NOTICE

THIS DOCUMENT HAS BEEN REPRODUCED FROM MICROFICHE. ALTHOUGH IT IS RECOGNIZED THAT CERTAIN PORTIONS ARE ILLEGIBLE, IT IS BEING RELEASED IN THE INTEREST OF MAKING AVAILABLE AS MUCH INFORMATION AS POSSIBLE.
A COMPUTER PROGRAM FOR CALCULATING AERODYNAMIC CHARACTERISTICS OF LOW ASPECT-RATIO WINGS WITH PARTIAL LEADING-EDGE SEPARATION

Sudhir C. Mehrotra and C. Edward Lan

THE UNIVERSITY OF KANSAS CENTER FOR RESEARCH, INC.
Lawrence, KS 66045

NASA Grant NSG-1046
May 1978
A COMPUTER PROGRAM FOR CALCULATING AERODYNAMIC CHARACTERISTICS OF
LOW ASPECT-RATIO WINGS WITH PARTIAL LEADING-EDGE SEPARATION

by

Sudhir C. Mehrotra

and

C. Edward Lan

Technical Report CRINC-FRL-266-2

April 1978

The Flight Research Laboratory
The University of Kansas Center for Research, Inc.
Lawrence, Kansas 66045

Prepared under NASA Grant NSG 1046
for
Langley Research Center
National Aeronautics and Space Administration
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>List of Symbols</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Introduction</td>
<td>1</td>
</tr>
<tr>
<td>2. Computer Program Description</td>
<td>2</td>
</tr>
<tr>
<td>2.1 Problem Definition</td>
<td>2</td>
</tr>
<tr>
<td>2.2 Program Capabilities</td>
<td>2</td>
</tr>
<tr>
<td>2.3 Geometry Description</td>
<td>3</td>
</tr>
<tr>
<td>2.3.1 Wing Geometry</td>
<td>3</td>
</tr>
<tr>
<td>2.3.2 Leading-Edge Vortex System Geometry</td>
<td>5</td>
</tr>
<tr>
<td>2.4 Solution Procedure</td>
<td>9</td>
</tr>
<tr>
<td>3. Input Data Format</td>
<td>12</td>
</tr>
<tr>
<td>4. Output Data Format</td>
<td>16</td>
</tr>
<tr>
<td>5. References</td>
<td>19</td>
</tr>
<tr>
<td>6. Appendices</td>
<td>20</td>
</tr>
<tr>
<td>6.1 Appendix A: Example Input and Output</td>
<td>20</td>
</tr>
<tr>
<td>6.2 Appendix B: Computer Program Listing</td>
<td>58</td>
</tr>
</tbody>
</table>
# LIST OF SYMBOLS

<table>
<thead>
<tr>
<th>Symbols</th>
<th>Description</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td>Wing span</td>
<td>m (ft)</td>
</tr>
<tr>
<td>c</td>
<td>Local chord</td>
<td>m (ft)</td>
</tr>
<tr>
<td>(C_R)</td>
<td>Root chord</td>
<td>m (ft)</td>
</tr>
<tr>
<td>M</td>
<td>Number of spanwise strips plus one</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>Number of bound elements</td>
<td></td>
</tr>
<tr>
<td>(x,y,z)</td>
<td>Wing rectangular coordinate system with x (x) in the streamwise direction and (y) to the right</td>
<td>m (ft)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Greek</th>
<th>Description</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(\alpha)</td>
<td>Angle of attack</td>
<td>deg</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subscripts</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(cp)</td>
<td>Control point</td>
<td></td>
</tr>
<tr>
<td>(i)</td>
<td>Chordwise bound element number</td>
<td></td>
</tr>
<tr>
<td>(j)</td>
<td>Spanwise strip number</td>
<td></td>
</tr>
<tr>
<td>(k)</td>
<td>Chordwise bound element number</td>
<td></td>
</tr>
<tr>
<td>(L)</td>
<td>Leading-edge</td>
<td></td>
</tr>
</tbody>
</table>
1. INTRODUCTION

This document describes in detail the necessary information for using a computer program to predict distributed and total aerodynamic characteristics for low aspect-ratio wings with partial leading-edge separation. This program is based on the numerical method developed in reference 1. The flow is assumed to be steady and inviscid. The wing boundary condition is formulated by the Quasi-Vortex-Lattice method. The leading-edge separated vortices are represented by discrete free vortex elements which are aligned with the local velocity vector at mid-points to satisfy the force free condition. The wake behind the trailing-edge is also force free. The flow tangency boundary condition is satisfied on the wing, including the leading- and trailing-edges.

The program is restricted to delta wings with zero thickness and no camber. It is written in Fortran language and runs on CDC 6600 Computer.
2. COMPUTER PROGRAM DESCRIPTION

2.1 PROBLEM DEFINITION

In steady symmetric flight at a high angle of attack, the flow over a thin low aspect-ratio highly sweptback wing separates along the leading-edge and the tips. In the following, only delta wings are considered. The wing can be represented by a bound vortex sheet, across which there exists a pressure difference, and the separated flow along leading-edges by force free vortex sheets, across which there is no pressure difference. In the present method, the Quasi-Vortex-Lattice method (reference 2) is used to simplify the induced velocity expressions due to the bound vortex sheet and discrete force free vortex elements for separated vortex sheets. The following boundary conditions are imposed on the flow model:

a. The flow must be tangential to the wing surface.

b. The leading-edge boundary condition and the trailing-edge Kutta condition are to be satisfied.

c. The vortex elements over the wing and wake behind the trailing-edge are force free.

This is a non-linear problem because the strengths of the wing bound vortices and free vortices, and the locations of the free vortex elements are unknown. Thus, the problem is solved by an iterative method.

2.2 PROGRAM CAPABILITIES

This computer program provides a theoretical method for determining the aerodynamic characteristics of low aspect-ratio thin delta wings without camber, with partial leading-edge separation. The following is a list of the aerodynamic characteristics the program calculates:

a. Spanwise and chordwise $\Delta C_p$ distributions
b. Spanwise distribution of sectional lift, induced-drag and pitching moment coefficients.

c. Total lift, induced-drag, pitching-moment and leading-edge thrust coefficients.

2.3 GEOMETRY DESCRIPTION

The origin of the rectangular coordinate system is at the wing apex. The wing lies in the x-y plane and the x-axis is taken along the wing center-line. The wing span is given by b and the surface area S.

2.3.1 WING GEOMETRY

The location of bound- and trailing-vortex elements for a typical case are shown in figure 1. The x-location of bound elements is given by the cosine law and is illustrated in figure 1.

\[ x_i = x_e + \frac{c}{2} (1 - \cos(\frac{\theta_i - 1}{2N} \pi)), \quad i = 1, 2, \ldots, N \]

where \( x_e \) is the leading-edge x-coordinate, c is the chord and N is the number of bound elements in a chordwise direction. The spanwise location of trailing elements is given by,

\[ y_j = \frac{b}{4} (1 - \cos(\frac{\theta_j - 1}{2M} \pi)), \quad j = 1, 2, \ldots, M \]

where b is the span and M is the number of legs of trailing vorticity, which is one higher than the number of spanwise strips of bound elements.

The locations of control points are given by,
Figure 1. Wing geometry without leading-edge vortex system
\[ x_{cp_k} = x_{cp_j} + \frac{c_j}{2} (1 - \cos(\frac{jM}{N})) \quad (3) \]

\[ k = 0, 1, 2, \ldots N \]

\[ y_{cp_j} = \frac{b}{4} (1 - \cos(\frac{jM}{M})) \quad (4) \]

\[ j = 1, 2, \ldots (N - 1) \]

where \( x_{cp_j} \) and \( c_j \) are the leading-edge x-coordinate and chord at \( y_{cp_j} \) respectively.

It has been found numerically that the aerodynamic characteristics depended on the number of spanwise strips, i.e. \( M \) of equation (2). Therefore, a parametric study has been made to find a relation between the aspect ratio and the number of spanwise strips for reasonably accurate results (Fig. 2) (Section 3 of ref. 1). It is to be noted that as the aspect ratio is decreased, the number of spanwise strips has to be increased. This is due to the fact that the spanwise variation of aerodynamic characteristics, such as pressure coefficient and thrust coefficient, is large for small aspect ratio wings. This study was performed by matching the lift coefficients obtained by using the present method to those obtained by using suction analogy (ref. 3) at one angle of attack.

2.3.2 LEADING-EDGE VORTEX SYSTEM GEOMETRY

The leading-edge vortex system is superimposed on the regular quasi-vortex-lattice grid. A typical vortex element is shown by points A through J in figure 3. These points are connected by a series of short straight segments. The initial location of these segments is shown by dashed lines and final
Figure 2. Variation of number of spanwise strips with aspect ratio
Figure 3. A typical vortex element of leading-edge vortex system
location by solid lines. These segments have the following characteristics:

a. Points A through E lie along a wing trailing vortex element.

Initially point A is one root chord away from the trailing-edge in the downstream direction and the line segments between A and D are parallel to the axis of symmetry. The line segments between points A and B are of equal length. In the final converged position these segments are aligned in the direction of the local velocity vector. The segments B-C and C-D are 0.1 C_R long. B–C is allowed to move only in the vertical direction whereas C–D is fixed in the wing plane because the flow is tangential to the trailing-edge. Segment D–E is also fixed in the wing plane.

b. Points E, F, G and H also lie in the wing plane. The location of segment E–F is ahead of the wing first bound element and is given by,

\[ x_E = x_{l,E} + \frac{c_E}{2} \left(1 - \cos\left(\frac{\pi}{2(N + 1)}\right)\right) \]  \hspace{1cm} (5.a)

\[ x_F = x_{l,F} + \frac{c_F}{2} \left(1 - \cos\left(\frac{\pi}{2(N + 1)}\right)\right) \]  \hspace{1cm} (5.b)

where the subscripts E and F refer to the points under consideration. The above two equations are similar to equation (1). It is to be noted that segment E–F is located at the first bound element for a grid of (N + 1) bound elements in a chordwise direction. The segments F–G and G–H are of the same length and point G lies on the leading-edge. The segment G–H is fixed in the wing plane due to the leading-edge boundary condition.
c. The initial location of point I is given by,

\[ x_I = x_P \]  \hspace{1cm} (6.a)

\[ y_I = y_P \]  \hspace{1cm} (6.b)

\[ z_I = 0.1 \cdot C_R \tan(22.5 - 0.5a) \text{ for } \alpha \leq 15^\circ \]  \hspace{1cm} (6.c)

or \[ z_I = 0.1 \cdot C_R \tan a \text{ for } \alpha > 15^\circ \]  \hspace{1cm} (6.d)

where \( C_R \) is the root chord and \( \alpha \) is the angle of attack.

Initially point J is one root chord away from the trailing-edge.

The segments between point I and J are of equal length and lie in a plane parallel to x-z plane. These segments are approximately at a height of 0.1 \( C_R \) above the wing plane. In the final converged position all the segments between points H and J are aligned in the direction of the local velocity vector.

d. The semi-infinite segments from points A to infinity and J to infinity are straight and are parallel to the undisturbed free-stream direction.

2.4 SOLUTION PROCEDURE

The basic unknowns of the problem are the bound vortex density on the wing, and the strengths and the locations of the elements of the leading-edge vortex system and the wake. The problem is nonlinear because the locations of the leading-edge vortex system and the wake are unknown a priori. Therefore, the problem is solved by the iterative process described below;
a. Prescribe the vortex lattice for the wing surface, and the initial locations of the free elements over the wing and in the wake.
b. By satisfying the wing boundary condition, obtain the bound vortex density of the wing and the strengths of free elements.
c. Calculate all the aerodynamic characteristics.
d. Calculate the forces acting on the free elements over the wing surface.
e. Adjust the free elements of the leading-edge vortex system and the wake in the local velocity vector direction.
f. Repeat steps b through e until a converged solution is obtained.

The initial locations of the free vortex elements are assumed by letting them leave the leading-edge in the undisturbed free-stream direction up-to a height of about ten percent of the root chord beyond which the elements are parallel to the wing plane. Initially, all the elements of the wake lie in the plane of the wing. In the iteration process, the force free condition is satisfied on the free elements from the root to the tip in the down-stream direction. The elements over the wing are adjusted before the elements of the wake. In the first iteration the segments over the wing are moved 100 percent according to the velocity computed at their mid-points. This movement is gradually reduced in steps of 90, 80 and 75 percent in the next three iterations, after which it remains at 75 percent (Section 2.5.2 of ref. 1). The segments in the wake are moved only 50 percent in each iteration. Thus, exact force free condition is not enforced because whenever the free elements come close to each other they induce unreasonably large velocities because viscous effects are not included in the present theory. These large velocities increase the forces on the segments and induce fluctuations in their locations.
The solution is assumed to have converged if in two consecutive iterations the difference between the total strengths of leading-edge free vortex elements is less than one percent and the absolute force acting on the free elements is in the neighborhood of a minimum. Thus, an exact force free condition is not enforced as discussed in the previous paragraph.
3. INPUT DATA FORMAT

The following is the description of input data cards for this program.

Card 1. Format (16A5)

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

Card 2. Format (6I5)

NCW Number of chordwise lines (limited to nine)

NSW Number of spanwise lines (one higher than number of spanwise strips of panels, limited to twenty). It depends on aspect-ratio and is determined by using figure 2.

NBRR Number of constant x-locations where \( \Delta C_p \)'s are to be interpolated (limited to twenty-five).

NCONTS = 0, Initial locations of free elements will be calculated in the program.

= 1, Initial locations of free elements will be read from data cards.

MITER Maximum number of iterations to be performed (usually between 10 and 15)

IPUNCH = 0, Coordinates of free elements will not be punched out after last iteration.

= 1, Coordinates of free elements will be punched out after last iteration.

Card 3. Format (6F10.5)

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

Card 4. Format (7F10.5)

ALPHA Angle of attack (in degrees).
AMACH Mach number.
DELTA Length of a segment of leading-edge free vortex elements (may be taken as 0.15 CR).
DL Length of a segment of wake elements (may be taken as 0.15 CR).
XEND x-coordinate beyond which free elements of leading-edge and wake system are represented by a single element going to infinity.
CBAR Reference chord.
AREA Total reference wing area.

Card 5. Format (8F10.5)

XBRR(I), Constant x-locations where
I = 1, NBRR ΔCp’s are to interpolated.

Card 6. Format (8F10.5)

CTT(I), Sectional leading-edge thrust coefficients for
I = 1,(NSW-1) spanwise strips. All these values are set equal to zero for complete leading-edge separation.

*** If NCONTS = 0, go back to card number 1 ***
Card 7. Format (10I2)

\[ \text{NELM}(I), \quad \text{One higher than the number of segments for each leading-} \]
\[ I = 1, (\text{NSW}-1) \text{ edge free vortex element (numbered from root to tip).} \]

Card 8. Format (8F10.5)

\[ \text{XE}(K), \quad x\text{-coordinates of the end-points of segments of } I \text{th} \]
\[ K = 1, \text{NELM}(I) \text{ leading-edge free vortex element.} \]

Card 9. Format (8F10.5)

\[ \text{YE}(K), \quad y\text{-coordinates of the end-points of segments of } I \text{th} \]
\[ K = 1, \text{NELM}(I) \text{ leading-edge free vortex element.} \]

Card 10. Format (8F10.5)

\[ \text{ZE}(K), \quad z\text{-coordinates of the end-points of segments of } I \text{th} \]
\[ K = 1, \text{NELM}(I) \text{ leading-edge free vortex element.} \]

***Cards 8 thru 10 are repeated (NSW-1) times.***

Card 11. Format (10I2)

\[ \text{NNELM}(I), \quad \text{One higher than the number of segments for each wake} \]
\[ I = 1, \text{NSW} \quad \text{element (numbered from root to tip).} \]

Card 12. Format (8F10.5)

\[ \text{XXE}(K), \quad x\text{-coordinates of the end-points of segments of } I \text{th} \]
\[ K = 1, \text{NNELM}(I) \text{ trailing wake element.} \]

Card 13. Format (8F10.5)

\[ \text{YYE}(K), \quad y\text{-coordinates of the end-points of segments of } I \text{th} \]
\[ K = 1, \text{NNELM}(I) \text{ trailing wake element.} \]

Card 14. Format (8F10.5)

\[ \text{ZZE}(K), \quad z\text{-coordinates of the end-points of segments of } I \text{th} \]
\[ K = 1, \text{NNEM}(I) \text{ trailing wake element.} \]

*** Cards 12 thru 14 are repeated NSW times.***
*** Go back to card number 1.***

Note: The punched data cards obtained by running this program with IPUNCH = 1, can be directly used for cards 7 thru 14 for further iterations.
4. **OUTPUT DATA FORMAT**

All the input data cards for each case are listed at the beginning of the output. The output data at each iteration step is as follows:

The title card (input data card number 1) is printed-out as it is inputted. The angle-of-attack (in degrees), Mach Number and iteration number are also listed. The end-point locations of the leading-edge free elements are listed next. The first row of numbers in each group are the x-coordinates, second row the y-coordinates and third row the z-coordinates. The end-point locations of the wake elements are listed in the similar manner. On the next two pages, x-y and y-z digital plots for leading-edge free-elements are made. It is to be noted that the leading-edge elements lying in the plane of the wing and along center line are not plotted. So, the elements next to the center line are represented by "l". When similar numbers are connected by straight lines, they represent the path of a free vortex element. A "+" sign represents a duplicate point. In these two plots there are (NSW-2) rows of free elements. The digital plots for wake elements are made on next two pages. The elements along center line are again not plotted. There are (NSW-1) elements.

Some of the intermediate variables are listed under following labels:

- **X/C**: Percent chord location
- **2Y/B**: Percent span location
- **GAMAY**: Bound vortex density over the wing ($\gamma_y$) at the given $(X/C, 2Y/B)$
- **CAPGAMA**: Strength of leading-edge free element ($\Gamma$) at the given $2Y/B$
- **DELTA-CP**: The total $\Delta C_p$ at the given $(X/C, 2Y/B)$
The sectional properties are listed under the following labels:

- **I**: Spanwise station number (numbered from root to tip)
- **CLI**: The sectional lift coefficient
- **CMI**: The sectional pitching moment coefficient about the y-axis
- **CDI**: The sectional induced drag coefficient
- **CTI**: The sectional leading-edge thrust coefficient.

The total lift, pitching moment, induced drag and leading-edge thrust coefficients are listed after sectional properties. The spanwise pressures at constant x-locations are listed under following labels:

- **Y**: y-coordinate
- **2Y/B(LOCAL)**: Percent span location based on local span
- **DELTA-CP**: The total ΔCp at the given (x,y)

The last item listed for each iteration is the absolute force acting on leading-edge free elements.

The last page of the output is the "Summary Sheet", which is used to pick up final converged solution. It has the following format:

The title (input data card number 1) is printed again. The angle of attack (in degrees) and Mach Number are also listed. The other variables listed are,

<table>
<thead>
<tr>
<th>ITERATION</th>
<th>Iteration number</th>
</tr>
</thead>
<tbody>
<tr>
<td>CL</td>
<td>The total lift coefficient</td>
</tr>
<tr>
<td>CM</td>
<td>The total pitching moment coefficient about y-axis</td>
</tr>
<tr>
<td>CD</td>
<td>The total induced drag coefficient</td>
</tr>
<tr>
<td>CT</td>
<td>The total leading-edge thrust coefficient</td>
</tr>
<tr>
<td>GMSUM</td>
<td>Total sum of the strengths of leading-edge free vortex elements, except the one at the center line.</td>
</tr>
</tbody>
</table>
FERR  Percent change in RMS values of two consecutive iterations
TFABS  Total absolute force acting on leading-edge free elements

This program has not yet been completely automated and the converged solution is to be picked by the user, from the Summary Sheet, by using the following criteria:

The solution is assumed to have converged if in two consecutive iterations the difference between the total strengths of leading-edge free vortex elements is less than one percent and the absolute force acting on the free elements is in the neighborhood of a minimum.
5. REFERENCES


6. APPENDICES

6.1 APPENDIX A: EXAMPLE INPUT AND OUTPUT

The following is an example of delta wing of aspect-ratio 2 at an angle-of-attack of 30 degrees. The flow is assumed to be completely separated from the leading-edge and so sectional leading-edge thrust coefficients are set to zero on card number 6. Listing of input data cards is given below:

Listing of Input Data Cards

<table>
<thead>
<tr>
<th>CARD NUMBER</th>
<th>ASPECT RATIO = 2.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>0.0</td>
</tr>
<tr>
<td>7</td>
<td>END</td>
</tr>
</tbody>
</table>

Output data is listed on the following pages. An inspection of the "Summary Sheet" suggests that the converged solution has been reached at 8th iteration.
**INPUT DATA CARDS**

**ASPECT RATIO = 2.0**

<table>
<thead>
<tr>
<th></th>
<th>6</th>
<th>7</th>
<th>5</th>
<th>0</th>
<th>10</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.00000</td>
<td>4.00000</td>
<td>0.00000</td>
<td>4.00000</td>
<td>4.00000</td>
<td>2.00000</td>
</tr>
<tr>
<td>30</td>
<td>0.00000</td>
<td>0.00000</td>
<td>0.60000</td>
<td>0.60000</td>
<td>7.50000</td>
<td>2.00000</td>
</tr>
<tr>
<td>1</td>
<td>0.00000</td>
<td>2.00000</td>
<td>3.00000</td>
<td>3.50000</td>
<td>3.75000</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0.00000</td>
<td>0.00000</td>
<td>0.00000</td>
<td>0.00000</td>
<td>0.00000</td>
<td>0.00000</td>
</tr>
</tbody>
</table>

**END OF INPUT DATA**
## ASPECT RATIO = 2.0

### LEADING EDGE ELEMENTS

<table>
<thead>
<tr>
<th>Aspect Ratio</th>
<th>4.0000</th>
<th>5.9412</th>
<th>6.5057</th>
<th>1.0000</th>
<th>0.0000</th>
<th>0.5109</th>
<th>4.0000</th>
<th>2.0251</th>
<th>6.4196</th>
<th>1.4339</th>
<th>1.0000</th>
<th>0.0000</th>
<th>0.5109</th>
<th>4.0000</th>
<th>3.5631</th>
<th>1.7418</th>
<th>1.0000</th>
<th>0.0000</th>
<th>0.4000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.4810</td>
<td>.6810</td>
<td>1.3151</td>
<td>.5661</td>
<td>.0000</td>
<td>.5309</td>
<td>.4810</td>
<td>2.0251</td>
<td>.0190</td>
<td>.3339</td>
<td>.0000</td>
<td>.0000</td>
<td>.0190</td>
<td>.3339</td>
<td>.0000</td>
<td>.0000</td>
<td>.0000</td>
<td>.0000</td>
<td>.0000</td>
</tr>
<tr>
<td></td>
<td>.0501</td>
<td>.4343</td>
<td>1.4051</td>
<td>.5661</td>
<td>.0000</td>
<td>.5309</td>
<td>.0501</td>
<td>2.0251</td>
<td>1.9000</td>
<td>1.0000</td>
<td>1.0000</td>
<td>1.0000</td>
<td>1.0000</td>
<td>1.0000</td>
<td>1.0000</td>
<td>1.0000</td>
<td>1.0000</td>
<td>1.0000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>.0000</td>
<td>.2582</td>
<td>.2182</td>
<td>.2182</td>
<td>.2182</td>
<td>.2182</td>
<td>.0000</td>
<td>2.0251</td>
<td>2.1000</td>
<td>2.6196</td>
<td>3.2196</td>
<td>3.0196</td>
<td>4.4196</td>
<td>5.0196</td>
<td>5.6196</td>
<td>6.2196</td>
<td>6.8196</td>
<td>7.4196</td>
<td></td>
</tr>
</tbody>
</table>
### WING VORTEX STRENGTHS

<table>
<thead>
<tr>
<th>X/C</th>
<th>2Y/R</th>
<th>GAMAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01704</td>
<td>0.04952</td>
<td>8.33720</td>
</tr>
<tr>
<td>0.14645</td>
<td>0.04952</td>
<td>1.56297</td>
</tr>
<tr>
<td>0.37059</td>
<td>0.04952</td>
<td>6.0264</td>
</tr>
<tr>
<td>0.62941</td>
<td>0.04952</td>
<td>4.4407</td>
</tr>
<tr>
<td>0.85355</td>
<td>0.04952</td>
<td>2.2943</td>
</tr>
<tr>
<td>0.98296</td>
<td>0.04952</td>
<td>0.7193</td>
</tr>
<tr>
<td>0.01704</td>
<td>1.18826</td>
<td>5.99420</td>
</tr>
<tr>
<td>0.14645</td>
<td>1.18826</td>
<td>1.18377</td>
</tr>
<tr>
<td>0.37059</td>
<td>1.18826</td>
<td>7.3233</td>
</tr>
<tr>
<td>0.62941</td>
<td>1.18826</td>
<td>4.4816</td>
</tr>
<tr>
<td>0.85355</td>
<td>1.18826</td>
<td>2.3360</td>
</tr>
<tr>
<td>0.98296</td>
<td>1.18826</td>
<td>0.7046</td>
</tr>
<tr>
<td>0.01704</td>
<td>3.3874</td>
<td>6.94864</td>
</tr>
<tr>
<td>0.14645</td>
<td>3.3874</td>
<td>1.00475</td>
</tr>
<tr>
<td>0.37059</td>
<td>3.3874</td>
<td>7.1030</td>
</tr>
<tr>
<td>0.62941</td>
<td>3.3874</td>
<td>4.4483</td>
</tr>
<tr>
<td>0.85355</td>
<td>3.3874</td>
<td>2.3903</td>
</tr>
<tr>
<td>0.98296</td>
<td>3.3874</td>
<td>0.7714</td>
</tr>
<tr>
<td>0.01704</td>
<td>6.1126</td>
<td>8.69819</td>
</tr>
<tr>
<td>0.14645</td>
<td>6.1126</td>
<td>1.01388</td>
</tr>
<tr>
<td>0.37059</td>
<td>6.1126</td>
<td>7.5967</td>
</tr>
<tr>
<td>0.62941</td>
<td>6.1126</td>
<td>4.7910</td>
</tr>
<tr>
<td>0.85355</td>
<td>6.1126</td>
<td>2.5817</td>
</tr>
<tr>
<td>0.98296</td>
<td>6.1126</td>
<td>0.7882</td>
</tr>
<tr>
<td>0.01704</td>
<td>8.1174</td>
<td>11.59210</td>
</tr>
<tr>
<td>0.14645</td>
<td>8.1174</td>
<td>1.27090</td>
</tr>
<tr>
<td>0.37059</td>
<td>8.1174</td>
<td>8.2058</td>
</tr>
<tr>
<td>0.62941</td>
<td>8.1174</td>
<td>5.6037</td>
</tr>
<tr>
<td>0.85355</td>
<td>8.1174</td>
<td>3.0312</td>
</tr>
<tr>
<td>0.98296</td>
<td>8.1174</td>
<td>0.9232</td>
</tr>
<tr>
<td>0.01704</td>
<td>9.5048</td>
<td>17.69230</td>
</tr>
<tr>
<td>0.14645</td>
<td>9.5048</td>
<td>1.80028</td>
</tr>
<tr>
<td>0.37059</td>
<td>9.5048</td>
<td>1.10401</td>
</tr>
<tr>
<td>0.62941</td>
<td>9.5048</td>
<td>7.7419</td>
</tr>
<tr>
<td>0.85355</td>
<td>9.5048</td>
<td>4.4792</td>
</tr>
<tr>
<td>0.98296</td>
<td>9.5048</td>
<td>1.3807</td>
</tr>
</tbody>
</table>

### LEADING-EDGE VORTEX STRENGTHS

<table>
<thead>
<tr>
<th>2Y/R</th>
<th>CAPGAMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01704</td>
<td>8.33720</td>
</tr>
<tr>
<td>0.14645</td>
<td>1.56297</td>
</tr>
<tr>
<td>0.37059</td>
<td>6.0264</td>
</tr>
<tr>
<td>0.62941</td>
<td>4.4407</td>
</tr>
<tr>
<td>0.85355</td>
<td>2.2943</td>
</tr>
<tr>
<td>0.98296</td>
<td>0.7193</td>
</tr>
<tr>
<td>0.01704</td>
<td>5.99420</td>
</tr>
<tr>
<td>0.14645</td>
<td>1.18377</td>
</tr>
<tr>
<td>0.37059</td>
<td>7.3233</td>
</tr>
<tr>
<td>0.62941</td>
<td>4.4816</td>
</tr>
<tr>
<td>0.85355</td>
<td>2.3360</td>
</tr>
<tr>
<td>0.98296</td>
<td>0.7046</td>
</tr>
<tr>
<td>0.01704</td>
<td>6.94864</td>
</tr>
<tr>
<td>0.14645</td>
<td>1.00475</td>
</tr>
<tr>
<td>0.37059</td>
<td>7.1030</td>
</tr>
<tr>
<td>0.62941</td>
<td>4.4483</td>
</tr>
<tr>
<td>0.85355</td>
<td>2.3903</td>
</tr>
<tr>
<td>0.98296</td>
<td>0.7714</td>
</tr>
<tr>
<td>0.01704</td>
<td>8.69819</td>
</tr>
<tr>
<td>0.14645</td>
<td>1.01388</td>
</tr>
<tr>
<td>0.37059</td>
<td>7.5967</td>
</tr>
<tr>
<td>0.62941</td>
<td>4.7910</td>
</tr>
<tr>
<td>0.85355</td>
<td>2.5817</td>
</tr>
<tr>
<td>0.98296</td>
<td>0.7882</td>
</tr>
<tr>
<td>0.01704</td>
<td>11.59210</td>
</tr>
<tr>
<td>0.14645</td>
<td>1.27090</td>
</tr>
<tr>
<td>0.37059</td>
<td>8.2058</td>
</tr>
<tr>
<td>0.62941</td>
<td>5.6037</td>
</tr>
<tr>
<td>0.85355</td>
<td>3.0312</td>
</tr>
<tr>
<td>0.98296</td>
<td>0.9232</td>
</tr>
<tr>
<td>0.01704</td>
<td>17.69230</td>
</tr>
<tr>
<td>0.14645</td>
<td>1.80028</td>
</tr>
<tr>
<td>0.37059</td>
<td>1.10401</td>
</tr>
<tr>
<td>0.62941</td>
<td>7.7419</td>
</tr>
<tr>
<td>0.85355</td>
<td>4.4792</td>
</tr>
<tr>
<td>0.98296</td>
<td>1.3807</td>
</tr>
<tr>
<td>X/C</td>
<td>2Y/B</td>
</tr>
<tr>
<td>------</td>
<td>-------</td>
</tr>
<tr>
<td>.01254</td>
<td>04952</td>
</tr>
<tr>
<td>.10908</td>
<td>04952</td>
</tr>
<tr>
<td>.28306</td>
<td>04952</td>
</tr>
<tr>
<td>.50000</td>
<td>04952</td>
</tr>
<tr>
<td>.71694</td>
<td>04952</td>
</tr>
<tr>
<td>.89092</td>
<td>04952</td>
</tr>
<tr>
<td>.98746</td>
<td>04952</td>
</tr>
<tr>
<td>.01254</td>
<td>18826</td>
</tr>
<tr>
<td>.10908</td>
<td>18826</td>
</tr>
<tr>
<td>.28306</td>
<td>18826</td>
</tr>
<tr>
<td>.50000</td>
<td>18826</td>
</tr>
<tr>
<td>.71694</td>
<td>18826</td>
</tr>
<tr>
<td>.89092</td>
<td>18826</td>
</tr>
<tr>
<td>.98746</td>
<td>18826</td>
</tr>
<tr>
<td>.01254</td>
<td>38874</td>
</tr>
<tr>
<td>.10908</td>
<td>38874</td>
</tr>
<tr>
<td>.28306</td>
<td>38874</td>
</tr>
<tr>
<td>.50000</td>
<td>38874</td>
</tr>
<tr>
<td>.71694</td>
<td>38874</td>
</tr>
<tr>
<td>.89092</td>
<td>38874</td>
</tr>
<tr>
<td>.98746</td>
<td>38874</td>
</tr>
<tr>
<td>.01254</td>
<td>61126</td>
</tr>
<tr>
<td>.10908</td>
<td>61126</td>
</tr>
<tr>
<td>.28306</td>
<td>61126</td>
</tr>
<tr>
<td>.50000</td>
<td>61126</td>
</tr>
<tr>
<td>.71694</td>
<td>61126</td>
</tr>
<tr>
<td>.89092</td>
<td>61126</td>
</tr>
<tr>
<td>.98746</td>
<td>61126</td>
</tr>
<tr>
<td>.01254</td>
<td>81174</td>
</tr>
<tr>
<td>.10908</td>
<td>81174</td>
</tr>
<tr>
<td>.28306</td>
<td>81174</td>
</tr>
<tr>
<td>.50000</td>
<td>81174</td>
</tr>
<tr>
<td>.71694</td>
<td>81174</td>
</tr>
<tr>
<td>.89092</td>
<td>81174</td>
</tr>
<tr>
<td>.98746</td>
<td>81174</td>
</tr>
<tr>
<td>.01254</td>
<td>95048</td>
</tr>
<tr>
<td>.10908</td>
<td>95048</td>
</tr>
<tr>
<td>.28306</td>
<td>95048</td>
</tr>
<tr>
<td>.50000</td>
<td>95048</td>
</tr>
<tr>
<td>.71694</td>
<td>95048</td>
</tr>
<tr>
<td>.89092</td>
<td>95048</td>
</tr>
<tr>
<td>.98746</td>
<td>95048</td>
</tr>
</tbody>
</table>
SECTIONAL PROPERTIES

<table>
<thead>
<tr>
<th>I</th>
<th>CLI</th>
<th>CMI</th>
<th>CDI</th>
<th>CTI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.92867</td>
<td>-1.25424</td>
<td>1.11392</td>
<td>0.00000</td>
</tr>
<tr>
<td>2</td>
<td>1.70269</td>
<td>-1.71973</td>
<td>0.98305</td>
<td>0.00000</td>
</tr>
<tr>
<td>3</td>
<td>1.62912</td>
<td>-2.27566</td>
<td>0.94057</td>
<td>0.00000</td>
</tr>
<tr>
<td>4</td>
<td>1.22177</td>
<td>-2.08599</td>
<td>0.70539</td>
<td>0.00000</td>
</tr>
<tr>
<td>5</td>
<td>0.98222</td>
<td>-1.95844</td>
<td>0.56708</td>
<td>0.00000</td>
</tr>
<tr>
<td>6</td>
<td>0.79862</td>
<td>-1.77018</td>
<td>0.46108</td>
<td>0.00000</td>
</tr>
</tbody>
</table>

TOTAL LIFT COEFFICIENT = 1.55805
TOTAL PITCHING MOMENT COEFFICIENT = -1.83185
TOTAL DRAG COEFFICIENT = 0.89954
TOTAL THRUST COEFFICIENT = 0.00000

SPANWISE PRESSURES AT CONSTANT X =

Y 2Y/B (LOCAL) DELTA-CP

| 1.00000 |
| 2.00000 |
| 3.00000 |
| 3.50000 |

ORIGINAL PAGE IS OF POOR QUALITY
<table>
<thead>
<tr>
<th>SPANWISE PRESSURES AT CONSTANT X</th>
<th>3.75000</th>
</tr>
</thead>
<tbody>
<tr>
<td>2Y/(LOCAL) DELTA-CP</td>
<td></td>
</tr>
<tr>
<td>09303</td>
<td></td>
</tr>
<tr>
<td>37651</td>
<td></td>
</tr>
<tr>
<td>77749</td>
<td></td>
</tr>
<tr>
<td>1.22252</td>
<td></td>
</tr>
<tr>
<td>1.62349</td>
<td></td>
</tr>
</tbody>
</table>

TOTAL ABSOLUTE FORCE ACTING ON LEADING-EDGE FREE ELEMENTS: 1.28618
<table>
<thead>
<tr>
<th>Alpha</th>
<th>A0,000</th>
<th>A0,000</th>
<th>A0,000</th>
<th>A0,000</th>
<th>A0,000</th>
<th>A0,000</th>
<th>A0,000</th>
<th>A0,000</th>
<th>A0,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fines</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fines</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fines</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fines</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fines</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fines</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fines</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fines</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fines</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fines</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fines</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fines</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fines</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Wing Vortex Strengths

<table>
<thead>
<tr>
<th>X/C</th>
<th>2Y/B</th>
<th>GAMAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>.01704</td>
<td>.04952</td>
<td>8.25052</td>
</tr>
<tr>
<td>.14645</td>
<td>.04952</td>
<td>1.36927</td>
</tr>
<tr>
<td>.37059</td>
<td>.04952</td>
<td>.61192</td>
</tr>
<tr>
<td>.62941</td>
<td>.04952</td>
<td>.51188</td>
</tr>
<tr>
<td>.85355</td>
<td>.04952</td>
<td>.22160</td>
</tr>
<tr>
<td>.98296</td>
<td>.04952</td>
<td>.03334</td>
</tr>
<tr>
<td>.01704</td>
<td>.19626</td>
<td>.5.80367</td>
</tr>
<tr>
<td>.14645</td>
<td>.18826</td>
<td>1.10192</td>
</tr>
<tr>
<td>.37059</td>
<td>.18826</td>
<td>.47379</td>
</tr>
<tr>
<td>.62941</td>
<td>.18826</td>
<td>.46999</td>
</tr>
<tr>
<td>.85355</td>
<td>.18826</td>
<td>.29190</td>
</tr>
<tr>
<td>.98296</td>
<td>.18826</td>
<td>.03814</td>
</tr>
<tr>
<td>.01704</td>
<td>.38874</td>
<td>7.13406</td>
</tr>
<tr>
<td>.14645</td>
<td>.38874</td>
<td>1.02614</td>
</tr>
<tr>
<td>.37059</td>
<td>.38874</td>
<td>.01492</td>
</tr>
<tr>
<td>.62941</td>
<td>.38874</td>
<td>.11520</td>
</tr>
<tr>
<td>.85355</td>
<td>.38874</td>
<td>.30132</td>
</tr>
<tr>
<td>.98296</td>
<td>.38874</td>
<td>.13724</td>
</tr>
<tr>
<td>.01704</td>
<td>.61126</td>
<td>8.92539</td>
</tr>
<tr>
<td>.14645</td>
<td>.61126</td>
<td>1.04178</td>
</tr>
<tr>
<td>.37059</td>
<td>.61126</td>
<td>.75280</td>
</tr>
<tr>
<td>.62941</td>
<td>.61126</td>
<td>.40170</td>
</tr>
<tr>
<td>.85355</td>
<td>.61126</td>
<td>.08733</td>
</tr>
<tr>
<td>.98296</td>
<td>.61126</td>
<td>-.00273</td>
</tr>
<tr>
<td>.01704</td>
<td>.81174</td>
<td>11.70835</td>
</tr>
<tr>
<td>.14645</td>
<td>.81174</td>
<td>1.22415</td>
</tr>
<tr>
<td>.37059</td>
<td>.81174</td>
<td>.80847</td>
</tr>
<tr>
<td>.62941</td>
<td>.81174</td>
<td>.53281</td>
</tr>
<tr>
<td>.85355</td>
<td>.81174</td>
<td>.27362</td>
</tr>
<tr>
<td>.98296</td>
<td>.81174</td>
<td>.08046</td>
</tr>
<tr>
<td>.01704</td>
<td>.95048</td>
<td>17.57587</td>
</tr>
<tr>
<td>.14645</td>
<td>.95048</td>
<td>1.78459</td>
</tr>
<tr>
<td>.37059</td>
<td>.95048</td>
<td>1.09015</td>
</tr>
<tr>
<td>.62941</td>
<td>.95048</td>
<td>.76081</td>
</tr>
<tr>
<td>.85355</td>
<td>.95048</td>
<td>.43806</td>
</tr>
<tr>
<td>.98296</td>
<td>.95048</td>
<td>.13460</td>
</tr>
</tbody>
</table>

### Leading-Edge Vortices Strengths

<table>
<thead>
<tr>
<th>2Y/B</th>
<th>GAMAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>2Y/B</td>
<td>GAMAY</td>
</tr>
<tr>
<td>I</td>
<td>C1I</td>
</tr>
<tr>
<td>----</td>
<td>-----</td>
</tr>
<tr>
<td>1</td>
<td>1.79394</td>
</tr>
<tr>
<td>2</td>
<td>1.77886</td>
</tr>
<tr>
<td>3</td>
<td>1.99753</td>
</tr>
<tr>
<td>4</td>
<td>1.31320</td>
</tr>
<tr>
<td>5</td>
<td>0.87826</td>
</tr>
<tr>
<td>6</td>
<td>0.68555</td>
</tr>
</tbody>
</table>

TOTAL LIFT COEFFICIENT = 1.66094
TOTAL PITCHING MOMENT COEFFICIENT = -2.07341
TOTAL DRAG COEFFICIENT = 0.95894
TOTAL THRUST COEFFICIENT = 0.00000

SPANWISE PRESSURES AT CONSTANT X = 1.00000
Y 2Y/B (LOCAL) DELTA-CP
0.09903 0.19806 2.52115
0.37651 0.75302 3.26689

SPANWISE PRESSURES AT CONSTANT X = 2.00000
Y 2Y/B (LOCAL) DELTA-CP
0.09903 0.09903 1.40484
0.37651 0.37651 1.92070
0.77748 0.77748 2.89741

SPANWISE PRESSURES AT CONSTANT X = 3.00000
Y 2Y/B (LOCAL) DELTA-CP
0.09903 0.06602 0.69986
0.37651 0.25101 1.41881
0.77748 0.51832 1.89848
1.22252 0.81501 1.03833

SPANWISE PRESSURES AT CONSTANT X = 3.50000
Y 2Y/B (LOCAL) DELTA-CP
0.09903 0.05659 0.47866
0.37651 0.21515 1.01330
0.77748 0.44427 1.84657
1.22752 0.69858 1.23075
1.62340 0.92771 0.99452
<table>
<thead>
<tr>
<th>( y )</th>
<th>( 2y/b ) (local)</th>
<th>( \Delta CP )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.09903</td>
<td>0.05282</td>
<td>0.64341</td>
</tr>
<tr>
<td>0.37651</td>
<td>0.20081</td>
<td>0.81792</td>
</tr>
<tr>
<td>0.77748</td>
<td>0.41466</td>
<td>1.51332</td>
</tr>
<tr>
<td>1.22252</td>
<td>0.65201</td>
<td>1.05705</td>
</tr>
<tr>
<td>1.62349</td>
<td>0.86586</td>
<td>0.46002</td>
</tr>
</tbody>
</table>

Total absolute force acting on leading-edge free elements: \( 0.42133 \)
Similar type of output data is printed for iterations 2 through 7.
### Table

**Aspect Ratio = 2.0**

<table>
<thead>
<tr>
<th>Leading Edge Elements</th>
<th>Number of Iterations</th>
<th>0.000</th>
<th>0.001</th>
<th>0.005</th>
<th>0.010</th>
<th>0.020</th>
<th>0.050</th>
<th>0.100</th>
<th>0.200</th>
<th>0.500</th>
<th>1.000</th>
<th>2.000</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.292</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>0.584</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>0.791</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>0.999</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

**ORIGINAL PAGE IS POOR QUALITY**
<table>
<thead>
<tr>
<th>X/C</th>
<th>2Y/8</th>
<th>DELTA-CP</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01254</td>
<td>0.04952</td>
<td>7.61337</td>
</tr>
<tr>
<td>0.10908</td>
<td>0.04952</td>
<td>4.55513</td>
</tr>
<tr>
<td>0.28306</td>
<td>0.04952</td>
<td>1.52432</td>
</tr>
<tr>
<td>0.50000</td>
<td>0.04952</td>
<td>1.29977</td>
</tr>
<tr>
<td>0.71694</td>
<td>0.04952</td>
<td>0.66022</td>
</tr>
<tr>
<td>0.89092</td>
<td>0.04952</td>
<td>0.36277</td>
</tr>
<tr>
<td>0.98746</td>
<td>0.04952</td>
<td>0.15256</td>
</tr>
<tr>
<td>0.01254</td>
<td>0.18826</td>
<td>6.36274</td>
</tr>
<tr>
<td>0.10908</td>
<td>0.18826</td>
<td>2.29859</td>
</tr>
<tr>
<td>0.28306</td>
<td>0.18826</td>
<td>1.73239</td>
</tr>
<tr>
<td>0.50000</td>
<td>0.18826</td>
<td>1.58317</td>
</tr>
<tr>
<td>0.71694</td>
<td>0.18826</td>
<td>1.21972</td>
</tr>
<tr>
<td>0.89092</td>
<td>0.18826</td>
<td>0.77920</td>
</tr>
<tr>
<td>0.98746</td>
<td>0.18826</td>
<td>0.50958</td>
</tr>
<tr>
<td>0.01254</td>
<td>0.38874</td>
<td>4.33651</td>
</tr>
<tr>
<td>0.10908</td>
<td>0.38874</td>
<td>2.91581</td>
</tr>
<tr>
<td>0.28306</td>
<td>0.38874</td>
<td>1.97543</td>
</tr>
<tr>
<td>0.50000</td>
<td>0.38874</td>
<td>1.63405</td>
</tr>
<tr>
<td>0.71694</td>
<td>0.38874</td>
<td>1.76146</td>
</tr>
<tr>
<td>0.89092</td>
<td>0.38874</td>
<td>1.44152</td>
</tr>
<tr>
<td>0.98746</td>
<td>0.38874</td>
<td>1.15567</td>
</tr>
<tr>
<td>0.01254</td>
<td>0.61126</td>
<td>3.55946</td>
</tr>
<tr>
<td>0.10908</td>
<td>0.61126</td>
<td>2.62342</td>
</tr>
<tr>
<td>0.28306</td>
<td>0.61126</td>
<td>1.33923</td>
</tr>
<tr>
<td>0.50000</td>
<td>0.61126</td>
<td>0.97921</td>
</tr>
<tr>
<td>0.71694</td>
<td>0.61126</td>
<td>0.18459</td>
</tr>
<tr>
<td>0.89092</td>
<td>0.61126</td>
<td>0.90131</td>
</tr>
<tr>
<td>0.98746</td>
<td>0.61126</td>
<td>0.66762</td>
</tr>
<tr>
<td>0.01254</td>
<td>0.81174</td>
<td>3.33069</td>
</tr>
<tr>
<td>0.10908</td>
<td>0.81174</td>
<td>2.47576</td>
</tr>
<tr>
<td>0.28306</td>
<td>0.81174</td>
<td>1.27152</td>
</tr>
<tr>
<td>0.50000</td>
<td>0.81174</td>
<td>0.73556</td>
</tr>
<tr>
<td>0.71694</td>
<td>0.81174</td>
<td>0.48107</td>
</tr>
<tr>
<td>0.89092</td>
<td>0.81174</td>
<td>0.27523</td>
</tr>
<tr>
<td>0.98746</td>
<td>0.81174</td>
<td>-0.11281</td>
</tr>
<tr>
<td>0.01254</td>
<td>0.95048</td>
<td>2.63992</td>
</tr>
<tr>
<td>0.10908</td>
<td>0.95048</td>
<td>2.47422</td>
</tr>
<tr>
<td>0.28306</td>
<td>0.95048</td>
<td>1.11563</td>
</tr>
<tr>
<td>0.50000</td>
<td>0.95048</td>
<td>0.74813</td>
</tr>
<tr>
<td>0.71694</td>
<td>0.95048</td>
<td>0.15061</td>
</tr>
<tr>
<td>0.89092</td>
<td>0.95048</td>
<td>-1.9024</td>
</tr>
<tr>
<td>0.98746</td>
<td>0.95048</td>
<td>-7.6758</td>
</tr>
</tbody>
</table>
### SECTIONAL PROPERTIES

<table>
<thead>
<tr>
<th>I</th>
<th>CL1</th>
<th>CM1</th>
<th>CD1</th>
<th>C11</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.56797</td>
<td>-1.04769</td>
<td>.90527</td>
<td>0.00000</td>
</tr>
<tr>
<td>2</td>
<td>1.49362</td>
<td>-1.64737</td>
<td>.86234</td>
<td>0.00000</td>
</tr>
<tr>
<td>3</td>
<td>1.73731</td>
<td>-2.58121</td>
<td>1.00304</td>
<td>0.00000</td>
</tr>
<tr>
<td>4</td>
<td>1.25071</td>
<td>-2.19754</td>
<td>.72210</td>
<td>0.00000</td>
</tr>
<tr>
<td>5</td>
<td>.90756</td>
<td>-1.80956</td>
<td>.52399</td>
<td>0.00000</td>
</tr>
<tr>
<td>6</td>
<td>.72602</td>
<td>-1.60937</td>
<td>.41917</td>
<td>0.00000</td>
</tr>
</tbody>
</table>

**TOTAL LIFT COEFFICIENT** = 1.45997

**TOTAL PITCHING MOMENT COEFFICIENT** = -1.86231

**TOTAL DRAG COEFFICIENT** = .84292

**TOTAL TRAVEL COEFFICIENT** = 0.00000

### SPANWISE Pressures at Constant \( x = 1 \)  \( y \) 2Y/B (LOCAL) DELTA-CP

<table>
<thead>
<tr>
<th>Y</th>
<th>2Y/B (LOCAL) DELTA-CP</th>
</tr>
</thead>
<tbody>
<tr>
<td>.9903</td>
<td>.19806</td>
</tr>
<tr>
<td>.37651</td>
<td>.75302</td>
</tr>
</tbody>
</table>

### SPANWISE Pressures at Constant \( x = 2 \)  \( y \) 2Y/B (LOCAL) DELTA-CP

<table>
<thead>
<tr>
<th>Y</th>
<th>2Y/B (LOCAL) DELTA-CP</th>
</tr>
</thead>
<tbody>
<tr>
<td>.09903</td>
<td>.09903</td>
</tr>
<tr>
<td>.37651</td>
<td>.37651</td>
</tr>
<tr>
<td>.77748</td>
<td>.77748</td>
</tr>
</tbody>
</table>

### SPANWISE Pressures at Constant \( x = 3 \)  \( y \) 2Y/B (LOCAL) DELTA-CP

<table>
<thead>
<tr>
<th>Y</th>
<th>2Y/B (LOCAL) DELTA-CP</th>
</tr>
</thead>
<tbody>
<tr>
<td>.09903</td>
<td>.06602</td>
</tr>
<tr>
<td>.37651</td>
<td>.25101</td>
</tr>
<tr>
<td>.77748</td>
<td>.51832</td>
</tr>
<tr>
<td>1.22252</td>
<td>.81501</td>
</tr>
</tbody>
</table>

### SPANWISE Pressures at Constant \( x = 3.5 \)  \( y \) 2Y/B (LOCAL) DELTA-CP

<table>
<thead>
<tr>
<th>Y</th>
<th>2Y/B (LOCAL) DELTA-CP</th>
</tr>
</thead>
<tbody>
<tr>
<td>.09903</td>
<td>.05659</td>
</tr>
<tr>
<td>.37651</td>
<td>.21515</td>
</tr>
<tr>
<td>.77748</td>
<td>.44427</td>
</tr>
<tr>
<td>1.22252</td>
<td>.69858</td>
</tr>
<tr>
<td>1.62349</td>
<td>.92771</td>
</tr>
</tbody>
</table>
Similar type of output data is printed for iterations 9 and 10.
## SUMMARY SHEET

**ASPECT RATIO = 2.0**

**ALPHA (deg.) = 30.000**  **MACH NUMBER = 0.000**

<table>
<thead>
<tr>
<th>ITERATION</th>
<th>CL</th>
<th>CM</th>
<th>CD</th>
<th>CT</th>
<th>GMSUM</th>
<th>PERR</th>
<th>TFABS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.5581</td>
<td>-1.8319</td>
<td>.8995</td>
<td>0.0000</td>
<td>3.2626</td>
<td>1.2862</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1.6609</td>
<td>-2.0734</td>
<td>.9589</td>
<td>0.0000</td>
<td>3.2710</td>
<td>.2571</td>
<td>.4213</td>
</tr>
<tr>
<td>2</td>
<td>1.5024</td>
<td>-1.9132</td>
<td>.8674</td>
<td>0.0000</td>
<td>3.1577</td>
<td>3.5233</td>
<td>.3423</td>
</tr>
<tr>
<td>3</td>
<td>1.4260</td>
<td>-1.8073</td>
<td>.8233</td>
<td>0.0000</td>
<td>3.1057</td>
<td>1.6609</td>
<td>.3454</td>
</tr>
<tr>
<td>4</td>
<td>1.4328</td>
<td>-1.8182</td>
<td>.8272</td>
<td>0.0000</td>
<td>3.1027</td>
<td>.0976</td>
<td>.2999</td>
</tr>
<tr>
<td>5</td>
<td>1.4558</td>
<td>-1.8541</td>
<td>.9405</td>
<td>0.0000</td>
<td>3.1204</td>
<td>.5712</td>
<td>.2140</td>
</tr>
<tr>
<td>6</td>
<td>1.4632</td>
<td>-1.3570</td>
<td>.8448</td>
<td>0.0000</td>
<td>3.1257</td>
<td>.1698</td>
<td>.1869</td>
</tr>
<tr>
<td>7</td>
<td>1.4648</td>
<td>-1.8697</td>
<td>.8437</td>
<td>0.0000</td>
<td>3.1292</td>
<td>.1117</td>
<td>.1858</td>
</tr>
<tr>
<td>8</td>
<td>1.4600</td>
<td>-1.8623</td>
<td>.8429</td>
<td>0.0000</td>
<td>3.1252</td>
<td>.1308</td>
<td>.1743</td>
</tr>
<tr>
<td>9</td>
<td>1.4598</td>
<td>-1.8612</td>
<td>.8428</td>
<td>0.0000</td>
<td>3.1260</td>
<td>.0263</td>
<td>.1754</td>
</tr>
<tr>
<td>10</td>
<td>1.4598</td>
<td>-1.8614</td>
<td>.8429</td>
<td>0.0000</td>
<td>3.1270</td>
<td>.0318</td>
<td>.1732</td>
</tr>
</tbody>
</table>

**ALL CASES COMPLETED**
6.2 APPENDIX B: COMPUTER PROGRAM LISTING

A listing of the computer program is given on the following pages.
OVERLAY (LEVSP,0,0)
PROGRAM LEVSP((INPUT,OUTPUT,TAPE1,TAPE2,TAPE3,TAPE5,INPUT,TAPE6=OUTPUT)
INPUT,PUNCH,TAPE4,TAPE7)

AERODYNAMICS OF LOW ASPECT-RATIO WINGS WITH PARTIAL LEADING-EDGE
SEPARATION (LEADING-EDGE VORTEX SEPARATION PROGRAM)
BY - SUDHIR C. MEHRUTRA AND C. EDWARD LAN
UNIVERSITY OF KANSAS

THIS PROGRAM IS RESTRICTED TO DELTA AND ARROW WINGS

PROGRAM IS DIVIDED INTO FIVE OVERLAYS.
OVERLAY (1,0) READS ALL THE DATA CARDS AND SETS UP INITIAL GEOMETRY
OF THE WING AND THE FREE ELEMENTS
OVERLAY (2,0) PLOTS FREE ELEMENTS OVER THE WING AND IN THE WAKE ON THE LINE PRINTER OUTPUT
OVERLAY (3,0) SOLVES FOR THE STRENGTHS OF WING AND LEADING-EDGE VORTEX SYSTEM
OVERLAY (4,0) COMPUTES THE AERODYNAMIC CHARACTERISTICS
OVERLAY (5,0) COMPUTES THE NEW LOCATIONS OF THE LEADING-EDGE AND TRAILING-EDGE VORTEXES

AS THE PROBLEM IS NONLINEAR, IT IS SOLVED BY ITERATION. ITERATION IS PERFORMED OVER OVERLAYS (2,0) THRU (4,0) TO OBTAIN THE FINAL CONVERGED SOLUTION.

THE DIMENSIONS OF THE FOLLOWING VARIABLES MUST BE CHECKED BEFORE RUNNING THE PROGRAM.

-D- APPEARS IN BLANK COMMON OF MAIN LINE (OVERLAY(0,0))
MUST BE DIMENSIONED MAXIMUM OF THE FOLLOWING VARIABLES:
N1=2,96
N2=3*NMAX*(NSW-1)+NSW
N3=3*NMAX*(NMAX+2)+NSW+1
N4=1*(NCP4+1)**2/4+10*NCP4+10*NSW+3*NCW-6
N5=29*NNG+75*NSW+10*NCW-14
N6=21*NNG+14*NSW+NCW-9

-W- APPEARS IN PROGRAM LOADS (OVERLAY(4,0))
MUST BE DIMENSIONED AT LEAST (1** NWG+3)**(NWNG+NCW+4)

LEV 10
LEV 20
LEV 30
LEV 40
LEV 50
LEV 60
LEV 70
LEV 80
LEV 90
LEV 100
LEV 110
LEV 120
LEV 130
LEV 140
LEV 150
LEV 160
LEV 170
LEV 180
LEV 190
LEV 200
LEV 210
LEV 220
LEV 230
LEV 240
LEV 250
LEV 260
LEV 270
LEV 280
LEV 290
LEV 300
LEV 310
LEV 320
LEV 330
LEV 340
LEV 350
LEV 360
LEV 370
LEV 380
LEV 390
LEV 400
-E- appears in program NEWSHAP (OVERLAY(5,0))

MUST BE DIMENSIONED AT LEAST (3*NSW*(NMAX+NNMAX)-3*NMAX+1)

WHERE:

NMAX = MAXIMUM NUMBER OF END-POINTS IN ANY ONE FREE

LEADING-EDGE VORTEX ELEMENT

NNMAX = MAXIMUM NUMBER OF END-POINTS IN ANY ONE WAKE

ELEMENT

NCW = NUMBER OF CHORDWISE LINES

NSW = NUMBER OF SPANWISE LINES (ONE HIGHER THAN

NUMBER OF SPANWISE ROWS OF PANELS)

NCPTTL = TOTAL NUMBER OF CONTROL POINTS OVER THE WING

INCLUDING THOSE AT THE LEADING-EDGE ((NCW+1)*

(NSW-1))

NWNG = TOTAL NUMBER OF CONTROL POINTS OVER THE WING

EXCLUDING THOSE AT THE LEADING-EDGE (NCW*

(NSW-1))

COMMON D(3000)

COMMON /ALLI/ NSW,NSW1,NCW,NWNG,NCPTTL,MITER,IPUNCH

COMMON /ALLA/ TTL(16),ALPHA,SINA,COSA,SAMPLE,BETA,BETA2,TANPH1,B7PLE

141,RSQR4,P4,D4,CO4,PI,D4SQ2,CRAR,HALF8,AREA

COMMON /ALLRA/ XE(40),YE(40),ZE(40),XXE(30),YYE(30),ZZE(30),ZMIN,NLEV 620

LELM(11)*,NNNLN11?)

COMMON /XPL0T/ XMN,YMN,ZMN,XMY,YMX,ZMX

COMMON /GM/ ITER1,L1,L2,L3,L4,L5,L6,L7,L8

COMMON /XSTN/ XPRT(25),NBRK

CALL OVERLAY (5HLEVSP,1,0)

ITER*0

CONTINUE

ALP=ALPHA*180./PI

AMACH=SORT(1,-BETA2)

WRITE FREE ELEMENTS LOCATIONS

WRITE (6,100) TTL,ALP,AMACH,ITER

REWIND 4

DO 30 I=1,NSW

READ (4) K,(XE(J),YE(J),ZE(J),J=1,K)

30 CONTINUE

WRITE (6,150) I
WRITE (6,140) (XE(J),J=1,K)
WRITE (6,140) (YE(J),J=1,K)
WRITE (6,140) (ZE(J),J=1,K)
WRITE (6,140) DO 40 I=1,NSW
C
READ (4) K,(XXE(J),YYE(J),ZZE(J),J=1,K)
C
WRITE (6,150) I
WRITE (6,140) (XXE(J),J=1,K)
WRITE (6,140) (YYE(J),J=1,K)
WRITE (6,140) (ZZE(J),J=1,K)
CALL OVERLAY (54LEVSP,2,0)
CALL OVERLAY (54LEVSP,3,0)
CALL OVERLAY (54LEVSP,4,0)
CALL OVERLAY (54LEVSP,5,0)
ITER=ITER+1
IF (ITER.LE.MITER) GO TO 20
IF (TPUNCH.EQ.0) GO TO 70
C
PUNCH-OUT FREE ELEMENTS LOCATIONS AFTER LAST ITERATION
REWIND 4
C
PUNCH 170, (NEL=M(I),I=1,NSW)
DO 50 I=1,NSW
C
READ (4) K,(XXE(J),YYE(J),ZZE(J),J=1,K)
C
PUNCH 160, (XXE(J),J=1,K)
PUNCH 160, (YYE(J),J=1,K)
PUNCH 160, (ZZE(J),J=1,K)
PUNCH 170, (MNUM=I),I=1,NSW
DO 60 I=1,NSW
C
READ (4) K,(XXE(J),YYE(J),ZZE(J),J=1,K)
C
PUNCH 160, (XXE(J),J=1,K)
PUNCH 160, (YYE(J),J=1,K)
PUNCH 160, (ZZE(J),J=1,K)
C
FORMULATION OF SUMMARY SHEET

70 REWIND 7
WRITE (6,110) TTL,ALP,AMACH
*MIT=MITER+1
GM1=0.
DO 90 I=1,MIT
J=I-1
C
***************LEVI190
READ (7) GMSUM
READ (7) CL,CM,CD,CTT
READ (7) TFABS,TAVRG,TLNTH
C
***************LEVI190
GM2=GMSUM
PRR=200.0*(ABS(GM1-GM2)/(GM1+GM2)
GM1=GM2
IF (1.EQ.1) GO TO 80
WRITE (6,120) J,CL,CM,CD,CTT,GMSUM,PRR,TFABS
GO TO 90
80 WRITE (6,130) J,CL,CM,CD,CTT,GMSUM,TFABS
90 CONTINUE
GO TO 10
C
C
100 FORMAT (1H1,16A5,1X,12HALPHA(DEG)='F6.3,14H MACH NUMBER='F6.3,14H
1.3,19H ITERATION NUMBER='I2,1X,21HLEADING EDGE ELEMENTS,1X,2LEVI1420
21H***************)
110 FORMAT (1H1,23X,13H SUMMARY SHEET,23X,13H***************),1X,1LEVI1440
16A5,2X,12HALPHA(DEG)='F6.3,14H MACH NUMBER='F6.3,66H ITERALEVI1450
2TION CL,CM,CD,CTT GMSUM PERR TFABS,66H LEVI1460
3 ******** ** ** ** ** ******** ELIV1470
120 FORMAT (17,4X,7F8.4)
130 FORMAT (17,4X,5F8.4)
140 FORMAT (14F9.4)
150 FORMAT (5H ****,12,4H*****)
160 FORMAT (10F8.5)
170 FORMAT (10I2)
180 FORMAT (1H1,14H WAKE ELEMENTS,14H ************)
END
FUNCTION ARCCOS (X)
C
CALCULATES ARC-COSINE OF X
ARCOS=0.
IF (X.EQ.1.) RETURN
IF (X.EQ.(-1.)) GO TO 10
XX=X/(SORT(1.-(X**2)))
ARCOS=1.5707963-ATAN(XX)
RETURN
10 ARCOS=3.1415926
RETURN
END
SUBROUTINE COTPROD (A, B, SUM)
CALCULATES DOT-PRODUCT OF TWO VECTORS

DIMENSION A(3), B(3)

SUM = 0.
DO 10 I = 1, 3
   SUM = SUM + A(I) * B(I)
10 CONTINUE

RETURN
END

C

10

SUM

RETURN

END

ORIGINAL PAGE IS OF POOR QUALITY
SUBROUTINE CRSVD (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 VOTWNG (C, THETP, XX, YY, ZZ, XN, YN, XTE, YTE, CONS, CONJ1, CONJ3, WNG)
1, CONJ1, CONJ2, CONJ3, CONK1, CONK2, CONK3, CONI, CONJ, CONK, SI, NSW, NCW, NWNG
2NG)

C EVALUATES INFLUENCE COEFFICIENTS FOR CALCULATION OF INDUCED
C VELOCITY DUE TO WING ELEMENTS
COMMON /ALLI/ NSW
COMMON /ALLRA/ XTE(30), YTE(30), ZZE(30)
COMMON /NCTT/, NCT, NCON
COMMON /XIYIZI/ XI, YI, ZI

DIMENSION THETP(1), C(1), CONS(1), XTE(1), YTE(1), SI(1), CONI(1), WNG
1, CONI(1), CONJ1(1), CONJ2(1), CONJ3(1), CONK1(1), CONK2(1), CONK3(1), CONKNG
23(1), CONI(1), CONJ(1), CONK(1), XN(NWNG, 2), YN(NWNG, 2), R(3), D(3WNG)

C DIMENSIONS OF FJ1, FJ2, FJ3-(2*NSW) ** SEE GEOM **
C DIMENSIONS OF FI2, FI3-(2*NCPITL) ** 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 AROUND ELEMENTS
D0 10 I=1, NSW
D0 10 J=1, NCW
NP=(I-1)*NCW+J
CALL INFL2 (XN(NP, 1), YN(NP, 1), 0, 0, XN(NP, 2), YN(NP, 2), 0, B)
A1=-YN(NP, 1)
A2=-YN(NP, 3)
CALL INFL2 (XN(NP, 1), A1, 0, 0, XN(NP, 2), A2, 0, D)
CONJ(NP)=CONJ(I)*R(1)-D(1))
CONJ(NP)=CONJ(I)*R(2)-D(2))
CONJ(NP)=CONJ(I)*R(3)-D(3))

10 C VELOCITY DUE TO TRAILING ELEMENTS ON THE WING SURFACE
D0 20 I=1, NSW
D0 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)=R(2)
FI3(NP)=B(3)
AYN=-YN(NP, 1)
NO=NC1+NP
CALL INFL2 (YN(NP,1),AYN,O,XTE(I),AYN,O,B)
FI2(NO)=B(2)
FI3(NO)=B(3)
20 CONTINUE
DO 30 J=1,NCW
NP1=MWG+J
NP2=NC1+NP1
NP=NC2+J
CALL INFL2 (YN(NP,2),YN(NP,2),O,XTE(NSW),YN(NP,2),O,B)
FI2(NP1)=B(2)
FI3(NP1)=R(3)
AYN=-YN(NP,2)
CALL INFL2 (YN(NP,2),AYN,O,XTE(NSW),AYN,O,B)
FI2(NP2)=R(2)
FI3(NP2)=R(3)
30 CONTINUE
DO 40 I=1,NSW1
NC 40 J=1,NCW
NP=(I-1)*NCW+J
I1=NP+NC1
I2=NP+NCW
I3=I1+NCW
CONJ? (NP)=CONS(I)*(FI2(I1)-FI2(NP)+FI2(I2)-FI2(I3))
CUNK2(NP)=CONS(I)*(FI3(I1)-FI3(NP)+FI3(I2)-FI3(I3))
C VELOCITY DUE TO TRAILING ELEMENTS BEYOND TRAILING EDGE
C
C
REWRITE 4
CALL SKTPR (4,NSW)
DO 80 I=2,NSW
READ (4) KK,(XXE(J),YYE(J),ZZE(J),J=1,KK)
C
C
FJ1(I)=0.
FJ2(I)=0.
FJ3(I)=0.
IF (I.EQ.NCT) GO TO 60
DO 50 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)
C
C
FJ2(I)=FJ2(I)+B(2)
FJ3(I)=FJ3(I)+B(3)
50 CONTINUE
CALL FUNA (XXE(KK),YXE(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)
60 CONTINUE
IN=I+NSW
FJ1(IN)=0.
FJ2(IN)=0.
FJ3(IN)=0.
DO 70 J=2,KK
AYT1=-YXE(J-1)
AYT2=-YXE(J)
CALL INFU? (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)
70 CONTINUE
AYT2=-YXE(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)
80 CONTINUE
FJ1(1)=0.
FJ2(1)=0.
FJ3(1)=0.
FJ1(NSW+1)=0.
FJ2(NSW+1)=0.
FJ3(NSW+1)=0.
DO 90 T=1,NSW1
11=I+1
12=I+NSW
13=I+2
EFJ1=CONS(I)*(FJ1(T2)-FJ1(I1)+FJ1(I1)-FJ1(I1))
EFJ2=CONS(I)*(FJ2(T2)-FJ2(I1)+FJ2(I1)-FJ2(I1))
EFJ3=CONS(I)*(FJ3(T2)-FJ3(I1)+FJ3(I1)-FJ3(I1))
90 CONTINUE
DO 90 J=1,NCW
NP=(I-1)*NCW+J
CONI3(NP)=EFJ1
CONJ3(NP)=EFJ2
CONK3(NP)=EFJ3
90
C TOTAL INDUCED VELOCITY
I=1
DO 100 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
100 CONTINUE
RETURN
END
SUBROUTINE VDTFRE (X,Y,Z,C1,CJ,CK,NSW1,BSQD4P,XLE,YLE)  
C  EVALUATES INFLUENCE COEFFICIENTS FOR CALCULATION OF INDUCED  
C  VELOCITY DUE TO FREE ELEMENTS  
COMMON /ALLPA/ XE(40),YE(40),ZE(40),XXE(30),YYE(30),ZZE(30)  
COMMON /NCTT/ NCT,NCON  
COMMON /XYIYIZ/ XI,YI,ZI  
DIMENSION C(1), CJ(1), CK(1), XLE(1), YLE(1), V(3), VVV(3)  
C  DIMENSION OF VDOL-(NSW1,3) ** SEE GEDM **  
DIMENSION VDOL(19,3)  
XI=X  
YI=Y  
ZI=Z  
NCT1=0  
*** REWIND 4  
***  
10  DO 60 I=1,NSW1  
60 V(1)=0.  
V(2)=0.  
V(3)=0.  
FJ1=0.  
FJ2=0.  
FJ3=0.  
***  
C  READ (4) KK, (XF(J),YE(J),ZE(J),J=1,KK)  
C  ***  
C  VELOCITY DUE TO FREE ELEMENTS AHEAD OF TRAILING-EDGE AND THOSE  
C  OVER THE WING  
C  OVER THE WING  
C  DO 20 J=1,K  
IF (1.EQ.NCON.AND.J.GT.4.AND.YI.GT.0.) GO TO 30  
CALL INFL4 (XF(J),YE(J),ZE(J),XXE(J),YYE(J),ZZE(J),V(1),V(2),V(3),VVV(1),VVV(2),VVV(3))  
V(1)=V(1)+VVV(1)  
V(2)=V(2)+VVV(2)  
V(3)=V(3)+VVV(3)  
20  CONTINUE  
If (1.EQ.NCON.AND.YI.GT.0.) GO TO 30  
CALL FUNA (XXE(J),YOE(J),ZE(J),FJ1,FJ2,FJ3)  
30  VDOL(I,1)=V(1)+FJ1  
VDOL(I,2)=V(2)+FJ2  
VDOL(I,3)=V(3)+FJ3
VTDL(I,3)=V(3)+FJ3
FJ1=0.
FJ2=0.
FJ3=0.
I1=I+1
C******************************************************************************
CALL SKIPR (4,NSW1)
READ (4) II,(XXE(J),YYE(J),ZZE(J),J=1,II)
******************************************************************************
C
IF (I1.EQ.NCT.AND.YI.GT.0.) GO TO 50
C VELOCITY DUE TO WAKE ELEMENTS
DO 40 J=1,IT
CALL INF12 (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)
40 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)
50 CONTINUE
VTDL(I,1)=VTDL(I,1)-FJ1
VTDL(I,2)=VTDL(I,2)-FJ2
VTDL(I,3)=VTDL(I,3)-FJ3
C******************************************************************************
REWIND 4
******************************************************************************
C
CALL SKIPR (4,I)
******************************************************************************
C
CONTINUE
YI=-YI
NCT1=NCT1+1
IF (NCT1.GT.1) GO TO 80
DO 70 I=1,NSW1
CI(I)=VTDL(I,1)
CJ(I)=VTDL(I,2)
CK(I)=VTDL(I,3)
70 CONTINUE
GO TO 10
SUBROUTINE FUNA (XT, YT, ZT, FJ1, FJ2, FJ3)

INDUCED VELOCITY DUE TO A VORTEX ELEMENT OF UNIT STRENGTH TRAILING

CALL CRSPPO (A, B, C)
CC=SORT(C(1)*C(1)+C(2)*C(2)+C(3)*C(3))
IF (CC.LE.1.E-10) Go TO 10
D5=2.*(TANPH1-ZT-XT*(ZT*ZT+XT*XT)+XI)
D4=XT*XI+R2PH1*(ZT-ZT-XT*ZT+XI)*2+(ZT-ZT-XT*ZT*ZT)*2)
D4=4.*D4*D4+D5*D5
IF (D4.LE.1.E-10) Go TO 10
R8=SQR(D4*XT*XT+D5*XT+D6)
FJ4=2.*(D4*D4-(2.*D4*XT*D5)/R8)/O
FJ1=(YT-YT)*TANPH1*FJ4
FJ2=ZT*XT*(ZT-XT)*TANPH1+FJ4
FJ3=-ZT*(YI-XT)*FJ4
RETURN

RETURN

RETURN

RETURN

END
SUBROUTINE INF12 (XI, YI, ZI, XI2, YI2, ZI2, VACL)
INDUCED VELOCITY DUE TO A VORTEX ELEMENT OF UNIT STRENGTH LYING
BETWEEN (XI, YI, ZI) AND (XI2, YI2, ZI2)

COMMON /VORINF/, VAPC, VAPCLP

DIMENSION VAPC(3), VAPCLP(3)

VAPC(1) = XI - X1
VAPC(2) = YI - Y1
VAPC(3) = ZI - Z1

VAPCLP(1) = XI2 - XI
VAPCLP(2) = YI2 - Y1
VAPCLP(3) = ZI2 - Z1

CALL CRSRD (VAPC, VAPCLP)
CALL DOPRD (VAPC, VAPCLP)
CALL DOPRD (VAPC, VAPCLP)
CALL DOPRD (VAPC, VAPCLP)

GO TO 10

10 CONTINUE

VACL = VACL1(1)*CONST
VACL = VACL2(1)*CONST
VACL = VACL3(1)*CONST

C

75
SUBROUTINE NEWEVIL (C, THETP, XEE, YEE, ZEE, XN, YN, XTE, YLE, CON5, DUMMY, COVEL
10 INI, COMJ, COMK, SI, NSW1, NCW, NWNG, CI, CJK, XLE, UU, YY, WW, CPCW1, XCP, YCP, VEL
20 GAMA, YYM)
C EVALUATES TOTAL VELOCITY AT POINT (XEE,YEE,ZEE)
VEL 40
COMMON /ALLRA/ AA17, SINJ, COSA, AB(5), BSQDAP
VEL 50
COMMON /GMA/ ITER, L1, L2, L3, L4, L5, L6, L7, L8
VEL 60
DIMENSION DUMMY(1), CONI(1), CONJ(1), CONK(1), CI(1), CK(1)
VEL 70
1, C1, THETP(1), XTE(1), XLE(1), YLE(1), COMS(1), SI(1), CPCW1(1) VEL 80
2, XCP(1), YCP(1), GAMA(1), YYM(1), XN(NWNG,2), YN(NWNG,2), NP(4), VEL 90
3U(4,3), V(3) VEL 100
C IF POINT IS IN THE WING PLANE, THE REGULAR METHOD FOR VELOCITY
VEL 110
C EVALUATION IS USED.
VEL 120
IF (ZEE.LE.0.00001) GO TO 110
VEL 130
IF (YEE.GT.YYM(NSW1)) GO TO 110
VEL 140
CH1=XTE(1)-XLF(1)
VEL 150
CH2=XTE(2)-XLE(2)
VEL 160
XLY=XLE(1)+YEE-YLF(1)*XLE(2)-XLF(1)/YLF(2)-YLF(1)
VEL 170
CHY=CH1*(YLF(1)-YLF(2))/CH2-Ch1
VEL 180
XC=XEE-XLY
VEL 190
IF (XC.LT.0.0.OR.XC.GT.1.0) GO TO 110
VEL 200
ZC=ZEE/CHY
VEL 210
C IF THE POINT (XEE,YEE,ZEE) IS AT Z/C(LOCAL) LESS THAN ZTOL, THE
VEL 220
C VELOCITY IS OBTAINED BY LINEAR INTERPOLATION OF THE VELOCITIES
VEL 230
C CALCULATED AROUND FOUR WING CONTROL POINTS AMONG WHICH THE POINT IS
VEL 240
C LOCATED. BY NUMERICAL EXPERIMENTATION ZTOL HAS BEEN OBTAINED TO BE
VEL 250
C 0.2.
VEL 260
ZTOL=0.2
VEL 270
IF (ZC.GE.ZTOL) GO TO 110
VEL 280
I=1
VEL 290
IF (YEE.LE.YYM(I)) GO TO 20
VEL 300
10 IF (YEE.GT.YYM(I) .AND. YEE.LE.YYM(I+1)) GO TO 20
VEL 310
I=I+1
VEL 320
IF (I.LT.NSW1) GO TO 10
VEL 330
J=1
VEL 340
IF (XC.LE.CPCW1(I)) GO TO 50
VEL 350
20 IF (XC.GT.CPCW1(J) .AND. XC.LE.CPCW1(J+1)) GO TO 40
VEL 360
J=J+1
VEL 370
IF (J.LT.NCW) GO TO 30
VEL 380
30 IF (NP(1)=1-1*NCW+J)
VEL 390
NP(2)=NP(1)+1
VEL 400
NP(3)=NP(1)+NCW
NP(4)=NP(3)+1
XC1=CPCW1(J)
XC2=CPCW1(J+1)
GO TO 60
50 NP(1)=NCW*NSW1+1
NP(2)=(I-1)*NCW+1
NP(3)=NP(1)+1
NP(4)=NP(2)+NCW
XC1=0.
XC2=CPCW1(1)
CONTINUE
40 EVALUATION OF INDUCED VELOCITY AT FOUR POINTS
DO 80 I=1,4
NN=NP(I)
CALL VOTWNG (C, THETP, XCP(MN), YCP(MA), ZEE, XN, YN, XTE, YLE, CONJ, DUMMY(VEL 560)
1L1), DUMMY(L2), DUMMY(L3), DUMMY(L4), DUMMY(L5), DUMMY(L6), DUMMY(L7), DUVEL 570)
COMM(L9), CONK, CONJ, CONK, SI, NSW1, NCW, NWNG)
U(I, 1)=0.
U(I, 2)=0.
U(I, 3)=0.
DO 70 J=1,NWNG
U(I, 1)=U(I, 1)+CONJ(J)*GAMA(J)
U(I, 2)=U(I, 2)+CONJ(J)*GAMA(J)
U(I, 3)=U(I, 3)+CONJ(J)*GAMA(J)
70 CONTINUE
60 INTERPOLATION
MN1=NP(1)
MN2=NP(3)
N1=YCP(MN1)
N2=YCP(MN2)
DO 90 I=1,3
UA=U(I, 1)+(U(3, I)-U(I, I))*(YEE-Y1)/(Y2-Y1)
UB=U(2, I)+(U(4, I)-U(2, I))*(YEE-Y1)/(Y2-Y1)
90 UI=UA+(UB-UA)*(XC-XC1)/(XC2-XC1)
UU=V(I)+COSA
VV=V(I)
WW=V(I)+SINA
CALL VOTFRE (XEE, YEE, ZEE, CI, CJ, CK, NSW1, B-0D4P, YLE, YLE)
C FINAL TOTAL VELOCITY
DO 100 J=1,NSW1
JJ=NSW1+J
UU=UU+CI(J)*GAMA(JJ)
VV=VV+CJ(J)*GAMA(JJ)
100 WW=WW+CK(J)*GAMA(JJ)
RETURN

C EVALUATION OF VELOCITY WHEN POINT IS IN THE WING PLANE
110 CONTINUE
CALL VINTNG (C,THETP,YEE,YEE,ZEE,XN,YN,XTE,YLE,CONS,DUMMY(L1),DUMMY(L1),DUMMY(L2),DUMMY(L3),DUMMY(L4),DUMMY(L5),DUMMY(L6),DUMMY(L7),DUMMY(L8),VEL 800
2CONI,CONJ,CONK,ST,NSW1,MCW,NSNG)
CALL VINTFR (YEE,YEE,ZEE,CI,CJ,CK,NSW1,BSOD4T,YLE,YLE)
C FREE STREAM VELOCITY
UU=GNSA
VV=0.
WW=SINA
C VELOCITY DUE TO FREE ELEMENTS
DO 120 I=1,NSW1
NO=NSW1+I
UU=UU+CI(I)*GAMA(NO)
VV=VV+CJ(I)*GAMA(NO)
120 WW=WW+CK(I)*GAMA(NO)
C VELOCITY DUE TO WING
DO 130 I=1,NSW1
NO=NO*(I-1)*NCW+J
UU=UU+CONT(NO)*GAMA(NO)
VV=VV+CONJ(NO)*GAMA(NO)
130 WW=WW+CONK(NO)*GAMA(NO)
RETURN
END
OVERLAY (LEVSP,1,0)  GEO 10
PROGRAM GEOM  GEO 20
C DEFINES THE WING AND FREE ELEMENT GEOMETRY  GEO 30
C MAXIMUM VALUES  GEO 40
C  ** NCW = 9  GEO 50
C  ** NNCW = NCW+1 = 10  GEO 60
C  ** NSW = 20  GEO 70
C  ** NSW = NSW-1 = 19  GEO 80
C  ** NWG = NNCW+NSW1 = 190  GEO 90
C  ** NCPTTL = (NNCW+1)*NSW1 = 209  GEO 100
COMMON XXL(2),TXT(2),YL(L2),CPCWL(10),CPCW1(10),SI(10),SN(10),SMN(1,N)  GEO 110
10,SWP(10),SLOPE(10),XL(2),10,C(19),THETP(19),CONS(19),CPSW1(19),XGE0  GEO 120
2LM(19),XTM(19),YLM(19),CTT(19),CPSW1(20),XLE(20),XTE(20),YLE(20),XGE0  GEO 130
3AVNG(190),YAVNG(190),XN(190),YN(190),XCP(209),YCP(209),X(10),Y(10)  GEO 140
420),Y(10),20  GEO 150
COMMON /ALL1/, NSW,NSW1,NCW,NWNG,NCPTTL,MITER,IPUNCH  GEO 160
COMMON /ALLRA/, TTL(16),ALPHA,SINA,COSA,SWPE,BETA,BETA2,TANPH1,B2PGE0  GEO 170
1H1,RSD4P,D4,CON,PI,D4SO2,BAR,HALF,AREA  GEO 180
COMMON /XSTN/, XARR(25),NBR0  GEO 190
THEND=5HEND  GEO 200
C***********************************************************GEO 210
READ (5,130) TTL  GEO 220
IF (TTL(1).EQ.THEND) GO TO 120  GEO 230
READ (5,160) NSW,NSW,NBRR,NCONTS,MITER,IPUNCH  GEO 240
NSW1=NSW-1  GEO 250
READ (5,150) (XXL(I),TXT(I),YL(I),I=1,2)  GEO 260
READ (5,150) ALPHA,AMACH,DELTA,DL,XEND,BAR,AREA  GEO 270
READ (5,150) (XBRK(I),I=1,NBRR)  GEO 280
READ (5,150) (CTT(I),I=1,NSW1)  GEO 290
C***********************************************************GEO 300
WRITE (6,170) TTL  GEO 310
WRITE (6,160) NSW,NSW,NBRR,NCONTS,MITER,IPUNCH  GEO 320
WRITE (6,150) (XXL(I),TXT(I),YL(I),I=1,2)  GEO 330
WRITE (6,150) ALPHA,AMACH,DELTA,DL,XEND,BAR,AREA  GEO 340
WRITE (6,150) (XBRK(I),I=1,NBRR)  GEO 350
WRITE (6,150) (CTT(I),I=1,NSW1)  GEO 360
NNCW=NCW  GEO 370
NCW=NNCW+1  GEO 380
C NPRC=0, USED FOR BOUND ELEMENTS = (NCW+1)  GEO 390
C NPRC=1, USED FOR BOUND ELEMENTS = NCW  GEO 400
NPRCY=0
10 IF (NPRCY.EQ.1) NCW=NCW
   *I=3.14159265
   FN2=2.*NCW
   PI=PI/FLOAT(NCW)
   TWOP=2.*PI
   DO 20 I=1,NCW
      CPCW1(I)=50.*(-COS((I-1.)*PI/FN2))
   20      CPCW1(I)=50.*(-COS(FLOAT(I)*PI/FLOAT(NCW)))
   CC=CPCW1(I)/100.
   SNN(I)=2.*SORT(CC*(1.-CC))
   PSIJ=(2.*FLOAT(I)-1.)*PI/2.
   SN(I)=SN(IPSIJ)/TWOP
   SI(I)=TWOP*SN(I)
   SWPE=ATAN((XXL(I)-XXL(1))/(YL(I)-YL(1)))
   FM2=2.*NSW
   DO 30 J=1,NSW
      CPSW1(J)=50.*(-COS((J-1.)*PI/FM2))
   30      CPSW1(J)=50.*(-COS(FLOAT(J)*PI/FLOAT(NSW)))
   CALL PNLWNG (NSW,NWNG,NCW)
   HALFR=YL(I)
   DO 50 I=1,NSW
      C(I)=XTM(I)-XLM(I)
      YYLM=YLM(I)/HALFR
   50      THETP(I)=ARCSIN(YYLM)
      NCPTRL=NSW+NWNG
      IF (NPRCY.EQ.1) GO TO 60
      NCW=NCW
       
       C       .............................................................
       .............................................................
       .............................................................
      C       .............................................................
      NPRCY=1
      GO TO 10
NPANEL = NP + J
XCP(NPANEL) = XLM(K) + CC*CPCW1(J)/100.
YCP(NPANEL) = YLM(K)
XAVWG(NPANEL) = XLM(K) + CC*CPCW1(J)/100.
YAVWG(NPANEL) = YLM(K)
DO 50 I = 1, 2
   KI = K + I - 1
   XN(NPANEL, I) = X(J, KI)
  YN(NPANEL, I) = Y(J, KI)
50 CONTINUE
LPANEL = NPANEL
DO 70 K = 1, NSW1
   NP = LPANEL + K
   XCP(NP) = XLM(K)
   YCP(NP) = YLM(K)
70 RETURN
END
SUBROUTINE FRELM (XXL, XXT, YL, XLE, XTE, YLE, PI, NCW1, NSW1, XEND, DELTA, AFLM) 
1LPHA, DL, NCONTS) 
Finds the initial coordinates of free vortex elements 
COMMON /ALL9/ XE(40), YE(40), ZE(40), XXE(30), YYE(30), ZZE(30), ZMIN, NELM 
XELM(11), NNELM(12) 
COMMON /XPL0T/ XMN, YMN, ZMN, XMX, YMX, ZMX 
DIMENSION XXL(1), XXT(1), YL(1), XLE(1), XTE(1), YLE(1) 
APHI=ALPHA 
APL=ALPHA*180./PI 
IF (APL,LE,15.) AHPI=(22.5-0.5*APL)*PI/180. 
NSW=NSW1+1 
THT1=I/(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 
DO 30 I=1,NSW1 
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*(YTE(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)=XTE(I)+0.05*(XTE(I)-XLE(I)) 
YE(6)=YLE(I) 
ZE(6)=ZMIN 
J=6
<table>
<thead>
<tr>
<th>XE</th>
<th>YE</th>
<th>ZE</th>
<th>NM</th>
<th>NELM</th>
<th>KL1</th>
<th>XE0</th>
<th>YE0</th>
<th>ZE0</th>
<th>XE1</th>
<th>YE1</th>
<th>ZE1</th>
<th>XE2</th>
<th>YE2</th>
<th>ZE2</th>
<th>XE3</th>
<th>YE3</th>
<th>ZE3</th>
<th>XE4</th>
<th>YE4</th>
<th>ZE4</th>
<th>XE5</th>
<th>YE5</th>
<th>ZE5</th>
<th>XE6</th>
<th>YE6</th>
<th>ZE6</th>
<th>XE7</th>
<th>YE7</th>
<th>ZE7</th>
</tr>
</thead>
<tbody>
<tr>
<td>XE0</td>
<td>YE0</td>
<td>ZE0</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>XE0</td>
<td>YE0</td>
<td>ZE0</td>
<td>XE1</td>
<td>YE1</td>
<td>ZE1</td>
<td>XE2</td>
<td>YE2</td>
<td>ZE2</td>
<td>XE3</td>
<td>YE3</td>
<td>ZE3</td>
<td>XE4</td>
<td>YE4</td>
<td>ZE4</td>
<td>XE5</td>
<td>YE5</td>
<td>ZE5</td>
<td>XE6</td>
<td>YE6</td>
<td>ZE6</td>
<td>XE7</td>
<td>YE7</td>
<td>ZE7</td>
</tr>
<tr>
<td>IF (XKM = 1) GO TO 10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ELSE GO TO 20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IF (XKM = 2) GO TO 40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ELSE GO TO 60</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EQUATION OF WALL ELEMENTS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>XE = XE0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>YE = YE0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZE = ZE0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IF (NMAX = NELM) GO TO 70</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>XE = XE1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>YE = YE1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZE = ZE1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IF (NMAX = NELM) GO TO 80</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>XE = XE2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>YE = YE2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZE = ZE2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IF (NMAX = NELM) GO TO 90</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>XE = XE3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>YE = YE3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZE = ZE3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IF (NMAX = NELM) GO TO 100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>XE = XE4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>YE = YE4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZE = ZE4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IF (NMAX = NELM) GO TO 110</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>XE = XE5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>YE = YE5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZE = ZE5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IF (NMAX = NELM) GO TO 120</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>XE = XE6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>YE = YE6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZE = ZE6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IF (NMAX = NELM) GO TO 130</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>XE = XE7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>YE = YE7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZE = ZE7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
C

K=J

IF (NCONTS.NE.0) WRITE (2) (XXE(J),YYE(J),ZZE(J),J=1,2)

WRITE (4) K,(XXE(J),YYE(J),ZZE(J),J=1,K)

C

NNMAX=0

DO 80 I=1,NSW1

IF (NNMAX.LT.NNELM(I)) NNMAX=NNELM(I)

C

WRITE (4) NNMAX,ZNMIN,NCONTS

C

XLNT=XEND-XMN

XMIN=XEND

XMAX=XEND+0.20*YLNT

YMN=0.

YMAX=YL(2)

ZMIN=-YL(2)/4.

ZMAX=YL(2)/2.

IF (NCONTS.EQ.0) GO TO 130

C READS LOCATION OF LEADING-EDGE ELEMENTS FROM INPUT DATA CARDS

C

REWIND 2

REWIND 4

READ (5,140) (NELM(I),I=1,NSW1)

DO 90 I=1,NSW1

K=NELM(I)

READ (5,150) ((X1,J=1,5),(XE(J),J=6,K))

READ (5,150) ((Y1,J=1,5),(YE(J),J=6,K))

READ (5,150) ((Z1,J=1,5),(ZE(J),J=6,K))

READ (2) (XXE(J),YYE(J),ZZE(J),J=1,5)

WRITE (4) K,(XXE(J),YYE(J),ZZE(J),J=1,K)

C READS LOCATION OF WAKE ELEMENTS FROM INPUT DATA CARDS

READ (5,160) (NNELM(I),I=1,NSW)

DO 100 I=1,NSW

K=NNELM(I)

READ (5,150) ((X1,J=1,2),(XXE(J),J=3,K))

READ (5,150) ((Y1,J=1,2),(YYE(J),J=3,K))

READ (5,150) ((Z1,J=1,2),(ZZE(J),J=3,K))

READ (2) (XXE(J),YYE(J),ZZE(J),J=1,2)

FLM 800

C

FLM 810

FLM 820

FLM 830

FLM 840

FLM 850

FLM 860

FLM 870

FLM 880

FLM 890

FLM 900

FLM 910

FLM 920

FLM 930

FLM 940

FLM 950

FLM 960

FLM 970

FLM 980

FLM 990

FLM 1000

FLM 1010

FLM 1020

FLM 1030

FLM 1040

FLM 1050

FLM 1060

FLM 1070

FLM 1080

FLM 1090

FLM 1100

FLM 1110

FLM 1120

FLM 1130

FLM 1140

FLM 1150

FLM 1160

FLM 1170

FLM 1180
100  WRITE (4) K,(XXF(J),YYE(J),ZZE(J),J=1,K)
WRITE (4) NMAX,NMIN,ZMAX,NCONT,A
REWIND 4
WRITE (6,160) (NELM(I),I=1,NSW)
DO 110 I=1,NSW
READ (4) K,(XE(J),YE(J),ZE(J),J=1,K)
WRITE (6,140) (XE(J),J=1,K)
WRITE (6,140) (YE(J),J=1,K)
WRITE (6,140) (ZE(J),J=1,K)
WRITE (6,160) (NELM(I),I=1,NSW)
DO 120 I=1,NSW
READ (4) K,(XXE(J),YYE(J),ZZE(J),J=1,K)
WRITE (6,140) (XXE(J),J=1,K)
WRITE (6,140) (YYE(J),J=1,K)
WRITE (6,140) (ZZE(J),J=1,K)
120  WRITE (6,170)
130  WRITE (6,170)
C  *****************************************************************
RETURN
C  140  FORMAT (14F9.4)
150  FORMAT (10F8.4)
160  FORMAT (10I2)
170  FORMAT (18H END OF INPUT DATA,/)
OVERLAY (LEVSP,2,0)
PROGRAM PLOT
C SETS UP DIMENSIONS FOR PLOTTING LEADING-EDGE AND WAKE ELEMENTS
COMMON D(11)
COMMON /ALLI/ NSW,NSW1
C ***********************************************PLT 60
REWIND 4
NN=NSW1+NSW
CALL SKIPR (4,NN)
READ (4) NMAX,NMAX,NMIN,NCONTS
C ***********************************************PLT 100
MXE=1
MYE=MXE+NSW1*NMAX
MZE=MYE+NSW1*NMAX
MNELM=MZE+NSW1*NMAX
MNEXT=MNELM+NSW1
C MNEXT=3*NSW*NMAX-3*NMAX+NSW
CALL PLOTT (D(MXE),D(MYE),D(MZE),D(MNELM),NSW1)
MXXE=1
MYYE=MYXE+NSW*(NMAX+2)
MZZE=MYYE+NSW*(NMAX+2)
MNNELM=MZZE+NSW*(NMAX+2)
MNNEXT=MNNELM+NSW
C MNEXT=3*NSW*(NMAX+2)+NSW+1
CALL PLOTT (D(MXXE),D(MYYE),D(MZZE),D(MNNELM),NSW)
RETURN
END
SUBROUTINE PLOT (XE,YE,ZE,NMM,NS)
C MANIPULATES LEADING-EDGE AND WAKE ELEMENTS COORDINATES IN A FORM
C SUITABLE FOR PLOTTING
COMMON /ALLI/ NSW,NSW1
COMMON /XPLG/ YMN,YMN,ZMN,XMX,YMX,ZMX
DIMENSION NMM(I), XE(NS,1), YE(NS,1), ZE(NS,1), LAY(14), LABZ(14)
DATA LAY/6H*6H,6H VS Y,6+6H +2H / DATA LABZ/6+6H,6H VS Z,6+6H +2H /
C
C*******************************************************************************
C REWIND 4
IF (NS,FO,NSW) GO TO 20
DO 10 I=1,NSW
READ (4) KK,(XE(I,J),YE(I,J),ZE(I,J),J=1,NS)
10 NMM(I)=KK
NC=4
LAY(8)=6H(LEAIDI)
LAY(9)=6HNG-EDG
LAY(10)=HE ELEM
LAY(11)=HENTS)
LABZ(9)=H(LEAIDI)
LABZ(9)=6HNG-EDG
LABZ(10)=HE ELEM
LABZ(11)=6HENTS)
GO TO 50
70 DO 30 I=1,NSW
30 READ (4)
DO 40 I=1,NSW
READ (4) KK,(XE(I,J),YE(I,J),ZE(I,J),J=1,NS)
40 NMM(I)=KK
LAY(8)=6H(WAKE
LAY(9)=5HELENEN
LABZ(10)=6HTS)
LABZ(11)=6H
LABZ(9)=5H(WAKE
LABZ(9)=6HELENEN
LABZ(10)=6HTS)
LABZ(11)=6H
C*******************************************************************************
C NC=0
50 DI 70 L=2,NS
I=L-1
K=NNM(L)-NC
DC 60 J=1,K
K*=J+NC
XE(I,J)=XE(L,KK)
YE(I,J)=YE(L,KK)
ZE(I,J)=ZE(L,KK)
XE(I,K+1)=XNN
YE(I,K+1)=YNN
ZE(I,K+1)=ZNN
XE(I,K+2)=XNY
YE(I,K+2)=YMX
ZE(I,K+2)=ZMX
NNM(I)=K+2
NS1=NS-1
CALL LNPL0T (XE,YE,NNM,NS1,NS,LABY)
CALL LNPL0T (XE,ZE,NNM,NS1,NS,LABZ)
RETURN
END
SUBROUTINE LNPLT (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(11)  
DATA SYM/IH1,1H2,1H3,1H4,1H5,1H6,1H7,1H8,1H9,1H0,1HA,1H8,1HC,1HD,1I  
1HE,1HF,1HG,1HI,1IT,1IJ/  
DATA YAXIS/IH1,9*1H,-1H1,9*1H,-1H1,9*1H,-1H1,9*1H,-1H1,9*1H,-1H1/  
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,N  
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/SCLAF  
ZMAX=ZMAX/SCLAF  
MIN=20.*(ZMIN-0.025)  
MAX=20.*(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
   XROT=BOTTOM*SCALE
   GO TO 20
70 CONTINUE
   YINC=0.0125*(TOP-BOTTOM)
   YLOW=TOP+YINC
   YINC=2.*YINC
   WRITE (6,160)
   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)-2
      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(I)=UP
      IF (KEY.NE.5) GO TO 120

LMP 410
LMP 420
LMP 430
LMP 440
LMP 450
LMP 460
LMP 470
LMP 480
LMP 490
LMP 500
LMP 510
LMP 520
LMP 530
LMP 540
LMP 550
LMP 560
LMP 570
LMP 580
LMP 590
LMP 600
LMP 610
LMP 620
LMP 630
LMP 640
LMP 650
LMP 660
LMP 670
LMP 680
LMP 690
LMP 700
LMP 710
LMP 720
LMP 730
LMP 740
LMP 750
LMP 760
LMP 770
LMP 780
LMP 790
TPP=TOP*SCALE
WRITE (6,170) TPP,ALINE
GO TO 130
120 WRITE (6,180) 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 (6,210) YAXIS
XINC=10.0*XINC
ALINE(I)=XBOT
DO 140 I=2,11
140 ALINE(I)=ALINE(I-1)+XINC
WRITE (6,190) (ALINE(I),I=1,11)
C
WRITE (6,200) (LABEL(I),I=1,14)
150 RETURN
C
160 FORMAT (1H1,/)  
170 FORMAT (F10.3,1X,101A1)  
180 FORMAT (11X,101A1)  
190 FORMAT (5X,11F10.3)  
200 FORMAT (/,,20X,13A6,A2)  
210 FORMAT (11X,101A1)  
END
OVERLAY (LEVSP,3,0)

PROGRAM SOLN

C
C SETS UP DIMENSIONS FOR SOLVING THE STRENGTHS OF WING AND LEADING-
C
C EDGE VORTEX SYSTEM
C
COMMON D(1)
C
COMMON /ALLI/ NSW,NSWI,NCW,NWNG,NCPTTL
LCl=1
LTHETP=LC+NSW
LXTE=LTHETP+NSW
LXLE=LXTE+NSW
LYLE=LYLE+NSW
LCONS=LYLE+NSW
LCTT=LCONS+NSW
LCOWL=LCTT+NSW
LCPSW=LCOWL+NCW
LSI=LCPSW+NSW
LSN=LSI+NCW
LXCP=LSN+NCW
LYCP=LXCP+NCPTTL
LXN=LYCP+NCPTTL
LYN=LYN+2*NWNG
LCONT=LYN+2*NWNG
LCONJ=LCONT+NWNG
LCONK=LCONJ+NWNG
LCI=LCONK+NWNG
LCJ=LCI+NWNG
LCK=LCJ+NWNG
LDUMY=LCK+NWNG
LNEXT=LDUMY+8*NWNG
C
C LNEXT=20*NWNG+10*NSW+3*NCW-6
MNEXT=LCJ+(NCPTTL+1)**2/4
C
MNEXT=(NCPTTL+1)**2/4+10*NWNG+10*NSW+3*NCW-6
CALL AERODN (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(LCONT),D(LCONJ),D(LSNI,
2,LCONK),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,XH,AER)
1YN,CONI,CONJ,CONK,CI,CJ,CK,DUMMY,CT,CP'/I,L,CPSW1)
C SOLVES FOR THE STRENGTHS OF WING AND LEADING-EDGE VORTEX SYSTEM
COMMON /ALL1/ NSW,NSW1,NCW,IWNG,NCPTTL
COMMON /ALLRA/ AA(I7),SINA,AS(6),BSQD4P
COMMON /GM/ ITER,L1,L2,L3,L4,L5,L6,L7,L8
COMMON /NCTT/ NCT,NCON
DIMENSION C(I7),THETP(I7),XTE(I7),XLE(I7),YLE(I7),CONS(I7),SI(I7),
1SN(I7),XCP(I7),YCP(I7),DUMMY(I7),CONI(I7),CONJ(I7),CONK(I7),CI(I7)
2CJ(I7),CK(I7),CT(I7),CPCLL(I7),CPSW1(I7),XH(NWNG,2),YN(NWNG,2)
C
C*******************************************************************************
C
REWINO 1
REWINO 2
REWINO 3
CALL SKIPR (1,5)
READ (1) (C(I7),I=1,NSW1)
READ (1) (THETP(I7),I=1,NSW1)
READ (1) (XTE(I7),XLE(I7),YLE(I7),I=1,NSW1)
CALL SKIPR (17)
READ (1) (CONS(I7),I=1,NSW1)
READ (1) (SI(I7),SN(I7),I=1,NCW)
READ (1) (XCP(I7),YCP(I7),I=1,NCPTTL)
READ (1) ((XN(I7,J),YN(I7,J),J=1,2),I=1,NWNG)
READ (1) (CT(I7),I=1,NSW1)
READ (1) (CPCLL(I7),I=1,NCW)
CALL SKIPR (1,2)
READ (1) (CPSW1(I7),I=1,NSW1)
C*******************************************************************************
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
NCW=0
NCT=0
DO 10 I=1,NCPTTL
ZCP=0.
CALL VDTWNG (C,THTP,XCP(I),YCP(I),ZCP,XN,YN,XT,YTE,YTE,CONS,DUMMY(L1)
1,DUMMY(L2),DUMMY(L3),DUMMY(L4),DUMMY(L5),DUMMY(L6),DUMMY(L7),DUMMY(L8)
2Y(L9),CONI,CONJ,CONK,SI,NSW1,NCW,NWNG)
WRITE (2) (CONX(J),J=1,NWNG)
CALL VDTFRE (XCP(I),YCP(I),ZCP,CJ,CX,NSW1,BSID4P,XLE,YLE)
WRITE (3) (CK(J),J=1,NSW1)
10 CONTINUE
C GAMA-EVALUATION
REWIND 2
REWIND 3
READ (2) (CONI(I),I=1,NWNG)
NWNG1=NWNG+1
NWNB=NWNG+NSW1
NWNB1=NWNB+1
READ (3) (CONI(I),I=NWNG1,NWNB)
CONI(NWNB1)=SINA
IJ=1
DO 20 I=1,NWNB
CJ(I)=CONI(I)/CONI(1)
IJ=2
NJ=NWNB1-1
30 CONTINUE
READ (2) (CONI(I),I=1,NWNG)
READ (3) (CONI(I),I=NWNG1,NWNB)
CONI(NWNB1)=SINA
IF (IJ.GT.NWNG) CONI(NWNB1)=SINA-CONI(1)/IJ+NWNG
CALL VISSEQN (NJ,IJ,CONJ,CJ,CONS)
IJ=IJ+1
NJ=IJ-1
IF (IJ.LE.NWNB) GO TO 30
WRITE (6,30)
DO 40 I=1,NW1
DO 40 J=1,NCW
NP=(I-1)*NCW+J
40 WRITE (5,70) JPCWJ(IJ),JPCW1(IJ),JPCW2(IJ)
WRITE (6,100)
DO 50 I=1,NSW1
J=NWNG+I
50 WRITE (6,90) CPSW1(I), C(J)
C EVALUATION OF SECTIONAL LEADING-EDGE THRUST
CALL THRT (CJ, CONI, CONJ)
NERR=0
DO 60 1=1,NSW1
60 IF (ABS(CONJ(I)-CT(I)),GE,(1,OE-10)) NERR = 1
IF (NERR.EQ.1) WRITE (6,110)
GMSUM=0.
DO 70 I=2,NSW1
KS=NWNG+I
70 GMSUM=GMSUM+C(J(KS))
C .................................................................................................................AER 910
REIND 2
WRITE (2) (CJ(I), I=1,NWNB)
WRITE (7) GMSUM
C .................................................................................................................AER 950
RETURN
C
80 FORMAT (1H1,///,22H WING VORTEX STRENGTHS,///,22H **************AER 980
1(((((),29H X/C 27/3 SAMAY,///,20H *** **** AER 990
2 *****))
90 FORMAT (3F10.5)
100 FORMAT (///,32H LEADING-EDGE VORICES STRENGTHS,///,31H ************AER 1020
1((((************,///,29H 27/3 SAPSAL,///,29H **** AER1030
2****))
110 FORMAT (///,34H ERROR IN SECTIONAL QT CALCULATION,///,10F10.5)
END
SUBROUTINE VMSEQN (NC1, K, AA, A, CA)
C
SOLVES A SYSTEM OF SIMULTANEOUS EQUATIONS
DIMENSION AA(I), CA(I), A(I)
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 90
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)
K'=0
L=L+1
M=M+1
SUBROUTINE THRST (SGM, CONK, CT)
C
EVALUATES SECTIONAL LEADING-EDGE THRUST COEFFICIENTS
COMMON /ALL1/ NSW, NSW1, NC, NWNG
COMMON /ALLRA/ A(17), SINA, COSA, SWPLE, A3, BETA2, AC(5), PI
DIMENSION SGM(1), CONK(1), CT(1)
AM2=1.-BETA2
FCOS=COS(SWPLE)
FTAN=TAN(SWPLE)
VAR1=FLOAT(NCW)*SORT(FTAN*FTAN+BETA2)
VAR2=SORT(1.-AM2*FCOS*FCOS)
REWIND 2
REWIND 3
CALL SKIPR (2,NWNG)
CALL SKIPR (3,NWNG)
DO 30 I=1,NSW1
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,NSW1)
DO 20 J=1,NSW1
JJ=NWNG+J
20 WL=WL+CONK(J)*SGM(JJ)
THRT1=(WL+SINA)/VAR1
30 CT(1)=((PI/2.)*VAR2*THRT1*THRT1/FCOS
RETURN
END

THR 10
THR 20
THR 30
THR 40
THR 50
THR 60
THR 70
THR 80
THR 90
THR 100
THR 110
THR 120
THR 130
THR 140
THR 150
THR 160
THR 170
THR 180
THR 190
THR 200
THR 210
THR 220
THR 230
THR 240
THR 250
THR 260
THR 270
LSCD=LSCM*NSW1
LCOSP=LSCD*NSW1
LCNC=LCOSP+NCW
LCSWL=LCNC+NSW
LCSW1=LCSWL+NSW
LDCPA=LCSW1+NSW
LDCP=LDCPA+NSW
LGMY=LGMW+NWNG
LWY=LGMY+NWNG+NSW
LCOEF=LWY+NWNG
LDCPN=LCOEF+NSW1*(H:NCW+1)
LWX=LDCPN+NSW1
LWY=LWX+NWNG+NCW
LNEXT=LWY+NWNG+NCW
C
LNEXT=28*NWNG+25*NSW+10*NCW-14
CALL COEFS (DLCT),D(LCJ),D(LCX),D(LCONI),D(LCONJ),D(LCONK),D(LXVW)
1NG1,D(LYVNG),D(LXLE),D(LXTE),D(LYLE),D(LSLI),D(LCT),D(LSVP),D(LXN)
2DLYN),D(LSNH),D(LTHTP),D(LCNS),D(GLUWHY),D(LCT),D(LJCT),D(LGWH)
3DLQSWP),D(LXVWNA),D(LYVWNA),NWNG)D(LGAMA),D(LGHL),D(LXH),D(LLHT)
4,D(LSLCL),D(LSCM),D(LSCD),D(LCSP),D(LCNC),D(LCSUL),D(LCSUL),D(LDCPL)
5A),D(LDCP),D(LGHNW),D(LGMY),D(LVY),D(LCOEF),D(LDCPN),D(LUX),D(LUY)
LW,M=NSW1)
RETURN
END
SUBROUTINE COEFS (CI, C2, CX, CONI, CONJ, CONK, XAVYNG, YAVYNG, XLE, XTE, YLCOF
10
1E, SI, CSUP, XN, YN, SN, THET? CONG, DUMMY, CT, OL, OCN, OSWP, XAVYNA, YAVYNA
COF 20
2NUNG, YAVA, GHL, XLM, THT, SECC1, SECCM, SECCD, COSP, CPC, CPSL, CPSM, DCPSM
CFOF 30
3DCP, GPRT, GSYM, SYM, DCA, DCPN, WX, DMS, YW, NSW)
COF 40
C
COMPUTES THE AERODYNAMIC CHARACTERISTICS
COF 50
COMMON /ALL/ NSW, NSW3, NCW
COF 60
COMMON /ALLRA/ AA(17), SINA, COSAB, AB(8), PI, AC, CADK, HALF3, ARFA
COF 70
COMMON /NCT/ NCT, NCON
COF 80
COMMON /XST/ XBR(25), NBR
COF 90
DIMENSION CI(1), CJ(1), CK(1), CONI(1), CONJ(1), CONK(1), XAVYN(1)
100
1, YAVYN(1), XLF(1), XTE(1), YLE(1), SI(1), C(1), SWP(1), SNN(1), COF
110
2CT(1), XHNGW(2), YHNGW(2), DUMMY(1), GAMA(1), GHL(1), XLM(1), COF
120
3 THT(1), SECC1(1), SECCM(1), SECCD(1), COSP(1), CPC(1), CPSL(1), COF
130
4CPSM(1), DCPSM(1), DCPS(1), GSYM(1), GSYM(1), VY(1), DCPN(1), WY(1), COF
140
SWP(1), XAVYN(1), YAVYN(1), COEF(NSW1, 1), CONS(1), THETP(1), ON(1), OCN(1), OSWP
COF 150
61, XAVYNA(1), YAVYNA(1)
COF 160
C
******************************************************************************
COF 170
REWIND 1
COF 180
READ (1) NNCT, NSW1
COF 190
READ (1) (Oi(1), OCN(1), OSWP(1), N=1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
COF 200
READ (1) XAVYN(1), YAVYN(1), I=1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
COF 210
READ (1) SNN(1), SWP(1), I=1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
COF 220
READ (1) XAVYN(1), YAVYN(1), I=1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
COF 230
READ (1) C(1), I=1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
COF 240
READ (1) (THETP(1), I=1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
COF 250
READ (1) (XTE(1), XLE(1), YLE(1), I=2,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
COF 260
READ (1) (XLM(1), YLM(1), I=2,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
COF 270
READ (1) (CONS(1), I=1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
COF 280
READ (1) (ST(1), ADUN, I=1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
COF 290
CALL SNIPR(1,1)
COF 300
READ (1) (XKN(1), I=1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
COF 310
READ (1) (CTT(1), I=1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
COF 320
CALL SNCOF(1,2)
COF 330
READ (1) (DCPSW(1), I=1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
COF 340
READ (1) (DCPS(1), I=1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
COF 350
NCM, NSN, NSW1
COF 360
READ (1)
COF 370
READ (1) : CA N, I = 1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
COF 380
PI=PI/(2.*FLAT(COF))
COF 390
PI=PI/(2.*FLAT(COF))
COF 400
DO 10 J=1,NCW
10 COSP(J)=COS((2.*FLOAT(J)-1.)*PIJ)
CONST=HALF*PI/(AREA*FLOAT(NSW))
C CALCULATION OF G parameters FOR WING SURFACE
NCON=0
NCT=0
DO 20 II=1,NSW1
DO 20 J=1,NCW
I=(II-1)*NCW+J
XEE=XAVNG(I)
YEE=YAVNG(I)
ZEE=0.
CALL NEWVEL (C,THETP,XEE,YEE,ZEE,XN,YN,XTE,YTE,CONS,DUMMY,CONT,CONCOF
1,CONM,SI,NSW1,NCW,NWNG,CI,CJ,CK,XLE,UU,YY,VV,WW,ADUM,BDUM,CDUM,GAMA,COF
2YLM)
TNSP=TAN(SWP(J))
GMY(I)=GAMA(I)*(UU-VV*TNSP)
20 CONTINUE
C READING LARGEP SRTO FOR THE WING
C CALCULATION OF INDUCED VELOCITIES AT BOUND ELEMENT END-POINTS ON WING SURFACE
DO 40 I=1,NSW1
DO 40 J=1,NCW
NP=(I-1)*NCW+J
XEE=XN(NP+2)
YEE=YN(NP+2)
CALL NEWVEL (C,THETP,XEE,YEE,ZEE,XN,YN,XTE,YTE,CONS,DUMMY,CONT,CONCOF
1,CONM,SI,NSW1,NCW,NWNG,CI,CJ,CK,XLE,UU,YY,VV,WW,ADUM,BDUM,CDUM,GAMA,COF
2YLM)
VV(NP)=VV
30 CONTINUE
40 CONTINUE
C CALCULATION OF G parameters FOR BOUND ELEMENTS NEAR LEADING-EDGE
DO 50 J=1,NCW
FJ=J
50 TH(J)=(2.*FJ-1.)*PI/(2.*FLOAT(NSW))
SUR=3.*FLOAT(NSW)/(4.*PI*SI(TH(J))
DO 40 I=1,NSW1
NSI=NWNG+1
60 GML(I)=GAMA(NGI)*SURA/C(I)  
C  
RESTART 3  
WRITE (3) (GML(I),I=1,NSW)  
C  
TNSP=TAN(OSWP(I))  
DO 70 I=1,NSW  
XEE=XAVWNA(I)  
YEE=YAVWNA(I)  
CALL NEWVEL (C,THEP,XEE,YEE,ZEEN,XN,YN,XTE,YTE,CONS,DUMMY,CONI,CONC)  
1J,CONK,S1,NSW1,NCW,NWNG,CJ,CJ,CK,XLE,LLU,LY,ADUM,BDUM,CDUM,GAMA,COF 900  
2YLM)  
NWWGII=NWNG+II  
GMY(NWWGII)=GML(I1)*(UU-VV*TNSP)  
70 CONTINUE  
C  
CALCULATION OF QCP-VALUES FOR WING POINTS  
PN=PI/(FLOAT(NCW))  
DO 80 I=1,NCW  
W(I)=0.  
WX(I)=XN(I,1)  
WY(I)=YN(I,1)  
80 DO 150 I=1,NSW1  
DO 140 J=1,NCW  
NP=(I-1)*NCW+J  
VYV=VY(NP)  
CPG=0.  
CPH=0.  
CPI=0.  
DO 100 JJ=1,J  
NPIN=(I-1)*NCW+JJ  
IF (J.EQ.JJ) GO TO 77 70  
CPG=CPG+GAMA(NPIN)*SJJ(JJ)  
GO TO 100  
70  
CPG=CPG+0.5*GAMA(NPIN)*SJJ(JJ)  
100 CONTINUE  
CPG=-CPG+PN*C(I)*VYV  
IF (I.EQ.NSW1) GO TO 130  
DO 120 JJ=1,J  
NPOT=I*NCW+JJ
IF (J.EQ.JJ) GO TO 110
CPH=CPH+GAMA(NPOT)*SI(JJ)
GO TO 120
110 CPH=CPH+0.5*GAMA(NPOT)*SI(JJ)
120 CONTINUE
CPH=CPH*PN*C(I+1)*VYY
130 CPI=2.*GAMA(NWNG+I)*VYY
W(NP+NCW)=CPG*CPH+CPI
WX(NP+NCW)=XN(NP,2)
WY(NP+NCW)=YN(NP,2)
140 CONTINUE
150 CONTINUE
N3=NWNG+NCW+3
CALL SURFSET (N3,WX,WY,W,CI)
DO 170 K=1,NCW
DO 160 J=1,NSW1
NP=(J-1)*NCW+K
DCPI=2.*GMY(NP)
XEE=XAVWNG(NP)
YEE=YAVWNG(NP)
CALL SURFORD (W,XEE,YEE,VV,N3)
DCPD=VV/(YLE(J+1)-YLE(J))
DCP(NP)=DCPI+DCPD
160 CONTINUE
170 CONTINUE
C CALCULATION OF INDUCED VELOCITIES AT END-POINTS OF BOUND ELEMENTS
C NEAR LEADING-EDGE
CPC=0.5*(1.-COS(THT(I)))
DO 180 I=2,NSW
XEE=XLE(I)+CPC*(XTE(I)-XLE(I))
YEE=YLE(I)
CALL NEWVEL (C,THT,I,XEE,YEE,ZEE,XN,XE,YE,CON5,DUMM,COHI,CONCO,1500
1J,CONK,SI,NSW,NCW,NWNG,CI,CK,XLE,UY,YY,W,AUM,3DUM,CDUM,GAMA,1510
2YLM)
180 YY(I)=VV
C DCP-INTERPOLATION FOR BOUND ELEMENTS OF WING
CALL INTGMY (NCW,NSW1,DCP,SNH,DEP,DUMY(I),DUMMY(11),DUMMY(NCW))
C CALCULATION OF DECREASE IN DCP-VALUES AT THE LEADING-EDGE
DCPA(1)=0.
DCPA(NSW)=0.
DO 190 I=2,NSW1
DCPA(I)=2.0*GAHA(NWNG+I)*VY(I)
190 CONTINUE
DO 200 I=1,NSW1
CNC(I)=2.0*GMY(NWNG+I)
200 CONTINUE
C
FINAL DCP-VALUES AT LARGER WING GRID
DO 230 I=1,NWP
DO 220 J=1,NCW
NP=(I-1)*NCW+J
GMNW(NP)=COEF(I,K)*
DO 210 K=1,NCW
FK=K
AM1=CO(S(FK*THT(I))
AM2=AM1*COEF(I,K+1)
GMNW(NP)=GMNW(NP)+AM2
210 CONTINUE
GMNW(NP)=GMNW(NP)/(SIN(THT(I))
IF (.NE.1) GO TO 220
NGI=NWNG+1
GMNW(NP)=GMNW(NP)+CNC(I)
220 CONTINUE
230 CONTINUE
DO 240 I=1,NWP
DCP(I)=GMNW(I)
PIJ=PI/(2.*FLOAT(NDCW))
WRITE (6,370)
DO 230 I=1,NWP
DO 220 J=1,NCW
NP=(I-1)*NCW+J
CM2=O.5*(1.-COS((2.0*FLOAT(I)-1.)*PIJ))
230 CONTINUE
WRITE (4,330) CPHW,CPSW1(I),DCP(NP)
DO 220 J=1,NCW
250 CPHJ=PIJ*COS((2.0*FLOAT(J)-1.)*PIJ)
C
EVALUATION OF SECTIONAL AND TOTAL AERODYNAMIC CHARACTERISTICS
CL=0.
CM=0.
CD=0.
CTT=0.
DO 280 I=1,NSW1
SECCL(I)=0.
SECCH(I)=0.
PHII=PI*FLOAT(I)/FLOAT(NSW)
DO 270 J=1,NNCW
NP=(I-1)*NNCW+J
SECCL(I)=SECCL(I)+DCP(NP)*QII(J)
SECCH(I)=SECCH(I)-DCP(NP)*QIJ(J)*(XLM(I)+0.5*C(I)*(1.-COSP(J)))/CBAC

270 CONTINUE
SECCL(I)=SECCL(I)*PI/(2.*FLOAT(NNCW))
SECCH(I)=SECCH(I)*PI/(2.*FLOAT(NNCW))
SECCD(I)=SECCL(I)*SINA-CT(I)*COSA
SECCL(I)=SECCL(I)*COSA+CT(I)*SINA
CL=CL+SECCL(I)*C(I)*SIN(PHII)
CM=CM+SECCH(I)*C(I)*SIN(PHII)
CD=CD+SECCD(I)*C(I)*SIN(PHII)

280 C=CTT+CT(I)*C(I)*SIN(PHII)
CL=CONST*CL
CM=CONST*CM
CD=CONST*CD
CTT=CONST*CTT
WRITE (7) CL,CM,CD,CTT
WRITE (6,340) (I,SECCL(I),SECCH(I),SECCD(I),CT(I),I=1,NSW1)
WRITE (6,350) CL,CM,CD,CTT
NNCW1=NNCW+1
CALL INTGMY (NNCW,NSW1,DCP,NNN,CDEF,DUMMY(1),DUMMY(NNCW1))
REWIND 1
CALL 3XIPR (1,8)
READ (1) (XLM(I),CI(I),I=1,NSW1)

C EVALUATION OF DCP AT CONSTANT X LOCATIONS
DO 330 X=1,NARR
XBR=XBR+X(K)
KY=1

290 IF (XBR-LT,XLM(KY)) GO TO 300
KY=KY+1
C

CF1970
CF1980
CF1990
CF2000
CF2010
CF2020
CF2030
CF2040
CF2050
CF2060
CF2070
CF2080
CF2090
CF2100
CF2110
CF2120
CF2130
CF2140
CF2150
CF2160
CF2170
CF2180
CF2190
CF2200
CF2210
CF2220
CF2230
CF2240
CF2250
CF2260
CF2270
CF2280
CF2290
CF2300
CF2310
CF2320
CF2330
CF2340
CF2350
IF (KY.LE.NSW1) GO TO 290

300
K Y=K Y-1
BLOCAL=CI(KY)+(CI(KY+1)-CI(KY))*(XBR-XLM(KY))/(XLM(KY+1)-XLM(KY))
DO 320 I=1,KY
CJ(I)=CI(I)/BLOCAL
XC=(XBR-XLM(I))/C(I)
THTA=ARCCOS(1.-Z2.*XC)
DCPN(I)=COEF(I,1)
DO 310 J=1,NNCW
310
DCPN(I)=DCPN(I)+COEF(I,J+1)*COS(FLOAT(J)*THTA)
320
DCPN(I)=DCPN(I)/(SIN(THTA))
WRITE (6,360) XBR,(CI(I),CJ(I),DCPN(I),I=1,KY)
330 CONTINUE
RETURN
C
340 FORMAT (1H1,,/9X,20HSECTIONAL PROPERTIES,,/9X,20H**********************)
1****,//9X,39H** CLI CMI CDI CTI,,/9X,39H* C0F2510
2 **** *** ** ** ***,(/II0,4F10.5)) C0F2520
350 FORMAT (//,9X,23HTOTAL LIFT COEFFICIENT=,F10.5,,/9X,34HTOTAL PITCH COEFFICIENT=,F10.5)
1MG MOMENT COEFFICIENT=,F10.5,,/9X,23HTOTAL DRAG COEFFICIENT=,F10.5
2,,/9X,25HTOTAL THRUST COEFFICIENT=,F10.5)
360 FORMAT (///,34HTOTAL PRESSURES AT CONSTANT X=,F10.5,,/8X,25HY)
1 2Y/R LOCAL DELTA-CP,,(1X,2F10.5,2X,F10.5))
370 FORMAT (1H1,,/5X,21HDELTA-CP DISTRIBUTION,,/5X,21H**********************)
1*****,//,30H X/C 2Y/R DELTA-CP,,/30H *** ***)
2* **********)
380 FORMAT (3F10.5)
END
SUBROUTINE INTGMY (NCY,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. DESSARAI, 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)
PYY=PYY+Y(I)*Y(I)

10    XB=RN*XB
    YB=RN*YB
    PXX=RN*PXX-XB*YB
    PXY=RN*PXY-XB*YB
    PYY=RN*PYY-YB*YB

IF (PXY*NE.0) TH=.5*ATAN2(2.,PXY,PYY-PXY)
    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*KB+UY*YB)
V8=-(VX*X9+VY*Y9)

C  PUT Z INTO ITS W LOCATION
IZ=N*NZ
DO 30 J=N4,N32
DO 20 I=1,3
20   W(I,J)=0
DO 30 I=1,N3
W(I,N3+J-N4)*W(IZ+1)
30   IZ=IZ-1

C  PUT 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
JR=N4-J
W(I,J)=1.
W(JR,N1)=W(I,J)
W(2,J)=UB+UX*X(J)+UY*Y(J)
W(JR,N2)=W(2,J)
W(3,J)=VB+VX*X(J)+VY*Y(J)
50   W(JR,N3)=W(3,J)
DO 60 J=1,N
J8=N4-J

C  COMPUTE H MATRIX IN W
DO 60 I=4,J8
IB=N4-I
R2=(W(2,J)-W(2,I)*W(3,J)-W(3,I8))**2
W(I,J)=R2*ALOG(R2+E)
60   W(J8,N3)=W(I,J)

C  MATINV IS THE SYSTEM LIBRARY ROUTINE FOR SOLVING LINEAR EQUATIONS
N31=N3+1
CALL MATINV (N3,N3,N3,1,W(1,N31),1,DET,ISCR,IKW,IKW(N4))

C  PUT S,U,V IN LOW W
W(1,1)=N3*(3+N7)
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)
W(I+3)=VB+VX*X(I)+VY*Y(I)
W(N1,2)=UR
W(N2,2)=UX
W(N3,2)=UY
W(N1,3)=VR
W(N2,3)=VR
W(N3,3)=VY
IF (NZ.EQ.0) RETURN
DO 90 J=4,NZ3
DO 80 I=1,N3
C LEFT SHIFT A,B MATICES N COLUMNS
W(I,J)=W(I,N+J)
RETURN
END
SUBROUTINE SURFORD (W,XP,YP,ZP,N3)
SURFACE SPLINE INTERPOLATION (ORDINATES)

WRITTEN BY ROBERT N. DESMARais, STRUCTURES AND DYNAMICS DIV.
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
   ZP=ZP+W(I,4)*R2*ALNG(RZ+W(I,3,1))
10 RETURN
END
SUBROUTINE MATINV (MAX,N,A,M,B,IOP,DETERM,ISCALE,IPIVOT,IMK)

MATRIX INVERSION WITH ACCOMPANYING SOLUTION OF LINEAR EQUATIONS

PROVIDED BY - ANALYSIS AND COMPUTATION DIVISION

LANGLEY RESEARCH CENTER

HAMPTON, VA. 23665

DIMENSION IPIVOT(N), A(MAX,N), B(MAX,N), IMK(MAX,Z)

EQUIVALENCE (IROW,JROW), (ICOLUMN,JCOLUMN), (AMAX,T,SWAP)

INITIALIZATION

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

SEARCH FOR PIVOT ELEMENT

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 IRW=J
ICOLUMN=K
AMAX=A(J,K)
CONTINUE
60 CONTINUE
IF (AMAX) 80,70,80
70 DETERM=0.0
ISCALE=0
GO TO 410
80 IPIVOT(ICOLUMN)=IPIVOT(ICOLUMN)+1
CONTINUE
IF (IROW-ICOLUMN) 90,130,90
90  DETERM=DETERM
  DO 100 I=1,N
  SWAP=A(IROW,L)
  A(IROW,L)=A(ICOLUMN,L)
100  A(ICOLUMN,L)=SWAP
  IF (I .GE. 130) GO TO 110
110  DO 120 L=1,N
  SWAP=B(IROW,L)
  B(IROW,L)=B(ICOLUMN,L)
120  B(ICOLUMN,L)=SWAP
130  INK(1,1)=IROW
  INK(1,2)=ICOLUMN
  PIVOT=A(ICOLUMN,ICOLUMN)
  IF (PIVOT .NE. 1) GO TO 270
  IF (PIVOT) 140,70,140
C
  SCALE THE DETERMINANT
C
140  PIVOT=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) 130,130,200
180  DETERM=DETERM/R1
  ISCALE=ISCALE-1
  IF (ABS(DETERM)-R2) 170,190,200
190  DETERM=DETERM/R1
  ISCALE=ISCALE-1
  IF (ABS(PIVOT)-R1) 230,210,210
200  PIVOT=PIVOT/R1
  ISCALE=ISCALE+1
  IF (ABS(PIVOT)-R2) 250,220,220
210  PIVOT=PIVOT/R1
  ISCALE=ISCALE+1
  GO TO 240
230 IF (ABS(PIVOTI)-R2) 240,240,260
240  PIVOTI=PIVOTI*R1
     ISCALE=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(ICOL,M,ICOL)=1.0
    DO 290 L=1,N
290  A(ICOL,L)=A(ICOL,L)/PIVOT
    IF (M) 320,320,300
300  DO 310 L=1,N
310  B(ICOL,L)=B(ICOL,L)/PIVOT
C
C  REDUCE NON-PIVOT ROWS
C
320  DO 370 L1=1,N
    IF (L1-ICOL) 330,370,330
330  T=A(L1,ICOL)
     A(L1,ICOL)=0.0
    DO 340 L=1,N
340  A(L1,L)=A(L1,L)-A(ICOL,L)*T
    IF (M) 370,370,350
350  DO 360 L=1,N
360  B(L1,L)=B(L1,L)-B(ICOL,L)*T
370  CONTINUE
C
C  INTERCHANGE COLUMNS
C
    DO 400 I=1,N
    L=N+1-I
    IF (IWK(L,1)-IWK(L,2)) 330,400,380
380  JROW=IWK(L,1)
     JCOLUMN=IWK(L,2)
    DO 390 K=1,N

SWAP = A(k, JROW)
A(k, JROW) = A(k, JCOLUMN)
A(k, JCOLUMN) = SWAP

390 CONTINUE
400 CONTINUE
410 RETURN
END
OVERLAY (LEVSP,5,0)
PROGRAM NEWSHAPE
C SETS UP DIMENSIONS FOR COMPUTING THE NEW LOCATIONS OF LEADING-EDGE VORTICES BY MAKING THOSE FORCE-FREE
COMMON (D1)
COMMON /NA1/ NSW1,NSW,NCW,NWNG,NCPTTL
DIMENSION E(2400)
C **************************************************************
REIND 4
NN=NSW1+NSW
CALL SKTPR (4,NN)
READ (4) NMAX,NNMAX,ZMIN,NCONT
C **************************************************************
LC=1
LTHETP=LC+NSW1
LXN=LTHETP+NSW1
LYN=LXN+2*NWNG
LXTE=LYN+2*NWNG
LXE=LXTE+NSW
LYLE=LYX+NSW
LYC=LYLE+NSW
LCONS=LYLE+NSW
LSI=LCONS+NSW
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
LNU1=LDUMY+8*NWNG
LNU2=LNU1+NSW1
LGA1=LNU1+NSW1
LGM1=LGA1+NCPTTL
LXLM=LGM1+NSW1
LCPCW=LYLM+NSW1
LNEXT=LCPCW+NSW1
C LNEXT=21*NWNG+14*NSW+NCW-9
MXE=1
MYE=MXE+NSW1*NMAX
MZE=MYE+NSW1*NMAX
MXE=MZE+NSW1*NMAX
MYE=MXE+NSW1*NMAX
MZE=MYE+NSW1*NMAX
MEXT=MZZE+NSW1*NMAX
MEXT=3*NSW1*NMAX-3*NMAX+3*NSW1*NMAX+1

CALL NEWELM (D(LC),D(THETP),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(LCONT),D(LHSP)
2.D(LCONK),D(LDUMY),NWNG,NCPTTL,E(MYE),E(MZE),E(MXZE),ENSP
3(MYE),E(MZZE),NSW1,NSW,NCW,ZMIN,NMAX,NNMAX,D(LNHEL),D(LNNHEL),NCONSP
4NTS,D(LGAMA),D(LGML),D(LYLM),D(LCPW))
RETURN
END
SUBROUTINE NEWELM (C, THETP, XN, YN, XTE, XLE, YLE, CONS, SI, XCP, YCP, CI, CJNL)
1, CK, CONI, CONJ, CONK, DUMMY, NWNG, NCPTTL, XE, YE, ZE, XXE, YYE, ZZE, NSW1, NSW1)
2, NC, ZHIN, MMX, NMAX, NCLEM, NCOLTS, GAMAI, GML, YLM, CPCW1)
C COMPUTES THE NEW LOCATIONS OF LEADING-EDGE AND TRAILING-EDGE
C VORTICES BY MAKING THOSE FORCE-FREE
COMMON /GM/ ITER
COMMON /NCTT/ NCT, NCON
COMMON /ALLRA/ TTL(15), ALPHAI, SINAI, AA(9), PI, AO(2), HALFB, AREA
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)
2, YCP(1), GAMA(1), GML(1), YLM(1), CPCW1(1), XN(NWNG, 2), YN(NWNG, 2)
3, NELM(1), NNELM(1), XE(NSW1, 1), YE(NSW1, 1), ZE(NSW1, 1), XXE(NSW1, 1)
4, YXE(NSW1, 1), ZZE(NSW1, 1), A(3), B(3), F(3)
C
C ************************************************************************************
C REWIND 1
C ************************************************************************************
CALL SKIPR (1, 5)
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) (ST(I), AC(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)
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)
REWIND 4
DO 10 I=1, NSW1
READ (4) (XE(I, J), YE(I, J), ZE(I, J), J=1, KK)
10 NELM(I)=KK
DO 20 I=1, NSW
READ (4) (XXE(I, J), YXE(I, J), ZZE(I, J), J=1, KK)
20 NNELM(I)=KK
C
C ************************************************************************************
C HALF=1.5*HALFB
C
TAVRG=TFABS/TLNTH
WRITE (6,170) TFABS
C
******************************
WRITE (7) TFABS,TAVRG,TLNTH
C
******************************
C CALCULATION OF THE COORDINATES OF LEADING-EDGE ELEMENTS BY
C SATISFYING FORCE-FREE CONDITION

DO 110 J=5,NMAX
DO 110 I=2,NSW1
NCON=I
K=NELM(I)-1
IF (J.GT.K) GO TO 110
XXX=XE(I,J+1)
Y/Y=YE(I,J+1)
ZZZ=ZE(I,J+1)
DLS=SORT((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,YTE,CONS,DUMMY,CONI,
1J,CONK,SI,NSW1,NCW,NWNG,C1,CJ,CK,XLE,UX,UX,CPCW1,XCP,YCP,GAMA,
YMLM10
2LM)
UVW=SORT(UU+UU+VV+VV+WW+WW)
IF (J.EQ.5) GO TO 50
VVA=ATL*VV/UVW
WVA=ATL*WW/UVW
DLY=VVA*DLS+BTL*(YE(I,J+1)-YE(I,J))
DLZ=WVA*DLS+BTL*(ZE(I,J+1)-ZE(I,J))
GO TO 60
50 CONTINUE
VVA=0.5*VV/UVW
WVA=0.5*WW/UVW
DLY=VVA*DLS+0.5*(YE(I,J+1)-YE(I,J))
DLZ=WVA*DLS+0.5*(ZE(I,J+1)-ZE(I,J))
GO TO 70
60 CONTINUE
IF ((DLZ/DLS).GT.SINA) DLZ=DLS*SINA
70 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)
DLX2=DLS*DLZ-DLY2*DLZ2
IF (DLX2.LE.0.) DLY2=DLY2/2.
IF (DLX2.LE.0.) DLZ2=DLZ2/2.
DLX2=SQRT(DLS*DLZ-DLY2*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 110
DO 80 JK=J?+KP
X=K(JK)=XE(I,JK)+DX
Y=K(JK)=YE(I,JK)+DY
Z=K(JK)=ZK(I,JK)+DZ
C
REWIND 4
DO 90 L=1,NSW
KS=NELM(L)
WRITE (4) KS,(XE(L,M),YE(L,M),ZE(L,M),M=1,KS)
DO 100 L=1,NSW
KS=NNELM(L)
WRITE (4) KS,(X=K(E(L,M),Y=(E(L,M),ZK(E(L,M),M=1,KS)
WRITE (4) NMAX,NNMAX,ZMIN,NCONTS
C
CALCULATION OF THE COORDINATES OF WAKE ELEMENTS BY SATISFYING
FORCE-FREE CONDITION
CTL=0.5
DIL=1.-CTL
C
NCON=0
DO 160 J=1,NNMAX
DO 160 I=2,NSW
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,J+1)-ZZE(I,J))*2)
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 NEWEL IC,THETP,XEE,YEE,ZEE,XN,YN,XTE,YLE,CONS,DUMMY,CONI,CONNL
1J,CONK,SI,NSWI,NCW,NWNG,CI,CJ,CK,XLE,UU,UV,WW,CPCW1,XCP,YCP,GAMA,YNL
2LM1
UW=SQRT(UU*UU+VV*VV+WW*WW)
IF (J.EQ.1) GO TO 130
VVA=CTL*VV/UW
WAA=CTL*WW/UW
DLY=VVA+L+L*(YYE(I,J+1)-YYE(I,J))
DLZ=VAA+L+L*(ZZE(I,J+1)-ZZE(I,J))
IF ((DLZ/WLS)*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
DL2=YINT-YYE(I,J)
DL2=DLZ
DLX2=WLS*WLS-DL2-DL2*DL2
IF (DLX2.LE.0.) DL2=DL2/2.
IF (DLX2.LE.0.) DLZ=DLZ/2.
DLX2=SQRT((WLS*WLS-DL2-DL2)*DL2)
XXE(I,J+1)=XXE(I,J)+DLX2
YYE(I,J+1)=YYE(I,J)+DLY2
ZEE(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
BALAL
J2=J+2
KP=K+1
IF (J2.GT.KP) GO TO 130
DO 120 JK=J2,KP
XXE(I,JK)=XXE(I,JK)+DX
YYE(I,JK)=YYE(I,JK)+DY
120 ZZE(I,JK)=ZZE(I,JK)+DZ
130 CONTINUE
C

REWIND 4
DO 140 L=1,NSW1
KS=NELM(L)
140 WRITE (4) KS,(XE(L,M),YE(L,M),ZE(L,M),M=1,KS)
DO 150 L=1,NSW
KS=NELM(L)
150 WRITE (4) KS,(XXF(L,M),YYE(L,M),ZZE(L,M),M=1,KS)
WRITE (4)NMUM,NMUMAX,ZMIN,CMCCTS
C
160 CONTINUE
RETURN
C
170 FORMAT (/,'59H TOTAL ABSOLUTE FORCE ACTING ON LEADING-EDGE FREE EL',X, 'ELEMENTS= ',F10.5)
END
This document describes in detail the necessary information for using a computer program to predict distributed and total aerodynamic characteristics for low aspect-ratio wings with partial leading-edge separation. The flow is assumed to be steady and inviscid. The wing boundary condition is formulated by the Quasi-Vortex-Lattice method. The leading-edge separated vortices are represented by discrete free vortex elements which are aligned with the local velocity vector at mid-points to satisfy the force free condition. The wake behind the trailing-edge is also force free. The flow tangency boundary condition is satisfied on the wing, including the leading- and trailing-edges.

The program is restricted to delta wings with zero thickness and no camber. It is written in Fortran language and runs on CDC 6600 Computer.