COMPUTER PROGRAM
FOR
PLATE AND STIFFENED PLATE
ELEMENT MODELS

Prepared by:
Adang Surahman
Alexis Ostapenko

Fritz Engineering Laboratory Library

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1. INTRODUCTION

The two computer programs described here are for generating the effective stress-strain relationship of plates and stiffened plates by using the methods given by A. Ostapenko and A. Surahman in "Structural Element Models for Hull Strength Analysis", Fritz Engineering Laboratory Report No. 480.6, Lehigh University, September 1982.

Each computer program consists of a main program and a number of subroutines. The function of each subroutine is briefly described for each case and the limitations of validity of the program are stated. Main emphasis is put on the definition of the input and output formats and of the principal variables used in the programs.
2. PLATE MODEL --- PROGRAM MPLATE

2.1 Components of Computer Program

1. Main program MPLATE reads and prints the input data (material properties, geometrical configuration, final strain and number of strain increments), and prints the output results (nondimensional stress and strain).

2. Subroutine SRPLAT generates stress-strain curves for the given aspect ratio, slenderness ratio, number of strain increments and final strain. This subroutine requires subroutines FSE and SUM.

3. Subroutine FSE defines coordinate functions \( f(e) \) and their values for a given relative strain \( e \) (Eqs. 2.13 and 2.14 of the source reference, see page 1).

4. Subroutine SUM computes the relative stress for the given values of aspect ratio, slenderness ratio and relative strain.

2.2 Ranges of Validity

The following variables of the method are limited in their ranges of application:

- **ALF** Aspect ratio \( 0.3 < ALF < 1.0; \) but for long plates \( ALF > 1.0 \), \( ALF = 1.0 \)
- **BET** Slenderness ratio \( 1.0 < BET < 3.5 \); this means, for example, for \( SY = 350 \text{ MPa} \) (50 ksi), \( 24 < (A/T \text{ or } B/T) < 110 \)
- **EL** Relative strain \( 0.0 < EL < 3.0 \)

For stocky plates (\( BET < 1.0 \)), a conservative approximation is made by setting \( BET = 1.0 \).
2.3 Data Preparation and Output Results

A. The following input data cards are required:

Card 1. Data card for geometrical and material properties
Format: 5F10.0
A Length of plate
B Width of plate
T Thickness of plate
SY Yield stress
E Modulus of elasticity

Card 2. Data card for number of strain increments and maximum strain value
Format: I10,F10.0
NE Number of strain increments
ELF Final strain

Note that for more than one stress-strain relationship, cards No. 1 and 2 are to be repeated. To terminate the input data, a blank card should be placed at the end.

B. The output consists of two sets of the arrays of relative strains ER and of relative stresses SR.

2.4 Example

Application of this program is illustrated by the following example:

Input data cards:
32.0 15.0 0.25 32.22 29000.
20 0.025
(blank card)
The computed results for this example are shown in the attached computer printout, at the end of the code listing (Appendix A).

2.5 Definition of Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Length of plate</td>
</tr>
<tr>
<td>ALF</td>
<td>Aspect ratio</td>
</tr>
<tr>
<td>B</td>
<td>Width of plate</td>
</tr>
<tr>
<td>BET</td>
<td>Slenderness ratio</td>
</tr>
<tr>
<td>C</td>
<td>Vector of coefficients</td>
</tr>
<tr>
<td>D</td>
<td>Vector of coefficients for variable strain</td>
</tr>
<tr>
<td>DE</td>
<td>Strain increment</td>
</tr>
<tr>
<td>DO</td>
<td>Stress constant for linear stress-strain behavior</td>
</tr>
<tr>
<td>E</td>
<td>Modulus of elasticity</td>
</tr>
<tr>
<td>EL</td>
<td>Dummy variable for strain</td>
</tr>
<tr>
<td>ELF</td>
<td>Final strain</td>
</tr>
<tr>
<td>EO</td>
<td>Limit of relative strain below which the stress-strain relationship is linear</td>
</tr>
<tr>
<td>ER</td>
<td>Relative strains</td>
</tr>
<tr>
<td>EY</td>
<td>Yield strain</td>
</tr>
<tr>
<td>FAB</td>
<td>Product of coordinate functions of ALF and BET</td>
</tr>
<tr>
<td>FE</td>
<td>Individual coordinate function for relative strain</td>
</tr>
<tr>
<td>NE</td>
<td>Number of strain increments</td>
</tr>
<tr>
<td>S,TS</td>
<td>Dummy variables for relative stresses</td>
</tr>
<tr>
<td>SR</td>
<td>Relative stresses</td>
</tr>
<tr>
<td>SY</td>
<td>Yield stress of plate</td>
</tr>
<tr>
<td>T</td>
<td>Thickness of plate</td>
</tr>
</tbody>
</table>
3. STIFFENED PLATE MODEL --- PROGRAM MSTPLA

3.1 Components of Computer Program

1. Main program MSTPLA reads and prints the input data (material properties, geometrical configuration, final strain and number of strain increments), and prints the output results (nondimensional stress and strain).

2. Subroutine STPLA generates the stress-strain curves for the following input parameters: slenderness ratio of the plate, slenderness ratio of the stiffened plate, ratio of the area of the stiffener to the area of the plate, ratio of the area of the flange to the area of the stiffener, number of strain increments, and the final strain. This subroutine requires subroutine FSE.

3. Subroutine FSE defines coordinate functions \( f(e) \) and their values for a given relative strain \( e \) (Eq. 3.18 of the source reference, see page 1).

3.2 Ranges of Validity

The following variables of the method are limited in their ranges of application:

- **BET** Plate slenderness  \( 1.0 < \text{BET} < 4.0 \)
- **AL** Panel slenderness  \( 20 < \text{AL} < 120 \)
- **R** Stiffener-to-plate area ratio  \( 0.2 < \text{R} < 0.5 \)
- **G** Flange-to stiffener area ratio  \( 0.0 < \text{G} < 0.6 \)
- **EL** Relative strain  \( 0.0 < \text{EL} < 2.0 \)

For stocky plates (\( \text{BET} < 1.0 \)), a conservative approximation is made by setting \( \text{BET} = 1.0 \).
3.3 Data Preparation and Output Results

A. The following input data cards are required:

Card 1. Data card for material properties
Format: 4F10.0
E  Modulus of elasticity
SY  Yield stress of plate
SW  Yield stress of web stiffener
SF  Yield stress of flange stiffener

Card 2. Data card for geometrical configuration
Format: 7F10.0
B  Width of plate
T  Thickness of plate
TW  Thickness of web of the stiffener
BW  Width of web of the stiffener
BF  Width of flange of the stiffener
TF  Thickness of flange of the stiffener
A  Length of stiffened plate

Card 3. Data card for number of strain increments and maximum strain value
Format: I10,F10.0
NE  Number of strain increments
ELF  Final strain

Note that for more than one stress-strain relationship, cards No. 1 and 3 are to be repeated. To terminate the input data, a blank card should be placed at the end.

B. The output consists of two sets of the arrays of relative strains ER and of relative stresses SR.
3.4 Example

Application of this program is illustrated by the following example:

Input data cards:

```
29100.  39.7  40.0  37.5
15.0   0.2604 0.168  2.92  3.93  0.203  58.5
```

(blank card)

The computed results for this example are shown in the attached computer
printout, at the end of the code listing (Appendix B).

3.5 Definition of Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Length of plate</td>
</tr>
<tr>
<td>AF</td>
<td>Area of flange of the stiffener</td>
</tr>
<tr>
<td>AL</td>
<td>Slenderness ratio of stiffened plate</td>
</tr>
<tr>
<td>AP</td>
<td>Area of plate</td>
</tr>
<tr>
<td>AR</td>
<td>Dummy variable for radius of gyration</td>
</tr>
<tr>
<td>AT</td>
<td>Total area of stiffened plate</td>
</tr>
<tr>
<td>AW</td>
<td>Area of web of the stiffener</td>
</tr>
<tr>
<td>B</td>
<td>Width of plate</td>
</tr>
<tr>
<td>BET</td>
<td>Slenderness ratio</td>
</tr>
<tr>
<td>BF</td>
<td>Width of flange of the stiffener</td>
</tr>
<tr>
<td>BW</td>
<td>Width of web of stiffener</td>
</tr>
<tr>
<td>C</td>
<td>Vector of coefficients</td>
</tr>
<tr>
<td>D</td>
<td>Vector of coefficients for variable strain</td>
</tr>
<tr>
<td>DE</td>
<td>Strain increment</td>
</tr>
</tbody>
</table>
E  Modulus of elasticity
EL  Dummy variable for strain
ELF Final strain
ER  Relative strains
EY  Yield strain
F  Product of coordinate functions
FE  Individual coordinate function for relative strain
FI  Dummy variable for moment of inertia
G  Ratio of the area of the flange to the total area of the stiffener
NE  Number of strain increments
Q  Substitute variable for \((AL)^3\)
R  Ratio of the area of the stiffener to the area of the plate
S,TS Dummy variables for relative stresses
SF  Yield stress of the flange of the stiffener
SR  Relative stresses
SW  Yield stress of the web of the stiffener
SY  Yield stress of the plate
T  Thickness of the plate
TF  Thickness of the flange of the stiffener
TW  Thickness of the web of the stiffener
YBAR Location of the elastic centroid of the combined plate-stiffener section
Appendix A. LISTING OF PROGRAM MPLATE
PROGRAM MPLATE(INPUT, OUTPUT, TAPE5=INPUT, TAPE6=OUTPUT)

*******************************************************************************

THIS PROGRAM GENERATES STRESS-STRAIN RELATIONSHIP FOR PLATES
EACH STRESS-STRAIN RELATIONSHIP REQUIRES:
1) GEOMETRICAL AND MATERIAL PROPERTY DATA CARD
2) NUMBER OF INCREMENT AND FINAL STRAIN DATA CARD
REPEAT CARDS 1 AND 2 FOR ADDITIONAL DATA, OR
PUT BLANK CARD TO TERMINATE THE DATA

*******************************************************************************

DIMENSION ER(50), SR(50)
IN=5
IO=6

*******************************************************************************

DEFINITION OF VARIABLES

A LENGTH OF PLATE
ALF ASPECT RATIO
B WIDTH OF PLATE
BET SLENDERNESS RATIO
DE STRAIN INCREMENT
E MODULUS OF ELASTICITY
ELF FINAL STRAIN
ER RELATIVE STRAINS
EY YIELD STRAIN
NE NUMBER OF INCREMENTS
SR RELATIVE STRESSES
SY YIELD STRESS
T THICKNESS OF PLATE

*******************************************************************************

1 FORMAT(8F10.3)
4 FORMAT(I10, F10.0)
5 FORMAT(10X, 8G12.4)
7 FORMAT(/,16X,3HALF,9X,3HBET,/) 
8 CONTINUE
11 FORMAT(1H1,9X,35H MATERIAL AND GEOMETRICAL PROPERTIES,2
10X,12HFINAL STRAIN,/) 
12 FORMAT(/,10X,16HSTRAIN STRESS,/) 

INPUT DATA: GEOMETRICAL AND MATERIAL PROPERTIES
READ(IN,1)A,B,T,SY,E
IF(A.LE.0.) GO TO 6

INPUT DATA: NUMBER OF INCREMENTS AND FINAL STRAIN
READ(IN,4)NE,ELF
WRITE(IO,11)
WRITE(IO,5)A,B,T,SY,E,ELF

COMPUTE YIELD STRAIN

EY=SY/E

COMPUTE ASPECT RATIO FOR WIDE PLATE

ALF=A/9

IF(ALF.GT.1.)GO TO 2

COMPUTE SLENDERNESS RATIO FOR WIDE PLATE

BET=(A/T)*SQRT(EY)
GO TO 3

COMPUTE ASPECT RATIO AND SLENDERNESS RATIO FOR LONG PLATE

2 ALF=1.0
BET=(B/T)*SQRT(EY)

3 CONTINUE
WRITE(IO,7)
WRITE(IO,5)ALF,BET

CORRECTION FOR STOCKY PLATE

IF(BET.LT.1.)BET=1.0

COMPUTE STRAIN INCREMENT AND NONDIMENSIONALIZE

DE=ELF/FLOAT(NE)
DE=DE/EY

COMPUTE RELATIVE STRESSES FOR GIVEN ASPECT AND SLENDERNESS RATIOS, NUMBER AND MAGNITUDE OF STRAIN INCREMENTS

CALL SRPLAT(ALF,BET,NE,DE,ER,SER)

PRINT THE OUTPUT

WRITE(IO,12)
DO 9 I=1,NE
WRITE(IO,5)ER(I),SR(I)
9 CONTINUE

GO TO 8
6 CONTINUE
STOP
END

SUBROUTINE SRPLAT(ALF,BET,NE,DE,ER,SER)

THIS SUBROUTINE GENERATES STRESS-STRAIN CURVES

INPUT SUBROUTINE VARIABLES: ALF, BET, NE, AND DE
**OUTPUT SUBROUTINE VARIABLES: ER AND SR**

**DIMENSION** ER(NE), SR(NE), FE(4), FAB(6), D(4), C(24)

**DATA** C/1.87047, -8.29395, 6.43772, -2.30871, 10.7606, -6.561366, -2.64158, 12.2138, -9.15021, 2.86624, -12.1271, 8.8312, -2.0.70829, 5.16043, -2.73789, 1.17787, -6.9439, 4.95664, 1.07311, -3.67336, 1.44893, 0.63884, 0.53692, 0.48398/

**DEFINITION OF VARIABLES**

- ALF: ASPECT RATIO (INPUT)
- BET: SLENDERNESS RATIO (INPUT)
- C: VECTOR OF COEFFICIENTS (24 TERMS)
- D: VECTOR OF COEFFICIENTS FOR VARIABLE STRAIN
- DE: RELATIVE STRAIN INCREMENT (INPUT)
- DO: STRESS CONSTANT FOR LINEAR RANGE OF STRESS-STRAIN BEHAVIOR
- EL: DUMMY VARIABLE FOR STRAIN
- EO: LIMIT OF RELATIVE STRAIN BELOW WHICH THE STRESS-STRAIN RELATIONSHIP IS LINEAR
- ER: RELATIVE STRAINS (OUTPUT)
- FAB: PRODUCT COORDINATE FUNCTION OF ALF AND BET
- FE: INDIVIDUAL COORDINATE FUNCTION FOR RELATIVE STRAIN
- ME: NUMBER OF STRAIN INCREMENTS (INPUT)
- S, TS: DUMMY VARIABLES FOR RELATIVE STRESSES
- SR: RELATIVE STRESSES (OUTPUT)

**GENERATE PRODUCT COORDINATE FUNCTION FAB**

```c
DO 1 I=1,3
   J=I+3
   FAB(I)=ALF**(I-1)/BET
   FAB(J)=FAB(I)/BET
1 CONTINUE

**COMPUTE COEFFICIENTS OF D**

```c
DO 2 I=1,4
   D(I)=0.0
   K=(I-1)*6
   DO 4 J=1,6
      KJ=K+J
      D(I)=D(I)+FAB(J)*C(KJ)
4 CONTINUE
2 CONTINUE

**COMPUTE THE LIMIT OF LINEAR RANGE EO**

```c
EO=(0.117*ALF*BET)/(1.0.15*BET)
```

**COMPUTE LINEAR STRESS CONSTANT DO**

```c
CALL FSE(FE,4,EO)
```
CALL SUM(TS,0,FE,4)
DO=TS/EO
IF(DD.GT.1.0)DO=1.0

EL=0.0

GENERATE STRESS-STRAIN RELATIONSHIP

CO 3 MM=1,NE
EL=EL+DE
ER(MM)=EL

LINEAR RANGE

S=EL*DO
IF(EL.LE.EO)GO TO 10

NONLINEAR RANGE

CALL FSE(FE,4,EL)
CALL SUM(TS,0,FE,4)
IF(TS.LT.S)S=TS
IF(S.GT.1.0)S=1.0

10 CONTINUE
SR(MM)=S
3 CONTINUE
RETURN
END

SUBROUTINE FSE(FE,N,EL)

THIS SUBROUTINE DEFINES INDIVIDUAL COORDINATE FUNCTIONS FE

DIMENSION FE(N)
FE(1)=EL
FE(2)=EL/(1.+0.5*EL**3)
FE(3)=EL/(1.+0.3*EL**2)
FE(4)=EL/(1.+3.*EL)
IF(EL.LE.1.) GO TO 6
ZZ=EL**10.
FE(1)=EL**(1./ZZ)
6 CONTINUE
RETURN
END

SUBROUTINE SUM(S,D,FE,N)

THIS SUBROUTINE COMPUTES RELATIVE STRESS

DIMENSION D(N),FE(N)
S=0.
DO 1 I=1,N
  1 S=S+D(I)*FE(I)
RETURN
END
<table>
<thead>
<tr>
<th>STRAIN</th>
<th>STRESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1125</td>
<td>7.140E-01</td>
</tr>
<tr>
<td>0.2250</td>
<td>1428</td>
</tr>
<tr>
<td>0.3375</td>
<td>2142</td>
</tr>
<tr>
<td>0.4500</td>
<td>2856</td>
</tr>
<tr>
<td>0.5625</td>
<td>3489</td>
</tr>
<tr>
<td>0.6750</td>
<td>4047</td>
</tr>
<tr>
<td>0.7876</td>
<td>4521</td>
</tr>
<tr>
<td>0.9001</td>
<td>4911</td>
</tr>
<tr>
<td>1.013</td>
<td>5218</td>
</tr>
<tr>
<td>1.125</td>
<td>5462</td>
</tr>
<tr>
<td>1.238</td>
<td>5645</td>
</tr>
<tr>
<td>1.350</td>
<td>5770</td>
</tr>
<tr>
<td>1.463</td>
<td>5845</td>
</tr>
<tr>
<td>1.575</td>
<td>5880</td>
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<tr>
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<td>5881</td>
</tr>
<tr>
<td>1.800</td>
<td>5856</td>
</tr>
<tr>
<td>1.913</td>
<td>5810</td>
</tr>
<tr>
<td>2.025</td>
<td>5746</td>
</tr>
<tr>
<td>2.138</td>
<td>5663</td>
</tr>
<tr>
<td>2.250</td>
<td>5582</td>
</tr>
</tbody>
</table>
Appendix B. LISTING OF PROGRAM MSTPLA
PROGRAM HSTPLA(INPUT, OUTPUT, TAPE5=INPUT, TAPE6=OUTPUT)

*****************************************************************************

THIS PROGRAM COMPUTES STRESS-STRAIN RELATIONSHIP FOR STIFFENED PLATES OF VARIOUS MATERIAL PROPERTIES AND GEOMETRICAL CONFIGURATIONS. EACH STRESS-STRAIN RELATIONSHIP REQUIRES:
1) MATERIAL PROPERTY DATA CARD
2) GEOMETRICAL CONFIGURATION DATA CARD
3) NUMBER OF INCREMENT AND FINAL STRAIN DATA CARD
REPEAT CARDS 1, 2 AND 3 FOR ADDITIONAL DATA, OR PUT BLANK CARD TO TERMINATE THE DATA

*****************************************************************************

DIMENSION ER(50), SR(50)
IN=5
IO=6

*****************************************************************************

DEFINITION OF SYMBOLS

A   LENGTH OF STIFFENED PLATE
AF  AREA OF FLANGE OF THE STIFFENER
AL  SLENDERNESS RATIO OF STIFFENED PLATE
AP  AREA OF PLATE
AR  DUMMY VARIABLE FOR RADIUS OF GYRATION
AT  TOTAL AREA OF STIFFENED PLATE
AW  AREA OF WEB OF THE STIFFENER
B   WIDTH OF PLATE
BET SLENDERNESS RATIO OF PLATE
BF  WIDTH OF FLANGE OF THE STIFFENER
BW  WIDTH OF WEB OF THE STIFFENER
DE  STRAIN INCREMENT
E   MODULUS OF ELASTICITY
ELF FINAL STRAIN
ER  RELATIVE STRAINS
FI  DUMMY VARIABLE FOR MOMENT OF INERTIA
G   RATIO OF THE AREA OF THE FLANGE TO THE TOTAL AREA OF THE STIFFENER
NE  NUMBER OF INCREMENTS
R   RATIO OF THE AREA OF THE STIFFENER TO THE AREA OF THE PLATE
SF  YIELD STRESS OF FLANGE OF THE STIFFENER
SR  RELATIVE STRESSES
SW  YIELD STRESS OF WEB OF THE STIFFENER
SY  YIELD STRESS OF PLATE
T   THICKNESS OF PLATE
TF  THICKNESS OF FLANGE OF THE STIFFENER
TW  THICKNESS OF WEB OF THE STIFFENER
YBAR LOCATION OF ELASTIC CENTROID

*****************************************************************************

1 FORMAT(8F10.0)
2 FORMAT(I10,F10.0)
INPUT DATA: MATERIAL PROPERTIES

READ(IN,1)E,SY,SW, SF
IF(E.LE.0.0)GO TO 6
WRITE(IO,4)
WRITE(IO,3)E,SY,SW, SF

INPUT DATA: GEOMETRICAL CONFIGURATION

READ(IN,1)B,T,TW,BW,BF,TF,A

INPUT DATA: NUMBER OF INCREMENTS AND FINAL STRAIN

READ(IN,2)NE,ELF
WRITE(IO,5)
WRITE(IO,3)B,T,TW,BW,BF,TF,A,ELF

COMPUTE YIELD STRAIN

EY=SY/E

COMPUTE CROSS-SECTIONAL PROPERTIES

AP=B*T
AF=TF*BF
AW=TW*BW
AT=AP+AW+AF
YBAR=(AF*(BW+(TF+T)/2.)+AW*(BW+T)/2.)/AT
FI=(AF*TF**2+AW*BW**2+AP*T**2)/12.
FI=FI+AP*YBAR**2+AW*(YBAR-(BW+T)/2.)**2
FI=FI+AF*(BW+(TF+T)/2.-YBAR)**2
AR=FI/AT

COMPUTE NONDIMENSIONAL PARAMETERS BET, AL, R, AND G

BET=SQRT(EY)*B/T
AL=A/SQRT(AR)
R=(AW*SW+AF*SF)/(AP*SY)
G=(AF*SF)/(AH*SW+AF*SF)
WRITE(IO,10)
WRITE(IO,3)BET,AL,R,G

CORRECTION FOR STOCKY PLATE

IF(BET.LT.1.0)BET=1.0

COMPUTE STRAIN INCREMENT AND NONDIMENSIONALIZE
DE=ELF/FLOAT(NE)
DE=DE/EY

COMPUTE RELATIVE STRESSES FOR GIVEN BET, AL, R, G, NUMBER AND MAGNITUDE OF STRAIN INCREMENTS

CALL STPLAT(BET,AL,R,G,NE,DE,ER,SR)

PRINT THE OUTPUT

WRITE(IO,7)
DO 9 I=1,NE
WRITE(IO,3)ER(I),SR(I)
9 CONTINUE

GO TO 8
6 CONTINUE
STOP
END

SUBROUTINE STPLAT(BET,AL,R,G,NE,DE,ER,SR)

THIS SUBROUTINE GENERATES STRES-STRAIN CURVES

INPUT SUBROUTINE VARIABLES: BET, AL, R, G, NE, AND DE
OUTPUT SUBROUTINE VARIABLES: ER AND SR

DIMENSION C(64),F(16),ER(NE),SR(NE),FE(4),D(4)
DATA C/-0.234335,0.166672,0.0839981,-0.0497556,-2.3432
14,5.05356,0.131313,-0.370513,1.54352,-1.8478,0.340607,
2-0.343781,6.66839,-9.47653,-1.20538,1.43628,6.82823,-7
3.17506,-0.521897,0.539135,-0.908406,-0.0927695,1.02432
4,-1.22688,-8.23679,9.00132,0.349496,-0.336788,5.78989,
5-3.32069,-0.332623,1.31386,-1.94062,1.91741,0.0846065,
6-0.0633754,2.44716,-1.58716,-0.109986,0.0619585,1.8189
72,-1.95978,0.24073,-0.254738,-3.44076,2.58061,-0.66221
81,0.714447,-2.90845,4.46035,0.4025,-0.664405,3.56832,-
96.47314,-1.2215,1.67663,5.26639,-5.62918,-0.979431,0.9
182608,-9.5838,10.8328,3.08281,-3.718297/

SOME OF THE COEFFICIENTS BELOW ARE MULTIPLIED BY
A FACTOR OF 10**5 DUE TO REPLACEMENT OF (AL)**3
BY Q=(AL)**3/10**5

******************************************************************************************************************

DEFINITION OF VARIABLES

AL SLENDERNESS RATIO OF STIFFENED PLATE (INPUT)
BET SLENDERNESS RATIO OF PLATE (INPUT)
C VECTOR OF COEFFICIENTS (64 TERMS)
D VECTOR OF COEFFICIENTS FOR VARIABLE STRAIN
DE RELATIVE STRAIN INCREMENT (INPUT)
EL DUMMY VARIABLE FOR STRAIN
ER RELATIVE STRAINS (OUTPUT)
F PRODUCT COORDINATE FUNCTION OF BET, AL, R,
NE  NUMBER OF INCREMENTS (INPUT)
G  RATIO OF THE AREA OF THE FLANGE TO THE
   TOTAL AREA OF THE STIFFENER (INPUT)
Q  SUBSTITUTE VARIABLE FOR AL**3
R  RATIO OF THE AREA OF THE STIFFENER TO
   THE AREA OF THE PLATE (INPUT)
S,T,S  DUMMY VARIABLES FOR STRAIN
SR  RELATIVE STRESSES (OUTPUT)

**************************
GENERATE PRODUCT COORDINATE FUNCTION F

N=0
Q=AL**3*1.E-05
DO 5 I=1,2
DO 5 II=1,2
DO 5 III=1,2
DO 5 IIII=1,2
N=N+1
F(N)=1./BET
IF(III.EQ.2)F(N)=F(N)/SQRT(BET)
IF(III.EQ.2)F(N)=F(N)*Q
IF(II.EQ.2)F(N)=F(N)*R
IF(I.EQ.2)F(N)=F(N)*G
5 CONTINUE

COMPUTE COEFFICIENTS OF D

DO 4 I=1,4
   D(I)=0.
   K=(I-1)*16
   DO 4 J=1,16
      KJ=K+J
      D(I)=D(I)+F(J)*C(KJ)
4 CONTINUE

GENERATE STRESS-STRAIN RELATIONSHIP

EL=0.
DO 2 K=1,NE
   EL=EL+OE
   CALL FSE(FE,4,EL)
   S=0.
   DO 1 I=1,4
      S=S+D(I)*FE(I)
      TS=EL
      IF(S.GT.TS)S=TS
      IF(S.GT.1.)S=1.
      IF(S.LT.0.01)S=0.01
      ER(K)=EL
      SR(K)=S
2 CONTINUE
RETURN
END
SUBROUTINE FSE(FE,N,EL)
THIS SUBROUTINE DEFINES INDIVIDUAL COORDINATE FUNCTIONS FE

DIMENSION FE(N)
FE(1)=EL
FE(2)=EL
FE(3)=EL
FE(4)=EL/(1.+0.4*EL**2)
IF(EL.LT.0.7) GO TO 6
ZZ=1./(EL+0.3)**3.5
FE(2)=(EL+0.3)**ZZ-0.3
FE(3)=0.5*(EL+0.3)**(16.-20.*EL)+0.2
IF(EL.LT.0.9) GO TO 6
FE(1)=0.625*(EL+0.1)**(4.3-3.*EL)+0.275
6 CONTINUE
RETURN
END
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B T TW BW BF TF LENGTH FINAL STRAIN

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