D.4 LAMDES User's Manual

This is the Lamar design program, LamDes2.f. It can be used as a non-planar LIDRAG to get span *e* for multiple lifting surface cases when user supplies spanload. It has also been called the Lamar/Mason optimization code. It finds the spanload to minimize the sum of the induced and pressure drag, including canards or winglets. It also provides the associated camber distribution for subsonic flow. Since two surfaces are included, it can find the minimum trimmed drag while satisfying a pitching moment constraint.

The program will prompt you for the input file name. A sample input file called lamdes.inp is on the disk, and the output obtained from this case is included here.

References:

J.E. Lamar, "A Vortex Latice Method for the Mean Camber Shapes of Trimmed Non-Coplanar Planforms with Minimum Vortex Drag," NASA TN D-8090, June, 1976.

W.H. Mason, "Wing-Canard Aerodynamics at Transonic Speeds - Fundamental Considerations on Minimum Drag Spanloads," AIAA Paper No. 82-0097, January 1982.

Input Instructions:

The program assumes the load distribution is constant chordwise until a designated chordwise location (XCFW on the first surface and XCFT on the second surface). The loading then decreases linearly to the trailing edge. This corresponds to a 6 & 6A series camber distribution (the value for the 6A series is usually 0.8). If airfoil polars are used to model the effects of viscosity, the polars are input in a streamwise coordinate system. The user is responsible for adjusting them from 2D to 3D.

This program uses an input file that is very similar to, *but not the same as*, the VLMpcv2 code. It is based on the same geometry and coordinate system ideas. Section D.6 should be consulted for a discussion of the geometry system.

Card #	Format	Field	Name	Remarks
1	Literal		DATA	Title card for the data set
2	8F10.6	1	PLAN	Number of lifting surfaces for the configuration; use 1 or 2.
		2	XMREF	c.g. shift from origin of input planform coordinate system (the program originally trimmed the configuration about the input planform origin). + is a c.g. shift forward - is a c.g. shift aft
		3	CREF	reference chord of the configuration, used only to nondimensionalize the pitching moment coefficients.
		4	SREF	reference area of the configuration

Card #	Format	Field	Name	Remarks
		5	TDKLUE	minimization clue = 0 - minimize induced drag only = 1 - minimize induced plus pressure drag
		6	CASE	options for the drag polar = 0, model polar, same *a*, CLmin, CD0 for each surface(see note 3 below). = 1, model polar, each surface has its own *a*, CLmin, CD0 = 2, one general polar for entire config. = 3, one general polar for each surface
		7	SPNKLU	spanload clue = 0 spanload is internally computed using the minimization = 1, no minimization is done, spanload is read in, and e and pressure drag are computed.

Geometric/Planform Data - see the VLMpc section (D.6) for more details

Card #	Format	Field	Name	Remarks
1-P	8F10.6	1	AAN(IT)	# of straight lines defining this surface
		2	XS(IT)	= 0. (not used in this code)
		3	YS(IT)	= 0. (not used in this code)
		4	RTCDHT(IT)	root chord height (- is “higher”)
		5	PDRG1(IT)	CLmin
		6	PDRG2(IT)	“*a*”
		7	PDRG3(IT)	CD0
2-P	8F10.6	1	XREG	X point of line segment (positive is forward)
		2	YREG	Y point of line segment (positive is forward)
		3	DIH	dihedral angle of line
		4	AMCD	sweep wing move code, set = 1 for this program

Note:
1. Card 2-P is read in AAN + 1 times. Surface description starts at forward centerline and works outboard and around, returning to the aft centerline of the surface.
2. Cards 1-P and 2-P are read in as a set for each lifting surface (see VLM4997 for clarification)
3. The model polar is given by: $C_d = a\,(C_l - C_{l\min})^2 + C_{D_0}$

Control Data (corresponding to “Group Two” data in Lamar’s nomenclature)

Card #	Format	Field	Name	Remarks
1-C	6F5.3,2F10.6	1	CONFIG	arbitrary configuration number or ID (may include up to four digits)
		2	SCW	Number of chordwise horseshoe vortices to be used to represent the wing; a maximum of 20 may be used, do not set to zero.
		3	VIC	nominal number of spanwise rows at which chordwise horseshoe may be located; a maximum of 50 may be used. The product of SCW and SSW cannot exceed 400 (see VLM4997 chapter for details of vortex layout).
		4	XMCH	Mach number, used to apply Prandtl-Glauert comressibility correction factor.
		5	CLDES	design lift coefficient for lifting system
		6	XITMAX	Maximum number of iterations allowed in finding the solution for minimum + pressure drag with arbitrary polars input. Must be less than 50. 20 is sufficient for most cases.
		7	EPSMAX	The convergence criteria for the general polar case.A value of .0005 appears to be reasonable.
2-C	6F10.4	1	XCFW	The chord fraction “*a*” at which the chord load shape changes from rooftop to a linear decrease to zero at the trailing edge on the first planform. See the introduction to this section for more discussion.
		2	XCFT	Same as XCFW, except applies to the second planform.
		3	FKON	Clue for constraints = 0 body moment constraint = 1 no constraints = 2 root bending moment constraint = 3 both moment anf root bending moment constraints.
		4	CMB	The design wing CM when FKON = 0
		5	FICAM	Camber computation clue. = 0, no cambers computed = 1, wing cambers computed

Card #	Format	Field	Name	Remarks
		6	PUNCH	clue to punch cambers out = 0 - no punch file created = 1 - cards output (unit 7)
		7	CRBMT	Design root bending moment for FKON = 2.
3-C	8F10.6	1	RELAX	The under-relaxation factor for the general polar solution. RELAX = .03 to .3 is satisfactory for most applications.
		2	FIOUTW	Output clue. = 0 - full iteration history is output = 1 - only final results are output
		3	CD0	Basic drag coefficient that will be added to the drag computed by summing the induced drag and the profile drag contained in the input polars.

Arbitrary Polar Input (the following cards are read only if CASE ≥ 2.)

Card #	Format	Field	Name	Remarks
1-D	Literal		TITLE	The identifying title for the input drag polar for this surface.
2-D	8F10.5	1	FNCLCD	The number of CL,CD pairs used to define the input polar.
3-D	8F10.5	1	FQCL	The value of streamwise lift coefficient for this pooint on the drag polar.
		2	FQCD	The value of streamwise drag coefficient for the given lift coefficient.

Note:
1. Card 3-D is read FNCLCD times
2. Cards 1-D, 2-D and 3-D are read for each planform if CASE = 3.

Spanload Input (the following cards are read only if SPNKLU = 1)

Card #	Format	Field	Name	Remarks
1-S	Literal		TITLE	This is the title card for the input spanloads.
2-S	7F10.5	1	FSPNPT	Number of points on the spanload to be read in for this planform.
3-S	7F10.5	1	YSPNPT	Span location in physical coordinates at which ccl/ca is input (y is positive here!)
		2	CLSPNP	The spanload at YSPNPT

Note:
1. Card 3-S is read FSPNPT times
2. Cards 2-S and 3-S are read for each planform as a set.

Sample Input: (note: it is important to put data in proper columns!)

```
Lamar program sample input - revised forward swept wing
  2.000    -8.000    89.50     26640.    1.0       3.0       0.0
  5.000     0.0       0.0      -8.8      0.0       0.0
  68.95     0.0       0.0       1.0
  68.95    -34.0
  49.61    -65.30     0.0       1.0
  25.64    -65.30     0.0       1.0
  22.25    -34.00
  22.25      0.00
  5.0        0.0      0.0       0.0      0.0       0.0
 -25.90      0.0      0.0       1.0
 -25.90    -34.0
  38.10    -164.0     0.0       1.0
  -2.40    -164.0     0.0       1.0
-147.90     -20.0
-147.90       0.0
1.0  10.0 20.  0.9  0.90 40.0  0.0006
 0.0       0.65      0.0       -0.10     1.0
 0.030     1.0       0.0        0.0      0.0       0.0
drag polar on canard (conv. sec)
18.0
  0.00      0.0000
  0.10      0.0000
  0.25      0.0002
  0.30      0.00078
  0.40      0.00175
  0.50      0.00315
  0.55      0.0040
  0.60      0.00535
  0.65      0.00685
  0.70      0.00880
  0.75      0.01125
  0.80      0.01485
  0.85      0.01975
  0.88      0.02400
  0.915     0.03600
  1.00      0.0880
  1.20      0.2680
  1.80      0.9880
  drag polar
22.0
  0.000     0.0003
  0.200     0.0003
  0.300     0.0005
  0.400     0.0008
  0.500     0.00125
  0.600     0.00178
  0.700     0.00244
  0.800     0.00324
  0.900     0.00442
  0.950     0.00528
  0.970     0.00570
  0.990     0.00621
  1.000     0.00650
  1.020     0.00730
  1.040     0.00820
  1.060     0.00930
  1.080     0.01090
  1.100     0.01280
  1.125     0.02400
  1.130     0.03600
  1.200     0.20400
  2.000     2.12400
```

Sample Output:

```
 enter name of input file: lamdes.inp

  Lamar Design Code     mods by W.H. Mason

  Lamar program sample input - revised forward swept wing

  plan   = 2.0  xmref =  -8.0000   cref   = 89.5000
  tdklue = 1.0  case  =   3.0      spnklu = 0.0
  sref   =   26640.0000

         1st REFERENCE PLANFORM HAS  5 CURVES
         ROOT CHORD HEIGHT =     -8.8000

         POINT   X         Y       SWEEP    DIHEDRAL
                REF       REF      ANGLE     ANGLE
           1  76.9500   0.0000   0.00000   0.00000
           2  76.9500 -34.0000  31.71155   0.00000
           3  57.6100 -65.3000  90.00000   0.00000
           4  33.6400 -65.3000  -6.18142   0.00000
           5  30.2500 -34.0000   0.00000   0.00000
           6  30.2500   0.0000

         2nd REFERENCE PLANFORM HAS  5 CURVES
         ROOT CHORD HEIGHT =      0.0000

         POINT   X         Y       SWEEP    DIHEDRAL
                REF       REF      ANGLE     ANGLE
           1 -17.9000   0.0000   0.00000   0.00000
           2 -17.9000 -34.0000 -26.21138   0.00000
           3  46.1000-164.0000  90.00000   0.00000
           4   5.6000-164.0000 -45.29687   0.00000
           5-139.9000 -20.0000   0.00000   0.00000
           6-139.9000   0.0000

         scw    = 10.0      vic = 20.0
         xitmax = 40.0   epsmax =  0.00060

        CONFIGURATION NO.      1.
        delta ord shift for moment =    -8.0000

        CURVE  1 IS SWEPT  0.0000 DEGREES ON PLANFORM  1
        CURVE  1 IS SWEPT  0.0000 DEGREES ON PLANFORM  2

         BREAK POINTS FOR THIS CONFIGURATION

       POINT   X         Y         Z       SWEEP  DIHEDRAL
                                           ANGLE    ANGLE
         1  76.9500   0.0000  -8.8000   0.0000   0.0000
         2  76.9500 -20.0000  -8.8000   0.0000   0.0000
         3  76.9500 -34.0000  -8.8000  31.7116   0.0000
         4  57.6100 -65.3000  -8.8000  90.0000   0.0000
         5  33.6400 -65.3000  -8.8000  -6.1814   0.0000
         6  30.2500 -34.0000  -8.8000   0.0000   0.0000
         7  30.2500   0.0000  -8.8000
         SECOND PLANFORM BREAK POINTS
         1 -17.9000   0.0000   0.0000   0.0000   0.0000
         2 -17.9000 -34.0000   0.0000 -26.2114   0.0000
         3  -2.4908 -65.3000   0.0000 -26.2114   0.0000
         4  46.1000-164.0000   0.0000  90.0000   0.0000
         5   5.6000-164.0000   0.0000 -45.2969   0.0000
         6-139.9000 -20.0000   0.0000   0.0000   0.0000
         7-139.9000   0.0000   0.0000
```

```
  280 HORSESHOE VORTICES USED
 PLANFORM     TOTAL        SPANWISE
    1           80             8
    2          200            20

  10. HORSESHOE VORTICES IN EACH CHORDWISE ROW

xcfw  = 0.00     xcft   =  0.65      fkon   =   0.00
ficam = 1.00     punch  =  0.00      crbmnt =   0.000
cmb   = -.10     iflag  =   1

relax = 0.03     fioutw =  1.00      cd0    =   0.0000
firbm = 0.00     yrbm   =  0.0000    zrbm   =   0.0000

drag polar on canard (conv. sec)


there are  1.0 polars on this surface

 18.0   points this polar  planform 1

         qcl      qcd
       0.0000    0.0000
       0.1000    0.0000
       0.2500    0.0002
       0.3000    0.0008
       0.4000    0.0018
       0.5000    0.0032
       0.5500    0.0040
       0.6000    0.0054
       0.6500    0.0069
       0.7000    0.0088
       0.7500    0.0113
       0.8000    0.0148
       0.8500    0.0198
       0.8800    0.0240
       0.9150    0.0360
       1.0000    0.0880
       1.2000    0.2680
       1.8000    0.9880

  drag polar


there are  1.0 polars on this surface

 22.0   points this polar  planform 2

         qcl      qcd
       0.0000    0.0003
       0.2000    0.0003
       0.3000    0.0005
       0.4000    0.0008
       0.5000    0.0012
       0.6000    0.0018
       0.7000    0.0024
       0.8000    0.0032
       0.9000    0.0044
       0.9500    0.0053
       0.9700    0.0057
       0.9900    0.0062
       1.0000    0.0065
       1.0200    0.0073
       1.0400    0.0082
```

```
                1.0600    0.0093
                1.0800    0.0109
                1.1000    0.0128
                1.1250    0.0240
                1.1300    0.0360
                1.2000    0.2040
                2.0000    2.1240

  LM = 70  IL = 71  JM = 72  IM = 73  TSPAN =-164.000    TSPANA = -65.300
  BOTL = 164.000    BOL  = 65.300     SNN   =  1.6400    DELTYB =  3.2800
  NMA(KBOT) = 50    KBOT = 2          NMA(KBIT) = 20     KBIT   =  1

           induced drag cd = 0.06815     pressure drag cdpt = 0.01665

           induced drag cd = 0.06818     pressure drag cdpt = 0.01441

           induced drag cd = 0.06827     pressure drag cdpt = 0.01255

           induced drag cd = 0.06839     pressure drag cdpt = 0.01139

           induced drag cd = 0.06850     pressure drag cdpt = 0.01053

           induced drag cd = 0.06863     pressure drag cdpt = 0.00976

           induced drag cd = 0.06876     pressure drag cdpt = 0.00915

           induced drag cd = 0.06885     pressure drag cdpt = 0.00886

           induced drag cd = 0.06893     pressure drag cdpt = 0.00868

           induced drag cd = 0.06898     pressure drag cdpt = 0.00856

           induced drag cd = 0.06902     pressure drag cdpt = 0.00847

           induced drag cd = 0.06905     pressure drag cdpt = 0.00841

           induced drag cd = 0.06907     pressure drag cdpt = 0.00836

           induced drag cd = 0.06909     pressure drag cdpt = 0.00832

           induced drag cd = 0.06911     pressure drag cdpt = 0.00829

           induced drag cd = 0.06913     pressure drag cdpt = 0.00826

           induced drag cd = 0.06915     pressure drag cdpt = 0.00823

           induced drag cd = 0.06916     pressure drag cdpt = 0.00821

           induced drag cd = 0.06917     pressure drag cdpt = 0.00819

           induced drag cd = 0.06918     pressure drag cdpt = 0.00817

           induced drag cd = 0.06919     pressure drag cdpt = 0.00816

           induced drag cd = 0.06920     pressure drag cdpt = 0.00815

           induced drag cd = 0.06921     pressure drag cdpt = 0.00814

           induced drag cd = 0.06921     pressure drag cdpt = 0.00813

           induced drag cd = 0.06922     pressure drag cdpt = 0.00812

           induced drag cd = 0.06923     pressure drag cdpt = 0.00811
```

```
          induced drag cd = 0.06923     pressure drag cdpt = 0.00810

          induced drag cd = 0.06924     pressure drag cdpt = 0.00810

          induced drag cd = 0.06924     pressure drag cdpt = 0.00809

          induced drag cd = 0.06924     pressure drag cdpt = 0.00809

          induced drag cd = 0.06925     pressure drag cdpt = 0.00808

        pressure drag iteration has converged

             k     eps        cl        cdi       cdp      cdi+cdp
             1  28.66362   0.90000   0.06815   0.01665   0.08480
             2   0.05789   0.90000   0.06818   0.01441   0.08260
             3   0.05278   0.90000   0.06827   0.01255   0.08082
             4   0.04274   0.90000   0.06839   0.01139   0.07978
             5   0.03408   0.90000   0.06850   0.01053   0.07903
             6   0.03155   0.90000   0.06863   0.00976   0.07839
             7   0.02773   0.90000   0.06876   0.00915   0.07791
             8   0.02043   0.90000   0.06885   0.00886   0.07772
             9   0.01549   0.90000   0.06893   0.00868   0.07761
            10   0.01218   0.90000   0.06898   0.00856   0.07754
            11   0.00994   0.90000   0.06902   0.00847   0.07749
            12   0.00847   0.90000   0.06905   0.00841   0.07746
            13   0.00724   0.90000   0.06907   0.00836   0.07743
            14   0.00616   0.90000   0.06909   0.00832   0.07741
            15   0.00519   0.90000   0.06911   0.00829   0.07740
            16   0.00442   0.90000   0.06913   0.00826   0.07739
            17   0.00371   0.90000   0.06915   0.00823   0.07738
            18   0.00310   0.90000   0.06916   0.00821   0.07737
            19   0.00263   0.90000   0.06917   0.00819   0.07736
            20   0.00221   0.90000   0.06918   0.00817   0.07736
            21   0.00183   0.90000   0.06919   0.00816   0.07735
            22   0.00154   0.90000   0.06920   0.00815   0.07735
            23   0.00131   0.90000   0.06921   0.00814   0.07734
            24   0.00112   0.90000   0.06921   0.00813   0.07734
            25   0.00095   0.90000   0.06922   0.00812   0.07734
            26   0.00084   0.90000   0.06923   0.00811   0.07734
            27   0.00076   0.90000   0.06923   0.00810   0.07733
            28   0.00069   0.90000   0.06924   0.00810   0.07733
            29   0.00064   0.90000   0.06924   0.00809   0.07733
            30   0.00061   0.90000   0.06924   0.00809   0.07733
            31   0.00057   0.90000   0.06925   0.00808   0.07733

 induced + pressure drag was minimized on this run

 ref. chord =    89.500  c average   =    81.2195  true area =  32771.566
 ref. area  = 26640.000  b/2         =   164.0000  ref ar    =  4.0384
 true ar    =    3.2828  Mach number =     0.9000

        first  planform   cl =   0.17126  cm =   0.11493  cb =  -0.01502
        second planform   cl =   0.72874  cm =  -0.21493  cb =  -0.18341

 1st planform   CL = 0.1713   CDP = 0.0042   CM =  0.1150   CB = -0.0151
 2nd planform   CL = 0.7292   CDP = 0.0038   CM = -0.2149   CB =  0.0000

          no root bending moment constraint

        CL DES  = 0.90000    CL COMPUTED =  0.9005    CM = -0.0999
        CD I    = 0.06925    E           =  0.9230
        CDPRESS = 0.00804    CDTOTAL     =  0.07729
```

first planform

Y	CL*C/CAVE	C/CAVE	CL	CD
-61.2000	0.21189	0.33178	0.63862	0.00651
-53.0000	0.33566	0.40510	0.82857	0.01765
-44.8000	0.41311	0.47842	0.86348	0.02166
-37.3500	0.46740	0.54503	0.85757	0.02082
-29.9000	0.49499	0.57498	0.86088	0.02129
-22.9000	0.50260	0.57498	0.87411	0.02317
-15.9000	0.50504	0.57498	0.87835	0.02377
-5.9000	0.50631	0.57498	0.88056	0.02419

second planform

-159.9000	0.33879	0.52480	0.64556	0.00208
-151.7000	0.53136	0.57711	0.92072	0.00478
-143.5000	0.64513	0.62942	1.02495	0.00752
-135.3000	0.72403	0.68173	1.06206	0.00946
-127.1000	0.78509	0.73404	1.06954	0.01006
-118.9000	0.83563	0.78635	1.06267	0.00951
-110.7000	0.87760	0.83866	1.04644	0.00855
-102.5000	0.91055	0.89096	1.02198	0.00739
-94.3000	0.93428	0.94327	0.99047	0.00622
-86.1000	0.94681	0.99558	0.95101	0.00530
-77.9000	0.94347	1.04789	0.90036	0.00443
-69.5500	0.90911	1.10116	0.82559	0.00354
-61.2000	0.82859	1.15442	0.71775	0.00258
-53.0000	0.74419	1.20673	0.61670	0.00189
-44.8000	0.67721	1.25904	0.53788	0.00145
-37.3500	0.63142	1.30656	0.48327	0.00117
-29.9000	0.60043	1.37894	0.43543	0.00096
-22.9000	0.58289	1.46602	0.39760	0.00079
-15.9000	0.57323	1.50210	0.38162	0.00074
-5.9000	0.56730	1.50210	0.37767	0.00073

mean camber lines to obtain the spanload

(subsonic linear theory)

y= -61.2000 y/(b/2) = -0.3732 chord= 26.9474

slopes, dz/dx, at control points, from front to rear

x/c	dz/dx
0.0750	0.1295
0.1750	0.0672
0.2750	0.0194
0.3750	-0.0200
0.4750	-0.0522
0.5750	-0.0775
0.6750	-0.0960
0.7750	-0.1077
0.8750	-0.1122
0.9750	-0.1081

mean camber shape (interpolated to 41 points)

x/c	z/c	delta x	delta z	(z-zle)/c
0.0000	-0.0299	0.0000	-0.8067	0.0000
0.0250	-0.0332	0.6737	-0.8944	-0.0040
0.0500	-0.0365	1.3474	-0.9831	-0.0080
0.0750	-0.0398	2.0211	-1.0717	-0.0121
0.1000	-0.0429	2.6947	-1.1558	-0.0159
0.1250	-0.0457	3.3684	-1.2310	-0.0195
0.1500	-0.0480	4.0421	-1.2945	-0.0226

0.1750	-0.0499	4.7158	-1.3456	-0.0252
0.2000	-0.0514	5.3895	-1.3857	-0.0275
0.2250	-0.0526	6.0632	-1.4166	-0.0294
0.2500	-0.0534	6.7368	-1.4399	-0.0310
0.2750	-0.0540	7.4105	-1.4563	-0.0323
0.3000	-0.0544	8.0842	-1.4660	-0.0334
0.3250	-0.0545	8.7579	-1.4689	-0.0343
0.3500	-0.0544	9.4316	-1.4651	-0.0349
0.3750	-0.0540	10.1053	-1.4548	-0.0353
0.4000	-0.0534	10.7790	-1.4383	-0.0354
0.4250	-0.0525	11.4526	-1.4160	-0.0353
0.4500	-0.0515	12.1263	-1.3884	-0.0351
0.4750	-0.0503	12.8000	-1.3556	-0.0346
0.5000	-0.0489	13.4737	-1.3181	-0.0339
0.5250	-0.0474	14.1474	-1.2760	-0.0331
0.5500	-0.0456	14.8211	-1.2297	-0.0322
0.5750	-0.0438	15.4948	-1.1794	-0.0310
0.6000	-0.0418	16.1684	-1.1254	-0.0298
0.6250	-0.0396	16.8421	-1.0679	-0.0284
0.6500	-0.0374	17.5158	-1.0074	-0.0269
0.6750	-0.0350	18.1895	-0.9440	-0.0253
0.7000	-0.0326	18.8632	-0.8781	-0.0236
0.7250	-0.0301	19.5369	-0.8100	-0.0218
0.7500	-0.0275	20.2105	-0.7400	-0.0200
0.7750	-0.0248	20.8842	-0.6682	-0.0181
0.8000	-0.0221	21.5579	-0.5950	-0.0161
0.8250	-0.0193	22.2316	-0.5205	-0.0141
0.8500	-0.0165	22.9053	-0.4452	-0.0120
0.8750	-0.0137	23.5790	-0.3696	-0.0100
0.9000	-0.0109	24.2527	-0.2942	-0.0079
0.9250	-0.0081	24.9263	-0.2196	-0.0059
0.9500	-0.0054	25.6000	-0.1458	-0.0039
0.9750	-0.0027	26.2737	-0.0728	-0.0020
1.0000	0.0000	26.9474	0.0000	0.0000

y= -53.0000 y/(b/2) = -0.3232 chord= 32.9022

slopes, dz/dx, at control points, from front to rear

x/c	dz/dx
0.0750	0.0783
0.1750	-0.0034
0.2750	-0.0572
0.3750	-0.0982
0.4750	-0.1306
0.5750	-0.1557
0.6750	-0.1740
0.7750	-0.1854
0.8750	-0.1898
0.9750	-0.1845

mean camber shape (interpolated to 41 points)

x/c	z/c	delta x	delta z	(z-zle)/c
0.0000	-0.1036	0.0000	-3.4093	0.0000
0.0250	-0.1056	0.8226	-3.4745	-0.0046
0.0500	-0.1076	1.6451	-3.5414	-0.0092
0.0750	-0.1097	2.4677	-3.6080	-0.0138
0.1000	-0.1115	3.2902	-3.6674	-0.0182
0.1250	-0.1128	4.1128	-3.7122	-0.0222
0.1500	-0.1136	4.9353	-3.7381	-0.0255
0.1750	-0.1138	5.7579	-3.7444	-0.0283
0.2000	-0.1135	6.5804	-3.7339	-0.0306
0.2250	-0.1128	7.4030	-3.7102	-0.0325
0.2500	-0.1117	8.2256	-3.6761	-0.0340

```
       0.2750    -0.1104     9.0481    -3.6333    -0.0353
       0.3000    -0.1089     9.8707    -3.5819    -0.0363
       0.3250    -0.1070    10.6932    -3.5220    -0.0371
       0.3500    -0.1050    11.5158    -3.4534    -0.0376
       0.3750    -0.1026    12.3383    -3.3766    -0.0379
       0.4000    -0.1001    13.1609    -3.2920    -0.0379
       0.4250    -0.0973    13.9834    -3.2003    -0.0377
       0.4500    -0.0943    14.8060    -3.1020    -0.0373
       0.4750    -0.0911    15.6285    -2.9975    -0.0367
       0.5000    -0.0878    16.4511    -2.8872    -0.0359
       0.5250    -0.0842    17.2737    -2.7715    -0.0350
       0.5500    -0.0806    18.0962    -2.6505    -0.0339
       0.5750    -0.0767    18.9188    -2.5247    -0.0327
       0.6000    -0.0728    19.7413    -2.3945    -0.0313
       0.6250    -0.0687    20.5639    -2.2601    -0.0298
       0.6500    -0.0645    21.3864    -2.1219    -0.0282
       0.6750    -0.0602    22.2090    -1.9804    -0.0265
       0.7000    -0.0558    23.0315    -1.8358    -0.0247
       0.7250    -0.0513    23.8541    -1.6886    -0.0228
       0.7500    -0.0468    24.6766    -1.5391    -0.0209
       0.7750    -0.0422    25.4992    -1.3875    -0.0189
       0.8000    -0.0375    26.3218    -1.2341    -0.0168
       0.8250    -0.0328    27.1443    -1.0792    -0.0147
       0.8500    -0.0281    27.9669    -0.9233    -0.0125
       0.8750    -0.0233    28.7894    -0.7671    -0.0104
       0.9000    -0.0186    29.6120    -0.6114    -0.0082
       0.9250    -0.0139    30.4345    -0.4569    -0.0061
       0.9500    -0.0092    31.2571    -0.3038    -0.0041
       0.9750    -0.0046    32.0796    -0.1517    -0.0020
       1.0000     0.0000    32.9022     0.0000     0.0000
```

Note this output is repeated for each span station. Most other stations are omitted

```
         y=   -5.9000      y/(b/2) =   -0.0360      chord=  122.0000


         slopes, dz/dx, at control points, from front to rear
         x/c         dz/dx
       0.0750    -0.0501
       0.1750    -0.0505
       0.2750    -0.0495
       0.3750    -0.0500
       0.4750    -0.0537
       0.5750    -0.0623
       0.6750    -0.0814
       0.7750    -0.0975
       0.8750    -0.1077
       0.9750    -0.1097

         mean camber shape (interpolated to 41 points)

         x/c         z/c      delta x    delta z    (z-zle)/c
       0.0000    -0.0697     0.0000    -8.5090     0.0000
       0.0250    -0.0685     3.0500    -8.3562    -0.0005
       0.0500    -0.0672     6.1000    -8.2034    -0.0010
       0.0750    -0.0660     9.1500    -8.0506    -0.0015
       0.1000    -0.0647    12.2000    -7.8975    -0.0020
       0.1250    -0.0635    15.2500    -7.7440    -0.0024
       0.1500    -0.0622    18.3000    -7.5900    -0.0029
       0.1750    -0.0609    21.3500    -7.4358    -0.0034
       0.2000    -0.0597    24.4000    -7.2818    -0.0039
```

```
       0.2250    -0.0584    27.4500    -7.1286    -0.0044
       0.2500    -0.0572    30.5000    -6.9763    -0.0049
       0.2750    -0.0559    33.5500    -6.8249    -0.0054
       0.3000    -0.0547    36.6000    -6.6742    -0.0059
       0.3250    -0.0535    39.6500    -6.5237    -0.0064
       0.3500    -0.0522    42.7000    -6.3728    -0.0069
       0.3750    -0.0510    45.7500    -6.2210    -0.0074
       0.4000    -0.0497    48.8000    -6.0676    -0.0079
       0.4250    -0.0485    51.8500    -5.9121    -0.0084
       0.4500    -0.0472    54.9000    -5.7537    -0.0088
       0.4750    -0.0458    57.9500    -5.5919    -0.0092
       0.5000    -0.0445    61.0000    -5.4262    -0.0096
       0.5250    -0.0431    64.0500    -5.2558    -0.0100
       0.5500    -0.0416    67.1000    -5.0791    -0.0102
       0.5750    -0.0401    70.1500    -4.8940    -0.0105
       0.6000    -0.0385    73.2000    -4.6978    -0.0106
       0.6250    -0.0368    76.2500    -4.4878    -0.0106
       0.6500    -0.0349    79.3000    -4.2627    -0.0105
       0.6750    -0.0330    82.3500    -4.0221    -0.0103
       0.7000    -0.0309    85.4000    -3.7669    -0.0100
       0.7250    -0.0287    88.4500    -3.4982    -0.0095
       0.7500    -0.0264    91.5000    -3.2174    -0.0089
       0.7750    -0.0240    94.5500    -2.9253    -0.0083
       0.8000    -0.0215    97.6000    -2.6231    -0.0076
       0.8250    -0.0189   100.6500    -2.3115    -0.0067
       0.8500    -0.0163   103.7000    -1.9920    -0.0059
       0.8750    -0.0137   106.7500    -1.6662    -0.0049
       0.9000    -0.0110   109.8000    -1.3359    -0.0040
       0.9250    -0.0082   112.8500    -1.0031    -0.0030
       0.9500    -0.0055   115.9000    -0.6690    -0.0020
       0.9750    -0.0027   118.9500    -0.3345    -0.0010
       1.0000     0.0000   122.0000     0.0000     0.0000
     twist table
     i         y        y/(b/2)      twist
     1   -61.20000    -0.37317     1.71469
     2   -53.00000    -0.32317     5.91587
     3   -44.80000    -0.27317     7.36720
     4   -37.35000    -0.22774    10.25835
     5   -29.90000    -0.18232     9.47910
     6   -22.90000    -0.13963     7.60813
     7   -15.90000    -0.09695     6.49868
     8    -5.90000    -0.03598     5.91663
     9  -159.89999    -0.97500    14.45816
    10  -151.70001    -0.92500    16.44655
    11  -143.50000    -0.87500    14.38027
    12  -135.30002    -0.82500    12.36750
    13  -127.10001    -0.77500    10.75520
    14  -118.90002    -0.72500     9.51973
    15  -110.70002    -0.67500     8.46040
    16  -102.50002    -0.62500     7.34168
    17   -94.30003    -0.57500     6.13154
    18   -86.10003    -0.52500     4.67249
    19   -77.90003    -0.47500     2.88238
    20   -69.55002    -0.42409     1.36595
    21   -61.20000    -0.37317     3.52797
    22   -53.00000    -0.32317     4.51491
    23   -44.80000    -0.27317     4.49845
    24   -37.35000    -0.22774     3.79378
    25   -29.90000    -0.18232     3.77474
    26   -22.90000    -0.13963     3.11226
    27   -15.90000    -0.09695     3.52109
    28    -5.90000    -0.03598     3.98970
STOP
```