTINE ANALYZ
      REAL*4 LLMASP,LLMASN,LLSASP,LLSASN,LLMAXP,LLMAXN,LLSAXP,LLSAXN,
     2L,MSAXP,MSAXN,MSASP,MSASN,MAXMOM,MINMOM,MAXSHR,MINSHR,INFLM,INFLV
      COMMON/PASAN1/LLMASP(11,10),LLMASN(11,10),LLSASP(11,10),LLSASN(11,
     110),LLMAXP(11,10),LLMAXN(11,10),LLSAXP(11,10),LLSAXN(11,10),
     2DLMUNF(11,10),DLSUNF(11,10),DLMBM(11,10),DLMSLS(11,10),DLSSLS(11,10
     30),DLMSLC(11,10),DLSSLC(11,10),MSASP(11,10),MSASN(
     411,10)                   ,MSAXP(11,10),MSAXN(11,10),IBETA(10,2),SL(10)
     5,LODKOD(7),PWHEEL(15),BETA(10,2),NWHL(14),L(10),DLSBM(11,10)
      COMMON/PASAN2/ SCLHHS,SCLLNE,SCLCOM,SCLCOV,NWHEEL,KCONT,NSPNS,NN
      COMMON/DUMP /A(10,10),ALPHA(10,10),INFLM(1400),INFLV(1400),
     1REACT(10,1000),LMMIN(15),LMMAX(15),LVMAX(15),LVMIN(15),LEXTRM(30),
     2LEXTRV(30),NODDSN(11,10)
      COMMON/BLK 1/ NPNTS,JPNT,JSPAN,N
      N=NN
C
C      ESTABLISH NODE NUMBERS OF DESIGN POINTS
C
      J4=1
      DO 18 J1=1,N
      IF(J1.EQ.1) S1=-L(J1)/10.
      IF(J1.GT.1) S1=SL(J1-1)-L(J1)/10.
      DEL=L(J1)/10.
      DO 18 J2=1,11
      S1=S1+DEL
      DO 14 J3=J4,2000
      S2=FLOAT(J3)
      S2MS1=S2-S1
      IF(S2MS1.LT.0.) GO TO 14
      J5=J3
      GO TO 16
   14 CONTINUE
   16 J4=J5
      IF(S2MS1.GT.0.5) S2=S2-.99
      NODDSN(J2,J1)=200+INT(S2)
   18 CONTINUE
C***********************************************************************
C****  MOMENTS AND SHEARS DUE TO PARTIAL CONTINUITY POUR ON SIMPLE SPANS
C***********************************************************************
      DO 30 J1=1,NSPNS
      IF(BETA(J1,1).EQ.0.AND.BETA(J1,2).EQ.0) GO TO 30
      DO 28 J2=1,11
      DELJ=(J2-1)*L(J1)/10.
      IF(DELJ.GT.BETA(J1,1)*L(J1)) GO TO 22
      DLMSLS(J2,J1)=BETA(J1,1)*L(J1)*(1.-.5*BETA(J1,1))*DELJ-.5*DELJ**2
      DLSSLS(J2,J1)=-BETA(J1,1)*L(J1)*(1.-.5*BETA(J1,1))+DELJ
      GO TO 24
   22 DL MSLS(J2,J1)=BETA(J1,1)*L(J1)*(1.-.5*BETA(J1,1))*DELJ-
     $BETA(J1,1)*L(J1)*(DELJ-.5*BETA(J1,1)*L(J1))
      DLSSLS(J2,J1)=-BETA(J1,1)*L(J1)*(1.-.5*BETA(J1,1))+BETA(J1,1)*L(J1
     $)
   24 IF(DELJ.GT.L(J1)*(1.-BETA(J1,2)))GO TO 26
      DL MSLS(J2,J1)=DLMSLS(J2,J1)+.5*BETA(J1,2)**2*DELJ*L(J1)
      DLSSLS(J2,J1)=DLSSLS(J2,J1)-.5*BETA(J1, 2)**2*L(J1)
      GO TO 28
   26 DLMSLS(J2,J1)=DLMSLS(J2,J1)+.5*BETA(J1,2)**2*L(J1)*DELJ-.5*(DELJ-
     $L(J1)*(1.-BETA(J1,2)))**2
      DLSSLS(J2,J1)=DLSSLS(J2,J1)-.5*BETA(J1,2)**2*L(J1)+DELJ-L(J1)*(1.-
```

```
     $BETA(J1,2))
  28 DLSSLS(J2,J1)=-DLSSLS(J2,J1)
  30 CONTINUE
C***********************************************************************
C****  COMPUTE MOMENTS AND SHEARS DUE TO BEAM WEIGHT  *******************
C***********************************************************************
      DO 20 J1=1,NSPNS
      DO 20 J2=1,11
      DELJ=(J2-1)*L(J1)/10
      DLMBM(J2,J1)=0.5*L(J1)*DELJ-.5*DELJ**2
  20 DLSBM(J2,J1)=+0.5*L(J1)-DELJ
C
C      BEGIN  COMPUTATIONS OF EFFECTS AT EACH DESIGN POINT
C
  52 CALL REACTN(L,SL)
      SUML=0
      DO 1000 JSPAN=1,NSPNS
      DO 1000 JPNT=1,11
      CALL INFLNE(L,SL)
      IF (KCONT.EQ.0) GO TO 53
C***********************************************************************
C******MOMENTS AND SHEARS DUE TO REMAINDER OF SLAB POURED ON CONTINUOUS
C******BEAM
C***********************************************************************
      NDISC=NODDSN(JPNT,JSPAN)
      AM=0
      AV=0
      DO 42 J2=1,N
      JSTRT=1+IBETA(J2,1)
      JSTOP=IBETA(J2,2)
      IF(JSTRT.GT.JSTOP) JSTRT=JSTOP
      DO 42 J1=JSTRT,JSTOP
      AM=AM+.5*(INFLM(J1-1)+INFLM(J1))
      AAA=INFLV(J1)
      IF(J1.EQ.NDISC) AAA=AAA-1
      AV=AV+.5*(INFLV(J1-1)+AAA)
  42 CONTINUE
      DLSSLC(JPNT,JSPAN)=DLSSLC(JPNT,JSPAN)+AV
      DLMSLC(JPNT,JSPAN)=DLMSLC(JPNT,JSPAN)+AM
C
C       FIND EXTREME VALUES OF INFLM(I)
C
  53 NDISC=NODDSN(JPNT,JSPAN)
      NEXTRM=0
      NEXTRV=0
      JSTOP=199+NPNTS
      IF(JSPAN.EQ.1.AND.JPNT.EQ.1) GO TO 61
      IF(JSPAN.EQ.N.AND.JPNT.EQ.11) GO TO 61
      DO 60 J1=1,N
      JSTRT=NODDSN(1,J1)
      JSTOP=NODDSN(11,J1)
      ZMIN=0
      ZMAX=0
      DO 56 J2=JSTRT,JSTOP
      IF(INFLM(J2).GE.ZMIN) GO TO 54
      ZMIN=INFLM(J2)
      JMIN=J2
  54 IF(INFLM(J2).LE.ZMAX) GO TO 56
```

```
      ZMAX=INFLM(J2)
      JMAX=J2
   56 CONTINUE
      IF(ZMAX.LE.1.E-05) GO TO 58
      NEXTRM=NEXTRM+1
      LEXTRM(NEXTRM)=JMAX
   58 IF(ABS(ZMIN).LE.1.E-05) GO TO 60
      NEXTRM=NEXTRM+1
      LEXTRM(NEXTRM)=JMIN
   60 CONTINUE
   61 IF(NEXTRM.EQ.0) LEXTRM(1)=200
      IF(NEXTRM.EQ.0) NEXTRM=1
C
C      FIND EXTREME VALUES OF INFLV(I)
C
      NEXTRV=0
      DO 45 J1=1,N
      JSTRT=NODDSN(1,J1)
      JSTOP=NODDSN(11,J1)
      ZVIN=0
      ZVAX=0
      DO 65 J2=JSTRT,JSTOP
      IF(J2.NE.NDISC) GO TO 63
      IF(INFLV(J2)-1.GE.ZVIN) GO TO 63
      ZVIN=INFLV(J2)-1
      JVIN=J2
   63 IF(INFLV(J2).GE.ZVIN) GO TO 64
      ZVIN=INFLV(J2)
      JVIN=J2
   64 IF(INFLV(J2).LE.ZVAX) GO TO 65
      ZVAX=INFLV(J2)
      JVAX=J2
   65 CONTINUE
      IF(ZVAX.LE.1.E-05) GO TO 43
      NEXTRV=NEXTRV+1
      LEXTRV(NEXTRV)=JVAX
   43 IF(ABS(ZVIN).LE.1.E-05) GO TO 45
      NEXTRV=NEXTRV+1
      LEXTRV(NEXTRV)=JVIN
   45 CONTINUE
      IF(NEXTRM.EQ.1) GO TO 47
      DO 44 J1=2,NEXTRM
      IF(LEXTRM(J1).GT.LEXTRM(J1-1)) GO TO 44
      JT=LEXTRM(J1-1)
      LEXTRM(J1-1)=LEXTRM(J1)
      LEXTRM(J1)=JT
   44 CONTINUE
   47 IF(NEXTRV.EQ.1) GO TO 51
      DO 48 J1=2,NEXTRV
      IF(LEXTRV(J1).GT.LEXTRV(J1-1)) GO TO 48
      JT=LEXTRV(J1-1)
      LEXTRV(J1-1)=LEXTRV(J1)
      LEXTRV(J1)=JT
   48 CONTINUE
      JSTOP=NEXTRV
      DO 50 J1=2,JSTOP
      IF(LEXTRV(J1).NE.LEXTRV(J1-1)) GO TO 50
      DO 49 J2=J1,NEXTRV
```

```
   49 LEXTRV(J2-1)=LEXTRV(J2)
      NEXTRV=NEXTRV-1
      GO TO 51
   50 CONTINUE
   51 CONTINUE
      NODSTP=199+NPNTS
      IF(LODKOD(1).EQ.0.AND.LODKOD(2).EQ.0) GO TO 126
      IF(LODKOD(1).NE.1) GO TO 68
      JTRIG=-1
      GO TO 70
 68   JTRIG=1
C*****************************************************************************
C********H OR HS TRUCK LOADING************************************************
C*****************************************************************************
C
C     H OR HS TRUCK LEFT TO RIGHT -- MOMENTS
C
   70 MAXSHR=-10000.
      MAXMOM=-10000.
      MINMOM=10000.
      MINSHR=10000.
      IF(JTRIG.EQ.-1) NMOVES=0
      IF(JTRIG.EQ.1) NMOVES=30
      LEXTRM(NEXTRM+1)=LEXTRM(NEXTRM)+NMOVES
      LEXTRV(NEXTRV+1)=LEXTRV(NEXTRV)+NMOVES
      DO 84 J1=1,NEXTRM
      JSTRT=LEXTRM(J1)
      JSTOP=JSTRT+NMOVES
      IF(JSTOP.GT.LEXTRM(J1+1)) JSTOP=LEXTRM(J1+1)
      DO 82 J2=JSTRT,JSTOP,2
      K1=J2+14
      ZMLR12=.25*INFLM(K1)+INFLM(J2)
      K3=J2-14
      IF(JTRIG) 80,80,72
 72   KSTRT=J2-30
      KSTOP=J2-14
      IF(KSTOP.LE.200) GO TO 80
      IF(KSTRT.GT.200) GO TO 78
      DO 74 J3=2,30,2
      J4=KSTOP-J3
      IF(J4.GT.200) GO TO 74
      GO TO 76
 74   CONTINUE
 76   KSTRT=J4
 78   CALL SORTIL(INFLM,ZMAX,JMAX,ZMIN,JMIN,KSTRT,KSTOP,0)
      ZMAX=ZMAX+ZMLR12
      ZMIN=ZMIN+ZMLR12
      CALL SORTHS  (MAXMOM,ZMAX,MINMOM,ZMIN,K1,J2,JMAX,JMIN,LMMAX,LMMIN)
      GO TO 82
 80   CALL SORTHS   (MAXMOM,ZMLR12,MINMOM,ZMLR12,K1,J2,K3,K3,LMMAX,LMMIN
     *)
 82   CONTINUE
 84   CONTINUE
C
C     H OR HS TRUCK RIGHT TO LEFT-MOMENTS
C
      DO 96 J1=1,NEXTRM
      JJ=NEXTRM+1-J1
```

```
      JSTRT=LEXTRM(JJ)
      JSTOP=JSTRT-NMOVES
      IF(JJ.EQ.1) GO TO 86
      IF(JSTOP.LT.LEXTRM(JJ-1)) JSTOP=LEXTRM(JJ-1)
   86 J2=JSTRT+2
   88 J2=J2-2
      K1=J2-14
      ZMRL12=.25*INFLM(K1)+INFLM(J2)
      K3=J2+14
      IF(JTRIG)94,94,90
   90 KSTRT=J2+14
      KSTOP=J2+30
      IF(KSTRT.GE.NODSTP) GO TO 94
      IF(KSTOP.GT.NODSTP)KSTOP=NODSTP
   92 CALL SORTIL(INFLM,ZMAX,JMAX,ZMIN,JMIN,KSTRT,KSTOP,0)
      ZMAX=ZMAX+ZMRL12
      ZMIN=ZMIN+ZMRL12
      CALL SORTHS  (MAXMOM,ZMAX,MINMOM,ZMIN,K1,J2,JMAX,JMIN,LMMAX,LMMIN)
      IF(J2.GT.JSTOP) GO TO 88
      GO TO 96
   94 CALL SORTHS  (MAXMOM,ZMRL12,MINMOM,ZMRL12,K1,J2,K3,K3,LMMAX,LMMIN)
   96 CONTINUE
C
C     H OR HS TRUCK LEFT TO RIGHT-SHEAR
C
      DO 110 J1=1,NEXTRV
      JSTRT=LEXTRV(J1)
      JSTOP=JSTRT+NMOVES
      IF(JSTOP.GT.LEXTRV(J1+1)) JSTOP=LEXTRV(J1+1)
      DO 108 J2=JSTRT,JSTOP,2
      K1=J2+14
      ZVLR12=.25*INFLV(K1)+INFLV(J2)
      ZVLR=ZVLR12
      IF(K1.EQ.NDISC) ZVLR=ZVLR-0.25
      IF(J2.EQ.NDISC) ZVLR=ZVLR-1.0
      K3=J2-14
      IF(JTRIG) 106,106,98
   98 KSTRT=J2-30
      KSTOP=J2-14
      IF(KSTOP.LT.200) GO TO 106
      IF(KSTRT.GE.200) GO TO 104
      DO 100 J3=2,30,2
      J4=KSTOP-J3
      IF(J4.GT.200) GO TO 100
      GO TO 102
  100 CONTINUE
  102 KSTRT=J4
  104 CALL SORTIL(INFLV,ZMAX,JMAX,ZMIN,JMIN,KSTRT,KSTOP,NDISC)
      ZMAX=ZMAX+ZVLR12
      ZMIN=ZMIN+ZVLR
      CALL SORTHS  (MAXSHR,ZMAX,MINSHR,ZMIN,K1,J2,JMAX,JMIN,LVMAX,LVMIN)
      GO TO 108
  106 CALL SORTHS  (MAXSHR,ZVLR12,MINSHR,ZVLR,K1,J2,K3,K3,LVMAX,LVMIN)
  108 CONTINUE
  110 CONTINUE
C
C     H OR HS TRUCK RIGHT TO LEFT-SHEAR
C
```

```
      DO 122 J1=1,NEXTRV
      JJ=NEXTRV+1-J1
      JSTRT=LEXTRV(JJ)
      JSTOP=JSTRT-NMOVES
      IF(JJ.EQ.1.AND.JSTOP.LT.200) JSTOP=200
      IF(JJ.EQ.1) GO TO 112
      IF(JSTOP.LT.LEXTRV(JJ-1)) JSTOP=LEXTRV(JJ-1)
  112 J2=JSTRT+2
  114 J2=J2-2
      K1=J2-14
      ZVRL12=.25*INFLV(K1)+INFLV(J2)
      ZVRL=ZVRL12
      IF(K1.EQ.NDISC) ZVRL=ZVRL-.25
      IF(J2.EQ.NDISC)ZVRL=ZVRL-1.0
      K3=J2+14
      IF(JTRIG) 120,120,116
  116 KSTRT=J2+14
      KSTOP=J2+30
      IF(KSTRT.GT.NODSTP) GO TO 120
      IF(KSTOP.GT.NODSTP) KSTOP=NODSTP+1
  118 CALL SORTIL(INFLV,ZMAX,JMAX,ZMIN,JMIN,KSTRT,KSTOP,NDISC)
      ZMAX=ZMAX+ZVRL12
      ZMIN=ZMIN+ZVRL12
      CALL SORTHS  (MAXSHR,ZMAX,MINSHR,ZMIN,K1,J2,JMAX,JMIN,LVMAX,LVMIN)
      GO TO 121
  120 CALL SORTHS  (MAXSHR,ZVLR12,MINSHR,ZVRL,K1,J2,K3,K3,LVMAX,LVMIN)
  121 IF(J2.GT.JSTOP) GO TO 114
  122 CONTINUE
C
C      FINAL CHECK OF MAXIMUM H OR HS MOMENT
C
      JSTP=3
      IF(JTRIG.EQ.-1)JSTP=1
      IF(JTRIG.EQ.-1)LMMAX(3)=LMMAX(2)+(LMMAX(2)-LMMAX(1))*30/14
      DO 123 J1=1,3
      K1=LMMAX(1)+J1-2
      K2=LMMAX(2)+J1-2
      S12 =.25*INFLM(K1)+INFLM(K2)
      DO 123 J2=1,JSTP
      K3=LMMAX(3)+J2-2
      K4=IABS(K2-K3)
      IF(K4.LT.14.OR.K4.GT.30) GO TO 123
      IF(JTRIG.EQ.-1) ZMAX=S12
      IF(JTRIG.EQ.+1) ZMAX=S12+INFLM(K3)
      DUMMY=-10000.
      CALL SORTHS  (MAXMOM,ZMAX,DUMMY  ,ZMAX,K1,K2,K3,K3,LMMAX,LMMIN)
  123 CONTINUE
C
C      FINAL CHECK OF MINIMUM H OR HS MOMENT
C
      IF(JTRIG.EQ.-1) LMMIN(3)=LMMIN(2)+(LMMIN(2)-LMMIN(1))*30/14
      DO 125 J1=1,3
      K1=LMMIN(1)+J1-2
      K2=LMMIN(2)+J1-2
      S12 =.25*INFLM(K1)+INFLM(K2)
      DO 125 J2=1,JSTP
      K3=LMMIN(3)+J2-2
      K4=IABS(K2-K3)
```

```
      IF(K4.LT.14.OR.K4.GT.30) GO TO 125
      IF(JTRIG.EQ.-1) ZMIN=S12
      IF(JTRIG.EQ.+1) ZMIN=S12+INFLM(K3)
      DUMMY=10000.
      CALL SORTHS  (DUMMY ,ZMIN,MINMOM,ZMIN,K1,K2,K3,K3,LMMAX,LMMIN)
  125 CONTINUE
C
C      FINAL CHECK ON MAXIMUM H OR HS SHEAR
C
      IF(JTRIG.EQ.-1) LVMAX(3)=LVMAX(2)+(LVMAX(2)-LVMAX(1))*30/14
      DO 127 J1=1,3
      K1=LVMAX(1)+J1-2
      K2=LVMAX(2)+J1-2
      S12   =.25*INFLV(K1)+INFLV(K2)
      DO 127 J2=1,JSTP
      K3=LVMAX(3)+J2-2
      K4=IABS(K2-K3)
      IF(K4.LT.14.OR.K4.GT.30) GO TO 127
      IF(JTRIG.EQ.-1) SMAX=S12
      IF(JTRIG.EQ.+1) SMAX=S12+INFLV(K3)
      CALL SORTHS  (MAXSHR,SMAX,MINSHR,SMAX,K1,K2,K3,K3,LVMAX,LVMIN)
  127 CONTINUE
      ZMSMAX=.25*INFLM(LVMAX(1))+INFLM(LVMAX(2))
      IF(JTRIG.EQ.-1) ZMSMAX=ZMSMAX+INFLM(LVMAX(3))
C
C
C      FINAL CHECK ON H OR HS MINIMUM SHEAR
C
      IF(JTRIG.EQ.-1) LVMIN(3)=LVMIN(2)+(LVMIN(2)-LVMIN(1))*30/14
      DO 227 J1=1,3
      K1=LVMIN(1)+J1-2
      K2=LVMIN(2)+J1-2
      S12   =.25*INFLV(K1)+INFLV(K2)
      IF(K1.EQ.NDISC)SMIN  =S12   -.25
      IF(K2.EQ.NDISC)SMIN  =S12   -1.0
      DO 227 J2=1,JSTP
      K3=LVMIN(3)+J2-2
      K4=IABS(K2-K3)
      IF(K4.LT.14.OR.K4.GT.30) GO TO 227
      IF(JTRIG.EQ.-1) SMIN=S12
      IF(JTRIG.EQ.+1) SMIN=S12+INFLV(K3)
      IF(JTRIG.EQ.+1.AND.K3.EQ.NDISC) SMIN=SMIN-1.0
      CALL SORTHS(MAXSHR,SMIN,MINSHR,SMIN,K1,K2,K3,K3,LVMAX,LVMIN)
C
  227 CONTINUE
      ZMSMIN=.25* INFLM(LVMIN(1))+INFLM(LVMIN(2))
      IF(JTRIG.EQ.-1) ZMSMIN=ZMSMIN+INFLM(LVMIN(3))
      CALL IMPACT (1,L,JPNT,JSPAN,RIMP,N)
      MAXMOM=MAXMOM*SCLHHS*RIMP
      IF(MINMOM.LT.0) CALL IMPACT (2,L,JPNT,JSPAN,RIMP,N)
      IF(MINMOM.GT.0) CALL IMPACT (1,L,JPNT,JSPAN,RIMP,N)
      MINMOM=MINMOM*SCLHHS*RIMP
      CALL IMPACT (3,L,JPNT,JSPAN,RIMP,N)
      MAXSHR=MAXSHR*SCLHHS*RIMP
      MINSHR=MINSHR*SCLHHS*RIMP
      ZMSMAX=ZMSMAX*SCLHHS*RIMP
      ZMSMIN=ZMSMIN*SCLHHS*RIMP
      LLMASP(JPNT,JSPAN)=MAXMOM
```

```
      LLMASN(JPNT,JSPAN)=MINMOM
      LLSASP(JPNT,JSPAN)=MAXSHR
      LLSASN(JPNT,JSPAN)=MINSHR
      MSASP(JPNT,JSPAN)=ZMSMAX
      MSASN(JPNT,JSPAN)=ZMSMIN
      IF(LLMASN(JPNT,JSPAN).GT.0) LLMASN(JPNT,JSPAN)=0
      IF(LLMASP(JPNT,JSPAN).LT.0) LLMASP(JPNT,JSPAN)=0
C***********************************************************************
C********AXLE TRAIN******************************************************
C***********************************************************************
C
C     AXLE TRAIN LEFT TO RIGHT-MOMENTS
C
  126 MAXSHR=-10000.
      MINSHR=10000.
      MINMOM=10000.
      MAXMOM=-10000.
      IF(LODKOD(3).EQ.0) GO TO 172
      LEXTRM(NEXTRM+1)=LEXTRM(NEXTRM)+NWHL(NWHEEL-1)
      LEXTRV(NEXTRV+1)=LEXTRV(NEXTRV)+NWHL(NWHEEL-1)
      DO 130 J1=1,NEXTRM
      JSTRT=LEXTRM(J1)
      JSTOP=JSTRT+NWHL(NWHEEL-1)
      IF(JSTOP.GT.LEXTRM(J1+1)) JSTOP=LEXTRM(J1+1)
      DO 130 J2=JSTRT,JSTOP,2
      ZMOM=INFLM(J2)*PWHEEL(1)
      DO 123 J3=2,NWHEEL
  123 ZMOM=ZMOM+INFLM(J2-NWHL(J3-1))*PWHEEL(J3)
  130 CALL SORTAX  (MAXMOM,ZMOM,MINMOM,ZMOM,J2,-1,NWHL,NWHEEL,
     1  LMMAX,LMMIN)
C
C     AXLE TRAIN RIGHT TO LEFT-MOMENTS
C
      DO 136 J1=1,NEXTRM
      JJ=NEXTRM+1-J1
      JSTRT=LEXTRM(JJ)
      JSTOP=JSTRT-NWHL(NWHEEL-1)
      IF(JJ.EQ.1) GO TO 131
      IF(JSTOP.LT.LEXTRM(JJ-1)) JSTOP=LEXTRM(JJ-1)
  131 J2=JSTRT+2
  132 J2=J2-2
      ZMOM=INFLM(J2)*PWHEEL(1)
      DO 134 J3=2,NWHEEL
  134 ZMOM=ZMOM+INFLM(J2+NWHL(J3-1))*PWHEEL(J3)
      CALL SORTAX  (MAXMOM,ZMOM,MINMOM,ZMOM,J2,1,NWHL,NWHEEL,
     1  LMMAX,LMMIN)
      IF(J2.GT.JSTOP) GO TO 132
  136 CONTINUE
C
C     AXLE TRAIN LEFT TO RIGHT-SHEAR
C
      DO  142 J1=1,NEXTRV
      JSTRT=LEXTRV(J1)
      JSTOP=JSTRT+NWHL(NWHEEL-1)
      IF(JSTOP.GT.LEXTRV(J1+1)) JSTOP=LEXTRV(J1+1)
      DO 142 J2=JSTRT,JSTOP
      ZVAX=INFLV(J2)*PWHEEL(1)
      DO 138 J3=2,NWHEEL
```

```
  138 ZVAX=ZVAX+INFLV(J2-NWHL(J3-1))*PWHEEL(J3)
      ZVIN=ZVAX
      IF(J2.EQ.NDISC) ZVIN=ZVIN-PWHEEL(1)
      IF(J2.EQ.NDISC) GO TO 142
      DO 140 J3=2,NWHEEL
      J4=J2-NWHL(J3-1)
      IF(J4.NE.NDISC) GO TO 140
      ZVIN=ZVIN-PWHEEL(J3)
      GO TO 142
  140 CONTINUE
  142 CALL SORTAX  (MAXSHR,ZVAX,MINSHR,ZVIN,J2,-1,NWHL,NWHEEL,
     1 LVMAX,LVMIN)
C
C     AXLE TRAIN RIGHT TO LEFT-SHEAR
C
      DO 152 J1=1,NEXTRV
      JJ=NEXTRV+1-J1
      JSTRT=LEXTRV(JJ)
      JSTOP=JSTRT-NWHL(NWHEEL-1)
      IF(JJ.EQ.1) GO TO 143
      IF(JSTOP.LT.LEXTRV(JJ-1)) JSTOP=LEXTRV(JJ-1)
  143 J2=JSTRT+2
  144 J2=J2-2
      ZVAX=INFLV(J2)*PWHEEL(1)
      DO 146 J3=2,NWHEEL
  146 ZVAX=ZVAX+INFLV(J2+NWHL(J3-1))*PWHEEL(J3)
      ZVIN=ZVAX
      IF(J2.EQ.NDISC) ZVIN=ZVIN-PWHEEL(1)
      IF(J2.EQ.NDISC) GO TO 150
      DO 148 J3=2,NWHEEL
      J4=J2+NWHL(J3-1)
      IF(J4.NE.NDISC) GO TO 148
      ZVIN=ZVIN-PWHEEL(J3)
      GO TO 150
  148 CONTINUE
  150 CALL SORTAX  (MAXSHR,ZVAX,MINSHR,ZVIN,J2,1,NWHL,NWHEEL,
     1 LVMAX,LVMIN)
      IF(J2.GT.JSTOP) GO TO 144
  152 CONTINUE
C
C     FINAL CHECK OF MAXIMUM AXLE TRAIN MOMENT
C
      DO 156 J1=1,3,2
      J2=J1-2
      ZMAX=0.
      DO 154 J3=1,NWHEEL
  154 ZMAX=ZMAX+INFLM(LMMAX(J3)+J2)*PWHEEL(J3)
      KDIRT=-1
      IF(LMMAX(2).GT.LMMAX(1))KDIRT=1
      J4=LMMAX(1)+J2
  156 CALL SORTAX  (MAXMOM,ZMAX, MINMOM,ZMAX,J4,KDIRT,NWHL,NWHEEL,
     1 LMMAX,LMMIN)
C
C     FINAL CHECK OF MINIMUM AXLE TRAIN MOMENT
C
      DO 160 J1=1,3,2
      J2=J1-2
      ZMIN=0.
```

```
      DO 158 J3=1,NWHEEL
  158 ZMIN=ZMIN+INFLM(LMMIN(J3)+J2)*PWHEEL(J3)
      KDIRT=-1
      IF(LMMIN(2).GT.LMMIN(1)) KDIRT=1
      J4=LMMIN(1)+J2
  160 CALL SORTAX  (MAXMOM,ZMIN,MINMOM,ZMIN,J4,KDIRT,NWHL,NWHEEL,
     1  LMMAX,LMMIN)
C
C     FINAL CHECK OF MAXIMUM AXLE TRAIN SHEAR
C
      DO 168 J1=1,3,2
      J2=J1-2
      ZVAX=0.
      DO 162 J3=1,NWHEEL
  162 ZVAX=ZVAX+INFLV(LVMAX(J3)+J2)*PWHEEL(J3)
      IF(LVMAX(2).GT.LVMAX(1)) KDIRT=1
      J4=LVMAX(1)+J2
  168 CALL SORTAX  (MAXSHR,ZVAX,MINSHR,ZVAX,J4,KDIRT,NWHL,NWHEEL,
     1   LVMAX,LVMIN)
      ZMSMAX=0.
      DO 169 J1=1,NWHEEL
  169 ZMSMAX=ZMSMAX+INFLM(LVMAX(J1))*PWHEEL(J1)
C
C      FINAL CHECK OF MINIMUM AXLE TRAIN SHEAR
C
      DO 268 J1=1,3,2
      J2=J1-2
      ZVIN=0.
      DO 262 J3=1,NWHEEL
  262 ZVIN=ZVIN+INFLV(LVMIN(J3)+J2)*PWHEEL(J3)
      DO 264 J3=1,NWHEEL
      IF(LVMIN(J3)+J2.NE.NDISC) GO TO 264
      ZVIN=ZVIN-PWHEEL(J3)
      GO TO 266
  264 CONTINUE
  266 KDIRT=-1
      IF(LVMIN(2).GT.LVMIN(1))KDIRT=1
      J4=LVMIN(1)+J2
  268 CALL SORTAX(MAXSHR,ZVIN,MINSHR,ZVIN,J4,KDIRT,NWHL,NWHEEL,LVMAX,
     1LVMIN   )
      ZMSMIN=0.
      DO 269 J1=1,NWHEEL
  269 ZMSMIN=ZMSMIN+INFLM(LVMIN(J1))*PWHEEL(J1)
      LLMAXP(JPNT,JSPAN)=MAXMOM
      LLMAXN(JPNT,JSPAN)=MINMOM
      LLSAXP(JPNT,JSPAN)=MAXSHR
      LLSAXN(JPNT,JSPAN)=MINSHR
      MSAXP(JPNT,JSPAN)=ZMSMAX
      MSAXN(JPNT,JSPAN)=ZMSMIN
C*****************************************************************************
C********LANE LOADING*********************************************************
C*****************************************************************************
  172 IF(LODKOD(1).EQ.0.AND.LODKOD(2).EQ.0) GO TO 186
      J1=NDISC/2
      J2=J1*2
      IF(J2.EQ.NDISC) JSTRT=200
      IF(J2.LT.NDISC) JSTRT=199
      JSTOP=NODSTP+2
```

```
C
C     SELECT MAX.AND MIN.EXTREMES OF INFLM(I) AND INFLV(I)
C
      ZMAX1=0.
      ZMIN1=0.
      ZMIN2=0.
      ZVAX=0.
      ZVIN=0.
      J2=0
      DO 176 J1=1,NEXTRM
      Q=INFLM(LEXTRM(J1))
      IF(Q.LE.ZMAX1) GO TO 174
      ZMAX1=Q
  174 IF(Q.GE.ZMIN1) GO TO 176
      ZMIN1=Q
      J2=LEXTRM(J1)
  176 CONTINUE
      IF(J2.EQ.0) GO TO 180
      STORE=INFLM(J2)
      INFLM(J2)=10000.
      DO 178 J1=1,NEXTRM
      Q=INFLM(LEXTRM(J1))
      IF(Q.GE.ZMIN2) GO TO 178
      ZMIN2=Q
  178 CONTINUE
      INFLM(J2)=STORE
  180 DO 183 J1=1,NEXTRV
      J2=LEXTRV(J1)
      Q=INFLV(J2)
      IF(Q.LE.ZVAX) GO TO 182
      ZVAX=Q
      ZMSVAX=INFLM(J2)
  182 IF(Q.GE.ZVIN) GO TO 185
      ZVIN=Q
      ZMSVIN=INFLM(J2)
  185 IF(J2.NE.NDISC) GO TO 183
      Q=INFLV(J2)-1.
      IF(Q.GE.ZVIN) GO TO 183
      ZVIN=Q
  183 CONTINUE
C
C     NUMERICAL INTEGRATION OF POSITIVE AND NEGATIVE AREAS UNDER
C     INFLM(I) AND INFLV(I) CURVES
C
      ZMSMAX=0.
      ZMSMIN=0.
      MAXMOM=0.
      MINMOM=0.
      SVAX=0.
      SVIN=0.
      DO 184 J1=JSTRT,JSTOP,2
      AM=INFLM(J1)+INFLM(J1+2)
      AV=INFLV(J1)+INFLV(J1+2)
      IF(AM.LT.0.) MINMOM=MINMOM+AM
      IF(AM.GT.0.) MAXMOM=MAXMOM+AM
      IF(AV.LT.0.) SVIN=SVIN+AV
      IF(AV.GT.0.) SVAX=SVAX+AV
      IF(AV.LT.0.) ZMSMIN=ZMSMIN+AM
```

```
      IF(AV.GT.0.) ZMSMAX=ZMSMAX+AM
  134 CONTINUE
      AV=INFLV(NDISC)+INFLV(NDISC-1)
      IF(AV.GT.0.) SVAX=SVAX-AV
      IF(AV.GT.0.) SVIN=SVIN-AV
      SVIN=SVIN-1.
      AREAM=MAXMOM+MINMOM
      AREAV=SVAX+SVIN
      IF(JPNT.EQ.1.AND.JSPAN.EQ.1) AREAV=AREAV+1.0
      CALL IMPACT (1,L,JPNT,JSPAN,RIMP ,N)
      MAXMOM=MAXMOM*SCLLNE*RIMP+ZMAX1*SCLCOM*RIMP
      IF(MINMOM.LT.0) CALL IMPACT (2,L,JPNT,JSPAN,RIMP,N)
      IF(MINMOM.GT.0) CALL IMPACT (1,L,JPNT,JSPAN,RIMP,N)
      MINMOM=MINMOM*SCLLNE*RIMP+(ZMIN1+ZMIN2)*SCLCOM*RIMP
      CALL IMPACT (3,L,JPNT,JSPAN,RIMP,N)
      MAXSHR=SVAX*SCLLNE*RIMP+ZVAX*SCLCOV*RIMP
      MINSHR=SVIN*SCLLNE*RIMP+ZVIN*SCLCOV*RIMP
      ZMSMAX=ZMSMAX*SCLLNE*RIMP+ZMSVAX*SCLCOV*RIMP
      ZMSMIN=ZMSMIN*SCLLNE*RIMP+ZMSVIN*SCLCOV*RIMP
      IF(LLMASP(JPNT,JSPAN).GE.MAXMOM) GO TO 350
      LLMASP(JPNT,JSPAN)=MAXMOM
  350 IF (LLMASN(JPNT,JSPAN).LE.MINMOM) GO TO 352
      LLMASN(JPNT,JSPAN)=MINMOM
  352 IF (LLSASP(JPNT,JSPAN).GE.MAXSHR) GO TO 354
      MSASP(JPNT,JSPAN)=ZMSMAX
      LLSASP(JPNT,JSPAN)=MAXSHR
  354 IF (LLSASN(JPNT,JSPAN).LE.MINSHR) GO TO 356
      LLSASN(JPNT,JSPAN)=MINSHR
      MSASN(JPNT,JSPAN)=ZMSMIN
  356 CONTINUE
C
C
C      COMPUTE MOMENT AT POINT OF MAX. AND MIN. SHEAR
C
C***********************************************************************
C*******UNIFORMLY DISTRIBUTED DEAD LOAD LOAD ON CONTINOUS BEAM *******
C***********************************************************************
C
  186 IF(LODKOD(4).EQ.0) GO TO 192
      IF(LODKOD(1).EQ.1.OR.LODKOD(2).EQ.1) GO TO 190
      AREAM=0.
      AREAV=0.
      J1=NDISC/2
      J2=J1*2
      IF(J2.EQ.NDISC) JSTRT=200
      IF(J2.LT.NDISC) JSTRT=199
      JSTOP=NODSTP+2
      DO 188 J1=JSTRT,JSTOP,2
      AREAM=AREAM+INFLM(J1)+INFLM(J1+2)
  188 AREAV=AREAV+INFLV(J1)+INFLV(J1+2)
      AREAV=AREAV-1.0
      IF(JPNT.EQ.1.AND.JSPAN.EQ.1) AREAV=AREAV+1.0
  190 MAXMOM=AREAM
      MAXSHR=AREAV
      DLMUNF(JPNT,JSPAN)=MAXMOM
      DLSUNF(JPNT,JSPAN)=MAXSHR
  192 CONTINUE
 1000 CONTINUE
```

```
      RETURN                                                    00026600
      END                                                       00026610
```

```
      SUBROUTINE SORTAX     (MAXEFT,ZMAX,MINEFT,ZMIN,J1,KDIRT,NWHL,JW,
     1  LMAX,LMIN)
      REAL*4 MAXEFT,MINEFT
      DIMENSION NWHL(14),LMAX(15),LMIN(15)
C
C
C
C     COMPARE MOMENT AT CURRENT POINT TO PREVIOUS MAX. AND MIN. VALUES
C
  100 IF(ZMAX.LE.MAXEFT) GO TO 110
      MAXEFT=ZMAX
      LMAX(1)=J1
      DO 102 J2=2,JW
  102 LMAX(J2)=J1+KDIRT*NWHL(J2-1)
  110 IF(ZMIN.GE.MINEFT) RETURN
      MINEFT=ZMIN
      LMIN(1)=J1
      DO 112 J2=2,JW
  112 LMIN(J2)=J1+KDIRT*NWHL(J2-1)
      RETURN
      END
```

```
      SUBROUTINE SORTIL(ZINF,ZMAX,JMAX,ZMIN,JMIN,KSTRT,KSTOP,JJ)
      DIMENSION ZINF(800)
      ZMIN=10000.
      ZMAX=-10000.
      DO 12 J2=KSTRT,KSTOP,2
      Z=ZINF(J2)
      IF(Z.LE.ZMAX) GO TO 10
      ZMAX=Z
      JMAX=J2
   10 IF(Z.GE.ZMIN) GO TO 12
      ZMIN=Z
      JMIN=J2
   12 CONTINUE
      IF(JJ.EQ.0) RETURN
      IF(KSTRT.LE.JJ.AND.KSTOP.GE.JJ) GO TO 14
      RETURN
   14 Z=ZINF(JJ)-1.0
      IF(Z.GE.ZMIN) RETURN
      ZMIN=Z
      JMIN=JJ
      RETURN
      END
```

```
C
C
      SUBROUTINE SORTHS      (MAXEFT,ZMAX,MINEFT,ZMIN,J1,J2,J3MAX,J3MIN,
     1 LMAX,LMIN)
      REAL*4 MAXEFT,MINEFT
      DIMENSION LMAX(15),LMIN(15)
C
C     COMPARE MOMENT AT CURRENT POINT FROM H-LOADING OR MAX. AND MIN.
C     MOMENT AT CURRENT POINT FROM HS-LOADING TO PREVIOUS
C     MAX.AND.MIN.VALUES
C
  100 IF(ZMAX.LE.MAXEFT) GO TO 110
      MAXEFT=ZMAX
      LMAX(1)=J1
      LMAX(2)=J2
      LMAX(3)=J3MAX
  110 IF(ZMIN.GE.MINEFT) RETURN
      MINEFT=ZMIN
      LMIN(1)=J1
      LMIN(2)=J2
      LMIN(3)=J3MIN
      RETURN
      END
```

```
      SUBROUTINE REACTN(L,SL)
      REAL*4 INFLM,INFLV,L
      COMMON/DUMP /A(10,10),ALPHA(10,10),INFLM(1400),INFLV(1400),
     1REACT(10,1000),LMMIN(15),LMMAX(15),LVMAX(15),LVMIN(15),LEXTRM(30),
     2LEXTRV(30),NODDSN(11,10)
      COMMON/BLK 1/ NPNTS,JPNT,JSPAN,N
      DIMENSION L(10),SL(10)
C               THIS SUBROUTINE COMPUTES INFLUENCE LINE ORDINATES FOR
C               REACTION FORCES
C
      NM1=N-1
C
C               COMPUTE ALPHA COEFFICIENTS
C
      DO 24 K=1,N
      DO 24 J=1,N
      SLKM1=0.
      SLJM1=0.
      IF(K.GT.1) SLKM1=SL(K-1)
      IF(J.GT.1) SLJM1=SL(J-1)
   24 ALPHA(K,J)=(SL(N)**3-SLKM1**3)/3.-(SLJM1+SLKM1)*(SL(N)**2-SLKM1**2
     *)/2.+SLJM1*SLKM1*(SL(N)-SLKM1)+L(N)*(SL(N)-SLJM1)*(SL(N)-SLKM1)
C
C               COMPUTE COEFFICIENT MATRIX A
C
      DO 26 K=1,NM1
      SLKM1=0.
      IF(K.GT.1) SLKM1=SL(K-1)
      DO 26 J=1,K
      SLJM1=0.
      IF(J.GT.1) SLJM1=SL(J-1)
      A(K,J)=(SL(N)-SLKM1)*(SL(N)-SLJM1)*ALPHA(N,N)/L(N)**2-(SL(N)-
     *SLKM1)*ALPHA(N,J)/L(N)-(SL(N)-SLJM1)*ALPHA(N,K)/L(N)
      A(K,J)=A(K,J)+ALPHA(K,J)
   26 A(J,K)=A(K,J)
C
C               FORM RIGHT HAND SIDE VECTORS
C
      NPNTS=0
      Z=0.
      DO 40 J=1,20000
      NPNTS=NPNTS+1
      DO 32 K=1,NM1
      SLKM1=0.
      IF(K.GT.1) SLKM1=SL(K-1)
      IF(Z.LE.SLKM1) T=SLKM1
      IF(Z.GT.SLKM1) T=Z
      IF(Z.LE.SL(NM1)) Q=SL(NM1)
      IF(Z.GT.SL(NM1)) Q=Z
   32 REACT(K,J)=(SL(N)**3-T**3)/3.-(Z+SLKM1)*(SL(N)**2-T**2)/2.+
     * Z*SLKM1*(SL(N)-T)-(SL(N)-Z)*(ALPHA(N,K)-(SL(N)-SLKM1)*ALPHA(N,N)
     */L(N))/L(N)-(SL(N)-SLKM1)*((SL(N)**3-Q**3)/3.-(Z+SL(NM1))*(SL(N)**
     *  2-Q**2)/2.+Z*SL(NM1)*(SL(N)-Q))/L(N)
      Z=Z+1.
      IF(Z.GT.SL(N)) GO TO 42
   40 CONTINUE
   42 CONTINUE
      CALL MATINV(A,NM1,REACT,NPNTS,DET,10,1000)
```

```
      Z=0.
      DO 55 J=1,NPNTS
      SUM1=0.
      SUM=0.
      DO 52 K=1,NM1
      SLKM1=0.
      IF(K.GT.1) SLKM1=SL(K-1)
   52 SUM=SUM+REACT(K,J)*(SL(N)-SLKM1)
      REACT(N,J)=(SL(N)-Z-SUM)/L(N)
   55 Z=Z+1.
      RETURN
      END
```

```
      SUBROUTINE INFLNE(L,SL)
      REAL*4 INFLM,INFLV,L
      COMMON/DUMP /A(10,10),ALPHA(10,10),INFLM(1400),INFLV(1400),
     1REACT(10,1000),LMMIN(15),LMMAX(15),LVMAX(15),LVMIN(15),LEXTRM(30),
     2LEXTRV(30),NODDSN(11,10)
      COMMON/BLK 1/ NPNTS,JPNT,JSPAN,N
      DIMENSION L(10),SL(10)
      NODDES=NODDSN(JPNT,JSPAN)
      J2=NODDES-200
      Z=FLOAT(J2)
      DO 22 J1=1,NPNTS
C
C      COMPUTE INFLM(J1)
C
      ZM=REACT(1,J1)*Z
      IF(JSPAN.EQ.1) GO TO 12
      DO 10 J2=2,JSPAN
   10 ZM=ZM+REACT(J2,J1)*(Z-SL(J2-1))
   12 J3=J1-1
      XARM=Z-FLOAT(J3)
      IF(XARM.LE.0.) GO TO 14
      ZM=ZM-XARM
C
C      COMPUTE INFLV(J1)
C
C
C     SUM CONTRIBUTIONS FROM REACTIONS
C
   14 XV=0.
      DO 16 J2=1,JSPAN
   16 XV=XV+REACT(J2,J1)
C
C      ADD CONTRIBUTION FROM UNIT LOAD
C
      JNODE=199+J1
      IF(JNODE.LT.NODDES) XV=XV-1.
      INFLM(J1+199) = ZM
   22 INFLV(199+J1)=XV
C
C      SET INFLM(I) AND INFLV(I) VALUES TO ZERO OVER SUPPORTS
C
      DO 30 J3=1,N
      JLFT=NODDSN(1,J3)
      INFLM(JLFT)=0.
   30 INFLV(JLFT)=0.
      JRGT=NODDSN(11,N)
      INFLM(JRGT)=0.
      INFLV(JRGT)=0.
      IF(JPNT.EQ.1) INFLV(NODDSN(1,JSPAN))=1.
      IF(JPNT.EQ.11) INFLV(NODDSN(11,JSPAN))=0.
      IF(JPNT.EQ.11.AND.JSPAN.EQ.N) GO TO 32
      GO TO 36
   32 DO 34 J3=1,NPNTS
   34 INFLM(199+J3)=0.
   36 CONTINUE
C
C      SET INFLV(I) AND INFLM(I) TO ZERO FOR ALL NODES TO LEFT OF FIRST
C      SUPPORT AND TO RIGHT OF LAST SUPPORT
```

```
C
      DO 7 I=1,199
      INFLM(I)=0.
    7 INFLV(I)=0.
      J=NPNTS+200
      K=J+200
      DO 8 I=J,K
      INFLM(I)=0.
    8 INFLV(I)=0.
      J=NPNTS+199
      RETURN
      END
```

```
      SUBROUTINE IMPACT (ITEST,L,JPNT,JSPAN,RIMP,N)
      REAL L(10)
      GO TO (100,200,300),ITEST
  100 RL=L(JSPAN)
      GO TO 400
  200 IF(JSPAN.EQ.1) RL=(L(1)+L(2))/2.
      IF(JSPAN.EQ.1) GO TO 400
      IF(JSPAN.EQ.N) RL=(L(N)+L(N-1))/2.
      IF(JSPAN.EQ.N) GO TO 400
      IF(JPNT.GT.6) RL=(L(JSPAN)+L(JSPAN+1))/2.
      IF(JPNT.LE.6) RL =(L(JSPAN)+L(JSPAN-1))/2.
      GO TO 400
  300 IF(JPNT.GT.6) RL=(JPNT-1)*L(JSPAN)*.1
      IF(JPNT.LE.6) RL=L(JSPAN)-(JPNT-1)*L(JSPAN)*.1
  400 RI=AMIN1(.30,50./(RL+125.))
      RIMP=1.+RI
      RETURN
      END
```