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VORCOR - A Computer Program for Calculating Characteristics of Wings With Edge Vortex Separation by Using a Vortex Filament and Core Model

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INTRODUCTION

This report is a supplement to reference 1 and describes the usage of a computer program implementing an improved vortex-core method described in reference 1. The method is applicable to cambered wings, straked wings or wings with leading-edge vortex flaps at subsonic speeds. The prediction of lifting pressure distribution and the computer time based on the diffused vortex-filament method in reference 2 have been improved by using a pair of concentrated vortex cores above the wing surface.

In the following, the program capabilities, input format and output format are described. Then, input data of two sample test cases (a delta wing with conical camber and a double delta wing) and the corresponding output, as well as the program listing are given.

PROGRAM CAPABILITIES

This program has the following main features:

(1) Arbitrary camber shapes may be defined at ten or less spanwise stations. Option for exactly defining leading-edge flap geometry is also provided.

(2) Eight spanwise strips are usually used for simple wings (such as delta wings) and nine spanwise strips for double delta wings.

(3) The side-edge vortex system is incorporated.

(4) In the core model method, the starting solution for wings at angles of attack less than 20 degrees is taken to be the initial shape at 20-degrees angle of attack.

INPUT DATA FORMAT

Group 1 Format (16A5)

TTL(I) Any title identifying the case to be run. END in first three columns terminates the job.

Group 2 Format (6I5)

NCW Number of chordwise vortex elements on the wing surface. Limited to nine.

NBRR Number of constant x-locations where the spanwise lifting pressures are to be interpolated. Limited to twenty-five.

NCONTS = 0, if initial locations of free elements are calculated in the program.

= 1, if initial locations of free elements are to be read from data cards. For wings at angles of attack less than 20 degrees, the initial shape at 20 degrees is to be used.

MITER Maximum number of iterations to be performed (usually between 7 and 9).

IPUNCH = 0, if coordinates of free elements after the last iteration are not to be punched out.

= 1, if coordinates of free elements after the last iteration are to be punched out.

KU1 = 2, two iterations to be performed in the vortex filament model.

Note: If KU1 is greater than MITER, the vortex filament model is to be run in the entire iteration process.

Group 3 Format (6I5)

NC Number of spanwise sections on the right wing (bounded by points of discontinuities in geometry, such as change in sweep). Limited to two. (See sketch 1).

M1(I) Number of spanwise strips in each spanwise section plus one. Limited to twenty.

ICAM = 0, for non-cambered airfoils.

= 1, if cambered ordinates are to be read in.

= 2, if camber slopes are defined analytically in subroutine ZCDX.

= 3, if there are flat leading-edge flaps attached to a non-cambered wing.

IST Number of y-stations at which camber ordinates are read in. Limited to ten. If ICAM=3, IST is the number of leading-edge flap segments; for example, IST would be 1 for a simple flat leading-edge flap. If ICAM=1, at least two y stations are needed, one being at the root and the other being at the tip.

ITERS = 0, for wings at angles of attack greater than 20 degrees and NCONTS=0.

= 3, for wings at angles of attack less than 20 degrees and NCONTS=1.

Group 4 Format (2I5)

ISPAN = 0, if the leading-edge free elements start from the center line of geometry.

= 1, if the leading-edge free elements do not start from the center line of geometry.

Use 0 always in the present version of the program.

ITRAKE = 1, for one vortex-core system on the right wing.

= 2, for two fortex-core system on the right wing.

Group 5 Format (8F10.5)

ALPHA Angle of attack (in degrees)

AMACH Mach number. Limited to subsonic flow.

DELTA Length of a segment of leading-edge free vortex elements (may be taken as 0.15 c_R, where c_R is the root chord).

DL Length of a segment of wake elements (may be taken as 0.15 c_R).

XEND x-coordinate beyond which free vortex elements from the leading edge and the wake are represented by a single element going to infinity.

CBAR Reference chord.

AREA Total reference wing area.

CLS Reference lift coefficient.

Note: The reference lift coefficient CLS for use in adjusting the core movement is based on the suction analogy as implemented by Lan (reference 3).

<u>Group 6</u> Format (9I5)

NFSH(I) Number of segments along each vortex element on the leading-edge free vortex sheet.

= 5, if ITERS = 0.

= 6, if ITERS = 3.

Omit Groups 7, 8 and 9 if ICAM ≠ 1. Repeat Group 7, 8, 9 IST times.

<u>Group 7</u> Format (4F10.6)

YT(I) y-station at which camber ordinates are read in.

XNUM Number of camber ordinates to be read in. Limited to 21.

CURV(I) = 0, if camber is to be formed by connecting straight segments, with first segment being regarded as flat leading-edge flap.

= 1, if cubic spline interpolation is used.

= 2, if cubic spline interpolation is used, with first segment being flat leading-edge flap.

CHND(I) Chord length at YT(I) station.

<u>Group 8</u> Format (8F10.6)

XT(I,J) x/c values at which camber ordinates are read in for YT(I) station.

<u>Group 9</u> Format (8F10.6)

CA(J) z/c values of camber ordinates at the corresponding XT(I,J) locations.

Omit Groups 10, 11 and 12 if ICAM ≠ 3. Repeat IST times.

<u>Group 10</u> Format (2F10.6)

YLEF(I,1) Extreme inboard y-coordinate of I-th flat leading-edge flap segment.

YLEF(I,2) Extreme outboard y-coordinate of I-th flat leading-edge flap segment.

<u>Group 11</u> Format (6F10.6)

XLF(I,1), YLF(I,1), Z1 } First corner point coordinates of I-th flat leading-edge flap segment. (see sketch 2)

XLF(I,2) YLF(I,2) Z2	Second corner point coordinates of I-th flat leading-edge flap segment.

Group 12 Format (6F10.6)

XLF(I,3) YLF(I,3) Z3	Third corner point coordinates of I-th flat leading-edge flap segment.
XLF(I,4) YLF(I,4) Z4	Fourth corner point coordinates of I-th flat leading-edge flap segment.

Note: The flat flap must be inside the boundary of planform described in Group 13.

Group 13 Format (6F10.5)

Corner-point coordinates of a spanwise section (See sketch 3).

XXL(1)	Leading-edge x-coordinate of the inboard chord.
XXT(1)	Trailing-edge x-coordinate of the inboard chord.
YL(1)	y-coordinate of the inboard chord.
XXL(2)	Leading-edge x-coordinate of the outboard chord.
XXT(2)	Trailing-edge x-coordinate of the outboard chord.
YL(2)	y-coordinate of the outboard chord.

Omit Groups 14, 15, 16, 17, 18 and 19 if NCONTS = 0.

Group 14 Format (10I2)

NELM(I)	Number of vortex segments along each vortex element in the leading-edge vortex system.

Group 15 Format (8F10.4)

XE(J) YE(J) ZE(J)	x-, y- and z-coordinates of endpoints (away from the leading edge) of the leading-edge vortex segments on and above the wing surface.

Group 16 Format (10I2)

NNELM(I)	Number of vortex segments along each vortex element in the wake

system behind the trailing edge.

Group 17 Format (8F10.4)

XXE(J) YYE(J) ZZE(J)	x-, y- and z-coordinates of downstream endpoints of wake vortex segments behind the trailing edge.

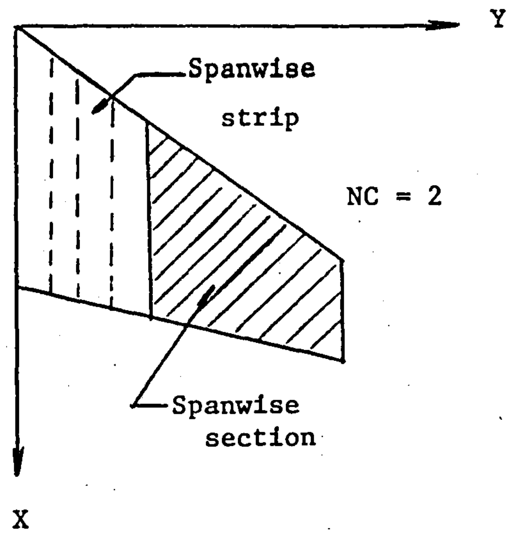
Omit Groups 18 and 19 if the wing planform has a zero tip chord.

Group 18 Format (10I2)

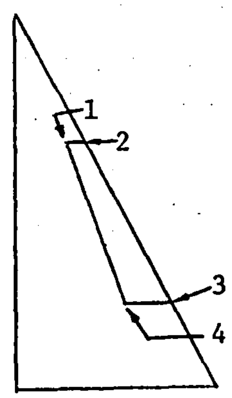
NTLM(I) Number of vortex segments along each vortex element in the side-edge vortex system.

Group 19 Format (8F10.4)

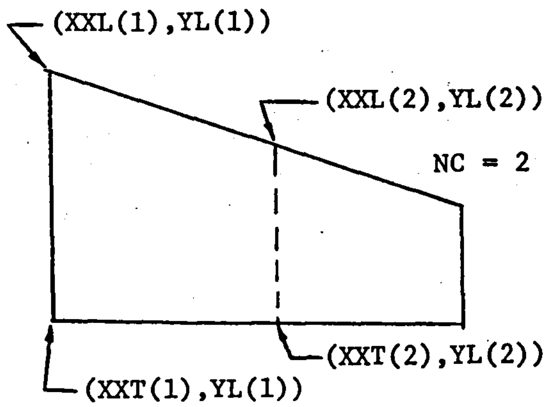
XTIP(I,J) YTIP(I,J) ZTIP(I,J)	x-, y- and z-coordinates of endpoints (away from the side edge) of vortex segments on side-edge vortex elements.



Sketch 1.



Sketch 2.



Sketch 3.

OUTPUT FORMAT

(1) First, all input data will be printed.

(2) Camber slopes at wing bound elements (with respect to fine grids).

DZDXV, DZDYV } At bound elements

(3) Camber slopes at wing control points and bound elements (with respect to coarse grids).

DZDX, DZDY } At control points

DZDYV At bound elements.

(4) Camber slopes at leading-edge control points of each spanwise strip.

DZDX, DZDY } At leading-edge control points.

(5) Leading-edge vortex element system:

XE, YE, ZE } x-, y- and z-coordinates of endpoints (away from the leading edge) of vortex segments in the leading-edge vortex element system on and above the wing.

(6) Wake element system:

XXE, YYE, ZZE } x-, y- and z-coordinates of each vortex segment in the wake system behind the trailing edge.

(7) Plots of leading-edge free elements above the wing and wake elements behind the trailing edge, on X-Y, X-Z and Y-Z planes respectively.

(8) Wing vortex-density distribution:

X/C	Nondimensional x-coordinate, referred to local chord (with respect to coarse grids).
2Y/B	nondimensional y-station, referred to wing semi-span.
GAMAY	Bound vortex density on the wing (γ_y) at the given (X/C, 2Y/B).

(9) Leading-edge vortex strengths:

2Y/B Nondimensional y-station, referred to wing semi-span.

CAPGAMA Strength of the leading-edge free element (Γ) at the given 2Y/B.

(10) Wing surface lifting-pressure distribution:

X/C Nondimensional x-coordinate, referred to local chord (with respect to fine grids).

2Y/B Nondimensional y-station, referred to wing semi-span.

DELTA-CP The total ΔC_p at the given (X/C, 2Y/B)

(11) Sectional characteristics:

I Spanwise station number (numbered from root to tip).

CLI Sectional lift coefficient.

CMI Sectional pitching moment coefficient about the y-axis.

CDI Sectional induced drag coefficient.

CTI Sectional leading-edge thrust coefficient.

(12) The next group of output variables is the overall aerodynamic characteristics.

(13) Spanwise lifting pressures at constant x-locations.

Y y-coordinate.

2Y/B(LOCAL) Nondimensional y-station, referred to wing local semi-span.

DELTA-CP Total ΔC_p at the given (x,y).

(14) Summary sheet:

ITERATION Iteration number.

CL The total lift coefficient.

CM The total pitching moment coefficient about y-axis.

CD The total induced drag coefficient.

CT The total leading-edge thrust coefficient.

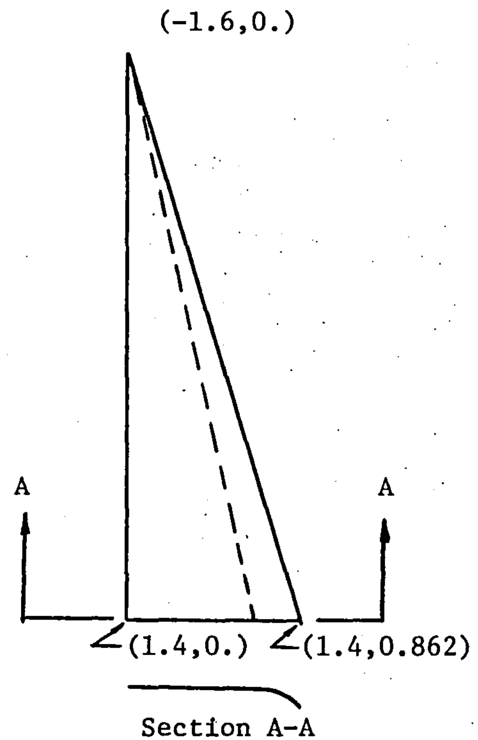
GMSUM Sum of strengths of leading-edge free vortex elements, except the one at the center line.

SFAC Sum of the magnitude of total force acting on the core and free sheet.

(15) The last portion of the output consists of the converged positions and orientations of free sheet vortex elements and the concentrated core, and aerodynamic characteristics corresponding to the solution in which "SFAC" of (14) reaches a minimum value in the iteration cycle.

1. Input Data of the First Sample Case

```
                                         C O L U M N   N U M B E R
                    11111111112222222222333333333344444444445555555555666666666677777777778
           12345678901234567890123456789012345678901234567890123456789012345678901234567890
CARD NUMBER
     1                         CONICAL CAMBER WING AT ALPHA 30.7 DEGREES
     2         6    3    0    8    0    2
     3         1    9    2    1    0
     4         0    1
     5     30.7      0.        0.25      0.75      5.5       2.0       2.586     1.297
     6         5    5    5    5    5    5    5    5
     7     -0.4      0.41      1.205
     8     0.        0.        0.        0.        0.        0.        0.        0.
     9     -1.6      1.4       0.        1.4       1.4       0.862
    10     -1.6      1.4       0.        1.4       1.4       0.862
    11     END
```



Output of the First Sample Case

```
INPUT DATA CARDS
                    CONICAL CAMBER WING AT ALPHA 30.7 DEGREES
   6     3     0     8     0     2
   1     9     2     1     0
   0     1
 30.70000   0.00000    .25000    .75000   5.50000   2.00000   2.58600   1.29700
   5     5     5     5     5     5     5     5
 -.40000    .41000   1.20500
 0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
 SPANWISE SECTION OF NUMBER     1
-1.60000   1.40000   0.00000   1.40000   1.40000    .86200

 CAMBER SLOPE AT FINE GRID BOUND ELEMENT

   DZDXV     DZDYV
  0.00000   0.00000
  0.00000   0.00000
  0.00000   0.00000
  0.00000   0.00000
  0.00000   0.00000
  0.00000   0.00000
  0.00000   0.00000
   .12741   -.51416
  0.00000   0.00000
  0.00000   0.00000
  0.00000   0.00000
  0.00000   0.00000
  0.00000   0.00000
  0.00000   0.00000
   .23158   -.89945
  0.00000   0.00000
  0.00000   0.00000
  0.00000   0.00000
  0.00000   0.00000
  0.00000   0.00000
  0.00000   0.00000
   .29498  -1.12608
   .06370   -.26520
  0.00000   0.00000
  0.00000   0.00000
  0.00000   0.00000
  0.00000   0.00000
  0.00000   0.00000
   .33447  -1.26531
   .15287   -.61032
   .02880   -.12231
  0.00000   0.00000
  0.00000   0.00000
```

0.00000	0.00000
0.00000	0.00000
.35909	-1.35156
.23490	-.91143
.12778	-.51555
.05278	-.22515
.00206	-.00891
0.00000	0.00000
0.00000	0.00000
.37309	-1.40356
.30968	-1.17452
.23187	-.90050
.17034	-.67546
.12696	-.51243
.09950	-.40671
.08616	-.35450
.38199	-1.42144
.36342	-1.36737
.33459	-1.26576
.30408	-1.15829
.27827	-1.06675
.26017	-1.00218
.25094	-.96914

SAPNWISE SECTION OF NUMBER 1

-1.60000 1.40000 0.00000 1.40000 1.40000 .86200

CAMBER SLOPE AT COARSE GRID BOUND ELEMENT

DZDX	DZDY	DZDYV
0.00000	0.00000	0.00000
0.00000	0.00000	0.00000
0.00000	0.00000	0.00000
0.00000	0.00000	0.00000
0.00000	0.00000	0.00000
0.00000	0.00000	0.00000
0.00000	0.00000	-.36323
0.00000	0.00000	0.00000
0.00000	0.00000	0.00000
0.00000	0.00000	0.00000
0.00000	0.00000	0.00000
0.00000	0.00000	0.00000
.02761	-.11734	-.78317
0.00000	0.00000	0.00000
0.00000	0.00000	0.00000
0.00000	0.00000	0.00000
0.00000	0.00000	0.00000
0.00000	0.00000	0.00000
.12675	-.51161	-1.04319
0.00000	0.00000	-.09657

0.00000	0.00000	0.00000
0.00000	0.00000	0.00000
0.00000	0.00000	0.00000
0.00000	0.00000	0.00000
.20825	-.81484	-1.21255
.04627	-.19450	-.47312
0.00000	0.00000	0.00000
0.00000	0.00000	0.00000
0.00000	0.00000	0.00000
0.00000	0.00000	0.00000
.27813	-1.06627	-1.32243
.14303	-.57334	-.80139
.05378	-.22515	-.38375
0.00000	0.00000	-.09129
0.00000	0.00000	0.00000
0.00000	0.00000	0.00000
.33423	-1.26448	-1.39086
.24389	-.94381	-1.10431
.17034	-.67546	-.79915
.12134	-.49097	-.57308
.09354	-.38346	-.42802
.08450	-.34799	-.35685
.37141	-1.39455	-1.42832
.33976	-1.28387	-1.34416
.30408	-1.15829	-1.22015
.27467	-1.05394	-1.10205
.25608	-.98755	-1.01548
.24978	-.96498	-.97064

CAMBER SLOPE AT THE LEADING EDGE CONTROL POINTS

DZDX	DZDY
.38452	-1.44024
.38452	-1.44024
.38452	-1.44024
.38452	-1.44024
.38452	-1.44024
.38452	-1.44024
.38452	-1.44024
.38452	-1.44024

END OF INPUT DATA

CONICAL CAMBER WING AT ALPHA 30.7 DEGREES

ALPHA(DEG.)=30.700 MACH NUMBER= 0.000 ITERATION NUMBER= 0

LEADING EDGE ELEMENTS

```
*******************
**** 1****
  1.4000  -1.3639  -1.5624  -1.6000  -1.7500  -1.4500  -1.2350
   .0577    .0577   0.0000   0.0000   0.0000   0.0000   0.0000
  0.0000   0.0000   0.0000   0.0000   0.0000    .1781    .3058
**** 2****
  1.4000  -1.0333  -1.3639  -1.3990  -1.5390  -1.2591  -1.0441   -.7941   -.5441   -.2941   -.0441    .2059    .4559    .7059
   .9559   1.2059   1.4559   1.7059   1.9559   2.2059   2.4559   2.7059   2.9559   3.2059   3.4559   3.7059   3.9559   4.2059
  4.4559   4.7059   4.9559   5.2059   5.4559   5.7059
   .1540    .1540    .0577    .0577    .0577    .0577    .0577    .0577    .0577    .0577    .0577    .0577    .0577    .0577
   .0577    .0577    .0577    .0577    .0577    .0577    .0577    .0577    .0577    .0577    .0577    .0577    .0577    .0577
   .0577    .0577    .0577    .0577    .0577    .0577
  0.0000   0.0000   0.0000   0.0000   0.0000    .1781    .3058    .3058    .3058    .3058    .3058    .3058    .3058    .3058
   .3058    .3058    .3058    .3058    .3058    .3058    .3058    .3058    .3058    .3058    .3058    .3058    .3058    .3058
   .3058    .3058    .3058    .3058    .3058    .3058
**** 3****
  1.4000   -.5878  -1.0333  -1.0642  -1.1874   -.9410   -.7260   -.4760   -.2260    .0240    .2740    .5240    .7740   1.0240
  1.2740   1.5240   1.7740   2.0240   2.2740   2.5240   2.7740   3.0240   3.2740   3.5240   3.7740   4.0240   4.2740   4.5240
  4.7740   5.0240   5.2740   5.5240
   .2836    .2836    .1540    .1540    .1540    .1540    .1540    .1540    .1540    .1540    .1540    .1540    .1540    .1540
   .1540    .1540    .1540    .1540    .1540    .1540    .1540    .1540    .1540    .1540    .1540    .1540    .1540    .1540
   .1540    .1540    .1540    .1540
  0.0000   0.0000   0.0000   0.0000   0.0000    .1781    .3058    .3058    .3058    .3058    .3058    .3058    .3058    .3058
   .3058    .3058    .3058    .3058    .3058    .3058    .3058    .3058    .3058    .3058    .3058    .3058    .3058    .3058
   .3058    .3058    .3058    .3058
**** 4****
  1.4000   -.0812   -.5878   -.6130   -.7137   -.5124   -.2974   -.0474    .2026    .4526    .7026    .9526   1.2026   1.4526
  1.7026   1.9526   2.2026   2.4526   2.7026   2.9526   3.2026   3.4526   3.7026   3.9526   4.2026   4.4526   4.7026   4.9526
  5.2026   5.4526   5.7026
   .4310    .4310    .2836    .2836    .2836    .2836    .2836    .2836    .2836    .2836    .2836    .2836    .2836    .2836
   .2836    .2836    .2836    .2836    .2836    .2836    .2836    .2836    .2836    .2836    .2836    .2836    .2836    .2836
   .2836    .2836    .2836
  0.0000   0.0000   0.0000   0.0000   0.0000    .1781    .3058    .3058    .3058    .3058    .3058    .3058    .3058    .3058
   .3058    .3058    .3058    .3058    .3058    .3058    .3058    .3058    .3058    .3058    .3058    .3058    .3058    .3058
   .3058    .3058    .3058
**** 5****
  1.4000    .4254   -.0812   -.1000   -.1750   -.0250    .1900    .4400    .6900    .9400   1.1900   1.4400   1.6900   1.9400
  2.1900   2.4400   2.6900   2.9400   3.1900   3.4400   3.6900   3.9400   4.1900   4.4400   4.6900   4.9400   5.1900   5.4400
  5.6900
   .5784    .5784    .4310    .4310    .4310    .4310    .4310    .4310    .4310    .4310    .4310    .4310    .4310    .4310
   .4310    .4310    .4310    .4310    .4310    .4310    .4310    .4310    .4310    .4310    .4310    .4310    .4310    .4310
   .4310
  0.0000   0.0000   0.0000   0.0000   0.0000    .1781    .3058    .3058    .3058    .3058    .3058    .3058    .3058    .3058
```

.3058	.3058	.3058	.3058	.3058	.3058	.3058	.3058	.3058	.3058	.3058	.3058	.3058	.3058
.3058													
**** 6*****													
1.4000	.8709	.4254	.4130	.3637	.4624	.6773	.9273	1.1773	1.4273	1.6773	1.9273	2.1773	2.4273
2.6773	2.9273	3.1773	3.4273	3.6773	3.9273	4.1773	4.4273	4.6773	4.9273	5.1773	5.4273	5.6773	
.7080	.7080	.5784	.5784	.5784	.5784	.5784	.5784	.5784	.5784	.5784	.5784	.5784	.5784
.5784	.5784	.5784	.5784	.5784	.5784	.5784	.5784	.5784	.5784	.5784	.5784	.5784	
0.0000	0.0000	0.0000	0.0000	0.0000	.1781	.3058	.3058	.3058	.3058	.3058	.3058	.3058	.3058
.3058	.3058	.3058	.3058	.3058	.3058	.3058	.3058	.3058	.3058	.3058	.3058	.3058	
**** 7*****													
1.4000	1.2016	.8709	.8642	.8374	.8910	1.1059	1.3559	1.6059	1.8559	2.1059	2.3559	2.6059	2.8559
3.1059	3.3559	3.6059	3.8559	4.1059	4.3559	4.6059	4.8559	5.1059	5.3559	5.6059			
.8043	.8043	.7080	.7080	.7080	.7080	.7080	.7080	.7080	.7080	.7080	.7080	.7080	.7080
.7080	.7080	.7080	.7080	.7080	.7080	.7080	.7080	.7080	.7080	.7080			
0.0000	0.0000	0.0000	0.0000	0.0000	.1781	.3058	.3058	.3058	.3058	.3058	.3058	.3058	.3058
.3058	.3058	.3058	.3058	.3058	.3058	.3058	.3058	.3058	.3058	.3058			
**** 8*****													
1.4000	1.3098	1.2016	1.1990	1.1890	1.2091	1.4240	1.6740	1.9240	2.1740	2.4240	2.6740	2.9240	3.1740
3.4240	3.6740	3.9240	4.1740	4.4240	4.6740	4.9240	5.1740	5.4240	5.6740				
.8620	.8331	.8043	.8043	.8043	.8043	.8043	.8043	.8043	.8043	.8043	.8043	.8043	.8043
.8043	.8043	.8043	.8043	.8043	.8043	.8043	.8043	.8043	.8043				
0.0000	0.0000	0.0000	0.0000	0.0000	.1781	.3058	.3058	.3058	.3058	.3058	.3058	.3058	.3058
.3058	.3058	.3058	.3058	.3058	.3058	.3058	.3058	.3058	.3058				

```
WAKE ELEMENTS
*************
**** 1****
   1.4000    1.7000    2.0000    2.7500    3.5000    4.2500    5.0000    5.7500
   0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
   0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
**** 2****
   1.4000    1.7000    2.0000    2.7500    3.5000    4.2500    5.0000    5.7500
    .0577     .0577     .0577     .0577     .0577     .0577     .0577     .0577
   0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
**** 3****
   1.4000    1.7000    2.0000    2.7500    3.5000    4.2500    5.0000    5.7500
    .1540     .1540     .1540     .1540     .1540     .1540     .1540     .1540
   0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
**** 4****
   1.4000    1.7000    2.0000    2.7500    3.5000    4.2500    5.0000    5.7500
    .2836     .2836     .2836     .2836     .2836     .2836     .2836     .2836
   0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
**** 5****
   1.4000    1.7000    2.0000    2.7500    3.5000    4.2500    5.0000    5.7500
    .4310     .4310     .4310     .4310     .4310     .4310     .4310     .4310
   0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
**** 6****
   1.4000    1.7000    2.0000    2.7500    3.5000    4.2500    5.0000    5.7500
    .5784     .5784     .5784     .5784     .5784     .5784     .5784     .5784
   0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
**** 7****
   1.4000    1.7000    2.0000    2.7500    3.5000    4.2500    5.0000    5.7500
    .7080     .7080     .7080     .7080     .7080     .7080     .7080     .7080
   0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
**** 8****
   1.4000    1.7000    2.0000    2.7500    3.5000    4.2500    5.0000    5.7500
    .8043     .8043     .8043     .8043     .8043     .8043     .8043     .8043
   0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
**** 9****
   1.4000    1.7000    2.0000    2.7500    3.5000    4.2500    5.0000    5.7500
    .8555     .8555     .8555     .8555     .8555     .8555     .8555     .8555
   0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
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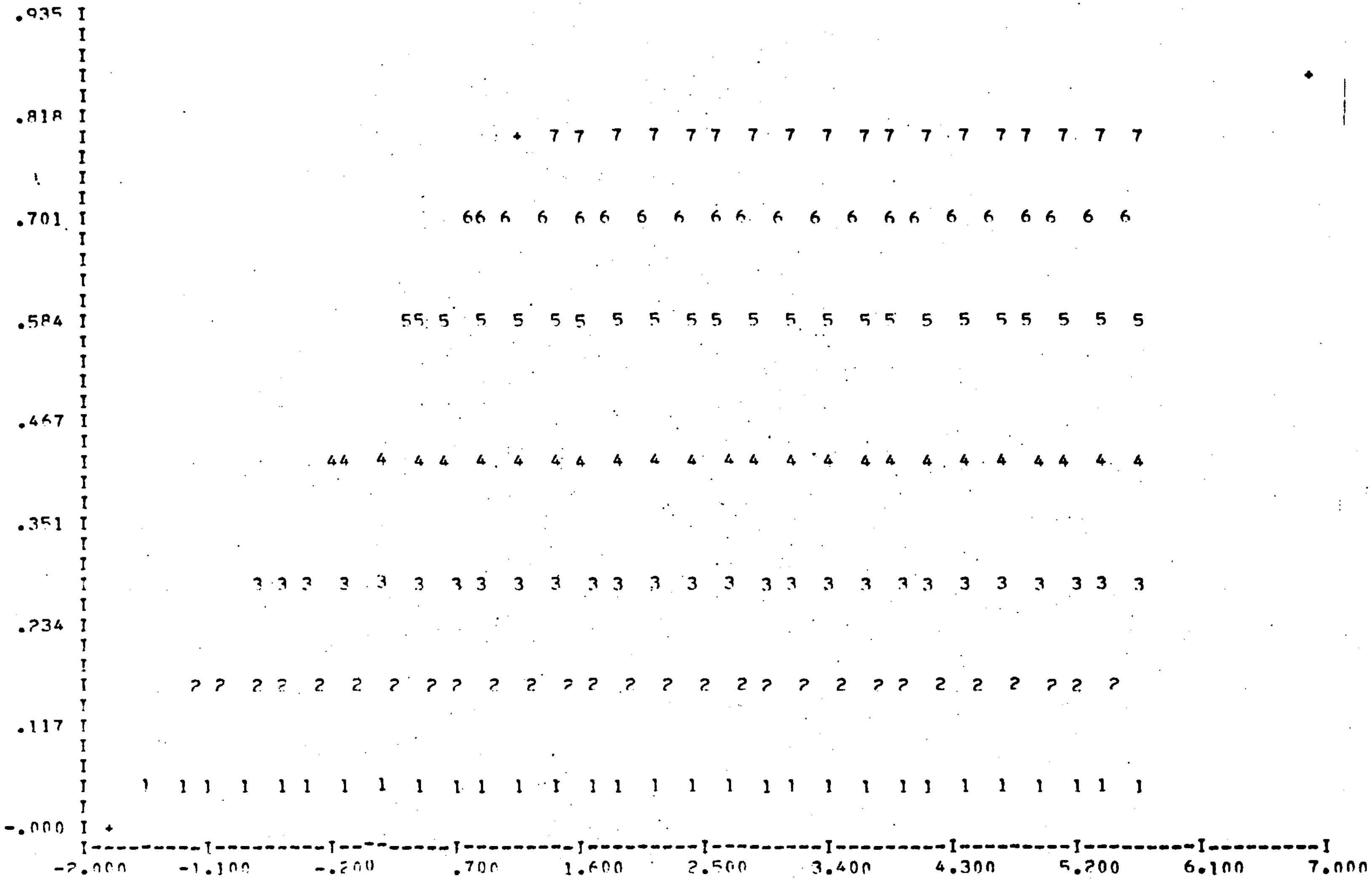

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.584
.467
.351
.234
.117
-.000
-2.000
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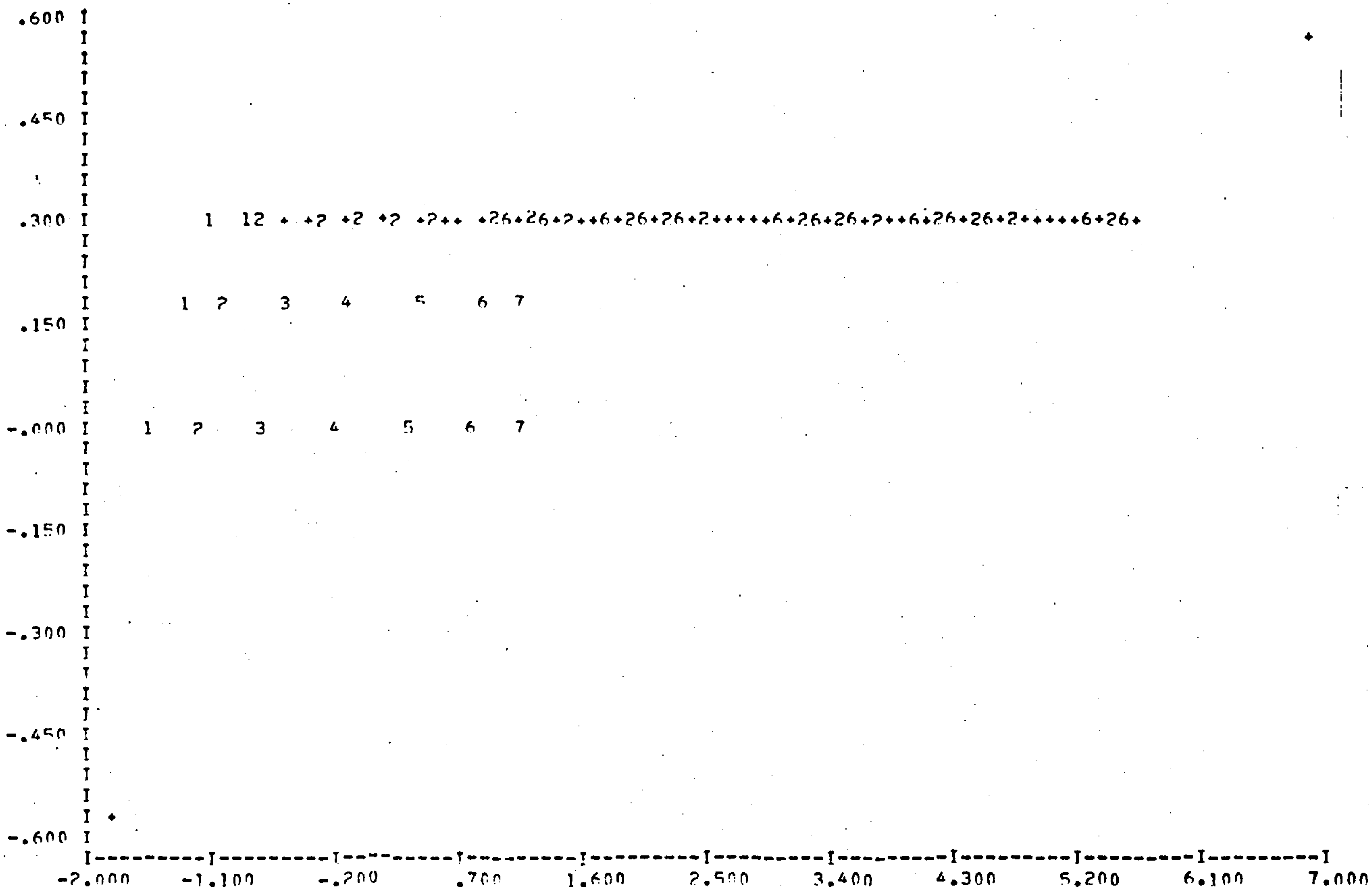
X VS Y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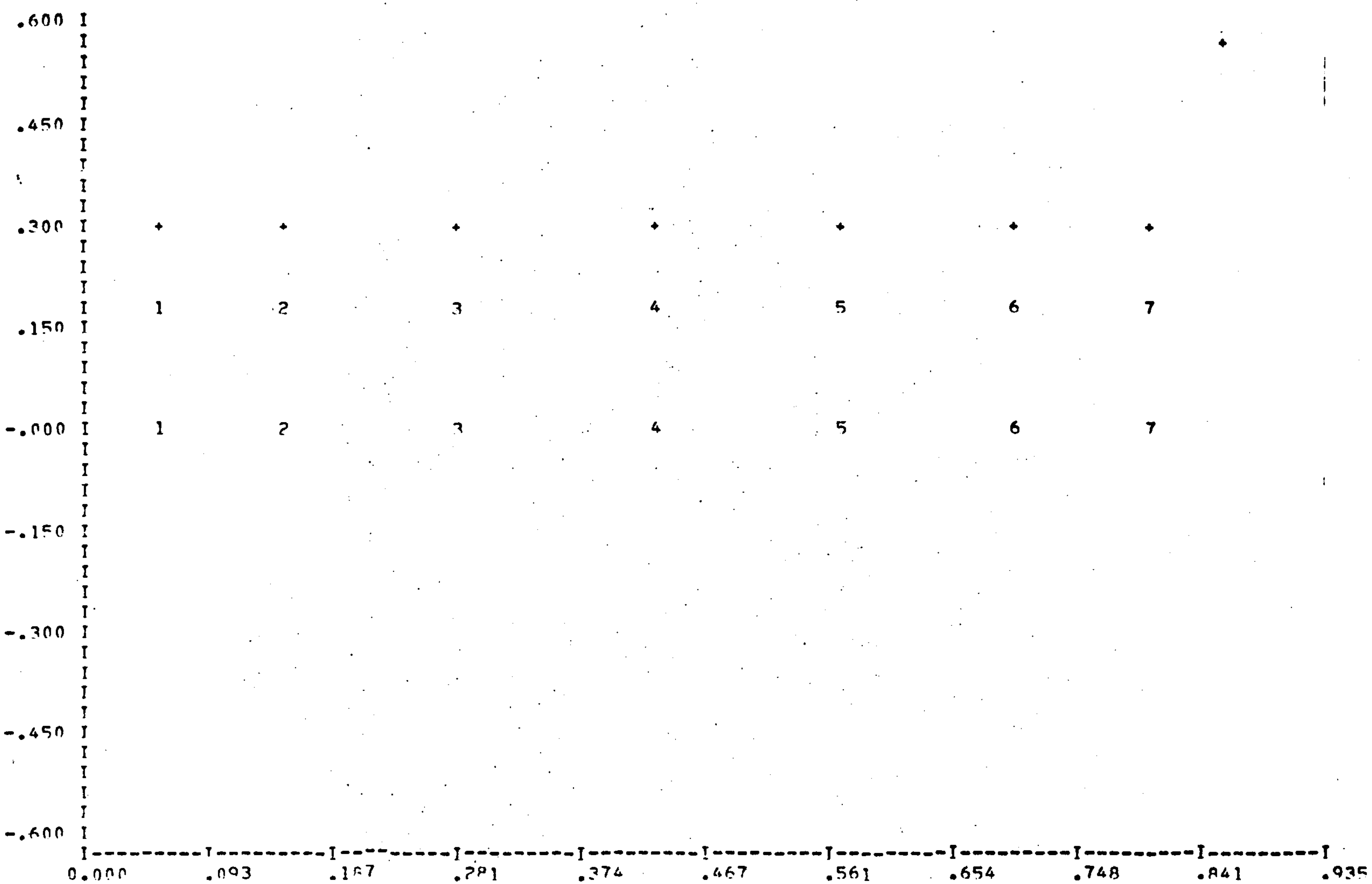
X VS Z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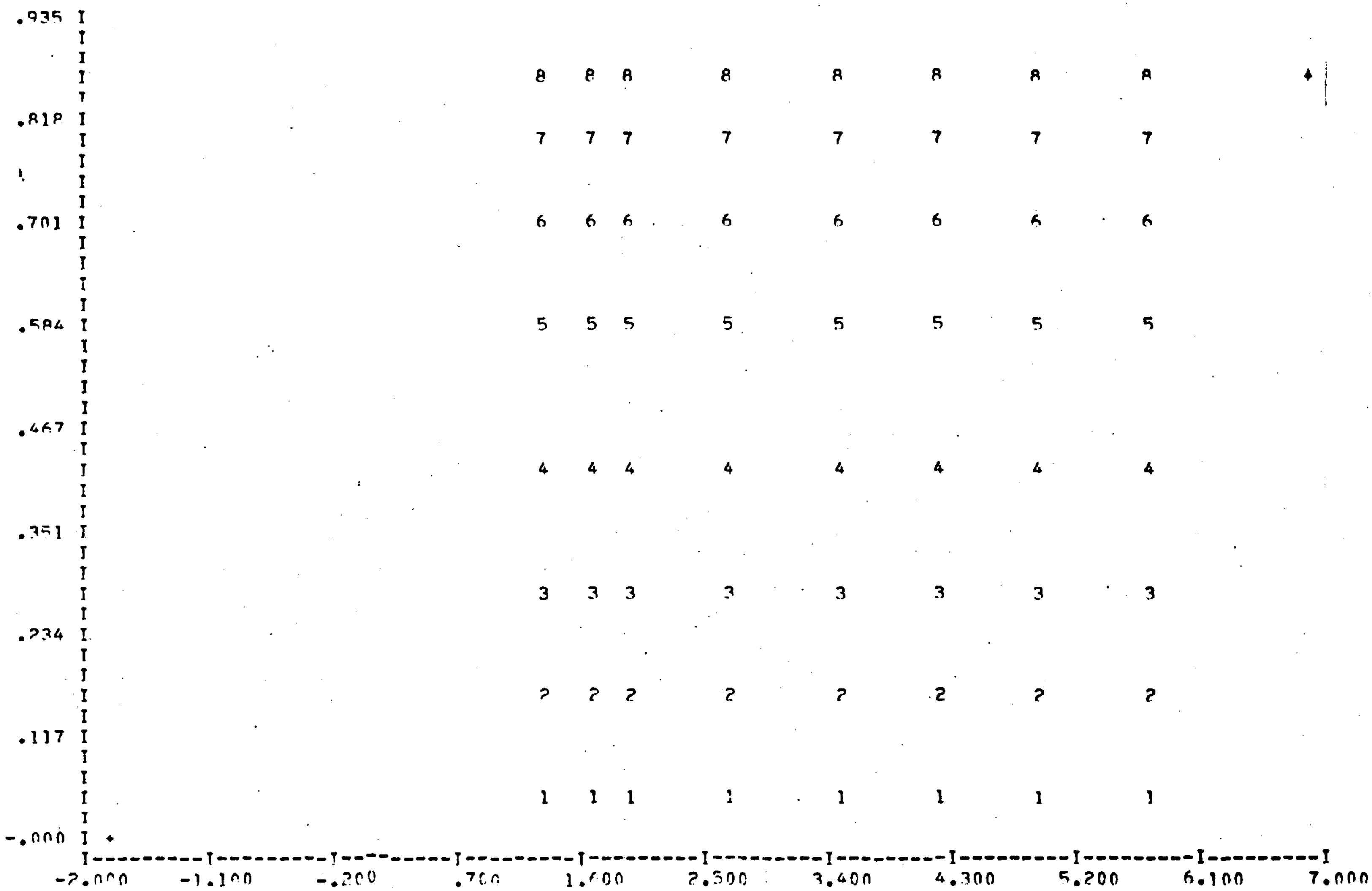
Y VS Z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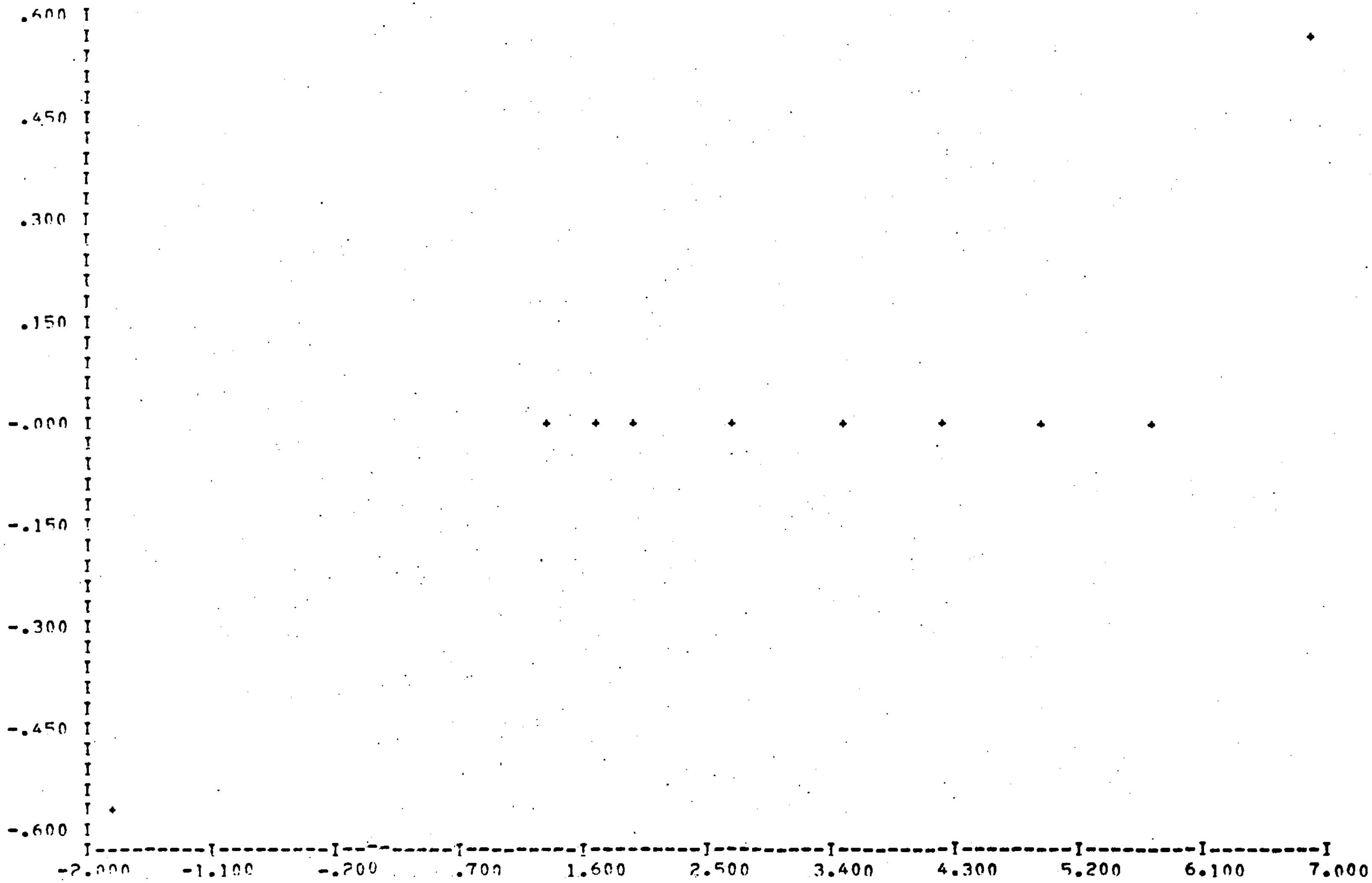
X VS Y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5.200
6.100
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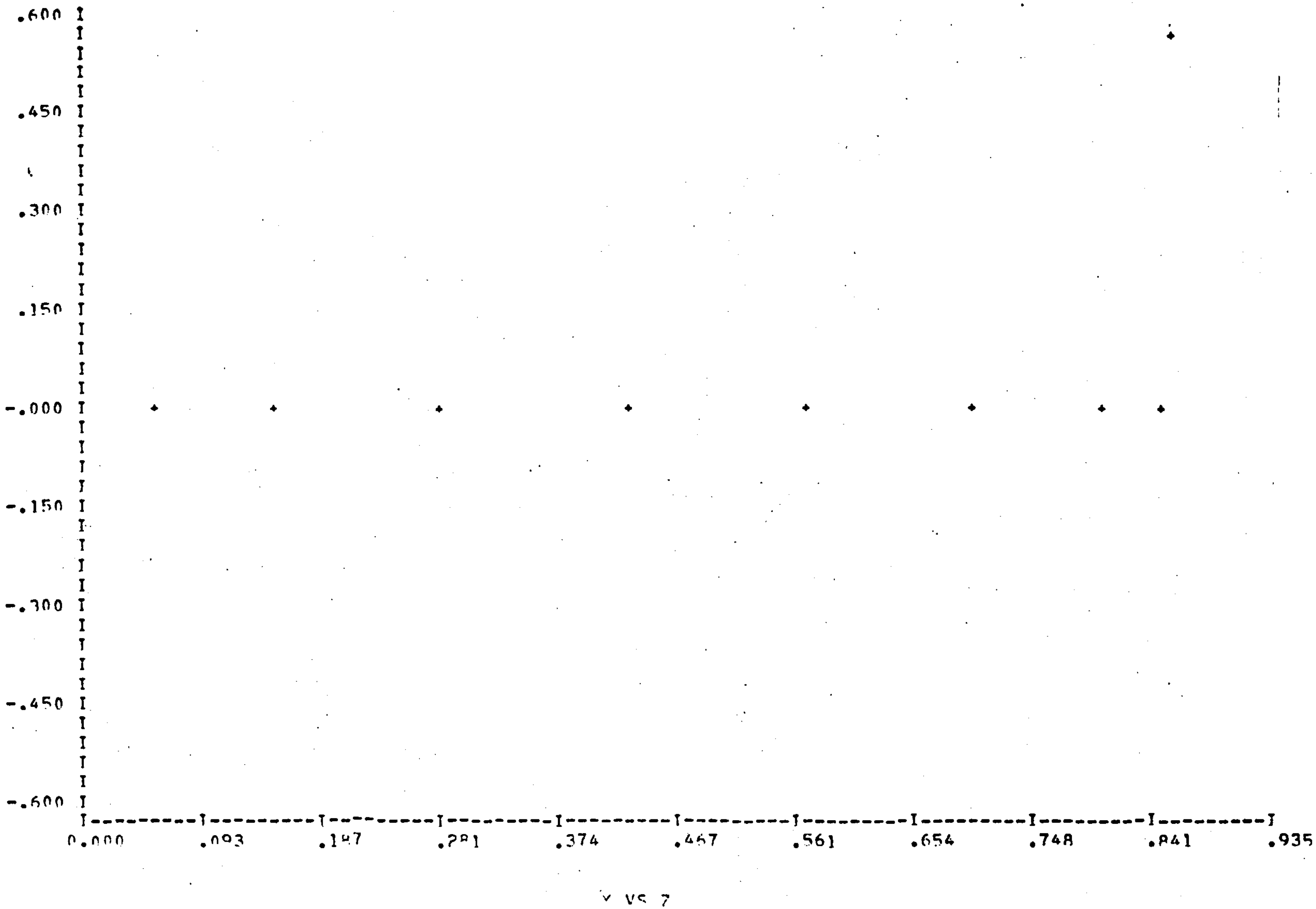
X VS Z



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.450
.300
.150
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-.300
-.450
-.600
0.000
.093
.187
.281
.374
.467
.561
.654
.748
.841
.935
Y VS Z

WING VORTEX STRENGTHS
****

X/C	2Y/B	GAMAY
***	****	*****
.01704	.03015	8.38200
.14645	.03015	1.01076
.37059	.03015	.57752
.62941	.03015	.33881
.85355	.03015	.18110
.98296	.03015	.05805
.01704	.11698	4.07479
.14645	.11698	.84278
.37059	.11698	.57724
.62941	.11698	.34876
.85355	.11698	.18796
.98296	.11698	.05825
.01704	.25000	3.28290
.14645	.25000	.80222
.37059	.25000	.52637
.62941	.25000	.34960
.85355	.25000	.19354
.98296	.25000	.05759
.01704	.41318	3.61828
.14645	.41318	.81333
.37059	.41318	.49334
.62941	.41318	.35042
.85355	.41318	.20046
.98296	.41318	.05876
.01704	.58682	4.41056
.14645	.58682	.79837
.37059	.58682	.52346
.62941	.58682	.37033
.85355	.58682	.21309
.98296	.58682	.06273
.01704	.75000	5.32481
.14645	.75000	.76511
.37059	.75000	.64004
.62941	.75000	.42758
.85355	.75000	.22763
.98296	.75000	.07022
.01704	.88302	6.99845
.14645	.88302	.84702
.37059	.88302	.68324
.62941	.88302	.50084
.85355	.88302	.29713
.98296	.88302	.09346

.01704	.96985	10.70191
.14645	.96985	1.14758
.37059	.96985	.77293
.62941	.96985	.61814
.85355	.96985	.41942
.98296	.96985	.15140

LEADING-EDGE VORTICES STRENGTHS
****

2Y/B	CAPGAMA
****	*******
.03015	1.12870
.11698	.50160
.25000	.36111
.41318	.32146
.58682	.28186
.75000	.20867
.88302	.12942
.96985	.05129

DELTA-CP DISTRIBUTION
****

X/C	2Y/B	DELTA-CP
***	****	********
.01254	.03015	.93644
.10908	.03015	1.58236
.28306	.03015	1.87504
.50000	.03015	.58962
.71694	.03015	.68475
.89092	.03015	.16296
.98746	.03015	.24880
.01254	.11698	10.46179
.10908	.11698	2.57370
.28306	.11698	.84952
.50000	.11698	1.03587
.71694	.11698	.50033
.89092	.11698	.54141
.98746	.11698	.17776
.01254	.25000	5.87619
.10908	.25000	1.19066
.28306	.25000	.76001
.50000	.25000	1.26132
.71694	.25000	.75740
.89092	.25000	.83658
.98746	.25000	.46474
.01254	.41318	5.66503
.10908	.41318	1.70542
.28306	.41318	.78709
.50000	.41318	1.18534
.71694	.41318	.92751
.89092	.41318	.86911
.98746	.41318	.56234
.01254	.58682	4.91002
.10908	.58682	3.88938
.28306	.58682	.83959
.50000	.58682	.57190
.71694	.58682	.76038
.89092	.58682	.49984
.98746	.58682	.39999
.01254	.75000	4.85511
.10908	.75000	4.20697
.28306	.75000	1.03986
.50000	.75000	.57927
.71694	.75000	.37819
.89092	.75000	.21812
.98746	.75000	-.07403
.01254	.88302	5.57029

.10908	.88302	4.99757
.28306	.88302	1.76241
.50000	.88302	1.00368
.71694	.88302	.00520
.89092	.88302	-.04567
.98746	.88302	-.63635
.01254	.96985	6.46233
.10908	.96985	6.35860
.28306	.96985	2.11451
.50000	.96985	1.84298
.71694	.96985	.57979
.89092	.96985	.35000
.98746	.96985	-.59505

SECTIONAL PROPERTIES
****

I	CL	CM	CD	CT
*	**	**	**	**
1	.81962	.23934	.48666	0.00000
2	1.24389	.40657	.67017	0.00000
3	.98137	-.02578	.52479	0.00000
4	1.02978	-.19773	.53115	0.00000
5	1.05218	-.31272	.47931	0.00000
6	.93987	-.41111	.34639	0.00000
7	1.01671	-.56347	.27208	0.00000
8	1.35887	-.87514	.28420	0.00000

TOTAL LIFT COEFFICIENT= 1.01587
TOTAL PITCHING MOMENT COEFFICIENT= -.03066
TOTAL DRAG COEFFICIENT= .51375
TOTAL THRUST COEFFICIENT= 0.00000

SPANWISE PRESSURE AT CONSTANT X=, -.40000

Y	2Y/B(LOCAL)	DELTA-CP
.02599	.07538	1.22605
.10083	.29244	.84703
.21550	.62500	.65597

SPANWISE PRESSURE AT CONSTANT X=, .41000

Y	2Y/B(LOCAL)	DELTA-CP
.02599	.04501	.58400
.10083	.17459	.79256
.21550	.37313	1.19617
.35616	.61668	1.10947
.50584	.87586	1.94922

SPANWISE PRESSURE AT CONSTANT X=, 1.20500

Y	2Y/B(LOCAL)	DELTA-CP
.02599	.03225	.40304
.10083	.12511	.64089
.21550	.26738	.89761
.35616	.44190	.86490
.50584	.62762	.54297
.64650	.80214	.31995
.76117	.94441	1.10036

Results for iterations 1 and 2 are omitted.

Initial Shape of the Free Sheet and Concentrated Core is shown in Iteration 3.

```
                    CONICAL CAMBER WING AT ALPHA 30.7 DEGREES
ALPHA(DEG.)=30.700  MACH NUMBER= 0.000  ITERATION NUMBER= 3

LEADING EDGE ELEMENTS
*********************
 **** 1*****
  1.4000  -1.3639  -1.5624  -1.6000  -1.6000  -1.6000  -1.6000  -1.6000  -1.6000  -1.6000  -1.6000  -1.6000  -1.2316   -.6755
  -.0534    .6895   1.6399   2.3086   3.0289   3.7492
   .0577    .0577   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000    .0656    .1647
   .2755    .4079    .5344    .5344    .5344    .5344
  0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000    .0805    .1151
   .1926    .2852    .4035    .4868    .5765    .6662
 **** 2*****
  1.4000  -1.0333  -1.3639  -1.3990  -1.5390  -1.5251  -1.5108  -1.4959  -1.4801  -1.2316  -1.2316  -1.2316   -.6755   -.0534
   .6895   1.6399   2.3086   3.0289   3.7492
   .1540    .1540    .0577    .0577    .0577    .0723    .0819    .0818    .0720    .0656    .0656    .0656    .1647    .2755
   .4079    .5344    .5344    .5344    .5344
  0.0000   0.0000   0.0000   0.0000   0.0000    .0265    .0537    .0819    .1046    .1101    .0805    .0805    .1151    .1926
   .2852    .4035    .4868    .5765    .6662
 **** 3*****
  1.4000   -.5878  -1.0333  -1.0642  -1.1874  -1.0932   -.9969   -.8962   -.7894   -.6755   -.6755   -.6755   -.0534    .6895
  1.6399   2.3086   3.0289   3.7492
   .2836    .2836    .1540    .1540    .1540    .1929    .2185    .2182    .1919    .1509    .1509    .1647    .2755    .4079
   .5344    .5344    .5344    .5344
  0.0000   0.0000   0.0000   0.0000   0.0000    .0707    .1432    .2184    .2789    .2935    .2104    .1151    .1926    .2852
   .4035    .4868    .5765    .6662
 **** 4*****
  1.4000   -.0812   -.5878   -.6130   -.7137   -.6025   -.4782   -.3394   -.2001   -.0534   -.0534   -.0534    .6895   1.6399
  2.3086   3.0289   3.7492
   .4310    .4310    .2836    .2836    .2836    .3260    .3444    .3262    .2783    .2244    .2244    .2755    .4079    .5344
   .5344    .5344    .5344
  0.0000   0.0000   0.0000   0.0000   0.0000    .1107    .2078    .2884    .3609    .3897    .2564    .1926    .2852    .4035
   .4868    .5765    .6662
 **** 5*****
  1.4000    .4254   -.0812   -.1000   -.1750   -.0450    .1341    .3159    .4958    .6895    .6895    .6895   1.6399   2.3086
  3.0289   3.7492
   .5784    .5784    .4310    .4310    .4310    .4689    .4735    .4420    .3800    .3048    .3048    .4079    .5344    .5344
   .5344    .5344
  0.0000   0.0000   0.0000   0.0000   0.0000    .1653    .2786    .3865    .4830    .5283    .3049    .2852    .4035    .4868
   .5765    .6662
 **** 6*****
  1.4000    .8709    .4254    .4130    .3637    .5432    .8194   1.0799   1.3522   1.6399   1.6399   1.6399   2.3086   3.0289
  3.7492
   .7080    .7080    .5784    .5784    .5784    .6077    .6042    .5526    .4705    .3837    .3837    .5344    .5344    .5344
   .5344
  0.0000   0.0000   0.0000   0.0000   0.0000    .2405    .3891    .5482    .6719    .7466    .3847    .4035    .4868    .5765
   .6662
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**** 7****

1.4000	1.2016	.8709	.8642	.8374	1.0374	1.3579	1.6649	1.9755	2.3086	2.3086	2.3086	3.0289	3.7492
.8043	.8043	.7080	.7080	.7080	.7265	.7105	.6434	.5422	.4455	.4455	.5344	.5344	.5344
0.0000	0.0000	0.0000	0.0000	0.0000	.2756	.4571	.6444	.8084	.9240	.5081	.4868	.5765	.6662

**** 8****

1.4000	1.3008	1.2016	1.1990	1.1890	1.4586	1.8571	2.2556	2.6364	3.0289	3.0289	3.0289	3.7492
.8620	.8331	.8043	.8043	.8043	.8302	.8263	.7769	.6450	.4887	.4887	.5344	.5344
0.0000	0.0000	0.0000	0.0000	0.0000	.3231	.5637	.8022	1.0380	1.2372	.6853	.5765	.6662

WAKE ELEMENTS

****

**** 1*****

1.4000	1.7000	2.0000	2.7500	3.5000	4.2500	5.0000	5.7500
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

**** 2*****

1.4000	1.7000	1.9969	2.7369	3.4555	4.1320	4.7960	5.5259
.0577	.0577	.0994	.2185	.3784	.5440	.5655	.6050
0.0000	0.0000	-.0103	.0176	.1606	.4390	.7870	.9552

**** 3*****

1.4000	1.7000	1.9876	2.7104	3.4257	4.1248	4.8049	5.4705
.1540	.1540	.2391	.4245	.5716	.6971	.7885	.7780
0.0000	0.0000	-.0060	.0692	.2402	.4809	.7836	1.1292

**** 4*****

1.4000	1.7000	1.9716	2.6451	3.3086	4.0065	4.7278	5.4233
.2836	.2836	.4109	.7118	1.0212	1.0775	1.0775	1.0775
0.0000	0.0000	.0064	.1417	.3047	.5733	.7791	1.0596

**** 5*****

1.4000	1.7000	1.9690	2.7036	3.3958	4.0762	4.7683	5.4337
.4310	.4310	.5571	.6937	.8938	1.0401	.9303	1.0075
0.0000	0.0000	.0414	.1063	.3147	.5941	.8613	1.1987

**** 6*****

1.4000	1.7000	1.9815	2.6673	3.3790	4.1033	4.8165	5.4610
.5784	.5784	.6688	.9391	1.0775	1.0775	1.0775	1.0039
0.0000	0.0000	.0505	.1889	.3809	.5756	.8077	1.1842

**** 7*****

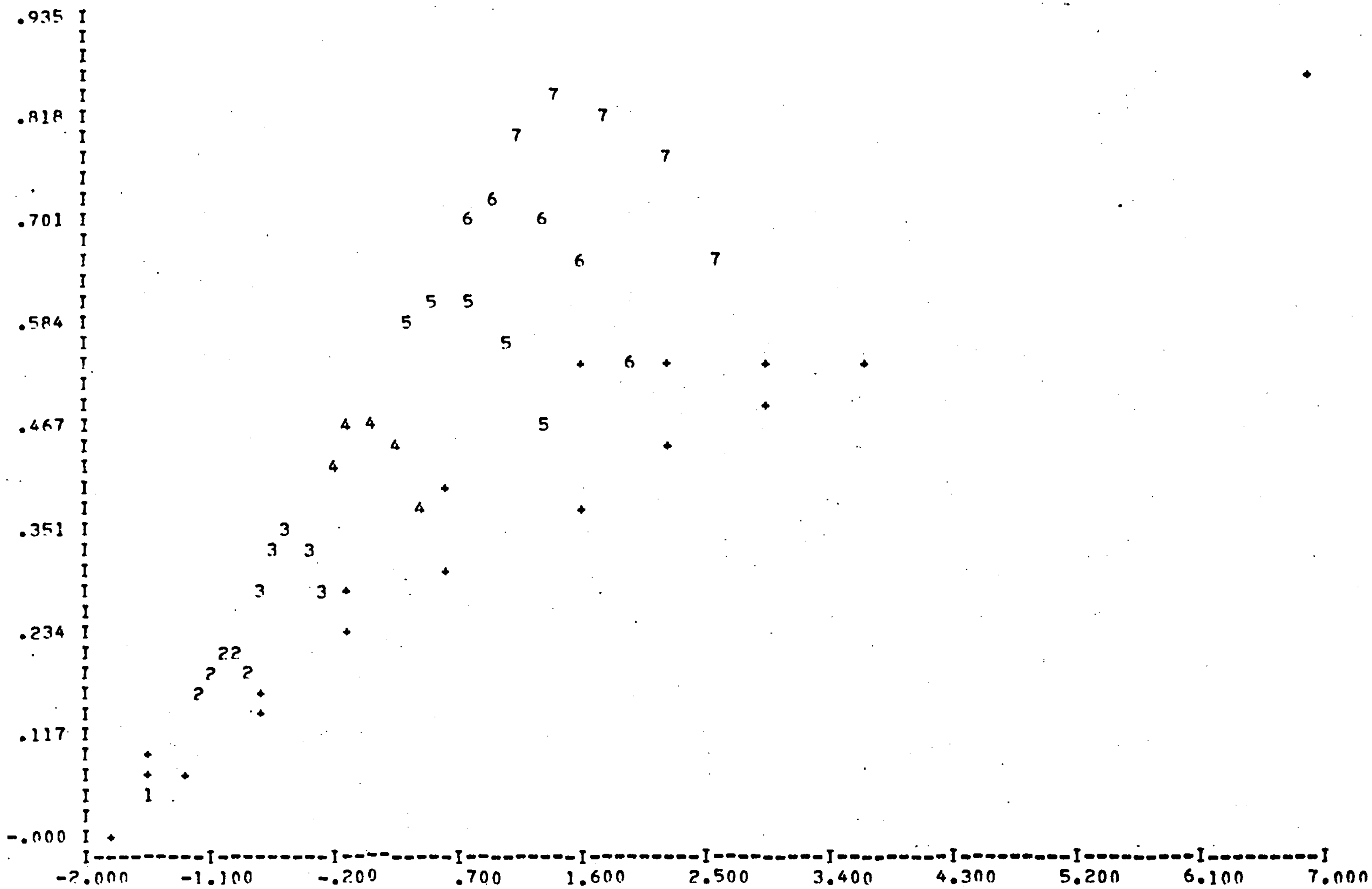
1.4000	1.7000	1.9842	2.6744	3.3636	4.0530	4.7559	5.4371
.7080	.7080	.7796	.9909	1.0775	1.0775	1.0775	1.0775
0.0000	0.0000	.0640	.2675	.5505	.8459	1.1076	1.4214

**** 8*****

1.4000	1.7000	1.9735	2.6232	3.2764	3.9204	4.5599	5.2008
.8043	.8043	.8669	1.0362	1.0775	1.0452	.9616	.8604
0.0000	0.0000	.1060	.4404	.8067	1.1896	1.5725	1.9486

**** 9*****

1.4000	1.7000	1.9522	2.5756	3.2153	3.9003	4.5757	5.2731
.8555	.8555	.9096	1.0747	.9933	.8853	.7305	.4737
0.0000	0.0000	.1532	.5361	.9190	1.2048	1.4918	1.5924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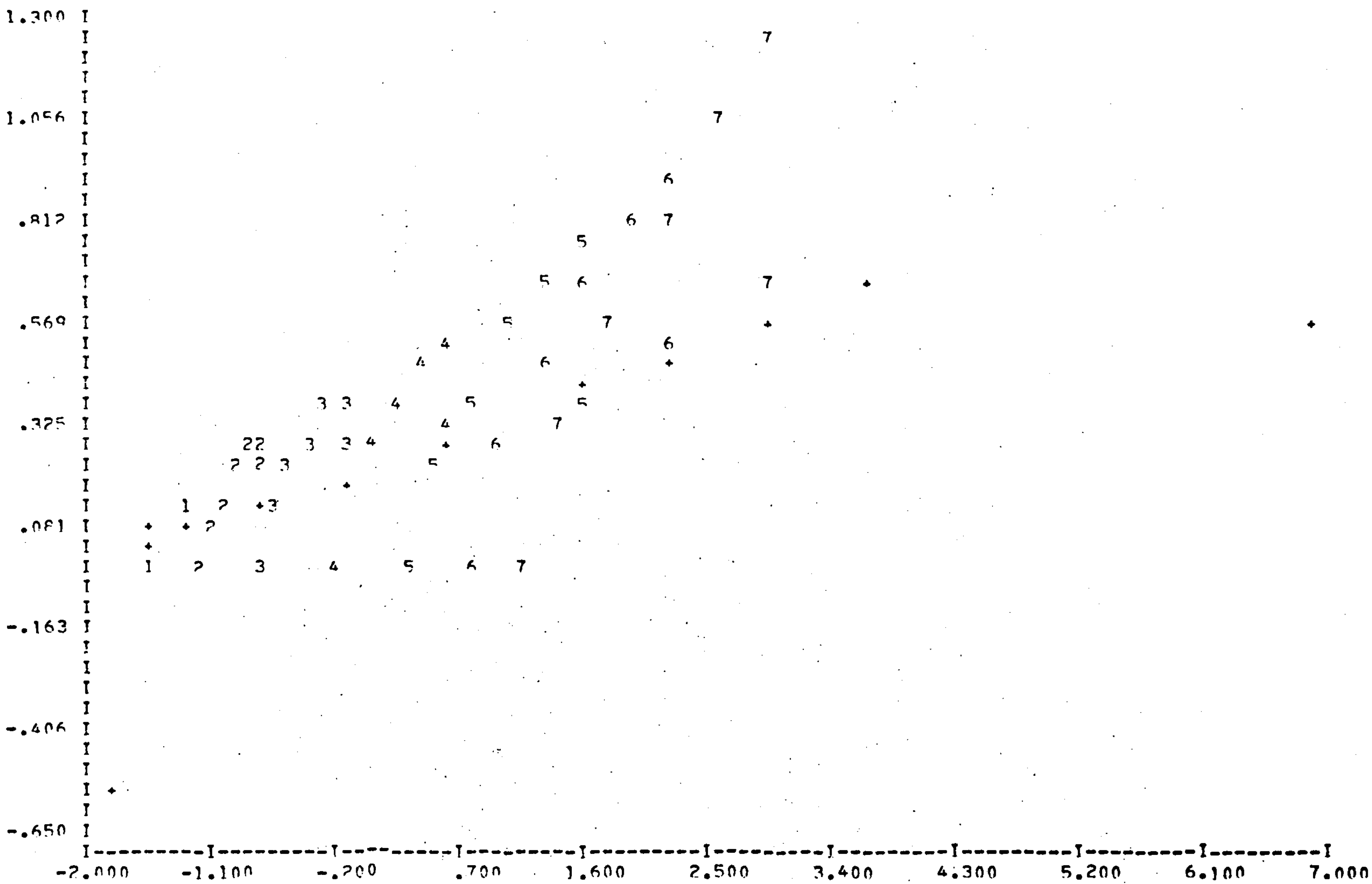
X VS Y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2.500
3.400
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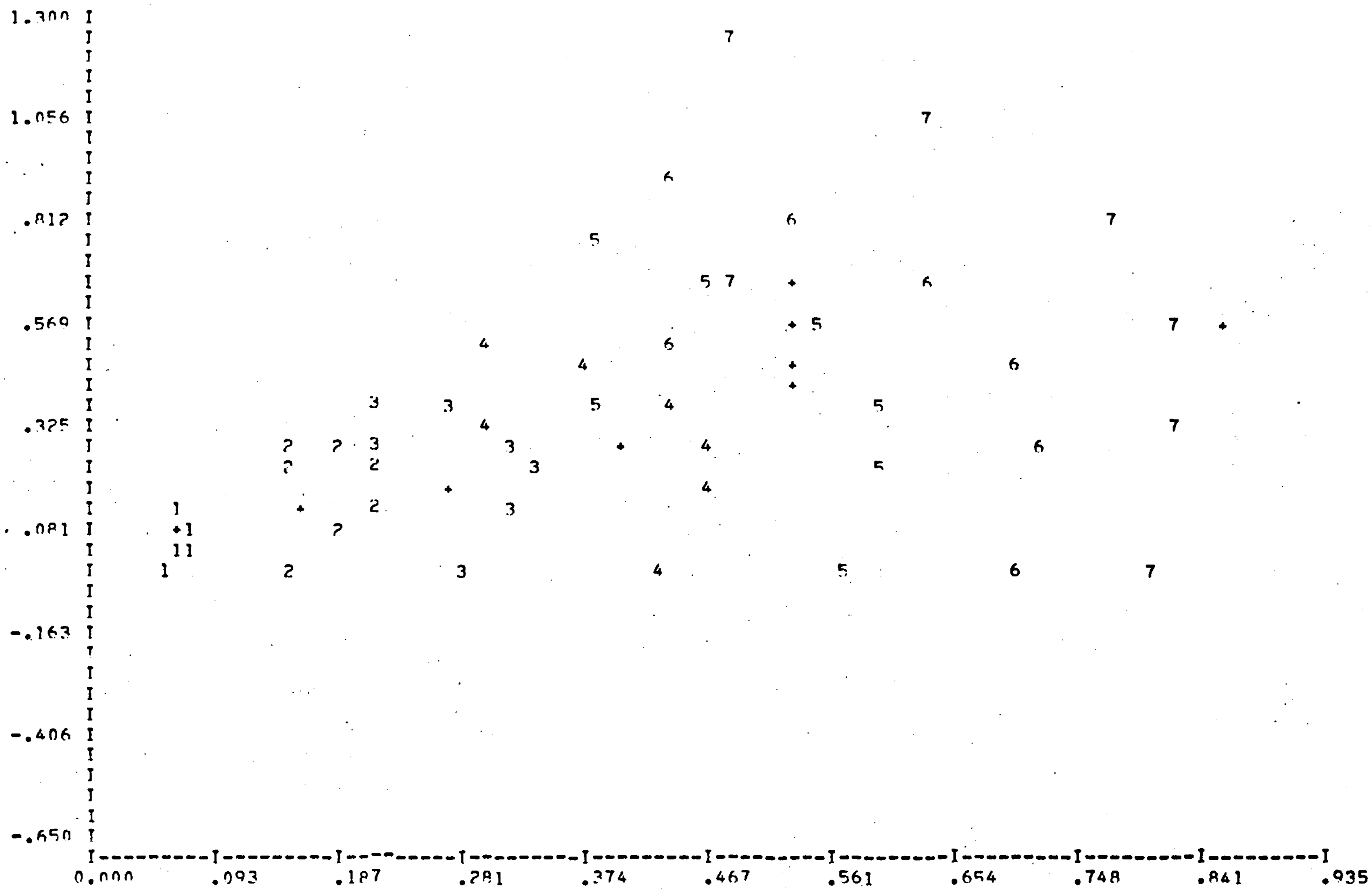
5.200
6.100
7.000

X VS Z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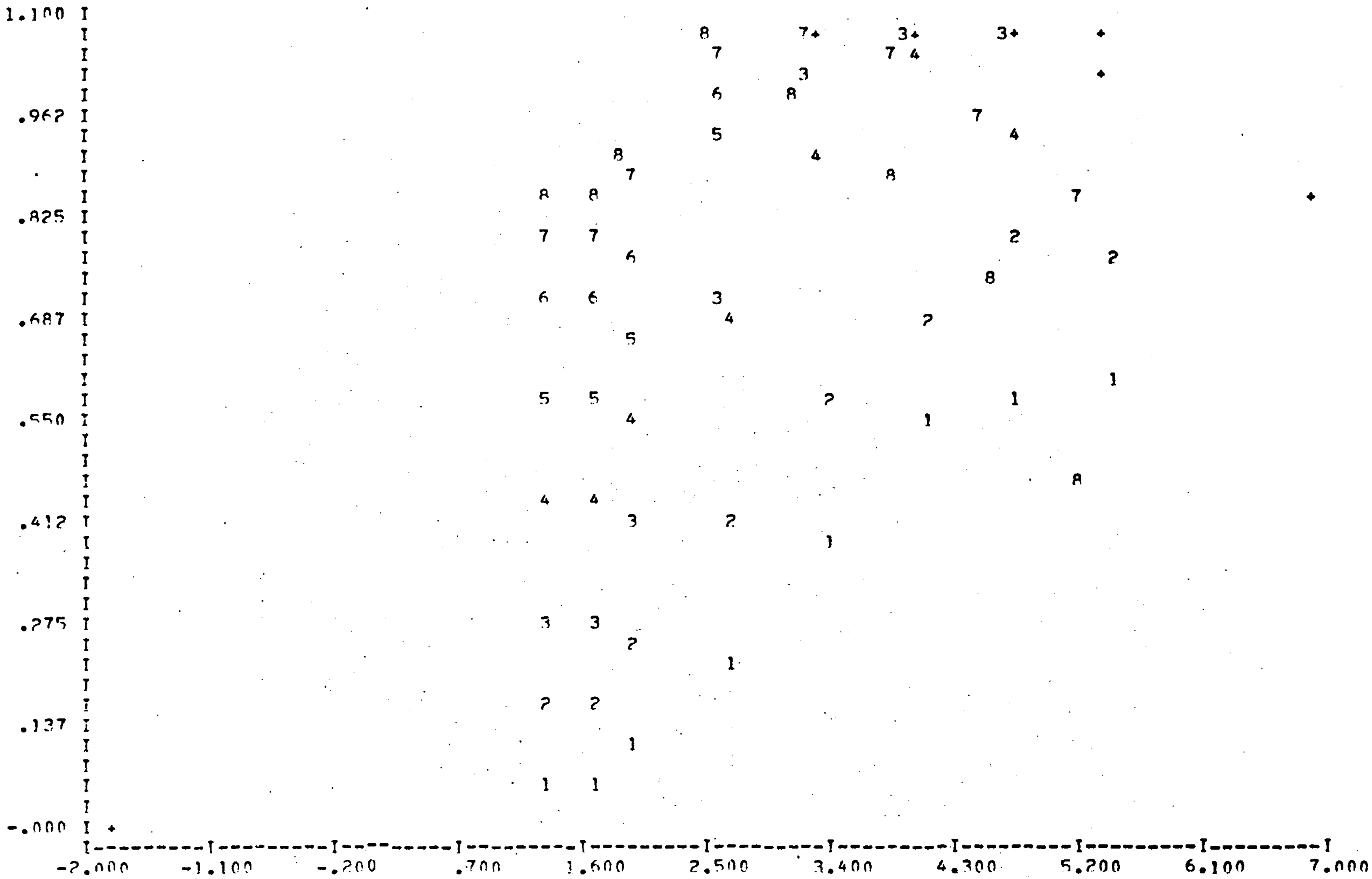
.569
.325
.081
-.163
-.406
-.650
0.000
.093
.187
.281
.374
.467
.561
.654
.748
.841
.935

Y VS Z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.962
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.550
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.275
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-2.000
-1.100
-.200
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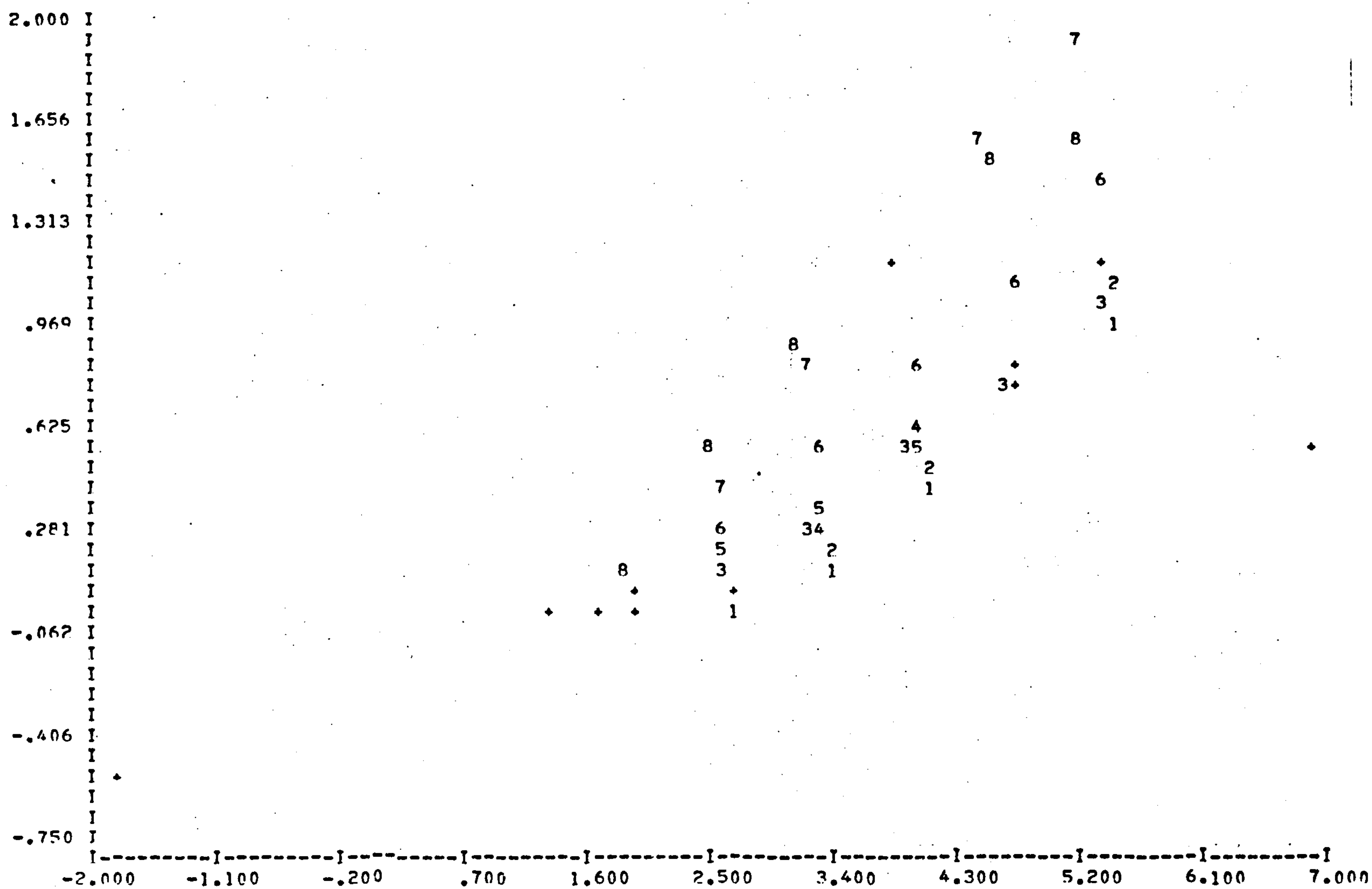
1.600
2.500
3.400
4.300
5.200
6.100
7.000

X VS Y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1.656
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.625
.281
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-.406
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.700
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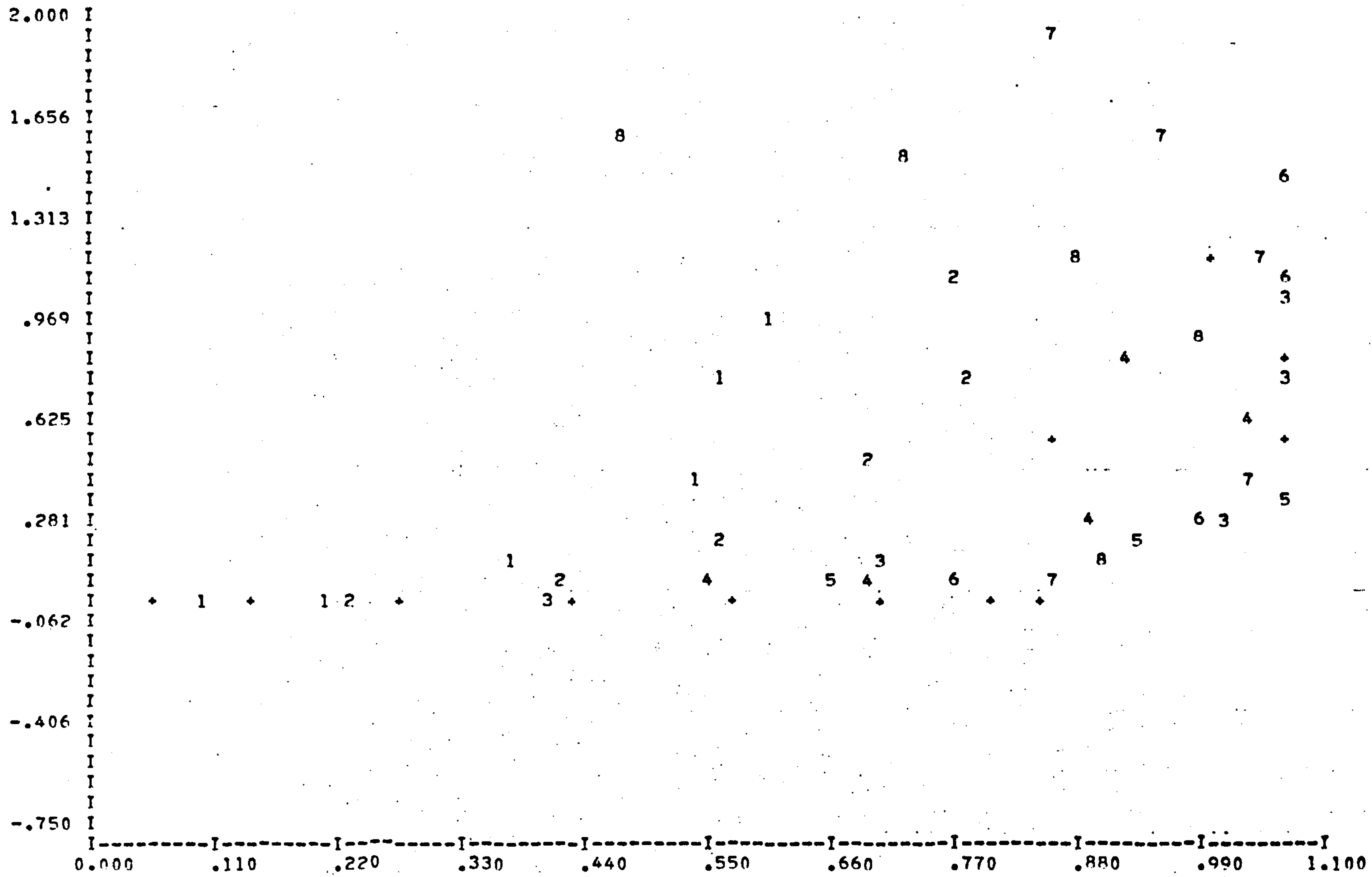
2.500
3.400
4.300
5.200
6.100
7.000

X VS 7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1.313
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.281
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-.406
-.750
0.000
.110
.220
.330
.440
.550
.660
.770
.880
.990
1.100

Y VS Z

WING VORTEX STRENGTHS
****

X/C ***	2Y/B ****	GAMAY *****
.01704	.03015	2.69948
.14645	.03015	.44077
.37059	.03015	.42606
.62941	.03015	.33144
.85355	.03015	.21837
.98296	.03015	.08506
.01704	.11698	1.60319
.14645	.11698	.28572
.37059	.11698	.41397
.62941	.11698	.33436
.85355	.11698	.22344
.98296	.11698	.08351
.01704	.25000	2.06415
.14645	.25000	.32235
.37059	.25000	.29850
.62941	.25000	.29331
.85355	.25000	.21136
.98296	.25000	.07323
.01704	.41318	2.53946
.14645	.41318	.47748
.37059	.41318	.23815
.62941	.41318	.21579
.85355	.41318	.16667
.98296	.41318	.05089
.01704	.58682	3.23341
.14645	.58682	.53154
.37059	.58682	.31264
.62941	.58682	.20575
.85355	.58682	.11987
.98296	.58682	.02939
.01704	.75000	3.92961
.14645	.75000	.54241
.37059	.75000	.45396
.62941	.75000	.28041
.85355	.75000	.13793
.98296	.75000	.03688
.01704	.88302	5.23080
.14645	.88302	.62764
.37059	.88302	.49692
.62941	.88302	.38249
.85355	.88302	.22302
.98296	.88302	.06904

.01704	.96985	8.10640
.14645	.96985	.87192
.37059	.96985	.58965
.62941	.96985	.47335
.85355	.96985	.32222
.98296	.96985	.11631

LEADING-EDGE VORTICES STRENGTHS
****

2Y/B	CAPGAMA
****	*******
.03015	.41388
.11698	.19614
.25000	.22825
.41318	.22664
.58682	.20691
.75000	.15402
.88302	.09673
.96985	.03885

DELTA-CP DISTRIBUTION

****

X/C	2Y/B	DELTA-CP
***	****	********
.01254	.03015	5.37273
.10908	.03015	1.20687
.28306	.03015	.76129
.50000	.03015	.73019
.71694	.03015	.52772
.89092	.03015	.38121
.98746	.03015	.14484
.01254	.11698	7.24640
.10908	.11698	2.50420
.28306	.11698	1.25580
.50000	.11698	.76442
.71694	.11698	.60438
.89092	.11698	.38654
.98746	.11698	.19248
.01254	.25000	2.59038
.10908	.25000	2.72487
.28306	.25000	2.20823
.50000	.25000	1.40225
.71694	.25000	.80584
.89092	.25000	.58850
.98746	.25000	.29099
.01254	.41318	3.49386
.10908	.41318	1.41421
.28306	.41318	1.55573
.50000	.41318	1.69482
.71694	.41318	1.11060
.89092	.41318	.93024
.98746	.41318	.54551
.01254	.58682	3.32251
.10908	.58682	2.27789
.28306	.58682	.80092
.50000	.58682	.91310
.71694	.58682	1.06551
.89092	.58682	.80414
.98746	.58682	.71854
.01254	.75000	3.53866
.10908	.75000	2.80547
.28306	.75000	.71763
.50000	.75000	.46314
.71694	.75000	.40929
.89092	.75000	.32594
.98746	.75000	.18231
.01254	.88302	4.22971

.10908	.88302	3.66379
.28306	.88302	1.15853
.50000	.88302	.51732
.71694	.88302	-.07571
.89092	.88302	-.15354
.98746	.88302	-.52354
.01254	.96985	4.66796
.10908	.96985	4.52855
.28306	.96985	1.53587
.50000	.96985	1.25348
.71694	.96985	.32264
.89092	.96985	.12931
.98746	.96985	-.50031

SECTIONAL PROPERTIES
****

I	CL	CM	CD	CT
*	**	**	**	**
1	.79292	.29097	.47080	0.00000
2	1.12264	.34315	.61919	0.00000
3	1.29834	.03883	.74537	0.00000
4	1.21109	-.28381	.66595	0.00000
5	.98632	-.37875	.49312	0.00000
6	.71392	-.33113	.27731	0.00000
7	.66261	-.35762	.16599	0.00000
8	.93610	-.60116	.19331	0.00000

TOTAL LIFT COEFFICIENT= 1.05961
TOTAL PITCHING MOMENT COEFFICIENT= -.03686
TOTAL DRAG COEFFICIENT= .57220
TOTAL THRUST COEFFICIENT= 0.00000

SPANWISE PRESSURE AT CONSTANT X=, -.40000

Y	2Y/B(LOCAL)	DELTA-CP
.02599	.07538	.76345
.10083	.29244	1.11946
.21550	.62500	2.51841

SPANWISE PRESSURE AT CONSTANT X=, .41000

Y	2Y/B(LOCAL)	DELTA-CP
.02599	.04501	.58770
.10083	.17459	.66697
.21550	.37313	1.20891
.35616	.61668	1.74667
.50584	.87586	1.29153

SPANWISE PRESSURE AT CONSTANT X=, 1.20500

Y	2Y/B(LOCAL)	DELTA-CP
.02599	.03225	.33228
.10083	.12511	.31834
.21550	.26738	.56316
.35616	.44190	.93004
.50584	.62762	.37366
.64650	.80214	.37784
.76117	.94441	.58189

Similar results for several iterations till " SFAC " value shows an increase (after fifth iteration) from previous value. (See summary sheet on next page)

The best solution is shown after summary sheet.

CONICAL CAMBER WING AT ALPHA 30.7 DEGREES

ALPHA(DEG.)=30.700 MACH NUMBER= 0.000

ITERATION	CL	CM	CD	CT	GMSUM	SFAC
*********	**	**	**	**	*****	****
0	1.0159	-.0307	.5137	0.0000	1.8554	
1	1.1006	-.0546	.5647	0.0000	1.8292	
2	1.1297	-.0925	.5834	0.0000	1.8104	
3	1.0596	-.0369	.5722	0.0000	1.1475	.6443
4	1.2647	-.0083	.6917	0.0000	1.1958	.7056
5	1.3036	-.0050	.7138	0.0000	1.2094	.7195
6	1.3058	-.0051	.7150	0.0000	1.2108	.7159
7	1.3071	-.0054	.7157	0.0000	1.2113	.7181

```
                              CONICAL CAMBER WING AT ALPHA 30.7 DEGREES
ALPHA(DEG.)=30.700  MACH NUMBER= 0.000  ITERATION NUMBER= 6

LEADING EDGE ELEMENTS
********************
 **** 1*****
   1.4000  -1.3639  -1.5624  -1.6000  -1.6000  -1.6000  -1.6000  -1.6000  -1.6000  -1.6000  -1.6000  -1.6000  -1.2316   -.6744
   -.0517    .6914   1.6433   2.3156   3.0410   3.7669
    .0577    .0577   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000    .0651    .1637
    .2739    .4059    .5322    .5307    .5297    .5296
   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000    .0643    .0920
    .1657    .2571    .3635    .4090    .4340    .4381
 **** 2*****
   1.4000  -1.0333  -1.3639  -1.3990  -1.5390  -1.4139  -1.3789  -1.3408  -1.2997  -1.2573  -1.2573  -1.2316   -.6744   -.0517
    .6914   1.6433   2.3156   3.0410   3.7669
    .1540    .1540    .0577    .0577    .0577    .0825    .0848    .0755    .0608    .0448    .0448    .0651    .1637    .2739
    .4059    .5322    .5307    .5297    .5296
   0.0000   0.0000   0.0000   0.0000   0.0000    .0238    .0539    .0801    .0977    .1039    .0727    .0643    .0920    .1657
    .2571    .3635    .4090    .4340    .4381
 **** 3*****
   1.4000   -.5878  -1.0333  -1.0642  -1.1874  -1.1038  -1.0104   -.9089   -.7993   -.6863   -.6863   -.6744   -.0517    .6914
   1.6433   2.3156   3.0410   3.7669
    .2836    .2836    .1540    .1540    .1540    .2200    .2260    .2013    .1621    .1195    .1195    .1637    .2739    .4059
    .5322    .5307    .5297    .5296
   0.0000   0.0000   0.0000   0.0000   0.0000    .0635    .1437    .2136    .2606    .2771    .1940    .0920    .1657    .2571
    .3635    .4090    .4340    .4381
 **** 4*****
   1.4000   -.0812   -.5878   -.6130   -.7137   -.6068   -.4932   -.3669   -.2264   -.0804   -.0804   -.0517    .6914   1.6433
   2.3156   3.0410   3.7669
    .4310    .4310    .2836    .2836    .2836    .3470    .3417    .2934    .2264    .1645    .1645    .2739    .4059    .5322
    .5307    .5297    .5296
   0.0000   0.0000   0.0000   0.0000   0.0000    .1048    .2155    .3038    .3562    .3658    .2325    .1657    .2571    .3635
    .4090    .4340    .4381
 **** 5*****
   1.4000    .4254   -.0812   -.1000   -.1750   -.0385    .1093    .2709    .4517    .6467    .6467    .6914   1.6433   2.3156
   3.0410   3.7669
    .5784    .5784    .4310    .4310    .4310    .4932    .4825    .4079    .3123    .2274    .2274    .4059    .5322    .5307
    .5297    .5296
   0.0000   0.0000   0.0000   0.0000   0.0000    .1522    .3037    .4221    .4827    .4858    .2624    .2571    .3635    .4090
    .4340    .4381
 **** 6*****
   1.4000    .8709    .4254    .4130    .3637    .5609    .7806   1.0206   1.2932   1.5847   1.5847   1.6433   2.3156   3.0410
   3.7669
    .7080    .7080    .5784    .5784    .5784    .6415    .6142    .4915    .3593    .2548    .2548    .5322    .5307    .5297
    .5296
   0.0000   0.0000   0.0000   0.0000   0.0000    .2191    .4414    .5937    .6597    .6638    .3019    .3635    .4090    .4340
    .4381
```

**** 7*****

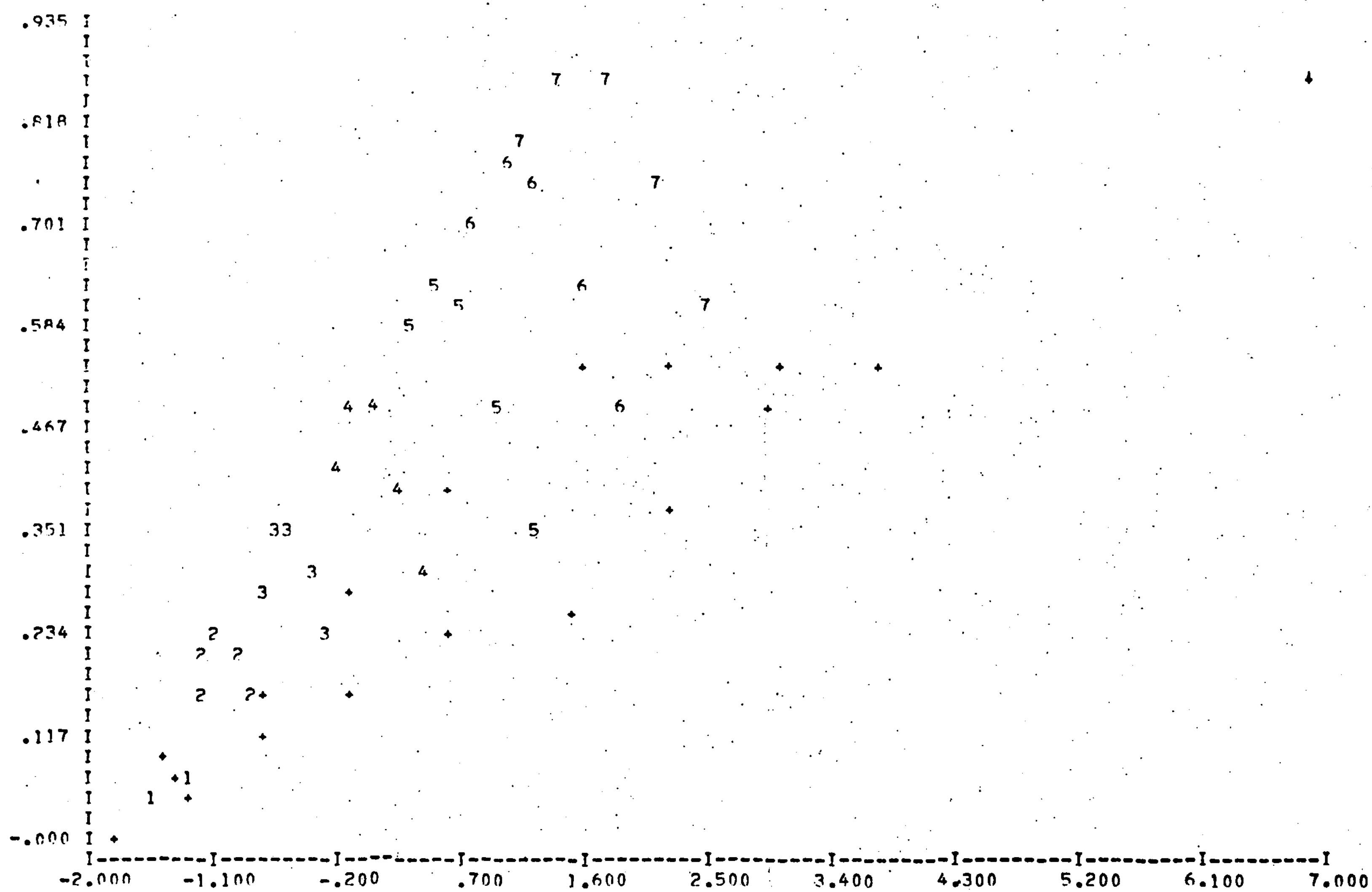
1.4000	1.2016	.8709	.8642	.8374	1.0677	1.3259	1.6041	1.9136	2.2479	2.2479	2.3156	3.0410	3.7669
.8043	.8043	.7080	.7080	.7080	.7650	.7516	.6329	.4875	.3642	.3642	.5307	.5297	.5296
0.0000	0.0000	0.0000	0.0000	0.0000	.2450	.5078	.7135	.8428	.9247	.5088	.4090	.4340	.4381

**** 8*****

1.4000	1.3008	1.2016	1.1990	1.1890	1.4857	1.8182	2.1826	2.5752	2.9903	2.9903	3.0410	3.7669
.8620	.8331	.8043	.8043	.8043	.8705	.8542	.7426	.6036	.4822	.4822	.5297	.5296
0.0000	0.0000	0.0000	0.0000	0.0000	.2921	.6175	.8875	1.0986	1.2750	.7231	.4340	.4381

WAKE ELEMENTS
****

**** 1****							
1.4000	1.7000	2.0000	2.7500	3.5000	4.2500	5.0000	5.7500
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
**** 2****							
1.4000	1.7000	1.9984	2.7365	3.4298	3.9714	4.6104	5.2510
.0577	.0577	.0871	.2198	.5006	.8507	.9376	1.0114
0.0000	0.0000	.0100	.0224	.0766	.4595	.8425	1.2254
**** 3****							
1.4000	1.7000	1.9905	2.6697	3.2258	3.8442	4.4285	5.1233
.1540	.1540	.2280	.5379	.8645	.6816	.3441	.0959
0.0000	0.0000	.0102	.0822	.4651	.8480	1.1754	1.3100
**** 4****							
1.4000	1.7000	1.9693	2.4627	3.0583	3.7053	4.3682	5.0568
.2836	.2836	.4142	.8534	.6062	.5002	.3561	.2851
0.0000	0.0000	.0205	.3756	.7585	1.1229	1.4426	1.7311
**** 5****							
1.4000	1.7000	1.9467	2.5430	3.1875	3.8371	4.5017	5.1681
.4310	.4310	.5966	.8818	.9037	.7978	.6282	.4016
0.0000	0.0000	.0415	.3958	.7787	1.1384	1.4417	1.7008
**** 6****							
1.4000	1.7000	1.9548	2.5881	3.2330	3.8837	4.4696	5.1204
.5784	.5784	.7300	.9768	.9850	.7823	.4663	.1493
0.0000	0.0000	.0456	.3627	.7456	1.0586	1.4042	1.6001
**** 7****							
1.4000	1.7000	1.9629	2.5980	3.2512	3.9097	4.5449	5.1788
.7080	.7080	.8397	1.0667	1.0664	.9689	.8200	.6096
0.0000	0.0000	.0596	.3877	.7562	1.1017	1.4716	1.8128
**** 8****							
1.4000	1.7000	1.9428	2.5755	3.2199	3.8597	4.5017	5.1481
.8043	.8043	.9469	1.0718	1.0466	.9547	.8228	.6678
0.0000	0.0000	.1035	.4864	.8693	1.2497	1.6142	1.9615
**** 9****							
1.4000	1.7000	1.9688	2.6000	3.2497	3.9305	4.6164	5.2689
.8555	.8555	.8721	1.0042	.9498	.8699	.7203	.4018
0.0000	0.0000	.1321	.5150	.8859	1.1901	1.4541	1.6418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2.500
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4.300
5.200
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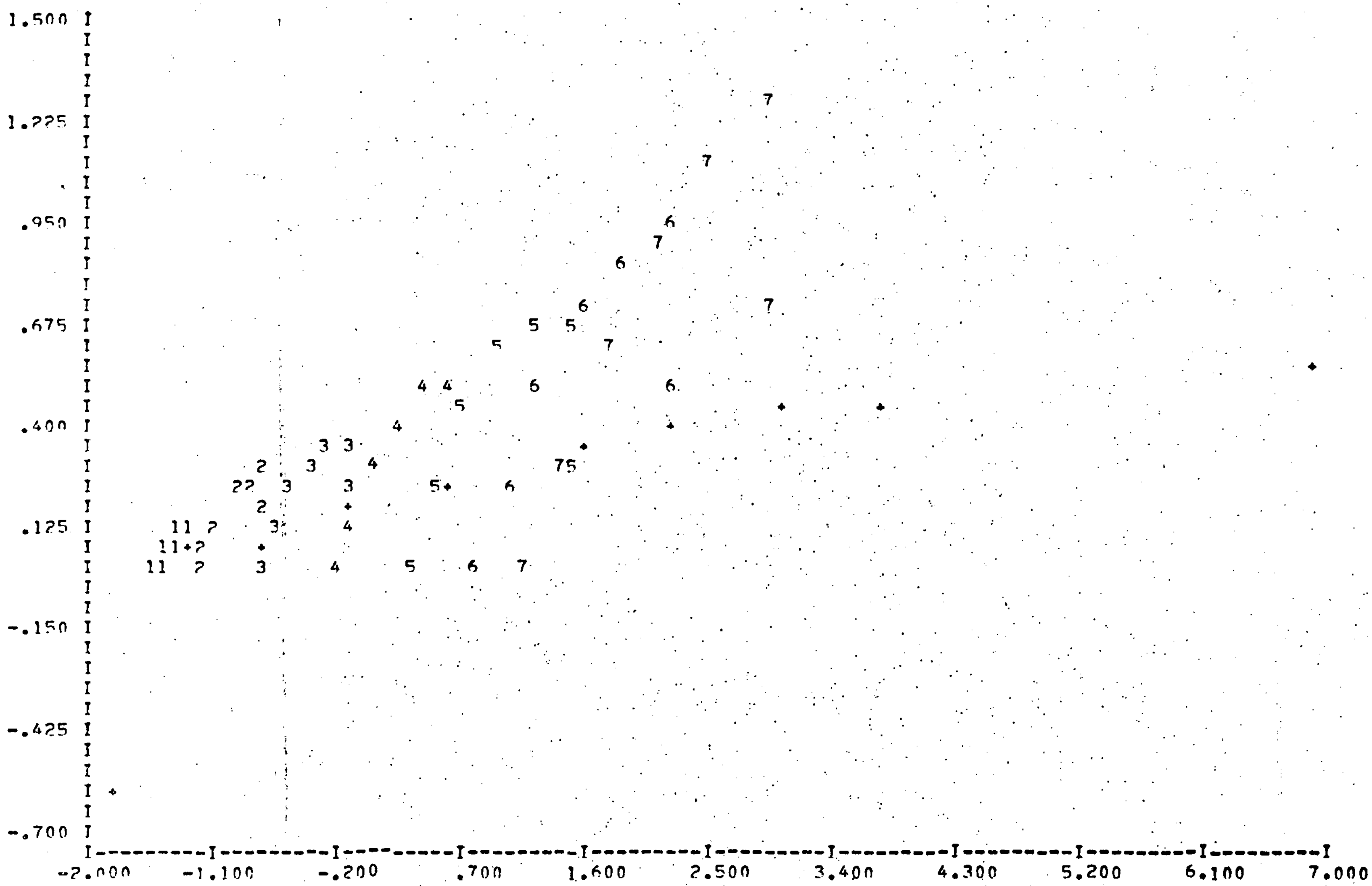
7.000

X VS Y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2.500
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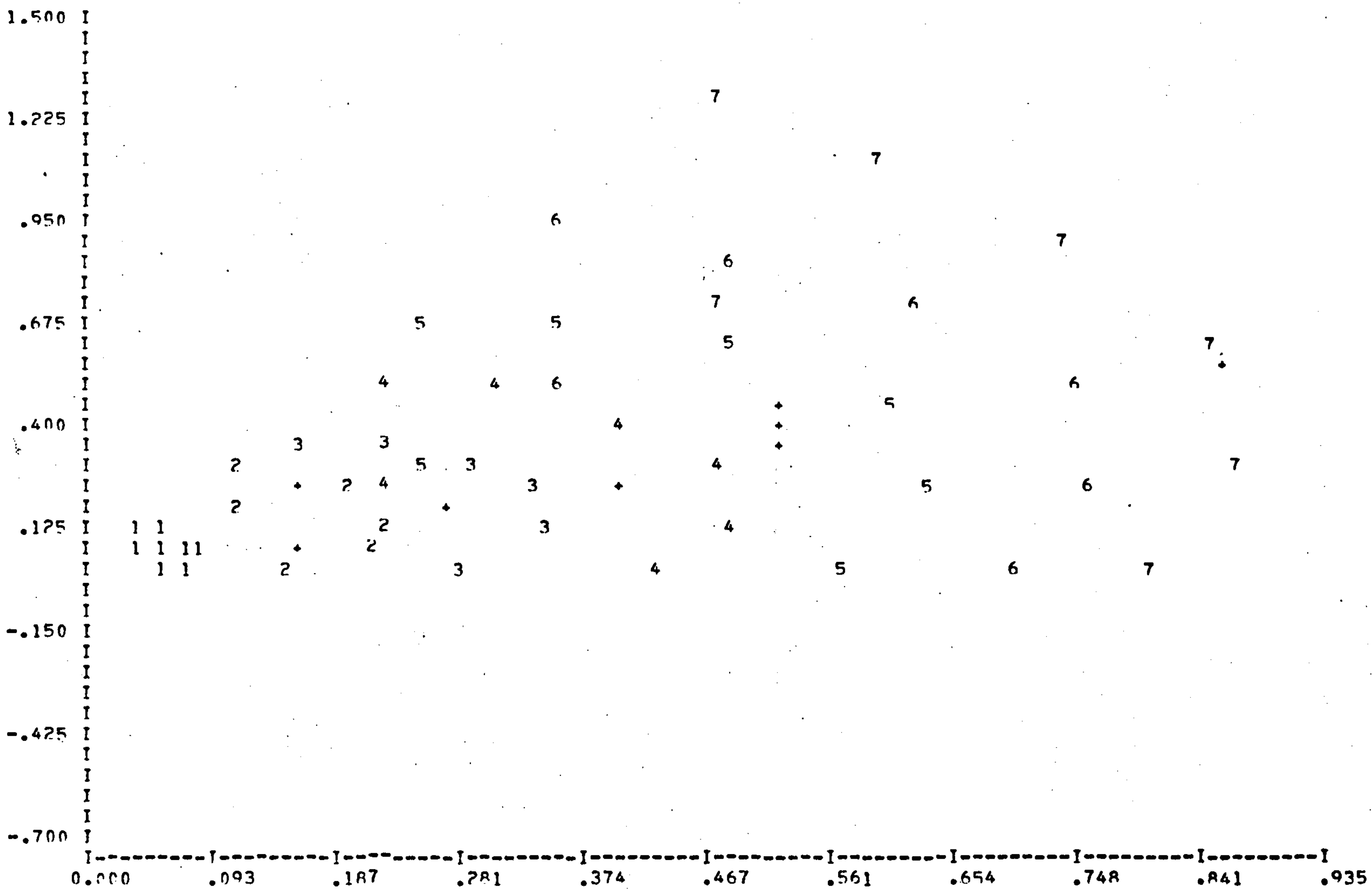
7.000

X VS Z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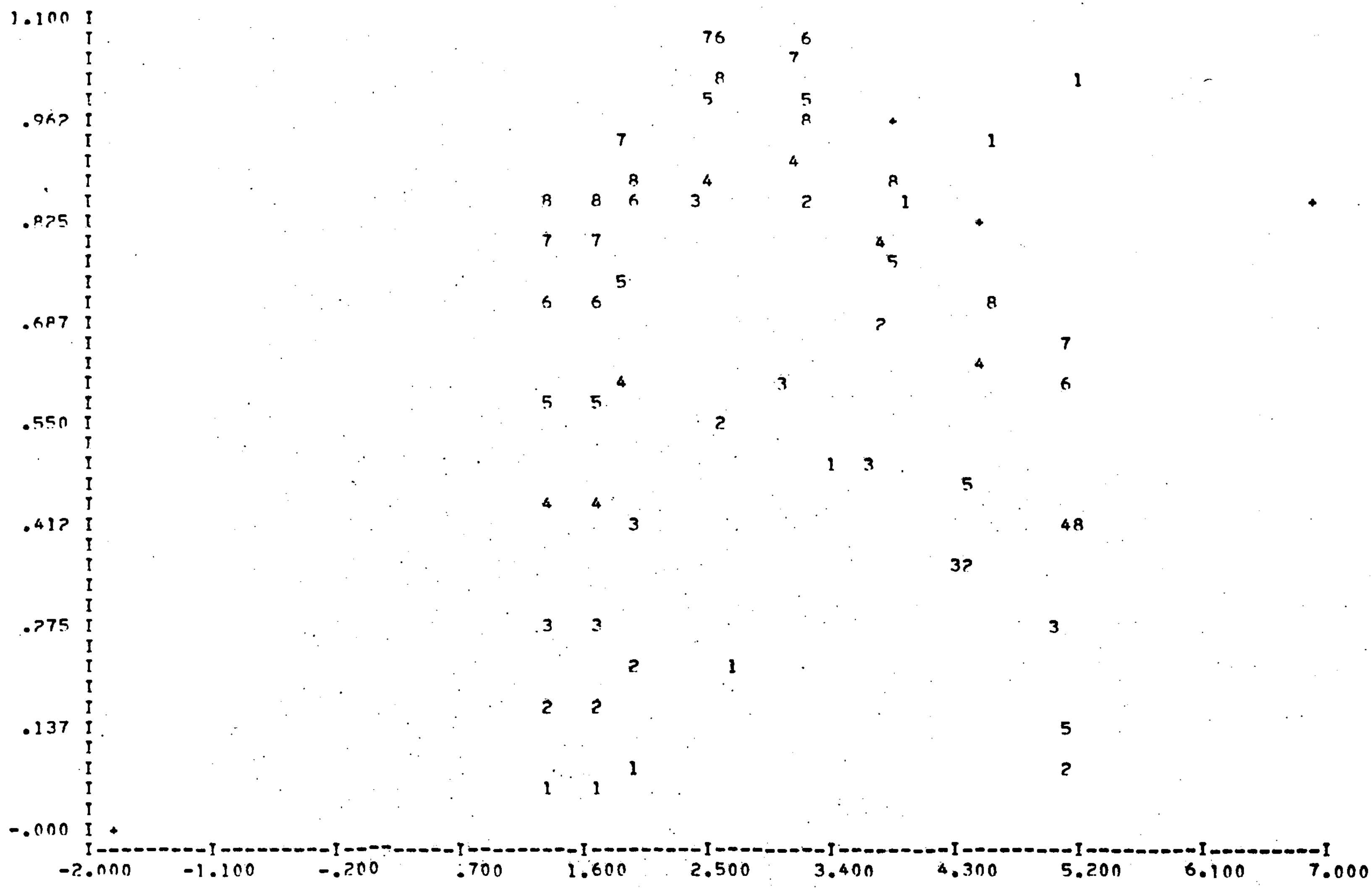
Y VS 7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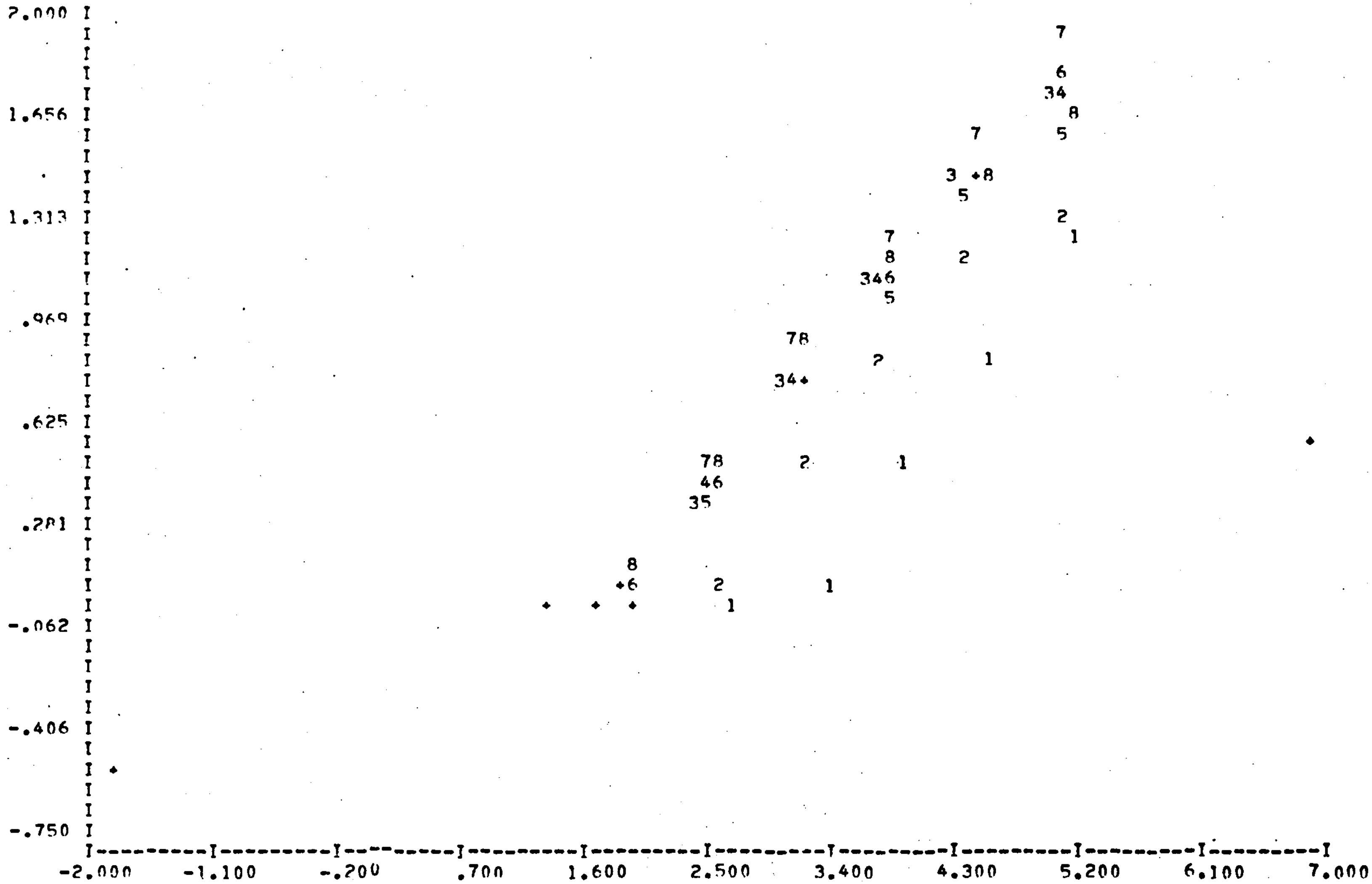
X VS Y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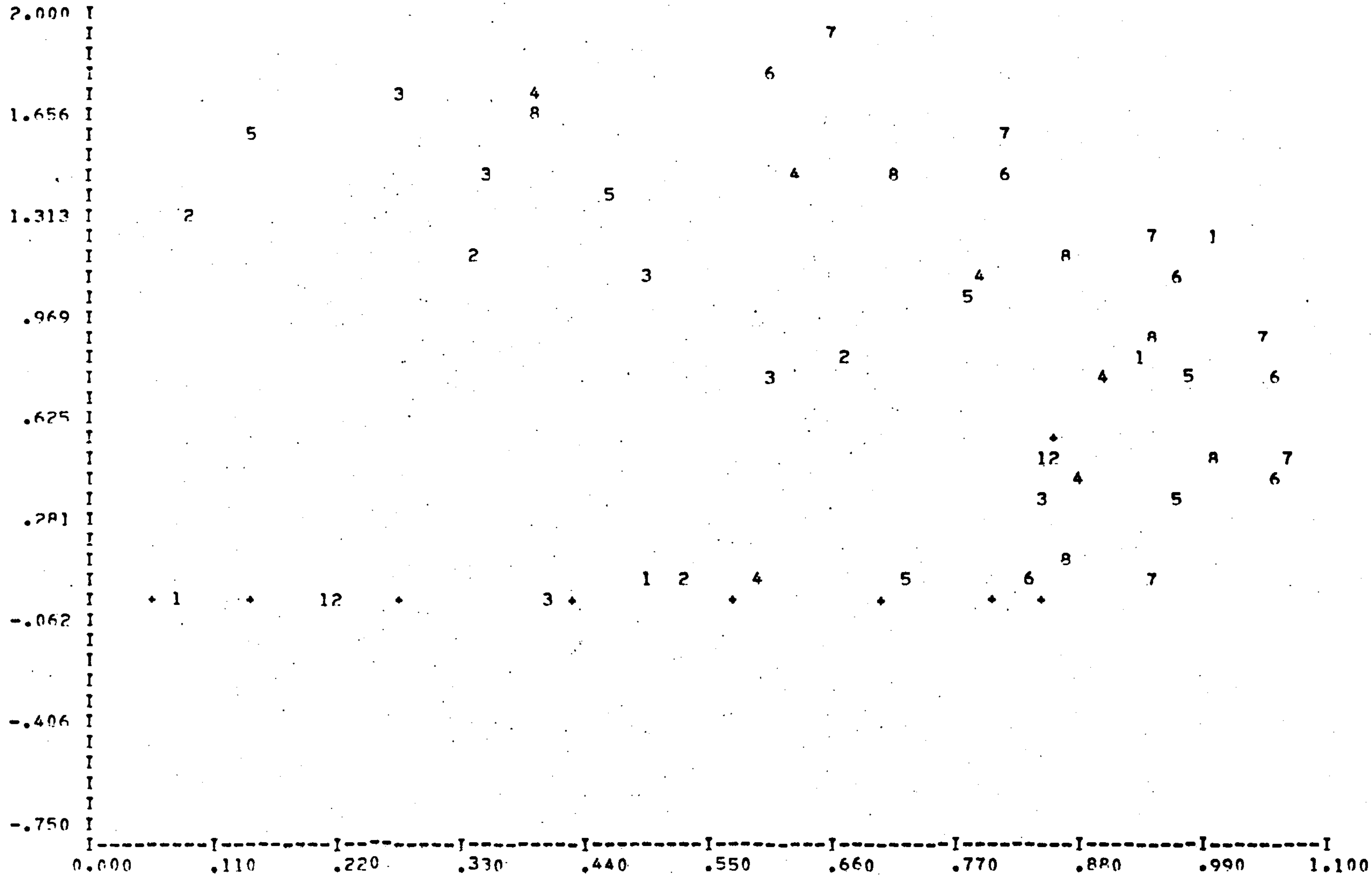
2.500
3.400
4.300
5.200
6.100
7.000

X VS Z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.330
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.550
.660
.770
.880
.990
1.100

Y VS Z

WING VORTEX STRENGTHS

X/C	2Y/B	GAMAY
.01704	.03015	2.42231
.14645	.03015	.46682
.37059	.03015	.43532
.62941	.03015	.33450
.85355	.03015	.21936
.98296	.03015	.09180
.01704	.11698	1.72066
.14645	.11698	.23409
.37059	.11698	.42675
.62941	.11698	.33703
.85355	.11698	.22520
.98296	.11698	.06031
.01704	.25000	2.28950
.14645	.25000	.26095
.37059	.25000	.27139
.62941	.25000	.28508
.85355	.25000	.21341
.98296	.25000	.07034
.01704	.41318	2.66610
.14645	.41318	.45586
.37059	.41318	.19710
.62941	.41318	.18512
.85355	.41318	.15992
.98296	.41318	.04560
.01704	.58682	3.28069
.14645	.58682	.51592
.37059	.58682	.29484
.62941	.58682	.18002
.85355	.58682	.10288
.98296	.58682	.02015
.01704	.75000	3.93349
.14645	.75000	.53743
.37059	.75000	.44080
.62941	.75000	.27561
.85355	.75000	.12935
.98296	.75000	.03276
.01704	.88302	5.22320
.14645	.88302	.62623
.37059	.88302	.48116
.62941	.88302	.37978
.85355	.88302	.22428
.98296	.88302	.06973

.01704	.96985	8.11529
.14645	.96985	.87299
.37059	.96985	.59069
.62941	.96985	.47464
.85355	.96985	.32345
.98296	.96985	.11680

LEADING-EDGE VORTICES STRENGTHS
****

2Y/B	CAPGAMA
****	*******
.03015	.37658
.11698	.21708
.25000	.25493
.41318	.23887
.58682	.21018
.75000	.15420
.88302	.09659
.96985	.03889

DELTA-CP DISTRIBUTION
****

X/C ***	2Y/B ****	DELTA-CP ********
.01254	.03015	6.98806
.10908	.03015	1.60492
.28306	.03015	.84178
.50000	.03015	.74088
.71694	.03015	.54086
.89092	.03015	.37889
.98746	.03015	.14148
.01254	.11698	9.54001
.10908	.11698	3.98147
.28306	.11698	1.73228
.50000	.11698	.72563
.71694	.11698	.67064
.89092	.11698	.34910
.98746	.11698	.23262
.01254	.25000	2.54033
.10908	.25000	4.04777
.28306	.25000	3.10560
.50000	.25000	1.67312
.71694	.25000	.91018
.89092	.25000	.63678
.98746	.25000	.34692
.01254	.41318	3.55714
.10908	.41318	1.60558
.28306	.41318	2.01749
.50000	.41318	2.13332
.71694	.41318	1.36905
.89092	.41318	1.15988
.98746	.41318	.71547
.01254	.58682	3.37465
.10908	.58682	2.22913
.28306	.58682	.84266
.50000	.58682	1.08304
.71694	.58682	1.30806
.89092	.58682	1.04583
.98746	.58682	.99100
.01254	.75000	3.62387
.10908	.75000	2.80979
.28306	.75000	.72867
.50000	.75000	.42655
.71694	.75000	.46319
.89092	.75000	.39202
.98746	.75000	.28355
.01254	.88302	4.28095

.10908	.88302	3.67314
.28306	.88302	1.13856
.50000	.88302	.46677
.71694	.88302	-.09444
.89092	.88302	-.17557
.98746	.88302	-.53312
.01254	.96985	4.59738
.10908	.96985	4.44246
.28306	.96985	1.51496
.50000	.96985	1.21636
.71694	.96985	.29743
.89092	.96985	.10011
.98746	.96985	-.52598

SECTIONAL PROPERTIES
****

I	CL	CM	CD	CT
*	**	**	**	**
1	.92808	.38875	.55105	0.00000
2	1.47793	.52553	.81515	0.00000
3	1.69031	.09114	.97860	0.00000
4	1.48083	-.36202	.82349	0.00000
5	1.10559	-.45157	.56406	0.00000
6	.74497	-.35166	.29396	0.00000
7	.64719	-.34701	.15941	0.00000
8	.91155	-.58499	.18766	0.00000

TOTAL LIFT COEFFICIENT= 1.30585
TOTAL PITCHING MOMENT COEFFICIENT= -.00512
TOTAL DRAG COEFFICIENT= .71502
TOTAL THRUST COEFFICIENT= 0.00000

SPANWISE PRESSURE AT CONSTANT X=, -.40000

Y	2Y/B(LOCAL)	DELTA-CP
.02599	.07538	.79051
.10083	.29244	1.43394
.21550	.62500	3.71329

SPANWISE PRESSURE AT CONSTANT X=, .41000

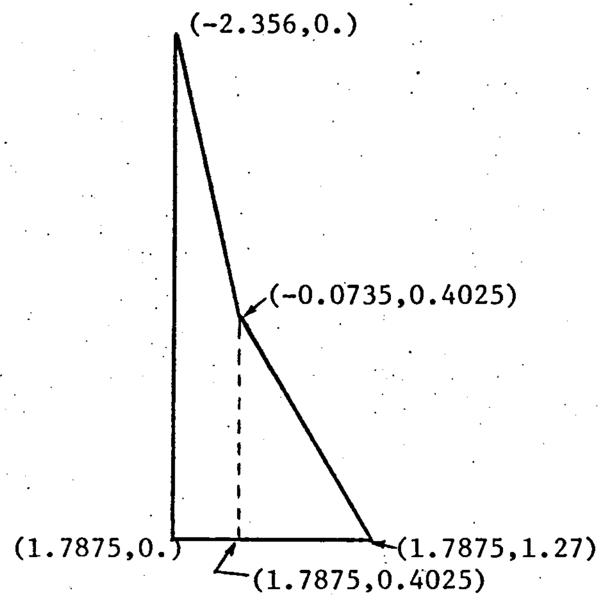
Y	2Y/B(LOCAL)	DELTA-CP
.02599	.04501	.60152
.10083	.17459	.67754
.21550	.37312	1.39777
.35616	.61668	2.22570
.50584	.87586	1.28191

SPANWISE PRESSURE AT CONSTANT X=, 1.20500

Y	2Y/B(LOCAL)	DELTA-CP
.02599	.03225	.22623
.10083	.12511	.23926
.21550	.26738	.60064
.35616	.44190	1.15861
.50584	.62762	1.12205
.64650	.80214	.43497
.76117	.94441	.53250

2. Input Data of the Second Sample Case

```
                                                C O L U M N   N U M B E R
                                 1111111111222222222233333333334444444444555555555566666666667777777778
                        12345678901234567890123456789012345678901234567890123456789012345678901234567890
CARD NUMBER
      1                                DOUBLE DELTA WING MODEL ONE (SCALING)
      2                      6        2        0        8        0        2
      3                      2        5        5        0        1        0
      4                      0        2
      5                 20.0      0.        0.6       1.2       6.0       2.3835    4.03      0.9
      6                      5        5        5        5        5        5        5        5        5
      7                 0.        1.0
      8                 0.        0.        0.        0.        0.        0.        0.        0.
      9                 0.
     10                 -2.356    1.7875    0.        -0.0735   1.7875    0.4025
     11                 -0.0735   1.7875    0.4025    1.7875    1.7875    1.27
     12                 -2.356    1.7875    0.        -0.0735   1.7875    0.4025
     13                 -0.0735   1.7875    0.4025    1.7875    1.7875    1.27
     14                 END
```



Output of the Second Sample Case

```
INPUT DATA CARDS
                       DOUBLE DELTA WING MODEL ONE (SCALING)
   6     2     0     8     0     2
   2     5     6     0     1     0
   0     2
20.00000   0.00000    .60000   1.20000   6.00000   2.38350   4.03000    .90000
   5     5     5     5     5     5     5     5     5
 0.00000   1.00000
 0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
 0.00000
SAPNWISE SECTION OF NUMBER     1
-2.35600   1.78750   0.00000   -.07350   1.78750    .40250
SAPNWISE SECTION OF NUMBER     2
 -.07350   1.78750    .40250   1.78750   1.78750   1.27000

CAMBER SLOPE AT FINE GRID FOUND ELEMENT

  DZDXV      DZDYV
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
```

```
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
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 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
 0.00000   0.00000
SAPNWISE SECTION OF NUMBER    1
-2.35600   1.78750   0.00000   -.07350   1.78750    .40250
SAPNWISE SECTION OF NUMBER    2
 -.07350   1.78750    .40250   1.78750   1.78750   1.27000

CAMBER SLOPE AT COARSE GRID BOUND ELEMENT

  DZDX      DZDY      DZDYV
 0.00000   0.00000   0.00000
 0.00000   0.00000   0.00000
 0.00000   0.00000   0.00000
 0.00000   0.00000   0.00000
 0.00000   0.00000   0.00000
 0.00000   0.00000   0.00000
 0.00000   0.00000   0.00000
 0.00000   0.00000   0.00000
```

0.00000	0.00000	0.00000
0.00000	0.00000	0.00000
0.00000	0.00000	0.00000
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0.00000	0.00000	0.00000
0.00000	0.00000	0.00000
0.00000	0.00000	0.00000
0.00000	0.00000	0.00000

CAMBER SLOPE AT THE LEADING EDGE CONTROL POINTS

DZDX	DZDY
0.00000	0.00000
0.00000	0.00000
0.00000	0.00000
0.00000	0.00000
0.00000	0.00000
0.00000	0.00000
0.00000	0.00000
0.00000	0.00000
0.00000	0.00000

END OF INPUT DATA

DOUBLE DELTA WING MODEL ONE (SCALING)
ALPHA(DEG.)=20.000 MACH NUMBER= 0.000 ITERATION NUMBER= 0

LEADING EDGE ELEMENTS

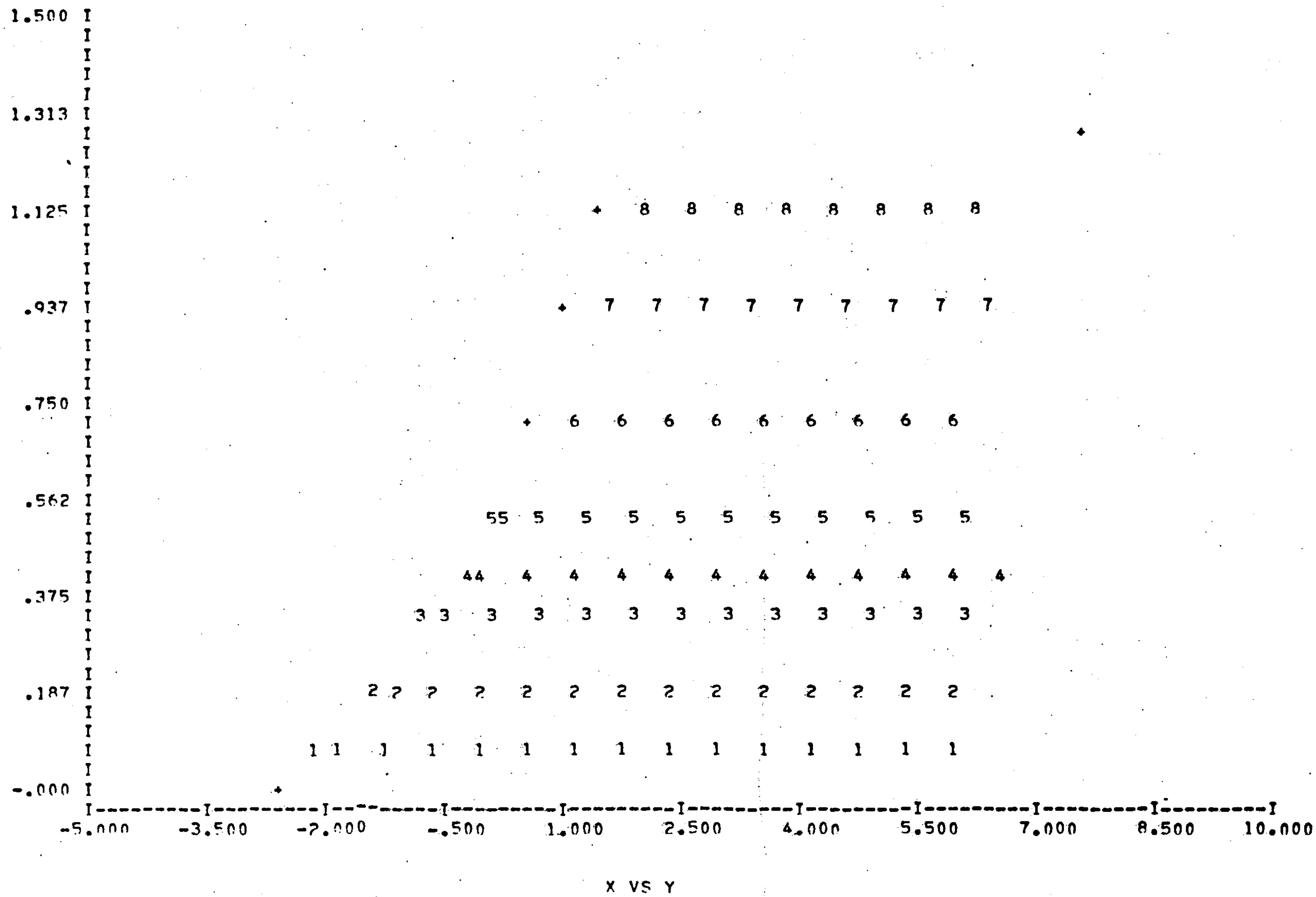
```
*******************
**** 1****
   1.7875  -1.8395  -2.3041  -2.3560  -2.5632  -2.1488  -1.5850
    .0830    .0830   0.0000   0.0000   0.0000   0.0000   0.0000
   0.0000   0.0000   0.0000   0.0000   0.0000    .1508    .3560
**** 2****
   1.7875  -1.1771  -1.8395  -1.8856  -2.0692  -1.7019  -1.1381   -.5381    .0619    .6619   1.2619   1.8619   2.4619   3.0619
   3.6619   4.2619   4.8619   5.4619   6.0619
    .2012    .2012    .0830    .0830    .0830    .0830    .0830    .0830    .0830    .0830    .0830    .0830    .0830    .0830
    .0830    .0830    .0830    .0830    .0830
   0.0000   0.0000   0.0000   0.0000   0.0000    .1508    .3560    .3560    .3560    .3560    .3560    .3560    .3560    .3560
    .3560    .3560    .3560    .3560    .3560
**** 3****
   1.7875   -.5147  -1.1771  -1.2148  -1.3649  -1.0646   -.5008    .0992    .6992   1.2992   1.8992   2.4992   3.0992   3.6992
   4.2992   4.8992   5.4992   6.0992
    .3195    .3195    .2012    .2012    .2012    .2012    .2012    .2012    .2012    .2012    .2012    .2012    .2012    .2012
    .2012    .2012    .2012    .2012
   0.0000   0.0000   0.0000   0.0000   0.0000    .1508    .3560    .3560    .3560    .3560    .3560    .3560    .3560    .3560
    .3560    .3560    .3560    .3560
**** 4****
   1.7875   -.0502   -.5147   -.5439   -.6605   -.4274    .1364    .7364   1.3364   1.9364   2.5364   3.1364   3.7364   4.3364
   4.9364   5.5364   6.1364
    .4025    .4025    .3195    .3195    .3195    .3195    .3195    .3195    .3195    .3195    .3195    .3195    .3195    .3195
    .3195    .3195    .3195
   0.0000   0.0000   0.0000   0.0000   0.0000    .1508    .3560    .3560    .3560    .3560    .3560    .3560    .3560    .3560
    .3560    .3560    .3560
**** 5****
   1.7875    .2190   -.0502   -.0735   -.1666    .0195    .5834   1.1834   1.7834   2.3834   2.9834   3.5834   4.1834   4.7834
   5.3834   5.9834   6.5834
    .5295    .5295    .4025    .4025    .4025    .4025    .4025    .4025    .4025    .4025    .4025    .4025    .4025    .4025
    .4025    .4025    .4025
   0.0000   0.0000   0.0000   0.0000   0.0000    .1508    .3560    .3560    .3560    .3560    .3560    .3560    .3560    .3560
    .3560    .3560    .3560
**** 6****
   1.7875    .6309    .2190    .1990    .1196    .2785    .8423   1.4423   2.0423   2.6423   3.2423   3.8423   4.4423   5.0423
   5.6423   6.2423
    .7240    .7240    .5295    .5295    .5295    .5295    .5295    .5295    .5295    .5295    .5295    .5295    .5295    .5295
    .5295    .5295
   0.0000   0.0000   0.0000   0.0000   0.0000    .1508    .3560    .3560    .3560    .3560    .3560    .3560    .3560    .3560
    .3560    .3560
**** 7****
   1.7875   1.1065    .6309    .6162    .5576    .6747   1.2386   1.8386   2.4386   3.0386   3.6386   4.2386   4.8386   5.4386
   6.0386
```

.9485	.9485	.7240	.7240	.7240	.7240	.7240	.7240	.7240	.7240	.7240	.7240	.7240	.7240
.7240													
0.0000	0.0000	0.0000	0.0000	0.0000	.1508	.3560	.3560	.3560	.3560	.3560	.3560	.3560	.3560
.3560													
**** *****													
1.7975	1.5184	1.1065	1.0978	1.0633	1.1323	1.6961	2.2961	2.8961	3.4961	4.0961	4.6961	5.2961	5.8961
6.4961													
1.1430	1.1430	.9485	.9485	.9485	.9485	.9485	.9485	.9485	.9485	.9485	.9485	.9485	.9485
.9485													
0.0000	0.0000	0.0000	0.0000	0.0000	.1508	.3560	.3560	.3560	.3560	.3560	.3560	.3560	.3560
.3560													
**** O****													
1.7975	1.6529	1.5184	1.5150	1.5013	1.5286	2.0924	2.6924	3.2924	3.8924	4.4924	5.0924	5.6924	6.2924
1.2700	1.2065	1.1430	1.1430	1.1430	1.1430	1.1430	1.1430	1.1430	1.1430	1.1430	1.1430	1.1430	1.1430
0.0000	0.0000	0.0000	0.0000	0.0000	.1508	.3560	.3560	.3560	.3560	.3560	.3560	.3560	.3560

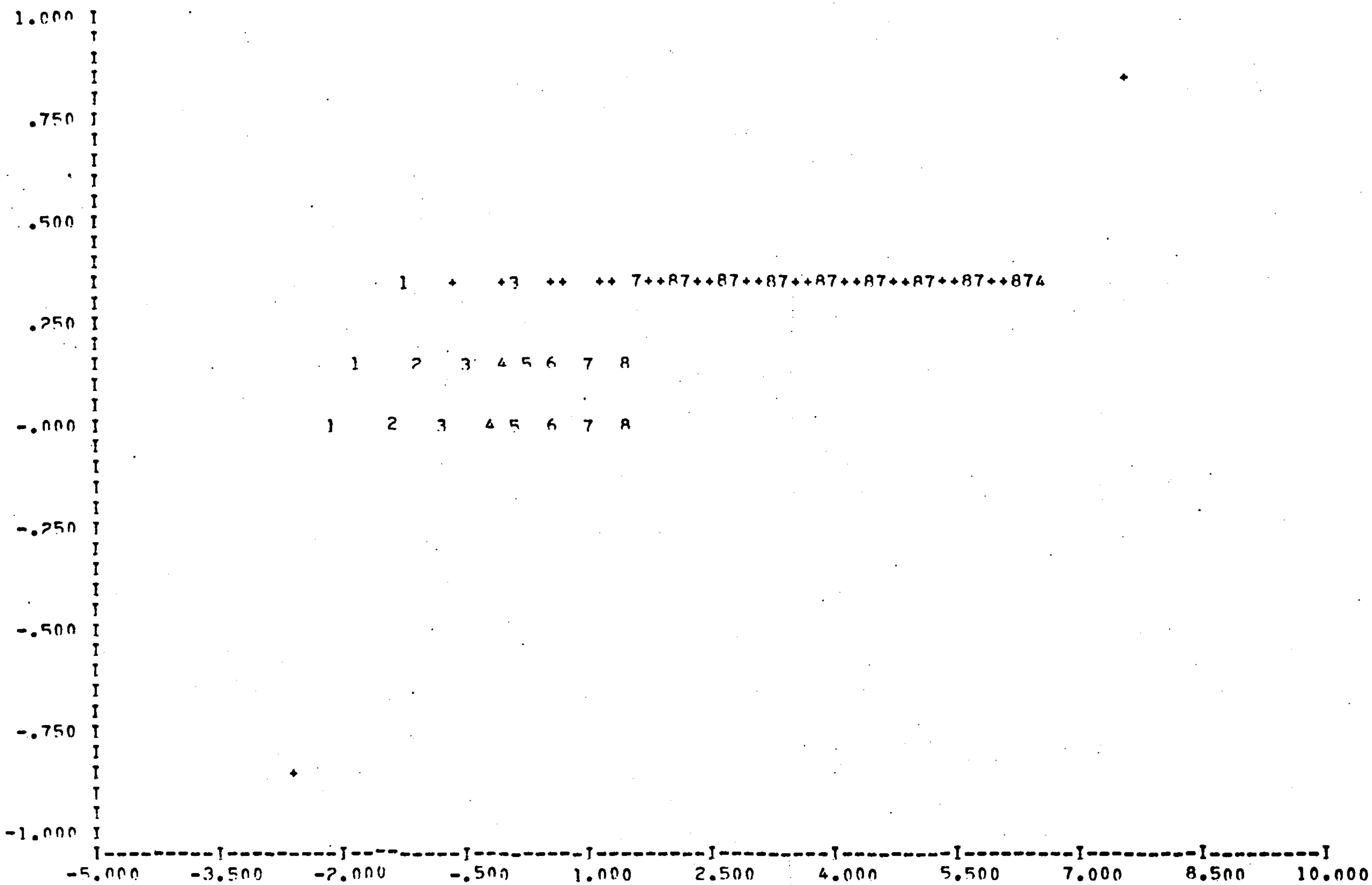
WAKE ELEMENTS

****

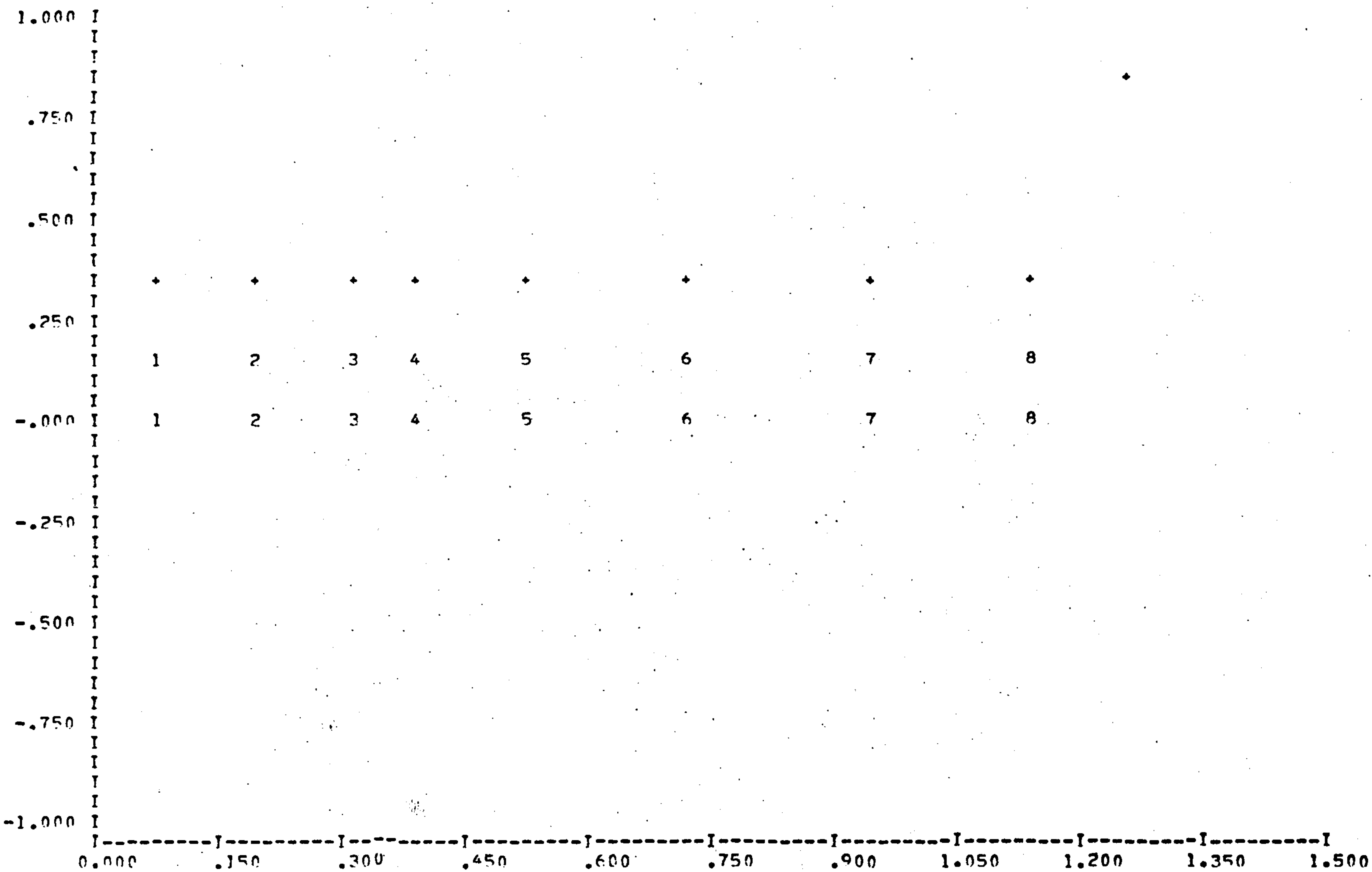
**** 1*****					
1.7875	2.2019	2.6162	3.8162	5.0162	6.2162
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
**** 2*****					
1.7875	2.2019	2.6162	3.8162	5.0162	6.2162
.0830	.0830	.0830	.0830	.0830	.0830
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
**** 3*****					
1.7875	2.2019	2.6162	3.8162	5.0162	6.2162
.2012	.2012	.2012	.2012	.2012	.2012
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
**** 4*****					
1.7875	2.2019	2.6162	3.8162	5.0162	6.2162
.3195	.3195	.3195	.3195	.3195	.3195
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
**** 5*****					
1.7875	2.2019	2.6162	3.8162	5.0162	6.2162
.4025	.4025	.4025	.4025	.4025	.4025
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
**** 6*****					
1.7875	2.2019	2.6162	3.8162	5.0162	6.2162
.5295	.5295	.5295	.5295	.5295	.5295
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
**** 7*****					
1.7875	2.2019	2.6162	3.8162	5.0162	6.2162
.7240	.7240	.7240	.7240	.7240	.7240
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
**** 8*****					
1.7875	2.2019	2.6162	3.8162	5.0162	6.2162
.9485	.9485	.9485	.9485	.9485	.9485
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
**** 9*****					
1.7875	2.2019	2.6162	3.8162	5.0162	6.2162
1.1430	1.1430	1.1430	1.1430	1.1430	1.1430
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
****10*****					
1.7875	2.2019	2.6162	3.8162	5.0162	6.2162
1.2552	1.2552	1.2552	1.2552	1.2552	1.2552
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000



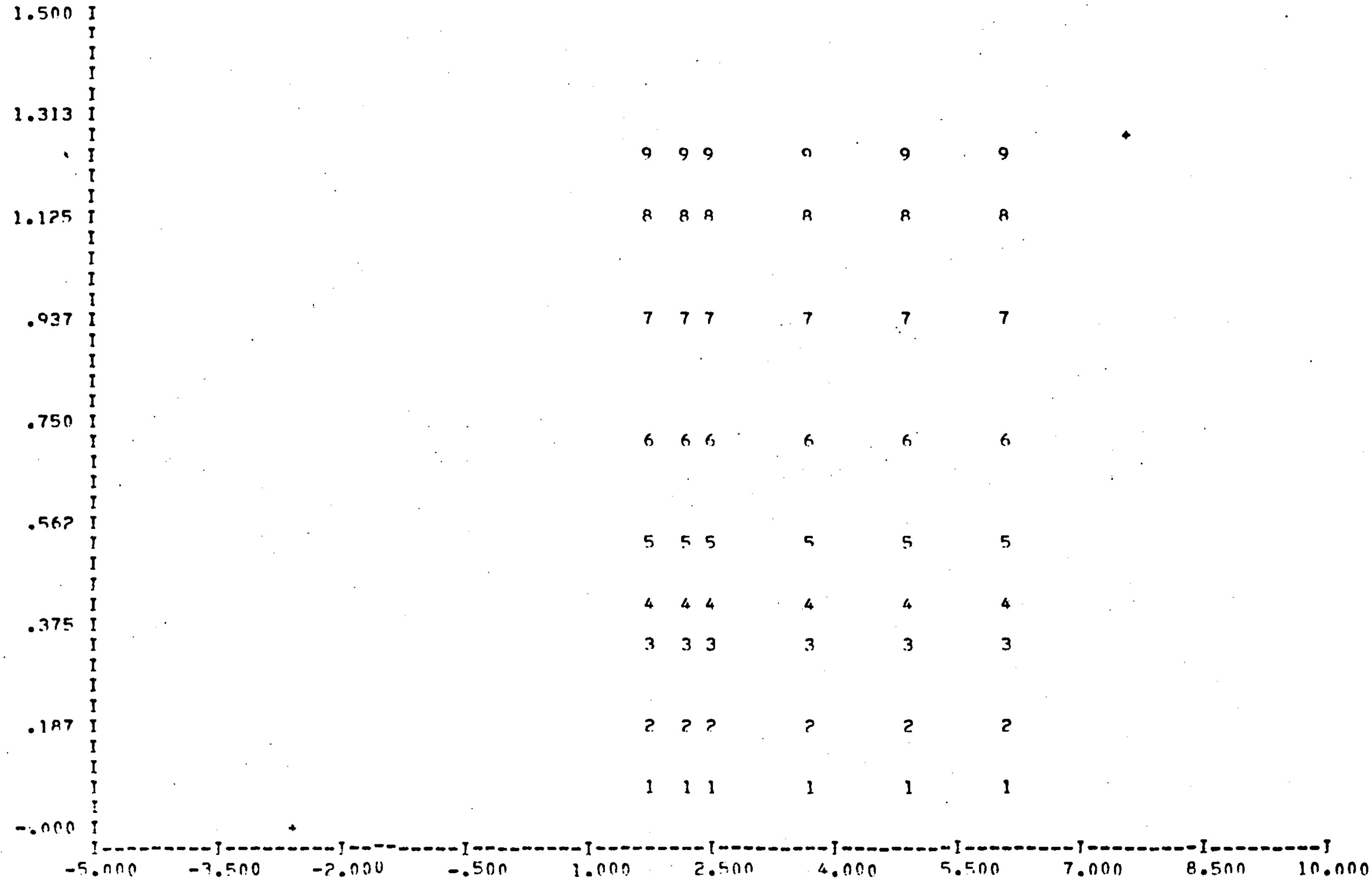
1.500
1.313
1.125
.937
.750
.562
.375
.187
-.000
-5.000
-3.500
-2.000
-.500
1.000
2.500
4.000
5.500
7.000
8.500
10.000
X VS Y


1.000
.750
.500
.250
-.000
-.250
-.500
-.750
-1.000
1 + +3 ++ ++ 7++87++87++87++87++87++87++87++874
1 2 3 4 5 6 7 8
1 2 3 4 5 6 7 8
-5.000
-3.500
-2.000
-.500
1.000
2.500
4.000
5.500
7.000
8.500
10.000

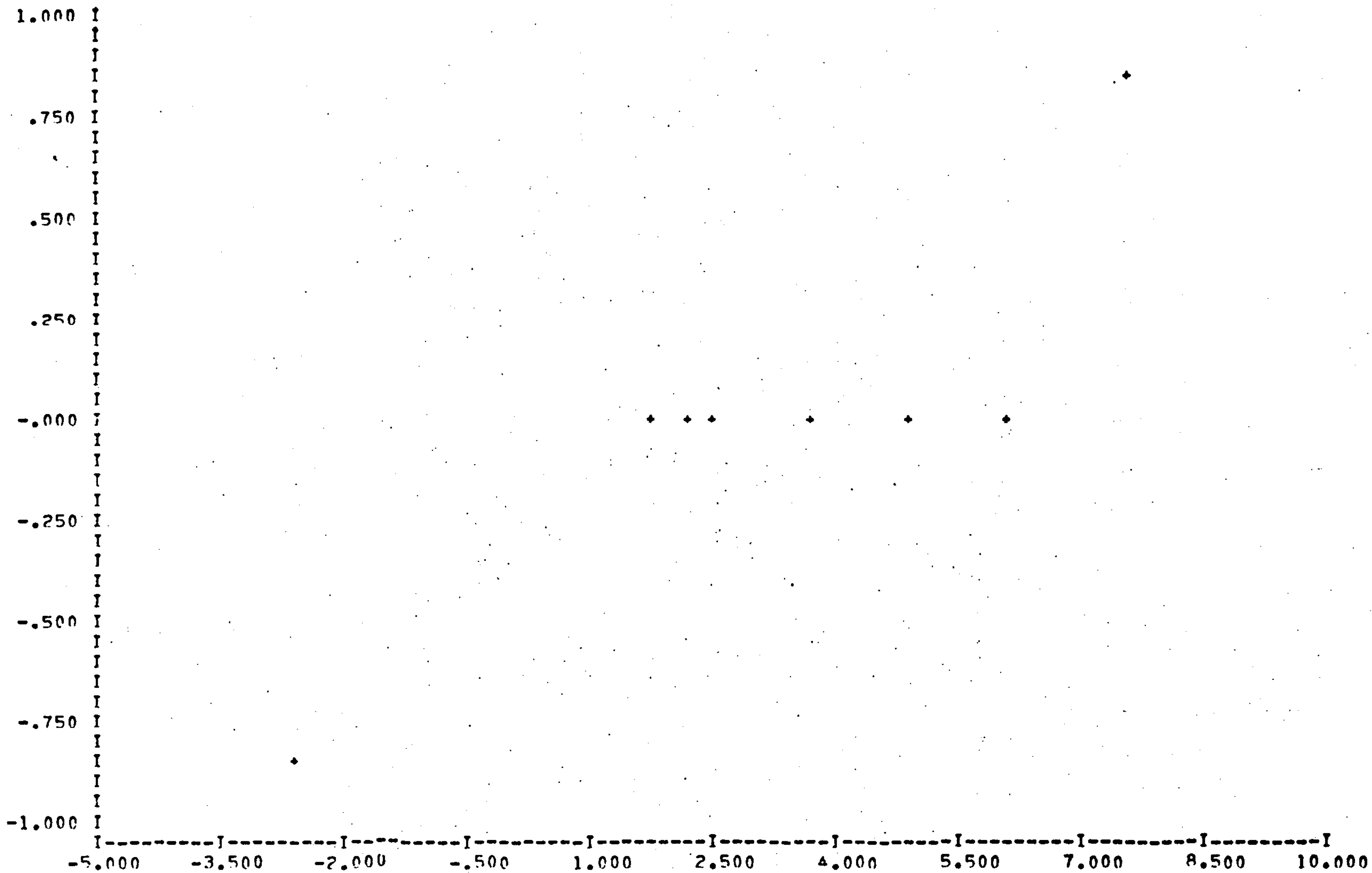
X VS Z


1.000
.750
.500
.250
-.000
-.250
-.500
-.750
-1.000
0.000
.150
.300
.450
.600
.750
.900
1.050
1.200
1.350
1.500
1 2 3 4 5 6 7 8
1 2 3 4 5 6 7 8

Y VS Z


1.500
1.313
1.125
.937
.750
.562
.375
.187
-.000
-5.000
-3.500
-2.000
-.500
1.000
2.500
4.000
5.500
7.000
8.500
10.000

X VS Y


1.000
.750
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-.500
-.750
-1.000
-5.000
-3.500
-2.000
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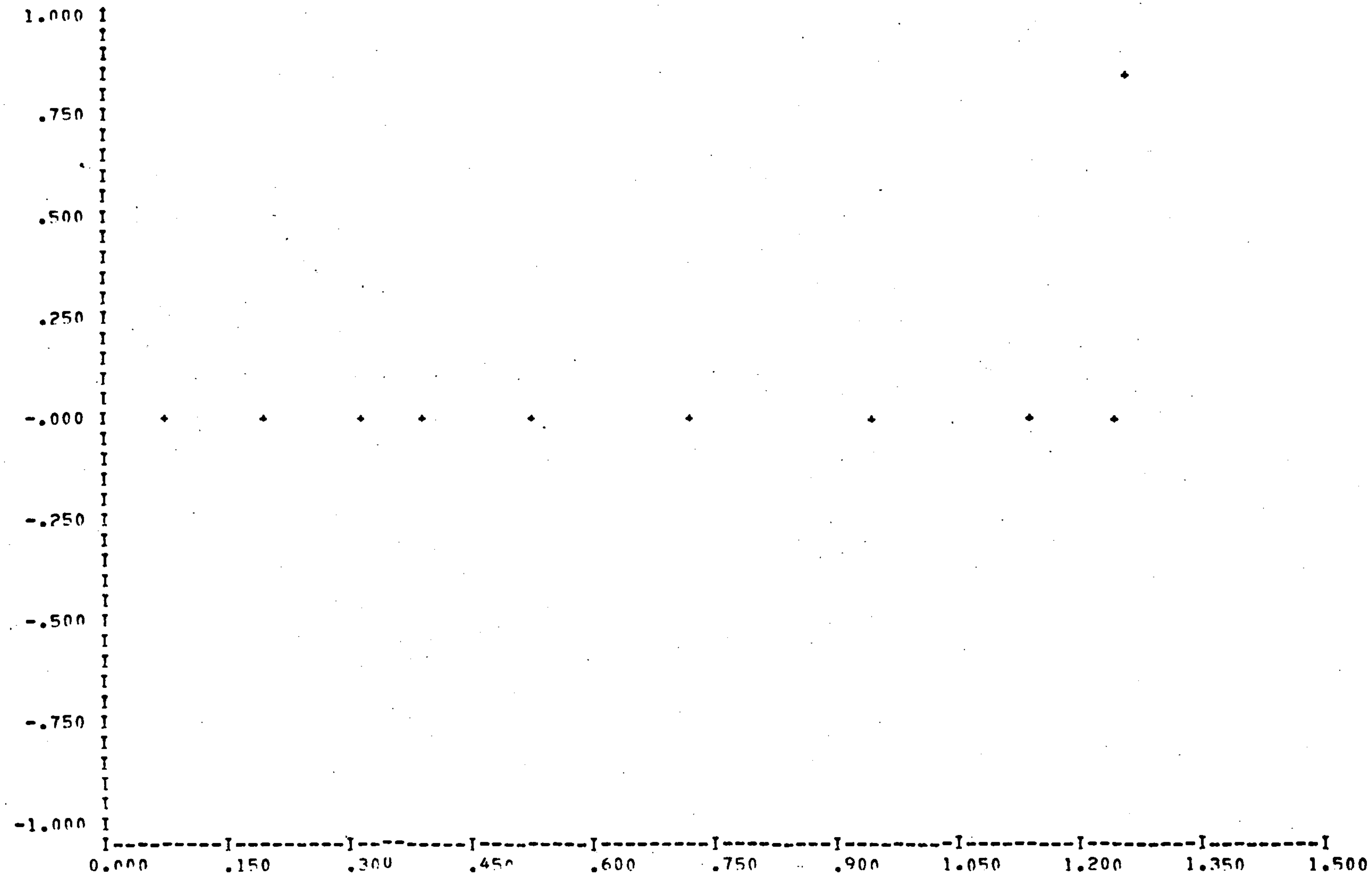
8.500
10.000

X VS Z


1.000
.750
.500
.250
-.000
-.250
-.500
-.750
-1.000
0.000
.150
.300
.450
.600
.750
.900
1.050
1.200
1.350
1.500

Y VS Z

WING VORTEX STRENGTHS
****

X/C	2Y/B	GAMAY
***	****	*****
.01704	.03026	2.59407
.14645	.03026	.55458
.37059	.03026	.48124
.62941	.03026	.41650
.85355	.03026	.20818
.98296	.03026	.06456
.01704	.10950	1.84774
.14645	.10950	.51271
.37059	.10950	.50379
.62941	.10950	.43369
.85355	.10950	.21543
.98296	.10950	.06394
.01704	.20743	2.16849
.14645	.20743	.61572
.37059	.20743	.56123
.62941	.20743	.39437
.85355	.20743	.20959
.98296	.20743	.05988
.01704	.28667	2.72216
.14645	.28667	.81409
.37059	.28667	.51791
.62941	.28667	.33941
.85355	.28667	.19500
.98296	.28667	.05518
.01704	.36269	3.36277
.14645	.36269	.70558
.37059	.36269	.44748
.62941	.36269	.30762
.85355	.36269	.18067
.98296	.36269	.05169
.01704	.48770	3.80582
.14645	.48770	.63311
.37059	.48770	.43098
.62941	.48770	.30090
.85355	.48770	.17102
.98296	.48770	.05169
.01704	.65846	5.19767
.14645	.65846	.62487
.37059	.65846	.46970
.62941	.65846	.30694
.85355	.65846	.17329
.98296	.65846	.05345

.01704	.82923	7.17912
.14645	.82923	.75970
.37059	.82923	.51800
.62941	.82923	.34963
.85355	.82923	.18928
.98296	.82923	.05787
.01704	.95424	11.06821
.14645	.95424	1.12482
.37059	.95424	.68775
.62941	.95424	.48266
.85355	.95424	.29289
.98296	.95424	.09640

LEADING-EDGE VORTICES STRENGTHS
****

2Y/B	CAPGAMA
****	*******
.03026	.49748
.10950	.31003
.20743	.29245
.29667	.28299
.36269	.29368
.49770	.27799
.65846	.25521
.82923	.17709
.95424	.07324

DELTA-CP DISTRIBUTION

X/C	2Y/B	DELTA-CP
.01254	.03026	2.62966
.10908	.03026	1.59500
.28306	.03026	.90802
.50000	.03026	1.02595
.71694	.03026	.70169
.89092	.03026	.38699
.98746	.03026	.16828
.01254	.10950	4.01913
.10908	.10950	.43372
.28306	.10950	.58924
.50000	.10950	1.05212
.71694	.10950	.81478
.89092	.10950	.55881
.98746	.10950	.30239
.01254	.20743	3.98947
.10908	.20743	.18237
.28306	.20743	.86410
.50000	.20743	1.51878
.71694	.20743	1.26026
.89092	.20743	.96383
.98746	.20743	.69370
.01254	.28667	4.93930
.10908	.28667	-.54324
.28306	.28667	.61739
.50000	.28667	1.33812
.71694	.28667	1.03098
.89092	.28667	1.00454
.98746	.28667	.71479
.01254	.36269	4.61817
.10908	.36269	2.05091
.28306	.36269	1.70809
.50000	.36269	1.48027
.71694	.36269	1.16088
.89092	.36269	.95976
.98746	.36269	.74452
.01254	.48770	2.83408
.10908	.48770	1.68652
.28306	.48770	1.21625
.50000	.48770	1.07119
.71694	.48770	1.01238
.89092	.48770	.78103
.98746	.48770	.66521
.01254	.65846	2.32425

.10908	.65846	1.77346
.28306	.65846	.94617
.50000	.65846	.74690
.71694	.65846	.72034
.89092	.65846	.48046
.98746	.65846	.32853
.01254	.82923	2.14580
.10908	.82923	1.85465
.28306	.82923	.88251
.50000	.82923	.57754
.71694	.82923	.33387
.89092	.82923	.18584
.98746	.82923	-.05753
.01254	.95424	1.99767
.10908	.95424	2.01973
.28306	.95424	.90859
.50000	.95424	.84597
.71694	.95424	.47257
.89092	.95424	.30501
.98746	.95424	-.10508

SECTIONAL PROPERTIES
****

I	CL	CM	CD	CT
*	**	**	**	**
1	.91402	.29392	.33268	0.00000
2	.82187	.06341	.29913	0.00000
3	1.09430	-.20372	.39829	0.00000
4	.92128	-.30765	.33532	0.00000
5	1.50465	-.48795	.54765	0.00000
6	1.13789	-.48842	.41416	0.00000
7	.89491	-.47787	.32572	0.00000
8	.71913	-.46625	.26174	0.00000
9	.83523	-.63475	.30400	0.00000

TOTAL LIFT COEFFICIENT= .97524
TOTAL PITCHING MOMENT COEFFICIENT= -.19059
TOTAL DRAG COEFFICIENT= .35496
TOTAL THRUST COEFFICIENT= 0.00000

SPANWISE PRESSURE AT CONSTANT X=, 0.00000

Y	2Y/B(LOCAL)	DELTA-CP
.03844	.08614	1.01798
.13906	.31166	1.03110
.26344	.59041	1.07920
.36406	.81593	.48499

SPANWISE PRESSURE AT CONSTANT X=, 1.00000

Y	2Y/B(LOCAL)	DELTA-CP
.03844	.04257	.50287
.13906	.15401	.72852
.26344	.29177	1.28738
.36406	.40321	1.17573
.46061	.51014	1.41442
.61937	.68598	1.08199
.83625	.92617	1.52318

Results for iterations 1 and 2 are omitted.

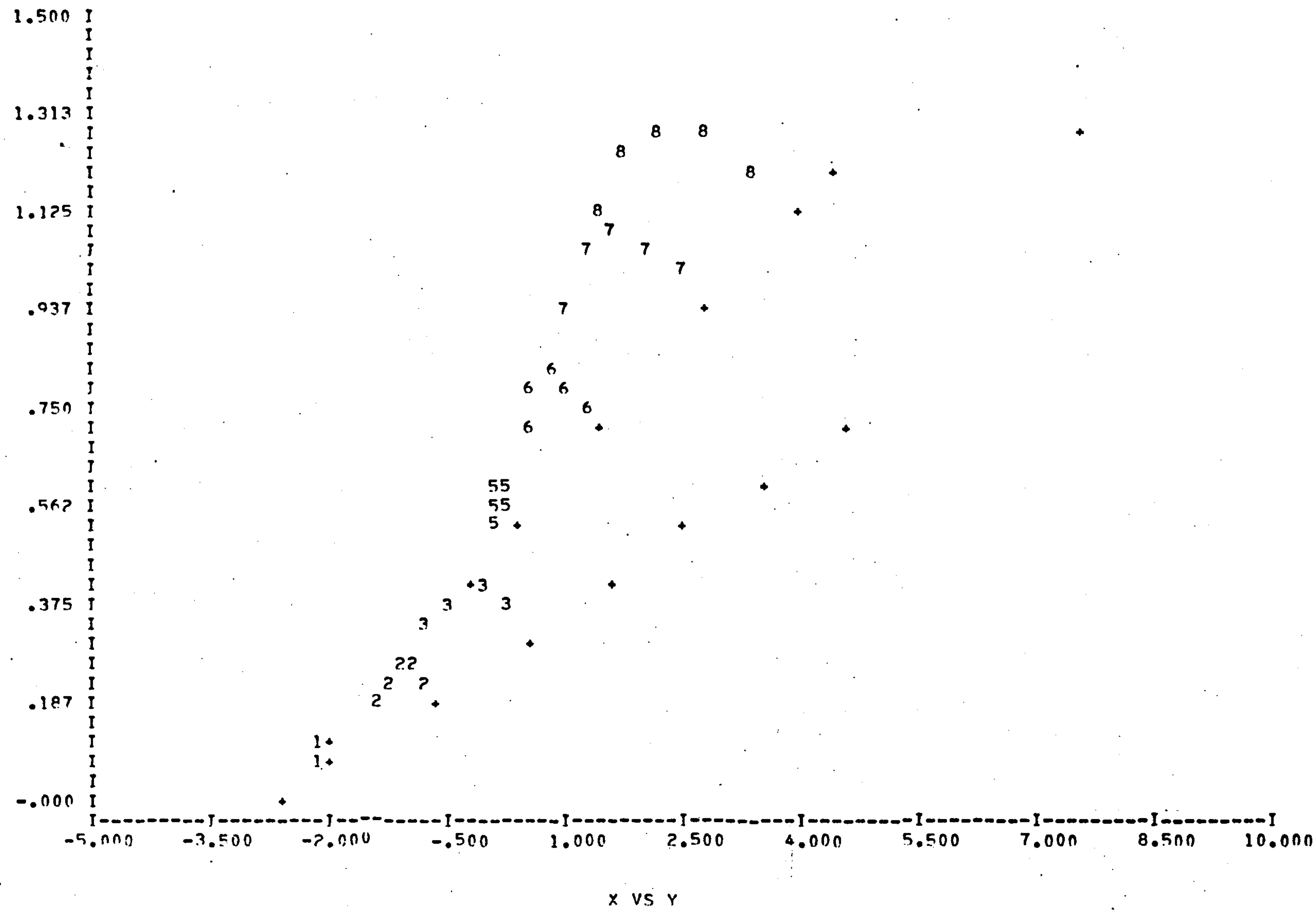
Initial Shape of the Free Sheet and Concentrated Core is shown in Iteration 3.

```
                      DOUBLE DELTA WING MODEL ONE (SCALING)
ALPHA(DEG.)=20.000  MACH NUMBER= 0.000  ITERATION NUMBER= 3

LEADING EDGE ELEMENTS
********************
 **** 1*****
   1.7875  -1.8395  -2.3041  -2.3560  -2.3560  -2.3560  -2.3560  -2.3560  -2.3560  -2.3560  -2.3560  -2.3560  -1.8619   -.6482
    .5654   1.6013   2.6371   3.6730   4.7089
    .0830    .0830   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000    .0810    .1965
    .3119    .4327    .5090    .6076    .7062
   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000    .0844    .2047
    .3250    .4277    .5304    .6331    .7358
 **** 2*****
   1.7875  -1.1771  -1.8395  -1.8856  -2.0692  -2.0294  -1.9898  -1.9485  -1.9056  -1.8619  -1.8619  -1.8619   -.6482    .5654
   1.6013   2.6371   3.6730   4.7089
    .2012    .2012    .0830    .0830    .0830    .0957    .1093    .1104    .0989    .0810    .0810    .0810    .1965    .3119
    .4105    .5090    .6076    .7062
   0.0000   0.0000   0.0000   0.0000   0.0000    .0291    .0586    .0833    .1032    .1206    .0844    .0844    .2047    .3250
    .4277    .5304    .6331    .7358
 **** 3*****
   1.7875   -.5147  -1.1771  -1.2148  -1.3649  -1.2274  -1.0903   -.9476   -.7993   -.6482   -.6482   -.6482    .5654   1.6013
   2.6371   3.6730   4.7089
    .3195    .3195    .2012    .2012    .2012    .2322    .2651    .2679    .2399    .1965    .1965    .1965    .3119    .4105
    .5090    .6076    .7062
   0.0000   0.0000   0.0000   0.0000   0.0000    .0707    .1421    .2021    .2503    .2926    .2047    .2047    .3250    .4277
    .5304    .6331    .7358
 **** 4*****
   1.7875   -.0502   -.5147   -.5439   -.6605   -.4253   -.1908    .0532    .3069    .5654    .5654    .5654   1.6013   2.6371
   3.6730   4.7089
    .4025    .4025    .3195    .3195    .3195    .3688    .4210    .4254    .3809    .3119    .3119    .3119    .4105    .5090
    .6076    .7062
   0.0000   0.0000   0.0000   0.0000   0.0000    .1123    .2257    .3209    .3974    .4646    .3250    .3250    .4277    .5304
    .6331    .7358
 **** 5*****
   1.7875    .2190   -.0502   -.0735   -.0735   -.0735   -.0735   -.0735   -.0735   -.0735   -.0735   -.0735    .4343   1.5858
   2.9156   4.0672   4.5324
    .5295    .5295    .4025    .4025    .4025    .4025    .4025    .4025    .4025    .4025    .4025    .4025    .5227    .7146
    .9362   1.1281   1.2057
   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000    .3101    .4239
    .5554    .6692    .7152
 **** 6*****
   1.7875    .6309    .2190    .1990    .1196    .1600    .2226    .2967    .3682    .4343    .4343    .4343   1.5858   2.9156
   4.0672   4.5324
    .7240    .7240    .5295    .5295    .5295    .5795    .5976    .5881    .5600    .5227    .5227    .5227    .7146    .9362
   1.1281   1.2057
   0.0000   0.0000   0.0000   0.0000   0.0000    .1309    .2052    .2468    .2889    .3398    .3101    .3101    .4239    .5554
    .6692    .7152
```

```
**** 7*****
  1.7875   1.1065    .6309    .6162    .5576    .6896    .8941   1.1365   1.3699   1.5858   1.5858   1.5858   2.9156   4.0672
  4.5324
   .9485    .9485    .7240    .7240    .7240    .7923    .8171    .8041    .7657    .7146    .7146    .7146    .9362   1.1281
  1.2057
  0.0000   0.0000   0.0000   0.0000   0.0000    .1790    .2806    .3374    .3949    .4646    .4239    .4239    .5554    .6692
   .7152
**** 8*****
  1.7875   1.5184   1.1065   1.0978   1.0633   1.3010   1.6695   2.1061   2.5267   2.9156   2.9156   2.9156   4.0672   4.5324
  1.1430   1.1430    .9485    .9485    .9485   1.0380   1.0705   1.0534   1.0031    .9362    .9362    .9362   1.1281   1.2057
  0.0000   0.0000   0.0000   0.0000   0.0000    .2346    .3676    .4420    .5174    .6087    .5554    .5554    .6692    .7152
**** 9*****
  1.7875   1.6529   1.5184   1.5150   1.5013   1.8306   2.3410   2.9458   3.5284   4.0672   4.0672   4.0672   4.5324
  1.2700   1.2065   1.1430   1.1430   1.1430   1.2508   1.2900   1.2694   1.2088   1.1281   1.1281   1.1281   1.2057
  0.0000   0.0000   0.0000   0.0000   0.0000    .2826    .4429    .5326    .6235    .7335    .6692    .6692    .7152
```

```
WAKE ELEMENTS
*************
 **** 1*****
   1.7875   2.2019   2.6162   3.8162   5.0162   6.2162
   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
 **** 2*****
   1.7875   2.2019   2.6141   3.8078   4.9993   6.1897
    .0830    .0830    .1235    .2391    .3605    .4650
   0.0000   0.0000    .0117    .0502    .1250    .2356
 **** 3*****
   1.7875   2.2019   2.6063   3.7711   4.9219   6.0373
    .2012    .2012    .2906    .5646    .7651   1.1722
   0.0000   0.0000    .0117    .1015    .3761    .5500
 **** 4*****
   1.7875   2.2019   2.6005   3.7413   4.8315   6.0231
    .3195    .3195    .4325    .7225   1.0516   1.1404
   0.0000   0.0000   -.0024    .2310    .6093    .7203
 **** 5*****
   1.7875   2.2019   2.6009   3.7761   4.9552   6.1166
    .4025    .4025    .5009    .7074    .8537   1.0986
   0.0000   0.0000   -.0524    .0756    .2436    .4206
 **** 6*****
   1.7875   2.2019   2.5932   3.7666   4.9363   6.1004
    .5295    .5295    .6635    .9087   1.1473   1.3377
   0.0000   0.0000   -.0248    .0294    .1514    .3717
 **** 7*****
   1.7875   2.2019   2.5852   3.7010   4.8541   5.9960
    .7240    .7240    .8793    .7160    .9615   1.1927
   0.0000   0.0000    .0243    .4347    .6583    .9456
 **** 8*****
   1.7875   2.2019   2.6034   3.7524   4.9057   6.0171
    .9485    .9485    .8561   1.1356   1.3968   1.5875
   0.0000   0.0000    .0435    .2479    .4518    .8623
 **** 9*****
   1.7875   2.2019   2.6012   3.7681   4.9312   5.9790
   1.1430   1.1430   1.0777   1.2857   1.4333    .9515
   0.0000   0.0000    .0889    .2765    .5321    .8637
 ****10*****
   1.7875   2.2019   2.5868   3.7007   4.8251   5.9527
   1.2552   1.2552   1.3265   1.5024   1.5875   1.5875
   0.0000   0.0000    .1356    .5461    .9565   1.3669
```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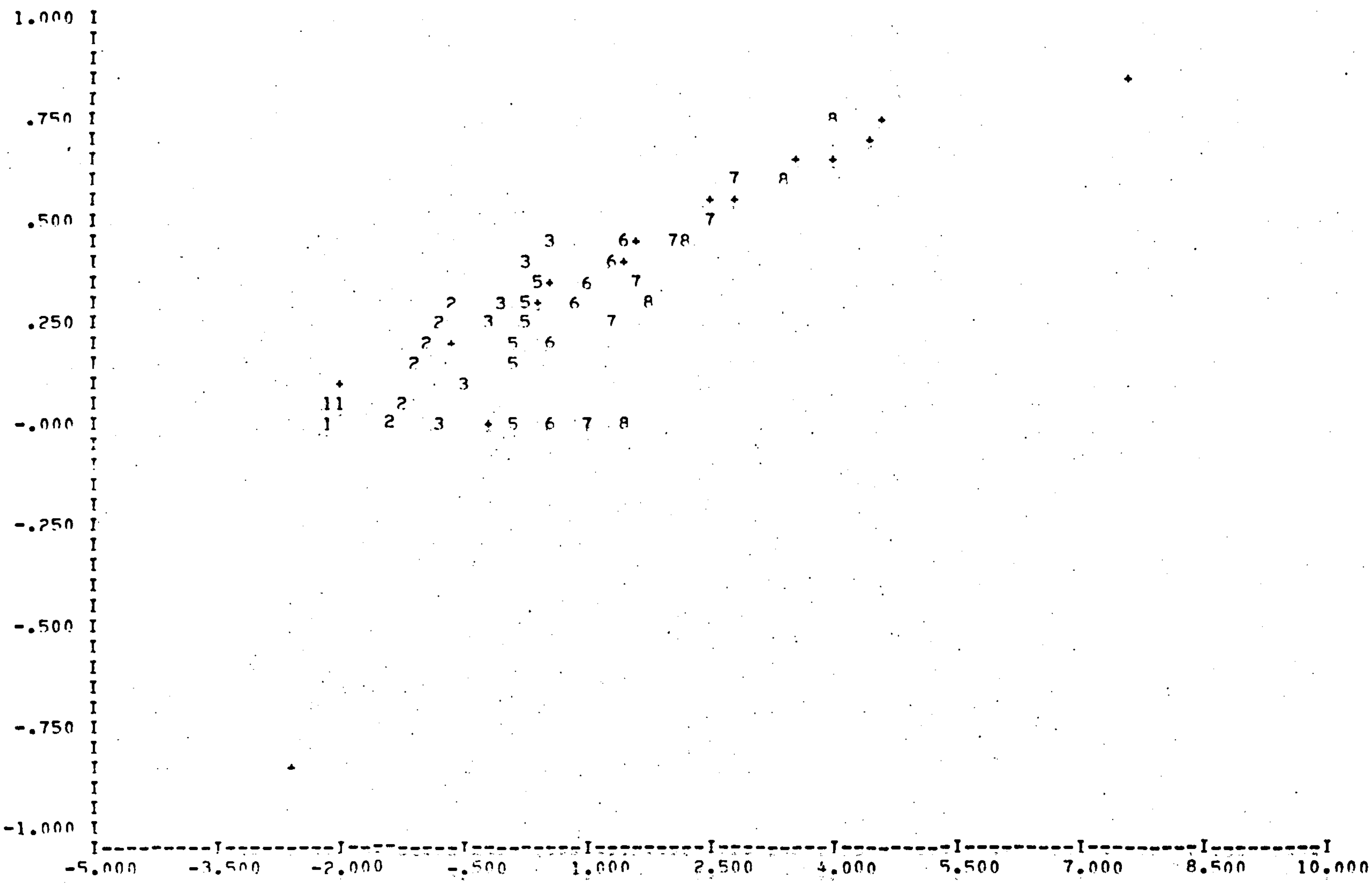
10.000
X VS Y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2.500
4.000
5.500
7.000
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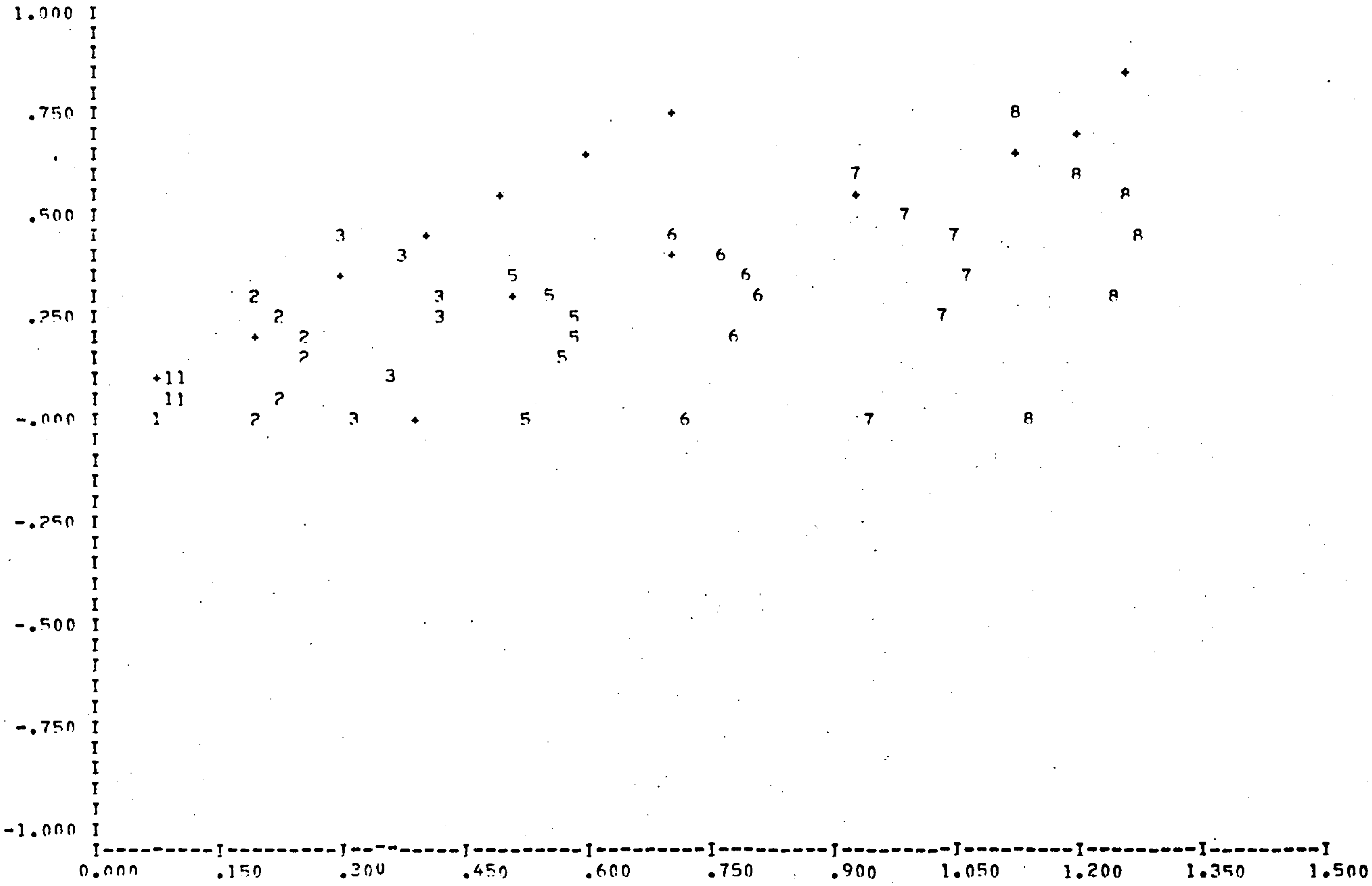
10.000

X VS Z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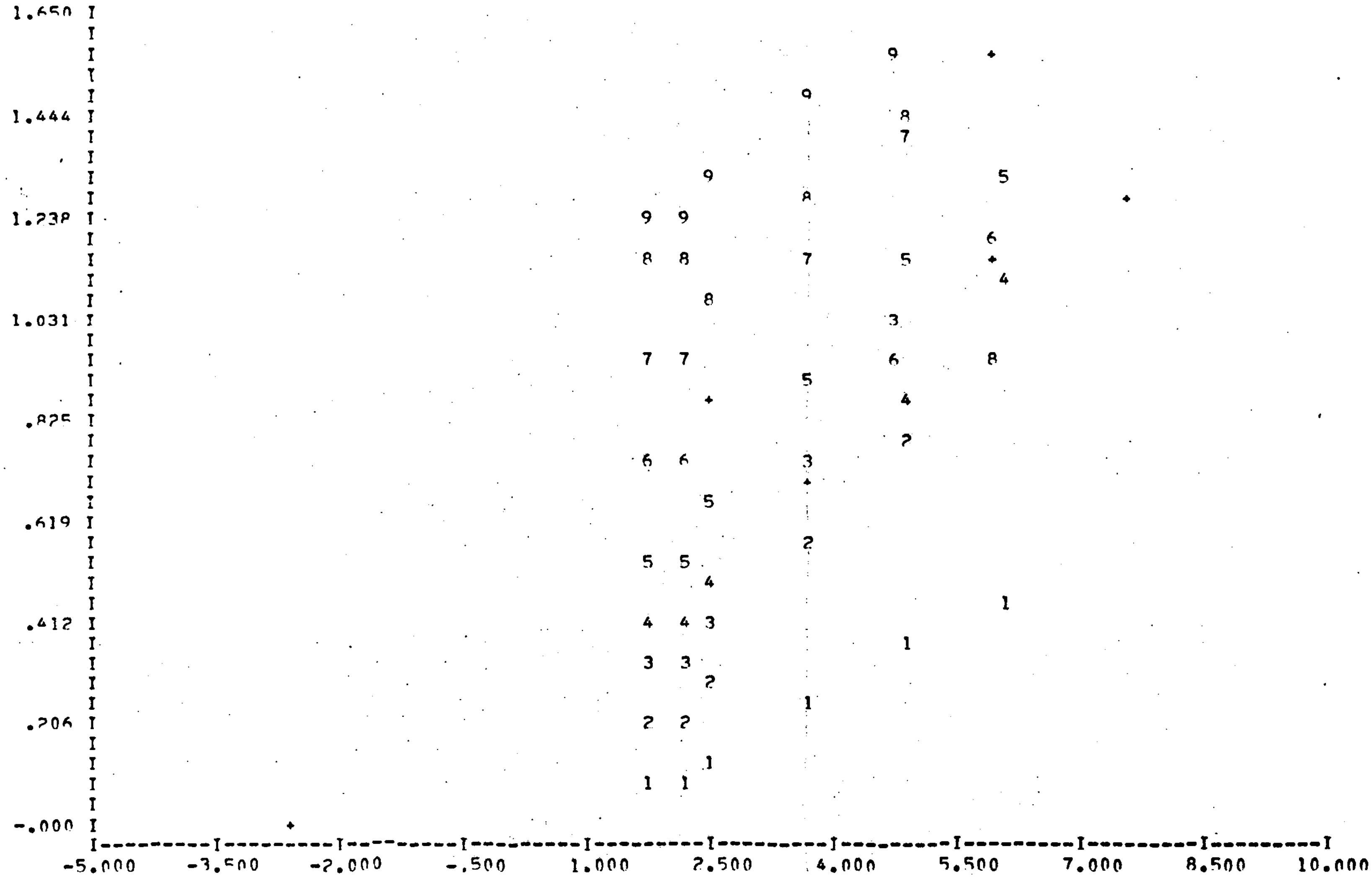
1.050
1.200
1.350
1.500

Y VS Z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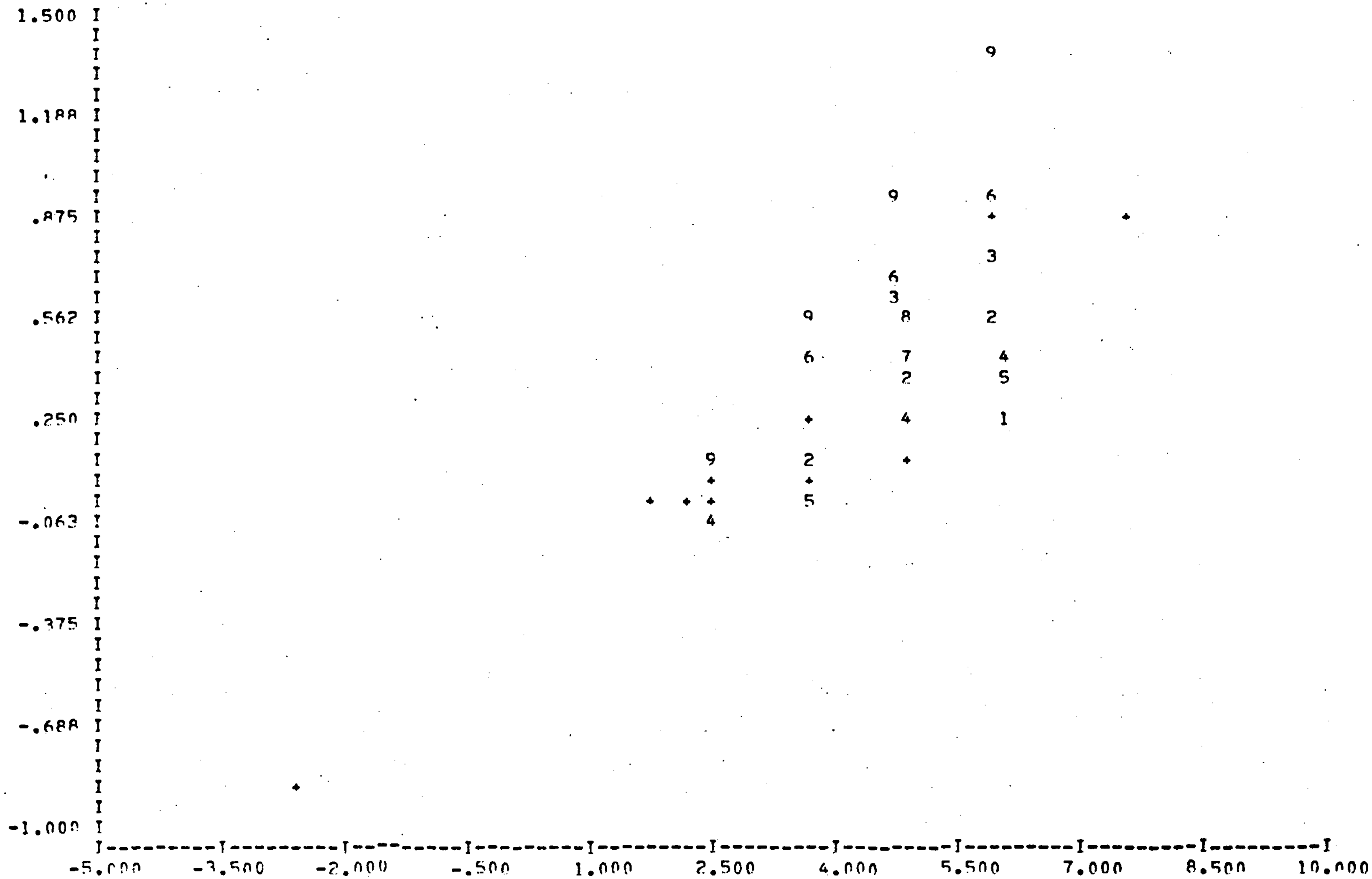
1.000
2.500
4.000
5.500
7.000
8.500
10.000

X VS Y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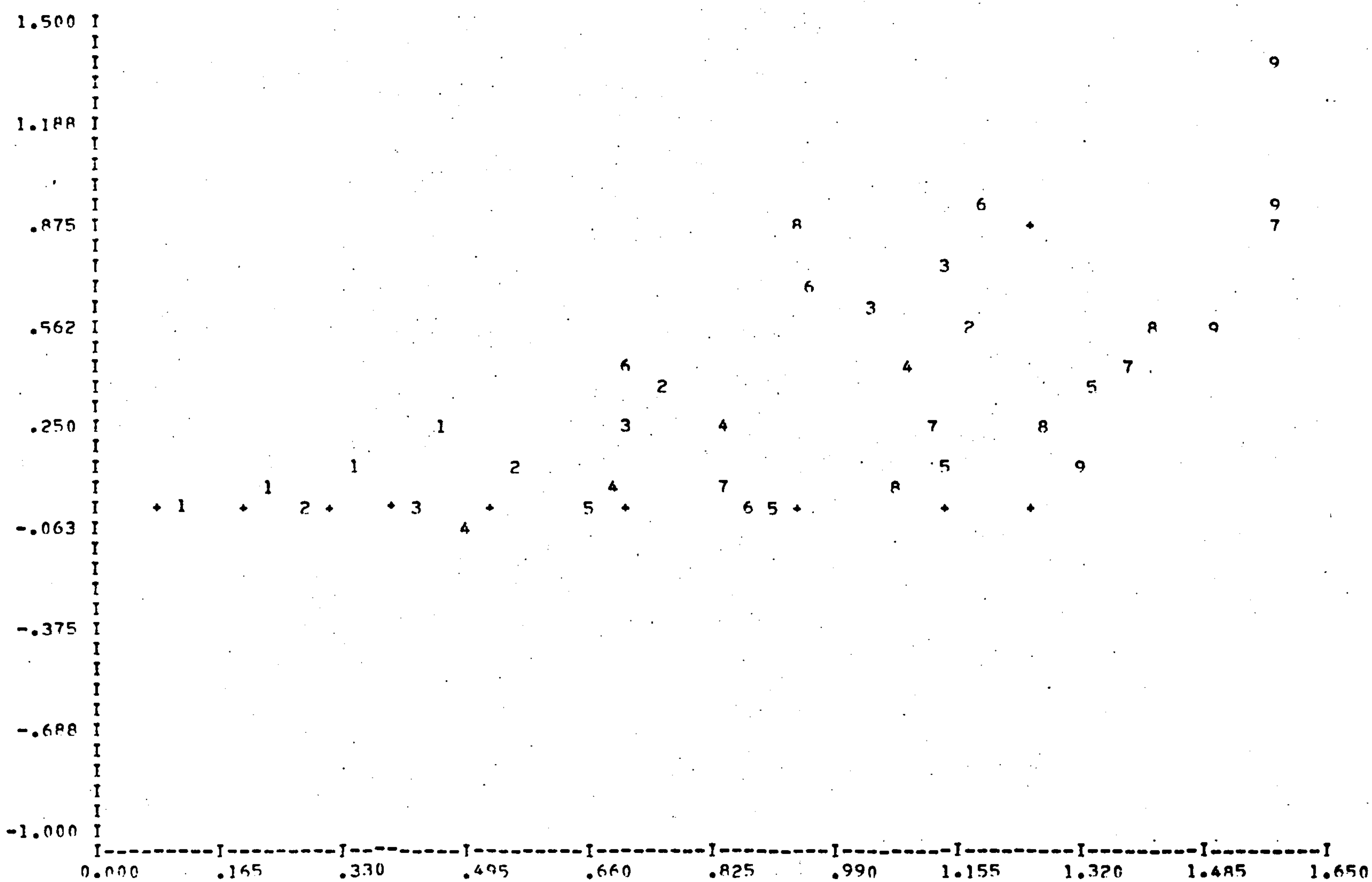
4.000
5.500
7.000
8.500
10.000

X VS 7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1.188
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.562
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.330
.495
.660
.825
.990
1.155
1.320
1.485
1.650

Y VS Z

WING VORTEX STRENGTHS
****

X/C ***	2Y/B ****	GAMAY *****
.01704	.03026	1.16655
.14645	.03026	.32423
.37059	.03026	.35653
.62941	.03026	.37494
.85355	.03026	.20965
.98296	.03026	.07753
.01704	.10950	1.13968
.14645	.10950	.30904
.37059	.10950	.37315
.62941	.10950	.38205
.85355	.10950	.21182
.98296	.10950	.07365
.01704	.20743	1.53600
.14645	.20743	.39808
.37059	.20743	.45155
.62941	.20743	.31617
.85355	.20743	.18866
.98296	.20743	.05938
.01704	.28667	1.84416
.14645	.28667	.69975
.37059	.28667	.39469
.62941	.28667	.24825
.85355	.28667	.15706
.98296	.28667	.04485
.01704	.36269	3.02992
.14645	.36269	.50711
.37059	.36269	.31690
.62941	.36269	.20740
.85355	.36269	.12733
.98296	.36269	.03317
.01704	.48770	3.11242
.14645	.48770	.48345
.37059	.48770	.29683
.62941	.48770	.19452
.85355	.48770	.10038
.98296	.48770	.02459
.01704	.65846	4.27184
.14645	.65846	.49318
.37059	.65846	.35985
.62941	.65846	.21589
.85355	.65846	.10538
.98296	.65846	.02945

.01704	.82923	6.05306
.14645	.82923	.62411
.37059	.82923	.40234
.62941	.82923	.28362
.85355	.82923	.15541
.98296	.82923	.04680
.01704	.95424	9.67653
.14645	.95424	.97577
.37059	.95424	.59063
.62941	.95424	.41087
.85355	.95424	.24795
.98296	.95424	.08148

LEADING-EDGE VORTICES STRENGTHS
****

2Y/B	CAPGAMA
.03026	.21875
.10950	.19305
.20743	.20768
.28667	.19398
.36269	.27156
.48770	.22727
.65846	.21033
.82923	.14945
.95424	.06405

DELTA-CP DISTRIBUTION
****

X/C	2Y/B	DELTA-CP
***	****	********
.01254	.03026	.42971
.10908	.03026	1.07984
.28306	.03026	.83555
.50000	.03026	.75921
.71694	.03026	.73044
.89092	.03026	.34812
.98746	.03026	.25502
.01254	.10950	2.82852
.10908	.10950	.79703
.28306	.10950	.89401
.50000	.10950	.97205
.71694	.10950	.69293
.89092	.10950	.41906
.98746	.10950	.15674
.01254	.20743	1.72386
.10908	.20743	-.20992
.28306	.20743	1.03863
.50000	.20743	1.51741
.71694	.20743	1.08278
.89092	.20743	.67433
.98746	.20743	.35061
.01254	.28667	7.84027
.10908	.28667	3.16404
.28306	.28667	1.31392
.50000	.28667	.63009
.71694	.28667	.92996
.89092	.28667	.40483
.98746	.28667	.46578
.01254	.36269	8.45642
.10908	.36269	2.00334
.28306	.36269	1.38517
.50000	.36269	1.28571
.71694	.36269	.84964
.89092	.36269	.74458
.98746	.36269	.46956
.01254	.48770	1.32732
.10908	.48770	1.29937
.28306	.48770	1.08632
.50000	.48770	.95596
.71694	.48770	.88967
.89092	.48770	.70772
.98746	.48770	.60836
.01254	.65846	1.82502

.10908	.65846	1.28225
.28306	.65846	.76076
.50000	.65846	.64379
.71694	.65846	.66539
.89092	.65846	.48549
.98746	.65846	.39853
.01254	.82923	1.98294
.10908	.82923	1.63616
.28306	.82923	.76444
.50000	.82923	.41354
.71694	.82923	.30774
.89092	.82923	.15503
.98746	.82923	-.01195
.01254	.95424	1.37264
.10908	.95424	1.35038
.28306	.95424	.71465
.50000	.95424	.61365
.71694	.95424	.35538
.89092	.95424	.19341
.98746	.95424	-.12076

SECTIONAL PROPERTIES
****

I	CL	CM	CD	CT
*	**	**	**	**
1	.67747	.13352	.24658	0.00000
2	.80642	.09343	.29351	0.00000
3	.88140	-.20084	.32080	0.00000
4	1.41811	-.17073	.51615	0.00000
5	1.47580	-.39687	.53715	0.00000
6	.93169	-.41901	.33911	0.00000
7	.74344	-.40669	.27059	0.00000
8	.61894	-.40048	.22528	0.00000
9	.59439	-.45180	.21634	0.00000

TOTAL LIFT COEFFICIENT= .88929
TOTAL PITCHING MOMENT COEFFICIENT= -.16675
TOTAL DRAG COEFFICIENT= .32367
TOTAL THRUST COEFFICIENT= 0.00000

SPANWISE PRESSURE AT CONSTANT X=, 0.00000

Y	2Y/B(LOCAL)	DELTA-CP
.03844	.08614	.77365
.13906	.31166	.98856
.26344	.59041	1.25688
.36406	.81593	2.73492

SPANWISE PRESSURE AT CONSTANT X=, 1.00000

Y	2Y/B(LOCAL)	DELTA-CP
.03844	.04257	.59200
.13906	.15401	.61522
.26344	.29177	1.11678
.36406	.40321	.81418
.46061	.51014	1.20301
.61937	.68598	.97445
.83625	.92617	1.12313

Similar results for several iterations till " SFAC " value shows an increase (after fifth iteration) from previous value. (See summary sheet on next page)

The best solution is shown after summary sheet.

DOUBLE DELTA WING MODEL ONE (SCALING)

ALPHA(DEG.)=20.000 MACH NUMBER= 0.000

ITERATION	CL	CM	CD	CT	GMSUM	SFAC
*********	**	**	**	**	*****	****
0	.9752	-.1906	.3550	0.0000	1.9627	
1	.8762	-.1590	.3189	0.0000	1.8095	
2	.9412	-.2111	.3426	0.0000	1.7998	
3	.8893	-.1667	.3237	0.0000	1.5174	.4826
4	.8734	-.1539	.3179	0.0000	1.5110	.3843
5	.8668	-.1506	.3155	0.0000	1.5034	.3292
6	.8497	-.1439	.3093	0.0000	1.4930	.4383

```
              DOUBLE DELTA WING MODEL ONE (SCALING)
ALPHA(DEG.)=20.000  MACH NUMBER= 0.000  ITERATION NUMBER= 5

LEADING EDGE ELEMENTS
*********************
 **** 1****
   1.7875  -1.8395  -2.3041  -2.3560  -2.3560  -2.3560  -2.3560  -2.3560  -2.3560  -2.3560  -2.3560  -2.3560  -1.8619   -.6478
    .5663   1.6024   2.6384   3.6744   4.7107
    .0830    .0830   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000    .0810    .1948
    .3102    .4305    .5066    .6052    .7035
   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000    .0844    .2020
    .3177    .4183    .5201    .6212    .7195
 **** 2****
   1.7875  -1.1771  -1.8395  -1.8856  -2.0692  -1.8944  -1.8379  -1.7827  -1.7262  -1.6650  -1.6650  -1.8619   -.6478    .5663
   1.6024   2.6384   3.6744   4.7107
    .2012    .2012    .0830    .0830    .0830    .1147    .1270    .1283    .1174    .0810    .0810    .0810    .1948    .3102
    .4305    .5066    .6052    .7035
   0.0000   0.0000   0.0000   0.0000   0.0000    .0201    .0501    .0819    .1129    .1356    .0994    .0844    .2020    .3177
    .4183    .5201    .6212    .7195
 **** 3****
   1.7875   -.5147  -1.1771  -1.2148  -1.3649  -1.2363  -1.0991   -.9651   -.8282   -.6796   -.6796   -.6478    .5663   1.6024
   2.6384   3.6744   4.7107
    .3195    .3195    .2012    .2012    .2012    .2784    .3082    .3113    .2848    .1948    .1948    .1948    .3102    .4305
    .5066    .6052    .7035
   0.0000   0.0000   0.0000   0.0000   0.0000    .0487    .1214    .1988    .2740    .3290    .2411    .2020    .3177    .4183
    .5201    .6212    .7195
 **** 4****
   1.7875   -.0502   -.5147   -.5439   -.6605   -.4341   -.1953    .0248    .2594    .5138    .5138    .5663   1.6024   2.6384
   3.6744   4.7107
    .4025    .4025    .3195    .3195    .3195    .4049    .4109    .3763    .2697    .1662    .1662    .3102    .4305    .5066
    .6052    .7035
   0.0000   0.0000   0.0000   0.0000   0.0000    .1084    .2250    .3627    .4398    .4132    .2736    .3177    .4183    .5201
    .6212    .7195
 **** 5****
   1.7875    .2190   -.0502   -.0735   -.0735   -.0735   -.0735   -.0735   -.0735   -.0735   -.0735   -.0735    .4343   1.5861
   2.9159   4.0677   4.5330
    .5295    .5295    .4025    .4025    .4025    .4025    .4025    .4025    .4025    .4025    .4025    .4025    .5227    .7134
    .9347   1.1263   1.2037
   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000    .3101    .4234
    .5547    .6667    .7126
 **** 6****
   1.7875    .6309    .2190    .1990    .1196    .2046    .2820    .3499    .4137    .4771    .4771    .4343   1.5861   2.9159
   4.0677   4.5330
    .7240    .7240    .5295    .5295    .5295    .5864    .6083    .6219    .6300    .5227    .5227    .5227    .7134    .9347
   1.1263   1.2037
   0.0000   0.0000   0.0000   0.0000   0.0000    .1040    .1613    .2116    .2710    .3682    .3384    .3101    .4234    .5547
    .6667    .7126
```

**** 7*****

1.7875	1.1065	.6309	.6162	.5576	.7466	.9478	1.1638	1.3658	1.5624	1.5624	1.5861	2.9159	4.0677
4.5330													
.9485	.9485	.7240	.7240	.7240	.8003	.8434	.8704	.8653	.7134	.7134	.7134	.9347	1.1263
1.2037													
0.0000	0.0000	0.0000	0.0000	0.0000	.1121	.2142	.3357	.4717	.6037	.5630	.4234	.5547	.6667
.7126													

**** 8*****

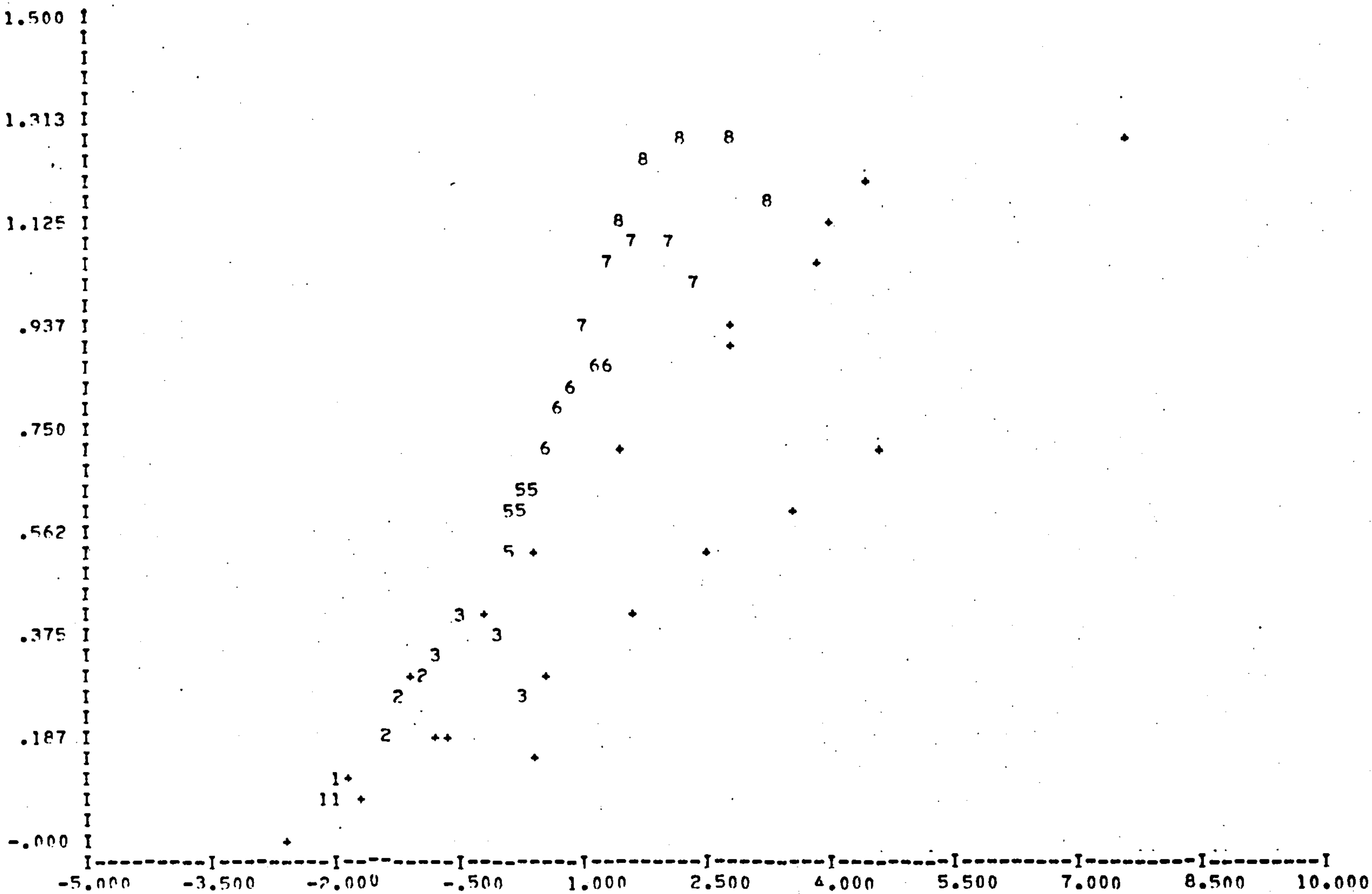
1.7875	1.5184	1.1065	1.0978	1.0633	1.3456	1.6885	2.0748	2.4455	2.8063	2.8063	2.9159	4.0677	4.5330
1.1430	1.1430	.9485	.9485	.9485	1.0346	1.0854	1.0958	1.0306	.9173	.9173	.9347	1.1263	1.2037
0.0000	0.0000	0.0000	0.0000	0.0000	.1801	.3654	.5825	.7909	.9393	.8860	.5547	.6667	.7126

**** 9*****

1.7875	1.6529	1.5184	1.5150	1.5013	1.3688	2.3308	2.8611	3.3832	3.8917	3.8917	4.0677	4.5330
1.2700	1.2065	1.1430	1.1430	1.1430	1.2289	1.2893	1.2814	1.1556	1.0328	1.0328	1.1263	1.2037
0.0000	0.0000	0.0000	0.0000	0.0000	.2398	.5055	.8105	1.0615	1.2492	1.1849	.6667	.7126

WAKE ELEMENTS
****

**** 1****					
1.7875	2.2019	2.6162	3.8162	5.0162	6.2162
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
**** 2****					
1.7875	2.2019	2.6140	3.8063	4.9954	6.1766
.0830	.0830	.1196	.2465	.3945	.5419
0.0000	0.0000	.0211	.0705	.1347	.2861
**** 3****					
1.7875	2.2019	2.6062	3.7531	4.9493	5.9826
.2012	.2012	.2879	.6151	1.0335	1.4850
0.0000	0.0000	.0264	.1586	.4103	.8208
**** 4****					
1.7875	2.2019	2.5935	3.6464	4.6577	5.8543
.3195	.3195	.4490	1.0004	1.4991	1.5875
0.0000	0.0000	.0387	.2046	.6150	.5977
**** 5****					
1.7875	2.2019	2.6025	3.7230	4.7922	5.8903
.4025	.4025	.5080	.8579	1.3312	1.5875
0.0000	0.0000	-.0038	.2454	.5152	.9256
**** 6****					
1.7875	2.2019	2.5878	3.7463	4.8560	5.9486
.5295	.5295	.6792	.9638	1.3088	1.5875
0.0000	0.0000	.0176	.1481	.4472	.8577
**** 7****					
1.7975	2.2019	2.5782	3.6990	4.7807	5.9084
.7240	.7240	.8877	1.3054	1.5875	1.5875
0.0000	0.0000	.0572	-.1207	.2897	.7001
**** 8****					
1.7875	2.2019	2.5767	3.6345	4.7208	5.8470
.9485	.9485	.7774	1.2294	1.5320	1.5875
0.0000	0.0000	.0436	.3854	.7958	1.2063
**** 9****					
1.7975	2.2019	2.5886	3.7749	4.8287	5.9559
1.1430	1.1430	1.0469	1.1577	1.5591	1.5875
0.0000	0.0000	.1134	.2568	.6672	1.0776
****10****					
1.7875	2.2019	2.5813	3.6902	4.8176	5.9450
1.2552	1.2552	1.3426	1.5474	1.5678	1.5469
0.0000	0.0000	.1417	.5521	.9626	1.3730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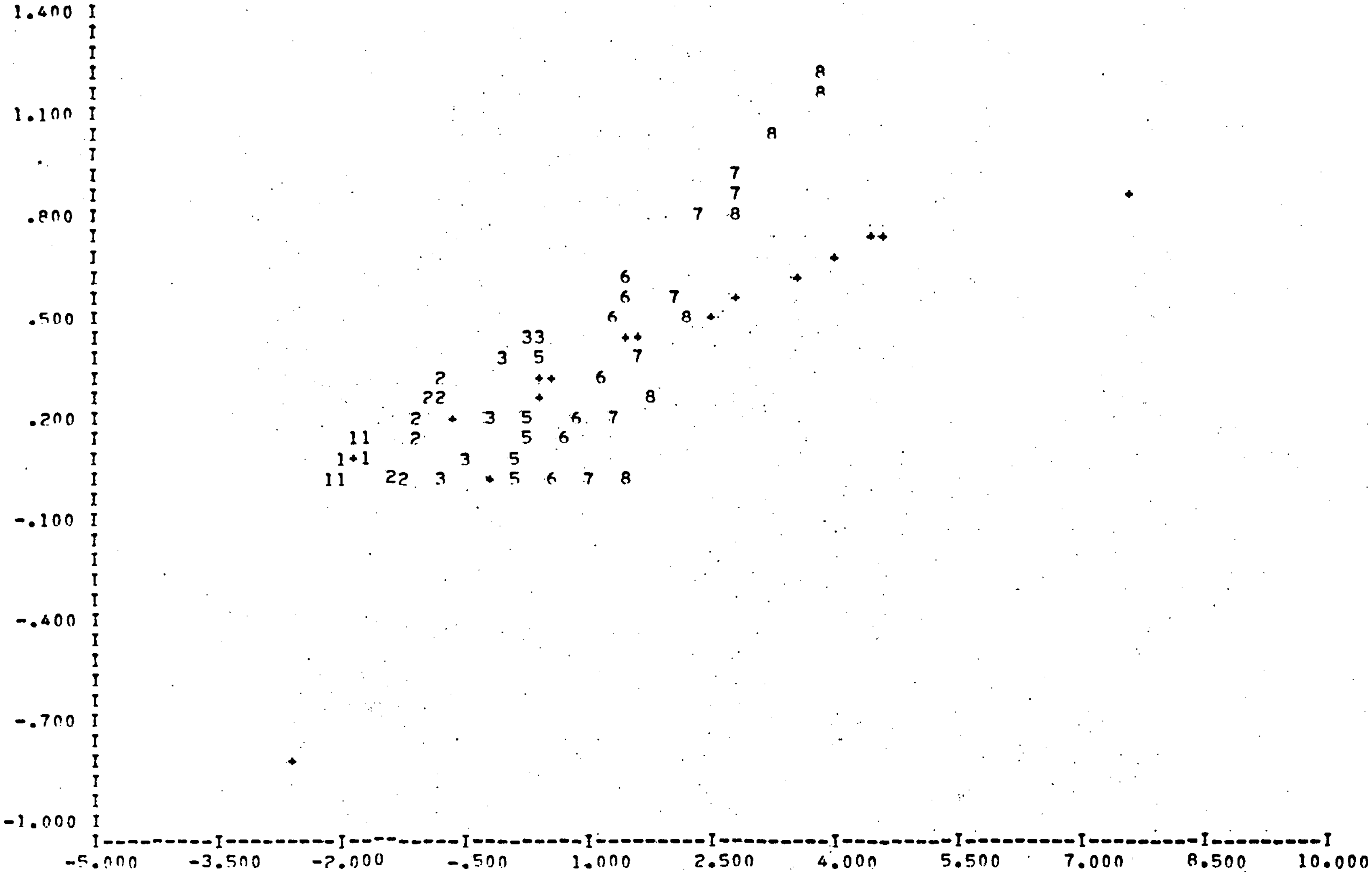
X VS Y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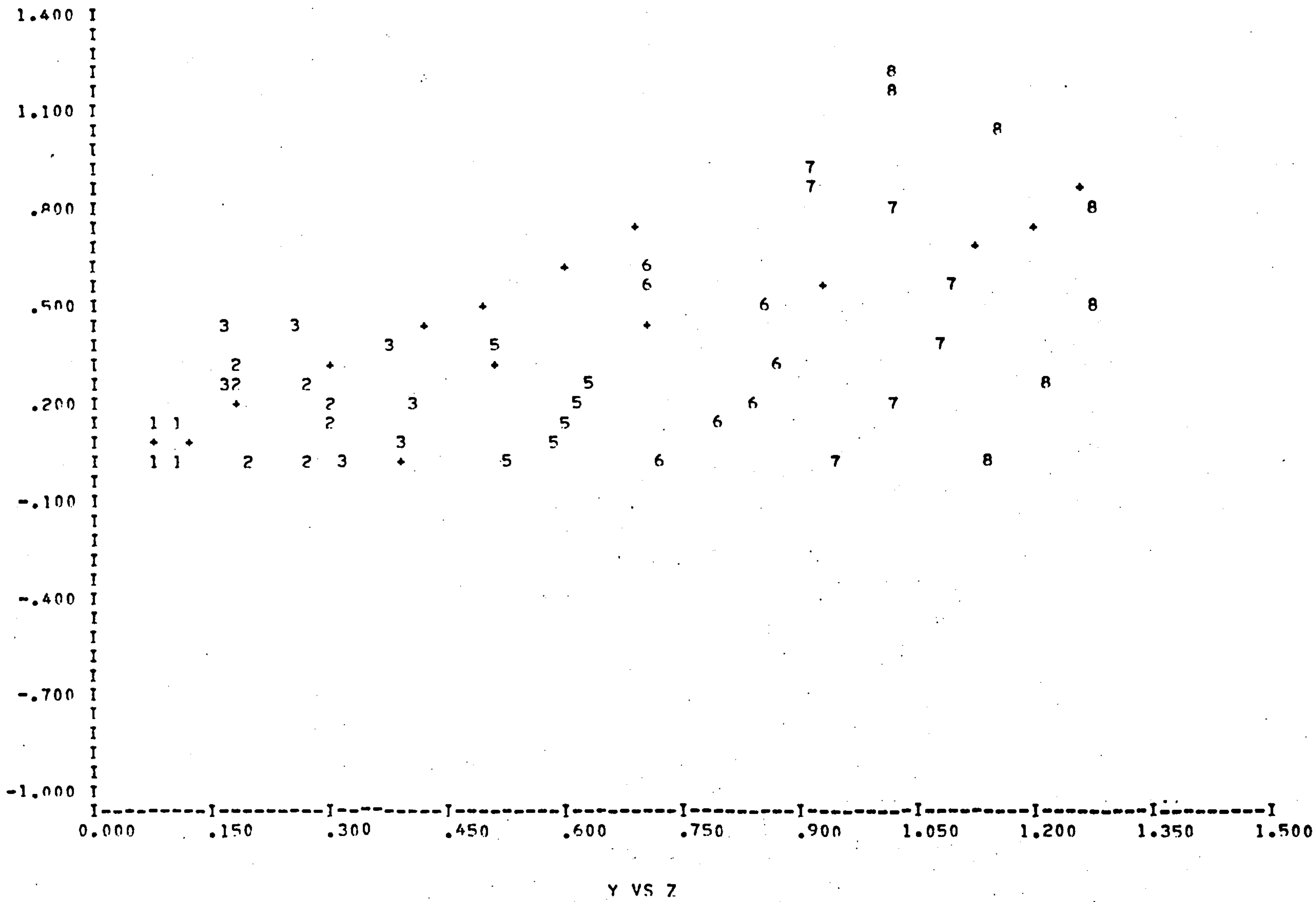
X VS 7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1.200
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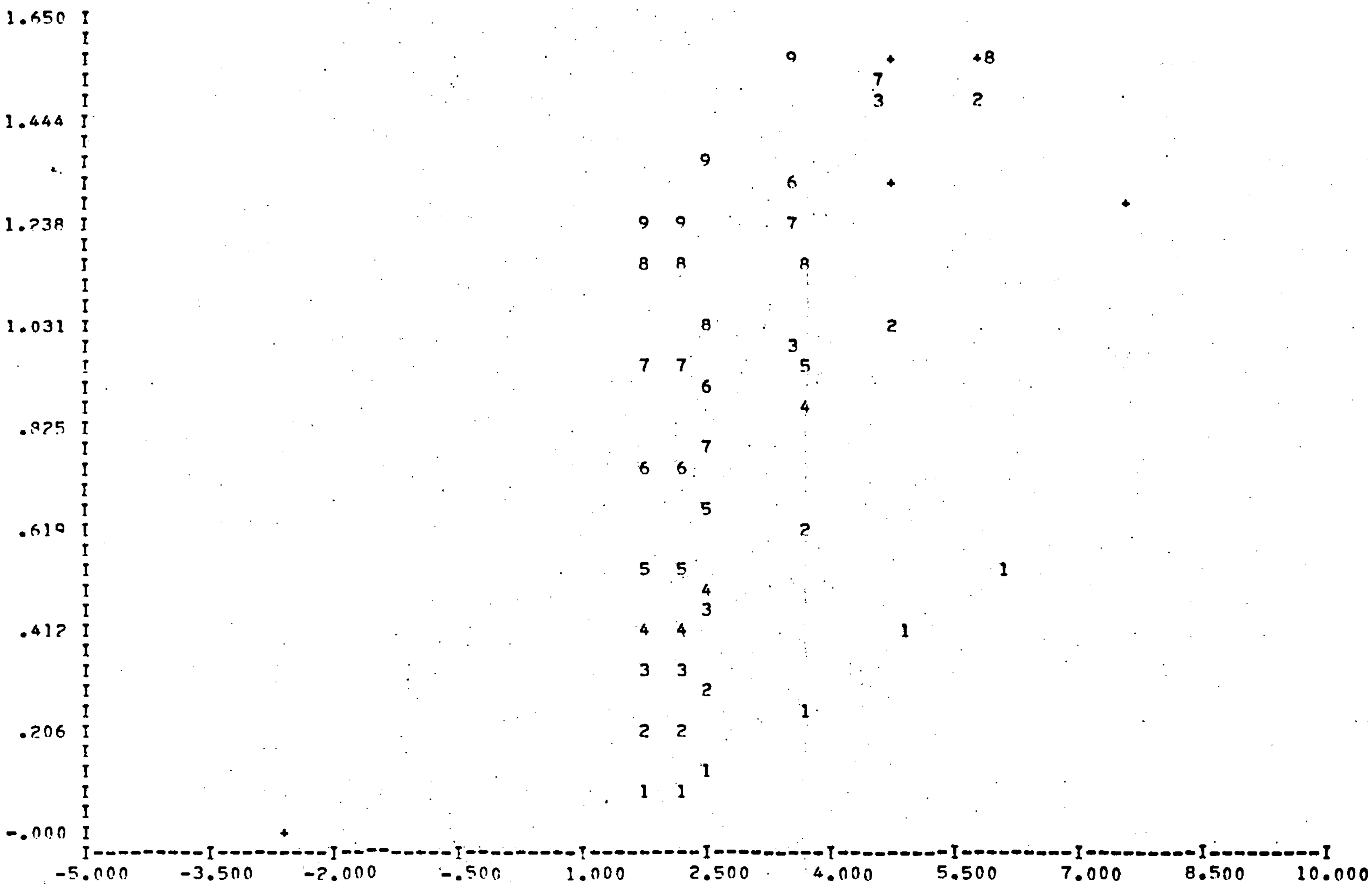
Y VS Z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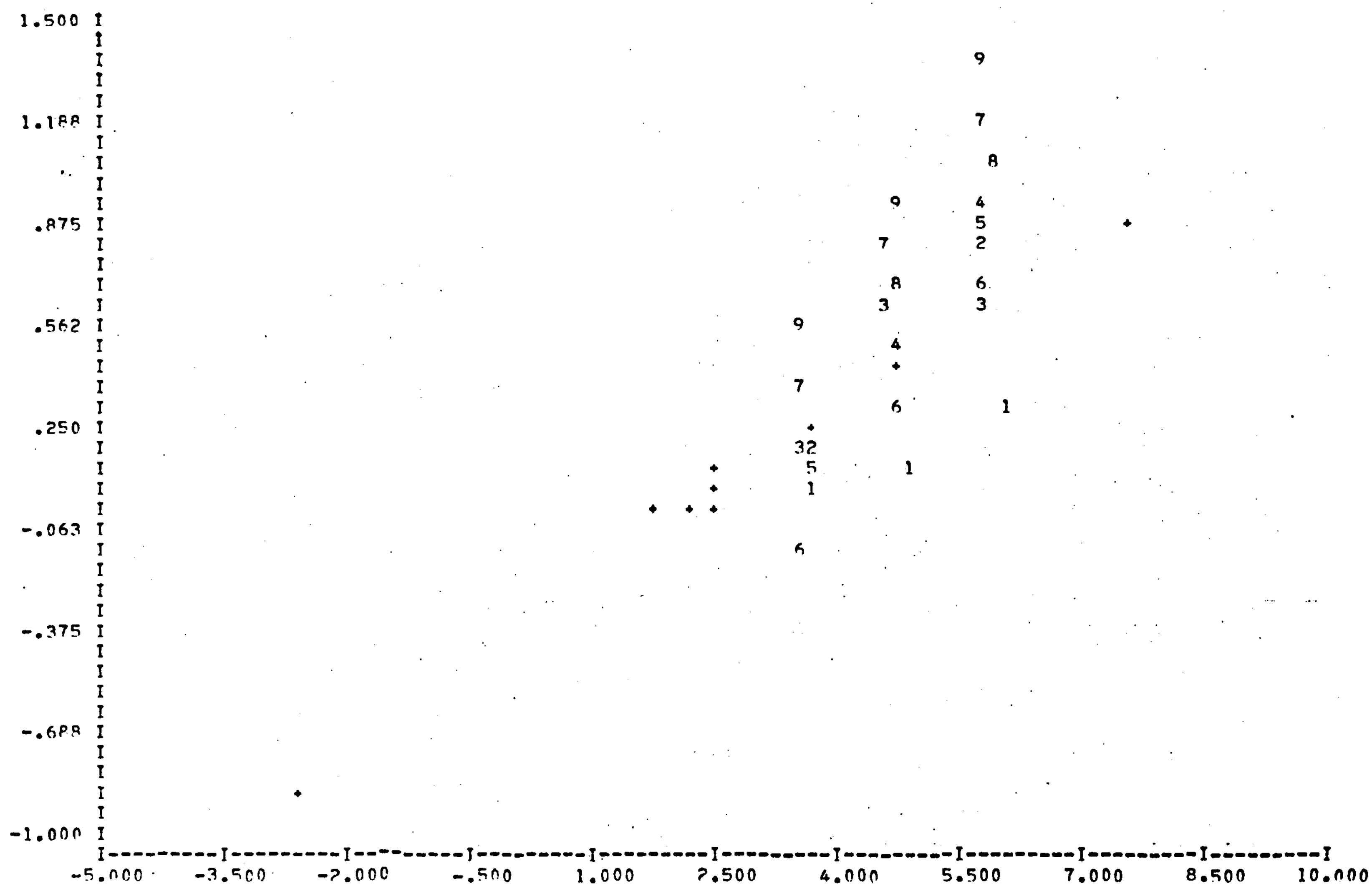
X VS Y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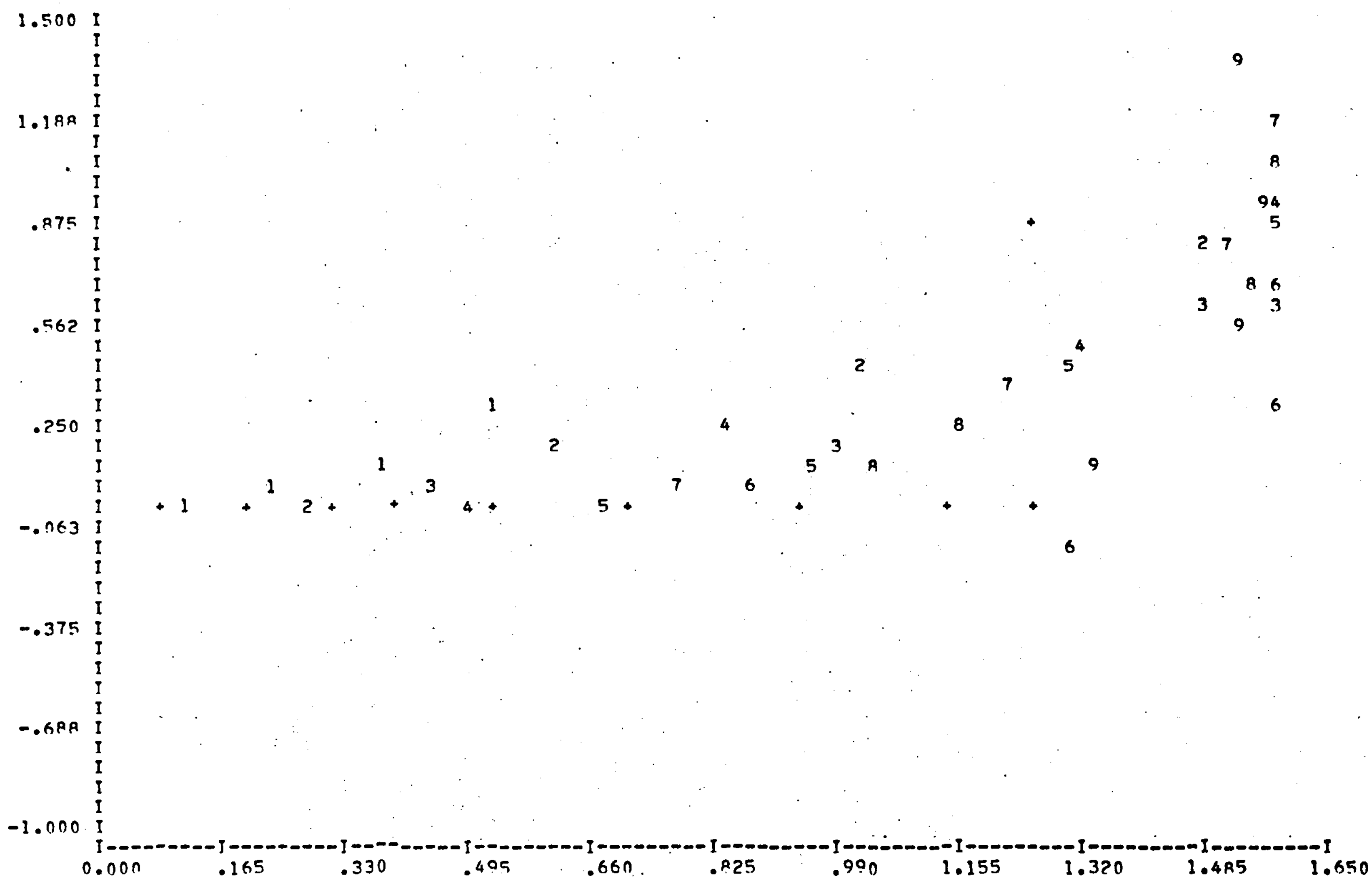
X VS Z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.165
.330
.495
.660
.825
.990
1.155
1.320
1.485
1.650

Y VS Z

WING VORTEX STRENGTHS
****

X/C	2Y/B	GAMAY
***	****	*****
.01704	.03026	.97697
.14645	.03026	.38215
.37059	.03026	.35159
.62941	.03026	.35290
.85355	.03026	.20349
.98296	.03026	.07610
.01704	.10950	1.22977
.14645	.10950	.31044
.37059	.10950	.36876
.62941	.10950	.35601
.85355	.10950	.20574
.98296	.10950	.07252
.01704	.20743	1.57073
.14645	.20743	.39824
.37059	.20743	.43781
.62941	.20743	.29094
.85355	.20743	.18331
.98296	.20743	.05902
.01704	.28667	1.84832
.14645	.28667	.67881
.37059	.28667	.37479
.62941	.28667	.23291
.85355	.28667	.15310
.98296	.28667	.04507
.01704	.36269	2.89782
.14645	.36269	.50371
.37059	.36269	.29915
.62941	.36269	.19963
.85355	.36269	.12529
.98296	.36269	.03389
.01704	.48770	2.98843
.14645	.48770	.44502
.37059	.48770	.29755
.62941	.48770	.19545
.85355	.48770	.10403
.98296	.48770	.02691
.01704	.65846	4.09470
.14645	.65846	.45920
.37059	.65846	.34521
.62941	.65846	.22731
.85355	.65846	.11791
.98296	.65846	.03322

.01704	.82923	5.90207
.14645	.82923	.59899
.37059	.82923	.38384
.62941	.82923	.27781
.85355	.82923	.15767
.98296	.82923	.04829
.01704	.95424	9.58142
.14645	.95424	.96095
.37059	.95424	.57694
.62941	.95424	.39807
.85355	.95424	.23883
.98296	.95424	.07833

LEADING-EDGE VORTICES STRENGTHS
****

2Y/B	CAPGAMA
****	*******
.03026	.18657
.10950	.20608
.20743	.21167
.28667	.19413
.36269	.26172
.48770	.21847
.65846	.20201
.82923	.14585
.95424	.06343

DELTA-CP DISTRIBUTION
****

X/C ***	2Y/B ****	DELTA-CP ********
.01254	.03026	.90496
.10908	.03026	1.28204
.28306	.03026	.88498
.50000	.03026	.71102
.71694	.03026	.69318
.89092	.03026	.33870
.98746	.03026	.24903
.01254	.10950	2.68298
.10908	.10950	.92909
.28306	.10950	.96079
.50000	.10950	.92916
.71694	.10950	.64143
.89092	.10950	.41340
.98746	.10950	.14867
.01254	.20743	1.30621
.10908	.20743	-.11517
.28306	.20743	1.03939
.50000	.20743	1.42176
.71694	.20743	1.01387
.89092	.20743	.65418
.98746	.20743	.33857
.01254	.28667	7.24285
.10908	.28667	2.92956
.28306	.28667	1.19925
.50000	.28667	.57214
.71694	.28667	.88029
.89092	.28667	.40340
.98746	.28667	.45483
.01254	.36269	7.96349
.10908	.36269	1.84363
.28306	.36269	1.25312
.50000	.36269	1.19310
.71694	.36269	.81768
.89092	.36269	.72404
.98746	.36269	.46685
.01254	.48770	1.45271
.10908	.48770	1.28982
.28306	.48770	1.03077
.50000	.48770	.88973
.71694	.48770	.55536
.89092	.48770	.68398
.98746	.48770	.59195
.01254	.65846	1.89426

.10908	.65846	1.23161
.28306	.65846	.75092
.50000	.65846	.61742
.71694	.65846	.67132
.89092	.65846	.47015
.98746	.65846	.38511
.01254	.82923	2.09114
.10908	.82923	1.68458
.28306	.82923	.80615
.50000	.82923	.40484
.71694	.82923	.32938
.89092	.82923	.16381
.98746	.82923	.00385
.01254	.95424	1.33408
.10908	.95424	1.29537
.28306	.95424	.68826
.50000	.95424	.58164
.71694	.95424	.33570
.89092	.95424	.17859
.98746	.95424	-.12067

SECTIONAL PROPERTIES
****

I	CL	CM	CD	CT
*	**	**	**	**
1	.71699	.18123	.26096	0.00000
2	.80969	.10646	.29470	0.00000
3	.93793	-.19245	.30498	0.00000
4	1.31511	-.16239	.47866	0.00000
5	1.37916	-.37423	.50161	0.00000
6	.90139	-.40234	.32808	0.00000
7	.73109	-.39964	.26609	0.00000
8	.64241	-.41574	.23382	0.00000
9	.56791	-.43157	.20670	0.00000

TOTAL LIFT COEFFICIENT= .86679
TOTAL PITCHING MOMENT COEFFICIENT= -.15059
TOTAL DRAG COEFFICIENT= .31549
TOTAL THRUST COEFFICIENT= 0.00000

SPANWISE PRESSURE AT CONSTANT X=. 0.00000

Y	2Y/B(LOCAL)	DELTA-CP
.03844	.08614	.72062
.13906	.31166	.95651
.26344	.59041	1.22761
.36406	.81593	2.52929

SPANWISE PRESSURE AT CONSTANT X=. 1.00000

Y	2Y/B(LOCAL)	DELTA-CP
.03844	.04257	.57018
.13906	.15401	.57436
.26344	.29177	1.04410
.36406	.40321	.75933
.46061	.51014	1.12420
.61937	.68598	.90551
.83625	.92617	1.08864

FORTRAN PROGRAM LISTING

This program was written in FORTRAN IV language and is operational on CDC Cyber 175 Computer system at Langley Research Center. The run stream (control cards) is listed at the end of the program. The following table is an index to the program listing.

```
      OVERLAY (LEVSP,0,0)
      PROGRAM LEVSP(INPUT,OUTPUT,TAPE1,TAPE2,TAPE3,TAPE5=INPUT,TAPE6=OUT
     1PUT.PUNCH,TAPE4.TAPE7,TAPE8,TAPE9,TAPE10)
C
C     AERODYNAMICS OF LOW ASPECT-RATIO WINGS WITH PARTIAL LEADING-EDGE
C     SEPARATION (LEADING-EDGE VORTEX SEPARATION PROGRAM)
C     BY - JENN LOUH PAO , SUDHIR C. MEHROTRA AND C. EDWARD LAN
C          UNIVERSITY OF KANSAS
C
C     THIS PROGRAM IS APPLICABLE TO NONPLANAR WINGS (LIMITED TO TWO
C     SPANWISE SECTIONS )
C
C     PROGRAM IS DIVIDED INTO FIVE OVERLAYS.
C     OVERLAY (1,0) READ ALL THE DATA CARDS AND SETS UP INITIAL
C                   GEOMETRY OF THE WING AND THE FREE ELEMENTS
C     OVERLAY (2,0) PLOTS FREE ELEMENTS OVER THE WING AND IN THE WAKE ON
C                   THE LINE PRINTER OUTPUT
C     OVERLAY (3,0) SOLVES FOR THE STRENGTHS OF WING AND LEADING-EDGE
C                   VORTEX SYSTEM
C     OVERLAY (4,0) COMPUTE THE AERODYNAMICS CHARACTERISTICS , THE
C                   SUM OF FREE SHEET AND CORE FORCES
C     OVERLAY (5,0) COMPUTES THE NEW LOCATIONS OF THE LEADING-EDGE AND
C                   TRAILING-EDGE VORTICES
C     AS THE PROBLEM IS NONLINEAR, IT IS SOLVED BY ITERATION. ITERATION
C     IS PERFORMED OVER OVERLAYS (2,0) THRU (4,0) TO OBTAIN THE FINAL
C     CONVERGED SOLUTION.
C
      COMMON DUMMY1(3000)
      COMMON /COEFF/ CL,FZMINS(10),FHS(2,10),RATIOS(2,10),
     1CFCORE(2,10),RATIOC(2,10)
      COMMON /NCTT/ NCT,NCON,NBT,NCOR(15),KU1,NFSH(15),KUC,FLG(10)
      COMMON /AERO/ NAERO,MAXL,MAXW,ISPAN,ISF,ITRAKE,ISC
      COMMON /TAPE/ ITEST,IGOOD,SFAC(10),KU3,NSTOP
      COMMON /SHPTE/ NTE,YST(15),AQT(14),BQT(14),CQT(14),DQT(14)
      COMMON /SHPLE/ NLE,YSL(15),AQL(14),BQL(14),CQL(14),DQL(14)
      COMMON /LANDA/ FGMA1,FBDA1,FGMA,CLS
      COMMON /LOCSP/ FTANTY(10,15),FTANTZ(10,15),CTANTY(40,2),CTANTZ(40,
     12)
      COMMON /LEFLP/ YLEF(10,2),XNF(10),YNF(10),ZNF(10),XLF(10,4),
     1YLF(10,4),SLP1(10),SS,CS,ITERS,ZBDYV(200),ZBDY(200)
     2,CURV(10),CHND(10),SZBDYV(200)
```

```
      COMMON /INFAV/ FYT(20),FZT(20),FYI(40),FZI(40),VXI(40),VYI(40),VZI
     1(40),FXT(20),TFORCE(20)
      COMMON /MDFAV/ FYP(40,2,2),FZP(40,2,2)
      COMMON /LOC/ FU1,FU2,XEND,PXL(5),PXT(5),PYL(5),ICL
      COMMON /ALLI/ NSW,NSW1,NCW,NWNG,NCPTTL,MITER,IPUNCH
      COMMON /ALLRA/ TTL(16),ALPHA,SINA,COSA,SWPLE,BETA,BETA2,TANPH1,B2P
     1H1,BSOD4P,D4,CON,PI,D4SQ2,CBAR,HALFB,AREA
      COMMON /ALLRB/ AX(210),ZMIN,NELM(11),NNELM(12),IST
      COMMON /ABC/ XE(10,40),YE(10,40),ZE(10,40),XXE(11,20),YYE(11,20),
     1ZZE(11,20),NMAX,NNMAX,NCONTS
      COMMON /OABC/ DXE(10,40),DYE(10,40),DZE(10,40)
      COMMON /XPLOT/ XMN,YMN,ZMN,XMX,YMX,ZMX
      COMMON /GM/ ITER,L1,L2,L3,L4,L5,L6,L7,L8
      COMMON /XSTN/ XBRR(25),NBRR
      COMMON /TIPVX/ XTIP(15,30),YTIP(15,30),ZTIP(15,30),NTLM(15),NTMAX
      COMMON /GENCF/ M1(5),NW(2),YBREAK(5),CH(90),SJ(31,3),MJW1(2),
     1MJW2(2),WIDTH(5),SWEEP(60),NTS,NC
      COMMON/CAMB/ ICAM,IM(10),XT(10,21),AAM(10,20),BBM(10,20),
     1CCM(10,20),DDM(10,20),YT(10),ZBDX(200),ZBDXV(200)
10    CALL OVERLAY (5HLEVSP,1,0)
      ITEST=9
      IGOOD= 10
      KU3=KU1+3
      NSTOP=0
      NSW1=NTS
      NSW=NTS+1
      ITER=ITERS
20    CONTINUE
      ALP=ALPHA*180./PI
      AMACH=SQRT(1.-BETA2)
C     WRITE FREE ELEMENTS LOCATIONS
      WRITE (6,140) TTL,ALP,AMACH,ITER
      IF (ITER.GE.KU3) WRITE (ITEST,140) TTL,ALP,AMACH,ITER
      DO 30 I=1,MAXL
      K=NELM(I)
      WRITE (6,180) I
      WRITE (6,170) (XE(I,J),J=1,K)
      WRITE (6,170) (YE(I,J),J=1,K)
30    WRITE (6,170) (ZE(I,J),J=1,K)
      WRITE (6,210)
      DO 40 I=1,MAXW
```

```
      K=NNELM(I)                                                        LEV 830
      WRITE (6,180) I                                                   LEV 840
      WRITE (6,170) (XXE(I,J),J=1,K)                                    LEV 850
      WRITE (6,170) (YYE(I,J),J=1,K)                                    LEV 860
   40 WRITE (6,170) (ZZE(I,J),J=1,K)                                    LEV 870
      IF (ITER.LT.KU3) GO TO 70                                         LEV 880
      M=ITEST                                                           LEV 890
      DO 50 I=1,MAXL                                                    LEV 900
      K=NELM(I)                                                         LEV 910
      WRITE (M,180) I                                                   LEV 920
      WRITE (M,170) (XE(I,J),J=1,K)                                     LEV 930
      WRITE (M,170) (YE(I,J),J=1,K)                                     LEV 940
      WRITE (M,170) (ZE(I,J),J=1,K)                                     LEV 950
   50 CONTINUE                                                          LEV 960
      WRITE (M,210)                                                     LEV 970
      DO 60 I=1,MAXW                                                    LEV 980
      K=NNELM(I)                                                        LEV 990
      WRITE (M,180) I                                                   LEV1000
      WRITE (M,170) (XXE(I,J),J=1,K)                                    LEV1010
      WRITE (M,170) (YYE(I,J),J=1,K)                                    LEV1020
      WRITE (M,170) (ZZE(I,J),J=1,K)                                    LEV1030
   60 CONTINUE                                                          LEV1040
   70 CONTINUE                                                          LEV1050
      CALL OVERLAY (5HLEVSP,2,0)                                        LEV1060
      NAERO=0                                                           LEV1070
      NSW=NTS+1                                                         LEV1080
      CALL OVERLAY (5HLEVSP,3,0)                                        LEV1090
      NAERO=1                                                           LEV1100
      NSW1=NTS                                                          LEV1110
      NSW=NTS+1                                                         LEV1120
      CALL OVERLAY (5HLEVSP,4,0)                                        LEV1130
      IF (NSTOP.NE.1) GO TO 75                                          LEV1135
      REWIND ITEST                                                      LEV1140
      ENDFILE ITEST                                                     LEV1145
      ENDFILE ITEST                                                     LEV1150
      GO TO 90                                                          LEV1155
   75 RATIOC(1,ITER)=1.                                                 LEV1160
      RATIOC(2,ITER)=1.                                                 LEV1170
      RATIOS(1,ITER)=1.                                                 LEV1180
      RATIOS(2,ITER)=1.                                                 LEV1190
      NSW1=NTS                                                          LEV1200
```

```
      NSW=NTS+1
      IF (ITER.LT.KU3) GO TO 80
      RATIOS(1,ITER)=ABS((FHS(1,ITER)-FHS(1,ITER-1))/FHS(1,ITER-1))
      RATIOC(1,ITER)=ABS((CFCORE(1,ITER)-CFCORE(1,ITER-1))/CFCORE(1,ITER
     1))
      IF (ITRAKE.NE.1) RATIOC(2,ITER)=ABS((CFCORE(2,ITER)-CFCORE(2,ITER-
     11))/CFCORE(2,ITER-1))
      IF (ITRAKE.NE.1) RATIOS(2,ITER)=ABS((FHS(2,ITER)-FHS(2,ITER-1))/FH
     1S(2,ITER-1))
80    CONTINUE
      IF (ITER.EQ.MITER) GO TO 90
      CALL OVERLAY (5HLEVSP,5,0)
      ITER=ITER+1
      IF (ITER.LE.MITER) GO TO 20
90    CONTINUE
      IF (IPUNCH.EQ.0) GO TO 120
C     PUNCH-OUT FREE ELEMENTS LOCATIONS AFTER LAST ITERATION
      REWIND 4
      PUNCH 200, (NELM(I),I=1,NSW1)
      DO 100 I=1,NSW1
      K=NELM(I)
      PUNCH 190, (XE(I,J),J=1,K)
      PUNCH 190, (YE(I,J),J=1,K)
100   PUNCH 190, (ZE(I,J),J=1,K)
      PUNCH 200, (NNELM(I),I=1,NSW)
      DO 110 I=1,NSW
      K=NNELM(I)
      PUNCH 190, (XXE(I,J),J=1,K)
      PUNCH 190, (YYE(I,J),J=1,K)
110   PUNCH 190, (ZZE(I,J),J=1,K)
C     FORMULATION OF SUMMARY SHEET
120   REWIND 7
      WRITE (6,150) TTL,ALP,AMACH
      MIT=MITER+1
      IF (ITERS.EQ.0) KSS=1
      IF (ITERS.EQ.3) KSS=4
      DO 130 I=KSS,MIT
      J=I-1
C     ******************************************************************
      READ (7) GMSUM
      READ (7) CL,CM,CD,CTT
```

```
C     *****************************************************************
      IF (ITER.LE.KU1) WRITE (6,160) J,CL,CM,CD,CTT,GMSUM
      IF (ITER.GT.KU1) WRITE (6,160) J,CL,CM,CD,CTT,GMSUM,SFAC(J)
  130 CONTINUE
      GO TO 10
C
  140 FORMAT (1H1,//,16A5,/,1X,12HALPHA(DEG.)=,F6.3,14H  MACH NUMBER=,F6
     1.3,19H  ITERATION NUMBER=,I2,//,1X,21HLEADING EDGE ELEMENTS,/,1X,2
     21H*********************)
  150 FORMAT (1H1,//,1X,16A5,//,2X,12HALPHA(DEG.)=,F6.3,14H  MACH NUMBER
     1=,F6.3,//,66H  ITERATION    CL        CM        CD        CT    GMSUM
     2 SFAC        ,/,58H  *********    **        **        **        **    **
     3***    ****)
  160 FORMAT (I7,4X,6F8.4)
  170 FORMAT (1H ,14F9.4)
  180 FORMAT (1H ,5H ****,I2,4H****)
  190 FORMAT (8F10.4)
  200 FORMAT (10I2)
  210 FORMAT (1H1,//,14H WAKE ELEMENTS,/,14H *************)
      END


      FUNCTION TAN(X)
      TAN=SIN(X)/COS(X)
      RETURN
      END


      SUBROUTINE SKIPR (NT,NR)
C     SKIPS NR-RECORDS OF TAPE NT
      DO 10 I=1,NR
   10 READ (NT)
      RETURN
      END


      FUNCTION ARCOS (X)
C     CALCULATES ARC-COSINE OF X
```

```
      ARCOS=0.
      IF (X.EQ.1.) RETURN
      IF (X.EQ.(-1.)) GO TO 10
      XX=X/(SQRT(1.-X*X))
      ARCOS=1.5707963-ATAN(XX)
      RETURN
10    ARCOS=3.1415926
      RETURN
      END


      SUBROUTINE DOTPRD (A,B,SUM)
C     CALCULATES DOT-PRODUCT OF TWO VECTORS
      DIMENSION A(3), B(3)
      SUM=0.
      DO 10 I=1,3
10    SUM=SUM+A(I)*B(I)
      RETURN
      END


      SUBROUTINE CRSPRD (A,B,C)
C     CALCULATES CROSS-PRODUCT OF TWO VECTORS
      DIMENSION A(3), B(3), C(3)
      C(1)=A(2)*B(3)-A(3)*B(2)
      C(2)=A(3)*B(1)-A(1)*B(3)
      C(3)=A(1)*B(2)-A(2)*B(1)
      RETURN
      END


      SUBROUTINE VDTWNG (C,THETP,XX,YY,ZZ,XN,YN,XTE,YTE,CONS,CONI1,CONI3
     1,CONJ1,CONJ2,CONJ3,CONK1,CONK2,CONK3,CONI,CONJ,CONK,SI,NSW1,NCW,NW
     2NG)
C     EVALUATES INFLUENCE COEFFICIENTS FOR CALCULATION OF INDUCED
C     VELOCITY DUE TO WING ELEMENTS
      COMMON /ALLI/ NSW
      COMMON /ALLRB/ XXE(30),YYE(30),ZZE(30)
```

```
     1,AX(120),ZMIN,NFLM(11),NNELM(12)
      COMMON /ABC/ PXE(10,40),PYE(10,40),PZE(10,40),PXXE(11,20),
     1PYYE(11,20),PZZE(11,20),NMAX,NNMAX,NCONTS
      COMMON /NCTT/ NCT,NCON,NBT,NCOR(15),KU1,NFSH(15),KUC
      COMMON /GENCF/ M1(5),NW(2),YBREAK(5),CH(90),SJ(31,3),MJW1(2),
     1MJW2(2),WIDTH(5),SWEEP(60),NTS,NC
      COMMON /LOC/ FU1,FU2,XEND,PXL(5),PXT(5),PYL(5)
      COMMON /AERO/ NAERO,MAXL,MAXW,ISPAN,ISF,ITRAKE,ISC
      COMMON /TIPVX/ XTIP(15,30),YTIP(15,30),ZTIP(15,30),NTLM(15)
      COMMON /XIYIZI/ XI,YI,ZI
      DIMENSION THETP(1), C(1), CONS(1), XTE(1), YTE(1), SI(1), CONI1(1)
     1, CONI3(1), CONJ1(1), CONJ2(1), CONJ3(1), CONK1(1), CONK2(1), CONK
     23(1), CONI(1), CONJ(1), CONK(1), XN(NWNG,2), YN(NWNG,2), B(3), D(3
     3)
C     DIMENSIONS OF FJ1,FJ2,FJ3-(2*NSW)  ** SEE GEOM **
C     DIMENSIONS OF FI2,FI3-(2*NCPTTL)  ** SEE GEOM **
      DIMENSION FJ1(40), FJ2(40), FJ3(40), FI2(418), FI3(418)
      XI=XX
      YI=YY
      ZI=ZZ
      NC1=NWNG+NCW
      NC2=NWNG-NCW
C     VELOCITY DUE TO BOUND ELEMENTS
      NSW1=NTS
      DO 10 I=1,NSW1
      DO 10 J=1,NCW
      NP=(I-1)*NCW+J
      CALL INFL2 (XN(NP,1),YN(NP,1),0.,XN(NP,2),YN(NP,2),0.,B)
      A1=-YN(NP,1)
      A2=-YN(NP,2)
      CALL INFL2 (XN(NP,1),A1,0.,XN(NP,2),A2,0.,D)
      CONI(NP)=CONS(I)*(B(1)-D(1))
      CONJ(NP)=CONS(I)*(B(2)-D(2))
10    CONK(NP)=CONS(I)*(B(3)-D(3))
C     VELOCITY DUE TO TRAILING ELEMENTS ON THE WING SURFACE
      DO 20 I=1,NSW1
      DO 20 J=1,NCW
      NP=(I-1)*NCW+J
      CALL INFL2 (XN(NP,1),YN(NP,1),0.,XTE(I),YN(NP,1),0.,B)
      FI2(NP)=B(2)
      FI3(NP)=B(3)
```

```
      AYN=-YN(NP,1)
      NQ=NC1+NP
      CALL INFL2 (XN(NP,1),AYN,0.,XTE(I),AYN,0.,B)
      FI2(NQ)=B(2)
      FI3(NQ)=B(3)
20    CONTINUE
      IF ((PXT(NC+1)-PXL(NC+1)).EQ.0.) GO TO 40
      DO 30 I=1,NCW
      NP1=NWNG+I
      NP2=NC1+NP1
      FI2(NP1)=0.
      FI2(NP2)=0.
      FI3(NP1)=0.
      FI3(NP2)=0.
      NN=NTLM(I)-1
      DO 30 J=1,NN
      CALL INFL2 (XTIP(I,J),YTIP(I,J),ZTIP(I,J),XTIP(I,J+1),YTIP(I,J+1),
     1ZTIP(I,J+1),B)
      FI2(NP1)=B(2)+FI2(NP1)
      FI3(NP1)=B(3)+FI3(NP1)
      AY1=-YTIP(I,J)
      AY2=-YTIP(I,J+1)
      CALL INFL2 (XTIP(I,J),AY1,ZTIP(I,J),XTIP(I,J+1),AY2,ZTIP(I,J+1),B)
      FI2(NP2)=B(2)+FI2(NP2)
      FI3(NP2)=B(3)+FI3(NP2)
30    CONTINUE
      GO TO 60
40    CONTINUE
      DO 50 J=1,NCW
      NP1=NWNG+J
      NP2=NC1+NP1
      NP=NC2+J
      CALL INFL2 (XN(NP,2),YN(NP,2),0.,XTE(NSW),YN(NP,2),0.,B)
      FI2(NP1)=B(2)
      FI3(NP1)=B(3)
      AYN=-YN(NP,2)
      CALL INFL2 (XN(NP,2),AYN,0.,XTE(NSW),AYN,0.,B)
      FI2(NP2)=B(2)
      FI3(NP2)=B(3)
50    CONTINUE
60    CONTINUE
```

```
      DO 70 I=1,NSW1
      DO 70 J=1,NCW
      NP=(I-1)*NCW+J
      I1=NP+NC1
      I2=NP+NCW
      I3=I1+NCW
      CONJ2(NP)=CONS(I)*(FI2(I1)-FI2(NP)+FI2(I2)-FI2(I3))
70    CONK2(NP)=CONS(I)*(FI3(I1)-FI3(NP)+FI3(I2)-FI3(I3))
C     VELOCITY DUE TO TRAILING ELEMENTS BEYOND TRAILING EDGE
      NSW1=MAXL
      IF ((PXT(NC+1)-PXL(NC+1)).EQ.0.) GO TO 90
      DO 80 I=1,NSW
      FJ1(I)=0.
      FJ2(I)=0.
      FJ3(I)=0.
      FJ1(I+NSW)=0.
      FJ2(I+NSW)=0.
      FJ3(I+NSW)=0.
80    CONTINUE
      NT=NSW1
      GO TO 100
90    NT=NSW
100   CONTINUE
      DO 150 I=2,NT
      KK=NNELM(I)
      DO 110 J=1,KK
      XXE(J)=PXXE(I,J)
      YYE(J)=PYYE(I,J)
      ZZE(J)=PZZE(I,J)
110   CONTINUE
      FJ1(I)=0.
      FJ2(I)=0.
      FJ3(I)=0.
      IF (I.EQ.NCT) GO TO 130
      DO 120 J=2,KK
      CALL INFL2 (XXE(J-1),YYE(J-1),ZZE(J-1),XXE(J),YYE(J),ZZE(J),B)
      FJ1(I)=FJ1(I)+B(1)
      FJ2(I)=FJ2(I)+B(2)
      FJ3(I)=FJ3(I)+B(3)
120   CONTINUE
      CALL FUNA (XXE(KK),YYE(KK),ZZE(KK),B(1),B(2),B(3))
```

```
      FJ1(I)=FJ1(I)+B(1)
      FJ2(I)=FJ2(I)+B(2)
      FJ3(I)=FJ3(I)+B(3)
130   CONTINUE
      IN=I+NSW
      FJ1(IN)=0.
      FJ2(IN)=0.
      FJ3(IN)=0.
      DO 140 J=2,KK
      AYT1=-YYE(J-1)
      AYT2=-YYE(J)
      CALL INFL2 (XXE(J-1),AYT1,ZZE(J-1),XXE(J),AYT2,ZZE(J),B)
      FJ1(IN)=FJ1(IN)+B(1)
      FJ2(IN)=FJ2(IN)+B(2)
      FJ3(IN)=FJ3(IN)+B(3)
140   CONTINUE
      AYT2=-YYE(KK)
      CALL FUNA (XXE(KK),AYT2,ZZE(KK),B(1),B(2),B(3))
      FJ1(IN)=FJ1(IN)+B(1)
      FJ2(IN)=FJ2(IN)+B(2)
      FJ3(IN)=FJ3(IN)+B(3)
150   CONTINUE
      FJ1(1)=0.
      FJ2(1)=0.
      FJ3(1)=0.
      FJ1(NSW+1)=0.
      FJ2(NSW+1)=0.
      FJ3(NSW+1)=0.
      DO 160 I=1,NSW1
      I1=I+1
      I2=I+NSW
      I3=I2+1
      EFJ1=CONS(I)*(FJ1(I2)-FJ1(I)+FJ1(I1)-FJ1(I3))
      EFJ2=CONS(I)*(FJ2(I2)-FJ2(I)+FJ2(I1)-FJ2(I3))
      EFJ3=CONS(I)*(FJ3(I2)-FJ3(I)+FJ3(I1)-FJ3(I3))
      DO 160 J=1,NCW
      NP=(I-1)*NCW+J
      CONI3(NP)=EFJ1
      CONJ3(NP)=EFJ2
160   CONK3(NP)=EFJ3
C     TOTAL INDUCED VELOCITY
```

```
      I=1
      DO 170 J=1,NWNG
      CONI(J)=(CONI(J)+CONI3(J))*SI(I)
      CONJ(J)=(CONJ(J)+CONJ2(J)+CONJ3(J))*SI(I)
      CONK(J)=(CONK(J)+CONK2(J)+CONK3(J))*SI(I)
      I=I+1
      IF (I.GT.NCW) I=1
  170 CONTINUE
      RETURN
      END


      SUBROUTINE VDTFRE (X,Y,Z,CI,CJ,CK,NSW1,BSQD4P,XLE,YLE)
C     EVALUATES INFLUENCE COEFFICIENTS FOR CALCULATION OF INDUCED
C     VELOCITY DUE TO FREE ELEMENTS
      COMMON /ALLRB/ XE(40),YE(40),ZE(40),XXE(30),YYE(30),ZZE(30)
     1,ZMIN,NELM(11),NNELM(12)
      COMMON /ABC/ PXE(10,40),PYE(10,40),PZE(10,40),PXXE(11,20),
     1PYYE(11,20),PZZE(11,20),NMAX,NNMAX,NCONTS
      COMMON /NCTT/ NCT,NCON,NBT,NCOR(15),KU1,NFSH(15),KUC,FLG(10)
      COMMON /AERO/ NAERO,MAXL,MAXW,ISPAN,ISE,ITRAKE,ISC
      COMMON /GENCF/ M1(5),NW(2),YBREAK(5),CH(90),SJ(31,3),MJW1(2),
     1MJW2(2),WIDTH(5),SWEEP(60),NTS,NC
      COMMON /LOC/ FU1,FU2,XEND,PXL(5),PXT(5),PYL(5)
      DIMENSION P(5),Q(5),R(5)
      COMMON /GM/ ITER
      COMMON /XIYIZI/ XI,YI,ZI
      DIMENSION CI(1), CJ(1), CK(1), XLE(1), YLE(1), V(3), VVV(3)
C     DIMENSION OF VTDL-(NSW1,3)  ** SEE GEOM **
      DIMENSION VTDL(19,3)
      XI=X
      YI=Y
      ZI=Z
      NCT1=0
   10 CONTINUE
      IF (ISPAN.EQ.0) NSW1=NTS
      IF (ISPAN.EQ.1) NSW1=MAXL
      DO 90 I=1,NSW1
      NCR=NCOR(I)
      V(1)=0.
```

```
      V(2)=0.
      V(3)=0.
      FJ1=0.
      FJ2=0.
      FJ3=0.
      KK=NELM(I)
      DO 20 J=1,KK
      XE(J)=PXE(I,J)
      YE(J)=PYE(I,J)
      ZE(J)=PZE(I,J)
20    CONTINUE
      K=KK-1
C     VELOCITY DUE TO FREE ELEMENTS AHEAD OF TRAILING-EDGE AND THOSE
C     OVER THE WING
      DO 40 J=1,K
      IF (ITER.GT.KU1.AND.I.EQ.1.AND.J.GE.3.AND.J.LT.NCR) GO TO 40
      IF (ITER.GT.KU1.AND.I.EQ.M1(1).AND.J.GE.3.AND.J.LT.NCR.AND.ITRAKE.
     1NE.1) GO TO 40
      IF (ABS(XE(J+1)-XI).LE.1.E-5) GO TO 40
      IF (I.EQ.NCON.AND.J.GT.4.AND.YI.GT.0.AND.ITER.LE.KU1) GO TO 40
      IF (I.EQ.NCON.AND.NBT.EQ.0.AND.J.GT.4.AND.J.LT.NCR.AND.YI.GT.0.AND
     1.ITER.GT.KU1) GO TO 40
      IF (ITER.GT.KU1.AND.J.GE.NCR.AND.YI.GT.0.AND.NBT.EQ.1) GO TO 40
      CALL INFL2 (XE(J),YE(J),ZE(J),XE(J+1),YE(J+1),ZE(J+1),VVV)
      IF (ITER.LE.KU1) GO TO 30
      IF (J.LT.NCR) GO TO 30
      IF (NAERO.EQ.0) GO TO 30
      IF (NCT1.GT.0.AND.J.LT.NCR) GO TO 30
C     INDUCED VELOCITIES MODIFIED BY VISCOUS CORE EFFECT
      P(1)=XE(J)-XE(J+1)
      P(2)=YE(J)-YE(J+1)
      P(3)=ZE(J)-ZE(J+1)
      CALL ABVLE (P,SUM)
      IF (SUM.LE.1.E-5) GO TO 30
      P(1)=P(1)/SUM
      P(2)=P(2)/SUM
      P(3)=P(3)/SUM
      Q(1)=XI-XE(J+1)
      Q(2)=YI-YE(J+1)
      Q(3)=ZI-ZE(J+1)
      CALL CRSPRD (P,Q,R)
```

```
      CALL ARVLE (P,D1)
      L1=1
      L3=M1(1)-1
      IF (ITRAKE.NE.1.AND.I.GE.M1(1)) L1=M1(1)
      IF (ITRAKE.NE.1.AND.I.GE.M1(1)) L3=M1(2)
      P(1)=PXE(L3,4)-PXE(L1,4)
      P(2)=PYE(L3,4)-PYE(L1,4)
      P(3)=PZE(L3,4)-PZE(L1,4)
      CALL ARVLE (P,SUM)
      P(1)=P(1)/SUM
      P(2)=P(2)/SUM
      P(3)=P(3)/SUM
      Q(1)=XE(J+1)-PXE(L1,4)
      Q(2)=YE(J+1)-PYE(L1,4)
      Q(3)=ZE(J+1)-PZE(L1,4)
      CALL CRSPRD (P,Q,R)
      CALL ARVLE (R,D2)
      D2=0.75*D2
      RATIO=D1/D2
      IF (RATIO.GT.1.) GO TO 30
      VVV(2)=VVV(2)*(RATIO**2)
      VVV(3)=VVV(3)*(RATIO**2)
30    CONTINUE
      V(1)=V(1)+VVV(1)
      V(2)=V(2)+VVV(2)
      V(3)=V(3)+VVV(3)
      IF (ITER.LE.KU1) GO TO 40
      CORR=0.
      IF (NAERO.EQ.0) GO TO 40
      IF (NBT.EQ.0) GO TO 40
      IF (I.EQ.NSW1) GO TO 40
      IF (ITRAKE.NE.1.AND.I.EQ.M1(1)-1) GO TO 40
      IF (J.LE.4.OR.J.GE.NCP-1) GO TO 40
C     SIDEWASH CORRECTION FACTOR
      CALL ORDER (I,J,P,Q,R)
      CALL SWAHC (I,P,Q,R,XI,YI,ZI,CORR)
      V(2)=V(2)+CORR
40    CONTINUE
      IF (ITER.LE.KU1.AND.I.EQ.NCON.AND.YI.GT.0.) GO TO 50
      IF (ITER.GT.KU1.AND.NBT.EQ.1.AND.YI.GT.0.) GO TO 50
      CALL FUNA (XE(K+1),YE(K+1),ZE(K+1),FJ1,FJ2,FJ3)
```

```
50    VTDL(I,1)=V(1)+FJ1
      VTDL(I,2)=V(2)+FJ2
      VTDL(I,3)=V(3)+FJ3
      FJ1=0.
      FJ2=0.
      FJ3=0.
      IF ((PXT(NC+1)-PXL(NC+1)).NE.0..AND.I.EQ.NSW1) GO TO 80
      I1=I+1
      II=NNELM(I1)
      DO 60 J=1,II
      XXE(J)=PXXE(I1,J)
      YYE(J)=PYYE(I1,J)
      ZZE(J)=PZZE(I1,J)
60    CONTINUE
      IF (I1.EQ.NCT.AND.YI.GT.0.) GO TO 80
C     VELOCITY DUE TO WAKE ELEMENTS
      DO 70 J=2,II
      CALL INFL2 (XXE(J-1),YYE(J-1),ZZE(J-1),XXE(J),YYE(J),ZZE(J),V)
      FJ1=FJ1+V(1)
      FJ2=FJ2+V(2)
      FJ3=FJ3+V(3)
70    CONTINUE
      CALL FUNA (XXE(II),YYE(II),ZZE(II),V(1),V(2),V(3))
      FJ1=FJ1+V(1)
      FJ2=FJ2+V(2)
      FJ3=FJ3+V(3)
80    CONTINUE
      VTDL(I,1)=VTDL(I,1)-FJ1
      VTDL(I,2)=VTDL(I,2)-FJ2
      VTDL(I,3)=VTDL(I,3)-FJ3
90    CONTINUE
      YI=-YI
      NCT1=NCT1+1
      IF (NCT1.GT.1) GO TO 110
      DO 100 I=1,NSW1
      CI(I)=VTDL(I,1)
      CJ(I)=VTDL(I,2)
      CK(I)=VTDL(I,3)
100   CONTINUE
      GO TO 10
C     TOTAL INDUCED VELOCITY
```

```
110   DO 120 I=1,NSW1
      CI(I)=BSQD4P*(CI(I)+VTDL(I,1))
      CJ(I)=BSQD4P*(CJ(I)-VTDL(I,2))
120   CK(I)=BSQD4P*(CK(I)+VTDL(I,3))
      RETURN
      END


      SUBROUTINE NORMAL (X,Y,Z,UN)
      DIMENSION X(5),Y(5),Z(5),A(3),B(3),C(3),UN(3)
      A(1)=X(3)-X(1)
      A(2)=Y(3)-Y(1)
      A(3)=Z(3)-Z(1)
      B(1)=X(4)-X(2)
      B(2)=Y(4)-Y(2)
      B(3)=Z(4)-Z(2)
      CALL CRSPRD (B,A,C)
      CALL ABVLE (C,ABSN)
      IF (ABSN.LE.1.E-5) GO TO 10
      UN(1)=C(1)/ABSN
      UN(2)=C(2)/ABSN
      UN(3)=C(3)/ABSN
      RETURN
10    UN(1)=0.
      UN(2)=0.
      UN(3)=0.
      RETURN
      END


      SUBROUTINE SWAHC (I,X,Y,Z,XI,YI,ZI,CORR)
      DIMENSION X(5),Y(5),Z(5),A(3),B(3),C(3),UN(3),FLPC(4)
      COMMON /NCTT/ NCT,NCON,NPT,NCOR(15),KU1,NFSH(15),KUC,FLG(10)
C     FIND THE FOUR CORNER POINTS AFTER PLANE  TRANSFORMATION
      CALL NORMAL (X,Y,Z,UN)
      XBAR=0.25*(X(1)+X(2)+X(3)+X(4))
      YBAR=0.25*(Y(1)+Y(2)+Y(3)+Y(4))
      ZBAR=0.25*(Z(1)+Z(2)+Z(3)+Z(4))
      DSD=ABS(UN(1)*(XBAR-X(1))+UN(2)*(YBAR-Y(1))+UN(3)*(ZBAR-Z(1)))
```

```
      IF (DSD.EQ.0.) GO TO 30
C     NEW PLANAR CORNER POINTS
      DO 10 K=1,4
      X(K)=X(K)+(-1)**(K+1)*UN(1)*DSD
      Y(K)=Y(K)+(-1)**(K+1)*UN(2)*DSD
      Z(K)=Z(K)+(-1)**(K+1)*UN(3)*DSD
10    CONTINUE
      CALL NORMAL (X,Y,Z,UN)
      IF (UN(1).EQ.0..AND.UN(2).EQ.0..AND.UN(3).EQ.0.) GO TO 30
      X(5)=X(1)
      Y(5)=Y(1)
      Z(5)=Z(1)
C     FIND THE SHORTEST DISTANCE FROM THE CONTROL POINT TO THE PLANE
      A(1)=X(1)-XI
      A(2)=Y(1)-YI
      A(3)=Z(1)-ZI
      CALL DOTPRD (A,UN,VDS)
      XO=XI+VDS*UN(1)
      YO=YI+VDS*UN(2)
      ZO=ZI+VDS*UN(3)
      CALL INOUT (X,Y,XO,YO,NSIDE)
      IF (NSIDE.NE.1) GO TO 30
C     FIND THE DISTANCE BETWEEN THE INTERSECTION POINT TO ALL EDGES OF
C     PANEL
      DO 20 K=1,4
      B(1)=XO-X(K)
      B(2)=YO-Y(K)
      B(3)=ZO-X(K)
      A(1)=X(K+1)-X(K)
      A(2)=Y(K+1)-Y(K)
      A(3)=Z(K+1)-Z(K)
      CALL ABVLE (A,DPD)
      A(1)=A(1)/DPD
      A(2)=A(2)/DPD
      A(3)=A(3)/DPD
      CALL CRSPRD (B,A,C)
      CALL ABVLE (C,DP)
      FLPC(K)=DP
20    CONTINUE
      FLPC(1)=-ABS(FLPC(1))
      FY=FLPC(4)/F(FLPC(4),0.,0.,0.,VDS)+FLPC(2)/F(FLPC(2),0.,0.,0.,VDS)
```

```
      CY1=FLPC(1)
      CY2=FLPC(3)
      CZ1=VDS
      CZ2=VDS
      IF (ABS(CZ1).LE.1.E-5.OR.ABS(CZ2).LE.1.E-5) GO TO 30
      G2=CY1**2+CZ1**2
      G3=CY2**2+CZ2**2
      G4=CZ2/G3+CZ1/G2
      AVGG=(FLG(I)+FLG(I+1))/2.
      G5=-0.5*FY*G4*AVGG*1.1
      G6=CZ2/ABS(CZ2)*ATAN(CY2/ABS(CZ2))
      G7=CZ1/ABS(CZ1)*ATAN(CY1/ABS(CZ1))
      G8=FY*(G6-G7)*AVGG/(FLPC(3)-FLPC(1))
      CORR=(G5+G8)/AVGG
C     FIND THE SIDE WASH CORRECTION FACTOR IN THE  LOCAL PANEL Y
      A(1)=X(3)-X(2)
      A(2)=Y(3)-Y(2)
      A(3)=Z(3)-Z(2)
      CALL ABVLE (A,TOL)
      A(1)=A(1)/TOL
      A(2)=A(2)/TOL
      A(3)=A(3)/TOL
      B(1)=X(4)-X(1)
      B(2)=Y(4)-Y(1)
      B(3)=Z(4)-Z(1)
      CALL ABVLE (B,TOL)
      B(1)=B(1)/TOL
      B(2)=B(2)/TOL
      B(3)=B(3)/TOL
      CC=(A(2)+B(2))/2.
      CORR=CORR*CC
      GO TO 40
   30 CORR=0.
   40 CONTINUE
      RETURN
      END


      SUBROUTINE ABVLE (A,ABSUM)
      DIMENSION A(3)
```

```
      ABSUM=SQRT(A(1)**2+A(2)**2+A(3)**2)
      RETURN
      END


      SUBROUTINE INOUT (X,Y,XO,YO,NSIDE)
C     TO CHECK THE CONTROL PT BY VECTOR ANALYSIS
       DIMENSION X(5),Y(5)
      X(5)=X(1)
      Y(5)=Y(1)
      NSIDE=1
      DO 10 I=1,4
      VECT=(XO-X(I))*(Y(I+1)-Y(I))-(X(I+1)-X(I))*(YO-Y(I))
      IF (VECT.LT.0.) NSIDE=0
10    CONTINUE
      RETURN
      END


      SUBROUTINE ORDER (I,J,X,Y,Z)
      DIMENSION X(5),Y(5),Z(5)
      COMMON /ABC/ PXE(10,40),PYE(10,40),PZE(10,40)
      X(1)=PXE(I,J+1)
      Y(1)=PYE(I,J+1)
      Z(1)=PZE(I,J+1)
      X(5)=X(1)
      Y(5)=Y(1)
      Z(5)=Z(1)
      X(2)=PXE(I,J)
      Y(2)=PYE(I,J)
      Z(2)=PZE(I,J)
      X(3)=PXE(I+1,J)
      Y(3)=PYE(I+1,J)
      Z(3)=PZE(I+1,J)
      X(4)=PXE(I+1,J+1)
      Y(4)=PYE(I+1,J+1)
      Z(4)=PZE(I+1,J+1)
      RETURN
      END
```

```
      FUNCTION F(X1,X,Y1,Y,Z1,Z)
      COMMON /ALLRA/ TTL(16),ALPHA,SINA,COSA,SWPLE,BETA,BETA2
      XX=X1-X
      YY=Y1-Y
      ZZ=Z1-Z
      F=SQRT(XX**2+BETA2*YY**2+BETA2*ZZ**2)
      RETURN
      END
```

```
      SUBROUTINE CAMBER (NPRCY,C,XCP,YCP,XN,YN,XLM,YLM,XAVWNG,YAVWNG)
      DIMENSION XN(190,2),YN(190,2),C(19),XLM(19),YLM(19)
      DIMENSION XCP(209),YCP(209),XAVWNG(190),YAVWNG(190)
      COMMON /ALLRB/ AX(210),ZMIN,NELM(11),NNELM(12),IST
      COMMON /ALLI/ NSW,NSW1,NCW,NWNG
      COMMON /LEFLP/ YLEF(10,2),XNF(10),YNF(10),ZNF(10),XLF(10,4),
     1YLF(10,4),SLP1(10),SS,CS,ITERS,ZBDYV(200),ZBDY(200)
     2,CURV(10),CHND(10),SZBDYV(200)
      COMMON/CAMB/ ICAM,IM(10),XT(10,21),AAM(10,20),BBM(10,20),
     1CCM(10,20),DDM(10,20),YT(10),ZBDX(200),ZBDXV(200)
C     NPRCY = 0 , FINE GRIDS
C     NPRCY = 1 , 2 . COARSE GRIDS.
      IF (NPRCY.EQ.2) GO TO 90
      IF (NPRCY.EQ.1) GO TO 10
      IF (NPRCY.EQ.0) GO TO 60
10    CONTINUE
C     FIND THE CAMBER SLOPE AT CONTROL POINTS
      DO 30 I=1,NSW1
      DO 30 J=1,NCW
      IJ=(I-1)*NCW+J
      XC=(XCP(IJ)-XLM(I))/C(I)
      IF (ICAM.EQ.3) XC=XCP(IJ)
      IF (ICAM.EQ.2) GO TO 20
      YK1=(YCP(IJ)-YN(IJ,1))/(YN(IJ,2)-YN(IJ,1))
      XK1=XN(IJ,1)+(XN(IJ,2)-XN(IJ,1))*YK1
      X1=(XK1-XLM(I))/C(I)
      CALL ZCR (XC,YCP(IJ),DZDX,ICAM,X1,1,C,DZDY)
```

```
      ZBDX(IJ)=DZDX                                                     CBR 280
      ZBDY(IJ)=DZDY                                                     CBR 290
      GO TO 30                                                          CBR 300
20    YC=YLM(I)                                                         CBR 310
      XC=XCP(IJ)                                                        CBR 320
      CALL ZCDX (XC,YC,DZDX,DZDY)                                       CBR 330
      ZBDX(IJ)=DZDX                                                     CBR 340
      ZBDY(IJ)=DZDY                                                     CBR 350
30    CONTINUE                                                          CBR 360
C     FIND THE CAMBER SLOPE AT LEADING-EDGE CONTROL POINTS              CBR 370
      DO 50 I=1,NSW1                                                    CBR 380
      IJ=NWNG+I                                                         CBR 390
      XC=0.                                                             CBR 400
      IF (ICAM.EQ.2) GO TO 40                                           CBR 410
      IF (ICAM.EQ.3) XC=XLM(I)                                          CBR 420
      Z1=XC                                                             CBR 430
      CALL ZCR (XC,YLM(I),DZDX,ICAM,Z1,1,C,DZDY)                        CBR 440
      ZBDX(IJ)=DZDX                                                     CBR 450
      ZBDY(IJ)=DZDY                                                     CBR 460
      GO TO 50                                                          CBR 470
40    XC=XLM(I)                                                         CBR 480
      YC=YLM(I)                                                         CBR 490
      CALL ZCDX (XC,YC,DZDX,DZDY)                                       CBR 500
      ZBDX(IJ)=DZDX                                                     CBR 510
      ZBDY(IJ)=DZDY                                                     CBR 520
50    CONTINUE                                                          CBR 530
      RETURN                                                            CBR 540
60    CONTINUE                                                          CBR 550
C     FIND CAMBER SLOPE AT BOUND ELEMENTS                               CBR 560
      DO 80 I=1,NSW1                                                    CBR 570
      DO 80 J=1,NCW                                                     CBR 580
      IJ=(I-1)*NCW+J                                                    CBR 590
      XC=(XAVWNG(IJ)-XLM(I))/C(I)                                       CBR 600
      IF (ICAM.EQ.3) XC=XAVWNG(IJ)                                      CBR 610
      IF (ICAM.EQ.2) GO TO 70                                           CBR 620
      Z1=XC                                                             CBR 630
      CALL ZCR (XC,YAVWNG(IJ),DZDX,ICAM,Z1,1,C,DZDY)                    CBR 640
      ZBDXV(IJ)=DZDX                                                    CBR 650
      ZBDYV(IJ)=DZDY                                                    CBR 660
      GO TO 80                                                          CBR 670
70    YC=YLM(I)                                                         CBR 680
```

```
      XC=XAVWNG(IJ)
      CALL ZCDX (XC,YC,DZDX,DZDY)
      ZBDXV(IJ)=DZDX
      ZBDYV(IJ)=DZDY
80    CONTINUE
      RETURN
90    CONTINUE
C     FIND CAMBER SLOPE AT BOUND ELEMENTS
      DO 110 I=1,NSW1
      DO 110 J=1,NCW
      IJ=(I-1)*NCW+J
      XC=(XAVWNG(IJ)-XLM(I))/C(I)
      IF (ICAM.EQ.3) XC=XAVWNG(IJ)
      IF (ICAM.EQ.2) GO TO 100
      Z1=XC
      CALL ZCP (XC,YAVWNG(IJ),DZDX,ICAM,Z1,1,C,DZDY)
      SZBDYV(IJ)=DZDY
      GO TO 110
100   YC=YLM(I)
      XC=XAVWNG(IJ)
      CALL ZCDX (XC,YC,DZDX,DZDY)
      SZBDYV(IJ)=DZDY
110   CONTINUE
      RETURN
      END


      SUBROUTINE ZCDX (X,Y,ZCX,DZDY)
C     DEFINE THE CAMBER SLOPE, DZDX, AT ANY X, Y LOCATION IN CLOSE FORM,
C     WHERE X AND DIMENSIONAL COORDINATES REFERED TO C.G.
C     CONICAL CAMBER FOR A CONFIGURATION IN NASA CR-2002
C
      YB=0.231303*(1.6+X)
      ZCX=0.
      DZDY=0.
      IF (Y.LT.YB) Y=0.
      IF (Y.LT.YB) RETURN
      XX=X
      R=0.06821207*(1.6+XX)
      ZC=-R+SQRT(R*R-(Y-YB)**2)
```

```
      ZCX=(0.231303*(Y-YB)-0.068212*ZC)/(ZC+R)                          ZCD 140
      DZDY=-(Y-YB)/(ZC+R)                                               ZCD 150
      Y=ZC                                                              ZCD 160
C     Y IS RETURNED AS THE Z COORDINATE.                                ZCD 170
      RETURN                                                            ZCD 180
      END                                                               ZCD 190-


      SUBROUTINE ZCR (X,Y,DZDX,ICAM,X1,KP,CHORD,DZDY)                   ZCR  10
      COMMON /ALLRB/ AX(210),ZMIN,NELM(11),NNELM(12),IST                ZCR  20
      COMMON /LEFLP/ YLEF(10,2),XNF(10),YNF(10),ZNF(10),XLF(10,4),      ZCR  30
     1YLF(10,4),SLP1(10),SS,CS,ITERS,ZBDYV(200),ZBDY(200)               ZCR  40
     2,CURV(10),CHND(10)                                                ZCR  50
      XE=X1                                                             ZCR  60
      KK=DZDX                                                           ZCR  70
      RR=DZDY                                                           ZCR  80
      DZDX=0.                                                           ZCR  90
      DZDY=0.                                                           ZCR 100
      IF (ICAM.EQ.1) GO TO 50                                           ZCR 110
      IF (ICAM.NE.3) GO TO 60                                           ZCR 120
      X1=0.                                                             ZCR 130
      I=1                                                               ZCR 140
10    IF (Y.GE.YLEF(I,1).AND.Y.LE.YLEF(I,2)) GO TO 20                   ZCR 150
      I=I+1                                                             ZCR 160
      IF (I.GE.IST) GO TO 60                                            ZCR 170
      IF (I.EQ.11) GO TO 60                                             ZCR 180
      GO TO 10                                                          ZCR 190
20    YB=YLF(I,1)+SLP1(I)*(X-XLF(I,1))                                  ZCR 200
      KCON=0                                                            ZCR 210
      IF (KK.NE.100) GO TO 30                                           ZCR 220
      XB=XLF(I,1)                                                       ZCR 230
      IF (SLP1(I).GT.1.E-18) XB=XLF(I,1)+(Y-YLF(I,1))/SLP1(I)           ZCR 240
      DX=RP/(XB-XE)                                                     ZCR 250
      IF (ABS(1.-DX).LE.0.1) KCON=1                                     ZCR 260
      IF (KCON.EQ.1) GO TO 40                                           ZCR 270
30    CONTINUE                                                          ZCR 280
      IF (Y.LE.YB) RETURN                                               ZCR 290
40    CONTINUE                                                          ZCR 300
      TEST1=PNLEF(X,Y,XLF,YLF,I,1,2)                                    ZCR 310
      IF (ABS(TEST1).LT.1.E-8.AND.Y.GE.YLF(I,1)) TEST1=1.E-8            ZCR 320
```

```
      IF (TEST1.LT.0.) RETURN
      TEST2=PNLEF(X,Y,XLF,YLF,I,4,3)
      IF (ABS(TEST2).LT.1.E-8.AND.Y.LE.YLF(I,3)) TEST2=1.E-8
      IF (TEST2.GT.0.) RETURN
      DZDX=-XNF(I)/ZNF(I)
      DZDY=-YNF(I)/ZNF(I)
      D=-XNF(I)*XLF(I,1)-YNF(I)*YLF(I,1)
      X1=-(D+XNF(I)*X+YNF(I)*Y)/ZNF(I)
      IF (KCON.EQ.0) GO TO 60
      DZDX=0.5*DZDX
      DZDY=0.5*DZDY
      X1=0.
      GO TO 60
   50 CALL ZCAM (X,Y,ZR,X1,KP,CHORD)
   60 RETURN
      END


      FUNCTION PNLEF(X,Y,XLF,YLF,I,J,K)
      DIMENSION XLF(10,4),YLF(10,4)
      PNLEF=(X-XLF(I,J))*(YLF(I,K)-YLF(I,J))-(XLF(I,K)-XLF(I,J))*(Y-YLF(
     1I,J))
      RETURN
      END


      SUBROUTINE ZCAM (X,Y,ZR,X1,KP,CHORD)
      DIMENSION ZZ(2),ZQ(2),C(15)
      COMMON /ALLRB/ AX(210),ZMIN,BX(23),IST
      COMMON/CAMB/ ICAM,IM(10),XT(10,21),AAM(10,20),BBM(10,20),
     1CCM(10,20),DDM(10,20),YT(10),ZBDX(200),ZBDXV(200)
      COMMON /LEFLP/ YLEF(10,2),XNF(10),YNF(10),ZNF(10),XLF(10,4),
     1YLF(10,4),SLP1(10),SS,CS,ITERS,ZBDYV(200),ZBDY(200)
     2,CURV(10),CHND(10)
      I=KP
      ZR=0.
   10 IF (Y.GT.YT(I).AND.Y.LT.YT(I+1)) GO TO 30
      I=I+1
      IF (I.GT.IST) GO TO 20
```

```
      GO TO 10
20    IF (Y.LT.YT(1)) I=1
      IF (Y.GT.YT(IST)) I=IST-1
30    IK=1
      XF=0.
      ICV=CURV(I)
      IF (ICV.EQ.1) GO TO 40
      XF1=XT(I,2)*CHND(I)
      IF (ABS(DDM(I,1)).LE.0.0001) XF1=XT(I,1)*CHND(I)
      XF2=XT(I+1,2)*CHND(I+1)
      YF=(Y-YT(I))/(YT(I+1)-YT(I))
      XF=(XF1+(XF2-XF1)*YF)/CHORD
      IF (X1.GT.XF) GO TO 40
      FAC=CHND(I+1)
      IF (FAC.LE.0.0001) FAC=1.
      DELTA=DDM(I,1)*CHND(I)+(DDM(I+1,1)*FAC-DDM(I,1)*CHND(I))*YF
      DELTA=DELTA/CHORD
      IF (IM(I).GT.2) ZQ(1)=DDM(I,2)*CHND(I)
      IF (IM(I).LE.2) ZQ(1)=(CCM(I,1)+DDM(I,1))*CHND(I)
      IF (IM(I+1).GT.2) ZQ(2)=DDM(I+1,2)*FAC
      IF (IM(I+1).LE.2) ZQ(2)=(CCM(I+1,1)+DDM(I+1,1))*FAC
      DK=(ZQ(1)+(ZQ(2)-ZQ(1))*YF)/CHORD
      DELTA=DELTA-DK
      GO TO 110
40    K=1
      IF (ICV.EQ.0) GO TO 150
50    IF (X.GE.XT(I,K).AND.X.LT.XT(I,K+1)) GO TO 60
      K=K+1
      IF (K.GE.IM(I)) GO TO 70
      GO TO 50
60    SM=X-XT(I,K)
      ZZ(IK)=3.*AAM(I,K)*SM*SM+2.*BBM(I,K)*SM+CCM(I,K)
      GO TO 90
70    IF (X.LT.XT(I,1)) GO TO 80
      K=IM(I)-1
      GO TO 60
80    K=1
      GO TO 60
90    IF (IK.EQ.2) GO TO 100
      I=I+1
      IK=IK+1
```

```
      GO TO 40
100   YF=(Y-YT(I-1))/(YT(I)-YT(I-1))
      ZR=ZZ(1)+(ZZ(2)-ZZ(1))*YF
      GO TO 150
110   IF (X.LT.XF) GO TO 140
      PI=3.14159265
      C(1)=-DELTA
      JR=15
      DO 120 J=2,JR
      XK=(J-1)*PI*XF
120   C(J)=-2.*DELTA*SIN(XK)/XK
      ZR=0.
      DO 130 J=1,JR
      XK=(J-1)*PI*X
130   ZR=ZR+C(J)*COS(XK)
      GO TO 150
140   ZR=-DELTA/XF
150   CONTINUE
      RETURN
      END
```

```
      SUBROUTINE FUNA (XT,YT,ZT,FJ1,FJ2,FJ3)
C     INDUCED VELOCITY DUE TO A VORTEX ELEMENT OF UNIT STRENGTH TRAILING
C     FROM (XT,YT,ZT) TO INFINITY
      COMMON /ALLRA/ AA(21),BETA2,TANPH1,B2PH1,AB,D4,AC(2),D4SQ2
      COMMON /XIYIZI/ XI,YI,ZI
      DIMENSION A(3), B(3), C(3)
      A(1)=XT-XI
      A(2)=YT-YI
      A(3)=ZT-ZI
      B(1)=XT+1-XI
      B(2)=YT-YI
      B(3)=ZT+TANPH1-ZI
      CALL CRSPRD (A,B,C)
      CC=SQRT(C(1)*C(1)+C(2)*C(2)+C(3)*C(3))
      IF (CC.LE.(1.E-10)) GO TO 10
      D5=2.*(B2PH1*(ZT-ZI-XT*TANPH1)-XI)
      D6=XI*XI+BETA2*((YI-YT)**2+(ZT-ZI-XT*TANPH1)**2)
      Q=4.*D4*D6-D5*D5
```

```
      IF (Q.LE.(1.E-10)) GO TO 10
      RB=SQRT(D4*XT*XT+D5*XT+D6)
      FJ4=2.*(D4SQ2-(2.*D4*XT+D5)/RB)/Q
      FJ1=(YT-YI)*TANPHI*FJ4
      FJ2=(ZT-ZI+(XI-XT)*TANPHI)*FJ4
      FJ3=-(YT-YI)*FJ4
      RETURN
   10 FJ1=0.
      FJ2=0.
      FJ3=0.
      RETURN
      END
```

```
      SUBROUTINE INFL2 (X1,Y1,Z1,X2,Y2,Z2,VACL)
C     INDUCED VELOCITY DUE TO A VORTEX ELEMENT OF UNIT STRENGTH LYING
C     BETWEEN (X1,Y1,Z1) AND (X2,Y2,Z2)
      COMMON /ALLRA/ AA(20),BETA
      COMMON /XIYIZI/ XI,YI,ZI
      DIMENSION VA(3), VL(3), VAP(3), VBP(3), VLP(3), VACL(3), VAPCLP(3)
      VA(1)=X1-XI
      VA(2)=Y1-YI
      VA(3)=Z1-ZI
      VL(1)=X2-X1
      VL(2)=Y2-Y1
      VL(3)=Z2-Z1
      VAP(1)=VA(1)
      VAP(2)=BETA*VA(2)
      VAP(3)=BETA*VA(3)
      VBP(1)=X2-XI
      VBP(2)=BETA*(Y2-YI)
      VBP(3)=BETA*(Z2-ZI)
      VLP(1)=VL(1)
      VLP(2)=BETA*VL(2)
      VLP(3)=BETA*VL(3)
      CALL CRSPRD (VA,VL,VACL)
      CALL CRSPRD (VAP,VLP,VAPCLP)
      CALL DOTPRD (VAPCLP,VAPCLP,DAPCLP)
      IF (ABS(DAPCLP).LT.(1.E-10)) GO TO 10
      CALL DOTPRD (VBP,VBP,DBP)
```

```
      BPMOD=SQRT(DBP)
      CALL DOTPRD (VAP,VAP,DAP)
      APMOD=SQRT(DAP)
      CALL DOTPRD (VBP,VLP,DBPLP)
      DBPLP=DBPLP/BPMOD
      CALL DOTPRD (VAP,VLP,DAPLP)
      DAPLP=DAPLP/APMOD
      CONST=(DBPLP-DAPLP)/DAPCLP
      GO TO 20
10    CONST=0.
20    CONTINUE
      VACL(1)=VACL(1)*CONST
      VACL(2)=VACL(2)*CONST
      VACL(3)=VACL(3)*CONST
      RETURN
      END


      SUBROUTINE NEWVEL (C,THETP,XEE,YEE,ZEE,XN,YN,XTE,YLE,CONS,DUMMY,CO
     1NI,CONJ,CONK,SI,NSW1,NCW,NWNG,CI,CJ,CK,XLE,UU,VV,WW,CPCW1,XCP,YCP,
     2GAMA,YYM)
C     EVALUATES TOTAL VELOCITY AT POINT (XEE,YEE,ZEE)
      COMMON /INDEX/ IND
      COMMON /NCTT/ NCT,NCON,NPT,NCOR(15),KU1,NFSH(15),KUC
      COMMON /AERO/ NAERO,MAXL,MAXW,ISPAN,ISF,ITRAKE,ISC
      COMMON /LOC/ FU1,FU2,XEND,PXL(5),PXT(5),PYL(5)
      COMMON /GENCF/ MI(5),NW(2),YBREAK(5),CH(90),SJ(31,3),MJW1(2),
     1MJW2(2),WIDTH(5),SWEEP(60),NTS,NC
      COMMON /ALLRA/ AA(17),SINA,COSA,AR(5),BSQD4P
      COMMON /GM/ ITER,L1,L2,L3,L4,L5,L6,L7,L8
      DIMENSION DUMMY(1), CONI(1), CONJ(1), CONK(1), CI(1), CJ(1), CK(1)
     1, C(1), THETP(1), XTE(1), XLE(1), YLE(1), CONS(1), SI(1), CPCW1(1)
     2, XCP(1), YCP(1), GAMA(1), YYM(1), XN(NWNG,2), YN(NWNG,2), NP(4),
     3U(4,3), V(3)
      NSW1=NTS
C     IF POINT IS IN THE WING PLANE, THE REGULAR METHOD FOR VELOCITY
C     EVALUATION IS USED.
      IF (ZEE.LE.0.00001) GO TO 130
      IF (YEE.GT.YYM(NSW1)) GO TO 130
      IF (ITRAKE.NE.1.AND.YEE.GT.PYL(2)) GO TO 10
```

```
      CH1=XTE(1)-XLE(1)
      CH2=XTE(2)-XLE(2)
      GO TO 20
10    CH1=PXT(2)-PXL(2)
      CH2=PXT(3)-PXL(3)
20    CONTINUE
      XLY=XLE(1)+(YEE-YLE(1))*(XLE(2)-XLE(1))/(YLE(2)-YLE(1))
      CHY=CH1+(YEE-YLE(1))*(CH2-CH1)/(YLE(2)-YLE(1))
      XC=(XEE-XLY)/CHY
      IF (XC.LT.0.0.OR.XC.GT.1.0) GO TO 130
      ZC=ZEE/CHY
C     IF THE POINT (XEE,YEE,ZEE) IS AT Z/C(LOCAL) LESS THAN ZTOL, THE
C     VELOCITY IS OBTAINED BY LINEAR INTERPOLATION OF THE VELOCITIES
C     CALCULATED ABOVE FOUR WING CONTROL POINTS AMONG WHICH THE POINT IS
C     LOCATED. BY NUMERICAL EXPERIMENTATION ZTOL HAS BEEN OBTAINED TO BE
C     0.2.
      ZTOL=0.2
      IF (ZC.GE.ZTOL) GO TO 130
      I=1
      IF (YEE.LE.YYM(I)) GO TO 40
30    IF (YEE.GT.YYM(I).AND.YEE.LE.YYM(I+1)) GO TO 40
      I=I+1
      IF (I.LT.NSW1) GO TO 30
40    J=1
      IF (XC.LE.CPCW1(1)) GO TO 70
50    IF (XC.GT.CPCW1(J).AND.XC.LE.CPCW1(J+1)) GO TO 60
      J=J+1
      IF (J.LT.NCW) GO TO 50
60    NP(1)=(I-1)*NCW+J
      NP(2)=NP(1)+1
      NP(3)=NP(1)+NCW
      NP(4)=NP(3)+1
      XC1=CPCW1(J)
      XC2=CPCW1(J+1)
      GO TO 80
70    NP(1)=NCW*NSW1+I
      NP(2)=(I-1)*NCW+1
      NP(3)=NP(1)+1
      NP(4)=NP(2)+NCW
      XC1=0.
      XC2=CPCW1(1)
```

```
80    CONTINUE
C     EVALUATION OF INDUCED VELOCITY AT FOUR POINTS
      DO 100 I=1,4
      NN=NP(I)
      CALL VDTWNG (C,THETP,XCP(NN),YCP(NN),ZEE,XN,YN,XTE,YLE,CONS,DUMMY(
     1L1),DUMMY(L2),DUMMY(L3),DUMMY(L4),DUMMY(L5),DUMMY(L6),DUMMY(L7),DU
     2MMY(L8),CONI,CONJ,CONK,SI,NSW1,NCW,NWNG)
      U(I,1)=0.
      U(I,2)=0.
      U(I,3)=0.
      DO 90 J=1,NWNG
      U(I,1)=U(I,1)+CONI(J)*GAMA(J)
      U(I,2)=U(I,2)+CONJ(J)*GAMA(J)
      U(I,3)=U(I,3)+CONK(J)*GAMA(J)
90    CONTINUE
100   CONTINUE
C     INTERPOLATION
      NN1=NP(1)
      NN2=NP(3)
      Y1=YCP(NN1)
      Y2=YCP(NN2)
      DO 110 I=1,3
      UA=U(1,I)+(U(3,I)-U(1,I))*(YEE-Y1)/(Y2-Y1)
      UB=U(2,I)+(U(4,I)-U(2,I))*(YEE-Y1)/(Y2-Y1)
110   V(I)=UA+(UB-UA)*(XC-XC1)/(XC2-XC1)
      UU=V(1)+COSA
      VV=V(2)
      WW=V(3)+SINA
      CALL VDTFRE (XEE,YEE,ZEE,CI,CJ,CK,NSW1,BSQD4P,XLE,YLE)
C     FINAL TOTAL VELOCITY
      DO 120 J=1,MAXL
      JJ=NWNG+J
      UU=UU+CI(J)*GAMA(JJ)
      VV=VV+CJ(J)*GAMA(JJ)
      WW=WW+CK(J)*GAMA(JJ)
120   CONTINUE
      RETURN
C     EVALUATION OF VELOCITY WHEN POINT IS IN THE WING PLANE
130   CONTINUE
      CALL VDTWNG (C,THETP,XEE,YEE,ZEE,XN,YN,XTE,YLE,CONS,DUMMY(L1),DUMM
     1Y(L2),DUMMY(L3),DUMMY(L4),DUMMY(L5),DUMMY(L6),DUMMY(L7),DUMMY(L8),
```

```
     2CONI,CONJ,CONK,SI,NSW1,NCW,NWNG)
      CALL VDTFRE (XEE,YEE,ZEE,CI,CJ,CK,NSW1,BSQD4P,XLE,YLE)
      UU=COSA
      VV=0.
      WW=SINA
C     VELOCITY DUE TO FREE ELEMENTS
      DO 140 I=1,MAXL
      NQ=NWNG+I
      UU=UU+CI(I)*GAMA(NQ)
      VV=VV+CJ(I)*GAMA(NQ)
      WW=WW+CK(I)*GAMA(NQ)
140   CONTINUE
C     VELOCITY DUE TO WING
      DO 150 I=1,NTS
      DO 150 J=1,NCW
      NQ=(I-1)*NCW+J
      UU=UU+CONI(NQ)*GAMA(NQ)
      VV=VV+CONJ(NQ)*GAMA(NQ)
      WW=WW+CONK(NQ)*GAMA(NQ)
150   CONTINUE
      NSW1=NTS
      NSW=NTS+1
      RETURN
      END


      SUBROUTINE VMSEQN (NC1,K,AA,A,CA)
      DIMENSION AA(1),CA(1),A(1)
      NC=K*NC1
      SUM1=0.
      K1=K-1
      JJ=1
      DO 10 J=1,K1
      SUM1=SUM1+AA(J)*A(JJ)
10    JJ=JJ+NC1+1
      SUM1=SUM1+AA(K)
      DO 30 I=1,NC1
      SUM2=0.
      JJ=I+1
      DO 20 J=1,K1
```

```
      SUM2=SUM2+AA(J)*A(JJ)
   20 JJ=JJ+NC1+1
      KK=K+I
      SUM2=SUM2+AA(KK)
   30 CA(I)=-SUM2/SUM1
      M=1
      L=0
      KNC=(K-1)*NC1
      DO 60 I=1,NC
      IF (I.GT.KNC) GO TO 50
      MM=(M-1)*NC1+1
      IF (I.EQ.MM) GO TO 70
   40 KK=KK+1
      IL=I+L
      A(I)=CA(KK)*BASE+A(IL)
      GO TO 60
   50 II=I-KNC
      A(I)=CA(II)
   60 CONTINUE
      GO TO 80
   70 II=MM+M-1
      BASE=A(II)
      KK=0
      L=L+1
      M=M+1
      GO TO 40
   80 CONTINUE
      RETURN
      END


      OVERLAY (LEVSP,1,0)
      PROGRAM GEOM
C     DEFINES THE WING AND FREE ELEMENT GEOMETRY
C     MAXIMUM VALUES
C     ** NCW = 9
C     ** NNCW = NCW+1 = 10
C     ** NSW = 20
C     ** NSW1 = NSW-1 = 19
C     ** NWNG = NNCW*NSW1 = 190
```

```
C        ** NCPTTL = (NNCW+1)*NSW1 = 209
         COMMON XXL(2),XXT(2),YL(2),CPCWL(10),CPCW1(10),SI(10),SN(10),SNN(1
        10),SWP(50),SLOPE(50),XL(2,10),C(19),THETP(19),CONS(19),CPSW1(19),X
        2LM(19),XTM(19),YLM(19),CTT(19),CPSWL(20),XLE(20),XTE(20),YLE(20),X
        3AVWNG(190),YAVWNG(190),XN(190,2),YN(190,2),XCP(209),YCP(209),X(10,
        420),Y(10,20)
         COMMON /ALLRB/ AXX(210),ZMIN,NELM(11),NNELM(12),IST
         COMMON /LEFLP/ YLEF(10,2),XNF(10),YNF(10),ZNF(10),XLF(10,4),
        1YLF(10,4),SLP1(10),SS,CS,ITERS,ZBDYV(200),ZBDY(200)
        2,CURV(10),CHND(10),SZBDYV(200)
         COMMON /ALLI/ NSW,NSW1,NCW,NWNG,NCPTTL,MITER,IPUNCH
         COMMON /ALLRA/ TTL(16),ALPHA,SINA,COSA,SWPLE,BETA,BETA2,TANPH1,B2P
        1H1,BSQD4P,D4,CON,PI,D4S02,CBAR,HALFB,AREA
         COMMON /MDFAV/ FYP(40,2,2),FZP(40,2,2)
         COMMON /XSTN/ XBRR(25),NBRR
         COMMON /COEFF/ CL,FZMINS(10),FHS(2,10),RATIOS(2,10),
        1CFCORE(2,10),RATIOC(2,10)
         COMMON /LOC/ FU1,FU2,XEND,PXL(5),PXT(5),PYL(5)
         COMMON /AERO/ NAERO,MAXL,MAXW,ISPAN,ISF,ITRAKE,ISC
         COMMON /GENCF/ M1(5),NW(2),YBREAK(5),CH(90),SJ(31,3),MJW1(2),
        1MJW2(2),WIDTH(5),SWEEP(60),NTS,NC
         COMMON /NCTT/ NCT,NCON,NBT,NCOR(15),KU1,NFSH(15),KUC
         COMMON /ABC/ AX(1860),NMAX,NNMAX,NCONTS
         COMMON /LANDA/ FGMA1,FBDA1,FGMA,CLS
         COMMON /TIPVX/ XTIP(15,30),YTIP(15,30),ZTIP(15,30),NTLM(15),NTMAX
         COMMON/CAMB/ ICAM,IM(10),XT(10,21),AAM(10,20),BBM(10,20),
        1CCM(10,20),DDM(10,20),YT(10),ZBDX(200),ZBDXV(200)
         COMMON /SHPLE/ NLE,YSL(15),AQL(14),BQL(14),CQL(14),DQL(14)
         COMMON /SHPTE/ NTE,YST(15),AQT(14),BQT(14),CQT(14),DQT(14)
         DIMENSION CPCWR(15),AW(201),CA(201),BA(15)
         THEND=5HEND
C     ***TITLE OF THE CASE TO BE RUN
         READ (5,490) TTL
         IF (TTL(1).EQ.THEND) GO TO 390
C     ***NCW = NUMBER OF BOUND ELEMENTS IN IN THE CHORDWISE DIRECTION
C        M(I) = NUMBER OF STRIPS IN EACH SPANWISE SECTION PLUS ONE
C        NC = NUMBER OF SPANWISE SECTIONS
C        NCONTS = 0, ITERS = 0, INITIAL LOCATIONS OF FREE ELEMENTS WILL BE
C        CALCULATED IN THE PROGRAM
C        NCONTS = 1, ITERS = 3, INITIAL LOCATIONS OF FREE ELEMENTS WILL BE
C        READ FROM DATA CARDS
```

```
C      ITRAKE = 1, ONE VORTEX CORE SYSTEM
C      ITRAKE = 2, TWO VORTEX CORE SYSTEM
C      ISPAN = 0, LEADING-EDGE VORTEX SYSTEM START FROM LINE OF SYMMETRY
C      ISPAN = 1, LEADING-EDGE VORTEX SYSTEM START FROM OUTBOARD SECTION
       READ (5,520) NCW,NBRR,NCONTS,MITER,IPUNCH,KU1
       READ (5,520) NC,(M1(I),I=1,NC),ICAM,IST,ITERS
       READ (5,520) ISPAN,ITRAKE
       NTS=0
       DO 10 I=1,NC
       NTS=NTS+M1(I)-1
10     CONTINUE
       NSW1=NTS
       NSW=NTS+1
       IF (ISPAN.EQ.0) GO TO 20
       MAXW=NSW-(M1(1)-1)
       MAXL=NSW1-(M1(1)-1)
       GO TO 30
20     MAXL=NSW1
       MAXW=NSW
30     CONTINUE
C   ***ALPHA AND AMACH ARE ANGLE OF ATTACK AND FREE FREE STREAM MACH NO
C      DELTA IS THE LENGTH OF A LEADING-EDGE FREE VORTEX SEGMENT
C      DL IS LENGTH OF A SEGMENT OF WAKE ELEMENTS
C      CBAR AND AREA ARE REFERENCE CHORD AND TOTAL REFERENCE WING AREA
C      NFSH(I) = NUMBER OF SEGMENTS ALONG EACG VORTEX ELEMENT ON FREE
C      VORTEX SHEET
       READ (5,510) ALPHA,AMACH,DELTA,DL,XEND,CBAR,AREA,CLS
       READ (5,520) (NFSH(I),I=1,NSW1)
       DO 40 I=1,NSW1
       NCOR(I)=NFSH(I)+6
40     CONTINUE
       READ (5,510) (XBRR(I),I=1,NBRR)
       READ (5,510) (CTT(I),I=1,NSW1)
       WRITE (6,530) TTL
       WRITE (6,520) NCW,NBRR,NCONTS,MITER,IPUNCH,KU1
       WRITE (6,520) NC,(M1(I),I=1,NC),ICAM,IST,ITERS
       WRITE (6,520) ISPAN,ITRAKE
       WRITE (6,510) ALPHA,AMACH,DELTA,DL,XEND,CBAR,AREA,CLS
       WRITE (6,520) (NFSH(I),I=1,NSW1)
       WRITE (6,510) (XBRR(I),I=1,NBRR)
       WRITE (6,510) (CTT(I),I=1,NSW1)
```

```
      SS=SIND(ALPHA)
      CS=COSD(ALPHA)
C  ***YT(I) IS Y-STATION AT WHICH CAMBER ORDINATES ARE READ IN
C     XNUM  IS NUMBER OF CAMBER ORDINATES TO BE READ IN. (LIMITED TO 21)
C     CURV(I) = 0.  IF CAMBER IS TO BE FORMED BY CONNECTING STRAIGHT
C     SEGMENTS, WITH FIRST SEGMENT BEING REGARDED AS FLAT  L.E. FLAP
C     CURV(I) = 1.  IF CUBIC SPLINE INTERPOLATION IS USED
C     CURV(I) = 2.  IF CUBIC SPLINE INTERPOLATION IS USED , WITH
C     FIRST SEGMENT BEING FLAT LEADING-EDGE FLAP
C     CHND(I)  IS CHORD LENGTH AT YT(I) STATION
C     ICAM = 0 FLAT WING
C     ICAM = 1 CAMBER ORDINATES TO BE READ IN
C     ICAM = 2 CAMBER ORDINATES TO BE DEFINED ANALYTICALLY
C     ICAM = 3 PLANE WITH L.E. FLAPS
      IF (ICAM.NE.1) GO TO 100
      DO 90 I=1,IST
      READ (5,510) YT(I),XNUM,CURV(I),CHND(I)
      WRITE (6,510) YT(I).XNUM.CURV(I),CHND(I)
      IM(I)=XNUM
      IR=IM(I)
      ICV=CURV(I)
C  ***XT(I.J)  X/C VALUES AT WHICH CAMBER ORDINATES ARE READ IN FOR
C     YT(I) STATION
C     CA(J)  Z/C VALUES IF CAMBER ORDINATES AT THE CORRESPONDING
C     XT(I,J) LOCATIONS
      READ (5,510) (XT(I,J),J=1,IR)
      WRITE (6,510) (XT(I.J),J=1,IR)
      READ (5,510) (CA(J),J=1,IR)
      WRITE (6,510) (CA(J),J=1,IR)
      DO 50 K=1,IR
50    AW(K)=XT(I,K)
      IF (ICV.EQ.0) GO TO 60
      CALL SPLINE (IR,AW,CA,AAM,BBM,CCM,DDM)
      GO TO 90
60    DO 80 J=2,IR
      AAM(I,J-1)=0.
      BBM(I,J-1)=0.
      IF (ABS(AW(J)-AW(J-1)).LE.1.E-20) GO TO 70
      CCM(I,J-1)=(CA(J)-CA(J-1))/(AW(J)-AW(J-1))
70    DDM(I,J-1)=CA(J-1)
80    CONTINUE
```

```
90    CONTINUE
100   CONTINUE
      IF (ICAM.NE.3) GO TO 120
C  ***YLEF(I,1) = EXTREME INBOARD Y-COORDINATE OF A L.E. FLAP
C     YLEF(I,2) = EXTREME OUTBOARD Y-COORDINATE OF A L.E. FLAP
C     X1,Y1,Z1, ETC. ARE CORNER POINT COORDINATES OF A L.E. FLAP INPUT
C     IN CLOCKWISE ORDER, FIRST FROM THE MOST INBOARD POINT.
      DO 110 I=1,IST
      READ (5,510) (YLEF(I,K),K=1,2)
      WRITE (6,510) (YLEF(I,K),K=1,2)
      READ (5,510) XLF(I,1),YLF(I,1),Z1,XLF(I,2),YLF(I,2),Z2
      WRITE (6,510) XLF(I,1),YLF(I,1),Z1,XLF(I,2),YLF(I,2),Z2
      READ (5,510) XLF(I,3),YLF(I,3),Z3,XLF(I,4),YLF(I,4),Z4
      WRITE (6,510) XLF(I,3),YLF(I,3),Z3,XLF(I,4),YLF(I,4),74
      IF (ABS(XLF(I,4)-XLF(I,1)).GT.1.E-18) SLP1(I)=(YLF(I,4)-YLF(I,1))/
     1(XLF(I,4)-XLF(I,1))
      IF (ABS(XLF(I,4)-XLF(I,1)).LE.1.E-18) SLP1(I)=1.E18
      XNF(I)=(YLF(I,4)-YLF(I,1))*(Z3-Z2)-(YLF(I,3)-YLF(I,2))*(Z4-Z1)
      YNF(I)=(XLF(I,3)-XLF(I,2))*(Z4-Z1)-(XLF(I,4)-XLF(I,1))*(Z3-Z2)
      ZNF(I)=(XLF(I,4)-XLF(I,1))*(YLF(I,3)-YLF(I,2))-(XLF(I,3)-XLF(I,2))
     1*(YLF(I,4)-YLF(I,1))
      IF (ABS(ZNF(I)).GT.1.E-3) GO TO 110
      XNF(I)=(YLF(I,4)-YLF(I,1))*(Z2-Z1)-(YLF(I,2)-YLF(I,1))*(Z4-Z1)
      YNF(I)=(XLF(I,2)-XLF(I,1))*(Z4-Z1)-(XLF(I,4)-XLF(I,1))*(Z2-Z1)
      ZNF(I)=(XLF(I,4)-XLF(I,1))*(YLF(I,2)-YLF(I,1))-(XLF(I,2)-XLF(I,1))
     1*(YLF(I,4)-YLF(I,1))
110   CONTINUE
120   CONTINUE
      IF (ICAM.EQ.0) IST=1
      NNCW=NCW
      NCW=NNCW+1
C     NPRCY=0, USED FOR BOUND ELEMENTS = (NCW+1)
C     NPRCY=1, USED FOR BOUND ELEMENTS = NCW
      NPRCY=0
130   IF (NPRCY.EQ.1) NCW=NNCW
      PI=3.14159265
      FN2=2*NCW
      PIJ=PI/FLOAT(NCW)
      TWOPI=2.*PI
      DO 140 I=1,NCW
      CPCWL(I)=50.*(1.-COS((2.*FLOAT(I)-1.)*PI/FN2))
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```
      CPCW1(I)=50.*(1.-COS(FLOAT(I)*PI/FLOAT(NCW)))                    GE01740
      CC=CPCWL(I)/100.                                                 GE01750
      SNN(I)=2.*SQRT(CC*(1.-CC))                                       GE01760
      PSIJ=(2.*FLOAT(I)-1.)*PIJ/2.                                     GE01770
      SN(I)=SIN(PSIJ)/TWOPI                                            GE01780
  140 SI(I)=TWOPI*SN(I)                                                GE01790
      NCS=0                                                            GE01800
      IPANEL=1                                                         GE01810
      DO 260 KK=1,NC                                                   GE01820
      WRITE (6,400) KK                                                 GE01830
C  ***XXL(I),XXT(I),YL(I)  DEFINE THE LEADING-EDGE AND TRAILING-EDGE   GE01840
C     LOCATIONS OF THE ROOT AND  TIP CHORDS IN EACH SPANWISE SECTION   GE01850
      READ (5,510) (XXL(I),XXT(I),YL(I),I=1,2)                         GE01870
      WRITE (6,510) (XXL(I),XXT(I),YL(I),I=1,2)                        GE01880
      ISC=1                                                            GE01890
C     IF ISC=1, SKIP THE FOLLOWING INPUT DATA                          GE01920
      IF (ISC.EQ.1) GO TO 200                                          GE01930
C  ***NLE= NUMBER OF INPUT POINTS TO DEFINE THE L.E. LIMITED TO 15     GE01940
C     NTE= NUMBER OF INPUT POINTS TO DEFINE THE T.E. LIMITED TO 15     GE01950
C     MCVL=1 IF THE CUBIC SPLINE IS USED TO INTERPOLATE THE L.E. SHAPE GE01960
C     MCVL=0 IF STRAIGHT SEGMENTS ARE ASSUMED FOR THE L.E. SHAPE       GE01970
C     MCVT=1 IF THE CUBIC SPLINE IS USED TO INTERPOLATE THE T.E. SHAPE GE01980
C     MCVT=0 IF STRAIGHT SEGMENTS ARE ASSUMED FOR THE T.E. SHAPE       GE01990
      READ (5,520) NLE,NTE,MCVL,MCVT                                   GE02000
      WRITE (6,520) NLE,NTE,MCVL,MCVT                                  GE02010
C  ***BA,YSL = X- AND Y- COORDINATES OF INPUT POINTS TO DEFINE THE L.E. GE02020
C     SHAPE RELATIVE TO THE L.E. OF INBOARD CHORD                      GE02030
      READ (5,510) (BA(I),I=1,NLE)                                     GE02040
      WRITE (6,510) (BA(I),I=1,NLE)                                    GE02050
      READ (5,510) (YSL(I),I=1,NLE)                                    GE02060
      WRITE (6,510) (YSL(I),I=1,NLE)                                   GE02070
      IF (MCVL.EQ.0) GO TO 150                                         GE02080
      CALL SPLINE (NLE,YSL,BA,AQL,BQL,CQL,DQL)                         GE02090
      GO TO 170                                                        GE02100
  150 DO 160 I=2,NLE                                                   GE02110
      AQL(I-1)=0.                                                      GE02120
      BQL(I-1)=0.                                                      GE02130
      CQL(I-1)=(BA(I)-BA(I-1))/(YSL(I)-YSL(I-1))                       GE02140
  160 DQL(I-1)=BA(I-1)                                                 GE02150
C  ***BA,YST = X- ANS Y- COORDINATES OF INPUT POINTS TO DEFINE THE T.E. GE02160
C     SHAPE RELATIVE TO THE T.E. OF INBOARD CHORD                      GE02170
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```
170   CONTINUE
      READ (5,510) (BA(I),I=1,NTE)
      WRITE (6,510) (BA(I),I=1,NTE)
      READ (5,510) (YST(I),I=1,NTE)
      WRITE (6,510) (YST(I),I=1,NTE)
      IF (MCVT.EQ.0) GO TO 180
      CALL SPLINE (NTE,YST,BA,AQT,BQT,CQT,DQT)
      GO TO 200
180   DO 190 I=2,NTE
      AQT(I-1)=0.
      BQT(I-1)=0.
      CQT(I-1)=(BA(I)-BA(I-1))/(YST(I)-YST(I-1))
190   DQT(I-1)=BA(I-1)
200   CONTINUE
      YBREAK(KK)=YL(2)
      XBRR(20+KK)=ATAN((XXL(2)-XXL(1))/(YL(2)-YL(1)))
      PXL(KK)=XXL(1)
      PXL(KK+1)=XXL(2)
      PXT(KK)=XXT(1)
      PXT(KK+1)=XXT(2)
      PYL(KK)=YL(1)
      PYL(KK+1)=YL(2)
      FM=M1(KK)
      NSW=M1(KK)
      NSW1=NSW-1
      DO 210 J=1,NSW
      FJ=FLOAT(J)*2.
210   CPSWL(J)=50.*(1.-COS((FJ-1.)*PI/(2.*FM)))
      DO 220 I=1,NSW1
      FI=I
220   CPSW1(I)=50.*(1.-COS(FI*PI/FLOAT(NSW)))
      IF (KK.EQ.NC) GO TO 230
      CPSWL(1)=0.
      CPSWL(NSW)=100.
      GO TO 240
230   CPSWL(1)=0.
      IF ((XXT(2)-XXL(2)).NE.0.) CPSWL(NSW)=100.
240   CONTINUE
      CALL PNLWNG (NSW,IPANEL,LPANEL,NCW,NCS,NTS,NC,KK,ISC)
      IPANEL=LPANEL+1
      NCS=NCS+NSW-1
```

```
      WIDTH(KK)=YL(2)-YL(1)                                             GE02590
      IF (KK.NE.NC) GO TO 260                                           GE02600
      HALFR=PYL(NC+1)                                                   GE02610
      DO 250 I=1,NTS                                                    GE02620
      CH(I)=XTM(I)-XLM(I)                                               GE02630
      C(I)=CH(I)                                                        GE02640
      YYLM=YLM(I)/HALFR                                                 GE02650
  250 THETP(I)=ARCOS(YYLM)                                              GE02660
  260 CONTINUE                                                          GE02670
      NCPTTL=NTS+LPANEL                                                 GE02680
      NWNG=LPANEL                                                       GE02690
      IF (NPRCY.EQ.1) GO TO 290                                         GE02700
      NCW1=NCW                                                          GE02710
      REWIND 1                                                          GE02720
      REWIND 7                                                          GE02730
      WRITE (1) NCW,NWNG                                                GE02740
      WRITE (1) (SI(I),SNN(I),I=1,NCW)                                  GE02750
      N2=NCW*NC                                                         GE02760
      WRITE (1) (SWP(I),I=1,N2)                                         GE02770
      WRITE (1) (XAVWNG(I),YAVWNG(I),I=1,NWNG,NCW)                      GE02780
      DO 270 I=1,NCW                                                    GE02790
  270 CPCWR(I)=CPCWL(I)/100.                                            GE02800
      WRITE (6,430)                                                     GE02810
      WRITE (6,440)                                                     GE02820
      NSW1=NTS                                                          GE02830
      NSW=NTS+1                                                         GE02840
      CALL CAMBER (NPRCY,C,XCP,YCP,XN,YN,XLM,YLM,XAVWNG,YAVWNG)         GE02850
      DO 280 I=1,NSW1                                                   GE02860
      DO 280 J=1,NCW                                                    GE02870
      IJ=(I-1)*NCW+J                                                    GE02880
      WRITE (6,510) ZBDXV(IJ),ZBDYV(IJ)                                 GE02890
  280 CONTINUE                                                          GE02900
      NPRCY=1                                                           GE02910
      GO TO 130                                                         GE02920
  290 DO 300 I=1,NCW                                                    GE02930
      CPCWL(I)=CPCWL(I)/100.                                            GE02940
  300 CPCW1(I)=CPCW1(I)/100.                                            GE02950
      NSW1=NTS                                                          GE02960
      NSW=NTS+1                                                         GE02970
      WRITE (6,450)                                                     GE02980
      CALL CAMBER (NPRCY,C,XCP,YCP,XN,YN,XLM,YLM,XAVWNG,YAVWNG)         GE02990
```

```
      CALL CAMBER (2,C,XCP,YCP,XN,YN,XLM,YLM,XAVWNG,YAVWNG)             GE03000
      WRITE (6,460)                                                     GE03010
      DO 310 I=1,NSW1                                                   GE03020
      DO 310 J=1,NCW                                                    GE03030
      IJ=(I-1)*NCW+J                                                    GE03040
      WRITE (6,510) ZBDX(IJ),ZBDY(IJ),SZBDYV(IJ)                        GE03050
310   CONTINUE                                                          GE03060
      WRITE (6,470)                                                     GE03070
      WRITE (6,480)                                                     GE03080
      DO 320 I=1,NSW1                                                   GE03090
      IJ=NWNG+I                                                         GE03100
      WRITE (6,510) ZBDX(IJ),ZBDY(IJ)                                   GE03110
320   CONTINUE                                                          GE03120
C     EVALUATING THE CONSTANTS                                          GE03130
      ALPHA=ALPHA*PI/180.                                               GE03140
      TANPH1=TAN(ALPHA)                                                 GE03150
      TANPH2=TANPH1*TANPH1                                              GE03160
      BETA2=1.-AMACH*AMACH                                              GE03170
      BETA=SQRT(BETA2)                                                  GE03180
      B2PH1=BETA2*TANPH1                                                GE03190
      D4=BETA2*TANPH2+1.                                                GE03200
      D4SQ2=2.*SQRT(D4)                                                 GE03210
      CON=BETA2/(8.*FLOAT(NCW))                                         GE03220
      BSQD4P=BETA2/(4.*PI)                                              GE03230
      DO 330 I=1,NC                                                     GE03240
      SWPLE=XBRR(20+I)                                                  GE03250
      CON1=COS(SWPLE)                                                   GE03260
      CON2=(SIN(SWPLE))/CON1                                            GE03270
      CON3=FLOAT(NCW)*SQRT(BETA2+CON2*CON2)                             GE03280
      CON4=2.*CON1/(PI*SQRT(1.-AMACH*AMACH*CON1*CON1))                  GE03290
      AW(I)=CON3                                                        GE03300
      CA(I)=CON4                                                        GE03310
330   CONTINUE                                                          GE03320
      N1=0                                                              GE03330
      DO 350 KI=1,NC                                                    GE03340
      N2=N1+M1(KI)-1                                                    GE03350
      II=N1+1                                                           GE03360
      DO 340 I=II,N2                                                    GE03370
340   CTT(I)=AW(KI)*SQRT(CA(KI)*CTT(I))                                 GE03380
      N1=N2                                                             GE03390
350   CONTINUE                                                          GE03400
```

```
      DO 360 I=1,NSW1                                                   GE03410
360   CONS(I)=CON*C(I)                                                  GE03420
      SINA=SIN(ALPHA)                                                   GE03430
      COSA=COS(ALPHA)                                                   GE03440
      DO 370 I=1,NSW                                                    GE03450
370   CPSWL(I)=YLE(I)/PYL(NC+1)                                         GE03460
      DO 380 I=1,NSW1                                                   GE03470
380   CPSW1(I)=YLM(I)/PYL(NC+1)                                         GE03480
      WRITE (1) (SNN(I),I=1,NCW)                                        GE03490
      N2=NCW*NC                                                         GE03500
      WRITE (1) (SWP(I),I=1,N2)                                         GE03510
      WRITE (1) (XAVWNG(I),YAVWNG(I),I=1,NWNG)                          GE03520
      WRITE (1) (C(I),I=1,NSW1)                                         GE03530
      WRITE (1) (THETP(I),I=1,NSW1)                                     GE03540
      WRITE (1) (XTE(I),XLE(I),YLE(I),I=1,NSW)                          GE03550
      WRITE (1) (XLM(I),YLM(I),I=1,NSW1)                                GE03560
      WRITE (1) (CONS(I),I=1,NSW1)                                      GE03570
      WRITE (1) (SI(I),SN(I),I=1,NCW)                                   GE03580
      WRITE (1) (XCP(I),YCP(I),I=1,NCPTTL)                              GE03590
      WRITE (1) ((XN(I,J),YN(I,J),J=1,2),I=1,NWNG)                      GE03600
      WRITE (1) (CTT(I),I=1,NSW1)                                       GE03610
      WRITE (1) (CPCWL(I),I=1,NCW)                                      GE03620
      WRITE (1) (CPCW1(I),I=1,NCW)                                      GE03630
      WRITE (1) (CPSWL(I),I=1,NSW)                                      GE03640
      WRITE (1) (CPSW1(I),I=1,NSW1)                                     GE03650
      IF ((PXT(NC+1)-PXL(NC+1)).NE.0.) MAXW=NTS                         GE03660
      CALL FRELM (XXL,XXT,YL,XLE,XTE,YLE,PI,NCW1,NSW1,XEND,DELTA,ALPHA,DGE03670
     1L,CPCWL)                                                          GE03680
      RETURN                                                            GE03690
390   WRITE (6,500)                                                     GE03700
      STOP                                                              GE03710
C                                                                       GE03730
400   FORMAT (29H  SAPNWISE SECTION OF NUMBER ,2X,I2)                   GE03740
430   FORMAT (1H0,40H CAMBER SLOPE AT FINE GRID BOUND ELEMENT)          GE03770
440   FORMAT (1H0,3X,5HDZDXV,5X,5HDZDYV)                                GE03780
450   FORMAT (1H0,42H CAMBER SLOPE AT COARSE GRID BOUND ELEMENT)        GE03790
460   FORMAT (1H0,3X,4HDZDX,7X,4HDZDY,5X,5HDZDYV)                       GE03800
470   FORMAT (1H0,48H CAMBER SLOPE AT THE LEADING EDGE CONTROL POINTS)  GE03810
480   FORMAT (1H0,3X,4HDZDX,7X,4HDZDY)                                  GE03820
490   FORMAT (16A5)                                                     GE03830
500   FORMAT (1H1,/,10X,19HALL CASES COMPLETED)                         GE03840
```

```
510   FORMAT (8F10.5)
520   FORMAT (10I5)
530   FORMAT (1H1,/,17H INPUT DATA CARDS/,16A5)
      END
```

```
      SUBROUTINE PNLWNG (NSW,IPANEL,LPANEL,NCW,NCS,NTS,NC,KI,ISC)
C     GENERATES THE GRID OF BOUND AND TRAILING VORTEX ELEMENTS
      COMMON XXL(2),XXT(2),YL(2),CPCWL(10),CPCW1(10),SI(10),SN(10),SNN(1
     10),SWP(50),SLOPE(50),XL(2,10),C(19),THETP(19),CONS(19),CPSW1(19),X
     2LM(19),XTM(19),YLM(19),CTT(19),CPSWL(20),XLE(20),XTE(20),YLE(20),X
     3AVWNG(190),YAVWNG(190),XN(190,2),YN(190,2),XCP(209),YCP(209),X(10,
     420),Y(10,20)
      IF (ISC.NE.1) GO TO 80
C     STRAIGHT LEADING-EDGE COMPUTATION
      DO 10 I=1,2
      D=XXT(I)-XXL(I)
      DO 10 J=1,NCW
10    XL(I,J)=XXL(I)+CPCWL(J)*D/100.
      SPAN=YL(2)-YL(1)
      DO 20 I=1,NCW
      II=(KI-1)*NCW+I
      SLOPE(II)=(XL(2,I)-XL(1,I))/SPAN
20    SWP(II)=ATAN(SLOPE(II))
      DO 30 I=1,NCW
      II=(KI-1)*NCW+I
30    CONTINUE
      DO 40 K=1,NSW
      YK=CPSWL(K)*SPAN/100.
      YL1=YL(1)+YK
      DO 40 J=1,NCW
      JJ=(KI-1)*NCW+J
      Y(J,K)=YL1
40    X(J,K)=XL(1,J)+SLOPE(JJ)*YK
      NSW1=NSW-1
      IF (NC.EQ.1) GO TO 50
      IF (KI.NE.1) GO TO 60
50    CONTINUE
      XLE(1)=XXL(1)
      XTE(1)=XXT(1)
```

```
      YLF(1)=YL(1)
60    CONTINUE
      X1=XXL(1)
      X2=XXT(1)
      DLE=(XXL(2)-XXL(1))/SPAN
      DTE=(XXT(2)-XXT(1))/SPAN
      DO 70 I=2,NSW
      II=NCS+I
      YLE(II)=Y(1,I)
      YLM(II-1)=YL(1)+CPSW1(I-1)*SPAN/100.
      DLEL=DLE*(Y(1,I)-Y(1,I-1))
      DTET=DTE*(Y(1,I)-Y(1,I-1))
      XLE(II)=XLE(II-1)+DLEL
      XTE(II)=XTE(II-1)+DTET
      XLM(II-1)=X1+SPAN*CPSW1(I-1)*DLE/100.
70    XTM(II-1)=X2+SPAN*CPSW1(I-1)*DTE/100.
      GO TO 110
C     CURVED LEADING-EDGE COMPUTATION
80    SPAN=YL(2)-YL(1)
      DO 90 K=1,NSW
      II=NCS+K
      YK=CPSWL(K)*SPAN/100.
      YC=YL(1)+YK
      XLE(II)=SHAPLE(YK)+XXL(1)
      XTE(II)=SHAPTE(YK)+XXT(1)
      YLE(II)=YC
      CHD=XTE(II)-XLE(II)
      DO 90 J=1,NCW
      Y(J.K)=YC
      X(J,K)=XLE(II)+CPCWL(J)*CHD/100.
90    CONTINUE
      NSW1=NSW-1
      DO 100 I=1,NSW1
      II=NCS+I
      YK1=CPSW1(I)*SPAN/100.
      YC1=YL(1)+YK1
      XLM(II)=XXL(1)+SHAPLE(YK1)
      XTM(II)=XXT(1)+SHAPTE(YK1)
      YLM(II)=YC1
100   CONTINUE
110   CONTINUE
```

```
C     DETERMINE THE CONTROL AND VORTEX POINTS ON THE WING SURFACE
      DO 130 K=1,NSW1
      KN=NCS+K
      CC=XTM(KN)-XLM(KN)
      DO 130 J=1,NCW
      NPANEL=IPANEL+(K-1)*NCW+J-1
      XCP(NPANEL)=XLM(KN)+CC*CPCW1(J)/100.
      YCP(NPANEL)=YLM(KN)
      XAVWNG(NPANEL)=XLM(KN)+CC*CPCWL(J)/100.
      YAVWNG(NPANEL)=YLM(KN)
      DO 120 I=1,2
      KA=K+I-1
      XN(NPANEL,I)=X(J,KA)
120   YN(NPANEL,I)=Y(J,KA)
130   CONTINUE
      LPANEL=NPANEL
      IF (KI.NE.NC) RETURN
      DO 140 K=1,NTS
      NP=LPANEL+K
      XCP(NP)=XLM(K)
140   YCP(NP)=YLM(K)
      RETURN
      END
```

```
      FUNCTION SHAPLE(Y)
      COMMON /SHPLE/ NLE,YSL(15),AQL(14),BQL(14),CQL(14),DQL(14)
      K=1
10    IF (Y.GE.YSL(K).AND.Y.LT.YSL(K+1)) GO TO 20
      K=K+1
      IF (K.GE.NLE) GO TO 30
      GO TO 10
20    SM=Y-YSL(K)
      SHAPLE=AQL(K)*SM**3+BQL(K)*SM**2+CQL(K)*SM+DQL(K)
      GO TO 50
30    IF (Y.LT.YSL(1)) GO TO 40
      K=NLE-1
      GO TO 20
40    K=1
      GO TO 20
```

```
50    RETURN
      END


      FUNCTION SHAPTE(Y)
      COMMON /SHPTE/ NTE,YST(15),AQT(14),BQT(14),CQT(14),DQT(14)
      K=1
10    IF (Y.GE.YST(K).AND.Y.LT.YST(K+1)) GO TO 20
      K=K+1
      IF (K.GE.NTE) GO TO 30
      GO TO 10
20    SM=Y-YST(K)
      SHAPTE=AQT(K)*SM**3+BQT(K)*SM**2+CQT(K)*SM+DQT(K)
      GO TO 50
30    IF (Y.LT.YST(1)) GO TO 40
      K=NTE-1
      GO TO 20
40    K=1
      GO TO 20
50    RETURN
      END


      SUBROUTINE FRELM (XXL,XXT,YL,XLE,XTE,YLE,PI,NCW1,NSW1,XEND,DELTA,A
     1LPHA,DL,CPCWL)
C     FINDS THE INETIAL COORDINATES OF FREE VORTEX ELEMENTS
      COMMON /ALLRB/ XE(40),YE(40),ZE(40),XXE(30),YYE(30),ZZE(30),ZMIN,N
     1ELM(11),NNELM(12)
      COMMON /XPLOT/ XMN,YMN,ZMN,XMX,YMX,ZMX
      COMMON /NCTT/ NCT,NCON,NPT,NCOR(15),KU1,NFSH(15),KUC
      COMMON /LOC/ FU1,FU2,YEND,PXL(5),PXT(5),PYL(5)
      COMMON /AERO/ NAERO,MAXL,MAXW,ISPAN,ISF,ITRAKE,ISC
      COMMON /GENCF/ M1(5),NW(2),YBREAK(5),CH(90),SJ(31,3),MJW1(2),
     1MJW2(2),WIDTH(5),SWEEP(60),NTS,NC
      COMMON /CAMB/ ICAM
      COMMON /TIPVX/ XTIP(15,30),YTIP(15,30),ZTIP(15,30),NTLM(15),NTMAX
      DIMENSION CPCWL(1)
      COMMON /ABC/ PXE(10,40),PYE(10,40),PZE(10,40),PXXE(11,20),
     1PYYE(11,20),PZZE(11,20),NMAX,NNMAX,NCONTS
```

```
      DIMENSION XXL(1), XXT(1), YL(1), XLE(1), XTE(1), YLE(1)
      AHPI=ALPHA
      ALP=ALPHA*180./PI
      IF (ALP.LE.15.) AHPI=(22.5-0.5*ALP)*PI/180.
      NSW=NSW1+1
      THT1=PI/(FLOAT(2*NCW1))
      CPC=0.5*(1.-COS(THT1))
      ZMIN=(XTE(1)-XLE(1))*TAN(AHPI)/10.
      SAHPI=SIN(AHPI)
      CAHPI=COS(AHPI)
      REWIND 2
      REWIND 4
C     EVALUATION OF COORDINATES OF LEADING-EDGE ELEMENTS
      IF (ISPAN.EQ.0) NSW1=NTS
      IF (ISPAN.EQ.0) NSW=NTS+1
      IF (ISPAN.EQ.1) NSW1=MAXL
      IF (ISPAN.EQ.1) NSW=MAXW
      DO 40 I=1,NSW1
      IF (I.EQ.NSW1) GO TO 10
      XE(1)=XTE(I+1)
      YE(1)=YLE(I+1)
      ZE(1)=0.
      XE(2)=XLE(I+1)+CPC*(XTE(I+1)-XLE(I+1))
      YE(2)=YLE(I+1)
      ZE(2)=0.
      XE(3)=XLE(I)+CPC*(XTE(I)-XLE(I))
      YE(3)=YLE(I)
      ZE(3)=0.
      XE(4)=XLE(I)
      YE(4)=YLE(I)
      ZE(4)=0.
      XE(5)=XLE(I)-0.05*(XTE(I)-XLE(I))
      IF (I.EQ.1) XMN=XE(5)
      YE(5)=YLE(I)
      ZE(5)=0.
      XE(6)=XE(4)+0.05*(XTE(I)-XLE(I))
      YE(6)=YE(4)
      ZE(6)=ZMIN
      J=6
      XE(7)=XE(6)+DELTA*CAHPI
      YE(7)=YE(6)
```

```
      ZE(7)=ZE(6)+DELTA*SAHPI
      IF (I.EQ.1) GO TO 30
      J=7
      GO TO 20
10    CONTINUE
      XE(1)=PXL(NC+1)+CPC*(PXT(NC+1)-PXL(NC+1))
      YE(1)=PYL(NC+1)
      ZE(1)=0.
      XE(3)=XLE(I)+CPC*(XTE(I)-XLE(I))
      YE(3)=YLE(I)
      ZE(3)=0.
      XE(2)=0.5*(XE(1)+XE(3))
      YE(2)=0.5*(YE(1)+YE(3))
      ZE(2)=0.5*(ZE(1)+ZE(3))
      XE(4)=XLE(I)
      YE(4)=YLE(I)
      ZE(4)=0.
      XE(5)=XLE(I)-0.05*(XTE(I)-XLE(I))
      YE(5)=YLE(I)
      ZE(5)=0.
      XE(6)=XE(4)+0.05*(XTE(I)-XLE(I))
      YE(6)=YE(4)
      ZE(6)=ZMIN
      XE(7)=XE(6)+DELTA*CAHPI
      YE(7)=YE(6)
      ZE(7)=ZE(6)+DELTA*SAHPI
      J=7
20    XE(J+1)=XE(J)+DELTA
      YE(J+1)=YE(J)
      ZE(J+1)=ZE(J)
      IF (XE(J+1).GE.XEND) GO TO 30
      J=J+1
      GO TO 20
30    NELM(I)=J+1
      K=NELM(I)
      IF (NCONTS.NE.0) WRITE (2) (XE(J),YE(J),ZE(J),J=1,5)
40    WRITE (4) K,(XE(J),YE(J),ZE(J),J=1,K)
      NMAX=0
      DO 50 I=1,NSW1
50    IF (NMAX.LT.NELM(I)) NMAX=NELM(I)
C     EVALUATION OF COORDINATES OF WAKE ELEMENTS
```

```
      YGL=0.95*(YLE(NSW)-YLE(NSW1))
      DO 100 I=1,MAXW
      XXE(1)=XTE(I)
      YYE(1)=YLE(I)
      ZZE(1)=0.
      XXE(2)=XXE(1)+(PXT(1)-PXL(1))/10.
      YYE(2)=YYE(1)
      ZZE(2)=ZZE(1)
      XXE(3)=XXE(2)+(PXT(1)-PXL(1))/10.
      YYE(3)=YYE(2)
      ZZE(3)=ZZE(2)
      J=3
      IF (I.EQ.NSW) GO TO 60
      GO TO 80
60    CONTINUE
      IF ((PXT(NC+1)-PXL(NC+1)).EQ.0.) GO TO 80
      XXE(1)=PXL(NC+1)+CPC*(PXT(NC+1)-PXL(NC+1))
      YYE(1)=PYL(NC+1)
      ZZE(1)=0.
      XXE(2)=XXE(1)+YGL*CAHPI
      YYE(2)=YYE(1)
      ZZE(2)=ZZE(1)+YGL*SAHPI
      J=2
70    IF (XXE(J).GE.XEND) GO TO 90
      XXE(J+1)=XXE(J)+DELTA*CAHPI
      YYE(J+1)=YYE(J)
      ZZE(J+1)=ZZE(J)+DELTA*SAHPI
      J=J+1
      GO TO 70
80    IF (XXE(J).GE.XEND) GO TO 90
      XXE(J+1)=XXE(J)+DL
      YYE(J+1)=YYE(J)
      ZZE(J+1)=ZZE(J)
      J=J+1
      GO TO 80
90    NNELM(I)=J
      K=J
      IF (NCONTS.NE.0) WRITE (2) (XXE(J),YYE(J),ZZE(J),J=1,2)
100   WRITE (4) K,(XXE(J),YYE(J),ZZE(J),J=1,K)
      NNMAX=0
      IF ((PXT(NC+1)-PXL(NC+1)).EQ.0.) NT=MAXL
```

```
      IF ((PXT(NC+1)-PXL(NC+1)).NE.0.) NT=MAXW
      DO 110 I=1,NT
110   IF (NNMAX.LT.NNELM(I)) NNMAX=NNELM(I)
      WRITE (4) NMAX,NNMAX,ZMIN,NCONTS
C     EVALUATION OF SIDE EDGE VORTEX ELEMENTS
      NCW=NCW1-1
      CAHPI=COS(AHPI/2.)
      SAHPI=SIN(AHPI/2.)
      IF ((PXT(NC+1)-PXL(NC+1)).EQ.0.) GO TO 180
      DO 120 I=1,NCW
      XTIP(I,1)=PXL(NC+1)+CPCWL(I)*(PXT(NC+1)-PXL(NC+1))
      YTIP(I,1)=PYL(NC+1)
      ZTIP(I,1)=0.
120   CONTINUE
      DO 150 I=1,NCW
      FL=(PXT(NC+1)-PXL(NC+1))/2.
      J=1
130   XTIP(I,J+1)=XTIP(I,J)+FL*CAHPI
      YTIP(I,J+1)=PYL(NC+1)+0.01
      ZTIP(I,J+1)=ZTIP(I,J)+FL*SAHPI
      IF (XTIP(I,J+1).GE.XEND) GO TO 140
      IF (XTIP(I,J+1).GE.PXT(NC+1)) FL=DELTA
      J=J+1
      GO TO 130
140   NTLM(I)=J+1
150   CONTINUE
      DO 160 I=1,NCW
      KK=NTLM(I)
      WRITE (6,280) (XTIP(I,J),J=1,KK)
      WRITE (6,280) (YTIP(I,J),J=1,KK)
      WRITE (6,280) (ZTIP(I,J),J=1,KK)
160   CONTINUE
      NTMAX=0
      DO 170 I=1,NCW
      IF (NTMAX.LT.NTLM(I)) NTMAX=NTLM(I)
170   CONTINUE
180   CONTINUE
      XLNT=XEND-XMN
      XMX=XEND
      XMX=XEND+0.20*XLNT
      YMN=0.
```

```
      YMX=PYL(NC+1)                                                     FLM1810
      ZMN=-PYL(NC+1)*0.6667                                             FLM1820
      ZMX=PYL(NC+1)*0.6667                                              FLM1830
      IF (NCONTS.EQ.0) GO TO 230                                        FLM1840
C     READS LOCATION OF LEADING-EDGE ELEMENTS FROM INPUT DATA CARDS     FLM1850
      REWIND 2                                                          FLM1860
      REWIND 4                                                          FLM1870
      READ (5,300) (NFLM(I),I=1,MAXL)                                   FLM1880
      DO 190 I=1,MAXL                                                   FLM1890
      K=NELM(I)                                                         FLM1900
      READ (5,290) ((X1,J=1,5),(XE(J),J=6,K))                           FLM1910
      READ (5,290) ((Y1,J=1,5),(YE(J),J=6,K))                           FLM1920
      READ (5,290) ((Z1,J=1,5),(ZE(J),J=6,K))                           FLM1930
      READ (2) (XE(J),YE(J),ZE(J),J=1,5)                                FLM1940
190   WRITE (4) K,(XE(J),YE(J),ZE(J),J=1,K)                             FLM1950
C     READS LOCATION OF WAKE ELEMENTS FROM INPUT DATA CARDS             FLM1960
      READ (5,300) (NNELM(I),I=1,MAXW)                                  FLM1970
      DO 200 I=1,MAXW                                                   FLM1980
      K=NNELM(I)                                                        FLM1990
      READ (5,290) ((X1,J=1,2),(XXE(J),J=3,K))                          FLM2000
      READ (5,290) ((Y1,J=1,2),(YYE(J),J=3,K))                          FLM2010
      READ (5,290) ((Z1,J=1,2),(ZZE(J),J=3,K))                          FLM2020
      READ (2) (XXE(J),YYE(J),ZZE(J),J=1,2)                             FLM2030
200   WRITE (4) K,(XXE(J),YYE(J),ZZE(J),J=1,K)                          FLM2040
      WRITE (4) NMAX,NNMAX,ZMIN,NCONTS                                  FLM2050
      IF ((PXT(NC+1)-PXL(NC+1)).EQ.0.) GO TO 220                        FLM2060
      READ (5,300) (NTLM(I),I=1,NCW)                                    FLM2070
      DO 210 I=1,NCW                                                    FLM2080
      K=NTLM(I)                                                         FLM2090
      READ (5,290) (XTIP(I,J),J=1,K)                                    FLM2100
      READ (5,290) (YTIP(I,J),J=1,K)                                    FLM2110
      READ (5,290) (ZTIP(I,J),J=1,K)                                    FLM2120
210   CONTINUE                                                          FLM2130
220   CONTINUE                                                          FLM2140
230   WRITE (6,310)                                                     FLM2150
      REWIND 4                                                          FLM2160
      DO 250 I=1,MAXL                                                   FLM2170
      READ (4) K,(XE(J),YE(J),ZE(J),J=1,K)                              FLM2180
      DO 240 J=1,K                                                      FLM2190
      PXE(I,J)=XE(J)                                                    FLM2200
      PYE(I,J)=YE(J)                                                    FLM2210
```

```
      PZE(I,J)=ZE(J)
240   CONTINUE
250   CONTINUE
      DO 270 I=1,MAXW
      READ (4) K,(XXE(J),YYE(J),ZZE(J),J=1,K)
      DO 260 J=1,K
      PXXE(I,J)=XXE(J)
      PYYE(I,J)=YYE(J)
      PZZE(I,J)=ZZE(J)
260   CONTINUE
270   CONTINUE
      RETURN
C
280   FORMAT (1H0,5X,8F10.5)
290   FORMAT (8F10.4)
300   FORMAT (10I2)
310   FORMAT (18H END OF INPUT DATA,//)
      END


      SUBROUTINE SPLINE (N,X,Y,A,B,C,D)
C     CUBIC SPLINE INTERPOLATION
      DIMENSION S(125),H(22),CA(22),X(1),Y(1)
      DIMENSION A(1),B(1),C(1),D(1)
      I=1
      NI=N+1
      N1=N-1
      H(NI)=0.
      H(1)=X(3)-X(2)
      H(2)=-X(3)+X(1)
      H(3)=X(2)-X(1)
      DO 10 K=4,N
10    H(K)=0.
      DO 20 K=1,N
20    S(K)=-H(K+1)/H(1)
      NJ=N-1
      DO 70 I=2,N
      IF (I.EQ.N) GO TO 30
      H(NI)=-6.*((Y(I+1)-Y(I))/(X(I+1)-X(I))-(Y(I)-Y(I-1))/(X(I)-X(I-1))
     1)
```

```
      GO TO 40
30    H(NI)=0.
40    DO 60 J=1,N
      H(J)=0.
      IF (I.EQ.N) GO TO 50
      IF (J.LT.(I-1).OR.J.GT.(I+1)) GO TO 60
      H(I-1)=X(I)-X(I-1)
      H(I)=2.*(X(I+1)-X(I-1))
      H(I+1)=X(I+1)-X(I)
      GO TO 60
50    H(N-2)=X(N)-X(N-1)
      H(N-1)=-X(N)+X(N-2)
      H(N)=X(N-1)-X(N-2)
60    CONTINUE
      II=I
      CALL VMSEQN (NJ,II,H,S,CA)
      NJ=NJ-1
70    CONTINUE
      DO 80 I=1,N1
      A(I)=(S(I+1)-S(I))/(6.*(X(I+1)-X(I)))
      B(I)=S(I)/2.
      C(I)=(Y(I+1)-Y(I))/(X(I+1)-X(I))-(X(I+1)-X(I))*(2.*S(I)+S(I+1))/6.
      D(I)=Y(I)
80    CONTINUE
      RETURN
      END
```

```
      OVERLAY (LEVSP,2,0)
      PROGRAM APLOT
C     SETS UP DIMENSIONS FOR PLOTTING LEADING-EDGE AND WAKE ELEMENTS
      COMMON D(1)
      COMMON /ALLI/ NSW,NSW1,NCW
      COMMON /ABC/ PXE(10,40),PYE(10,40),PZE(10,40),PXXE(11,20),
     1PYYE(11,20),PZZE(11,20),NMAX,NNMAX,NCONTS
      COMMON /AERO/ NAERO,MAXL,MAXW,ISPAN,ISF,ITRAKE,ISC
      NSW=MAXW
      NSW1=MAXL
      MXE=1
      MYE=MXE+NSW1*40
```

```
      MZE=MYE+NSW1*40                                                   PLT 130
      MNELM=MZE+NSW1*40                                                 PLT 140
      MNEXT=MNELM+NSW1                                                  PLT 150
C     MNEXT=3*NSW*NMAX-3*NMAX+NSW                                       PLT 160
      CALL PLOTT (D(MXE),D(MYE),D(MZE),D(MNELM),NSW1,1)                 PLT 170
      MXXE=1                                                            PLT 180
      MYYE=MXXE+NSW*(NNMAX+2)                                           PLT 190
      MZZE=MYYE+NSW*(NNMAX+2)                                           PLT 200
      MNNELM=MZZE+NSW*(NNMAX+2)                                         PLT 210
      MNNEXT=MNNELM+NSW                                                 PLT 220
C     MNNEXT=3*NSW*(NNMAX+2)+NSW+1                                      PLT 230
      CALL PLOTT (D(MXXE),D(MYYE),D(MZZE),D(MNNELM),NSW,2)              PLT 240
      MTXE=1                                                            PLT 250
      MTYE=MTXE+NCW*40                                                  PLT 260
      MTZE=MTYE+NCW*40                                                  PLT 270
      MTELM=MTZE+NCW*40                                                 PLT 280
      MTEXT=MTELM+NCW                                                   PLT 290
C     MTEXT=3*NCW*40+NCW+1                                              PLT 300
      CALL PLOTT (D(MTXE),D(MTYE),D(MTZE),D(MTELM),NCW,3)               PLT 310
      RETURN                                                            PLT 320
      END                                                               PLT 330-


      SUBROUTINE PLOTT (XE,YE,ZE,NNM,NS,LS)                             PTT  10
C     MANIPULATES LEADING-EDGE AND WAKE ELEMENTS COORDINATES IN A FORM  PTT  20
C     SUITABLE FOR PLOTTING                                             PTT  30
      COMMON /ALLI/ NSW,NSW1,NCW                                        PTT  40
      COMMON /TIPVX/ XTIP(15,30),YTIP(15,30),ZTIP(15,30),NTLM(15)       PTT  50
      COMMON /LOC/ FU1,FU2,XEND,PXL(5),PXT(5),PYL(5)                    PTT  60
      COMMON /GENCF/ M1(5),NW(2),YBREAK(5),CH(90),SJ(31,3),MJW1(2),     PTT  70
     1MJW2(2),WIDTH(5),SWEEP(60),NTS,NB                                 PTT  80
      COMMON /AERO/ NAERO,MAXL,MAXW,ISPAN,ISF,ITRAKE,ISC                PTT  90
      COMMON /XPLOT/ XMN,YMN,ZMN,XMX,YMX,ZMX                            PTT 100
      COMMON /ABC/ PXE(10,40),PYE(10,40),PZE(10,40),PXXE(11,20),        PTT 110
     1PYYE(11,20),PZZE(11,20),NMAX,NNMAX,NCONTS                         PTT 120
      COMMON /ALLRB/ AX(210),ZMIN,NELM(11),NNELM(12)                    PTT 130
      DIMENSION NNM(1), XE(NS,1), YE(NS,1), ZE(NS,1), LABY(14), LABZ(14)PTT 140
      DIMENSION LABX(14)                                                PTT 150
      DATA LABX/6*6H      ,6HY VS Z,6*6H      ,2H  /                    PTT 160
      DATA LABY/6*6H      ,6HX VS Y,6*6H      ,2H  /                    PTT 170
```

```
      DATA LABZ/6*6H      ,6HX VS Z,6*6H      ,2H  /
      NSW=MAXW
      NSW1=MAXL
      IF (LS.EQ.2) GO TO 30
      IF (LS.EQ.3) GO TO 60
      DO 20 I=1,NSW1
      KK=NELM(I)
      DO 10 J=1,KK
      XE(I,J)=PXE(I,J)
      YE(I,J)=PYE(I,J)
      ZE(I,J)=PZE(I,J)
10    CONTINUE
20    NNM(I)=KK
      NC=4
      GO TO 90
30    CONTINUE
      DO 50 I=1,NSW
      KK=NNELM(I)
      DO 40 J=1,KK
      XE(I,J)=PXXE(I,J)
      YE(I,J)=PYYE(I,J)
      ZE(I,J)=PZZE(I,J)
40    CONTINUE
50    NNM(I)=KK
C     ****************************************************************
      NC=0
      GO TO 90
60    CONTINUE
      IF (ABS(PXT(NB+1)-PXL(NB+1)).LE.0.00001) RETURN
      DO 80 I=1,NCW
      KK=NTLM(I)
      DO 70 J=1,KK
      XE(I,J)=XTIP(I,J)
      YE(I,J)=YTIP(I,J)
      ZE(I,J)=ZTIP(I,J)
70    CONTINUE
      XE(I,KK+1)=XMN
      YE(I,KK+1)=YMN
      ZE(I,KK+1)=ZMN
      XE(I,KK+2)=XMX
      YE(I,KK+2)=YMX
```

```
      ZE(I,KK+2)=ZMX
80    NNM(I)=KK+2
      NS1=NS
      GO TO 120
90    DO 110 L=2,NS
      I=L-1
      K=NNM(L)-NC
      DO 100 J=1,K
      KK=J+NC
      XE(I,J)=XE(L,KK)
      YE(I,J)=YE(L,KK)
100   ZE(I,J)=ZE(L,KK)
      XE(I,K+1)=XMN
      YE(I,K+1)=YMN
      ZE(I,K+1)=ZMN
      XE(I,K+2)=XMX
      YE(I,K+2)=YMX
      ZE(I,K+2)=ZMX
110   NNM(I)=K+2
      NS1=NS-1
120   CONTINUE
      CALL LNPLOT (XE,YE,NNM,NS1,NS,LABY)
      CALL LNPLOT (XE,ZE,NNM,NS1,NS,LABZ)
      CALL LNPLOT (YE,ZE,NNM,NS1,NS,LABX)
      RETURN
      END
```

```
      SUBROUTINE LNPLOT (X,Y,NELM,M,MMAX,LABEL)
C     GENERATES PLOT ON LINE PRINTER (WRITTEN BY KU COMPUTATION CENTER)
      DIMENSION NELM(MMAX), X(MMAX,1), Y(MMAX,1), ALINE(101), YAXIS(101)
     1, SYM(20), LABEL(1)
      COMMON /TAPE/ ITEST,IGOOD,SFAC(10),KU3,NSTOP
      DATA SYM/1H1,1H2,1H3,1H4,1H5,1H6,1H7,1H8,1H9,1H0,1HA,1HB,1HC,1HD,1
     1HE,1HF,1HG,1HH,1HI,1HJ/
      DATA YAXIS/1HI,9*1H-,1HI,9*1H-,1HI,9*1H-,1HI,9*1H-,1HI,9*1H-,1HI,9
     1*1H-,1HI,9*1H-,1HI,9*1H-,1HI,9*1H-,1HI,9*1H-,1HI/
      DATA BLANK,UP,PLUS/1H ,1HI,1H+/
      XMAX=X(1,1)
      XMIN=X(1,1)
```

```
      YMAX=Y(1,1)
      YMIN=Y(1,1)
      DO 10 I=1,M
      N=NELM(I)
      DO 10 J=1,N
      IF (X(I,J).GT.XMAX) XMAX=X(I,J)
      IF (X(I,J).LT.XMIN) XMIN=X(I,J)
      IF (Y(I,J).GT.YMAX) YMAX=Y(I,J)
      IF (Y(I,J).LT.YMIN) YMIN=Y(I,J)
10    CONTINUE
      KEY=1
      ZMAX=XMAX
      ZMIN=XMIN
20    RANGE=ZMAX-ZMIN
      IF (RANGE.EQ.0.0) RANGE=ZMAX/2.
      SCALE=1.0E-9
30    SCALE=10.*SCALE
      IF (SCALE.LT.RANGE) GO TO 30
      ZMIN=ZMIN/SCALE
      ZMAX=ZMAX/SCALE
      MIN=20.*(ZMIN-0.025)
      MAX=20.0*(ZMAX+0.025)
      BOTTOM=0.05*FLOAT(MIN)
      TOP=0.05*FLOAT(MAX)
      RANGE=0.1*(TOP-BOTTOM)
      IF (RANGE.EQ.0.0) RANGE=0.1*(TOP/2.)
40    IF (BOTTOM.LE.ZMIN) GO TO 50
      BOTTOM=BOTTOM-RANGE
      GO TO 40
50    IF (TOP.GE.ZMAX) GO TO 60
      TOP=TOP+RANGE
      GO TO 50
60    CONTINUE
      IF (KEY.EQ.2) GO TO 70
      KEY=2
      ZMAX=YMAX
      ZMIN=YMIN
      YINC=0.01*(TOP-BOTTOM)
      XINC=YINC*SCALE
      XBOT=BOTTOM*SCALE
      GO TO 20
```

```
70    CONTINUE
      YINC=0.0125*(TOP-BOTTOM)
      YLOW=TOP+YINC
      YINC=2.*YINC
      WRITE (6,150)
      IF (ITER.GE.KU3) WRITE (ITEST,150)
      KEY=5
80    CONTINUE
      DO 90 IJ=2,101
90    ALINE(IJ)=BLANK
      YHIGH=YLOW
      YLOW=YHIGH-YINC
      YHS=SCALE*YHIGH
      YLS=SCALE*YLOW
      DO 110 I=1,M
      N=NELM(I)
      DO 110 J=1,N
      IF (Y(I,J).GT.YHS.OR.Y(I,J).LE.YLS) GO TO 110
      INDEX=(X(I,J)-XBOT)/XINC
      INDEX=INDEX+1
      IF (INDEX.GT.101) INDEX=101
      IF (ALINE(INDEX).NE.BLANK) GO TO 100
      ALINE(INDEX)=SYM(I)
      GO TO 110
100   ALINE(INDEX)=PLUS
110   CONTINUE
      ALINE(1)=UP
      IF (KEY.NE.5) GO TO 120
      TPP=TOP*SCALE
      WRITE (6,160) TPP,ALINE
      IF (ITER.GE.KU3) WRITE (ITEST,160) TPP,ALINE
      GO TO 130
120   WRITE (6,170) ALINE
      IF (ITER.GE.KU3) WRITE (ITEST,170) ALINE
130   CONTINUE
      KEY=KEY-1
      IF (KEY.EQ.0) KEY=5
      TOP=TOP-YINC
      IF (TOP.GE.BOTTOM) GO TO 80
      IF (KEY.NE.4) GO TO 80
      WRITE (6,200) YAXIS
```

```
      IF (ITER.GE.KU3) WRITE (ITEST,200) YAXIS
      XINC=10.0*XINC
      ALINE(1)=XBOT
      DO 140 I=2,11
140   ALINE(I)=ALINE(I-1)+XINC
      WRITE (6,180) (ALINE(I),I=1,11)
      IF (ITER.GE.KU3) WRITE (ITEST,180) (ALINE(I),I=1,11)
      WRITE (6,190) (LABEL(I),I=1,14)
      IF (ITER.GE.KU3) WRITE (ITEST,190) (LABEL(I),I=1,14)
      RETURN
C
150   FORMAT (1H1,/)
160   FORMAT (1H ,F10.3,1X,101A1)
170   FORMAT (1H ,11X,101A1)
180   FORMAT (1H ,5X,11F10.3)
190   FORMAT (1H ,//,20X,13A6,A2)
200   FORMAT (1H ,11X,101A1)
      END
```

```
      OVERLAY (LEVSP,3,0)
      PROGRAM SOLN
C     SETS UP DIMENSIONS FOR SOLVING THE STRENGTHS OF WING AND LEADING-
C     EDGE VORTEX SYSTEM
      COMMON D(1)
      COMMON /ALLI/ NSW,NSW1,NCW,NWNG,NCPTTL
      LC=1
      LTHETP=LC+NSW1
      LXTE=LTHETP+NSW1
      LXLE=LXTE+NSW
      LYLE=LXLE+NSW
      LCONS=LYLE+NSW
      LCTT=LCONS+NSW1
      LCPWL=LCTT+NSW1
      LCPSW=LCPWL+NCW
      LSI=LCPSW+NSW1
      LSN=LSI+NCW
      LXCP=LSN+NCW
      LYCP=LXCP+NCPTTL
      LXN=LYCP+NCPTTL
```

```
      LYN=LXN+2*NWNG
      LCONI=LYN+2*NWNG
      LCONJ=LCONI+NWNG
      LCONK=LCONJ+NWNG
      LCI=LCONK+NWNG
      LCJ=LCI+NWNG
      LCK=LCJ+NWNG
      LDUMY=LCK+NWNG
      LNEXT=LDUMY+8*NWNG
C     LNEXT=20*NWNG+10*NSW+3*NCW-6
      MNEXT=LCJ+(NWNG+1)**2/4
C     MNEXT=(NWNG+1)**2/4+10*NWNG+10*NSW+3*NCW-6
      CALL AEROUN (NWNG,D(LC),D(LTHETP),D(LXTE),D(LXLE),D(LYLE),D(LCONS)
     1,D(LSI),D(LSN),D(LXCP),D(LYCP),D(LXN),D(LYN),D(LCONI),D(LCONJ),D(L
     2CONK),D(LCI),D(LCJ),D(LCK),D(LDUMY),D(LCTT),D(LCPWL),D(LCPSW))
      RETURN
      END


      SUBROUTINE AERODN (NWNG,C,THETP,XTE,XLE,YLE,CONS,SI,SN,XCP,YCP,XN,
     1YN,CONI,CONJ,CONK,CI,CJ,CK,DUMMY,CT,CPCWL,CPSW1)
C     SOLVES FOR THE STRENGTHS OF WING AND LEADING-EDGE VORTEX SYSTEM
      COMMON /TAPE/ ITEST,IGOOD,SFAC(10),KU3,NSTOP
      COMMON /LEFLP/ YLEF(10,2),XNF(10),YNF(10),ZNF(10),XLF(10,4),
     1YLF(10,4),SLP1(10),SS,CS,ITERS,ZBDYV(200),ZBDY(200)
      COMMON /ALLI/ NSW,NSW1,NCW,IWNG,NCPTTL
      COMMON /ALLRA/ AA(17),SINA,AB(6),BSQD4P
      COMMON /GM/ ITER,L1,L2,L3,L4,L5,L6,L7,L8
      COMMON /NCTT/ NCT,NCON,NBT,NCOR(15),KU1,NFSH(15),KUC,FLG(10)
      COMMON /AERO/ NAERO,MAXL,MAXW,ISPAN,ISF,ITRAKE,ISC
      COMMON /GENCF/ M1(5),NW(2),YBREAK(5),CH(90),SJ(31,3),MJW1(2),
     1MJW2(2),WIDTH(5),SWEEP(60),NTS,NC
      COMMON/CAMB/ ICAM,IM(10),XT(10,21),AAM(10,20),BBM(10,20),
     1CCM(10,20),DDM(10,20),YT(10),ZBDX(200),ZBDXV(200)
      DIMENSION C(1), THETP(1), XTE(1), XLE(1), YLE(1), CONS(1), SI(1),
     1SN(1), XCP(1), YCP(1), DUMMY(1), CONI(1), CONJ(1), CONK(1), CI(1),
     2 CJ(1), CK(1), CT(1), CPCWL(1), CPSW1(1), XN(NWNG,2), YN(NWNG,2)
C     ******************************************************************
      REWIND 1
      REWIND 2
```

```
      REWIND 3
      CALL SKIPR (1,7)
      READ (1) (C(I),I=1,NSW1)
      READ (1) (THETP(I),I=1,NSW1)
      READ (1) (XTE(I),XLE(I),YLE(I),I=1,NSW)
      CALL SKIPR (1,1)
      READ (1) (CONS(I),I=1,NSW1)
      READ (1) (SI(I),SN(I),I=1,NCW)
      READ (1) (XCP(I),YCP(I),I=1,NCPTTL)
      READ (1) ((XN(I,J),YN(I,J),J=1,2),I=1,NWNG)
      READ (1) (CT(I),I=1,NSW1)
      READ (1) (CPCWL(I),I=1,NCW)
      CALL SKIPR (1,2)
      READ (1) (CPSW1(I),I=1,NSW1)
C     ******************************************************************
C     INFLUENCE COEFFICIENT MATRIX EVALUATION
      L1=1
      L2=L1+NWNG
      L3=L2+NWNG
      L4=L3+NWNG
      L5=L4+NWNG
      L6=L5+NWNG
      L7=L6+NWNG
      L8=L7+NWNG
      NCON=0
      NCT=0
      DO 10 I=1,NCPTTL
      ZCP=0.
      CALL VDTWNG (C,THETP,XCP(I),YCP(I),ZCP,XN,YN,XTE,YLE,CONS,DUMMY(L1
     1),DUMMY(L2),DUMMY(L3),DUMMY(L4),DUMMY(L5),DUMMY(L6),DUMMY(L7),DUMM
     2Y(L8),CONI,CONJ,CONK,SI,NSW1,NCW,NWNG)
      WRITE (2) (CONK(J),J=1,NWNG)
      CALL VDTFRE (XCP(I),YCP(I),ZCP,CI,CJ,CK,NSW1,BSQD4P,XLE,YLE)
      WRITE (3) (CK(J),J=1,MAXL)
10    CONTINUE
C     GAMA-EVALUATION
      REWIND 2
      REWIND 3
      READ (2) (CONI(I),I=1,NWNG)
      NWNG1=NWNG+1
      NWNB=NWNG+MAXL
```

```
      NWNB1=NWNB+1
      READ (3) (CONI(I),I=NWNG1,NWNB)
      CONI(NWNB1)=(SINA-ZBDX(1)*AB(1))
      IJ=1
      DO 20 I=1,NWNB
20    CJ(I)=-CONI(I+1)/CONI(1)
      IJ=2
      NJ=NWNB-1
30    CONTINUE
      READ (2) (CONI(I),I=1,NWNG)
      READ (3) (CONI(I),I=NWNG1,NWNB)
      CONI(NWNB1)=(SINA-ZBDX(IJ)*AB(1))
      IF (IJ.GT.NWNG) CONI(NWNB1)=(SINA-CT(IJ-NWNG)-ZBDX(IJ)*AB(1))
      CALL VMSEQN (NJ,IJ,CONI,CJ,CONK)
      IJ=IJ+1
      NJ=NJ-1
      IF (IJ.LE.NWNB) GO TO 30
      WRITE (6,80)
      IF (ITER.GE.KU3) WRITE (ITEST,80)
      DO 40 I=1,NSW1
      DO 40 J=1,NCW
      NP=(I-1)*NCW+J
      IF (ITER.GE.KU3) WRITE (ITEST,90) CPCWL(J),CPSW1(I),CJ(NP)
40    WRITE (6,90) CPCWL(J),CPSW1(I),CJ(NP)
      WRITE (6,100)
      IF (ITER.GE.KU3) WRITE (ITEST,100)
      DO 50 I=1,MAXL
      J=NWNG+I
      FLG(I)=CJ(J)
      IF (ITER.GE.KU3) WRITE (ITEST,90) CPSW1(I),CJ(J)
50    WRITE (6,90) CPSW1(I),CJ(J)
C     EVALUATION OF SECTIONAL LEADING-EDGE THRUST
      CALL THRST (CJ,CONI,CONJ)
      NERR=0
      DO 60 I=1,MAXL
60    IF (ABS(CONJ(I)-CT(I)).GE.(1.0E-10)) NERR=1
      IF (NERR.EQ.1) WRITE (6,110)
      GMSUM=0.
      DO 70 I=2,MAXL
      KS=NWNG+I
70    GMSUM=GMSUM+CJ(KS)
```

```
C     ........•..............................................................
      REWIND 2
      WRITE (2) (CJ(I),I=1,NWNB)
      WRITE (7) GMSUM
C     ........•..............................................................
      RETURN
C
80    FORMAT (1H1,//,22H WING VORTEX STRENGTHS,/,22H ******************
     1**,//,29H      X/C      2Y/B     GAMAY,/,29H      ***      ****
     2  *****)
90    FORMAT (1H ,3F10.5)
100   FORMAT (1H ,//,32H LEADING-EDGE VORTICES STRENGTHS,/,31H *********
     1*********************,//,20H     2Y/B    CAPGAMA,/,20H     ****
     2 *******)
110   FORMAT (//,34H ERROR IN SECTIONAL CT CALCULATION,/,10F10.5)
      END


      SUBROUTINE THRST (SGM,CONK,CT)
C     EVALUATES SECTIONAL LEADING-EDGE THRUST COEFFICIENTS
      COMMON /ALLI/ NSW,NSW1,NCW,NWNG
      COMMON /AERO/ NAERO,MAXL,MAXW,ISPAN,ISF,ITRAKE,ISC
      COMMON /LEFLP/ YLEF(10,2),XNF(10),YNF(10),ZNF(10),XLF(10,4),
     1YLF(10,4),SLP1(10),SS,CS,ITERS,ZBDYV(200),ZBDY(200)
      COMMON /ALLRA/ AA(17),SINA,COSA,SWPLE,AB,BETA2,AC(5),PI
      COMMON/CAMB/ ICAM,IM(10),XT(10,21),AAM(10,20),BBM(10,20),
     1CCM(10,20),DDM(10,20),YT(10),ZBDX(200),ZBDXV(200)
      DIMENSION SGM(1), CONK(1), CT(1)
      AM2=1.-BETA2
      FCOS=COS(SWPLE)
      FTAN=TAN(SWPLE)
      VAR1=FLOAT(NCW)*SQRT(FTAN*FTAN+BETA2)
      VAR2=SQRT(1.-AM2*FCOS*FCOS)
      REWIND 2
      REWIND 3
      CALL SKIPR (2,NWNG)
      CALL SKIPR (3,NWNG)
      DO 30 I=1,MAXL
      WL=0.
      READ (2) (CONK(J),J=1,NWNG)
```

```
      DO 10 J=1,NWNG
10    WL=WL+CONK(J)*SGM(J)
      READ (3) (CONK(J),J=1,MAXL)
      DO 20 J=1,MAXL
      JJ=NWNG+J
20    WL=WL+CONK(J)*SGM(JJ)
      THRT1=(WL+(SINA-ZBDX(NWNG+I)*COSA))/VAR1
30    CT(I)=(PI/2.)*VAR2*THRT1*THRT1/FCOS
      RETURN
      END
```

```
      OVERLAY (LEVSP,4,0)
      PROGRAM LOADS
C     SETS UP DIMENSIONS FOR EVALUATING AERODYNAMIC CHARACTERSTICS
      COMMON D(1)
      COMMON /ALLI/ NSW,NSW1,NCW,NWNG
      COMMON /GENCF/ M1(5),NW(2),YBREAK(5),CH(90),SJ(31,3),MJW1(2),
     1MJW2(2),WIDTH(5),SWEEP(60),NTS,NC
      DIMENSION W(5000)
      NNCW=NCW+1
      NWNP=NNCW*NSW1
      LCI=1
      LCJ=LCI+NWNG
      LCK=LCJ+NWNG
      LCONI=LCK+NWNG
      LCONJ=LCONI+NWNG
      LCONK=LCONJ+NWNG
      LXVWNG=LCONK+NWNG
      LYVWNG=LXVWNG+NWNG
      LXLE=LYVWNG+NWNG
      LXTE=LXLE+NSW
      LYLE=LXTE+NSW
      LSI=LYLE+NSW
      LC=LSI+NCW
      LSWP=LC+NSW1
      LXN=LSWP+NCW*NC
      LYN=LXN+2*NWNG
      LSNN=LYN+2*NWNG
      LTHETP=LSNN+NCW
```

```
      LCONS=LTHETP+NSW1
      LDUMMY=LCONS+NSW1
      LCT=LDUMMY+8*NWNG
      LQI=LCT+NSW1
      LQNN=LQI+NNCW
      LQSWP=LQNN+NNCW
      LXVWNA=LQSWP+NNCW*NC
      LYVWNA=LXVWNA+NSW1
      LGAMA=LYVWNA+NSW1
      LGML=LGAMA+NWNG+NSW1
      LXLM=LGML+NSW1
      LTHT=LXLM+NSW1
      LSCL=LTHT+NNCW
      LSCM=LSCL+NSW1
      LSCD=LSCM+NSW1
      LCOSP=LSCD+NSW1
      LCNC=LCOSP+NNCW
      LCSWL=LCNC+NSW1
      LCSW1=LCSWL+NSW
      LDCPA=LCSW1+NSW1
      LDCP=LDCPA+NSW
      LGMNW=LDCP+NWNP
      LGMY=LGMNW+NWNP
      LVY=LGMY+NWNG+NSW1
      LCOEF=LVY+NWNG
      LDCPN=LCOEF+NSW1*(NNCW+1)
      LWX=LDCPN+NSW1
      LWY=LWX+NWNG+NCW
      LNEXT=LWY+NWNG+NCW
C     LNEXT=28*NWNG+25*NSW+10*NCW-14
      CALL COEFS (D(LCI),D(LCJ),D(LCK),D(LCONI),D(LCONJ),D(LCONK),D(LXVW
     1NG),D(LYVWNG),D(LXLE),D(LXTE),D(LYLE),D(LSI),D(LC),D(LSWP),D(LXN),
     2D(LYN),D(LSNN),D(LTHETP),D(LCONS),D(LDUMMY),D(LCT),D(LQI),D(LQNN),
     3D(LQSWP),D(LXVWNA),D(LYVWNA),NWNG,D(LGAMA),D(LGML),D(LXLM),D(LTHT)
     4,D(LSCL),D(LSCM),D(LSCD),D(LCOSP),D(LCNC),D(LCSWL),D(LCSW1),D(LDCP
     5A),D(LDCP),D(LGMNW),D(LGMY),D(LVY),D(LCOEF),D(LDCPN),D(LWX),D(LWY)
     6,W,NSW1)
      RETURN
      END
```

```
      SUBROUTINE COEFFS (CI,CJ,CK,CONI,CONJ,CONK,XAVWNG,YAVWNG,XLE,XTE,YL
     1E,SI,C,SWP,XN,YN,SNN,THETP,CONS,DUMMY,CT,QI,QNN,QSWP,XAVWNA,YAVWNA
     2,NWNG,GAMA,GML,XLM,THT,SECCL,SECCM,SECCD,COSP,CNC,CPSWL,CPSW1,DCPA
     3,DCP,GMNW,GMY,VY,COEF,DCPN,WX,WY,W,NSW1)
C     COMPUTES THE AERODYNAMIC CHARACTERSTICS
      COMMON /COEFF/ CL,FZMINS(10),FHS(2,10),RATIOS(2,10),
     1CFCORE(2,10),RATIOC(2,10)
      COMMON /ALLRB/ AX(210),ZMIN,NELM(11)
      COMMON /GM/ ITER
      COMMON /LEFLP/ YLEF(10,2),XNF(10),YNF(10),ZNF(10),XLF(10,4),
     1YLF(10,4),SLP1(10),SS,CS,ITERS,ZBDYV(200),ZBDY(200)
     2,CURV(10),CHND(10),SZBDYV(200)
      COMMON /AERO/ NAERO,MAXL,MAXW,ISPAN,ISF,ITRAKE,ISC
      COMMON /ALLI/ NSW,NSWB,NCW,LWNG,NCPTTL,MITER
      COMMON /LOC/ FU1,FU2,XEND,PXL(5),PXT(5),PYL(5)
      COMMON /GENCF/ M1(5),NW(2),YBREAK(5),CH(90),SJ(31,3),MJW1(2),
     1MJW2(2),WIDTH(5),SWEEP(60),NTS,NC
      COMMON /ALLRA/ AA(17),SINA,COSA,AB(8),PI,AC,CBAR,HALFB,AREA
      COMMON /NCTT/ NCT,NCON,NBT,NCOR(15),KU1,NFSH(15),KUC,FLG(10)
      COMMON /XSTN/ XBRR(25),NBRR
      COMMON/CAMB/ ICAM,IM(10),XT(10,21),AAM(10,20),BBM(10,20),
     1CCM(10,20),DDM(10,20),YT(10),ZBDX(200),ZBDXV(200)
      DIMENSION CI(1), CJ(1), CK(1), CONI(1), CONJ(1), CONK(1), XAVWNG(1
     1), YAVWNG(1), XLE(1), XTE(1), YLE(1), SI(1), C(1), SWP(1), SNN(1),
     2 CT(1), XN(NWNG,2), YN(NWNG,2), DUMMY(1), GAMA(1), GML(1), XLM(1),
     3 THT(1), SECCL(1), SECCM(1), SECCD(1), COSP(1), CNC(1), CPSWL(1),
     4CPSW1(1), DCPA(1), DCP(1), GMNW(1), GMY(1), VY(1), DCPN(1), WX(1),
     5 WY(1), W(1), COEF(NSW1,1), CONS(1), THETP(1), QI(1), QNN(1), QSWP
     6(1), XAVWNA(1), YAVWNA(1)
      DIMENSION CONST(3),XCP(100),YCP(100),CPCW1(10),YLM(15)
      DIMENSION AW(4000),AWX(100),AWY(100)
      COMMON /TAPE/ ITEST,IGOOD,SFAC(10),KU3,NSTOP
      DIMENSION F(3),FTX(10,10),FTY(10,10),FTZ(10,10),A(3),B(3),GA(3)
      DIMENSION GT(20)
      COMMON /ABC/ XE(10,40),YE(10,40),ZE(10,40)
C     ******************************************************************
      NSW1=NTS
      NSW=NTS+1
      REWIND 1
      READ (1) NNCW,NWNP
```

```
      READ (1) (QI(I),QNN(I),I=1,NNCW)
      N2=NNCW*NC
      READ (1) (QSWP(I),I=1,N2)
      READ (1) (XAVWNA(I),YAVWNA(I),I=1,NSW1)
      READ (1) (SNN(I),I=1,NCW)
      N3=NCW*NC
      READ (1) (SWP(I),I=1,N3)
      READ (1) (XAVWNG(I),YAVWNG(I),I=1,NWNG)
      READ (1) (C(I),I=1,NSW1)
      READ (1) (THETP(I),I=1,NSW1)
      READ (1) (XTE(I),XLE(I),YLE(I),I=1,NSW)
      READ (1) (XLM(I),YLM(I),I=1,NSW1)
      READ (1) (CONS(I),I=1,NSW1)
      READ (1) (SI(I),ADUM,I=1,NCW)
      READ (1) (XCP(I),YCP(I),I=1,NCPTTL)
      READ (1) ((XN(I,J),YN(I,J),J=1,2),I=1,NWNG)
      READ (1) (CT(I),I=1,NSW1)
      CALL SKIPR (1,1)
      READ (1) (CPCW1(I),I=1,NCW)
      READ (1) (CPSWL(I),I=1,NSW)
      READ (1) (CPSW1(I),I=1,NSW1)
      NWNB=NWNG+NSW1
      REWIND 2
      READ (2) (GAMA(I),I=1,NWNB)
C     ******************************************************************
      PIJ=PI/(2.*FLOAT(NCW))
      DO 10 J=1,NCW
10    COSP(J)=COS((2.*FLOAT(J)-1.)*PIJ)
      IJ=M1(1)
      Y1=YLE(IJ)
      MSW=M1(1)
      CONST(1)=Y1*PI/(AREA*FLOAT(MSW))
      IF (ITRAKE.EQ.1) GO TO 20
      Y2=HALFB-Y1
      MSW=M1(2)
      CONST(2)=Y2*PI/(AREA*FLOAT(MSW))
20    CONTINUE
      DO 40 I=1,NSW1
      GT(I)=0.
      K1=1
      IF (ITRAKE.NE.1.AND.I.GE.M1(1)) K1=M1(1)
```

```
30    GT(I)=GT(I)+GAMA(NWNG+K1)                                          COF 820
      K1=K1+1                                                            COF 830
      IF (K1.GT.I) GO TO 40                                              COF 840
      GO TO 30                                                           COF 850
40    CONTINUE                                                           COF 860
C     CALCULATION OF GMY-VALUES FOR WING SURFACE                         COF 870
      NCON=0                                                             COF 880
      NCT=0                                                              COF 890
      NBT=0                                                              COF 900
      KI=1                                                               COF 910
      MX=M1(KI)-1                                                        COF 920
      DO 70 II=1,NSW1                                                    COF 930
      IF (II.GT.MX) GO TO 50                                             COF 940
      GO TO 60                                                           COF 950
50    KI=KI+1                                                            COF 960
      MX=MX+M1(KI)-1                                                     COF 970
60    CONTINUE                                                           COF 980
      DO 70 J=1,NCW                                                      COF 990
      I=(II-1)*NCW+J                                                     COF1000
      JJ=(KI-1)*NCW+J                                                    COF1010
      XEE=XAVWNG(I)                                                      COF1020
      YEE=YAVWNG(I)                                                      COF1030
      ZEE=0.                                                             COF1040
      CALL NEWVEL (C,THETP,XEE,YEE,ZEE,XN,YN,XTE,YLE,CONS,DUMMY,CONI,CONCOF1050
     1J,CONK,SI,NSW1,NCW,NWNG,CI,CJ,CK,XLE,UU,VV,WW,ADUM,BDUM,CDUM,GAMA,COF1060
     2YLM)                                                               COF1070
      UU=UU                                                              COF1080
      VV=VV                                                              COF1090
      ST=SQRT(1.+SZBDYV(I)**2)                                           COF1100
      SD=SZBDYV(I)/ST                                                    COF1110
      TNSP=TAN(SWP(JJ))                                                  COF1120
      PHIY=ATAN(SZBDYV(I))                                               COF1130
      ACP=SS*SIN(PHIY)                                                   COF1140
      GMY(I)=GAMA(I)*(UU-(VV*COS(PHIY)+ACP)*TNSP)                        COF1150
70    CONTINUE                                                           COF1160
C     CALCULATION OF INDUCED VELOCITIES AT BOUND ELEMENT END-POINTS ON   COF1180
C     WING SURFACE                                                       COF1190
      NAERO=0                                                            COF1200
      DO 90 I=1,NSW1                                                     COF1210
      DO 80 J=1,NCW                                                      COF1220
      NP=(I-1)*NCW+J                                                     COF1230
```

```
      XEE=XN(NP,2)
      YEE=YN(NP,2)
      CALL NEWVEL (C,THETP,XEE,YEE,ZEE,XN,YN,XTE,YLE,CONS,DUMMY,CONI,CON
     1J,CONK,SI,NSW1,NCW,NWNG,CI,CJ,CK,XLE,UU,VV,WW,ADUM,BDUM,CDUM,GAMA,
     2YLM)
      ST=SQRT(1.+SZBDYV(NP)**2)
      SD=SZBDYV(NP)
      VY(NP)=VV
80    CONTINUE
90    CONTINUE
C     CALCULATION OF GMY-VALUES FOR BOUND ELEMENTS NEAR LEADING-EDGE
      DO 100 J=1,NNCW
      FJ=J
100   THT(J)=(2.*FJ-1.)*PI/(2.*FLOAT(NNCW))
      SURA=8.*FLOAT(NNCW)/(4.*PI*SIN(THT(1)))
      DO 110 I=1,MAXL
      NGI=NWNG+I
110   GML(I)=GAMA(NGI)*SURA/C(I)
C     ....................................................................
      REWIND 3
      WRITE (3) (GML(I),I=1,NSW1)
C     ....................................................................
      NAERO=1
      DO 140 II=1,MAXL
      XEE=XAVWNA(II)
      YEE=YAVWNA(II)
      CALL NEWVEL (C,THETP,XEE,YEE,ZEE,XN,YN,XTE,YLE,CONS,DUMMY,CONI,CON
     1J,CONK,SI,NSW1,NCW,NWNG,CI,CJ,CK,XLE,UU,VV,WW,ADUM,BDUM,CDUM,GAMA,
     2YLM)
      JJ=1
      KI=1
      MX=M1(KI)-1
      TNSP=TAN(QSWP(JJ))
      IF (II.GT.MX) GO TO 120
      GO TO 130
120   KI=KI+1
      MX=MX+M1(KI)-1
      JJ=(KI-1)*NNCW+1
      TNSP=TAN(QSWP(JJ))
130   CONTINUE
      NWNGII=NWNG+II
```

```
      IJ=(II-1)*NNCW+1                                                  COF1650
      ST=SQRT(1.+ZBDYV(IJ)**2)                                          COF1660
      SD=ZBDYV(IJ)/ST                                                   COF1670
      PHIY=ATAN(ZBDYV(IJ))                                              COF1680
      ACP=SS*SIN(PHIY)                                                  COF1690
      GMY(NWNGII)=GML(II)*(UU-(VV*COS(PHIY)+ACP)*TNSP)                  COF1700
  140 CONTINUE                                                          COF1710
C     CALCULATION OF DCP-VALUES FOR WING POINTS                         COF1720
      PN=PI/(FLOAT(NCW))                                                COF1730
      DO 150 I=1,NCW                                                    COF1740
      W(I)=0.                                                           COF1750
      WX(I)=XN(I,1)                                                     COF1760
  150 WY(I)=YN(I,1)                                                     COF1770
      DO 230 I=1,NSW1                                                   COF1780
      DO 220 J=1,NCW                                                    COF1790
      NP=(I-1)*NCW+J                                                    COF1800
      VYY=VY(NP)                                                        COF1810
      CPG=0.                                                            COF1820
      CPH=0.                                                            COF1830
      CPI=0.                                                            COF1840
      IF (I.EQ.NSW1.AND.(PXT(NC+1)-PXL(NC+1)).NE.0.) GO TO 210          COF1850
      DO 170 JJ=1,J                                                     COF1860
      NPIN=(I-1)*NCW+JJ                                                 COF1870
      IF (J.EQ.JJ) GO TO 160                                            COF1880
      CPG=CPG+GAMA(NPIN)*SI(JJ)                                         COF1890
      GO TO 170                                                         COF1900
  160 CPG=CPG+0.5*GAMA(NPIN)*SI(JJ)                                     COF1910
  170 CONTINUE                                                          COF1920
      IF (I.EQ.NSW1) ACPG=CPG*C(I)*PN                                   COF1930
      CPG=-CPG*PN*C(I)*VYY                                              COF1940
      IF (I.EQ.NSW1) GO TO 200                                          COF1950
      DO 190 JJ=1,J                                                     COF1960
      NPOT=I*NCW+JJ                                                     COF1970
      IF (J.EQ.JJ) GO TO 180                                            COF1980
      CPH=CPH+GAMA(NPOT)*SI(JJ)                                         COF1990
      GO TO 190                                                         COF2000
  180 CPH=CPH+0.5*GAMA(NPOT)*SI(JJ)                                     COF2010
  190 CONTINUE                                                          COF2020
      CPH=CPH*PN*C(I+1)*VYY                                             COF2030
      GO TO 210                                                         COF2040
  200 Y1=YLE(NSW)                                                       COF2050
```

```
      A1=SQRT(1.-(Y1/HALFB)**2)
      A2=SQRT(1.-(YLM(I)/HALFB)**2)
      CPH=ACPG*A1/A2*VYY
210   CPI=2.*GAMA(NWNG+I)*VYY
      IF (I.NE.NSW1) W(NP+NCW)=2.*(CPG+CPH+CPI)/(YLE(I+2)-YLE(I))
      IF (I.EQ.NSW1) W(NP+NCW)=(CPG+CPH+CPI)/(YLE(I+1)-YLE(I))
      WX(NP+NCW)=XN(NP,2)
      WY(NP+NCW)=YN(NP,2)
220   CONTINUE
230   CONTINUE
C     STRAKE SECTION INTERPOLATION
      LL=1
      INIP=0
      MSX=M1(1)-1
      MPX=M1(1)
      N3=NCW*M1(1)+3
      DO 240 I=1,MPX
      DO 240 J=1,NCW
      NP=(I-1)*NCW+J
      AW(NP)=W(NP)
      AWX(NP)=WX(NP)
      AWY(NP)=WY(NP)
240   CONTINUE
      GO TO 270
C     WING SECTION INTERPOLATION
250   LL=2
      INIP=NCW*(M1(1)-1)
      MSX=M1(2)-1
      MPX=M1(2)
      N3=NCW*M1(2)+3
      DO 260 I=1,MPX
      DO 260 J=1,NCW
      NP=(I-1)*NCW+J
      MP=NP+INIP
      AW(NP)=W(MP)
      AWX(NP)=WX(MP)
      AWY(NP)=WY(MP)
260   CONTINUE
270   CALL SURFSET (N3,AWX,AWY,AW,CI)
      DO 290 K=1,NCW
      DO 280 J=1,MSX
```

```
      NP=INIP+(J-1)*NCW+K
      DCP1=2.*GMY(NP)
      XEE=XAVWNG(NP)
      YEE=YAVWNG(NP)
      CALL SURFORD (AW,XEE,YEE,VV,N3)
      DCPD=VV
      DCP(NP)=DCP1+DCPD
280   CONTINUE
290   CONTINUE
      IF (ITRAKE.NE.1.AND.LL.EQ.1) GO TO 250
C     CALCULATION OF INDUCED VELOCITIES AT END-POINTS OF BOUND ELEMENTS
C     NEAR LEADING-EDGE
      NAERO=0
      CPC=0.5*(1.-COS(THT(1)))
      DO 300 I=2,NSW
      XEE=XLE(I)+CPC*(XTE(I)-XLE(I))
      YEE=YLE(I)
      CALL NEWVEL (C,THETP,XEE,YEE,ZEE,XN,YN,XTE,YLE,CONS,DUMMY,CONI,CON
     1J,CONK,SI,NSW1,NCW,NWNG,CI,CJ,CK,XLE,UU,VV,WW,ADUM,BDUM,CDUM,GAMA,
     2YLM)
      IJ=(I-2)*NNCW+1
      ST=SQRT(1.+ZBDYV(IJ)**2)
      SD=ZBDYV(IJ)/ST
300   VY(I)=VV
C     DCP-INTERPOLATION FOR BOUND ELEMENTS OF WING
      CALL INTGMY (NCW,NSW1,DCP,SNN,COEF,DUMMY(1),DUMMY(NNCW))
C     CALCULATION OF DECREASE IN DCP-VALUES AT THE LEADING-EDGE
      DO 310 I=1,NSW1
      CNC(I)=-2.*GMY(NWNG+I)
310   CONTINUE
C     FINAL DCP-VALUES AT LARGER WING GRID
      DO 350 I=1,NSW1
      DO 340 J=1,NNCW
      NP=(I-1)*NNCW+J
      GMNW(NP)=COEF(I,1)
      DO 320 K=1,NCW
      FK=K
      AMI1=COS(FK*THT(J))
      AMI2=AMI1*COEF(I,K+1)
      GMNW(NP)=GMNW(NP)+AMI2
320   CONTINUE
```

```
      GMNW(NP)=GMNW(NP)/(SIN(THT(J)))
      IF (J.NE.1) GO TO 330
      NGI=NWNG+I
      GMNW(NP)=GMNW(NP)+CNC(I)
330   CONTINUE
340   CONTINUE
350   CONTINUE
      DO 360 I=1,NWNP
360   DCP(I)=GMNW(I)
      DO 370 I=1,NWNP
370   CONTINUE
      PIJ=PI/(2.*FLOAT(NNCW))
      WRITE (6,650)
      IF (ITER.GE.KU3) WRITE (ITEST,650)
      DO 380 I=1,NSW1
      DO 380 J=1,NNCW
      NP=(I-1)*NNCW+J
      CPCW=0.5*(1.-COS((2.*FLOAT(J)-1.)*PIJ))
      IF (ITER.GE.KU3) WRITE (ITEST,660) CPCW,CPSW1(I),DCP(NP)
380   WRITE (6,660) CPCW,CPSW1(I),DCP(NP)
      DO 390 J=1,NNCW
390   COSP(J)=COS((2.*FLOAT(J)-1.)*PIJ)
C     EVALUATION OF SECTIONAL AND TOTAL AERODYNAMIC CHARACTERSTICS
      CL=0.
      CM=0.
      CD=0.
      CTT=0.
      DO 430 I=1,NSW1
      SECCL(I)=0.
      SECCD(I)=0.
      SECCM(I)=0.
      KS=1
      MSW=M1(1)
      NIM=0
      IF (ITRAKE.NE.1.AND.I.GT.M1(1)-1) GO TO 400
      GO TO 410
400   KS=2
      MSW=M1(2)
      NIM=M1(1)-1
410   CONTINUE
      PHII=PI*FLOAT(I-NIM)/FLOAT(MSW)
```

```
      SPI=SIN(PHII)
      DO 420 J=1,NNCW
      NP=(I-1)*NNCW+J
      FT=SQRT(1.+ZBDXV(NP)**2+ZBDYV(NP)**2)
      FAC=(ZBDXV(NP)*SS+CS)/FT
      FAS=(-ZBDXV(NP)*CS+SS)/FT
      SECCL(I)=SECCL(I)+DCP(NP)*QI(J)*FAC
      SECCD(I)=SECCD(I)+DCP(NP)*QI(J)*FAS
      SECCM(I)=SECCM(I)-DCP(NP)*QI(J)*(XLM(I)+0.5*C(I)*(1.-COSP(J)))/CBA
     1R/FT
  420 CONTINUE
      SECCL(I)=SECCL(I)*PI/(2.*FLOAT(NNCW))
      SECCM(I)=SECCM(I)*PI/(2.*FLOAT(NNCW))
      SECCD(I)=SECCD(I)*PI/(2.*FLOAT(NNCW))
      NL=NWNG+I
      FAS=(-ZBDXV(NL)*CS+SS)/FT
      FAC=(ZBDXV(NL)*SS+CS)/FT
      FT=SQRT(1.+ZBDXV(NL)**2+ZBDYV(NL)**2)
      SECCL(I)=SECCL(I)+CT(I)*FAC
      SECCD(I)=SECCD(I)-CT(I)*FAS
      CL=CL+SECCL(I)*C(I)*SPI*CONST(KS)
      CM=CM+SECCM(I)*C(I)*SPI*CONST(KS)
      CD=CD+SECCD(I)*C(I)*SPI*CONST(KS)
  430 CTT=CTT+CT(I)*C(I)*SPI*CONST(KS)
C     ..................................................................
      WRITE (7) CL,CM,CD,CTT
C     ..................................................................
      WRITE (6,620) (I,SECCL(I),SECCM(I),SECCD(I),CT(I),I=1,NSW1)
      IF (ITER.GE.KU3) WRITE (ITEST,620) (I,SECCL(I),SECCM(I),SECCD(I),C
     1T(I),I=1,NSW1)
      WRITE (6,630) CL,CM,CD,CTT
      IF (ITER.GE.KU3) WRITE (ITEST,630) CL,CM,CD,CTT
      NNCW1=NNCW+1
      CALL INTGMY (NNCW,NSW1,DCP,QNN,COEF,DUMMY(1),DUMMY(NNCW1))
      REWIND 1
      CALL SKIPR (1,10)
      READ (1) (XLM(I),CI(I),I=1,NSW1)
C     EVALUATION OF DCP AT CONSTANT X LOCATIONS
      DO 520 K=1,NBRR
      XBR=XBRR(K)
      IF (XBR.GE.PXL(NC+1)) GO TO 460
```

```
      KY=1                                                              COF3700
  440 IF (XBR.LT.XLM(KY)) GO TO 450                                     COF3710
      KY=KY+1                                                           COF3720
      IF (KY.LE.NSW1) GO TO 440                                         COF3730
  450 KY=KY-1                                                           COF3740
      BLOCAL=CI(KY)+(CI(KY+1)-CI(KY))*(XBR-XLM(KY))/(XLM(KY+1)-XLM(KY)) COF3750
      GO TO 470                                                         COF3760
  460 BLOCAL=PYL(NC+1)                                                  COF3770
      KY=NSW1                                                           COF3780
  470 CONTINUE                                                          COF3790
      DO 490 I=1,KY                                                     COF3800
      CJ(I)=CI(I)/BLOCAL                                                COF3810
      XC=(XBR-XLM(I))/C(I)                                              COF3820
      THTA=ARCOS(1.-2.*XC)                                              COF3830
      DCPN(I)=COEF(I,1)                                                 COF3840
      DO 480 J=1,NNCW                                                   COF3850
  480 DCPN(I)=DCPN(I)+COEF(I,J+1)*COS(FLOAT(J)*THTA)                    COF3860
      DCPN(I)=DCPN(I)/(SIN(THTA))                                       COF3870
C     WHENEVER THE NEGATIVE CP OCCURS AFTER SPANWISE INTERPOLATION, THE COF3880
C     FOLLOWING CORRECTION WILL BE MADE                                 COF3890
      IF (DCPN(I).GT.0.) GO TO 490                                      COF3900
      IF (I.EQ.1) GO TO 490                                             COF3910
      DX=CJ(I-1)-1.0                                                    COF3920
      DY=DCPN(I-1)-0.                                                   COF3930
      DYDX=DY/DX                                                        COF3940
      DX1=CJ(I)-1.0                                                     COF3950
      DCPN(I)=DYDX*DX1                                                  COF3960
  490 CONTINUE                                                          COF3970
      IF (DCPN(1).LT.0.) GO TO 500                                      COF3980
      GO TO 510                                                         COF3990
  500 DX=CJ(2)                                                          COF4000
      DY=DCPN(2)-0.5*DCPN(2)                                            COF4010
      DYDX=DY/DX                                                        COF4020
      DX1=CJ(1)                                                         COF4030
      DCPN(1)=0.5*DCPN(2)+DYDX*DX1                                      COF4040
  510 CONTINUE                                                          COF4050
      WRITE (6,640) XBR,(CI(I),CJ(I),DCPN(I),I=1,KY)                    COF4060
      IF (ITER.GE.KU3) WRITE (ITEST,640) XBR,(CI(I),CJ(I),DCPN(I),I=1,KYCOF4070
     1)                                                                 COF4080
  520 CONTINUE                                                          COF4090
C     COMPUTE THE FORCE ON THE FREE SHEET SEGMENTS AFTER SATISFING      COF4100
```

```
C     BOUNDARY CONDITION                                                COF4110
      IF (ITER.LT.KU1+1) GO TO 610                                      COF4120
      SFAC(ITER)=0.                                                     COF4130
      NCT=0                                                             COF4140
      LL=1                                                              COF4150
      L1=1                                                              COF4160
      KS=2                                                              COF4170
      KE=M1(1)-1                                                        COF4180
      GO TO 540                                                         COF4190
530   LL=2                                                              COF4200
      L1=M1(1)                                                          COF4210
      KS=M1(1)+1                                                        COF4220
      KE=MAXL                                                           COF4230
540   CONTINUE                                                          COF4240
      NAERO=0                                                           COF4250
      NCR2=NCOR(L1)-2                                                   COF4260
      DO 550 J=5,NCR2                                                   COF4270
      DO 550 I=KS,KE                                                    COF4280
      GMA=GAMA(NWNG+I)                                                  COF4290
      NBT=0                                                             COF4300
      NCON=I                                                            COF4310
      XEE=0.5*(XE(I,J)+XE(I,J+1))                                       COF4320
      YEE=0.5*(YE(I,J)+YE(I,J+1))                                       COF4330
      ZEE=0.5*(ZE(I,J)+ZE(I,J+1))                                       COF4340
      IF (J.EQ.5) FZMINS(I)=0.50*ZE(I,J+1)                              COF4350
      CALL NEWVEL (C,THETP,XEE,YEE,ZEE,XN,YN,XTE,YLE,CONS,DUMMY,CONI,CONCOF4360
     1J,CONK,SI,NSW1,NCW,NWNG,CI,CJ,CK,XLE,UU,VV,WW,CPCW1,XCP,YCP,GAMA,YCOF4370
     2LM)                                                               COF4380
      A(1)=XE(I,J+1)-XE(I,J)                                            COF4390
      A(2)=YE(I,J+1)-YE(I,J)                                            COF4400
      A(3)=ZE(I,J+1)-ZE(I,J)                                            COF4410
      GA(1)=GMA*A(1)/AREA                                               COF4420
      GA(2)=GMA*A(2)/AREA                                               COF4430
      GA(3)=GMA*A(3)/AREA                                               COF4440
      B(1)=UU                                                           COF4450
      B(2)=VV                                                           COF4460
      B(3)=WW                                                           COF4470
      CALL CRSPRD (B,GA,F)                                              COF4480
      FTX(I,J)=F(1)                                                     COF4490
      FTY(I,J)=F(2)                                                     COF4500
      FTZ(I,J)=F(3)                                                     COF4510
```

```
550   CONTINUE                                                          COF4520
      NSW5=NELM(L1)-NCOR(L1)                                            COF4530
      NAERO=1                                                           COF4540
      CFTX=0.                                                           COF4550
      CFTY=0.                                                           COF4560
      CFTZ=0.                                                           COF4570
      FCXYZ=0.                                                          COF4580
      DO 560 I=1,NSW5                                                   COF4590
      II=NCOR(L1)+I                                                     COF4600
      NCON=(L1-1)+I                                                     COF4610
      IF (NCON.GE.KE) NCON=KE                                           COF4620
      NBT=1                                                             COF4630
      XEE=0.5*(XE(L1,II-1)+XE(L1,II))                                   COF4640
      YEE=0.5*(YE(L1,II-1)+YE(L1,II))                                   COF4650
      ZEE=0.5*(ZE(L1,II-1)+ZE(L1,II))                                   COF4660
      GMA=GT(NCON)                                                      COF4670
      A(1)=XE(L1,II)-XE(L1,II-1)                                        COF4680
      A(2)=YE(L1,II)-YE(L1,II-1)                                        COF4690
      A(3)=ZE(L1,II)-ZE(L1,II-1)                                        COF4700
      CALL NEWVEL (C,THETP,XEE,YEE,ZEE,XN,YN,XTE,YLE,CONS,DUMMY,CONI,CONCOF4710
     1J,CONK,SI,NSW1,NCW,NWNG,CI,CJ,CK,XLE,UU,VV,WW,CPCW1,XCP,YCP,GAMA,YCOF4720
     2LM)                                                               COF4730
      GA(1)=GMA*A(1)/AREA                                               COF4740
      GA(2)=GMA*A(2)/AREA                                               COF4750
      GA(3)=GMA*A(3)/AREA                                               COF4760
      B(1)=UU                                                           COF4770
      B(2)=VV                                                           COF4780
      B(3)=WW                                                           COF4790
      CALL CRSPRD (B,GA,F)                                              COF4800
      FCXYZ=FCXYZ+SQRT(F(1)**2+F(2)**2+F(3)**2)                         COF4810
      CFTX=CFTX+F(1)                                                    COF4820
      CFTY=CFTY+F(2)                                                    COF4830
      CFTZ=CFTZ+F(3)                                                    COF4840
560   CONTINUE                                                          COF4850
      CFTXYZ=SQRT(CFTX**2+CFTY**2+CFTZ**2)                              COF4860
      CFCORE(LL,ITER)=CFTXYZ                                            COF4870
      TFTX=0.                                                           COF4880
      TFTY=0.                                                           COF4890
      TFTZ=0.                                                           COF4900
      FSXYZ=0.                                                          COF4910
      DO 580 I=KS,KE                                                    COF4920
```

```
      NCC=NCOR(I)-2                                                     COF4930
      DO 570 J=5,NCC                                                    COF4940
      TFTX=TFTX+FTX(I,J)                                                COF4950
      TFTY=TFTY+FTY(I,J)                                                COF4960
      TFTZ=TFTZ+FTZ(I,J)                                                COF4970
      FSXYZ=FSXYZ+SQRT(FTX(I,J)**2+FTY(I,J)**2+FTZ(I,J)**2)             COF4980
  570 CONTINUE                                                          COF4990
  580 CONTINUE                                                          COF5000
      TFXYZ=SQRT(TFTX**2+TFTY**2+TFTZ**2)                               COF5010
      FHS(LL,ITER)=TFXYZ                                                COF5020
      SFAC(ITER)=SFAC(ITER)+(FCXYZ+FSXYZ)                               COF5030
      IF (ITRAKE.NE.1.AND.LL.EQ.1) GO TO 530                            COF5040
      IF (ITER.EQ.KU3) GO TO 600                                        COF5050
      IF (ITER.GE.KU3+1) GO TO 590                                      COF5060
      GO TO 610                                                         COF5070
  590 CONTINUE                                                          COF5080
      IF (SFAC(ITER).LE.SFAC(ITER-1)) GO TO 600                         COF5090
      REWIND ITEST                                                      COF5100
      NSTOP=1                                                           COF5110
      MITER=ITER                                                        COF5120
      GO TO 610                                                         COF5130
  600 I=ITEST                                                           COF5140
      ITEST=IGOOD                                                       COF5150
      IGOOD=I                                                           COF5160
      NSTOP=0                                                           COF5170
      REWIND ITEST                                                      COF5180
  610 CONTINUE                                                          COF5190
      RETURN                                                            COF5200
C                                                                       COF5210
  620 FORMAT (1H1,//,9X,20HSECTIONAL PROPERTIES,/,9X,20H****************COF5230
     1****,//,9X,38HI      CL          CM         CD          CT,/,9X,38H*   COF5240
     2 **        **          **          **,/,(I10,4F10.5))             COF5250
  630 FORMAT (1H ,/,9X,23HTOTAL LIFT COEFFICIENT=,F10.5,/,9X,34HTOTAL PICOF5260
     1TCHING MOMENT COEFFICIENT=,F10.5,/,9X,23HTOTAL DRAG COEFFICIENT=,FCOF5270
     210.5,/,9X,25HTOTAL THRUST COEFFICIENT=,F10.5)                     COF5280
  640 FORMAT (1H ,//,34H SPANWISE PRESSURE AT CONSTANT X=,F10.5,/,8X,25HCOF5290
     1Y    2Y/B(LOCAL) DELTA-CP,/,(1X,2F10.5,2X,F10.5))                 COF5300
  650 FORMAT (1H1,//,5X,21HDELTA-CP DISTRIBUTION,/,5X,21H***************COF5310
     1******,/,30H      X/C      2Y/B   DELTA-CP,/,30H      ***      ***COF5320
     2*   ********)                                                     COF5330
  660 FORMAT (1H ,3F10.5)                                               COF5340
```

```
      END

      SUBROUTINE INTGMY (NCW,NSW1,SGM,SNN,COEF,F,THETA)
C     SETS UP COEFFICIENTS OF A MATRIX FOR DCP-INTERPOLATION
      DIMENSION SGM(1), SNN(1), F(1), THETA(1), COEF(NSW1,1)
      PI=3.14159265
      N1=NCW+1
      FN=NCW
      DO 40 I=1,NSW1
      DO 10 J=1,NCW
      NK=(I-1)*NCW+J
      FJ=J
      THETA(J)=(2.*FJ-1.)*PI/(2.*FN)
   10 F(J)=SGM(NK)*SNN(J)
      DO 30 J=1,N1
      COEF(I,J)=0.
      FJ=J
      DO 20 K=1,NCW
   20 COEF(I,J)=COEF(I,J)+F(K)*COS((FJ-1.)*THETA(K))
      IF (J.EQ.1) COEF(I,J)=COEF(I,J)/FN
      IF (J.NE.1) COEF(I,J)=COEF(I,J)*2./FN
   30 CONTINUE
   40 CONTINUE
      RETURN
      END

      SUBROUTINE SURFSET (N3,X,Y,W,IWK)
C       SET UP PROGRAM FOR SURFACE SPLINE
C       WRITTEN BY - ROBERT N. DESMARAIS, STRUCTURES AND DYNAMICS DIV.
C                    LANGLEY RESEARCH CENTER, HAMPTON, VA.23665
      DIMENSION X(1), Y(1), W(N3,1), IWK(1)
      E=1.E-10
      NZ=1
      N=N3-3
      N1=N+1
      N2=N+2
      N4=N3+1
```

```
      RN=1./N
      N3Z=N3+NZ
      NZ3=NZ+3
C       COMPUTE SCALING PARAMETERS, UB,UX,UY,VB,VX,XY
      XB=0.
      YB=0.
      PXX=0.
      PXY=0.
      PYY=0.
      TH=0.
      DO 10 I=1,N
      XB=XB+X(I)
      YB=YB+Y(I)
      PXX=PXX+X(I)*X(I)
      PXY=PXY+X(I)*Y(I)
   10 PYY=PYY+Y(I)*Y(I)
      XB=RN*XB
      YB=RN*YB
      PXX=RN*PXX-XB*XB
      PXY=RN*PXY-XB*YB
      PYY=RN*PYY-YB*YB
      IF (PXY.NE.0) TH=.5*ATAN2(2.*PXY,PYY-PXX)
      CT=COS(TH)
      ST=SIN(TH)
      C2=CT*CT
      CS=2.*CT*ST
      S2=ST*ST
      SU=1./SQRT(PXX*C2-PXY*CS+PYY*S2)
      SV=1./SQRT(PXX*S2+PXY*CS+PYY*C2)
      UX=SU*CT
      UY=-SU*ST
      VX=SV*ST
      VY=SV*CT
      UB=-(UX*XB+UY*YB)
      VB=-(VX*XB+VY*YB)
C       PUT Z INTO ITS W LOCATION
      IZ=N*NZ
      DO 30 J=N4,N3Z
      DO 20 I=1,3
   20 W(I,J)=0
      DO 30 I=4,N3
```

```
      W(I,N37+N4-J)=W(IZ,1)
30    IZ=IZ-1
C       PUT 1,U,V (SCALED X,Y) INTO THEIR W LOCATIONS
      DO 40 J=N1,N3
      DO 40 I=1,3
40    W(I,J)=0
      DO 50 J=1,N
      JB=N4-J
      W(1,J)=1.
      W(JB,N1)=W(1,J)
      W(2,J)=UB+UX*X(J)+UY*Y(J)
      W(JB,N2)=W(2,J)
      W(3,J)=VB+VX*X(J)+VY*Y(J)
50    W(JB,N3)=W(3,J)
      DO 60 J=1,N
      JB=N4-J
C       COMPUTE H MATRIX IN W
      DO 60 I=4,JB
      IB=N4-I
      R2=(W(2,J)-W(2,IB))**2+(W(3,J)-W(3,IB))**2
      W(I,J)=R2*ALOG(R2+E)
60    W(JB,IB)=W(I,J)
C      MATOPS IS THE SYSTEM LIBRARY ROUTINE FOR SOLVING LINEAR EQUATIONS
      N31=N3+1
      CALL MATINV (N3,N3,W,1,W(1,N31),1,DET,ISC,IWK,IWK(N4))
C       PUT S,U,V IN LOW W
      W(1,1)=N3*(3.+NZ)
      W(2,1)=N
      W(3,1)=E
      DO 70 I=1,N
      W(I+3,1)=0
      W(I,2)=UB+UX*X(I)+UY*Y(I)
70    W(I,3)=VB+VX*X(I)+VY*Y(I)
      W(N1,2)=UB
      W(N2,2)=UX
      W(N3,2)=UY
      W(N1,3)=VB
      W(N2,3)=VX
      W(N3,3)=VY
      IF (NZ.EQ.0) RETURN
      DO 80 J=4,NZ3
```

```
      DO 80 I=1,N3
C       LEFT SHIFT A,B MATRICES N COLUMNS
80    W(I,J)=W(I,N+J)
      RETURN
      END


      SUBROUTINE SURFORD (W,XP,YP,ZP,N3)
C       SURFACE SPLINE INTERPOLATION (ORDINATES)
C       WRITTEN BY - ROBERT N. DESMARAIS, STRUCTURES AND DYNAMICS DIV.
C                    LANGLEY RESEARCH CENTER, HAMPTON, VA.23665
      DIMENSION W(N3,1)
      N=N3-3
      N1=N+1
      N2=N+2
      U=W(N1,2)+W(N2,2)*XP+W(N3,2)*YP
      V=W(N1,3)+W(N2,3)*XP+W(N3,3)*YP
      ZP=W(N1,4)+W(N2,4)*U+W(N3,4)*V
      DO 10 I=1,N
      R2=(U-W(I,2))**2+(V-W(I,3))**2
10    ZP=ZP+W(I,4)*R2*ALOG(R2+W(3,1))
      RETURN
      END


      SUBROUTINE MATINV (MAX,N,A,M,B,IOP,DETERM,ISCALE,IPIVOT,IWK)
C     MATRIX INVERSION WITH ACCOMPANYING SOLUTION OF LINEAR EQUATIONS
C     PROVIDED BY - ANALYSIS AND COMPUTATION DIVISION
C                   LANGLEY RESEARCH CENTER
C                   HAMPTON, VA. 23665
      DIMENSION IPIVOT(N), A(MAX,N), B(MAX,N), IWK(MAX,2)
      EQUIVALENCE (IROW,JROW), (ICOLUM,JCOLUM), (AMAX,T,SWAP)
C
C     INITIALIZATION
C
      ISCALE=0
      R1=10.0**100
      R2=1.0/R1
      DETERM=1.0
```

```
      DO 10 J=1,N
10    IPIVOT(J)=0
      DO 370 I=1,N
C
C     SEARCH FOR PIVOT ELEMENT
C
      AMAX=0.0
      DO 60 J=1,N
      IF (IPIVOT(J)-1) 20,60,20
20    DO 50 K=1,N
      IF (IPIVOT(K)-1) 30,50,410
30    IF (ABS(AMAX)-ABS(A(J,K))) 40,50,50
40    IROW=J
      ICOLUM=K
      AMAX=A(J,K)
50    CONTINUE
60    CONTINUE
      IF (AMAX) 80,70,80
70    DETERM=0.0
      ISCALE=0
      GO TO 410
80    IPIVOT(ICOLUM)=IPIVOT(ICOLUM)+1
C
C     INTERCHANGE ROWS TO PUT PIVOT ELEMENT ON DIAGONAL
C
      IF (IROW-ICOLUM) 90,130,90
90    DETERM=-DETERM
      DO 100 L=1,N
      SWAP=A(IROW,L)
      A(IROW,L)=A(ICOLUM,L)
100   A(ICOLUM,L)=SWAP
      IF (M) 130,130,110
110   DO 120 L=1,M
      SWAP=B(IROW,L)
      B(IROW,L)=B(ICOLUM,L)
120   B(ICOLUM,L)=SWAP
130   IWK(I,1)=IROW
      IWK(I,2)=ICOLUM
      PIVOT=A(ICOLUM,ICOLUM)
      IF (IOP.EQ.1) GO TO 270
      IF (PIVOT) 140,70,140
```

```
C
C     SCALE THE DETERMINANT
C
140   PIVOTI=PIVOT
      IF (ABS(DETERM)-R1) 170,150,150
150   DETERM=DETERM/R1
      ISCALE=ISCALE+1
      IF (ABS(DETERM)-R1) 200,160,160
160   DETERM=DETERM/R1
      ISCALE=ISCALE+1
      GO TO 200
170   IF (ABS(DETERM)-R2) 180,180,200
180   DETERM=DETERM*R1
      ISCALE=ISCALE-1
      IF (ABS(DETERM)-R2) 190,190,200
190   DETERM=DETERM*R1
      ISCALE=ISCALE-1
200   IF (ABS(PIVOTI)-R1) 230,210,210
210   PIVOTI=PIVOTI/R1
      ISCALE=ISCALE+1
      IF (ABS(PIVOTI)-R1) 260,220,220
220   PIVOTI=PIVOTI/R1
      ISCALF=ISCALE+1
      GO TO 260
230   IF (ABS(PIVOTI)-R2) 240,240,260
240   PIVOTI=PIVOTI*R1
      ISCALF=ISCALE-1
      IF (ABS(PIVOTI)-R2) 250,250,260
250   PIVOTI=PIVOTI*R1
      ISCALE=ISCALE-1
260   DETERM=DETERM*PIVOTI
C
C     DIVIDE PIVOT ROW BY PIVOT ELEMENT
C
270   IF (PIVOT) 280,70,280
280   A(ICOLUM,ICOLUM)=1.0
      DO 290 L=1,N
290   A(ICOLUM,L)=A(ICOLUM,L)/PIVOT
      IF (M) 320,320,300
300   DO 310 L=1,M
310   B(ICOLUM,L)=B(ICOLUM,L)/PIVOT
```

```
C                                                                       MAT 970
C     REDUCE NON-PIVOT ROWS                                             MAT 980
C                                                                       MAT 990
  320 DO 370 L1=1,N                                                     MAT1000
      IF (L1-ICOLUM) 330,370,330                                        MAT1010
  330 T=A(L1,ICOLUM)                                                    MAT1020
      A(L1,ICOLUM)=0.0                                                  MAT1030
      DO 340 L=1,N                                                      MAT1040
  340 A(L1,L)=A(L1,L)-A(ICOLUM,L)*T                                     MAT1050
      IF (M) 370,370,350                                                MAT1060
  350 DO 360 L=1,M                                                      MAT1070
  360 B(L1,L)=B(L1,L)-B(ICOLUM,L)*T                                     MAT1080
  370 CONTINUE                                                          MAT1090
C                                                                       MAT1100
C     INTERCHANGE COLUMNS                                               MAT1110
C                                                                       MAT1120
      DO 400 I=1,N                                                      MAT1130
      L=N+1-I                                                           MAT1140
      IF (IWK(L,1)-IWK(L,2)) 380,400,380                                MAT1150
  380 JROW=IWK(L,1)                                                     MAT1160
      JCOLUM=IWK(L,2)                                                   MAT1170
      DO 390 K=1,N                                                      MAT1180
      SWAP=A(K,JROW)                                                    MAT1190
      A(K,JROW)=A(K,JCOLUM)                                             MAT1200
      A(K,JCOLUM)=SWAP                                                  MAT1210
  390 CONTINUE                                                          MAT1220
  400 CONTINUE                                                          MAT1230
  410 RETURN                                                            MAT1240
      END                                                               MAT1250-


      OVERLAY (LEVSP,5,0)                                               NSP  10
      PROGRAM NEWSHAP                                                   NSP  20
C     SETS UP DIMENSIONS FOR COMPUTING THE NEW LOCATIONS OF LEADING-EDGENSP  30
C     AND TRAILING-EDGE VORTICES BY MAKING THOSE FORCE-FREE             NSP  40
      COMMON D(1)                                                       NSP  50
      COMMON /ALLI/ NSW,NSW1,NCW,NWNG,NCPTTL                            NSP  60
      COMMON /ABC/ PXE(10,40),PYE(10,40),PZE(10,40),PXXE(11,20),        NSP  70
     1PYYE(11,20),PZZE(11,20),NMAX,NNMAX,NCONTS                         NSP  80
      LC=1                                                              NSP  90
```

```
      LTHETP=LC+NSW1
      LXN=LTHETP+NSW1
      LYN=LXN+2*NWNG
      LXTE=LYN+2*NWNG
      LXLE=LXTE+NSW
      LYLE=LXLE+NSW
      LCONS=LYLE+NSW
      LSI=LCONS+NSW1
      LXCP=LSI+NCW
      LYCP=LXCP+NCPTTL
      LCI=LYCP+NCPTTL
      LCJ=LCI+NWNG
      LCK=LCJ+NWNG
      LCONI=LCK+NWNG
      LCONJ=LCONI+NWNG
      LCONK=LCONJ+NWNG
      LDUMY=LCONK+NWNG
      LGAMA=LDUMY+8*NWNG
      LGML=LGAMA+NCPTTL
      LYLM=LGML+NSW1
      LCPCW=LYLM+NSW1
      LNEXT=LCPCW+NSW1
C     LNEXT=21*NWNG+14*NSW+NCW-9
      CALL NEWELM (D(LC),D(LTHETP),D(LXN),D(LYN),D(LXTE),D(LXLE),D(LYLE)
     1,D(LCONS),D(LSI),D(LXCP),D(LYCP),D(LCI),D(LCJ),D(LCK),D(LCONI),D(L
     2CONJ),D(LCONK),D(LDUMY),NWNG,NCPTTL,NSW1,NSW,NCW,D(LGAMA),D(LGML),
     3D(LYLM),D(LCPCW))
      RETURN
      END


      SUBROUTINE NEWELM (C,THETP,XN,YN,XTE,XLE,YLE,CONS,SI,XCP,YCP,CI,CJ
     1,CK,CONI,CONJ,CONK,DUMMY,NWNG,NCPTTL,NSW1,NSW,NCW,GAMA,GML,YLM,CPC
     2W1)
C     COMPUTES THE NEW LOCATIONS OF LEADING-EDGE AND TRAILING-EDGE
C     VORTICES BY MAKING THOSE FORCE-FREE
      COMMON /INDEX/ IND
      COMMON /GM/ ITER
      COMMON /LOC/ FU1,FU2,XEND,PXL(5),PXT(5),PYL(5),ICL
      COMMON /GENCF/ M1(5),NW(2),YBREAK(5),CH(90),SJ(31,3),MJW1(2),
```

```
     1MJW2(2),WIDTH(5),SWEEP(60),NTS,NC
      COMMON /LANDA/ FGMA1,FBDA1,FGMA,CLS
      COMMON/CAMB/ ICAM,IM(10),XT(10,21),AAM(10,20),BBM(10,20),
     1CCM(10,20),DDM(10,20),YT(10),ZBDX(200),ZBDXV(200)
      COMMON /TIPVX/ XTIP(15,30),YTIP(15,30),ZTIP(15,30),NTLM(15),NTMAX
      COMMON /NCTT/ NCT,NCON,NBT,NCOR(15),KU1,NFSH(15),KUC
      COMMON /ABC/ XE(10,40),YE(10,40),ZE(10,40),XXE(11,20),
     1YYE(11,20),ZZE(11,20),NMAX,NNMAX,NCONTS
      COMMON /OABC/ DXE(10,40),DYE(10,40),DZE(10,40)
      COMMON /ALLRB/ AX(210),ZMIN,NELM(11),NNELM(12)
      COMMON /LOCSP/ FTANTY(10,15),FTANTZ(10,15),CTANTY(40,2),CTANTZ(40,
     12)
      COMMON /INFAV/ FYT(20),FZT(20),FYI(40),FZI(40),VXI(40),VYI(40),VZI
     1(40),FXT(20),TFORCE(20)
      COMMON /MDFAV/ FYP(40,2,2),FZP(40,2,2)
      COMMON /ALLRA/ TTL(16),ALPHA,SINA,AA(9),PI,AB(2),HALFB,AREA
      COMMON /AERO/ NAERO,MAXL,MAXW,ISPAN,ISF,ITRAKE,ISC
      COMMON /XSTN/ XBRR(25)
      DIMENSION DUMMY(1), CONI(1), CONJ(1), CONK(1), CI(1), CJ(1), CK(1)
     1, C(1), THETP(1), XTE(1), XLE(1), YLE(1), CONS(1), SI(1), XCP(1),
     2YCP(1), GAMA(1), GML(1), YLM(1), CPCW1(1), XN(NWNG,2), YN(NWNG,2),
     3A(3),B(3),F(3)
      DIMENSION FTX(10,10),FTY(10,10),FTZ(10,10),SFBDA(40,2),SFGMA(40,2)
      COMMON /COEFF/ CL,FZMINS(10),FHS(2,10),RATIOS(2,10),
     1CFCORE(2,10),RATIOC(2,10)
      DIMENSION GT(10),GA(3),XB(40,2),YB(40,2),ZB(40,2)
      DIMENSION FSIN(4),XE1(10,40),YE1(10,40),ZE1(10,40)
      DIMENSION XE2(10,40),YE2(10,40),ZE2(10,40),TOS(15)
C     ..................................................................
      REWIND 1
      CALL SKIPR (1,7)
      READ (1) (C(I),I=1,NSW1)
      READ (1) (THETP(I),I=1,NSW1)
      READ (1) (XTE(I),XLE(I),YLE(I),I=1,NSW)
      READ (1) (XLM,YLM(I),I=1,NSW1)
      READ (1) (CONS(I),I=1,NSW1)
      READ (1) (SI(I),AC,I=1,NCW)
      READ (1) (XCP(I),YCP(I),I=1,NCPTTL)
      READ (1) ((XN(I,J),YN(I,J),J=1,2),I=1,NWNG)
      CALL SKIPR (1,2)
      READ (1) (CPCW1(I),I=1,NCW)
```

```
      REWIND 2
      READ (2) (GAMA(I),I=1,NCPTTL)
      REWIND 3
      READ (3) (GML(I),I=1,NSW1)
      BHALF=1.25*HALFB
      ATL=1.-0.1*FLOAT(ITER)
      IF (NCONTS.NE.0) ATL=0.75
      IF (ATL.LT.0.75) ATL=0.75
      BTL=1.-ATL
      IF (ITER.LE.KU1) GO TO 70
      KU5=KU1+1
      KU6=KU1+2
      KU7=KU1+3
      NSW1=MAXL
      DO 20 I=1,NSW1
      GT(I)=0.
      K1=1
      IF (ITRAKE.NE.1.AND.I.GE.M1(1)) K1=M1(1)
10    GT(I)=GT(I)+GAMA(NWNG+K1)
      K1=K1+1
      IF (K1.GT.I) GO TO 20
      GO TO 10
20    CONTINUE
C     COMPUTATIONS OF RELAXATION PARAMETERS FOR THE CORE  MODEL
      ALPA=ALPHA*180./PI
      ALPHB=ALPHA
      IF (ALPA.LT.10.) ALPHB=10.*PI/180.
      IF (ITER.EQ.KU5) GO TO 30
      IF (ITER.EQ.KU6) GO TO 40
      IF (ITER.GE.KU7) GO TO 70
30    CONTINUE
      FBDA=0.
      FGMA=0.
      IF (CL.GT.CLS) FBDA=-(CL-CLS)*SIN(ALPHA)/CLS
      FBDA=2.*FBDA
      IF (CL.LT.CLS) FGMA=-1.5*(CLS-CL)/(CLS*TAN(ALPHB))
      IF (CL.LT.CLS.AND.ALPA.LT.20..AND.ALPA.GE.10.) FGMA=0.5*FGMA
      IF (CL.LT.CLS.AND.ALPA.LT.10.) FGMA=0.50*FGMA
      FGMA1=FGMA
      GO TO 60
40    CONTINUE
```

```
      FBDA=0.
      FGMA=0.
      FGMA1=0.
      IF (ICL.EQ.1) GO TO 50
      FBDA=-(CL-CLS)*SIN(ALPHA)/CLS
      GO TO 60
50    FGMA=0.75*(CL-CLS)/(CLS*TAN(ALPHB))
      FGMA1=FGMA
60    CONTINUE
      IF (CL.GT.CLS) CONST=FBDA
      IF (CL.LT.CLS) CONST=FGMA1
      IF (CL.GT.CLS) ICL=1
      IF (CL.LT.CLS) ICL=0
70    CONTINUE
      IF (ITER.EQ.KU1) GO TO 220
      IF (ITER.GT.KU1) GO TO 260
C     DIFFUSED VORTEX FILAMENT MODEL
C     CALCULATION OF THE COORDINATES OF LEADING-EDGE ELEMENTS BY
C     SATISFYING FORCE-FREE CONDITION
      NBT=0
      DO 120 J=5,NMAX
      DO 120 I=2,MAXL
      NCON=I
      K=NELM(I)-1
      IF (J.GT.K) GO TO 120
      XXX=XE(I,J+1)
      YYY=YE(I,J+1)
      ZZZ=ZE(I,J+1)
      DLS=SQRT((XE(I,J+1)-XE(I,J))**2+(YE(I,J+1)-YE(I,J))**2+(ZE(I,J+1)-
     1ZE(I,J))**2)
      XEE=(XE(I,J)+XE(I,J+1))/2.
      YEE=(YE(I,J)+YE(I,J+1))/2.
      ZEE=(ZE(I,J)+ZE(I,J+1))/2.
      CALL NEWVEL (C,THETP,XEE,YEE,ZEE,XN,YN,XTE,YLE,CONS,DUMMY,CONI,CONN
     1J,CONK,SI,NSW1,NCW,NWNG,CI,CJ,CK,XLE,UU,VV,WW,CPCW1,XCP,YCP,GAMA,YN
     2LM)
      UVW=SQRT(UU*UU+VV*VV+WW*WW)
      IF (J.EQ.5) GO TO 80
      VVA=ATL*VV/UVW
      WWA=ATL*WW/UVW
      DLY=VVA*DLS+BTL*(YE(I,J+1)-YE(I,J))
```

```
      DLZ=WWA*DLS+BTL*(ZE(I,J+1)-ZE(I,J))
      GO TO 90
80    CONTINUE
      VVA=0.5*VV/UVW
      WWA=0.5*WW/UVW
      DLY=VVA*DLS+0.5*(YE(I,J+1)-YE(I,J))
      DLZ=WWA*DLS+0.5*(ZE(I,J+1)-ZE(I,J))
      GO TO 100
90    CONTINUE
      IF ((DLZ/DLS).GT.SINA) DLZ=DLS*SINA
100   CONTINUE
      YINT=YE(I,J)+DLY
      ZINT=ZE(I,J)+DLZ
      IF (YINT.LE.YE(2,5)) YINT=YE(2,5)
      IF (YINT.GE.BHALF) YINT=BHALF
      IF (ZINT.LE.ZMIN) ZINT=ZMIN
      DLY2=YINT-YE(I,J)
      DLZ2=ZINT-ZE(I,J)
      DLX22=DLS*DLS-DLY2*DLY2-DLZ2*DLZ2
      IF (DLX22.LE.0.) DLY2=DLY2/2.
      IF (DLX22.LE.0.) DLZ2=DLZ2/2.
      DLX2=SQRT(DLS*DLS-DLY2*DLY2-DLZ2*DLZ2)
      XE(I,J+1)=XE(I,J)+DLX2
      YE(I,J+1)=YE(I,J)+DLY2
      ZE(I,J+1)=ZE(I,J)+DLZ2
      DX=XE(I,J+1)-XXX
      DY=YE(I,J+1)-YYY
      DZ=ZE(I,J+1)-ZZZ
      J2=J+2
      KP=K+1
      IF (J2.GT.KP) GO TO 120
      DO 110 JK=J2,KP
      XE(I,JK)=XE(I,JK)+DX
      YE(I,JK)=YE(I,JK)+DY
110   ZE(I,JK)=ZE(I,JK)+DZ
120   CONTINUE
130   CONTINUE
C     CALCULATION OF THE COORDINATES OF WAKE ELEMENTS BY SATISFYING
C     FORCE-FREE CONDITION
      NAERO=0
      CTL=0.5
```

```
      DTL=1.-CTL
      NCON=0
      NBT=0
      DO 160 J=1,NNMAX
      DO 160 I=2,MAXW
      NCT=I
      K=NNELM(I)-1
      IF (J.GT.K) GO TO 160
      XXX=XXE(I,J+1)
      YYY=YYE(I,J+1)
      ZZZ=ZZE(I,J+1)
      WLS=SQRT((XXE(I,J+1)-XXE(I,J))**2+(YYE(I,J+1)-YYE(I,J))**2+(ZZE(I,
     1J+1)-ZZE(I,J))**2)
      XEE=(XXE(I,J)+XXE(I,J+1))/2.
      YEE=(YYE(I,J)+YYE(I,J+1))/2.
      ZEE=(ZZE(I,J)+ZZE(I,J+1))/2.
      CALL NEWVEL (C,THETP,XEE,YEE,ZEE,XN,YN,XTE,YLE,CONS,DUMMY,CONI,CONN
     1J,CONK,SI,NSW1,NCW,NWNG,CI,CJ,CK,XLE,UU,VV,WW,CPCW1,XCP,YCP,GAMA,YN
     2LM)
      UVW=SQRT(UU*UU+VV*VV+WW*WW)
      IF (J.EQ.1) GO TO 150
      VVA=CTL*VV/UVW
      WWA=CTL*WW/UVW
      DLY=VVA*WLS+DTL*(YYE(I,J+1)-YYE(I,J))
      DLZ=WWA*WLS+DTL*(ZZE(I,J+1)-ZZE(I,J))
      IF ((DLZ/WLS).GT.SINA) DLZ=WLS*SINA
      YINT=YYE(I,J)+DLY
      IF (YINT.LE.(YLE(2)/2.)) YINT=YLE(2)/2.
      IF (YINT.GE.BHALF) YINT=BHALF
      DLY2=YINT-YYE(I,J)
      DLZ2=DLZ
      DLX22=WLS*WLS-DLY2*DLY2-DLZ2*DLZ2
      IF (DLX22.LE.0.) DLY2=DLY2/2.
      IF (DLX22.LE.0.) DLZ2=DLZ2/2.
      DLX2=SQRT(WLS*WLS-DLY2*DLY2-DLZ2*DLZ2)
      XXE(I,J+1)=XXE(I,J)+DLX2
      YYE(I,J+1)=YYE(I,J)+DLY2
      ZZE(I,J+1)=ZZE(I,J)+DLZ2
      DX=XXE(I,J+1)-XXX
      DY=YYE(I,J+1)-YYY
      DZ=ZZE(I,J+1)-ZZZ
```

```
      J2=J+2
      KP=K+1
      IF (J2.GT.KP) GO TO 150
      DO 140 JK=J2,KP
      XXE(I,JK)=XXE(I,JK)+DX
      YYE(I,JK)=YYE(I,JK)+DY
140   ZZE(I,JK)=ZZE(I,JK)+DZ
150   CONTINUE
160   CONTINUE
C     CALCULATION OF THE COORDINATES OF TIP VORTICES BY SATISFING
C     FORCE FREE CONDITION
      IF ((PXT(NC+1)-PXL(NC+1)).EQ.0.) GO TO 210
      CTL=0.5
      DTL=1.-CTL
      NCON=0
      NBT=0
      DO 190 J=1,NTMAX
      DO 190 I=1,NCW
      NCT=I
      K=NTLM(I)-1
      IF (J.GT.K) GO TO 190
      XXX=XTIP(I,J+1)
      YYY=YTIP(I,J+1)
      ZZZ=ZTIP(I,J+1)
      TLS=SQRT((XTIP(I,J+1)-XTIP(I,J))**2+(YTIP(I,J+1)-YTIP(I,J))**2+(ZT
     1IP(I,J+1)-ZTIP(I,J))**2)
      XEE=0.5*(XTIP(I,J+1)+XTIP(I,J))
      YEE=0.5*(YTIP(I,J+1)+YTIP(I,J))
      ZEE=0.5*(ZTIP(I,J+1)+ZTIP(I,J))
      CALL NEWVEL (C,THETP,XEE,YEE,ZEE,XN,YN,XTE,YLE,CONS,DUMMY,CONI,CON
     1J,CONK,SI,NSW1,NCW,NWNG,CI,CJ,CK,XLE,UU,VV,WW,CPCW1,XCP,YCP,GAMA,Y
     2LM)
      UVW=SQRT(UU**2+VV**2+WW**2)
      IF (J.EQ.1) GO TO 180
      VVA=CTL*VV/UVW
      WWA=CTL*WW/UVW
      DLY=VVA*TLS+DTL*(YTIP(I,J+1)-YTIP(I,J))
      DLZ=WWA*TLS+DTL*(ZTIP(I,J+1)-ZTIP(I,J))
      DLX=SQRT(TLS**2-DLY**2-DLZ**2)
      XTIP(I,J+1)=XTIP(I,J)+DLX
      YTIP(I,J+1)=YTIP(I,J)+DLY
```

```
      ZTIP(I,J+1)=ZTIP(I,J)+DLZ
      IF (ZTIP(I,J+1).LE.0..AND.YTIP(I,J+1).LE.HALFB.AND.XTIP(I,J+1).LE.
     1PXT(NC+1)) ZTIP(I,J+1)=ZMIN
      DX=XTIP(I,J+1)-XXX
      DY=YTIP(I,J+1)-YYY
      DZ=ZTIP(I,J+1)-ZZZ
      J2=J+2
      KP=K+1
      IF (J2.GT.KP) GO TO 180
      DO 170 JK=J2,KP
      XTIP(I,JK)=XTIP(I,JK)+DX
      YTIP(I,JK)=YTIP(I,JK)+DY
  170 ZTIP(I,JK)=ZTIP(I,JK)+DZ
  180 CONTINUE
  190 CONTINUE
      DO 200 I=1,NCW
      KK=NTLM(I)
      WRITE (6,740) (XTIP(I,J),J=1,KK)
      WRITE (6,740) (YTIP(I,J),J=1,KK)
      WRITE (6,740) (ZTIP(I,J),J=1,KK)
  200 CONTINUE
  210 CONTINUE
      RETURN
  220 CONTINUE
C     DETERMINE THE INITIAL SHAPE OF FREE SHEET AND CORE FROM THE
C     ESTABLISHED LEADING-EDGE VORTEX FILAMENT SYSTEM
      NSW1=MAXL
      CALL CORE (XB,YB,ZB,XEND,GAMA,NSW1,NELM,NWNG,NXB)
      CALL MODEL (XB,YB,ZB,NELM,NXB,M1,LASTE)
      CALL LIRITN (NCOR,NELM,M1,LASTE)
      CALL APEXC (NELM,NCOR,M1)
      NSW1=MAXL
      NSW=MAXW
C     PUNCH CARDS FOR ANGLE OF ATTACK IS LESS THAN TWENTY DEGREES
      PUNCH 760, (NELM(I),I=1,NSW1)
      DO 230 I=1,NSW1
      K=NELM(I)
      PUNCH 750, (XE(I,J),J=1,K)
      PUNCH 750, (YE(I,J),J=1,K)
      PUNCH 750, (ZE(I,J),J=1,K)
  230 CONTINUE
```

```
      PUNCH 760, (NNELM(I),I=1,NSW)                                     NLM2970
      DO 240 I=1,NSW                                                    NLM2980
      K=NNELM(I)                                                        NLM2990
      PUNCH 750, (XXE(I,J),J=1,K)                                       NLM3000
      PUNCH 750, (YYE(I,J),J=1,K)                                       NLM3010
      PUNCH 750, (ZZE(I,J),J=1,K)                                       NLM3020
  240 CONTINUE                                                          NLM3030
      IF ((PXT(NC+1)-PXL(NC+1)).EQ.0.) RETURN                           NLM3040
      PUNCH 760, (NTLM(I),I=1,NCW)                                      NLM3050
      DO 250 I=1,NCW                                                    NLM3060
      K=NTLM(I)                                                         NLM3070
      PUNCH 750, (XTIP(I,J),J=1,K)                                      NLM3080
      PUNCH 750, (YTIP(I,J),J=1,K)                                      NLM3090
      PUNCH 750, (ZTIP(I,J),J=1,K)                                      NLM3100
  250 CONTINUE                                                          NLM3110
      RETURN                                                            NLM3120
  260 CONTINUE                                                          NLM3130
C     VORTEX CORE MODEL                                                 NLM3140
      NAERO=1                                                           NLM3150
      CALL CFAEC (C,THETP,XN,YN,XTE,XLE,YLE,YLM,CONS,CONI,CONJ,CONK,DUMMNLM3160
     1Y,SI,NSW1,NCW,NWNG,CI,CJ,CK,CPCW1,XCP,YCP,GAMA,AREA,ITER,GT,1)    NLM3170
C     CALCULATION OF THE NEW LOCATIONS OF FREE SHEET SEGMENTS BY        NLM3180
C     SATISFING FORCE FREE CONDITION                                    NLM3190
      NAERO=0                                                           NLM3200
      DO 290 I=2,MAXL                                                   NLM3210
      IF (ITRAKE.NE.1.AND.I.EQ.M1(1)) GO TO 290                         NLM3220
      NCR2=NCOR(I)-2                                                    NLM3230
      DO 280 J=5,NCR2                                                   NLM3240
      A(1)=XE(I,J+1)-XE(I,J)                                            NLM3250
      A(2)=YE(I,J+1)-YE(I,J)                                            NLM3260
      A(3)=ZE(I,J+1)-ZE(I,J)                                            NLM3270
      IF (J.EQ.NCR2) GO TO 270                                          NLM3280
      FTANTY(I,J)=A(2)/A(1)                                             NLM3290
      FTANTZ(I,J)=A(3)/A(1)                                             NLM3300
      GO TO 280                                                         NLM3310
  270 TOS(I)=A(3)                                                       NLM3320
  280 CONTINUE                                                          NLM3330
  290 CONTINUE                                                          NLM3340
      LL=1                                                              NLM3350
      L1=1                                                              NLM3360
      KS=2                                                              NLM3370
```

```
      KE=M1(1)-1
      GO TO 310
  300 LL=2
      L1=M1(1)
      KS=M1(1)+1
      KE=MAXL
  310 CONTINUE
      IF (ITRAKE.NE.1.AND.ITER.GE.KU7) GO TO 320
      IF (ITER.EQ.KU5) GO TO 330
      IF (ITRAKE.EQ.1.AND.ITER.GE.KU7.AND.RATIOS(LL,ITER).LE.0.05) GO TO
     1 320
      ATL=0.5
      BTL=0.75
      GO TO 340
  320 ATL=0.90
      BTL=0.95
      GO TO 340
  330 ATL=0.5
      BTL=0.5
  340 CONTINUE
      NCR2=NCOR(L1)-2
      DO 430 J=5,NCR2
      DO 420 I=KS,KE
      GMA=GAMA(NWNG+I)
      XXX=XE(I,J+1)
      YYY=YE(I,J+1)
      ZZZ=ZE(I,J+1)
      NBT=0
      NCON=I
      XEE=0.5*(XE(I,J)+XE(I,J+1))
      YEE=0.5*(YE(I,J)+YE(I,J+1))
      ZEE=0.5*(ZE(I,J)+ZE(I,J+1))
      CALL NEWVEL (C,THETP,XEE,YEE,ZEE,XN,YN,XTE,YLE,CONS,DUMMY,CONI,CON
     1J,CONK,SI,NSW1,NCW,NWNG,CI,CJ,CK,XLE,UU,VV,WW,CPCW1,XCP,YCP,GAMA,Y
     2LM)
      A(1)=XE(I,J+1)-XE(I,J)
      A(2)=YE(I,J+1)-YE(I,J)
      A(3)=ZE(I,J+1)-ZE(I,J)
      DLS=SQRT(A(1)**2+A(2)**2+A(3)**2)
      GA(1)=GMA*A(1)/AREA
      GA(2)=GMA*A(2)/AREA
```

```
      GA(3)=GMA*A(3)/AREA
      B(1)=UU
      B(2)=VV
      B(3)=WW
      CALL CRSPRD (B,GA,F)
      FTX(I,J)=F(1)
      FTY(I,J)=F(2)
      FTZ(I,J)=F(3)
      IF (I.EQ.KS.AND.LL.EQ.1) GO TO 420
      IF (J.EQ.NCR2) GO TO 410
      TANTY=VV/UU
      TANTZ=WW/UU
      IF (J.EQ.5) GO TO 350
      TANTY=(1.-ATL)*TANTY+ATL*FTANTY(I,J)
      TANTZ=(1.-ATL)*TANTZ+ATL*FTANTZ(I,J)
      GO TO 360
  350 TANTY=(1.-BTL)*TANTY+BTL*FTANTY(I,J)
      TANTZ=(1.-BTL)*TANTZ+BTL*FTANTZ(I,J)
  360 CONTINUE
      DLX=DLS/SQRT(1.+TANTY**2+TANTZ**2)
      DLY=DLX*TANTY
      DLZ=DLX*TANTZ
      XE(I,J+1)=XE(I,J)+DLX
      YE(I,J+1)=YE(I,J)+DLY
      ZE(I,J+1)=ZE(I,J)+DLZ
      IF (ITER.EQ.KU5) GO TO 380
      IF (ZE(I,J+1).LT.FZMINS(I).AND.J.EQ.5) GO TO 370
      GO TO 380
  370 ZE(I,J+1)=FZMINS(I)
      DLZ=ZE(I,J+1)-ZZZ
      DLY=SQRT(DLS**2-DLX**2-DLZ**2)
      YE(I,J+1)=YE(I,J)+DLY
  380 CONTINUE
      DX=XE(I,J+1)-XXX
      DY=YE(I,J+1)-YYY
      DZ=ZE(I,J+1)-ZZZ
      J2=J+2
      KP=NCOR(I)-1
      IF (J2.GT.KP) GO TO 400
      DO 390 JK=J2,KP
      XE(I,JK)=XE(I,JK)+DX
```

```
      YE(I,JK)=YE(I,JK)+DY                                              NLM4200
      ZE(I,JK)=ZE(I,JK)+DZ                                              NLM4210
  390 CONTINUE                                                          NLM4220
  400 CONTINUE                                                          NLM4230
      GO TO 420                                                         NLM4240
  410 NCR3=NCR2+1                                                       NLM4250
      XE(I,NCR3)=XE(I,NCR2)                                             NLM4260
      YE(I,NCR3)=YE(I,NCR2)                                             NLM4270
      ZE(I,NCR3)=ZE(I,NCR2)+TOS(I)                                      NLM4280
  420 CONTINUE                                                          NLM4290
  430 CONTINUE                                                          NLM4300
      IF (LL.EQ.2) GO TO 450                                            NLM4310
C     LINEAR INTERPOLATION                                              NLM4320
      RXE=(XE(KS,4)-PXL(LL))/(XE(KS+1,4)-PXL(LL))                       NLM4330
      RYE=(YE(KS,4)-PYL(LL))/(YE(KS+1,4)-PYL(LL))                       NLM4340
      NXOR=NCOR(KS)-1                                                   NLM4350
      DO 440 L=6,NXOR                                                   NLM4360
      XE(KS,L)=(XE(KS+1,L)-PXL(LL))*RXE+PXL(LL)                         NLM4370
      YE(KS,L)=(YE(KS+1,L)-PYL(LL))*RYE+PYL(LL)                         NLM4380
      ZE(KS,L)=ZE(KS+1,L)*RYE                                           NLM4390
  440 CONTINUE                                                          NLM4400
  450 CONTINUE                                                          NLM4410
      IF (ITRAKE.NE.1.AND.LL.EQ.1) GO TO 300                            NLM4420
      CALL NEWDA                                                        NLM4430
C     CALCULATION OF THE NEW LOCATIONS OF CONCENTRATED CORE BY          NLM4440
C     SATISFING THE FORCE FREE CONDITION                                NLM4450
      LL=1                                                              NLM4460
      L1=1                                                              NLM4470
      L3=L1+1                                                           NLM4480
      LMAX=M1(1)-1                                                      NLM4490
      KS=2                                                              NLM4500
      KE=LMAX                                                           NLM4510
      LO=L1-1                                                           NLM4520
      GO TO 470                                                         NLM4530
  460 LL=2                                                              NLM4540
      L1=M1(1)                                                          NLM4550
      L3=L1+1                                                           NLM4560
      LMAX=MAXL                                                         NLM4570
      KS=M1(1)+1                                                        NLM4580
      KE=LMAX                                                           NLM4590
      LO=L1-1                                                           NLM4600
```

```
470   CONTINUE
      FSMIN=FHS(LL,ITER)
      NAERO=1
      NFINAL=0
      CALL CFAEC (C,THETP,XN,YN,XTE,XLE,YLE,YLM,CONS,CONI,CONJ,CONK,DUMM
     1Y,SI,NSW1,NCW,NWNG,CI,CJ,CK,CPCW1,XCP,YCP,GAMA,AREA,ITER,GT,2)
      IF (ITER.EQ.KU5.OR.ITER.EQ.KU6) GO TO 480
      A1=TFORCE(LL)
      B1=TFORCE(LL)
      CALL SEGMNT (A1,B1,NELM,NCOR,SFGMA,SFBDA)
480   CONTINUE
490   CONTINUE
      NCT=0
      NFINAL=NFINAL+1
      FACTOR=1.0
      IF (ITER.GE.KU7.AND.RATIOC(LL,ITER).LT.0.05) FACTOR=0.1
      NAERO=1
      NSW5=NELM(L1)-NCOR(L1)
      DO 570 I=1,NSW5
      IF (I.EQ.1) GO TO 570
      II=NCOR(L1)+I
      NCON=LO+I
      IF (NCON.GE.LMAX) NCON=LMAX
      NBT=1
      XXX=XE(L1,II)
      YYY=YE(L1,II)
      ZZZ=ZE(L1,II)
      XEE=0.5*(XE(L1,II-1)+XE(L1,II))
      YEE=0.5*(YE(L1,II-1)+YE(L1,II))
      ZEE=0.5*(ZE(L1,II-1)+ZE(L1,II))
      GMA=GT(NCON)
      A(1)=XE(L1,II)-XE(L1,II-1)
      A(2)=YE(L1,II)-YE(L1,II-1)
      A(3)=ZE(L1,II)-ZE(L1,II-1)
      CALL NEWVEL (C,THETP,XEE,YEE,ZEE,XN,YN,XTE,YLE,CONS,DUMMY,CONI,CON
     1J,CONK,SI,NSW1,NCW,NWNG,CI,CJ,CK,XLE,UU,VV,WW,CPCW1,XCP,YCP,GAMA,Y
     2LM)
      GA(1)=GMA*A(1)/AREA
      GA(2)=GMA*A(2)/AREA
      GA(3)=GMA*A(3)/AREA
      B(1)=UU
```

```
      B(2)=VV                                                           NLM5020
      B(3)=WW                                                           NLM5030
      CALL CRSPRD (B,GA,F)                                              NLM5040
      FYI(I)=F(2)                                                       NLM5050
      FZI(I)=F(3)                                                       NLM5060
      IF (ITER.EQ.KU5.OR.ITER.EQ.KU6) GO TO 530                         NLM5070
      IF (NFINAL.EQ.1.OR.NFINAL.EQ.3) SIGN=1.0                          NLM5080
      IF (NFINAL.EQ.2.OR.NFINAL.EQ.4) SIGN=-1.0                         NLM5090
      GO TO (510,510,500,500), NFINAL                                   NLM5100
  500 CONTINUE                                                          NLM5110
      FGMA1=SIGN*SFGMA(I,LL)                                            NLM5120
      FBDA=0.                                                           NLM5130
      CONST=FGMA1                                                       NLM5140
      GO TO 520                                                         NLM5150
  510 FBDA=SIGN*SFBDA(I,LL)                                             NLM5160
      FGMA1=0.                                                          NLM5170
      CONST=FBDA                                                        NLM5180
  520 CONTINUE                                                          NLM5190
  530 CONTINUE                                                          NLM5200
      TANTY=CTANTY(I,LL)-FBDA*ABS(FZI(I))/(GA(1)*B(1))*FACTOR           NLM5210
      TANTZ=CTANTZ(I,LL)+FGMA1*ABS(FYI(I))/(GA(1)*B(1))*FACTOR          NLM5220
      DLS=SQRT(A(1)**2+A(2)**2+A(3)**2)                                 NLM5230
      DLX=DLS/SQRT(1.+TANTY**2+TANTZ**2)                                NLM5240
      DLY=DLX*TANTY                                                     NLM5250
      DLZ=DLX*TANTZ                                                     NLM5260
      XE(L1,II)=XE(L1,II-1)+DLX                                         NLM5270
      YE(L1,II)=YE(L1,II-1)+DLY                                         NLM5280
      ZE(L1,II)=ZE(L1,II-1)+DLZ                                         NLM5290
      IF (ZE(L1,II).LT.0.) ZE(L1,II)=ZMIN                               NLM5300
C      TO ADJUST THE ENTIRE CORE SIMULTANEOUSLY                         NLM5310
      IF (I.EQ.NSW5) GO TO 550                                          NLM5320
      DX=XE(L1,II)-XXX                                                  NLM5330
      DY=YE(L1,II)-YYY                                                  NLM5340
      DZ=ZE(L1,II)-ZZZ                                                  NLM5350
      KN=II+1                                                           NLM5360
      KK=NELM(L1)                                                       NLM5370
      DO 540 IL=KN,KK                                                   NLM5380
      XE(L1,IL)=XE(L1,IL)+DX                                            NLM5390
      YE(L1,IL)=YE(L1,IL)+DY                                            NLM5400
      ZE(L1,IL)=ZE(L1,IL)+DZ                                            NLM5410
  540 CONTINUE                                                          NLM5420
```

```
550   CONTINUE                                                          NLM5430
      DO 560 IK=L3,LMAX                                                 NLM5440
      NK=NELM(IK)                                                       NLM5450
      JK=NCOR(IK)                                                       NLM5460
      DO 560 L=JK,NK                                                    NLM5470
      XE(IK,L)=XE(IK-1,L+1)                                             NLM5480
      YE(IK,L)=YE(IK-1,L+1)                                             NLM5490
      ZE(IK,L)=ZE(IK-1,L+1)                                             NLM5500
560   CONTINUE                                                          NLM5510
570   CONTINUE                                                          NLM5520
      IF (ITRAKE.NE.1) GO TO 580                                        NLM5530
      IF (ITER.GT.KU6) GO TO 580                                        NLM5540
C     ADJUST THE 2ND END POINT OF THE FIRST CORE SEGMENT BY             NLM5550
C     LINEAR INTERPOLATION FROM THE THIRD POINT AND APEX.               NLM5560
      NXOR1=NCOR(L1)+1                                                  NLM5570
      NXOR2=NCOR(L1)+2                                                  NLM5580
      NXOR=NCOR(L1)                                                     NLM5590
      RY=(YE(L1,NXOR2)-PYL(LL))/(XE(L1,NXOR2)-PXL(LL))                  NLM5600
      RZ=(ZE(L1,NXOR2)-0.)/(XE(L1,NXOR2)-PXL(LL))                       NLM5610
      YE(L1,NXOR1)=RY*(XE(L1,NXOR1)-PXL(LL))+PYL(LL)                    NLM5620
      ZE(L1,NXOR1)=RZ*(XE(L1,NXOR1)-PXL(LL))                            NLM5630
      ZE(L1,NXOR1)=0.5*(ZE(L1,NXOR1)+ZE(L1,NXOR2))                      NLM5640
      YE(L1+1,NXOR)=YE(L1,NXOR1)                                        NLM5650
      ZE(L1+1,NXOR)=ZE(L1,NXOR1)                                        NLM5660
580   CONTINUE                                                          NLM5670
C     CHECK FREE SHEET AND CORE LOCATION AFTER CORE ADJUSTMENTS         NLM5680
C     NOTE THAT FIRST CORE SEGMENT FROM APEX IS COVERED BY FREE SHEET   NLM5690
      DO 600 II=KS,KE                                                   NLM5700
      NXOR=NCOR(II)                                                     NLM5710
      NCA=NCOR(II)-1                                                    NLM5720
      IF (YE(II,NXOR).LT.YE(II,NCA)) GO TO 590                          NLM5730
      GO TO 600                                                         NLM5740
590   NCB=NXOR-2                                                        NLM5750
      YE(II,NCA)=YE(II,NXOR)                                            NLM5760
      YE(II,NCB)=YE(II,NXOR)                                            NLM5770
600   CONTINUE                                                          NLM5780
      CALL CFAEC (C,THETP,XN,YN,XTE,XLE,YLE,YLM,CONS,CONI,CONJ,CONK,DUMMNLM5790
     1Y,SI,NSW1,NCW,NWNG,CI,CJ,CK,CPCW1,XCP,YCP,GAMA,AREA,ITER,GT,2)    NLM5800
      NCR2=NCOR(L1)-2                                                   NLM5810
      NAERO=0                                                           NLM5820
      FTX1=0.                                                           NLM5830
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```
      FTY1=0.
      FTZ1=0.
      FR123=0.
      DO 610 J=5,NCR2
      DO 610 I=KS,KE
      GMA=GAMA(NWNG+I)
      NBT=0
      NCON=I
      XEE=0.5*(XE(I,J)+XE(I,J+1))
      YEE=0.5*(YE(I,J)+YE(I,J+1))
      ZEE=0.5*(ZE(I,J)+ZE(I,J+1))
      CALL NEWVEL (C,THETP,XEE,YEE,ZEE,XN,YN,XTE,YLE,CONS,DUMMY,CONI,CON
     1J,CONK,SI,NSW1,NCW,NWNG,CI,CJ,CK,XLE,UU,VV,WW,CPCW1,XCP,YCP,GAMA,Y
     2LM)
      A(1)=XE(I,J+1)-XE(I,J)
      A(2)=YE(I,J+1)-YE(I,J)
      A(3)=ZE(I,J+1)-ZE(I,J)
      GA(1)=GMA*A(1)/AREA
      GA(2)=GMA*A(2)/AREA
      GA(3)=GMA*A(3)/AREA
      B(1)=UU
      B(2)=VV
      B(3)=WW
      CALL CRSPRD (B,GA,F)
      FTX1=FTX1+F(1)
      FTY1=FTY1+F(2)
      FTZ1=FTZ1+F(3)
      FR123=FR123+SQRT(F(1)**2+F(2)**2+F(3)**2)
  610 CONTINUE
      FSIN(NFINAL)=SQRT(FTX1**2+FTY1**2+FTZ1**2)
      IF (ITER.GT.KU6) GO TO 620
      CALL NEWDA
      GO TO 730
  620 CONTINUE
C     COMPARE THE FREE SHEET FORCE AFTER EACH INNER CYCLE (+Y, -Y,
C     +Z, -Z) OF VORTEX CORE&S MOVEMENT
      IF (NFINAL.EQ.1.OR.NFINAL.EQ.3) GO TO 630
      IF (NFINAL.EQ.2.OR.NFINAL.EQ.4) GO TO 650
  630 CONTINUE
      DO 640 I=L1,LMAX
      JK=NCOR(I)
```

```
      NK=NELM(I)
      DO 640 J=JK,NK
      XE1(I,J)=XE(I,J)
      YE1(I,J)=YE(I,J)
      ZE1(I,J)=ZE(I,J)
640   CONTINUE
      CALL NEWBC (MAXL)
      GO TO 490
650   DO 660 I=L1,LMAX
      JK=NCOR(I)
      NK=NELM(I)
      DO 660 J=JK,NK
      XE2(I,J)=XE(I,J)
      YE2(I,J)=YE(I,J)
      ZE2(I,J)=ZE(I,J)
660   CONTINUE
      CALL NEWBC (MAXL)
C     COMPARE THE FREE SHEET FORCE IN THE INNER ITERATION
      X1=FSIN(NFINAL-1)
      X2=FSIN(NFINAL)
      CALL MINMAX (X1,X2,XMN,XMX)
      IF (XMN.GT.FSMIN) GO TO 720
      IF (X2.LT.X1) ID=2
      IF (X1.LT.X2) ID=1
      IF (ID.EQ.2) GO TO 670
      GO TO 690
670   DO 680 I=L1,LMAX
      JK=NCOR(I)
      NK=NELM(I)
      DO 680 J=JK,NK
      XE(I,J)=XE2(I,J)
      YE(I,J)=YE2(I,J)
      ZE(I,J)=ZE2(I,J)
680   CONTINUE
      GO TO 710
690   DO 700 I=L1,LMAX
      JK=NCOR(I)
      NK=NELM(I)
      DO 700 J=JK,NK
      XE(I,J)=XE1(I,J)
      YE(I,J)=YE1(I,J)
```

```
      ZE(I,J)=ZE1(I,J)                                                  NLM6660
  700 CONTINUE                                                          NLM6670
  710 CONTINUE                                                          NLM6680
      IF (ID.EQ.1) FSMIN=X1                                             NLM6690
      IF (ID.EQ.2) FSMIN=X2                                             NLM6700
      CALL NEWDA                                                        NLM6710
  720 CONTINUE                                                          NLM6720
      IF (NFINAL.EQ.4) GO TO 730                                        NLM6730
      GO TO 490                                                         NLM6740
  730 CONTINUE                                                          NLM6750
      IF (ITRAKE.NE.1.AND.LL.EQ.1) GO TO 460                            NLM6760
      GO TO 130                                                         NLM6770
C                                                                       NLM6780
  740 FORMAT (1H0,5X,8F10.5)                                            NLM6800
  750 FORMAT (8F10.4)                                                   NLM6810
  760 FORMAT (10I2)                                                     NLM6820
      END                                                               NLM6830-


      SUBROUTINE CORE (XB,YB,ZB,XEND,GAMA,NSW1,NELM,NWNG,NXB)           CRE   10
C     FIND THE CENTROID OF THE DIFFUSED LEADING-EDGE VORTEX             CRE   20
C     ELEMENT SYSTEM                                                    CRE   30
      DIMENSION XB(40,2),YB(40,2),ZB(40,2),GAMA(1),YSTN(40),ZSTN(40),   CRE   40
     1NELM(1)                                                           CRE   50
      COMMON /ABC/ XE(10,40),YE(10,40),ZE(10,40)                        CRE   60
      COMMON /AERO/ NAERO,MAXL,MAXW,ISPAN,ISF,ITRAKE,ISC                CRE   70
      COMMON /GENCF/ M1(5)                                              CRE   80
      COMMON /LOC/ FU1,FU2,BEND,PXL(5),PXT(5),PYL(5)                    CRE   90
      SEGL=(PXT(1)-PXL(1))/8.                                           CRE  100
      IF (ITRAKE.NE.1) GO TO 10                                         CRE  110
      LL=1                                                              CRE  120
      L1=1                                                              CRE  130
      NSW2=NSW1-1                                                       CRE  140
      L2=2                                                              CRE  150
      ISECT=1                                                           CRE  160
      L3=L2                                                             CRE  170
      NSW1=MAXL                                                         CRE  180
      GO TO 30                                                          CRE  190
   10 LL=1                                                              CRE  200
      L1=1                                                              CRE  210
```

```
      NSW2=(M1(1)-1)-1                                                  CRE 220
      L2=2                                                              CRE 230
      ISECT=1                                                           CRE 240
      L3=L2                                                             CRE 250
      NSW1=M1(1)-1                                                      CRE 260
      GO TO 30                                                          CRE 270
   20 LL=2                                                              CRE 280
      L1=M1(1)                                                          CRE 290
      NSW2=(M1(1)-1)+(M1(2)-1)-1                                        CRE 300
      L2=L1+1                                                           CRE 310
      ISECT=2                                                           CRE 320
      L3=L1+1                                                           CRE 330
      NSW1=MAXL                                                         CRE 340
   30 CONTINUE                                                          CRE 350
      XB(1,LL)=XE(L1,4)                                                 CRE 360
      YB(1,LL)=YE(L1,4)                                                 CRE 370
      ZB(1,LL)=ZE(L1,4)                                                 CRE 380
      II=1                                                              CRE 390
      DO 40 I=L2,NSW2                                                   CRE 400
      II=II+1                                                           CRE 410
      XB(II,LL)=0.5*(XE(I+1,4)+XE(I,4))                                 CRE 420
   40 CONTINUE                                                          CRE 430
      K=II                                                              CRE 440
   50 K=K+1                                                             CRE 450
      XB(K,LL)=XB(K-1,LL)+SEGL                                          CRE 460
      IF (XB(K,LL).LT.XEND) GO TO 50                                    CRE 470
      NXB=K                                                             CRE 480
      J=2                                                               CRE 490
   60 XBAR=XB(J,LL)                                                     CRE 500
      CALL CENTRD (XBAR,YSTN,ZSTN,NMAX,NSW1,NELM,ISECT)                 CRE 510
      SUMY=0.                                                           CRE 520
      SUMZ=0.                                                           CRE 530
      GMSUM=0.                                                          CRE 540
      DO 70 I=L3,NMAX                                                   CRE 550
      II=NWNG+I                                                         CRE 560
      GMSUM=GMSUM+GAMA(II)                                              CRE 570
      SUMY=SUMY+YSTN(I)*GAMA(II)                                        CRE 580
   70 SUMZ=SUMZ+ZSTN(I)*GAMA(II)                                        CRE 590
      YBAR=SUMY/GMSUM                                                   CRE 600
      ZBAR=SUMZ/GMSUM                                                   CRE 610
      YB(J,LL)=YBAR                                                     CRE 620
```

```
      ZB(J,LL)=ZBAR
      J=J+1
      IF (J.LE.NXP) GO TO 60
      IF (ITRAKE.NE.1.AND.LL.EQ.1) GO TO 20
      RETURN
      END
```

```
      SUBROUTINE CFAEC (C,THETP,XN,YN,XTE,XLE,YLE,YLM,CONS,CONI,CONJ,CON
     1K,DUMMY,SI,NSW1,NCW,NWNG,CI,CJ,CK,CPCW1,XCP,YCP,GAMA,AREA,ITER,GT,
     2N)
      DIMENSION DUMMY(1),CONS(1),CONI(1),CONJ(1),CONK(1),CI(1),CJ(1),
     1CK(1),C(1),THETP(1),XLE(1),XTE(1),YLE(1),YLM(1),SI(1),GAMA(1),
     2XCP(1),YCP(1),CPCW1(1),XN(NWNG,2),YN(NWNG,2),A(3),B(3),F(3),GA(3),
     3GT(3),FXP(40,2,2)
      COMMON /NCTT/ NCT,NCON,NBT,NCOR(15)
      COMMON /ABC/ XE(10,40),YE(10,40),ZE(10,40)
      COMMON /AERO/ NAERO,MAXL,MAXW,ISPAN,ISF,ITRAKE,ISC
      COMMON /ALLRB/ AX(210),ZMIN,NELM(11)
      COMMON /GENCF/ M1(5)
      COMMON /MUFAV/ FYP(40,2,2),FZP(40,2,2)
      COMMON /INFAV/ FYT(20),FZT(20),FYI(40),FZI(40),VXI(40),VYI(40),
     1VZI(40),FXT(20),TFORCE(20)
      NCT=0
      LL=1
      L1=1
      L0=L1-1
      L2=M1(1)-1
      GO TO 20
   10 LL=2
      L1=M1(1)
      L0=L1-1
      L2=MAXL
   20 CONTINUE
      FXT(LL)=0.
      FYT(LL)=0.
      FZT(LL)=0.
      NSW5=NELM(L1)-NCOR(L1)
      DO 30 I=1,NSW5
      II=NCOR(L1)+I
```

```
      NCON=LO+I
      IF (NCON.GE.L2) NCON=L2
      NBT=1
      XEE=0.5*(XE(L1,II-1)+XE(L1,II))
      YEE=0.5*(YE(L1,II-1)+YE(L1,II))
      ZEE=0.5*(ZE(L1,II-1)+ZE(L1,II))
      GMA=GT(NCON)
      A(1)=XE(L1,II)-XE(L1,II-1)
      A(2)=YE(L1,II)-YE(L1,II-1)
      A(3)=ZE(L1,II)-ZE(L1,II-1)
      CALL NEWVEL (C,THETP,XEE,YEE,ZEE,XN,YN,XTE,YLE,CONS,DUMMY,CONI,CON
     1J,CONK,SI,NSW1,NCW,NWNG,CI,CJ,CK,XLE,UU,VV,WW,CPCW1,XCP,YCP,GAMA,Y
     2LM)
      GA(1)=GMA*A(1)/AREA
      GA(2)=GMA*A(2)/AREA
      GA(3)=GMA*A(3)/AREA
      B(1)=UU
      B(2)=VV
      B(3)=WW
      CALL CRSPRD (B,GA,F)
      FXP(I,N,LL)=F(1)
      FYP(I,N,LL)=F(2)
      FZP(I,N,LL)=F(3)
      FXT(LL)=FXT(LL)+F(1)
      FYT(LL)=FYT(LL)+F(2)
      FZT(LL)=FZT(LL)+F(3)
   30 CONTINUE
      TFORCE(LL)=SQRT(FXT(LL)**2+FYT(LL)**2+FZT(LL)**2)
      IF (ITRAKE.NE.1.AND.LL.EQ.1) GO TO 10
      RETURN
      END


      SUBROUTINE SEGMNT (ASTAR,BSTAR,NELM,NCOR,SFGMA,SFBDA)
C     COMPUTE THE SEGMENT FORCE OF THE CORE
      DIMENSION NELM(1),NCOR(1),SFBDA(40,2),SFGMA(40,2)
      COMMON /MDFAV/ FYP(40,2,2),FZP(40,2,2)
      COMMON /GENCF/ M1(5)
      COMMON /AERO/ NAERO,MAXL,MAXW,ISPAN,ISF,ITRAKE,ISC
      LL=1
```

```
      L1=1
      GO TO 20
10    LL=2
      L1=M1(1)
20    CONTINUE
      NSW5=NELM(L1)-NCOR(L1)
      DO 30 I=1,NSW5
      IF (FZP(I,2,LL).GT.0..AND.FZP(I,1,LL).GT.0.) FZ=0.1
      IF (FZP(I,2,LL).LT.0..AND.FZP(I,1,LL).LT.0.) FZ=-0.1
      IF (FZP(I,2,LL).GT.0..AND.FZP(I,1,LL).LT.0.) FZ=0.1
      IF (FZP(I,2,LL).LT.0..AND.FZP(I,1,LL).GT.0.) FZ=-0.1
      SFGMA(I,LL)=FZ*(FZP(I,2,LL)-FZP(I,1,LL))/(ABS(FZP(I,1,LL)))*BSTAR
      SFGMA(I,LL)=10.*SFGMA(I,LL)
      IF (FZP(I,2,LL)*FZP(I,1,LL).LT.0.) SFGMA(I,LL)=0.
      IF (FYP(I,2,LL).GT.0..AND.FYP(I,1,LL).GT.0.) FY=0.5
      IF (FYP(I,2,LL).LT.0..AND.FYP(I,1,LL).LT.0.) FY=-0.5
      IF (FYP(I,2,LL).GT.0..AND.FYP(I,1,LL).LT.0.) FY=0.5
      IF (FYP(I,2,LL).LT.0..AND.FYP(I,1,LL).GT.0.) FY=-0.5
      SFBDA(I,LL)=FY*(FYP(I,2,LL)-FYP(I,1,LL))/(ABS(FYP(I,1,LL)))*ASTAR
      IF (FYP(I,2,LL)*FYP(I,1,LL).LT.0.) SFBDA(I,LL)=-0.25*ABS((FYP(I,2,
     1LL)-FYP(I,1,LL))/FYP(I,1,LL))
      IF (ABS(SFGMA(I,LL)).GT.1.0) SFGMA(I,LL)=0.
      IF (ABS(SFBDA(I,LL)).GT.1.0) SFBDA(I,LL)=0.
30    CONTINUE
      IF (ITRAKE.NE.1.AND.LL.EQ.1) GO TO 10
      RETURN
      END


      SUBROUTINE NEWBC (NSW1)
      COMMON /ABC/ XE(10,40),YE(10,40),ZE(10,40)
      COMMON /ALLRB/ AX(210),ZMIN,NELM(11)
      COMMON /OABC/ DXE(10,40),DYE(10,40),DZE(10,40)
      DO 20 I=1,NSW1
      K=NELM(I)
      DO 10 J=1,K
      XE(I,J)=DXE(I,J)
      YE(I,J)=DYE(I,J)
      ZE(I,J)=DZE(I,J)
10    CONTINUE
```

```
20    CONTINUE
      RETURN
      END


      SUBROUTINE NEWDA
      DIMENSION A(3)
      COMMON /ABC/ XE(10,40),YE(10,40),ZE(10,40)
      COMMON /ALLRB/ AX(210),ZMIN,NELM(11)
      COMMON /OABC/ DXE(10,40),DYE(10,40),DZE(10,40)
      COMMON /GENCF/ M1(5)
      COMMON /AERO/ NAERO,MAXL,MAXW,ISPAN,ISF,ITRAKE,ISC
      COMMON /LOCSP/ BX(300),CTANTY(40,2),CTANTZ(40,2)
      COMMON /NCTT/ NCT,NCON,NBT,NCOR(15)
      COMMON /MDFAV/ FYP(40,2,2),FZP(40,2,2)
      DO 20 I=1,MAXL
      K=NELM(I)
      DO 10 J=1,K
      DXE(I,J)=XE(I,J)
      DYE(I,J)=YE(I,J)
      DZE(I,J)=ZE(I,J)
10    CONTINUE
20    CONTINUE
      LL=1
      L1=1
      GO TO 40
30    LL=2
      L1=M1(1)
40    CONTINUE
      NSW5=NELM(L1)-NCOR(L1)
      DO 50 I=1,NSW5
      II=NCOR(L1)+I
      A(1)=XE(L1,II)-XE(L1,II-1)
      A(2)=YE(L1,II)-YE(L1,II-1)
      A(3)=ZE(L1,II)-ZE(L1,II-1)
      CTANTY(I,LL)=A(2)/A(1)
      CTANTZ(I,LL)=A(3)/A(1)
50    CONTINUE
      IF (ITRAKE.NE.1.AND.LL.EQ.1) GO TO 30
      RETURN
```

```
      END

      SUBROUTINE MODEL (XB,YB,ZB,NELM,NXB,M1,LASTE)
      DIMENSION M1(1)
      DIMENSION XB(40,2),YB(40,2),ZB(40,2),
     1FXE(10),FYE(10),FZE(10),BXE(10),BYE(10),BZE(10),NELM(1)
      COMMON /NCTT/ NCT,NCON,NBT,NCOR(15),KU1,NFSH(15)
      COMMON /AERO/ NAERO,MAXL,MAXW,ISPAN,ISF,ITRAKE,ISC
      COMMON /ABC/ XE(10,40),YE(10,40),ZE(10,40)
      NSW1=MAXL
      IF (ISPAN.EQ.0) IX=1
      IF (ISPAN.EQ.1) IX=2
      DO 110 I=2,NSW1
      IF (ITRAKE.EQ.1) GO TO 10
      NN2=M1(1)+2
      LL=0
      IF (I.EQ.M1(1)-2) LL=1
      IF (I.EQ.NN2) LL=2
      IF (LL.EQ.0) GO TO 110
      GO TO 20
   10 LL=1
   20 CONTINUE
      NIT=NFSH(I)
      NN=NELM(I)
      J=5
   30 IC=1
      CALL CHOPS (LL,IC,I,J,XB,YB,ZB,NXB,NGB,FXE,FYE,FZE,XCA,XCB,ZCA,ZCB
     1)
      IF (NGB.EQ.1) GO TO 50
      IF ((J+1).EQ.NELM(I)) GO TO 40
      J=J+1
      IF (J.LT.NN) GO TO 30
   40 CONTINUE
      ISF=0
      WRITE (6,120)
      LASTE=I
      RETURN
   50 CONTINUE
      XE(I,J+1)=FXE(I)
```

```
      YE(I,J+1)=FYE(I)
      ZE(I,J+1)=FZE(I)
      NOC=(J-4)+1
      IF (NOC.GE.4) GO TO 90
      IF (NOC.EQ.2) GO TO 60
      IF (NOC.EQ.3) GO TO 80
60    DO 70 MK=1,3
      FM=MK
      XE(I,MK+5)=FM/3.*(FXE(I)-XE(I,5))+XE(I,5)
      YE(I,MK+5)=FM/3.*(FYE(I)-YE(I,5))+YE(I,5)
      ZE(I,MK+5)=FM/3.*(FZE(I)-ZE(I,5))+ZE(I,5)
70    CONTINUE
      NOC=4
      GO TO 90
80    XE(I,8)=FXE(I)
      YE(I,8)=FYE(I)
      ZE(I,8)=FZE(I)
      XE(I,7)=XE(I,6)
      YE(I,7)=YE(I,6)
      ZE(I,7)=ZE(I,6)
      XE(I,6)=0.5*(XE(I,5)+XE(I,6))
      YE(I,6)=0.5*(YE(I,5)+YE(I,6))
      ZE(I,6)=0.5*(ZE(I,5)+ZE(I,6))
      NOC=4
90    CALL LEADLM (NOC,BXE,BYE,BZE,NIT,I)
      DO 100 MJ=1,NIT
      JJ=MJ+5
      XE(I,JJ)=BXE(MJ)
      YE(I,JJ)=BYE(MJ)
      ZE(I,JJ)=BZE(MJ)
100   CONTINUE
      ZBZ=ZCA+(FXE(I)-XCA)*(ZCB-ZCA)/(XCB-XCA)
      NCR=NCOR(I)
      NCR1=NCR-1
      XE(I,NCR)=FXE(I)
      YE(I,NCR)=FYE(I)
      ZE(I,NCR)=ZBZ
110   CONTINUE
      ISF=1
      RETURN
C
```

```
C
120   FORMAT (1H1,,68H FAIL TO GET INTERSECTION BY THE WELL DEFINED FREE
     1  VORTEX ELEMENTS )
      END


      SUBROUTINE CHOPS (LL,IC,I,J,XB,YB,ZB,NXB,NGB,FXE,FYE,FZE,XCA,XCB,Z
     1CA,ZCB)
C     FIND THE INTERSECTION BETWEEN THE LEADING EDGE VORTEX FILAMENT
C     AND THE CENTROID OF THE LEADING EDGE VORTEX SYSTEM
      DIMENSION FXE(10),FYE(10),FZE(10)
      DIMENSION XB(40,2),YB(40,2),ZB(40,2),A(3),B(3),C(3)
      COMMON /ABC/ XE(10,40),YE(10,40),ZE(10,40)
      NGB=0
C     CHECK POINT 1 AND 2 ON VORTEX FILAMENT
10    CONTINUE
      A(1)=XE(I,J+1)-XB(IC,LL)
      A(2)=YE(I,J+1)-YB(IC,LL)
      A(3)=0.
      B(1)=XB(IC+1,LL)-XB(IC,LL)
      B(2)=YB(IC+1,LL)-YB(IC,LL)
      B(3)=0.
      CALL CRSPRD (A,B,C)
      C1=C(3)
      A(1)=XE(I,J)-XB(IC,LL)
      A(2)=YE(I,J)-YB(IC,LL)
      A(3)=0.
      CALL CRSPRD (A,B,C)
      C2=C(3)
      IF (C1*C2.GT.0.) GO TO 20
C     CHECK POINT 3 AND 4 ON CENTROID
      A(1)=XB(IC+1,LL)-XE(I,J)
      A(2)=YB(IC+1,LL)-YE(I,J)
      A(3)=0.
      B(1)=XE(I,J+1)-XE(I,J)
      B(2)=YE(I,J+1)-YE(I,J)
      B(3)=0.
      CALL CRSPRD (A,B,C)
      C1=C(3)
      A(1)=XB(IC,LL)-XE(I,J)
```

```
      A(2)=YB(IC,LL)-YE(I,J)
      A(3)=0.
      CALL CRSPRD (A,B,C)
      C2=C(3)
      IF (C1*C2.GT.0.) GO TO 20
      NGB=1
      XCA=XE(I,J)
      CALL CFSET (XCA,YCA,ZCA,IC,XB,YB,ZB,LL)
      XCB=XE(I,J+1)
      CALL CFSET (XCB,YCB,ZCB,IC,XB,YB,ZB,LL)
      XYAB=(XCB-XCA)/(YCB-YCA)
      XYE=(XE(I,J+1)-XE(I,J))/(YE(I,J+1)-YE(I,J))
      BB1=XCA-(XYAB*YCA)
      BB2=XE(I,J)-(XYE*YE(I,J))
      DENOM=XYAB-XYE
      FXE(I)=(XYAB*BB2-XYE*BB1)/DENOM
      FYE(I)=(BB2-BB1)/DENOM
      FZE(I)=ZE(I,J)+(FXE(I)-XE(I,J))*(ZE(I,J+1)-ZE(I,J))/(XE(I,J+1)-XE(
     1I,J))
      RETURN
20    IC=IC+1
      IF (IC.GE.NXB) RETURN
      GO TO 10
      END


      SUBROUTINE LIRITN (NCOR,NELM,M1,LASTE)
      COMMON /LOC/ FU1,FU2,XEND,PXL(5),PXT(5),PYL(5)
      COMMON /AERO/ NAERO,MAXL,MAXW,ISPAN,ISF,ITRAKE,ISC
      COMMON /ALLRA/ TTL(16),ALPHA
      COMMON /ABC/ PXE(10,40),PYE(10,40),PZE(10,40)
      DIMENSION M1(1),NCOR(1),NELM(1)
C
C     LINEAR INTERPOLATION OF LAST TWO VORTEX STRIPS
C
      IF (ISPAN.EQ.0) IX=1
      IF (ISPAN.EQ.1) IX=2
      NSW1=MAXL
      IF (ITRAKE.EQ.1) GO TO 50
      NN2=M1(1)+2
```

```
      DO 40 I=2,MAXL
      IF (I.EQ.M1(1)) GO TO 40
      IF (I.EQ.M1(1)-2.OR.I.EQ.NN2) GO TO 40
      IF (I.LE.M1(1)-1) GO TO 20
      LAXN=NN2
      RXE=(PXE(I,5)-PXL(IX+1))/(PXE(LAXN,5)-PXL(IX+1))
      RYE=PYE(I,5)/PYE(LAXN,5)
      NXOR=NCOR(I)
      DO 10 L=6,NXOR
      PXE(I,L)=PXL(IX+1)+(PXE(LAXN,L)-PXL(IX+1))*RXE
      PYE(I,L)=PYE(LAXN,L)*RYE
      PZE(I,L)=PZE(LAXN,L)*RYE
10    CONTINUE
      GO TO 40
20    CONTINUE
      N=M1(1)-2
      RXE=(PXE(I,5)-PXL(IX))/(PXE(N,5)-PXL(IX))
      RYE=PYE(I,5)/PYE(N,5)
      NXOR=NCOR(I)
      DO 30 M=6,NXOR
      PXE(I,M)=PXL(IX)+(PXE(N,M)-PXL(IX))*RXE
      PYE(I,M)=PYE(N,M)*RYE
      PZE(I,M)=PZE(N,M)*RYE
30    CONTINUE
40    CONTINUE
      GO TO 150
50    CONTINUE
      IF (ISF.EQ.0) GO TO 60
      GO TO 80
60    NST=NSW1/2
      DO 70 I=LASTE,NSW1
      NXOR=NCOR(I)
      DO 70 L=6,NXOR
      X1=(PXE(NST,L-1)-PXL(1))**2
      Y1=(PYE(NST,L-1)-PYL(1))**2
      Z1=(PZE(NST,L-1))**2
      FL1=SQRT(X1+Y1+Z1)
      X2=(PXE(I,L-1)-PXL(1))**2
      Y2=(PYE(I,L-1)-PYL(1))**2
      Z2=(PZE(I,L-1))**2
      FL2=SQRT(X2+Y2+Z2)
```

```
      FK=FL1/FL2
      PXE(I,L)=PXE(I,L-1)+(PXE(NST,L)-PXE(NST,L-1))/FK
      PYE(I,L)=PYE(I,L-1)+(PYE(NST,L)-PYE(NST,L-1))/FK
      PZE(I,L)=PZE(I,L-1)+(PZE(NST,L)-PZE(NST,L-1))/FK
70    CONTINUE
80    CONTINUE
      RXE=(PXE(2,5)-PXL(1))/(PXE(3,5)-PXL(1))
      RYE=(PYE(2,5)-PYL(1))/(PYE(3,5)-PYL(1))
      NXOB=NCOR(2)-1
      DO 90 L=6,NXOB
      PXE(2,L)=(PXE(3,L)-PXL(1))*RXE+PXL(1)
      PYE(2,L)=(PYE(3,L)*RYE)+PYL(1)
      PZE(2,L)=PZE(3,L)*RYE
90    CONTINUE
      NELM(NSW1)=12
      NSW5=NSW1+NELM(NSW1)-NCOR(NSW1)-1
      NCR=NCOR(NSW1)
      NCA=NCOR(NSW1-1)
      DY=(PYE(NSW1,NCR)-PYE(NSW1-1,NCA))
      DX=(PXE(NSW1,NCR)-PXE(NSW1-1,NCA))
      DYDX=DY/DX
      DO 100 I=NSW1,NSW5
      J=I-NSW1+1
      JJ=J-1
      DXX=PXE(NSW1,NCR+J)-PXE(NSW1,NCR+JJ)
      PYE(NSW1,NCR+J)=PYE(NSW1,NCR+JJ)+(DYDX*DXX)
      PXE(NSW1,NCR+J)=PXE(NSW1,NCR+JJ)+DX
100   CONTINUE
      DO 130 I=2,NSW5
      IF (I.GE.NSW1) GO TO 110
      JK=NCOR(I)+1
      NK=NCOR(I+1)
      II=I
      GO TO 120
110   CONTINUE
      II=NSW1-1
      JK=NCOR(II)+(I-II)+1
      NK=NCOR(NSW1)+I-NSW1+1
120   IF (II.LT.2) GO TO 130
      PXE(II,JK)=PXE(II+1,NK)
      PYE(II,JK)=PYE(II+1,NK)
```

```
      PZE(II,JK)=PZE(II+1,NK)
      II=II-1
      NK=JK
      JK=NCOR(II)+(I-II)+1
      GO TO 120
130   CONTINUE
      LL=1
      L1=NSW1
      L3=2
      DO 140 I=2,NSW1
      NELM(I)=NELM(NSW1)+(NSW1-I)
140   CONTINUE
      GO TO 250
150   CONTINUE
      LL=1
      L1=M1(1)-1
      L2=L1-1
      NSW6=L2
      L3=2
      GO TO 170
160   LL=2
      L1=MAXL
      L2=L1-1
      NSW6=L2
      L3=M1(1)+1
170   CONTINUE
      NCA=NCOR(L2)
      NCR=NCOR(L1)
      DXX=PXE(L1,NCR)-PXE(L2,NCA)
      DYY=PYE(L1,NCR)-PYE(L2,NCA)
      DZZ=PZE(L1,NCR)-PZE(L2,NCA)
      DYDX=DYY/DXX
      DZDX=DZZ/DXX
      DX=(PXT(LL)-PXL(LL))/4.
      IC=1
      PAV=0.5*(PXT(LL)+PXT(LL+1))+0.5*(PXT(LL)-PXL(LL))
      PAX=PXE(L1,NCR)+DX
180   IF (PAX.GT.PAV) GO TO 190
      IC=IC+1
      PAX=PAX+DX
      GO TO 180
```

```
190     JJ=NCR+IC
        I=L1
        J=NCR+1
        DO 200 K=J,JJ
        PXE(I,K)=PXE(I,K-1)+DX
        PYE(I,K)=PYE(I,K-1)+DX*DYDX
        PZE(I,K)=PZE(I,K-1)+DX*DZDX
200     CONTINUE
        NELM(L1)=JJ
        DO 210 I=L3,NSW6
        NELM(I)=NELM(L1)+(L1-I)
210     CONTINUE
C       UP TO THIS STEP, THE NODE POINT OF THE CORE IS NO. 11
        KK=L1-1
220     LA=NELM(KK)-NCOR(KK)
        DO 230 I=1,LA
        J=NCOR(KK)+I
        PXE(KK,J)=PXE(KK+1,J-1)
        PYE(KK,J)=PYE(KK+1,J-1)
        PZE(KK,J)=PZE(KK+1,J-1)
230     CONTINUE
        KK=KK-1
        IF (KK.LT.L3) GO TO 240
        GO TO 220
240     CONTINUE
250     CONTINUE
        DO 260 I=L3,L1
        NCOR(I)=NCOR(I)+1
        NELM(I)=NELM(I)+1
        M=NCOR(I)
        K=NELM(I)
        DO 260 J=M,K
        JJ=K-(J-M)
        PXE(I,JJ)=PXE(I,JJ-1)
        PYE(I,JJ)=PYE(I,JJ-1)
        PZE(I,JJ)=PZE(I,JJ-1)
260     CONTINUE
C       THE ORDER OF THE NODE POINT ALONG THE CORE IS 12TH
        TT=TAN(ALPHA)
        CALL AZCORE (TT,PXL,PXT,PYL,NCOR,NELM,L1,L3,LL)
        IF (ITRAKE.NE.1.AND.LL.EQ.1) GO TO 160
```

```
      RETURN
      END


      SUBROUTINE AZCORE (TT,PXL,PXT,PYL,NCOR,NELM,L1,L3,LL)
      DIMENSION PXL(1),PXT(1),PYL(1),NCOR(1),NELM(1)
      COMMON /ABC/ XE(10,40),YE(10,40),ZE(10,40)
      COMMON /AERO/ NAERO,MAXL,MAXW,ISPAN,ISF,ITRAKE,ISC
      COMMON /CAMB/ ICAM
      IF (ITRAKE.NE.1) GO TO 20
C     SMITH&S RESULTS  ARE APPLIED ONLY TO THE ONE CORE SYSTEM
      PXP=PXL(LL)
      TANG=(PYL(LL+1)-PYL(LL))/(PXT(LL)-PXL(LL))
      TRT=TT/TANG
      DO 10 I=L3,L1
      K=NELM(I)
      NN=NCOR(I)
      DO 10 IK=NN,K
      TZAE=TANG*(XE(I,IK)-PXP)
      IF (TRT.LT.1.2) ZE(I,IK)=TZAE*(0.189*TRT+0.08)
      IF (TRT.GE.1.2.AND.TRT.LT.2.2) ZE(I,IK)=TZAE*(0.1333*TRT+0.158)
      IF (TRT.GE.2.2) ZE(I,IK)=TZAE*(0.13*TRT+0.132)
10    CONTINUE
20    CONTINUE
      NXOR=NCOR(L3)
      FZMIN=0.2*(XE(L3,NXOR)-PXL(LL))*TT
      IF (ZE(L3,NXOR).LT.FZMIN) ZE(L3,NXOR)=FZMIN
      RETURN
      END


      SUBROUTINE APEXC (NELM,NCOR,M1)
      DIMENSION M1(1),NCOR(1),NELM(1)
      COMMON /ABC/ XE(10,40),YE(10,40),ZE(10,40)
      COMMON /AERO/ NAERO,MAXL,MAXW,ISPAN,ISF,ITRAKE,ISC
      COMMON /LOC/ FU1,FU2,XEND,PXL(5),PXT(5),PYL(5)
      LL=1
      IM=1
      L1=M1(1)-1
```

```
      L3=IM
      GO TO 20
10    IM=M1(1)
      LL=2
      L1=MAXL
      L3=IM
20    CONTINUE
      NELM(IM)=NELM(IM+1)+1
      NCOR(IM)=NCOR(IM+1)
      K=NCOR(IM)
      DO 30 IJ=5,K
      XE(IM,IJ)=XE(IM,4)
      YE(IM,IJ)=YE(IM,4)
      ZE(IM,IJ)=ZE(IM,4)
30    CONTINUE
      NSW8=NELM(IM)-NCOR(IM)
      DO 40 I=1,NSW8
      J=NCOR(IM)+I
      XE(IM,J)=XE(IM+1,J-1)
      YE(IM,J)=YE(IM+1,J-1)
      ZE(IM,J)=ZE(IM+1,J-1)
40    CONTINUE
      CALL AYCORE (PXL,PXT,PYL,NCOR,NELM,L1,L3,LL)
      IF (ITRAKE.NE.1.AND.LL.EQ.1) GO TO 10
      RETURN
      END


      SUBROUTINE AYCORE (PXL,PXT,PYL,NCOR,NELM,L1,L3,LL)
      DIMENSION PXL(1),PXT(1),PYL(1),NELM(1),NCOR(1)
      COMMON /ABC/ XE(10,40),YE(10,40),ZE(10,40)
      COMMON /AERO/ NAERO.MAXL,MAXW.ISPAN,ISF,ITRAKE,ISC
      COMMON /ALLPA/ TTL(16).ALPHA
      TANG=(PYL(LL+1)-PYL(LL))/(PXL(LL+1)-PXL(LL))
      PAV=0.5*(PXT(LL)+PXT(LL+1))
      DO 10 I=L3,L1
      K=NELM(I)
      NN=NCOR(I)
      DO 10 IK=NN,K
      TZAE=TANG*(XE(I,IK)-PXL(LL))
```

```
      IF (XE(I,IK).GT.PAV) TZAE=PYL(LL+1)-PYL(LL)
      FYE=0.6*TZAE
      IF (YE(I,IK).GT.FYE.AND.XE(I,IK).LT.PAV) GO TO 10
      IF (XE(I,IK).GE.PAV.AND.YE(I,IK).GT.FYE) GO TO 10
      YE(I,IK)=0.62*TZAE+PYL(LL)
10    CONTINUE
C     SET UP THE GOOD SHAPE OF THE STRAKE CORE ON THE X-Y PLANE
      IF (ITRAKE.EQ.1.OR.LL.NE.1) GO TO 60
      KK=NCOR(L1)
      JJ=NELM(L1)-1
      DXX=XE(L1,KK)-XE(L1-1,KK)
      DYY=YE(L1,KK)-YE(L1-1,KK)
      DZZ=ZE(L1,KK)-ZE(L1-1,KK)
      DYDX=DYY/DXX
      DZDX=DZZ/DXX
      DO 20 I=KK,JJ
      DX=XE(L1,I+1)-XE(L1,I)
      YE(L1,I+1)=YE(L1,I)+DX*DYDX
      ZE(L1,I+1)=ZE(L1,I)+DX*DZDX
20    CONTINUE
C     REGROUP THE NODE POINTS ALONG THE CORE ON THE STRAKE SECTION
      KK=L1-1
30    LA=NELM(KK)-NCOR(KK)
      DO 40 I=1,LA
      J=NCOR(KK)+I
      XE(KK,J)=XE(KK+1,J-1)
      YE(KK,J)=YE(KK+1,J-1)
      ZE(KK,J)=ZE(KK+1,J-1)
40    CONTINUE
      KK=KK-1
      IF (KK.LT.2) GO TO 50
      GO TO 30
50    CONTINUE
60    CONTINUE
C     TO SET UP THE INITIAL FREE SHEET AND CORE IN STANDARD FORM
      IF (ITRAKE.NE.1) RETURN
      NXOR=NCOR(L3)
      NXOR1=NXOR+1
      NXOR2=NXOR+2
      RY=(YE(L3,NXOR2)-PYL(LL))/(XE(L3,NXOR2)-PXL(LL))
      RZ=(ZE(L3,NXOR2)-0.)/(XE(L3,NXOR2)-PXL(LL))
```

```
      YE(L3,NXOR1)=RY*(XE(L3,NXOR1)-PXL(LL))+PYL(LL)
      ZE(L3,NXOR1)=RZ*(XE(L3,NXOR1)-PXL(LL))
      ZE(L3,NXOR1)=0.5*(ZE(L3,NXOR1)+ZE(L3,NXOR2))
C     MODIFY THE FREE SHEET PORTION NEAR APEX REGION
      XE(L3+1,NXOR)=XE(L3,NXOR1)
      YE(L3+1,NXOR)=YE(L3,NXOR1)
      ZE(L3+1,NXOR)=ZE(L3,NXOR1)
C     ******
      XE(L3+1,NXOR-1)=XE(L3+1,NXOR)
      YE(L3+1,NXOR-1)=YE(L3+1,NXOR)
      ZE(L3+1,NXOR-1)=ZE(L3+1,NXOR)
C     ******
      XE(L3+1,NXOR-2)=XE(L3+1,NXOR)
      YE(L3+1,NXOR-2)=YE(L3+1,NXOR)
      RETURN
      END


      SUBROUTINE LEADLM (NOC,BXE,BYE,BZE,NIT,I)
      DIMENSION PNT(20,3),ELEN(20),COEF(20,4,3),
     1BXE(5),BYE(5),BZE(5),SP(20)
      COMMON /ABC/ XE(10,40),YE(10,40),ZE(10,40)
C     LEADING-EDGE VORTEX SEGMENT STARTS FROM FIFTH POINT OF LEADING
C     EDGE FREE ELEMENT ON FREE SHEET
      NOC1=NOC-1
      DO 10 J=1,NOC
      JJ=J+4
      PNT(J,1)=XE(I,JJ)
      PNT(J,2)=YE(I,JJ)
      PNT(J,3)=ZE(I,JJ)
10    CONTINUE
      EPS=0.
      N=0
      MAXN=20
      MAXSP=20
      IX=NOC
      IPT=-1
      CALL CSIPAR (MAXN,IX,PNT,N,MAXSP,EPS,K1,IPT,ELEN,COEF,CPT,IERR)
      SP(1)=0.
      ST=0.
```

```
      DO 20 K=2,NOC
      SP(K)=SP(K-1)+ELEN(K-1)
   20 ST=ST+ELEN(K-1)
      DO 50 L=1,NIT
      FL=L
      DS=ST*FL/NIT
      LL=1
   30 IF (DS.GT.SP(LL).AND.DS.LE.SP(LL+1)) GO TO 40
      LL=LL+1
      GO TO 30
   40 DT=(DS-SP(LL))/(SP(LL+1)-SP(LL))
      BXE(L)=COEF(LL,1,1)*(DT**3)+COEF(LL,2,1)*(DT**2)+COEF(LL,3,1)*DT+C
     1OEF(LL,4,1)
      BYE(L)=COEF(LL,1,2)*(DT**3)+COEF(LL,2,2)*(DT**2)+COEF(LL,3,2)*DT+C
     1OEF(LL,4,2)
      BZE(L)=COEF(LL,1,3)*(DT**3)+COEF(LL,2,3)*(DT**2)+COEF(LL,3,3)*DT+C
     1OEF(LL,4,3)
   50 CONTINUE
      RETURN
      END


      SUBROUTINE CFSET (XX1,YY1,ZZ1,IC,XB,YB,ZB,LL)
      DIMENSION XB(40,2),YB(40,2),ZB(40,2)
      D1=XX1-XB(IC,LL)
      D2=XB(IC+1,LL)-XB(IC,LL)
      D3=YB(IC+1,LL)-YB(IC,LL)
      YY1=YB(IC,LL)+(D3*D1)/D2
      D4=ZB(IC+1,LL)-ZB(IC,LL)
      ZZ1=ZB(IC,LL)+(D4*D1)/D2
      RETURN
      END


      SUBROUTINE MINMAX (X1,X2,XMN,XMX)
      XMN=AMIN1(X1,X2)
      XMX=AMAX1(X1,X2)
      RETURN
      END
```

```
      SUBROUTINE CENTRD (XSTN,YSTN,ZSTN,NMAX,NSW1,NELM,ISECT)
      DIMENSION YSTN(1),ZSTN(1),NELM(1)
      COMMON /ABC/ XE(10,40),YE(10,40),ZE(10,40)
      COMMON /GENCF/ M1(5)
      COMMON /AERO/ NAERO,MAXL,MAXW,ISPAN,ISF,ITRAKE.ISC
      I=2
      IF (ITRAKE.NE.1.AND.ISECT.EQ.2) I=M1(1)+1
      NSUB=5
      K=NSUB
10    KMAX=NELM(I)
      IF (XE(I,K).GE.XSTN) GO TO 60
20    IF (XE(I,K).LE.XSTN.AND.XE(I,K+1).GE.XSTN) GO TO 30
      K=K+1
      IF (K.EQ.KMAX) GO TO 50
      GO TO 20
30    CALL COORD (XSTN,I,K,YSTN(I),ZSTN(I))
40    I=I+1
      K=NSUB
      IF (I.GT.NSW1) GO TO 70
      GO TO 10
50    YSTN(I)=YE(I,K)
      ZSTN(I)=ZE(I,K)
      GO TO 40
60    NMAX=I-1
      RETURN
70    NMAX=NSW1
      RETURN
      END
```

```
      SUBROUTINE COORD (XS,I,K,YS,ZS)
      COMMON /ABC/ XE(10,40),YE(10,40),ZE(10,40)
      DX=XE(I,K+1)-XE(I,K)
      DY=YE(I,K+1)-YE(I,K)
      DZ=ZE(I,K+1)-ZE(I,K)
      YS=YE(I,K)+DY*(XS-XE(I,K))/DX
      ZS=ZE(I,K)+DZ*(XS-XE(I,K))/DX
```

```
      RETURN                                                            C00  80
      END                                                               C00  90-


      SUBROUTINE CSIPAR(MAXN,IX,PNT,N,MAXSP,EPS,K1,IPT,ELEN,COEF,CPT,   CSIP0010
     1                  IERR)                                           CSIP0020
C***********************************************************************CSIP0030
C*                                                                     *CSIP0040
C*    PURPOSE:                                                         *CSIP0050
C*                SUBROUTINE CSIPAR COMPUTES PARAMETRIC CUBIC SPLINE   *CSIP0060
C*                COEFFICIENTS TO APPROXIMATE A SMOOTH CURVE THROUGH A *CSIP0070
C*                3D SET OF INPUT POINTS AND OPTIONALLY COMPUTES AN    *CSIP0080
C*                ENRICHED CURVE.                                      *CSIP0090
C*                                                                     *CSIP0100
C*        USE:                                                         *CSIP0110
C*                CALL CSIPAR(MAXN,IX,PNT,N,MAXSP,EPS,K1,IPT,ELEN,     *CSIP0120
C*                            COEF,CPT,IERR)                           *CSIP0130
C*                                                                     *CSIP0140
C*       MAXN     AN INPUT INTEGER SPECIFYING THE MAXIMUM NUMBER OF    *CSIP0150
C*                NODE POINTS AS GIVEN IN THE DIMENSION STATEMENT OF   *CSIP0160
C*                THE CALLING PROGRAM.                                 *CSIP0170
C*                                                                     *CSIP0180
C*         IX     AN INPUT INTEGER SPECIFYING THE ACTUAL NUMBER OF     *CSIP0190
C*                NODE POINTS DEFINING THE CURVE.  IX @ MAXN.          *CSIP0200
C*                                                                     *CSIP0210
C*        PNT     A TWO-DIMENSIONAL INPUT ARRAY DIMENSIONED (MAXN,3)   *CSIP0220
C*                IN THE CALLING PROGRAM.  ON ENTRY TO CSIPAR,         *CSIP0230
C*                PNT(K,1), PNT(K,2), PNT(K,3) CONTAIN THE X,Y, AND Z  *CSIP0240
C*                COORDINATES RESPECTIVELY OF THE K-TH NODE POINT TO   *CSIP0250
C*                BE FITTED.                                           *CSIP0260
C*                                                                     *CSIP0270
C*          N     AN INPUT INTEGER SPECIFYING THE NUMBER OF            *CSIP0280
C*                INTERPOLATED POINTS TO BE COMPUTED BETWEEN EACH PAIR *CSIP0290
C*                OF NODE POINTS.  IF N=0, COMPUTATION OF THE          *CSIP0300
C*                ENRICHED CURVE IS OMITTED.                           *CSIP0310
C*                                                                     *CSIP0320
C*      MAXSP     AN INPUT INTEGER SPECIFYING THE MAXIMUM NUMBER OF    *CSIP0330
C*                POINTS ALLOWED IN THE ENRICHED CURVE, AS GIVEN IN    *CSIP0340
C*                THE DIMENSION STATEMENT OF THE CALLING PROGRAM.      *CSIP0350
```

```
C*              MAXSP SHOULD BE AT LEAST (IX-1) * (N+1) + 1 TO        *CSIP0360
C*              PROVIDE FOR ALL INTERPOLATED POINTS.  IF AN ENRICHED *CSIP0370
C*              CURVE IS NOT CALCULATED, A DUMMY ARGUMENT SHOULD      *CSIP0380
C*              BE SPECIFIED FOR MAXSP.                               *CSIP0390
C*                                                                    *CSIP0400
C*       EPS    AN INPUT PARAMETER USED TO TEST CURVATURE OF THE      *CSIP0410
C*              ENRICHED CURVE.  IF THE ABSOLUTE VALUE OF THE SECOND *CSIP0420
C*              DERIVATIVE AT AN INTERPOLATED POINT IS LESS THAN      *CSIP0430
C*              EPS, THE POINT WILL BE OMITTED FROM THE ENRICHED      *CSIP0440
C*              CURVE.  IF EPS=0, ALL INTERPOLATED POINTS WILL BE     *CSIP0450
C*              RETAINED.  IF AN ENRICHED CURVE IS NOT CALCULATED,    *CSIP0460
C*              A DUMMY ARGUMENT SHOULD BE SPECIFIED FOR EPS.         *CSIP0470
C*                                                                    *CSIP0480
C*       K1     AN INPUT INTEGER SPECIFYING WHETHER A NODE POINT IS   *CSIP0490
C*              TO BE RETAINED IN THE ENRICHED CURVE WHEN THE SECOND *CSIP0500
C*              DERIVATIVE AT THE POINT IS LESS THAN EPS.             *CSIP0510
C*                 K1=1  ALL NODE POINTS WILL BE RETAINED.            *CSIP0520
C*                 K1=2  NODE POINTS WILL BE OMITTED IF SECOND        *CSIP0530
C*                       DERIVATIVE IS LESS THAN EPS.                 *CSIP0540
C*              IF AN ENRICHED CURVE IS NOT CALCULATED, A DUMMY       *CSIP0550
C*              ARGUMENT SHOULD BE SPECIFIED FOR K1.                  *CSIP0560
C*                                                                    *CSIP0570
C*       IPT    AN INPUT/OUTPUT INTEGER HAVING THE FOLLOWING          *CSIP0580
C*              FUNCTIONS:                                            *CSIP0590
C*                                                                    *CSIP0600
C*              INPUT:                                                *CSIP0610
C*                                                                    *CSIP0620
C*              =-1  WHENEVER A NEW PNT ARRAY IS SPECIFIED,IPT MUST   *CSIP0630
C*                   BE INPUT AS -1 SO THAT THE ROUTINE WILL BE       *CSIP0640
C*                   INITIALIZED.                                     *CSIP0650
C*                                                                    *CSIP0660
C*              OUTPUT:                                               *CSIP0670
C*                                                                    *CSIP0680
C*              =N   THERE ARE A TOTAL OF N POINTS IN THE             *CSIP0690
C*                   ENRICHED CURVE.                                  *CSIP0700
C*                                                                    *CSIP0710
C*       ELEN   A ONE-DIMENSIONAL OUTPUT ARRAY DIMENSIONED AT LEAST  *CSIP0720
C*              IX IN THE CALLING PROGRAM.  ON RETURN FROM CSIPAR,    *CSIP0730
C*              ELEN(K) CONTAINS THE CHORD LENGTH BETWEEN NODE        *CSIP0740
C*              POINTS K AND K+1.                                     *CSIP0750
C*                                                                    *CSIP0760
```

```
C*         COEF     A THREE-DIMENSIONAL OUTPUT ARRAY DIMENSIONED          *CSIP0770
C*                  (MAXN,4,3) IN THE CALLING PROGRAM.  ON RETURN FROM    *CSIP0780
C*                  CSIPAR, COEF(K,M,N) CONTAINS THE M-TH CUBIC COEFFIC-  *CSIP0790
C*                  IENT FOR THE N-TH COORDINATE IN THE INTERVAL BETWEEN  *CSIP0800
C*                  NODE POINTS K AND K+1.                                *CSIP0810
C*                  ORDER OF CUBIC COEFFICIENTS IS:                       *CSIP0820
C*                    COEF(K,1,1)=AX   COEF(K,1,2)=AY   COEF(K,1,3)=AZ    *CSIP0830
C*                    COEF(K,2,1)=BX   COEF(K,2,2)=BY   COEF(K,2,3)=BZ    *CSIP0840
C*                    COEF(K,3,1)=CX   COEF(K,3,2)=CY   COEF(K,3,3)=CZ    *CSIP0850
C*                    COEF(K,4,1)=DX   COEF(K,4,2)=DY   COEF(K,4,3)=DZ    *CSIP0860
C*                  WHERE:                                                *CSIP0870
C*                    FX = AX*T**3 + BX*T**2 + CX*T + DX                  *CSIP0880
C*                    FY = AY*T**3 + BY*T**2 + CY*T + DY                  *CSIP0890
C*                    FZ = AZ*T**3 + BZ*T**2 + CZ*T + DZ                  *CSIP0900
C*                  AND:                                                  *CSIP0910
C*                     T = CHORDAL DISTANCE PARAMETER.                    *CSIP0920
C*                                                                        *CSIP0930
C*          CPT     A TWO-DIMENSIONAL OUTPUT ARRAY DIMENSIONED (MAXSP,3)  *CSIP0940
C*                  IN THE CALLING PROGRAM.  ON RETURN FROM CSIPAR,       *CSIP0950
C*                  CPT(K,1), CPT(K,2), CPT(K,3) CONTAIN THE X,Y,Z        *CSIP0960
C*                  COORDINATES RESPECTIVELY OF THE K-TH POINT ON THE     *CSIP0970
C*                  ENRICHED CURVE.  IF AN ENRICHED CURVE IS NOT          *CSIP0980
C*                  CALCULATED, A DUMMY ARGUMENT SHOULD BE SPECIFIED      *CSIP0990
C*                  FOR CPT.                                              *CSIP1000
C*                                                                        *CSIP1010
C*         IERR     AN OUTPUT INTEGER ERROR CODE.                         *CSIP1020
C*                  =0   NORMAL RETURN NO ERROR IN CALCULATION            *CSIP1030
C*                  =-1  INCOMPLETE FAIRED  CURVE                         *CSIP1040
C*                  =-2  LESS THAN FOUR NODE POINTS WERE SPECIFIED.       *CSIP1050
C*                       ROUTINE TERMINATES.                              *CSIP1060
C*                                                                        *CSIP1070
C*                                                                        *CSIP1080
C*                                                                        *CSIP1090
C*    REQUIRED ROUTINES                      NONE                         *CSIP1100
C*                                                                        *CSIP1110
C*    SOURCE                                 SUBROUTINE SPFIT WRITTEN BY  *CSIP1120
C*                                           CMPB, MODIFIED BY COMPUTER   *CSIP1130
C*                                           SCIENCES CORPORATION         *CSIP1140
C*                                                                        *CSIP1150
C*    LANGUAGE                               FORTRAN                      *CSIP1160
C*                                                                        *CSIP1170
```

```
C*     DATE RELEASED                          OCTOBER 3, 1973                  *
C*                                                                             *
C*     LATEST REVISION                        OCTOBER 3, 1973                  *
C*                                                                             *
C*                                                                             *
C*******************************************************************************
      DIMENSION PNT(MAXN,3),ELEN(1),COEF(MAXN,4,3),CPT(MAXSP,3)
      DIST(X1,Y1,Z1,X2,Y2,Z2)=SQRT((X2-X1)**2+(Y2-Y1)**2+(Z2-Z1)**2)
      IF (IPT  .NE. -1) GO TO 92
      IF(IX .LT. 4) GO TO 140
      IEPR = 0
      N1=IX-1
C
C         COMPUTES CHORD LENGTHS
C
      DO 30 NN=2,IX
         ELEN(NN-1)=DIST(PNT(NN-1,1),PNT(NN-1,2),PNT(NN-1,3),
     1   PNT(NN,1),PNT(NN,2),PNT(NN,3))
30       CONTINUE
C
C         SETUP COEFFICIENT MATRIX WITH UNCLAMPED END POINTS
C         SETS 2ND DER=0. AT P1 AND PN
C
      COEF(1,1,1)=0.
      COEF(1,1,2)=2.
      COEF(1,1,3)=1.
      COEF  (IX,1,1)=1.
      COEF  (IX,1,2)=2.
      COEF  (IX,1,3)=0.
      DO 40 NN=2,N1
         COEF(NN,1,1)=ELEN(NN)
         COEF(NN,1,2)=2.*(ELEN(NN-1)+ELEN(NN))
         COEF(NN,1,3)=ELEN(NN-1)
40       CONTINUE
C
C         SOLVE FOR SLOPES
C
      DO 70 I=1,3
         COEF(1,4,1)=(3./ELEN(1))*(PNT(2,I)-PNT(1,I))
         COEF  (IX,4,1)=(3./ELEN  (IX-1))*(PNT(IX,I)-PNT(IX-1,I))
         DO 60 NN=2,N1
```

```
            COEF(NN,4,I)=(3./(ELEN(NN-1)*ELEN(NN)))*
     1      (ELEN(NN-1)**2*(PNT(NN+1,I)-PNT(NN,I))+
     2      ELEN(NN)**2*(PNT(NN,I)-PNT(NN-1 ,I)))
 60         CONTINUE
C
C          SOLVE TRIDIAGONAL MATRIX
C
         COEF(1,2,I)=COEF(1,1,3)/COEF(1,1,2)
         COEF(1,3,I)=COEF(1,4,I)/COEF(1,1,2)
         DO 63 K=2,IX
            KM1=K-1
            TEMP=COEF(K,1,2)-COEF(K,1,1)*COEF(KM1,2,1)
            COEF(K,2,1)= COEF(K,1,3)/TEMP
            COEF(K,3,I)=(COEF(K,4,I)-COEF(K,1,1)*COEF(KM1,3,I))/TEMP
 63         CONTINUE
         DO 67 K=1,N1
            KK=IX-K
            COEF(KK,3,I)=COEF(KK,3,I)-COEF(KK,2,1)*COEF(KK+1,3,I)
 67         CONTINUE
 70      CONTINUE
C
C          COMPUTE CUBIC COEFFICIENTS FOR EACH SEGMENT
C
      DO 90 NN=1,N1
         EL=1./ELEN(NN)
         EL2=EL*EL
         EL3=EL*EL2
         DO 90 I=1,3
            COEF(NN,4,I)=PNT(NN,I)
            F=PNT(NN+1,I)-PNT(NN,I)
            COEF(NN,2,I)=
     1      F*EL2*3.-
     2      EL*(2.*COEF(NN,3,I)+COEF(NN+1,3,I))
            COEF(NN,1,I)=
     1      -F*EL3*2.+
     2      EL2*(COEF(NN,3,I)+COEF(NN+1,3,I))
C
C          REFERENCE LENGTH TO 1.
C
            COEF(NN,1,I)=COEF(NN,1,I)/EL3
            COEF(NN,2,I)=COEF(NN,2,I)/EL2
```

```
            COEF(NN,3,I)=COEF(NN,3,I)/EL
90          CONTINUE
   92 IPT = 0
      IF (N .EQ. 0) RETURN
      IF(K1 .EQ. 0 ) K1 =1
C
C          COMPUTE ENRICHED POINTS
C
      IFIT = N+1
      XFIT=IFIT
      DELT=1./XFIT
      DO 120 NN=1,N1
         DO 110 NF=1,IFIT
            F=NF-1
            T=DELT*F
            IF(NN.EQ.1.AND.NF.EQ.1)GO TO 95
            IF(NF.EQ. 1.AND. K1 .EQ. 1 ) GO TO 95
            T6=6.*T
            EX=ABS(T6*COEF(NN,1,1)+2.*COEF(NN,2,1))
            EY=ABS(T6*COEF(NN,1,2)+2.*COEF(NN,2,2))
            EZ=ABS(T6*COEF(NN,1,3)+2.*COEF(NN,2,3))
            EE=(EX+EY+EZ)/(ELEN(NN)*ELEN(NN))
            IF(EE.LT.EPS)GO TO 110
95          IF(IPT .GE. MAXSP ) GO TO 130
            IPT=IPT+1
            DO 100 I=1,3
100            CPT(IPT,I)=((T*COEF(NN,1,I) + COEF(NN,2,I))*T+ COEF(NN,3,
     1         I))*T+COEF(NN,4,I)
110         CONTINUE
120      CONTINUE
      IF ( IPT .GE. MAXSP ) GO TO 130
      IPT=IPT+1
      DO 125 I=1,3
125      CPT (IPT,I)=PNT(IX,I)
      RETURN
130   IERR=-1
      RETURN
140   IERR =-2
      RETURN
      END
```

*** RUN STREAM ***

```
LEVSP,T1777,CM177000.
USER,XXXXXX.
CHARGE,YYYYYY,LRC.
FTN.
LGO.
REWIND,TAPE9.        }
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7/8/9 - CARD

** COMPUTER PROGRAM **

7/8/9 - CARD

** DATA CARDS **

6/7/8/9 - CARD
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16. Abstract

A computer code based on an improved vortex filament - vortex core method for predicting aerodynamic characteristics of slender wings with edge vortex separations has been developed. The code is applicable to camber wings, straked wings or wings with leading-edge vortex flaps at subsonic speeds. The prediction of lifting pressure distribution and the computer time have been improved by using a pair of concentrated vortex cores above the wing surface. The main features of this computer program are: (1) arbitrary camber shape may be defined and option for exactly defining leading-edge flap geometry is also provided; (2) the side-edge vortex system is incorporated.

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