SSC-226

TANKER LONGITUDINAL STRENGTH ANALYSIS USER'S MANUAL AND COMPUTER PROGRAM

SHIP STRUCTURE COMMITTEE

1972

SHIP STRUCTURE COMMITTEE

AN INTERAGENCY ADVISORY
COMMITTEE DEDICATED TO IMPROVING
THE STRUCTURE OF SHIPS

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ADDRESS CORRESPONDENCE TO:

SECRETARY
SHIP STRUCTURE COMMITTEE
U.S. COAST GUARD HEADQUARTERS
WASHINGTON, D.C. 20591

SR-196
1972

Dear Sir:

One of the most important goals of the Ship Structure Committee is the improvement of methods for design and analysis of ship hull structures. This report is the second in a sequence of four Ship Structure Committee reports on a project directed toward development of an accurate, but less expensive, computer aided structural analysis method.

This report contains the User's Manual and computer program for the longitudinal strength analysis portion of the program. Other reports of this project are:

SSC-225 - Structural Analysis of Longitudinally Framed Ships

SSC-227 - Tanker Transverse Strength Analysis-- User's Manual

SSC-228 - Tanker Transverse Strength Analysis-- Programmer's Manual

Comments on this report would be welcomed.

Sincerely,

W. F. REA, III
Rear Admiral, U. S. Coast Guard
Chairman, Ship Structure Committee

SSC-226

Final Report

on

Project SR-196, "Computer Design of
Longitudinally Framed Ships"

to the

Ship Structure Committee

TANKER LONGITUDINAL STRENGTH ANALYSIS
USER'S MANUAL AND COMPUTER PROGRAM

by

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under

Department of the Navy
Naval Ship Engineering Center
Contract No. N00024-70-C-5219

U. S. Coast Guard Headquarters
Washington, D. C.
1972

ABSTRACT

This report, the second in a sequence of four Ship Structure Committee Reports on a method for performing structural analysis of a tanker hull, contains the User's Manual and Computer Program for the longitudinal strength analysis portion of the program.

CONTENTS

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TANKER LONGITUDINAL STRENGTH ANALYSIS:

The computer program for the longitudinal strength analysis is simple and can be used independently to compute the longitudinal stresses and shear forces of the side shells and the longitudinal bulkheads.

Input:

Card No.		Format
1	Number of transverses (maximum 50), MT	(I5)
2	Type of transverses (JD(I), I= 1,MT)	(40I2)
	JD(I) = 1 for web frame	
	= 2 for swash bulkhead	
	= 3 for oil tight bulkhead	
3	A_s , A_b , I_s , I_b , E , μ , L	(7E11.4)
	A_s = cross-sectional area of shell	
	A_b = cross-sectional area of longitudinal bulkhead	
	I_s = moment of inertia of shell	
	I_b = moment of inertia of bulkhead	
	E = Young's modulus	
	μ = Poisson's ratio	
	L = length of holds(transverse spacing)	
4	W_{wt}, W_{ct}, Zs_{deck}, Zs_{bottom}, Zb_{deck}, Zb_{bottom}	(7E11.4)
	W_{wt} = width wing tank	
	W_{ct} = width central tank	
	Zs_{deck} = section modulus of shell at deck	
	Zs_{bottom} = section modulus of shell at bottom	
	Zb_{deck} = section modulus of bulkhead at deck	
	Zb_{bottom} = section modulus of bulkhead at bottom	

Card No.		Format
5	$Aweb_{wt}$, $Aswash_{wt}$, Aot_{wt}	(7E11.4)

$Aweb_{wt}$ = Shear area for web frame in wing tank

$Aswash_{wt}$ = Shear area for swash bulkhead in wing tank

Aot_{wt} = Shear area for oil-tight bulkhead in wing tank

6	$Aweb_{ct}$, $Aswash_{ct}$, Aot_{ct}	(7E11.4)

$Aweb_{ct}$ = Shear area for web frame in central tank

$Aswash_{ct}$ = Shear area for swash bulkhead in central tank

Aot_{ct} = Shear area for oil-tight bulkhead in central tank

7	$Iweb_{wt}$, $Iswash_{wt}$, Iot_{wt}	(7E11.4)

$Iweb_{wt}$ = Moment of inertia for web frame in wing tank

$Iswash_{wt}$ = Moment of inertia for swash bulkhead in wing tank

Iot_{wt} = Moment of inertia for oil-tight bulkhead in wing tank

8	$Iweb_{ct}$, $Iswash_{ct}$, Iot_{ct}	(7E11.4)

$Iweb_{ct}$ = Moment of inertia for web frame in central tank

$Iswash_{ct}$ = Moment of inertia for swash bulkhead in central tank

Iot_{ct} = Moment of inertia for oil-tight bulkhead in central tank

Card No.		Format
9a-9n	Q_{wt} , Q_{ct} , N (one card per hold)*	(1x,4E11.4)

Q_{wt} = Uniform load in wing tank

Q_{ct} = Uniform load in central tank

N = 1 if either Q_{wt} or Q_{ct} are non-zero

= 0 if there are no loads in this hold

* There are MT+1 holds or transverse spans.

Output

The output includes the longitudinal stress, the change of shear forces of the longitudinal members.

Example

The longitudinal analysis for tanker KOCKUMS 520 is used as an example. Results from this calculation are based on the relative loading between loading conditions No. 6 and No. 8. They should not be regarded as the actual stress or shear force for full load condition.

The length units are in centimeters and the weight units are kilograms.

REACTIONS AT THE INTERSECTIONS

	1	2
	shells	longitudinal bulkheads
1	-.13508+06	.21546+06
2	-.37010+05	.10605+06
3	.16282+06	-.93080+05
4	-.34042+05	.11029+06
5	-.14088+06	.19352+06
6	.14012+06	.61027+05
7	.32907+06	.14258+05
8	.23292+06	.92301+05
9	.63476+05	.24285+06
10	.23665+06	.94220+05
11	.24936+06	.77523+05
12	.15740+05	.31214+06
13	.25121+06	.76910+05
14	.23513+06	.90529+05
15	.80845+05	.25358+06
16	.23080+06	.92196+05
17	.23349+06	.98423+05
18	.83975+05	.24467+06
19	.22728+06	.78431+05
20	.29010+06	.10946+06
21	-.32625+06	.57042+05
22	-.43985+06	-.51984+06
23	-.40585+06	-.44545+06
24	-.61202+06	-.26968+06
25	-.42373+06	-.45027+06
26	-.42347+06	-.45099+06
27	-.61008+06	-.27142+06
28	-.40454+06	-.44122+06
29	-.39623+06	-.59474+06

INPUTS FOR THE PRIMARY STRENGTH

LENGTH E GNU AND THE WIDTH OF THE TANKS

.1540+05 .2050+07 .3000-00 .1308+04 .1128+04 .1605+08 .1468+08

AREAS AND I OF THE LONG BHDS & SHELLS

.5052+04 .3906+04 .2164+11 .1985+11 .1844+08 .1636+08

AREAS OF THE TRANSVERSES .6636+03 .1713+04 .3780+04 .6984+03 .2189+04
.3880+04

MOMENT OF INERTIA OF THE TRANSVERSES

.5000+10 .6060+10 .6060+10 .5560+10 .6610+10 .6330+10

BENDING MOMENT AND STRESSES

	1			2		
	M_s	σ_d	σ_b	M_b	σ_d	σ_b
2	.9148+09	.5700+02	.4961+02	.9711+09	.6615+02	.5936+02
3	.1426+10	.8884+02	.7733+02	.1347+10	.9175+02	.8233+02
4	.1853+10	.1155+03	.1005+03	.1770+10	.1206+03	.1082+03
5	.2298+10	.1432+03	.1246+03	.2137+10	.1456+03	.1306+03
6	.2816+10	.1754+03	.1527+03	.2405+10	.1638+03	.1470+03
7	.3261+10	.2032+03	.1768+03	.2641+10	.1799+03	.1614+03
8	.3538+10	.2204+03	.1918+03	.2870+10	.1955+03	.1754+03
9	.3694+10	.2302+03	.2003+03	.3052+10	.2079+03	.1865+03
10	.3808+10	.2373+03	.2065+03	.3109+10	.2118+03	.1900+03
11	.3801+10	.2368+03	.2061+03	.3117+10	.2123+03	.1905+03
12	.3665+10	.2284+03	.1988+03	.3086+10	.2102+03	.1886+03
13	.3522+10	.2194+03	.1910+03	.2894+10	.1972+03	.1769+03
14	.3249+10	.2024+03	.1762+03	.2663+10	.1814+03	.1628+03
15	.2656+10	.1779+03	.1549+03	.2386+10	.1625+03	.1458+03
16	.2421+10	.1508+03	.1313+03	.1978+10	.1347+03	.1209+03
17	.1868+10	.1164+03	.1013+03	.1523+10	.1037+03	.9310+02
18	.1195+10	.7443+02	.6476+02	.1017+10	.6931+02	.6219+02
19	.4783+09	.2980+02	.2594+02	.3863+09	.2632+02	.2361+02
20	-.3547+09	-.2210+02	-.1923+02	-.2851+09	-.1942+02	-.1743+02
21	-.1337+10	-.8327+02	-.7248+02	-.1013+10	-.6899+02	-.6191+02
22	-.2151+10	-.1340+03	-.1166+03	-.1770+10	-.1206+03	-.1082+03
23	-.2740+10	-.1707+03	-.1486+03	-.2260+10	-.1539+03	-.1381+03
24	-.3120+10	-.1944+03	-.1692+03	-.2521+10	-.1717+03	-.1541+03
25	-.3186+10	-.1985+03	-.1728+03	-.2644+10	-.1801+03	-.1616+03
26	-.3034+10	-.1890+03	-.1645+03	-.2536+10	-.1727+03	-.1550+03
27	-.2665+10	-.1661+03	-.1445+03	-.2196+10	-.1496+03	-.1342+03
28	-.1983+10	-.1236+03	-.1075+03	-.1717+10	-.1169+03	-.1049+03
29	-.1093+10	-.6812+02	-.5929+02	-.1011+10	-.6887+02	-.6180+02

UNIFORM LOADS OF THE TRANSVERSES

UNIFORM LOADS OF THE TRANSVERSES

-.7710+06	.8420+06
-.7710+06	.8420+06
-.7710+06	.8420+06
-.7710+06	.8420+06
-.7710+06	.8420+06
-.7710+06	.8420+06
.9760+06	-.6480+06
.9760+06	-.6480+06
.9760+06	-.6480+06
.9760+06	-.6480+06
.9760+06	-.6480+06
.9760+06	-.6480+06
.9760+06	-.6480+06
.9760+06	-.6480+06
.9760+06	-.6480+06
.9760+06	-.6480+06
.9760+06	-.6480+06
.9760+06	-.6480+06
.9760+06	-.6480+06
.9670+06	-.6480+06
.9760+06	-.6480+06
-.2270+06	-.6480+06
-.2270+06	-.6480+06
-.2270+06	-.6480+06
-.2270+06	-.6480+06
-.2270+06	-.6480+06
-.2270+06	-.6480+06
-.2270+06	-.6480+06
-.2270+06	-.6480+06
-.2270+06	-.6480+06

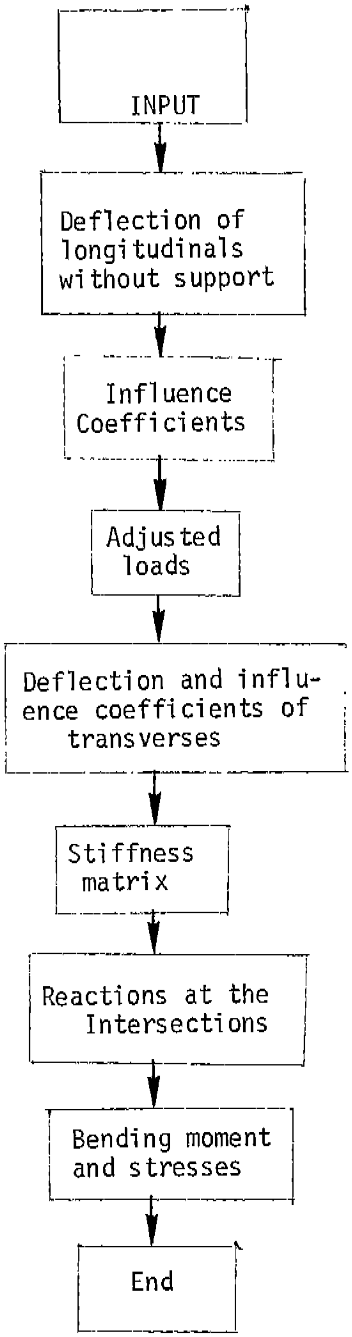
M_s = Bending moment of the shells

M_b = Bending moment of the longitudinal bulkheads

σ_d = Stress on deck

σ_b = Stress on bottom

Flow Chart.


INPUT
Deflection of longitudinals without support
Influence Coefficients
Adjusted loads
Deflection and influence coefficients of transverses
Stiffness matrix
Reactions at the Intersections
Bending moment and stresses
End

```
      PROGRAM LONG(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)
CZZZZIE  FR5   MOMENT,MOMENT,MOME
      DIMENSION A(3,2),YI(3,2),Q(50,2),AF(50,50),AE(50,50)
      DIMENSION IND(50,3),JD(50),T(50),R(50)
      DIMENSION YB(50),YC(50),D(50)
       DIMENSION DY(50,2),LQ(50)
      READ (5,88) MT
       MY=MT+1
      READ (5,89) (JD(I),I=1,MT)
   79 FORMAT(2E11.4,I8)
   88  FORMAT(15I5)
   89 FORMAT (40I2)
   98 FORMAT(7E11.4)
      READ (5,98) AI,AJ,XI,XJ,E,GNU,ZLEN
      READ (5,98) Y1,Y2,SM1,SM2,SN1,SN2
C AI,AJ.....WEB AREA OF THE SHELLS AND THE LONGITUDINAL BULKHEADS
C XI,XJ.....MOMENT OF INERTIA OF THE SHELLS AND BULKHEADS
C ZLEN......LENGTH OF THE HOLDS
C Y1,Y2.....WIDTH OF THE WING AND CENTRAL TANKS
      READ (5,98) (A(I,1),I=1,3)
      READ (5,98) (A(I,2),I=1,3)
C A(I,J)....SHEAR AREA OF THE WEB FRAMES,SWASH BULKHEADS AND OIL-
C           TIGHT BULKHEADS
      READ (5,98) (YI(I,1),I=1,3)
      READ (5,98) (YI(I,2),I=1,3)
C YI(I,J)...MOMENT OF INERTIA OF THE WEB FRAMES,SWASH BULKHEADS,
C           AND OIL-TIGHT BULKHEADS
  309   DO 77 I=1,MY
   77 READ (5,79) (Q(I,J),J=1,2),LQ(I)
C      UNNIFORM LOADS OF THE TRANSVERSES
   99 FORMAT (1X,12E11.4)
       WRITE (6,100)
  900 FORMAT(/1X,31H UNIFORM LOADS  ALONG THE HOLD  //)
  100 FORMAT(//33H INPUTS FOR THE PRIMARY STRENGTH    //)
       WRITE (6,101)
       WRITE (6,99) ZLEN,E,GNU,Y1,Y2,SM1,SM2
  101 FORMAT (//40H LENGTH E GNU AND THE WIDTH OF THE TANKS  //)
       WRITE (6,102)
        WRITE (6,99) AI,AJ,XI,XJ,SN1,SN2
  102 FORMAT(//40H AREAS AND  I  OF THE LONG BHDS ' SHELLS  //)
      WRITE (6,103) ((A(I,J),I=1,3),J=1,2)
  103 FORMAT(//25H AREAS OF THE TRANSVERSES  6E11.4)
     WRITE (6,104)   ((YI(I,J),I=1,3),J=1,2)
  104 FORMAT(//37H MOMENT OF INERTIA OF THE TRANSVERSES  //6E11.4)
           WRITE (6,105)
       DO 1 I=1,MY
    1 WRITE (6,99) (Q(I,J),J=1,2)
  105 FORMAT (//47H UNIFORM AND CONCENTRATED LOADS ON THE SPACINGS //)
      SP=ZLEN/FLOAT(MY)
         NH=1
       IF (XJ.GT.0.0) GO TO 1001
          NH=0
          GO TO 30
 1001    DO 3 I=1,MT
       X=FLOAT(I)*SP
      DO 2 J=1,2
     DY(I,J)=0.
      DO 2 K=1,MY
      M=K-1
       IF (LQ(K).EQ.0) GO TO 2
       X1=FLOAT(M)*SP
       X2=FLOAT(K)*SP
      C=X2-X1
      XD=ZLEN-X1/2.-X2/2.
       XW=Q(K,J)
       XW=XW/E
      R1=XW*XD/ZLEN
     ADD=8.*R1*(X*X-ZLEN**2)*X
     ADD=ADD+XW*X*(8.*XD**3-2.*X2*C*C+C**3)/ZLEN
      IF (X.GT.X2)  GO TO 222
     ADD=ADD+XW*X**2.*C*C
      IF (X.LT.X1) GO TO 223
     ADD=ADD-2.*XW*(X-X1)**4/C
      GO TO 223
  222 ADD=ADD-8.*XW*(X-X1/2.-X2/2.)**3+XW*(2.*X2*C*C-C**3)
  223  DY(I,J)=DY(I,J)-ADD/48.
    2 CONTINUE
      DO 39 J=1,MT
     IF (I.GT.J)  GO TO 224
      B=ZLEN-FLOAT(J)*SP
     AF(I,J)=X*B/E*(ZLEN**2-B*B-X*X)/ZLEN/6.
      GO TO 39
  224 AF(I,J)=AF(J,I)
   39 CONTINUE
    3 CONTINUE
      CALL MATINS(AF,50,MT,AE,50,0,DE,ID,IND)
```

```
      IF (ID.EQ.2)   GO TO 225
      DO 4 I=1,MT
       DO 4 J=1,2
      Q(I,J)=0.
      DO 4 K=1,MT
  4   Q(I,J)=Q(I,J)+AF(I,K)*DY(K,J)
      WRITE (6,226)
226  FORMAT(//35H UNIFORM LOADS OF THE TRANSVERSES   //)
      DO 227 I=1,MT
227  WRITE (6,99) (Q(I,L),L=1,2)
       DO 10 I=1,MT
     X=FLOAT(I)*SP
      DO 10 J=1,MT
      IF (I.GT.J) GO TO 9
      B=ZLEN-FLOAT(J)*SP
      X=FLOAT(I)*SP
    AC=X*B/E*(ZLEN**2-B*B-X*X)/ZLEN/6.
    AD=X*B/ZLEN/E*2.*(1.+GNU)
    AF(I,J)=AC/XI+AD/AI
    AE(I,J)=AC/XJ+AD/AJ
      GO TO 10
  9  AF(I,J)=AF(J,I)
      AE(I,J)=AE(J,I)
 10  CONTINUE
      DO 20 I=1,MT
      IJ=JD(I)
      A1=A(IJ,1)
      A2=A(IJ,2)
      B1=YI(IJ,1)
      B2=YI(IJ,2)
      Q1=Q(I,1)/Y1
      Q2=Q(I,2)/Y2
      QQ=(Q1*Y1+Q2*Y2)
      CALL DECO(B1,B2,A1,A2,Y1,Y2,Q1,Q2,XK,XD,I)
      D(I)=XD
        WRITE (6,99) D(I),XK
       DO 18 J=1,MT
       AE(I,J)=AE(I,J)+AF(I,J)
      IF (I.NE.J) GO TO 18
      AE(I,J)=AE(I,J)+XK
 18   CONTINUE
     DO 19 J=1,MT
 19  D(I)=D(I)+AF(I,J)*(Q(J,1)+Q(J,2))
 20  CONTINUE
          WRITE (6,99) (D(K),K=1,MT)
     CALL MATINS(AE,50,MT,AF,50,0,DE,ID,IND)
    IF (ID.EQ.1) GO TO 30
225   WRITE (6,21)
 21  FORMAT (//25H  MATRIX SINGULAR           //)
      STOP
 30       WRITE (6,33) (K,K=1,2)
 33  FORMAT (//32H REACTIONS AT THE INTERSECTIONS   2I10//)
      DO 40 I=1,MT
      R(I)=0.
          IF(NH.EQ.1) GO TO 301
        T(I)=Q(I,1)+Q(I,2)
          GO TO 40
301    DO 35 J=1,MT
 35   R(I)=R(I)+AE(I,J)*D(J)
      T(I)=Q(I,1)+Q(I,2)-R(I)
 40  WRITE (6,46) I,T(I),R(I)
 46  FORMAT (I15,2E16.5)
      WRITE (6,62) (K,K=1,2)
       XM=0.
       XN=0.
      DO 50 I=1,MT
      XN=XN+R(I)*(1.-FLOAT(I)/FLOAT(MY))
      XM=XM+T(I)*(1.-FLOAT(I)/FLOAT(MY))
 50  CONTINUE
      YB(1)=XM*SP
      YC(1)=XN*SP
      DO 60 I=2,MT
      J=I-1
       XM=XM-T(J)
      XN=XN-R(J)
      YB(I)=YB(J)+XM*SP
       SB=YB(I)/SM1
     SD=YB(I)/SN1
     YC(I)=YC(J)+XN*SP
      SC=YC(I)/SM2
     SE=YC(I)/SN2
     WRITE (6,64) I,YB(I),SB,SD,YC(I),SC,SE
 60  CONTINUE
 62  FORMAT(//28H BENDING MOMENT AND STRESSES  I10,I20,//)
 64  FORMAT(I4,6E11.4)
    STOP
     END
```

```
CZZZZIE   FR5 MULT,MULT,MULT
          SUBROUTINE MULT(D,B,C,M)
          DIMENSION B(M,M),C(M,M),D(M,M)
          DO 1 I=1,M
           DO 1 J=1,M
          D(I,J)=0.
            DO 11 K=1,M
   11      D(I,J)=D(I,J)+B(I,K)*C(K,J)
    1     CONTINUE
          RETURN
           END
CZZZZIE   FR5 EQUA,EQUA,EQUA
           SUBROUTINE EQUA(A,B,M)
           DIMENSION A(M,M),B(M,M)
           DO 1 I=1,M
           DO 1 J=1,M
    1      A(I,J)=B(I,J)
           RETURN
           END
CZZZZIE   FR5 DECO,DECO,DECO
            SUBROUTINE DECO(XI,YI,A1,A2,A,C,Q1,Q2,XK,XD,M)
C          THIS IS FOR THE LONGITUDINAL STRESSES OF SHIPS.
            DIMENSION T1(5,5),T2(5,5),T(5,5)
            CALL TM(A1,XI,A,Q1,T1,0.,M)
            CALL TM(A2,YI,C,Q2,T2,0.,M)
            CALL MULT (T,T2,T1,5)
          N=1
    1     QQ=T(2,2)*T(4,4)-T(2,4)*T(4,2)
              U=T(2,4)*T(4,5)/QQ-T(2,5)*T(4,4)/QQ
              V=T(2,5)*T(4,2)/QQ-T(2,2)*T(4,5)/QQ
          X=T1(1,2)*U+T1(1,4)*V+T1(1,5)
           GO TO (2,3),N
    2     XD=X
    6     T1(1,5)=0.
           T1(2,5)=0.
           T1(3,5)=0.
           T1(4,5)=-1.
           T2(1,5)=0.
          T2(2,5)=0.
          T2(3,5)=0.
          T2(4,5)=0.
          CALL MULT (T,T2,T1,5)
           N=N+1
          GO TO 1
    3     XK=X
            RETURN
          END
CZZZZIE   FR5 TM,TM,TM
          SUBROUTINE TM(A1,XI,A,Q,T,P,M)
          DIMENSION T(5,5)
           DO 1 I=1,5
           DO 1 J=1,5
    1      T(I,J)=0.
          T(1,1)=1.
          EI=30000000.*XI
          T(1,2)=-A
          T(1,3)=-A*A/2./EI
          T(1,4)=-A**3/6./EI
          T(1,5)=Q*A**4/24./EI
          E=30000000.
          G=E/2./1.3
          AG=A1*G
          T(4,4)=1.
          T(5,5)=1.
          T(4,5)=-Q*A-R
         T(2,2)=1.
         T(2,3)=A/EI
         T(2,4)=A*A/2./EI
         T(2,5)=-Q*A**3/6./EI
          T(3,5)=-Q*A*A/2.
         T(3,3)=1.
         T(3,4)=A
           IF (M.EQ.0) GO TO 2
          T(1,4)=T(1,4)+A/AG
          T(1,5)=T(1,5)-Q*A*A/2./AG
    2      CONTINUE
          RETURN
           END
CZZZZIE   FR5 MATINS,MATINS,MATINS
          SUBROUTINE MATINS(A,NR,N1,B,NC,M1,DETERM,ID,INDEX)
          EQUIVALENCE (IROW,JROW), (ICOLUM,JCOLUM), (AMAX, T, SWAP)
                                 DIMENSION A(NR,NR), B(NR,NC), INDEX(NR,3)
```

```
C
C      INITIALIZATION
C
       N=N1
      M=M1
       DETERM= 1.0E-08
       DO 20 J=1,N
   20 INDEX(J,3) = 0
       DO 550 I=1,N
C
C     SEARCH FOR PIVOT ELEMENT
C
      AMAX = 0.0
      DO 105 J=1,N
      IF(INDEX(J,3)-1) 60, 105, 60
   60 DO 100 K=1,N
      IF(INDEX(K,3)-1) 80, 100, 715
   80 IF (       AMAX -ABS (A(J,K))) 85, 100, 100
   85 IROW=J
      ICOLUM =K
      AMAX = ABS (A(J,K))
 100  CONTINUE
 105  CONTINUE
      INDEX(ICOLUM,3) = INDEX(ICOLUM,3) +1
      INDEX(I,1)=IROW
      INDEX(I,2)=ICOLUM
C
C     INTERCHANGE ROWS TO PUT PIVOT ELEMENT ON DIAGONAL
C
      IF (IROW-ICOLUM) 140, 310, 140
  140 DETERM=-DETERM
      DO 200 L=1,N
      SWAP=A(IROW,L)
      A(IROW,L)=A(ICOLUM,L)
  200 A(ICOLUM,L)=SWAP
      IF(M) 310, 310, 210
  210 DO 250 L=1, M
      SWAP=B(IROW,L)
      B(IROW,L)=B(ICOLUM,L)
  250 B(ICOLUM,L)=SWAP
C
C     DIVIDE PIVOT ROW BY PIVOT ELEMENT
C
  310 PIVOT   =A(ICOLUM,ICOLUM)
      DETERM=DETERM*PIVOT
  330 A(ICOLUM,ICOLUM)=1.0
      DO 350 L=1,N
  350 A(ICOLUM,L)=A(ICOLUM,L)/PIVOT
      IF(M) 380, 380, 360
  360 DO 370 L=1,M
  370 B(ICOLUM,L)=B(ICOLUM,L)/PIVOT
C
C     REDUCE NON-PIVOT ROWS
C
  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
C
C     INTERCHANGE COLUMNS
C
      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
      DO 730 K = 1,N
      IF(INDEX(K,3) -1) 715,720,715
 720   CONTINUE
 730   CONTINUE
       ID = 1
 810  RETURN
 715  ID = 2
       GO TO 810
      END
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This report, the second in a sequence of four Ship Structure Committee Reports on a method for performing structural analysis of a tanker hull, contains the User's Manual and Computer Program for the longitudinal strength analysis portion of the program.

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Advisory Group II, "Ship Structural Design" prepared the project prospectus and evaluated the proposals for this project.

The SR-196 Project Advisory Committee provided the liaison technical guidance, and reviewed the project reports with the investigator.

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