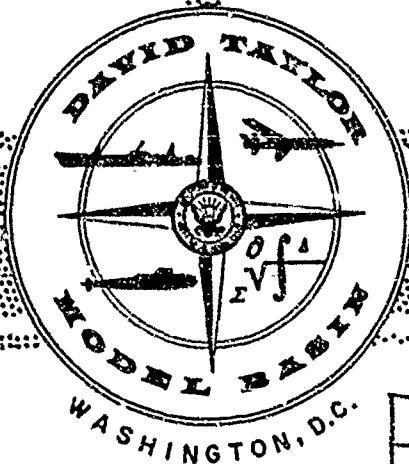


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HYDRODYNAMIC ASPECT OF PROPELLER DESIGN BASED ON

LIFTING-SURFACE THEORY

PART II

ARBITRARY CHORDWISE LOAD DISTRIBUTION

by

Henry M. Cheng

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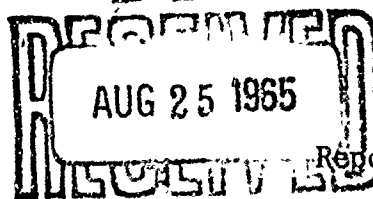
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NOTATION

A_0	Coefficient for loading due to angle of attack in Equation [I]
A_1	Area of a lifting surface
A_2	Area of the helical surface behind the trailing edge of a lifting surface extended to infinity
A_3	Area between a superimposed lifting line and the trailing edge
A_n	Coefficients for loading due to sine series in Equation [I]
a	Fraction of the chord from leading edge over which loading is uniform
a_n	Coefficients as defined in Equation [17] of Reference 2
b_n	Coefficients as defined in Equation [21] of Reference 2
C_0	Coefficients as defined in Equation [I]
C_L	Section lift coefficient
C_m	Ordinate of mean line
D	Diameter of propeller
$\overline{dr}$	Length vector of an elementary bound vortex line on a lifting surface; $\overline{dr}/ dr $ is a unit vector tangent to the bound vortex line
$\overline{ds}$	Length vector of an elementary free vortex line; $\overline{ds}/ rd\phi $ is a unit vector tangent to the free vortex line
J_s	Advance coefficient based on ship velocity
$k^{ba} k^{bt}$	Kernel functions, Equations [VIa] and [VIb]
$k^{fa} k^{ft}$	Kernel functions, Equations [VIc] and [VIId]
L	Chordwise coordinate of any point with respect to reference line
L_l	Chordwise coordinate of leading edge
L_t	Chordwise coordinate of trailing edge
L_T	Chord length
n	Revolutions per unit time
P	Point on lifting surface at which mean line is sought

p	Pitch-diameter ratio
$\bar{R}$	Distance vector between two points
r	Radial coordinate
r_h	Radial coordinate of hub
r_o	Radial coordinate of point P
u_a, u_t	Nondimensional axial and tangential components, respectively, of induced velocity from lifting-line calculation based on ship velocity
V	Nondimensional inflow velocity based on ship speed
$\bar{V}_B$	Induced velocity vector at point P due to radial bound circulation
V_{ba}, V_{bt}	Axial and tangential components of $\bar{V}_B$
$\bar{V}_F$	Induced velocity vector at point P due to free circulation
V_{fa}, V_{ft}	Axial and tangential components of $\bar{V}_F$
$\bar{V}_L$	Velocity vector at a lifting line induced by trailing free vortex sheets
$\bar{V}_P$	Total induced velocity vector at point P
$\bar{V}_{PL}$	Total induced velocity vector at point P relative to $\bar{V}_L$
V_s	Ship velocity
V_x	Nondimensional local longitudinal velocity based on ship velocity
$\bar{v}$	Nondimensional induced velocity
v_a, v_t	Nondimensional axial and tangential components, respectively, of induced velocity v based on ship velocity
v_n	Nondimensional induced downwash at point P normal to helical chord line based on ship velocity
v_{ba}, v_{bt}	Axial and tangential components of $\bar{V}_B$ within a strip between r_1 and r_2
v_{fa}, v_{ft}	Axial and tangential components of $\bar{V}_F$ within a strip between r_1 and r_2
x, y, z	Cartesian coordinates
x	Chordwise coordinate
w_x	Local wake fraction

y	Radial coordinate as defined in Equation [17]
Z	Number of propeller blades
α_i	Ideal angle of attack
β	Advance angle
β_i	Hydrodynamic pitch angle
Γ	Nondimensional circulation = circulation / πDV_s
$\Gamma(r)$	Nondimensional bound circulation distribution along a lifting line
$\Gamma_c(r)$	Nondimensional free circulation distribution on free vortex sheet trailing a lifting line or a lifting surface
$\Gamma_f(r, \theta)$	Nondimensional free circulation distribution
$\Gamma_r(r, \theta)$	Nondimensional bound circulation distribution on a lifting surface
$\Gamma_\theta(r, \theta)$	Nondimensional free circulation distribution on a lifting surface
γ	Circulation per unit angle = $\frac{\Gamma(r)}{\theta_T}$
δ_0	Half width of a strip between r_1 and r_2
θ	Angular coordinate = $L \cos \beta_i / r$
θ_l	Angular coordinate of leading edge
θ_0	Angular coordinate of point P
θ_t	Angular coordinate of trailing edge
θ_T	Total chord length in terms of angular coordinate
ξ	$x - x_0$
ϕ	$\theta - \theta_0$
ϕ_l	$\theta_l - \theta_0$
ϕ_m	$\phi + 2\pi(m - 1)/Z$
ψ	Chordwise coordinate $\psi = \cos^{-1} [1 - 2(\theta_l - \theta)/\theta_T]$

ABSTRACT

A propeller camber calculation method using Pien's scheme based on lifting-surface theory for any arbitrary, not necessarily uniform, chordwise load distribution is reported. The pertinent mathematical formulations and the relevant numerical computations are presented. Included also are the results of some sample calculations. The instructions for preparation of computer input data and the FORTRAN listing of the computer program are included in the Appendixes.

ADMINISTRATIVE INFORMATION

This work was covered by Subproject S-ROLL 01. 01. of Task 0401 under the Bureau of Ships In-House Independent Research Program.

INTRODUCTION

A propeller camber calculation method based on lifting-surface theory using Pien's scheme¹ was reported recently in Reference 2. In that reference, the problem was limited to the case where the chordwise load distribution is uniform. In the present report, the scope is enlarged to include the problem of nonuniform chordwise distribution. This report is essentially an extension of the previous report, and presents only the revised portions of the formulations necessitated from this extension. For the basic formulations and numerical computations, the reader is referred to Reference 2.

The chordwise load distribution is assumed to be in the form of a combination of three parts: a constant, which represents a uniform loading; an angle of attack term, which represents a flat plate; and a sine series with a finite number of terms, which represents any arbitrary modes of loading. The coefficients of these terms are adjustable so that a desired distribution may be adequately approximated. This affords a considerable degree of freedom in handling cases of various load distributions. This flexibility makes it possible to use the computer program in the design of supercavitating propellers. Provisions are also included

¹References are listed on page 49.

in the computer program to facilitate the calculation for load distributions corresponding to the commonly used NACA Sections; i.e., the chordwise loading is partially uniform from the leading edge to a point on the chord, and decreases linearly from that point on to zero at the trailing edge.

This report also includes the results of some sample calculations to compare the camber distribution for various shapes of chordwise loading and to demonstrate the usage of the computing program. Instructions for the preparation of input data and the FORTRAN listing of the computer program are given in Appendixes A and B, respectively.

MATHEMATICAL FORMULATION

The basic expressions for the induced velocity components, Equations [11]* and [12], were developed in Reference 2. They were derived without any restrictions as to the type of chordwise loading. From these equations, a set of working formulas, Equations [16] and [19], was derived for the special case of uniform chordwise loading. For the present problem, because the load distribution along the chord is not necessarily uniform, a set of working equations corresponding to Equations [16] and [19] has been developed as follows.

The coordinate systems are those shown in Figures 1 and 2.

LOAD DISTRIBUTION

Let us assume that the bound circulation distribution $\Gamma_r(r, \theta)$ at any point (r, θ) on the blade may be represented by the following equation:

$$\Gamma_r(r, \theta) = \gamma(r) \left[C_0(r) + A_0(r) \cot \frac{\psi}{2} + \sum_{n=1}^m A_n(r) \sin n\psi \right] \quad [I]$$

* Roman numerals denote equation numbers in this report to distinguish from Arabic numerals used in Reference 2.

where $\gamma(r) = \Gamma(r) / \theta_T(r)$; C_0 , A_0 , and A_n are constant coefficients and, in general, are functions of r ; and ψ is a new chordwise coordinate and is defined as shown in Figure 3:

$$\psi = \cos^{-1} \left[1 - \frac{2}{\theta_T(r)} (\theta_\ell(r) - \theta) \right] \quad [\text{II}]$$

The first term of Equation [I] represents a constant load distribution; the second, the contribution due to angle of attack; the third, some arbitrary distribution in the form of a sine series with amplitude functions A_n . The first three coefficients must have a relationship of

$$C_0(r) + \frac{\pi}{2} \left[A_0(r) + \frac{1}{2} A_1(r) \right] = 1$$

so that

$$\int_{\theta_t(r)}^{\theta_\ell(r)} \Gamma_r(r, \theta) d\theta = \Gamma(r)$$

is satisfied. Equation [I] can be reduced to the uniform load distribution case with a constant density of $\gamma(r)$ if $A_n = 0$ ($n = 0, 1, 2, \dots, m$) and $C_0 = 1$.

The expression for the free circulation on the lifting surface $\Gamma_\theta(r, \theta)$ was derived in Reference 2 as:

$$\Gamma_\theta(r, \theta) = - \frac{d}{dr} \left[\int_{\theta}^{\theta_\ell(r)} \Gamma_r(r, \theta) d\theta \right] dr \quad [\text{III}]$$

With $\Gamma_r(r, \theta)$ from Equation [I] substituted and with an appropriate change of variable, the integration and differentiation may be carried out in a straightforward manner. The resulting expression is

$$\begin{aligned} \Gamma_\theta(r, \theta) = & - \frac{1}{2} \left\{ (C_0(r) \Gamma'(r) (1 - \cos \psi) + C_0(r) \Gamma(r) \psi' \sin \psi \right. \\ & + (A_0(r) \Gamma'(r) (\psi + \sin \psi) + A_0(r) \Gamma(r) \psi' (1 + \cos \psi) \\ & \left. + \frac{1}{2} \sum_{n=1}^m \left[(A_n(r) \Gamma(r))' \left(\frac{\sin(n-1)\psi}{n-1} - \frac{\sin(n+1)\psi}{n+1} \right) \right] \right\} \end{aligned}$$

$$+ A_n(r) \Gamma(r) \psi' \left(\cos(n-1)\psi - \cos(n+1)\psi \right) \Big] \Big\} dr \quad [\text{IIIa}]$$

where prime denotes differentiation with respect to r and

$$\psi' = \left[2 \theta_\ell'(r) - \theta_T'(r) (1 - \cos \psi) \right] / \left(\theta_T(r) \sin \psi \right) \quad [\text{IIa}]$$

The free circulation in the slipstream $\Gamma_c(r)$ has, of course, the following form:

$$\begin{aligned} \Gamma_c(r) &= - \frac{d}{dr} \left[\int_{\theta_t(r)}^{\theta_\ell(r)} \Gamma_r(r, \theta) d\theta \right] dr \\ &= - \frac{d}{dr} \Gamma(r) dr \end{aligned} \quad [\text{IV}]$$

INDUCED VELOCITIES

The equations for the induced velocity components were developed in Equation [16], of Reference 2. They are

$$v_{ba}(r_o, \theta_o) = \frac{1}{4\pi} \iint_{A_1} \Gamma_r(r, \phi) k^{ba}(r_o, \theta_o, r, \phi) d\phi dr \quad [\text{Va}]$$

$$v_{bt}(r_o, \theta_o) = \frac{1}{4\pi} \iint_{A_1} \Gamma_r(r, \phi) k^{bt}(r_o, \theta_o, r, \phi) d\phi dr \quad [\text{Vb}]$$

$$v_{fa}(r_o, \theta_o) = \frac{1}{4\pi} \iint_{A_1} \left[\Gamma_\theta(r, \phi) + \Gamma'(r) dr \right] k^{fa}(r_o, \theta_o, r, \phi) d\phi \quad [\text{Vc}]$$

$$v_{ft}(r_o, \theta_o) = \frac{1}{4\pi} \iint_{A_1} \left[\Gamma_\theta(r, \phi) + \Gamma'(r) dr \right] k^{ft}(r_o, \theta_o, r, \phi) d\phi \quad [\text{Vd}]$$

where the $\Gamma'(r)$ term equals zero for $\phi > 0$,

$$k^{ba}(r_o, \theta_o, r, \phi) = - r_o \sin \phi / R^3 \quad [\text{VIa}]$$

$$k^{bt}(r_o, \theta_o, r, \phi) = \phi [p(r) \cos \phi + p'(r) (r_o - r \cos \phi)] / \pi R^3 \quad [\text{VIb}]$$

$$k^{fa}(r_o, \theta_o, r, \phi) = r(r - r_o \cos \phi) / R^3 \quad [\text{VIc}]$$

$$k^{ft}(r_o, \theta_o, r, \phi) = p(r) (r_o - r \cos \phi - r \sin \phi) / \pi R^3 \quad [VI d]$$

$$R = \left[r^2 - 2 r_o r \cos \phi + r_o^2 + (\phi p(r)/\pi)^2 \right]^{1/2}$$

where $p(r)$ is hydrodynamic pitch-diameter ratio, and

$$\begin{aligned} \phi(\psi) = \theta - \theta_o &= \theta_\ell(r) - \theta_\ell(r_o) - \frac{1}{2} \left[\theta_T(r) (1 - \cos \psi) \right. \\ &\quad \left. - \theta_T(r_o) (1 - \cos \psi_o) \right] \\ d\phi &= - \frac{\theta_T(r)}{2} \sin \psi \, d\psi \end{aligned}$$

With the bound circulation functions of Equation [I] substituted into Equations [Va] and [Vb], the free circulation functions of Equations [III] substituted into Equations [Vc] and [Vd], and appropriate change of variable from ϕ to ψ , the integrals may be evaluated. Equations [Va] through [Vd] thus evaluated correspond to Equations [16a] through [16d] for the special case of uniform distribution given in Reference 2.

The foregoing discussion constitutes the only change in the formulation involved in extending the problem from the special case of uniform chordwise load distribution to a general case of arbitrary distribution.

NUMERICAL COMPUTATIONS

Since the problem discussed here is essentially an extension of the problem dealt with in Reference 2, the numerical computations are basically identical except that the evaluations of the bound and free circulation functions $\Gamma_r(r, \theta)$ and $\Gamma_\theta(r, \theta)$ have necessarily been modified as indicated in the previous section.

The revised new computer program for the case of arbitrary chordwise load distribution is designated as Applied Mathematics Laboratory Problem XPLA, which is a modification of the program developed for the case of uniform chordwise loading, XPLU. For incorporation of the necessary changes in the computations and for convenience, the program has been broken up into several subroutines. The FORTRAN listing of the program is given in Appendix B.

Let us now examine the assumed load distribution $\Gamma_r(r, \theta)$ of Equation [I]. It is an expression of linear combinations of three parts: a constant, an angle of attack, and a sine series. The coefficients C_0 , A_0 , and A_n are determined such that the load distribution can be represented adequately. In the determination of these coefficients, the circulation distribution $\Gamma_r(r, \theta)$ at a number of radii is chosen to meet a specific design situation. Due to the considerations of computer storage capacity and of required computing time, the number of m terms of the sine series has to be limited; accordingly, for the present program, m is limited to 5. Although this is considered to be adequate for most cases having smooth distribution curves, it is not an accurate approximation for curves with abrupt load changes; e.g., the commonly used NACA $a = 0.8$ mean line. For load distributions of this type, the constant loading term in Equation [I] is modified such that it has two parts: the uniform loading portion from the loading edge to the point $x/L_T = a$ on the chord and the linearly decreasing load portion from this point to the trailing edge. The load distributions for $a < 1$ are written as follows:

for $0 \leq \psi \leq \psi_a = \cos^{-1}(1 - 2a)$,

$$\Gamma_r(r, \psi) = \frac{2}{1+a} (\gamma)_{1.0}, \quad [\text{VIIa}]$$

and for $\psi_a \leq \psi \leq \pi$

$$\Gamma_r(r, \psi) = \frac{1 + \cos \psi}{1 - a^2} (\gamma)_{1.0} \quad [\text{VIIb}]$$

where $(\gamma)_{1.0} = \gamma(r)$ denotes the load density corresponding to $a = 1.0$ mean line. Equations [VIIa] and [VIIb] are used in Equations [Va] and [Vb] for the evaluation of the induced velocities due to the bound system.

An expression is then derived for the free circulation density on the lifting surface by substituting the above load distribution in Equation [III]. After carrying out the integration and differentiation, we finally obtain for $0 \leq \psi \leq \psi_a$

$$\Gamma_\theta(r, \theta) = -\frac{1}{1+a} \left[\Gamma'(r) (1 - \cos \psi) + \Gamma(r) \psi' \sin \psi \right] dr, \quad [\text{VIIIa}]$$

and for $\psi_a \leq \psi \leq \pi$

$$\Gamma_{\theta}(r, \theta) = - \left\{ \frac{\Gamma'(r)}{1+a} \left[2a - \frac{1}{2(1-a)} \left(\cos \psi - \cos \psi_a + \frac{1}{2} \sin^2 \psi_a - \frac{1}{2} \sin^2 \psi \right) \right] \right. \\ \left. + \frac{\Gamma(r)}{2(1-a^2)} \psi' \sin \psi (1 + \cos \psi) \right\} dr \quad [\text{VIIb}]$$

These two equations are used in Equations [Vc] and [Vd] for evaluation of the induced velocities due to the free system.

RESULTS OF SAMPLE CALCULATIONS

A number of representative sample cases have been computed using the new computer program XPLA. The results of these cases are reported to demonstrate the effect of chordwise loading on blade geometry.

LOAD DISTRIBUTION CORRESPONDING TO VARIOUS NACA MEAN LINES

The first case is for a propeller having a rectangular expanded outline with an aspect ratio of 10. It has zero hydrodynamic pitch and a uniform bound circulation distribution along the radius. Physically, this fictitious propeller resembles a two-dimensional wing, although the motion involved here is rotational rather than linear translational. The purpose of this calculation is to determine the mean line shapes induced by the uniform radial bound circulation but with various chordwise load distributions corresponding to NACA $a = 1.0, 0.8, 0.6, 0.4,$ and 0.2 . A comparison is made with those of the NACA two-dimensional airfoils. The calculated camber distributions at $r/R = 0.7$ for the various loadings are shown in Figure 4. For comparison, the corresponding two-dimensional distributions as given in Reference 3 are also plotted.

The second set of calculations was made for a five-bladed propeller with symmetrical blades. The blade outline, pitch distribution, and radial bound circulation distribution are the same as those of Propeller 3916A of Reference 2 except that the chordwise loading has been arbitrarily changed from $a = 1.0$ to $a = 0.8, a = 0.6, a = 0.4,$ and $a = 0.2$. The propellers for these cases are designated as 3916D, 3916E, 3916F, and 3916G, respectively. The results are shown in Tables 1 through 4. For

comparison, the chordwise distributions of the camber for these propellers at $r/R = 0.7$ are plotted in Figure 5. Similarly, another set of calculations was made for a propeller with skewed blades, which is the same as Propeller 3917A of Reference 2 except for the chordwise loading. The propeller designations for these cases are 3917D, 3917E, 3917F, and 3917G. The calculated camber ratio distributions are shown in Table 5. Figures 6, 7, and 8 show the relative camber distribution of the various cases at various radii for the various lift coefficients shown in terms of the maximum camber of $a = 1.0$. The curves are plotted with the nose-tail line as reference. The ideal angle of attack shown is the one between the helical chord line and the nose-tail reference line. Also shown on these figures are the two-dimensional results. The ideal angle of attack for the symmetrical and skewed propeller blades at various radii for various a values is shown in Figure 9 and is compared with the two-dimensional data corrected to the same lift coefficients in Table 6.

From these comparisons, note that the calculated camber lines at the middle portion of the fictitious narrow rectangular blades are fairly close to the two-dimensional data. For blades of usual propeller shape, however, taking into account the blade shape and the free circulation, the calculated camber lines are somewhat different from those of the two-dimensional cases; these differences are even greater at regions nearing the hub and tip. Figures 6, 7, 8, and 9, and Tables 1 through 5 show that the effect of skew is considerable.

ANGLE OF ATTACK

Calculations have also been made for the abovementioned fictitious narrow rectangular blade of aspect ratio 10 with chordwise load distribution similar to that due to an angle of attack. The calculated results are given in Figure 10. Again, the curves show fairly good agreement with the two-dimensional flat plate. However, the same cannot be said for a blade of usual propeller shape, as is evident from the set of curves shown on the figure representing Propeller 3916J. This propeller is the same as Propeller 3916A in all respects except that the chordwise loading has been arbitrarily changed from uniform to that corresponding to an angle of attack. The calculated results are shown in Table 7. The difference

between this three-dimensional case and the two-dimensional flat plate case is appreciable and represents the three-dimensionality effect of this particular propeller blade.

SINUSOIDAL DISTRIBUTION

Another sample calculation is for Propeller 3916K which is similar to Propeller 3916A except its chordwise loading is sinusoidal, the first term of the sine series. The results of this calculation are shown in Table 8. Figure 11 compares the induced velocities and the camber distributions of this propeller and Propeller 3916A, which has a uniform chordwise loading.

SUPERCAVITATING PROPELLERS

An inspection of the assumed form of the chordwise circulation function of Equation [I] indicates that the loading over the blade can be arbitrarily assigned by adjusting the number of terms and the values of the various coefficients. This flexibility makes it possible to use the computer program in the design calculation of supercavitating propellers. In the two-dimensional analysis, there are a few well-known load distributions which give low drag supercavitating hydrofoils at zero cavitation number. These are the so-called Tulin-Burkhard 2-term, and the Johnson 3- and 5-term foils where theoretical characteristics have been established.⁴ Calculations for propellers having chordwise loading similar to these foils were made using the new computer program. The outline of the blade has been assumed to be rectangular with an aspect ratio of 10 and zero hydrodynamic pitch and a constant bound circulation distribution along the radius to simulate as closely as possible the two-dimensional case. The calculated camber ratios are shown in Tables 9, 10, and 11. The comparative values of the "camber ratio to design life coefficient ratios" at $r/R = 0.3$, 0.6 , and 0.9 , are plotted in Figure 12. For comparison, the two-dimensional data of Reference 4 are also shown in this figure. The agreement between results of the approximate two-dimensional rectangular blade and those of the true two-dimensional is considered quite good, even though there is discrepancy in the regions nearing the hub and tip, $r/R = 0.3$ and $r/R = 0.9$, which could well be expected.

DISCUSSION

The preceding sample calculations were presented to provide a clearer picture of the effect of chordwise loading on the mean line distribution.

The following discussion concerns the results of these limited sample calculations:

In general, the effect of chordwise load distribution on blade geometry is not negligible.

For chordwise loading corresponding to NACA $a < 1.0$ mean lines, the calculated camber distribution and angle of attack are different from those based on the two-dimensional cases, even though the relative effect on the mean line distributions in the middle portion of the blade are not too much different from those of two-dimensional cases.

Skew of the blade materially affects the mean line distribution as well as the angle of attack.

The program as developed may be used for calculations of propellers with various chordwise load distributions and may also be used for the design of supercavitating foils not taking into account the cavity thickness effect.

CONCLUDING REMARKS

A method for correcting the propeller blade geometry for the three-dimensionality of the flow has been given for the case of arbitrary chordwise load distribution. This report and TMB Report 1802² complete the discussions on the numerical computational procedure for the hydrodynamic aspect of propeller design based on lifting-surface theory using Pien's scheme.

Both Reference 2 and this present report have shown that three-dimensionality has considerable effect on blade geometry. Many contributing factors, such as number of blades, blade outline, pitch distribution, radial load distribution, and chordwise load distribution, come into play. The contributions of each of these parameters may vary depending on the nature of the problem or on the combinations of these parameters. It appears that, when practicable, each problem should be treated individually.

It is hoped that the computer program as developed can serve as a useful tool to provide propeller designers with a method for obtaining the blade geometry for certain prescribed chordwise load distributions. This program may also be used in the design calculations of supercavitating blades. Experimental verification of this design method has been contemplated and test results of propeller models designed using this method will be reported when available.

Since computers may not always be accessible to propeller designers, it may be advisable to devise some correction factors, taking into account three-dimensionality using two-dimensional data as a basis for a limited number of cases. This work will be deferred until a satisfactory program is developed for the inverse problem of predicting performance for a given propeller in steady flow. At that time the effect on pressure distribution due to variations in blade geometry can be calculated. If pressure distribution is not too sensitive to the changes of camber distributions, then the use of such correction factors would be justified, otherwise their use would lead to unsatisfactory pressure distributions.

It should be noted that the thickness effect has not been included. As brought out in Reference 2, recent work by Kerwin and Leopold may be incorporated to take account of the thickness effect.

The work on the inverse problems of predicting performance for a given propeller design in steady and unsteady flows is underway; results will be reported soon.

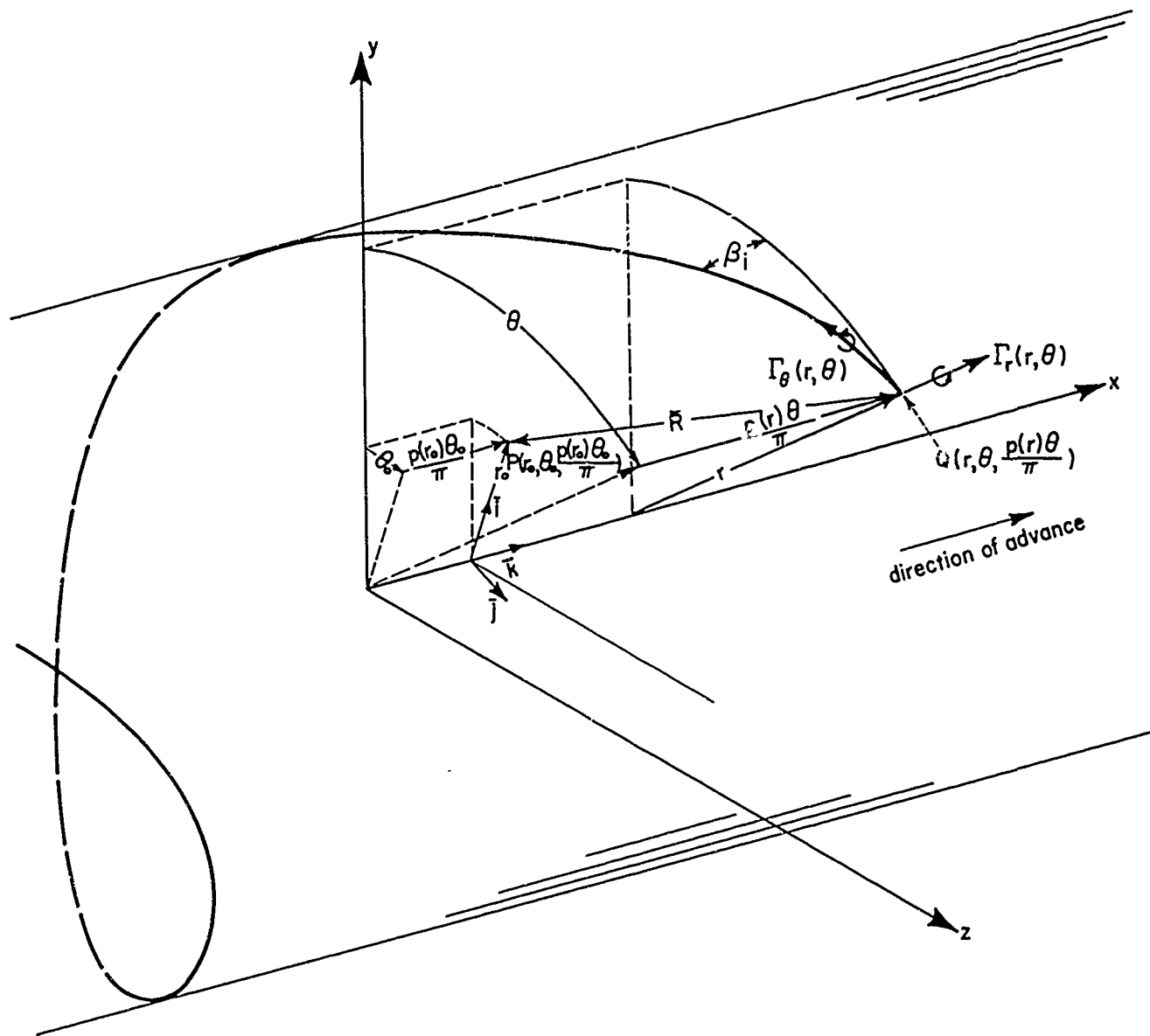
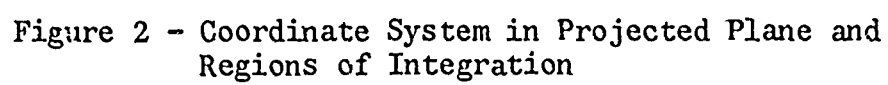
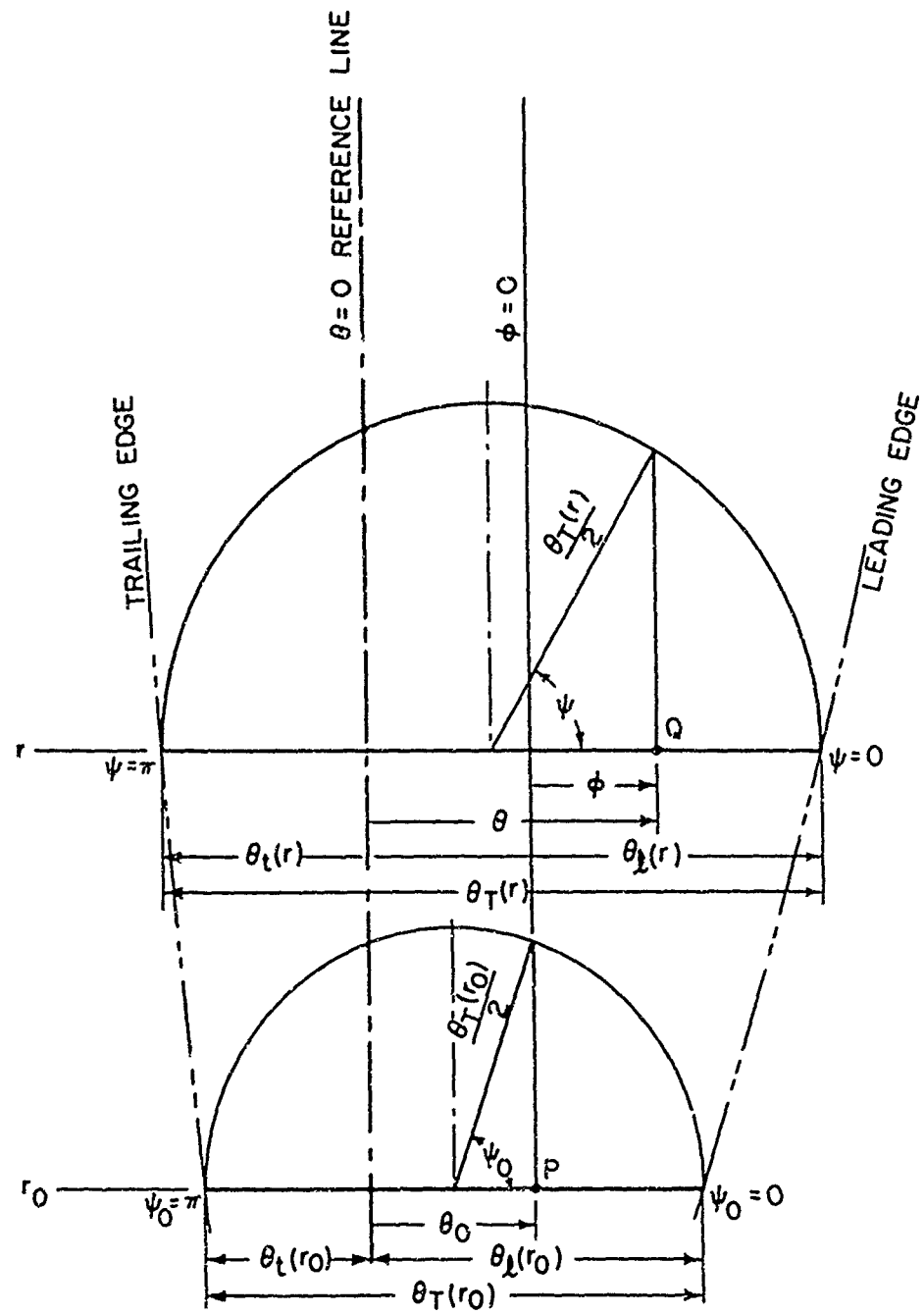


Figure 1 - Coordinate System





$$\theta = \theta_l(r) - \frac{\theta_T(r)}{2} (1 - \cos \psi) ; \quad \psi = \cos^{-1} \left\{ 1 - \frac{2}{\theta_T(r)} [\theta_l(r) - \theta] \right\}$$

$$\phi = \theta - \theta_0$$

$$\psi = \cos^{-1} \left\{ 1 - \frac{2}{\theta_T(r)} \left[\theta_l(r) - \theta_l(r_0) - \phi + \frac{\theta_T(r_0)}{2} (1 - \cos \psi_0) \right] \right\}$$

Figure 3 - Chordwise Coordinate Systems

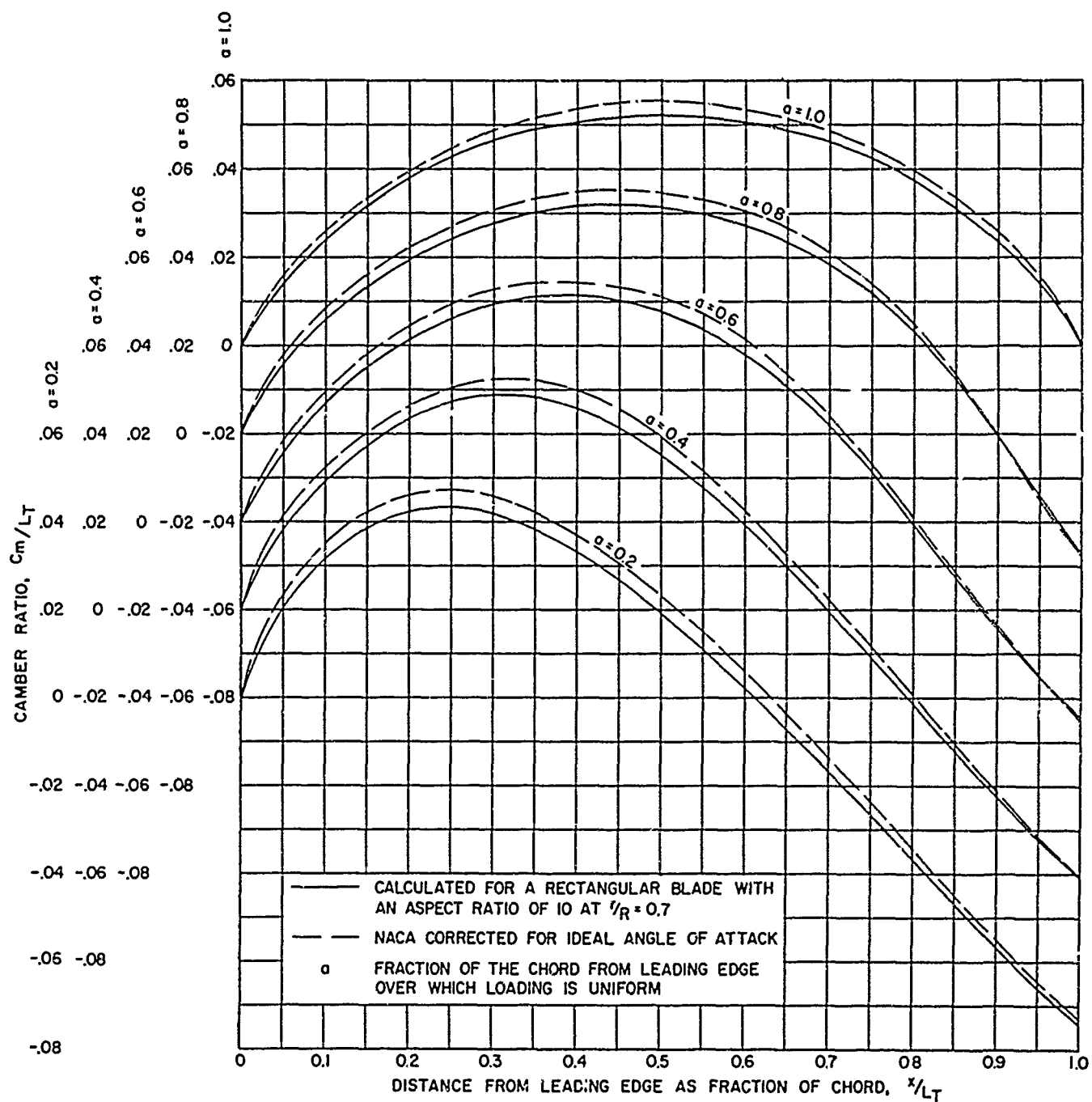


Figure 4 - Camber Lines for a Rectangular Propeller Blade with Various. Chordwise Load Distributions Corresponding to NACA $a = 1.0$, 0.8 , 0.6 , 0.4 , and 0.2 at $C_{\ell_i} = 1.0$

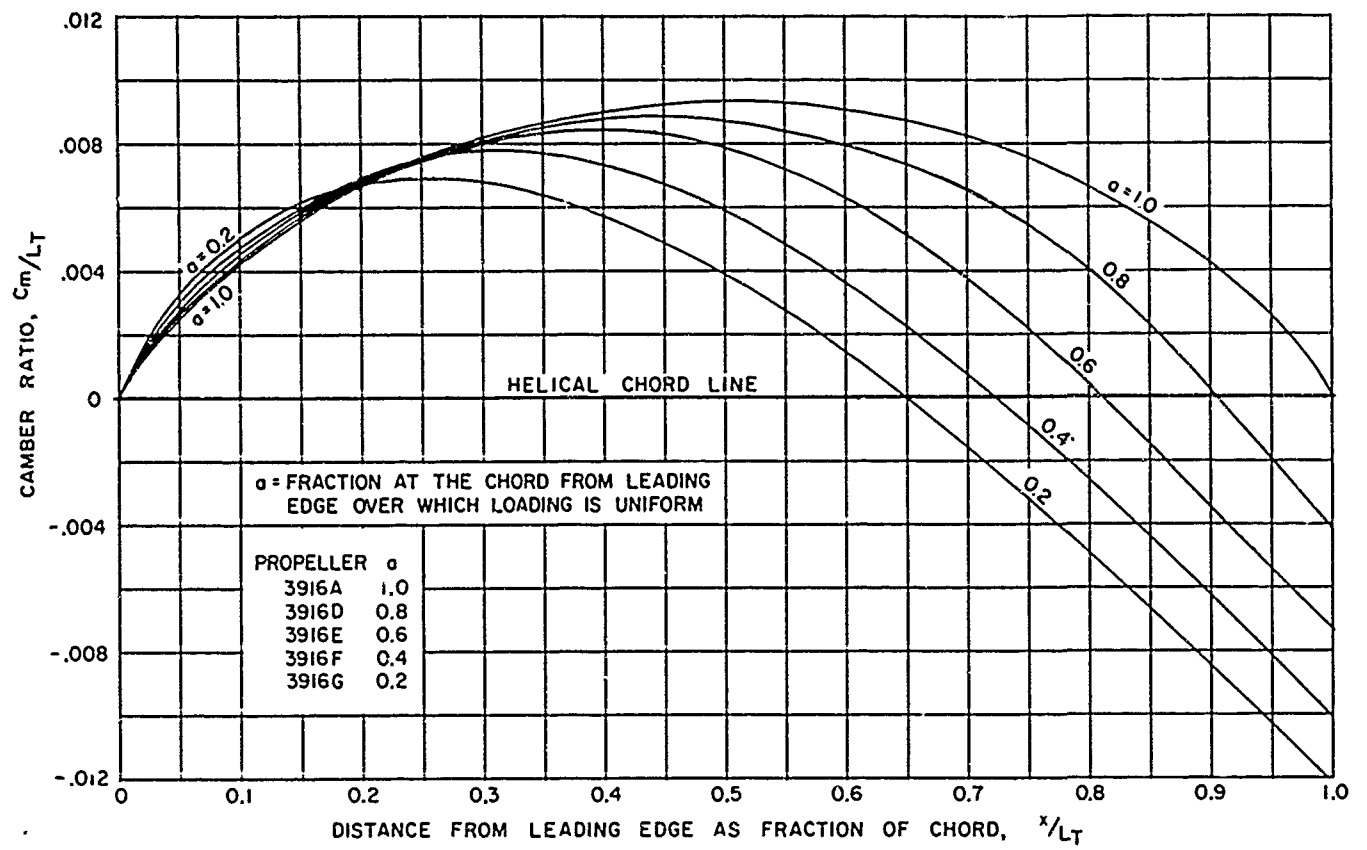


Figure 5 - Camber Distributions at $r/R = 0.7$ of Propellers 3916A, 3916D, 3916E, 3916F, and 3916G

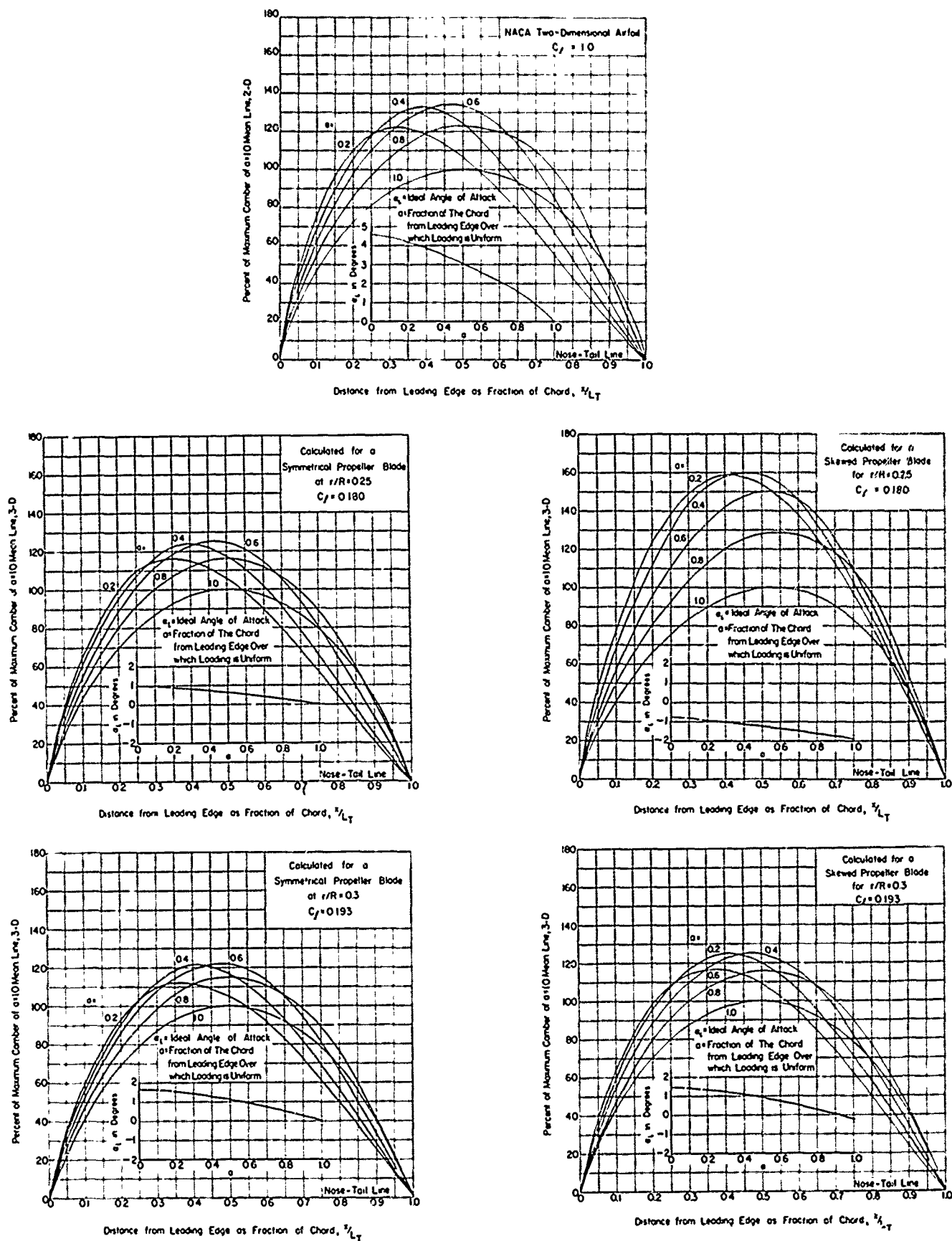


Figure 6 - Relative Camber Distributions of Three-Dimensional Blades (Symmetrical and Skewed) and NACA Two-Dimensional Airfoil with Various Chordwise Load Distributions Corresponding to NACA $a = 1.0, 0.8, 0.6, 0.4$, and 0.2 at $r/R = 0.25$ and 0.3

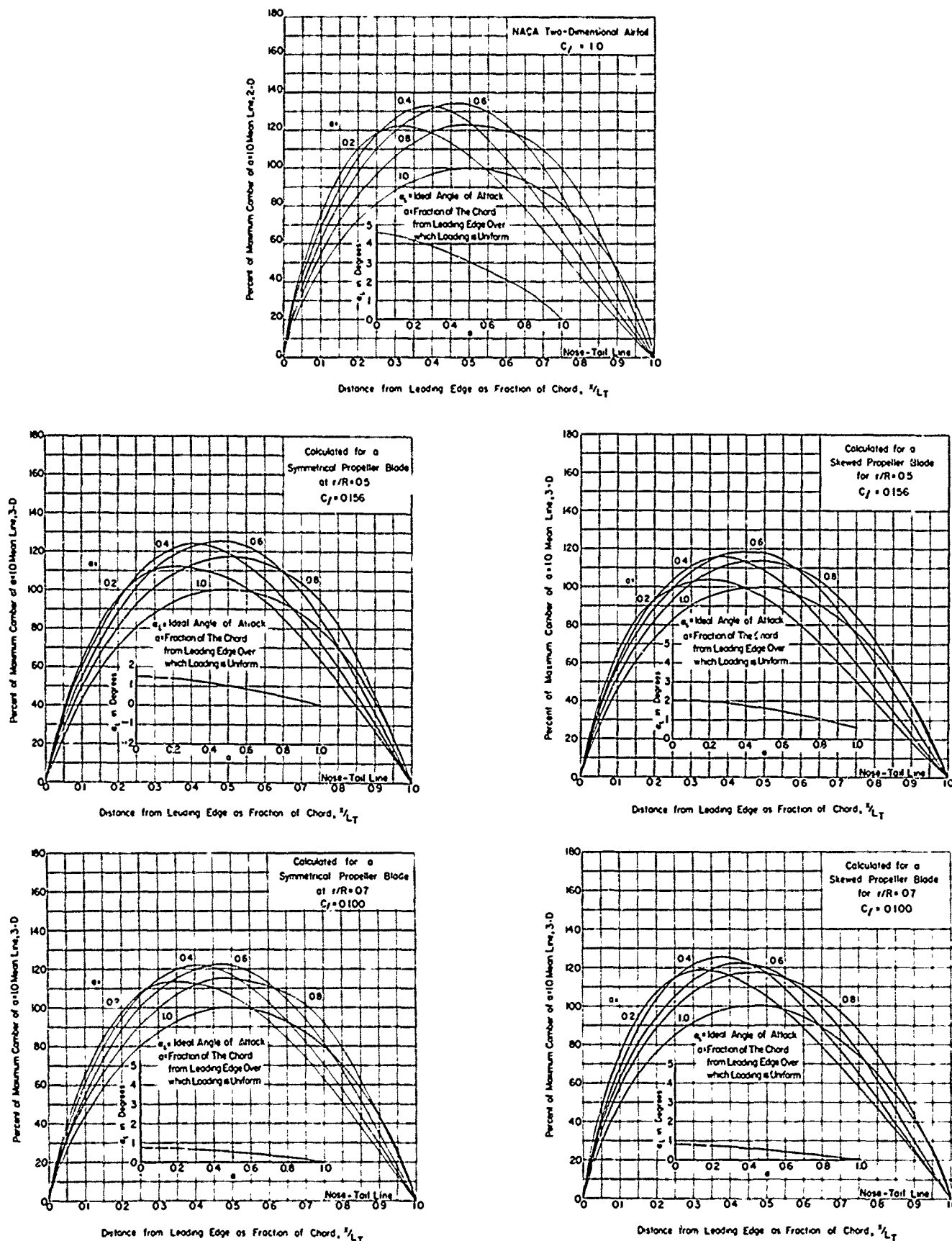


Figure 7 - Relative Camber Distributions of Three-Dimensional Blades (Symmetrical and Skewed) and NACA Two-Dimensional Airfoil with Various Chordwise Load Distributions Corresponding to NACA $a = 1.0, 0.8, 0.6, 0.4$, and 0.2 at $r/R = 0.5$ and 0.7

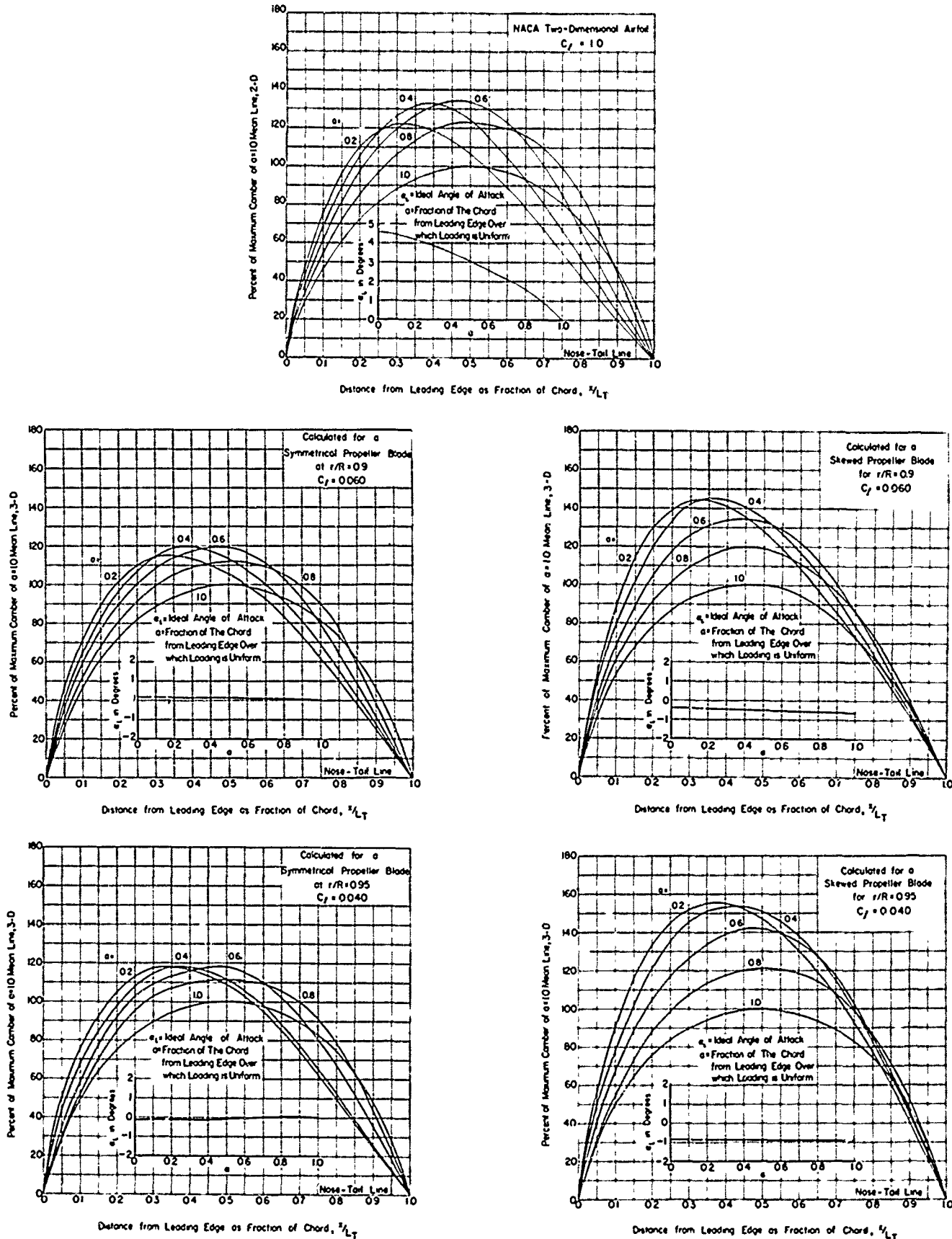


Figure 8 - Relative Camber Distributions of Three-Dimensional Blades (Symmetrical and Skewed) and NACA Two-Dimensional Airfoil with Various Chordwise Load Distributions Corresponding to NACA $a = 1.0, 0.8, 0.6, 0.4,$ and 0.2 at $r/R = 0.9$ and 0.95

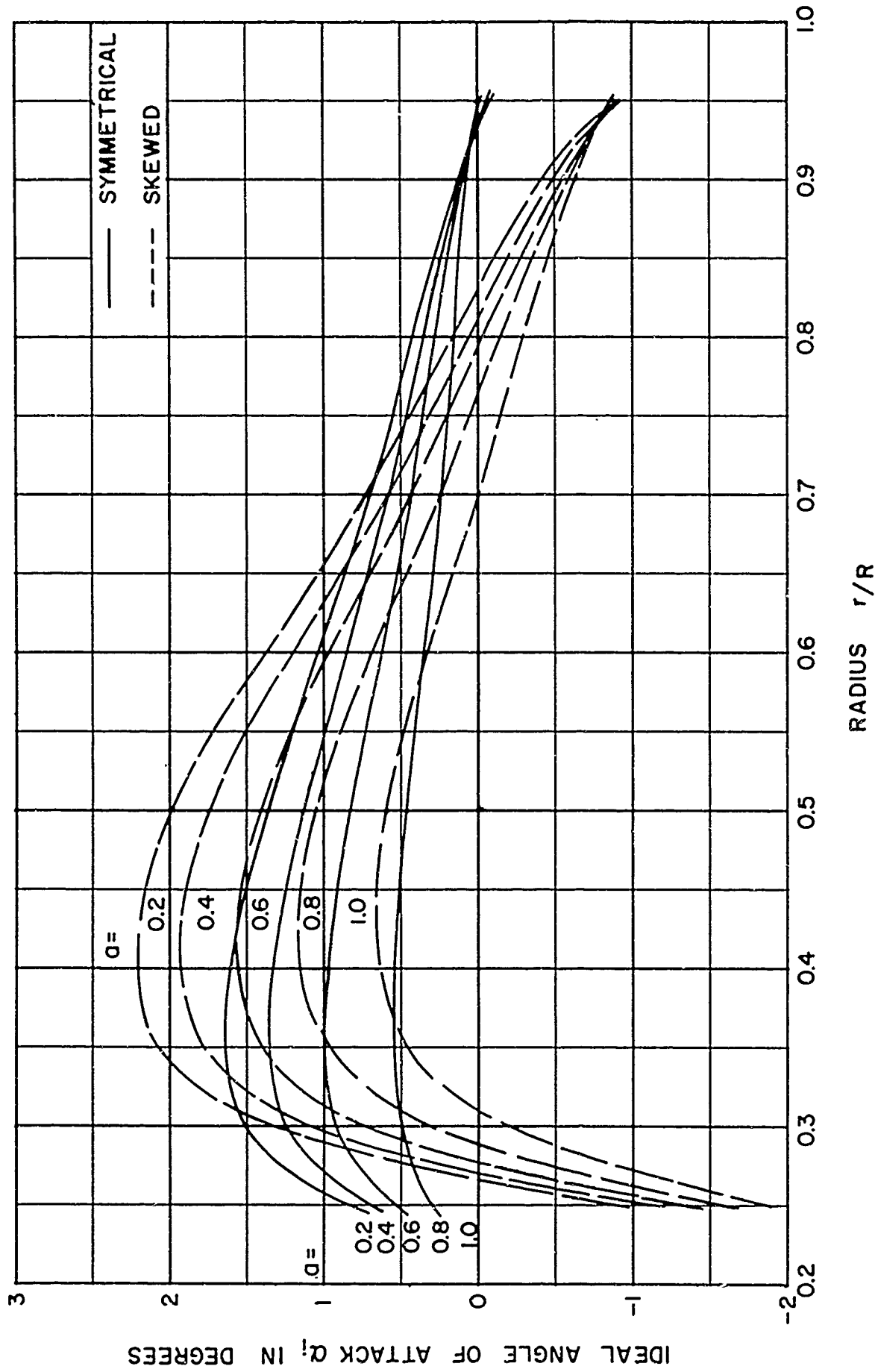


Figure 9 - Comparison of Ideal Angle of Attack, Symmetrical versus Skewed Propeller Blade, for Various Chordwise Load Distributions Corresponding to NACA $a = 1.0, 0.8, 0.6, 0.4, \text{ and } 0.2$

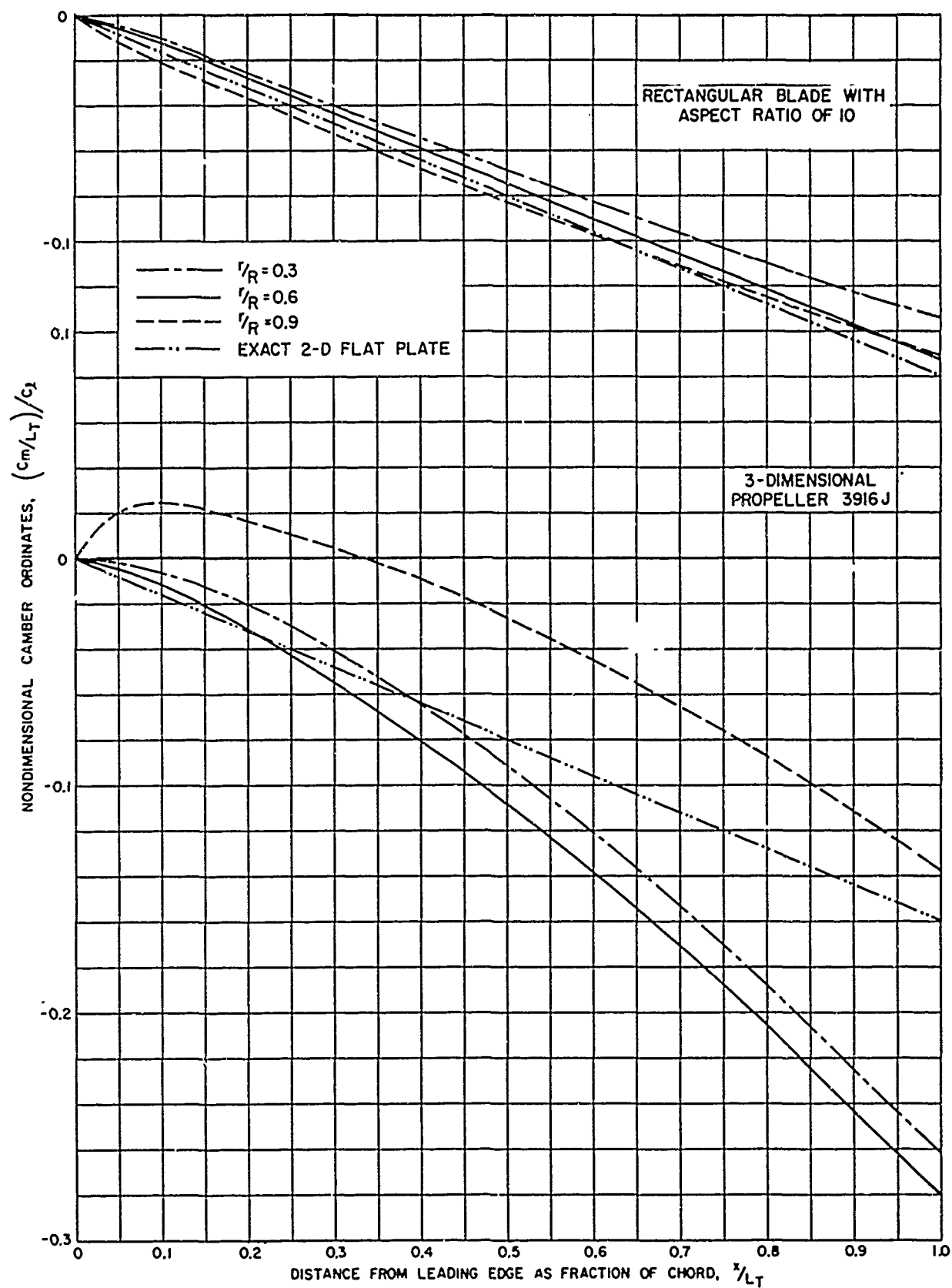


Figure 10 - Comparisons of Camber Distributions due to Angle of Attack of a Rectangular Blade and a Three-Dimensional Propeller (3916J) with a Two-Dimensional Flat Plate

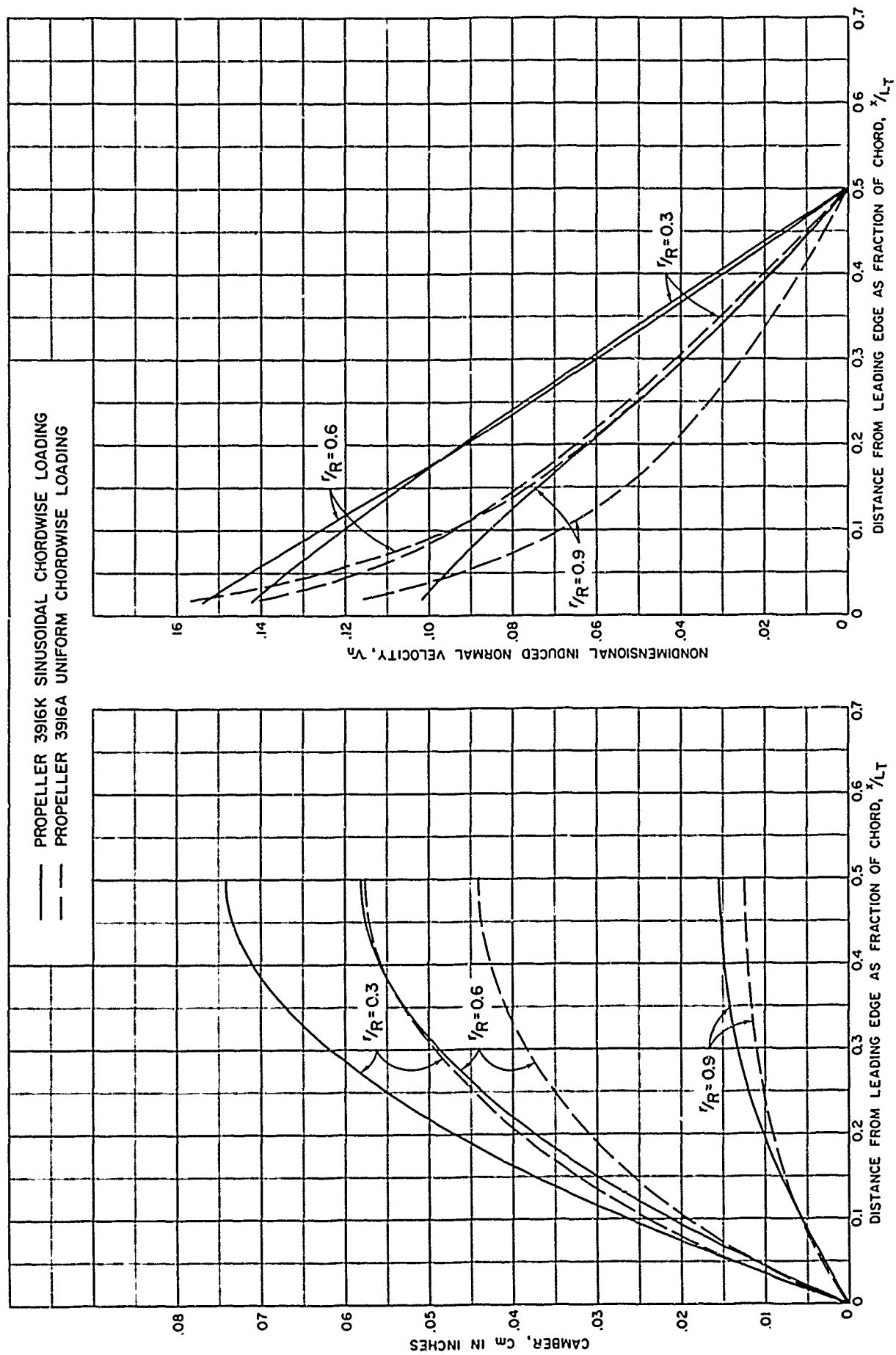


Figure 11 - Comparisons of Induced Normal Velocities and Camber Distributions, Uniform versus Sinusoidal Chordwise Loading

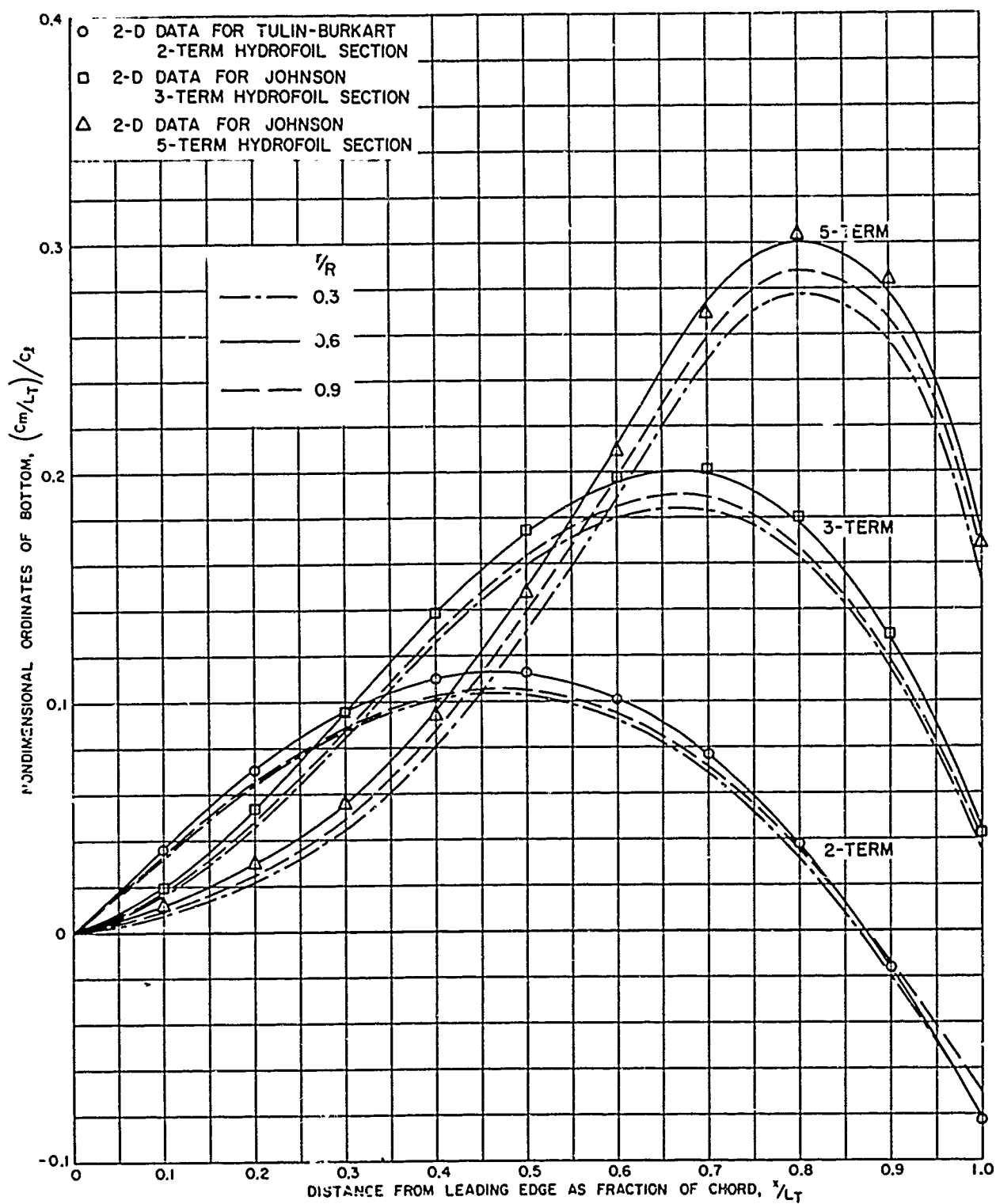


Figure 12 - Comparisons of Rectangular Supercavitating Blades with Various Chordwise Load Distributions at Zero Cavitation Number

TABLE 1
Calculated Induced Velocities and Camber Distributions for
Propeller 3916D, $a = 0.8$

CAMBER DISTRIBUTION PROPELLER 3916D A=0.8 XPLA(1-12-64)									
INPUT DATA									
18									
0.00500	0.10000	2.00000	0.15000	0.00000					
0.00500	0.01000	0.01000	0.02000	0.03510	0.05000	0.07000	0.09000	0.12900	Card 1 (see Appendix A for explanation)
0.17000	0.22000	0.20000	0.35200	0.44000	0.55200	0.70900	0.94500	1.00000	Card 2
0.01986	0.10166	0.23724	0.40828	0.59172	0.76276	0.89834	0.98014	0.99000	Card 3
0.01000	0.10000	0.20000	0.35000	0.50000	0.65000	0.80000	0.90000	0.99000	Card 5
0.20000	0.30000	0.40000	0.50000	0.60000	0.70000	0.80000	0.90000	1.00000	Card 6
0.15400	0.16600	0.21500	0.23100	0.23200	0.21750	0.18500	0.13400	0.02000	Card 7
0.30800	0.37200	0.43000	0.46200	0.46400	0.43500	0.37000	0.26800	0.04000	Card 8
1.86210	1.22835	0.90766	0.70429	0.56622	0.46392	0.38698	0.32722	0.27960	r
0.01695	0.02214	0.02371	0.02230	0.01883	0.01414	0.00856	0.00000	0.00000	$L_f(r)/D$
0.25000	0.30000	0.40000	0.50000	0.60000	0.70000	0.80000	0.90000	0.95000	$L_t(r)/D$
1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	$\tan \beta_f(r)$
0.14500	0.16902	0.20861	0.22173	0.20765	0.17661	0.13584	0.08937	0.06500	$\Gamma(r)$
0.16010	0.16676	0.16039	0.13704	0.10517	0.07483	0.04889	0.02767	0.01770	r_0
1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	$V_x(r_0)$
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	$u_a(r_0)$
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	$u_t(r_0)$
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	Card 8A
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	$C_0(r)$
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	$A_0(r)$
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	$C_1(r)$
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	$A_1(r)$
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	$A_2(r)$
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	$A_3(r)$
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	$A_4(r)$
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	$A_5(r)$
1.00000	0.82400	8.00000	1.00000	1.00000	0.00000	0.00000	0.00000	0.00000	Card 9
OUTPUT DATA									
AXIAL INDUCED VELOCITY COMPONENT									
	RX/RB	0.2500	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9500
X/LT									
0.0199		0.0471	0.0695	0.1124	0.1328	0.1402	0.1381	0.1401	0.1202
0.1017		0.0277	0.0558	0.0659	0.0781	0.0813	0.0777	0.0740	0.0681
0.2372		0.0145	0.0301	0.0334	0.0393	0.0410	0.0347	0.0373	0.0339
0.4083		0.0026	0.0051	0.0041	0.0048	0.0056	0.0061	0.0069	0.0071
0.5917		-0.0094	-0.0206	-0.0253	-0.0297	-0.0297	-0.0262	-0.0224	-0.0167
0.7628		-0.0242	-0.0501	-0.0613	-0.0719	-0.0728	-0.0666	-0.0597	-0.0499
0.8983		-0.0394	-0.0798	-0.1020	-0.1200	-0.1220	-0.1135	-0.1024	-0.0871
0.9801		-0.0368	-0.0790	-0.1034	-0.1224	-0.1234	-0.1128	-0.0993	-0.0799
TANGENTIAL INDUCED VELOCITY COMPONENT									
	RX/RB	0.2500	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9500
X/LT									
0.0199		-0.0808	-0.1169	-0.1043	-0.0930	-0.0777	-0.0623	-0.0528	-0.0387
0.1017		-0.0506	-0.0746	-0.0626	-0.0554	-0.0454	-0.0352	-0.0279	-0.0219
0.2372		-0.0277	-0.0411	-0.0326	-0.0285	-0.0233	-0.0178	-0.0142	-0.0111
0.4083		-0.0055	-0.0073	-0.0045	-0.0039	-0.0034	-0.0030	-0.0028	-0.0026
0.5917		0.0175	0.0278	0.0241	0.0212	0.0166	0.0118	0.0082	0.0051
0.7628		0.0442	0.0671	0.0581	0.0511	0.0406	0.0300	0.0221	0.0156
0.8983		0.0693	0.1045	0.0946	0.0838	0.0671	0.0505	0.0378	0.0274
0.9801		0.0644	0.1028	0.0949	0.0845	0.0670	0.0495	0.0361	0.0247
INDUCED DOWNWASH DUE TO FIRST BLADE ONLY									
	RX/RB	0.2500	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9500
X/LT									
0.0199		0.0933	0.1472	0.1533	0.1622	0.1603	0.1515	0.1497	0.1263
0.1017		0.0574	0.0931	0.0909	0.0957	0.0932	0.0853	0.0791	0.0716
0.2372		0.0311	0.0508	0.0466	0.0486	0.0472	0.0426	0.0399	0.0357
0.4083		0.0060	0.0089	0.0061	0.0061	0.0065	0.0067	0.0074	0.0076
0.5917		-0.0198	-0.0346	-0.0350	-0.0365	-0.0340	-0.0288	-0.0238	-0.0174
0.7628		-0.0502	-0.0837	-0.0844	-0.0882	-0.0834	-0.0730	-0.0637	-0.0523
0.8983		-0.0796	-0.1314	-0.1392	-0.1464	-0.1393	-0.1242	-0.1091	-0.0913
0.9801		-0.0742	-0.1296	-0.1403	-0.1487	-0.1404	-0.1232	-0.1056	-0.0836
	RX/RB	0.2500	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9500
P/D		1.1560	1.1577	1.1406	1.1063	1.0673	1.0202	0.9726	0.9252
L.E.		1.3607	1.4880	1.7200	1.8480	1.8560	1.7400	1.4800	1.0720
CHRD		2.7213	2.9760	3.4400	3.6960	3.7120	3.4800	2.9600	2.1440
CAMBER DISTRIBUTION									
X/LT									
0.0100		0.0020	0.0032	0.0032	0.0031	0.0027	0.0021	0.0016	0.0009
0.1000		0.0154	0.0245	0.0242	0.0233	0.0199	0.0152	0.0111	0.0062
0.2000		0.0244	0.0392	0.0377	0.0362	0.0307	0.0233	0.0168	0.0096
0.3500		0.0319	0.0515	0.0484	0.0464	0.0393	0.0297	0.0213	0.0122
0.5000		0.0330	0.0529	0.0491	0.0469	0.0399	0.0303	0.0220	0.0127
0.6500		0.0278	0.0439	0.0402	0.0384	0.0330	0.0256	0.0190	0.0113
0.8000		0.0153	0.0229	0.0198	0.0190	0.0172	0.0143	0.0116	0.0074
0.9000		0.0016	0.0002	-0.0030	-0.0027	-0.0007	0.0012	0.0029	0.0027
0.9900		-0.0124	-0.0234	-0.0275	-0.0263	-0.0201	-0.0129	-0.0063	-0.0022
CAMBER RATIOS									
X/LT									
0.0100		0.0007	0.0011	0.0009	0.0008	0.0007	0.0006	0.0005	0.0004
0.1000		0.0057	0.0082	0.0070	0.0063	0.0053	0.0044	0.0038	0.0029
0.2000		0.0090	0.0132	0.0110	0.0098	0.0083	0.0067	0.0057	0.0045
0.3500		0.0117	0.0173	0.0141	0.0125	0.0106	0.0085	0.0072	0.0057
0.5000		0.0121	0.0178	0.0143	0.0127	0.0107	0.0087	0.0074	0.0059
0.6500		0.0102	0.0147	0.0117	0.0104	0.0089	0.0074	0.0064	0.0053
0.8000		0.0056	0.0077	0.0057	0.0052	0.0046	0.0041	0.0039	0.0035
0.9000		0.0006	0.0001	-0.0009	-0.0007	-0.0002	0.0003	0.0010	0.0013
0.9900		-0.0045	-0.0079	-0.0080	-0.0071	-0.0054	-0.0037	-0.0021	-0.0010

NOTES: 1. Calculation based on one blade only
2. Calculated camber in inches

TABLE 3
Calculated Induced Velocities and Camber Distributions for
Propeller 3916F, $\alpha = 0.4$

CAMBER DISTRIBUTION PROPELLER 3916F $\alpha = 0.4$ XPLA(1-12-64)

INPUT DATA

```

18
0.00500 0.10000 2.00000150.00000
0.00500 0.01000 0.01600 0.02400 0.03510 0.05000 0.07000 0.09600 0.12900
0.17000 0.22000 0.28000 0.35200 0.44000 0.55200 0.70900 0.94500 1.00000

8 9 1 9 0 0 0 40
0.01986 0.10166 0.23724 0.40828 0.59172 0.76276 0.89834 0.98014
0.01000 0.10000 0.20000 0.35000 0.50000 0.65000 0.80000 0.90000 0.99000
0.20000 0.30000 0.40000 0.50000 0.60000 0.70000 0.80000 0.90000 1.00000
0.15400 0.18600 0.21500 0.23100 0.23200 0.21750 0.18500 0.13400 0.02000
0.30800 0.37200 0.43000 0.46200 0.46400 0.43500 0.37000 0.26800 0.04000
1.86210 1.22835 0.90766 0.70429 0.56622 0.46392 0.38698 0.32722 0.27960
0. 0.01695 0.02214 0.02371 0.02230 0.01883 0.01414 0.00856 0.
0.25000 0.30000 0.40000 0.50000 0.60000 0.70000 0.80000 0.90000 0.95000
1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000
0.14600 0.16902 0.20861 0.22173 0.20765 0.17661 0.13584 0.08937 0.06500
0.16010 0.16678 0.16039 0.13704 0.10517 0.07483 0.04889 0.02767 0.01770
1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000
0. -0. -0. -0. -0. -0. -0. -0. -0.
0. -0. -0. -0. -0. -0. -0. -0. -0.
0. -0. -0. -0. -0. -0. -0. -0. -0.
0. -0. -0. -0. -0. -0. -0. -0. -0.
0. -0. -0. -0. -0. -0. -0. -0. -0.
0. -0. -0. -0. -0. -0. -0. -0. -0.
0. -0. -0. -0. -0. -0. -0. -0. -0.
1 1.00000 0.82400 8.00000 1.00000 1.00000 0.

```

Card 1 (see Appendix A for explanation)

Card 2

Card 3

Card 5

Card 6

Card 7

Card 8

Card 8A

Card 9

r
 $L_1(r)/D$
 $L_2(r)/D$
 $\tan \beta_1(r)$
 $\Gamma(r)$
 r_0
 $V_x(r_0)$
 $u_a(r_0)$
 $u_t(r_0)$
 $C_0(r)$
 $A_0(r)$
 $C_x(r)$
 $A_1(r)$
 $A_2(r)$
 $A_3(r)$
 $A_4(r)$
 $A_5(r)$

OUTPUT DATA

AXIAL INDUCED VELOCITY COMPONENT

RX/RB	0.2500	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9000	0.9500
X/LT	0.0199	0.0539	0.0976	0.1211	0.1431	0.1536	0.1554	0.1639	0.1657
0.1017	0.0288	0.0539	0.0610	0.0721	0.0774	0.0771	0.0780	0.0773	0.0784
0.2372	0.0109	0.0198	0.0175	0.0205	0.0237	0.0252	0.0290	0.0315	0.0333
0.4083	-0.0095	-0.0193	-0.0295	-0.0342	-0.0323	-0.0270	-0.0193	-0.0107	-0.0004
0.5917	-0.0250	-0.0506	-0.0664	-0.0771	-0.0760	-0.0672	-0.0557	-0.0406	-0.0229
0.7628	-0.0313	-0.0663	-0.0858	-0.1006	-0.0999	-0.0890	-0.0754	-0.0579	-0.0379
0.8983	-0.0319	-0.0712	-0.0933	-0.1102	-0.1093	-0.0973	-0.0817	-0.0624	-0.0409
0.9801	-0.0296	-0.0696	-0.0920	-0.1090	-0.1077	-0.0945	-0.0773	-0.0552	-0.0324

TANGENTIAL INDUCED VELOCITY COMPONENT

RX/RB	0.2500	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9000	0.9500
X/LT	0.0199	-0.0928	-0.1283	-0.1131	-0.1007	-0.0855	-0.0706	-0.0625	-0.0475
0.1017	-0.0531	-0.0733	-0.0589	-0.0519	-0.0438	-0.0355	-0.0300	-0.0256	-0.0242
0.2372	-0.0215	-0.0281	-0.0186	-0.0159	-0.0143	-0.0123	-0.0119	-0.0111	-0.0110
0.4083	0.0157	0.0249	0.0265	0.0233	0.0172	0.0113	0.0062	0.0024	-0.0011
0.5917	0.0444	0.0675	0.0622	0.0543	0.0419	0.0296	0.0200	0.0119	0.0055
0.7628	0.0559	0.0877	0.0800	0.0704	0.0586	0.0392	0.0271	0.0173	0.0097
0.8983	0.0542	0.0924	0.0857	0.0763	0.0594	0.0424	0.0291	0.0186	0.0104
0.9801	0.0514	0.0894	0.0838	0.0750	0.0582	0.0409	0.0272	0.0161	0.0076

INDUCED DOWNWASH DUE TO FIRST BLADE ONLY

RX/RB	0.2500	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9000	0.9500
X/LT	0.0199	0.1071	0.1612	0.1657	0.1750	0.1758	0.1707	0.1754	0.1532
0.1017	0.0601	0.0909	0.0847	0.0889	0.0889	0.0848	0.0836	0.0814	0.0820
0.2372	0.0239	0.0343	0.0254	0.0260	0.0276	0.0280	0.0313	0.0334	0.0350
0.4083	-0.0184	-0.0315	-0.0397	-0.0414	-0.0366	-0.0292	-0.0202	-0.0109	-0.0001
0.5917	-0.0510	-0.0843	-0.0909	-0.0943	-0.0868	-0.0734	-0.0592	-0.0423	-0.0235
0.7628	-0.0639	-0.1099	-0.1173	-0.1228	-0.1140	-0.0972	-0.0801	-0.0604	-0.0391
0.8983	-0.0645	-0.1168	-0.1267	-0.1340	-0.1244	-0.1061	-0.0867	-0.0651	-0.0421
0.9801	-0.0593	-0.1133	-0.1244	-0.1323	-0.1224	-0.1029	-0.0819	-0.0575	-0.0333

RX/RB	0.2500	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9000	0.9500
P/D	1.1560	1.1577	1.1406	1.1063	1.0673	1.0202	0.9726	0.9252	0.8976
L.E.	1.3607	1.4880	1.7200	1.8480	1.8560	1.7400	1.4800	1.0720	0.7472
CHORD	2.7213	2.9740	3.4400	3.6960	3.7120	3.4800	2.9600	2.1440	1.4943

CAMBER DISTRIBUTION

X/LT	0.0100	0.0024	0.0036	0.0034	0.0035	0.0030	0.0024	0.0019	0.0011	0.0006
0.1000	0.0172	0.0259	0.0250	0.0240	0.0209	0.0165	0.0126	0.0074	0.0046	0.0046
0.2000	0.0261	0.0393	0.0365	0.0349	0.0303	0.0240	0.0183	0.0111	0.0071	0.0071
0.3500	0.0304	0.0451	0.0394	0.0377	0.0333	0.0268	0.0210	0.0132	0.0087	0.0087
0.5000	0.0240	0.0342	0.0268	0.0256	0.0240	0.0206	0.0177	0.0119	0.0085	0.0085
0.6500	0.0098	0.0108	0.0023	0.0024	0.0055	0.0078	0.0099	0.0083	0.0073	0.0073
0.8000	-0.0083	-0.0201	-0.0296	-0.0279	-0.0188	-0.0092	-0.0006	0.0032	0.0051	0.0051
0.9000	-0.0211	-0.0427	-0.0531	-0.0505	-0.0370	-0.0220	-0.0086	-0.0007	0.0034	0.0034
0.9900	-0.0319	-0.0630	-0.0745	-0.0712	-0.0536	-0.0335	-0.0156	-0.0040	0.0021	0.0021

CAMBER RATIO

X/LT	0.0100	0.0009	0.0012	0.0010	0.0009	0.0008	0.0007	0.0006	0.0005	0.0004
0.1000	0.0063	0.0087	0.0073	0.0065	0.0056	0.0047	0.0043	0.0035	0.0031	0.0031
0.2000	0.0096	0.0132	0.0104	0.0094	0.0082	0.0069	0.0062	0.0052	0.0047	0.0047
0.3500	0.0112	0.0151	0.0115	0.0102	0.0090	0.0077	0.0071	0.0062	0.0058	0.0058
0.5000	0.0088	0.0115	0.0078	0.0069	0.0065	0.0059	0.0060	0.0056	0.0057	0.0057
0.6500	0.0036	0.0036	0.0007	0.0007	0.0015	0.0022	0.0033	0.0039	0.0049	0.0049
0.8000	-0.0031	-0.0067	-0.0086	-0.0075	-0.0051	-0.0026	-0.0002	0.0015	0.0034	0.0034
0.9000	-0.0077	-0.0143	-0.0154	-0.0137	-0.0100	-0.0063	-0.0029	-0.0003	0.0023	0.0023
0.9900	-0.0117	-0.0212	-0.0217	-0.0193	-0.0144	-0.0096	-0.0053	-0.0019	0.0014	0.0014

NOTES: 1. Calculation based on one blade only

2. Calculated camber in inches

TABLE 4
Calculated Induced Velocities and Camber Distributions for
Propeller 3916G, $a = 0.2$

CAMBER DISTRIBUTION PROPELLER 3916G $A=0.2$ XPLA(1-12-64)

INPUT DATA

```

0.00500 0.10000 2.00000 150.00000
0.00500 0.01000 0.01600 0.02400 0.03510 0.05000 0.07000 0.09400 0.12900
0.17000 0.22000 0.28000 0.35200 0.44000 0.55200 0.70900 0.94500 1.00000
0.01984 0.10166 0.23724 0.40828 0.59172 0.74274 0.89834 0.98014
0.01000 0.10000 0.20000 0.35000 0.50000 0.65000 0.80000 0.90000 0.99000
0.20000 0.30000 0.40000 0.50000 0.60000 0.70000 0.80000 0.90000 1.00000
0.15400 0.18600 0.21500 0.23100 0.23200 0.21750 0.18500 0.13400 0.02000
0.30800 0.37200 0.43000 0.48200 0.54400 0.63500 0.73000 0.82800 0.94000
1.86210 1.22835 0.90766 0.70429 0.54622 0.44392 0.38698 0.32722 0.27960
0.01695 0.02214 0.02371 0.02230 0.01883 0.01614 0.00854 0.
0.25000 0.30000 0.40000 0.50000 0.60000 0.70000 0.80000 0.90000 0.95000
1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000
0.14500 0.16902 0.20861 0.22173 0.20745 0.17461 0.13584 0.08937 0.06500
0.16010 0.16678 0.16039 0.13704 0.10317 0.07483 0.04889 0.02767 0.01770
1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000
0. -0. -0. -0. -0. -0. -0. -0. -0.
0. -0. -0. -0. -0. -0. -0. -0. -0.
0. -0. -0. -0. -0. -0. -0. -0. -0.
0. -0. -0. -0. -0. -0. -0. -0. -0.
0. -0. -0. -0. -0. -0. -0. -0. -0.
0. -0. -0. -0. -0. -0. -0. -0. -0.
0. -0. -0. -0. -0. -0. -0. -0. -0.
0. -0. -0. -0. -0. -0. -0. -0. -0.
1 1.00000 0.82600 8.00000 1.00000 1.00000 0.

```

Card 1 (see Appendix A for explanation)

Card 2

Card 3

Card 4

Card 5

Card 6

Card 7

Card 8

Card 9

Card 10

Card 11

Card 12

Card 13

Card 14

Card 15

Card 16

Card 17

Card 18

Card 19

Card 20

Card 21

Card 22

Card 23

Card 24

Card 25

Card 26

Card 27

Card 28

Card 29

Card 30

Card 31

Card 32

Card 33

Card 34

Card 35

Card 36

Card 37

Card 38

Card 39

Card 40

Card 41

Card 42

Card 43

Card 44

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Card 65

Card 66

Card 67

Card 68

Card 69

Card 70

Card 71

Card 72

Card 73

Card 74

Card 75

Card 76

Card 77

Card 78

Card 79

Card 80

Card 81

Card 82

Card 83

Card 84

Card 85

OUTPUT DATA

AXIAL INDUCED VELOCITY COMPONENT

RX/RB	0.2500	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9000	0.9500
X/LT	0.0199	0.0585	0.1030	0.1267	0.1496	0.1623	0.1646	0.1794	0.1501
0.0199	0.0285	0.0511	0.0555	0.0656	0.0720	0.0738	0.0774	0.0799	0.0847
0.2372	0.0034	0.0057	-0.0023	-0.0024	0.0011	0.0049	0.0120	0.0185	0.0247
0.4083	-0.0188	-0.0294	-0.0431	-0.0499	-0.0479	-0.0409	-0.0309	-0.0193	-0.0055
0.5917	-0.0256	-0.0529	-0.0697	-0.0812	-0.0798	-0.0700	-0.0573	-0.0407	-0.0215
0.7428	-0.0305	-0.0658	-0.0856	-0.1005	-0.0994	-0.0879	-0.0734	-0.0550	-0.0339
0.8983	-0.0308	-0.0699	-0.0918	-0.1084	-0.1072	-0.0947	-0.0785	-0.0585	-0.0361
0.9801	-0.0287	-0.0685	-0.0906	-0.1073	-0.1056	-0.0920	-0.0744	-0.0517	-0.0282

TANGENTIAL INDUCED VELOCITY COMPONENT

RX/RB	0.2500	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9000	0.9500
X/LT	0.0199	-0.1002	-0.1355	-0.1186	-0.1055	-0.0907	-0.0762	-0.0689	-0.0531
0.0199	-0.0524	-0.0699	-0.0542	-0.0477	-0.0412	-0.0345	-0.0304	-0.0269	-0.0265
0.2372	-0.0088	-0.0097	-0.0004	-0.0001	-0.0021	-0.0035	-0.0058	-0.0073	-0.0088
0.4083	0.0251	0.0385	0.0393	0.0344	0.0258	0.0174	0.0104	0.0049	0.0009
0.5917	0.0457	0.0704	0.0652	0.0570	0.0439	0.0308	0.0204	0.0118	0.0049
0.7428	0.0543	0.0867	0.0795	0.0702	0.0544	0.0385	0.0262	0.0162	0.0094
0.8983	0.0540	0.0905	0.0842	0.0750	0.0582	0.0412	0.0278	0.0173	0.0089
0.9801	0.0494	0.0875	0.0823	0.0737	0.0570	0.0398	0.0261	0.0150	0.0045

INDUCED DOWNWASH DUE TO FIRST BLADE ONLY

RX/RB	0.2500	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9000	0.9500
X/LT	0.0199	0.1158	0.1701	0.1736	0.1831	0.1859	0.1832	0.1923	0.1569
0.0199	0.0594	0.0865	0.0775	0.0811	0.0830	0.0814	0.0834	0.0843	0.0887
0.2372	0.0092	0.0111	-0.0014	-0.0019	0.0020	0.0059	0.0133	0.0199	0.0262
0.4083	-0.0291	-0.0485	-0.0583	-0.0604	-0.0543	-0.0444	-0.0325	-0.0199	-0.0053
0.5917	-0.0522	-0.0880	-0.0954	-0.0992	-0.0910	-0.0765	-0.0608	-0.0424	-0.0220
0.7428	-0.0621	-0.1088	-0.1169	-0.1226	-0.1133	-0.0959	-0.0779	-0.0573	-0.0349
0.8983	-0.0620	-0.1144	-0.1245	-0.1318	-0.1219	-0.1032	-0.0833	-0.0610	-0.0371
0.9801	-0.0572	-0.1111	-0.1224	-0.1302	-0.1200	-0.1002	-0.0788	-0.0538	-0.0289

RX/RB	0.2500	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9000	0.9500
P/D	1.1560	1.1577	1.1424	1.1063	1.0673	1.0202	0.9724	0.9252	0.8976
L.E.	1.3607	1.4880	1.7200	1.8480	1.8560	1.7400	1.4800	1.0720	0.7472
CHORD	2.7213	2.9760	3.4400	3.6960	3.7120	3.4800	2.9600	2.1440	1.4943

CAMBER DISTRIBUTION

X/LT	0.0100	0.0026	0.0037	0.0038	0.0036	0.0032	0.0026	0.0021	0.0012	0.0007
0.0100	0.0182	0.0267	0.0255	0.0245	0.0215	0.0174	0.0136	0.0081	0.0052	0.0035
0.1000	0.0258	0.0374	0.0339	0.0324	0.0287	0.0233	0.0185	0.0115	0.0077	0.0058
0.2000	0.0257	0.0366	0.0295	0.0282	0.0261	0.0221	0.0187	0.0124	0.0087	0.0067
0.3000	0.0165	0.0213	0.0119	0.0115	0.0131	0.0134	0.0139	0.0104	0.0083	0.0071
0.4000	0.0017	-0.0036	-0.0142	-0.0133	-0.0066	-0.0002	0.0057	0.0068	0.0071	0.0051
0.5000	-0.0160	-0.0344	-0.0462	-0.0437	-0.0309	-0.0170	-0.0046	0.0019	0.0034	0.0024
0.6000	-0.0283	-0.0564	-0.0694	-0.0661	-0.0488	-0.0295	-0.0122	-0.0018	0.0036	0.0025
0.7000	-0.0387	-0.0744	-0.0904	-0.0864	-0.0651	-0.0407	-0.0190	-0.0049	0.0025	0.0016

CAMBER RATIO

X/LT	0.0100	0.0009	0.0013	0.0013	0.0010	0.0009	0.0007	0.0007	0.0005	0.0005
0.0100	0.0047	0.0090	0.0074	0.0064	0.0058	0.0050	0.0044	0.0038	0.0035	0.0035
0.1000	0.0095	0.0124	0.0098	0.0088	0.0077	0.0067	0.0062	0.0054	0.0051	0.0051
0.2000	0.0095	0.0123	0.0086	0.0076	0.0070	0.0064	0.0063	0.0058	0.0058	0.0058
0.3000	0.0041	0.0071	0.0035	0.0031	0.0035	0.0039	0.0037	0.0049	0.0056	0.0056
0.4000	0.0006	-0.0012	-0.0041	-0.0036	-0.0018	-0.0000	0.0019	0.0032	0.0047	0.0047
0.5000	-0.0059	-0.0115	-0.0134	-0.0118	-0.0083	-0.0049	-0.0015	0.0009	0.0034	0.0034
0.6000	-0.0104	-0.0190	-0.0202	-0.0179	-0.0131	-0.0085	-0.0041	-0.0008	0.0024	0.0024
0.7000	-0.0142	-0.0257	-0.0263	-0.0234	-0.0175	-0.0117	-0.0064	-0.0023	0.0016	0.0016

NOTES: 1. Calculation based on one blade only

2. Calculated camber in inches

TABLE 5
Calculated Camber Distributions for Propellers 3917A, 3917D,
3917E, 3917F, and 3917G

INPUT DATA									Card 1 (see Appendix A for explanation)	
18									Card 2	
0.00300	0.10000	2.00000	0.1500000	0.00000	0.05000	0.07000	0.09000	0.12900	Card 3	
0.00500	0.01000	0.01600	0.02400	0.03510	0.05000	0.07000	0.09000	0.12900		
0.17000	0.22000	0.28000	0.35200	0.44000	0.55200	0.70900	0.94500	1.00000		
0	0	0	0	0	0	0	0	0	Card 5	
0.01986	0.10166	0.23724	0.40828	0.59172	0.76276	0.89834	0.98014		Card 6	
0.01000	0.10000	0.20000	0.35000	0.50000	0.65000	0.80000	0.90000	0.99000	Card 7	
0.20000	0.30000	0.40000	0.50000	0.60000	0.70000	0.80000	0.90000	1.00000	Card 8	
0.12500	0.20900	0.26400	0.28400	0.27300	0.22700	0.14900	0.03300	-0.11300	r	
0.30600	0.37200	0.43000	0.46200	0.46400	0.43500	0.37000	0.26600	0.04000	$L_f(r)/D$	
1.66210	1.22835	0.90766	0.70429	0.56622	0.46392	0.38698	0.32722	0.27960	$L_t(r)/D$	
0.	0.01695	0.02214	0.02371	0.02230	0.01883	0.01414	0.00856	0.	$\tan \beta_f(r)$	
0.25000	0.30000	0.40000	0.50000	0.60000	0.70000	0.80000	0.90000	0.95000	$\Gamma(r)$	
1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	r_0	
0.14500	0.16902	0.20861	0.22173	0.20765	0.17661	0.13584	0.08937	0.06500	$V_{\infty}(r_0)$	
0.16010	0.16678	0.16019	0.13704	0.10517	0.07463	0.04889	0.02767	0.01770	$u_{\infty}(r_0)$	
1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	$C_D(r)$	Card 8A
0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	$A_0(r)$	
0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	$C_L(r)$	
0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	$A_1(r)$	
0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	$A_2(r)$	
0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	$A_3(r)$	
0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	$A_4(r)$	
0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	$A_5(r)$	
1	1.00000	0.82600	0.00000	1.00000	1.00000	0.				Card 9

CAMBER RATIO										PROPELLER 3917A A=1.0	
X/LT											
0.0100	0.0011	0.0012	0.0009	0.0008	0.0008	0.0007	0.0007	0.0006	0.0005		
0.1000	0.0049	0.0050	0.0061	0.0057	0.0054	0.0051	0.0048	0.0045	0.0038		
0.2000	0.0156	0.0145	0.0093	0.0086	0.0080	0.0076	0.0075	0.0073	0.0066		
0.3500	0.0238	0.0197	0.0111	0.0103	0.0097	0.0099	0.0094	0.0102	0.0096		
0.5000	0.0301	0.0217	0.0101	0.0095	0.0092	0.0103	0.0106	0.0120	0.0124		
0.6500	0.0344	0.0206	0.0068	0.0065	0.0068	0.0092	0.0103	0.0129	0.0144		
0.8000	0.0364	0.0164	0.0010	0.0013	0.0027	0.0067	0.0086	0.0130	0.0158		
0.9000	0.0361	0.0115	-0.0044	-0.0035	-0.0011	0.0042	0.0072	0.0126	0.0161		
0.9900	0.0334	0.0044	-0.0113	-0.0096	-0.0060	0.0008	0.0044	0.0114	0.0156		

CAMBER RATIO										PROPELLER 3917D A=0.8	
X/LT											
0.0100	0.0012	0.0012	0.0009	0.0008	0.0008	0.0008	0.0007	0.0006	0.0005		
0.1000	0.0076	0.0093	0.0062	0.0058	0.0055	0.0054	0.0052	0.0049	0.0042		
0.2000	0.0166	0.0147	0.0090	0.0084	0.0080	0.0081	0.0079	0.0079	0.0073		
0.3500	0.0257	0.0194	0.0100	0.0094	0.0092	0.0097	0.0101	0.0110	0.0108		
0.5000	0.0314	0.0204	0.0079	0.0075	0.0076	0.0097	0.0107	0.0127	0.0136		
0.6500	0.0351	0.0179	0.0030	0.0031	0.0044	0.0079	0.0099	0.0134	0.0156		
0.8000	0.0355	0.0111	-0.0051	-0.0041	-0.0013	0.0043	0.0076	0.0131	0.0167		
0.9000	0.0326	0.0035	-0.0128	-0.0109	-0.0067	0.0006	0.0051	0.0117	0.0166		
0.9900	0.0284	-0.0046	-0.0265	-0.0177	-0.0121	-0.0033	0.0025	0.0105	0.0160		

CAMBER RATIO										PROPELLER 3917E A=0.6	
X/LT											
0.0100	0.0012	0.0013	0.0009	0.0008	0.0008	0.0008	0.0007	0.0006	0.0005		
0.1000	0.0076	0.0096	0.0062	0.0058	0.0057	0.0057	0.0056	0.0054	0.0047		
0.2000	0.0176	0.0136	0.0086	0.0081	0.0080	0.0083	0.0084	0.0084	0.0078		
0.3500	0.0266	0.0189	0.0094	0.0081	0.0084	0.0096	0.0105	0.0117	0.0119		
0.5000	0.0328	0.0188	0.0049	0.0048	0.0060	0.0089	0.0104	0.0133	0.0147		
0.6500	0.0344	0.0132	-0.0025	-0.0018	0.0006	0.0067	0.0088	0.0134	0.0168		
0.8000	0.0316	0.0033	-0.0132	-0.0112	-0.0067	0.0007	0.0056	0.0122	0.0169		
0.9000	0.0279	-0.0047	-0.0211	-0.0161	-0.0122	-0.0032	0.0029	0.0109	0.0167		
0.9900	0.0242	-0.0119	-0.0279	-0.0243	-0.0176	-0.0046	0.0007	0.0096	0.0163		

CAMBER RATIO										PROPELLER 3917F A=0.4	
X/LT											
0.0100	0.0014	0.0014	0.0010	0.0009	0.0009	0.0009	0.0009	0.0008	0.0006		
0.1000	0.0113	0.0100	0.0062	0.0059	0.0059	0.0061	0.0060	0.0057	0.0052		
0.2000	0.0192	0.0152	0.0081	0.0077	0.0079	0.0084	0.0089	0.0094	0.0089		
0.3500	0.0276	0.0178	0.0064	0.0063	0.0072	0.0084	0.0106	0.0123	0.0127		
0.5000	0.0317	0.0145	0.0041	0.0037	0.0029	0.0076	0.0095	0.0129	0.0151		
0.6500	0.0311	0.0068	-0.0093	-0.0077	-0.0037	0.0028	0.0068	0.0123	0.0163		
0.8000	0.0278	-0.0037	-0.0231	-0.0173	-0.0114	-0.0026	0.0034	0.0109	0.0164		
0.9000	0.0239	-0.0114	-0.0277	-0.0246	-0.0163	-0.0063	0.0010	0.0098	0.0164		
0.9900	0.0204	-0.0183	-0.0343	-0.0299	-0.0218	-0.0095	-0.0012	0.0087	0.0161		

CAMBER RATIO										PROPELLER 3917G A=0.2	
X/LT											
0.0100	0.0016	0.0015	0.0010	0.0010	0.0010	0.0010	0.0010	0.0009	0.0007		
0.1000	0.0123	0.0105	0.0062	0.0060	0.0061	0.0065	0.0066	0.0064	0.0057		
0.2000	0.0202	0.0148	0.0070	0.0068	0.0074	0.0085	0.0091	0.0097	0.0093		
0.3500	0.0271	0.0150	0.0031	0.0033	0.0030	0.0078	0.0096	0.0117	0.0126		
0.5000	0.0293	0.0100	-0.0016	-0.0035	-0.0004	0.0046	0.0078	0.0118	0.0145		
0.6500	0.0250	0.0017	-0.0143	-0.0121	-0.0072	0.0000	0.0049	0.0109	0.0155		
0.8000	0.0212	-0.0047	-0.0230	-0.0216	-0.0148	-0.0052	0.0016	0.0096	0.0158		
0.9000	0.0206	-0.0113	-0.0324	-0.0282	-0.0199	-0.0087	-0.0008	0.0065	0.0156		
0.9900	0.0172	-0.0210	-0.0359	-0.0340	-0.0245	-0.0119	-0.0028	0.0074	0.0154		

*JL calculation based on one blade only

TABLE 6
Comparison of Ideal Angle of Attack,
Symmetrical and Skewed Blades, with Two-Dimensional Data

Radius	r/R	0.25	0.30	0.50	0.70	0.90	0.95
Lift Coefficient	C_L	0.180	0.193	0.156	0.100	0.060	0.040
Ideal angle of attack, deg	α_i						
$a = 0.8$							
two-dimensional		0.28	0.30	0.24	0.15	0.09	0.06
symmetrical blade		0.29	0.50	0.46	0.24	0.07	0.02
skewed blade		-1.60	0.31	1.06	0.23	-0.59	-0.90
$a = 0.6$							
two-dimensional		0.46	0.50	0.40	0.26	0.15	0.10
symmetrical blade		0.52	0.92	0.83	0.42	0.10	-0.01
skewed blade		-1.37	0.73	1.43	0.40	-0.55	-0.92
$a = 0.4$							
two-dimensional		0.62	0.67	0.54	0.35	0.20	0.14
symmetrical blade		0.69	1.26	1.14	0.57	0.12	-0.07
skewed blade		-1.15	1.07	1.75	0.57	-0.48	-0.91
$a = 0.2$							
two-dimensional		0.75	0.80	0.65	0.42	0.25	0.17
symmetrical blade		0.83	1.51	1.38	0.69	0.14	-0.08
skewed blade		-0.96	1.34	1.97	0.72	-0.41	-0.87

TABLE 7
Calculated Induced Velocities and Camber Distributions for
Propeller 3916J, Chordwise Load Distribution Corresponding
to Angle of Attack

PROPELLER 3916J ANGLE OF ATTACK TERM ONLY XPLA(1-12-65)

INPUT DATA

```

18
0.00500 0.10000 2.00000130.00000
30500 0.01000 0.01600 0.02400 0.03510 0.05000 0.07000 0.09600 0.12900
0.17000 0.22000 0.28000 0.35200 0.44000 0.55200 0.70900 0.94500 1.00000
8 9 0 9 0 0 0 0 0
0.01986 0.10166 0.23724 0.40828 0.59172 0.76276 0.89834 0.98014
0.81000 0.10000 0.20000 0.35000 0.50000 0.65000 0.80000 0.90000 0.99000
0.20000 0.30000 0.40000 0.50000 0.60000 0.70000 0.80000 0.90000 1.00000
0.15400 0.18600 0.21500 0.23100 0.23200 0.21750 0.18500 0.13400 0.02000
0.30800 0.37200 0.43000 0.46200 0.46400 0.43500 0.37000 0.26800 0.04000
1.86210 1.22635 0.90766 0.70429 0.56622 0.46392 0.36698 0.32722 0.27960
0. 0.01695 0.02214 0.02371 0.02230 0.01883 0.01414 0.00856 0.
0.25000 0.30000 0.40000 0.50000 0.60000 0.70000 0.80000 0.90000 0.95000
1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000
0.14500 0.16902 0.20861 0.22173 0.20765 0.17661 0.13584 0.08937 0.06500
0.16010 0.16678 0.16039 0.13704 0.10517 0.07483 0.04889 0.02767 0.01770
0. -0. -0. -0. -0. -0. -0. -0. -0.
0.63662 0.63662 0.63662 0.63662 0.63662 0.63662 0.63662 0.63662
8. -0. -0. -0. -0. -0. -0. -0. -0.
0. -0. -0. -0. -0. -0. -0. -0. -0.
0. -0. -0. -0. -0. -0. -0. -0. -0.
0. -0. -0. -0. -0. -0. -0. -0. -0.
0. -0. -0. -0. -0. -0. -0. -0. -0.
0. -0. -0. -0. -0. -0. -0. -0. -0.
1 1.00000 0.82600 8.00000 1.00000 1.00000 0.

```

Card 1 (see Appendix A for explanation)

Card 2

Card 3

Card 5

Card 6

Card 7

Card 8

r

$L_j(r)/B$

$L_t(r)/B$

$\tan \beta_t(r)$

$\Gamma(r)$

r_0

$V_{\infty}(r_0)$

$u_0(r_0)$

$u_z(r_0)$

Card 8A

$C_D(r)$

$A_0(r)$

$C_x(r)$

$A_1(r)$

$A_2(r)$

$A_3(r)$

$A_4(r)$

$A_5(r)$

Card 9

OUTPUT DATA

AXIAL INDUCED VELOCITY COMPONENT

RX/RO	0.2500	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9000	0.9500
X/LT									
0.0199	-0.0038	-0.0068	-0.0335	-0.0360	-0.0186	0.0067	0.0730	0.0880	0.1368
0.1017	-0.0127	-0.0226	-0.0461	-0.0550	-0.0503	-0.0418	-0.0263	-0.0070	0.0116
0.2372	-0.0177	-0.0339	-0.0548	-0.0636	-0.0603	-0.0514	-0.0372	-0.0219	-0.0104
0.4083	-0.0214	-0.0445	-0.0629	-0.0734	-0.0708	-0.0605	-0.0465	-0.0303	-0.0113
0.5917	-0.0242	-0.0537	-0.0716	-0.0839	-0.0817	-0.0702	-0.0553	-0.0368	-0.0158
0.7628	-0.0263	-0.0607	-0.0796	-0.0937	-0.0916	-0.0791	-0.0634	-0.0440	-0.0222
0.8983	-0.0277	-0.0654	-0.0858	-0.1014	-0.0994	-0.0862	-0.0693	-0.0486	-0.0259
0.9801	-0.0284	-0.0678	-0.0895	-0.1059	-0.1040	-0.0901	-0.0722	-0.0481	-0.0237

TANGENTIAL INDUCED VELOCITY COMPONENT

RX/RO	0.2500	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9000	0.9500
X/LT									
0.0199	-0.0041	0.0016	0.0249	0.0210	0.0071	-0.0059	-0.0305	-0.0307	-0.0430
0.1017	0.0153	0.0250	0.0399	0.0354	0.0254	0.0166	0.0078	0.0002	-0.0056
0.2372	0.0283	0.0432	0.0467	0.0429	0.0319	0.0215	0.0122	0.0051	0.0010
0.4083	0.0373	0.0589	0.0579	0.0500	0.0384	0.0261	0.0160	0.0081	0.0014
0.5917	0.0429	0.0708	0.0663	0.0586	0.0447	0.0306	0.0194	0.0103	0.0029
0.7628	0.0459	0.0788	0.0732	0.0651	0.0520	0.0346	0.0224	0.0127	0.0047
0.8983	0.0471	0.0833	0.0781	0.0699	0.0540	0.0378	0.0245	0.0142	0.0058
0.9801	0.0472	0.0854	0.0808	0.0727	0.0563	0.0392	0.0255	0.0140	0.0051

INDUCED DOWNWASH DUE TO FIRST BLADE ONLY

RX/RO	0.2500	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9000	0.9500
X/LT									
0.0199	0.0012	-0.0055	-0.0415	-0.0415	-0.0196	0.0085	0.0791	0.0932	0.1434
0.1017	-0.0198	-0.0336	-0.0624	-0.0653	-0.0562	-0.0449	-0.0274	-0.0067	0.0127
0.2372	-0.0334	-0.0549	-0.0733	-0.0767	-0.0682	-0.0557	-0.0391	-0.0224	-0.0103
0.4083	-0.0429	-0.0738	-0.0855	-0.0893	-0.0806	-0.0659	-0.0492	-0.0313	-0.0112
0.5917	-0.0491	-0.0888	-0.0976	-0.1023	-0.0931	-0.0766	-0.0585	-0.0382	-0.0160
0.7628	-0.0528	-0.0994	-0.1082	-0.1141	-0.1044	-0.0863	-0.0672	-0.0458	-0.0226
0.8983	-0.0545	-0.1059	-0.1160	-0.1232	-0.1131	-0.0941	-0.0735	-0.0506	-0.0265
0.9801	-0.0550	-0.1091	-0.1206	-0.1285	-0.1182	-0.0982	-0.0765	-0.0501	-0.0241
RX/RO	0.2500	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9000	0.9500
P/O	1.1560	1.1577	1.1406	1.1063	1.0673	1.0202	0.9726	0.9252	0.8976
L/E	1.3607	1.4880	1.7200	1.8480	1.8560	1.7400	1.4800	1.0720	0.7472
CHORD	2.7213	2.9760	3.4400	3.6960	3.7120	3.4200	2.9600	2.1440	1.4943

CAMBER DISTRIBUTION

X/LT	0.0100	0.1000	0.2000	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9000	0.9500
0.0100	0.0001	0.0001	-0.0007	-0.0006	-0.0001	0.0000	0.0000	0.0011	0.0008	0.0008	0.0008
0.1000	-0.0014	-0.0033	-0.0095	-0.0089	-0.0053	-0.0016	0.0029	0.0029	0.0029	0.0034	0.0034
0.2000	-0.0065	-0.0116	-0.0222	-0.0210	-0.0146	-0.0061	-0.0005	0.0019	0.0019	0.0033	0.0033
0.3000	-0.0170	-0.0290	-0.0437	-0.0415	-0.0304	-0.0187	-0.0061	-0.0003	-0.0003	0.0027	0.0027
0.4000	-0.0297	-0.0511	-0.0663	-0.0649	-0.0487	-0.0310	-0.0131	-0.0032	-0.0032	0.0020	0.0020
0.5000	-0.0440	-0.0768	-0.0957	-0.0910	-0.0693	-0.0449	-0.0211	-0.0066	-0.0066	0.0010	0.0010
0.6000	-0.0592	-0.1053	-0.1257	-0.1198	-0.0920	-0.0603	-0.0301	-0.0105	-0.0105	-0.0002	-0.0002
0.7000	-0.0698	-0.1256	-0.1471	-0.1405	-0.1085	-0.0715	-0.0368	-0.0135	-0.0135	-0.0012	-0.0012
0.8000	-0.0795	-0.1445	-0.1673	-0.1600	-0.1240	-0.0821	-0.0430	-0.0162	-0.0162	-0.0021	-0.0021

CAMBER RATIO

X/LT	0.0100	0.1000	0.2000	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9000	0.9500
0.0100	0.0001	0.0000	-0.0002	-0.0002	-0.0000	0.0001	0.0000	0.0004	0.0004	0.0005	0.0005
0.1000	-0.0005	-0.0011	-0.0028	-0.0024	-0.0014	-0.0005	0.0010	0.0014	0.0014	0.0023	0.0023
0.2000	-0.0074	-0.0039	-0.0065	-0.0057	-0.0039	-0.0023	-0.0002	0.0009	0.0009	0.0022	0.0022
0.3000	-0.0062	-0.0098	-0.0127	-0.0112	-0.0082	-0.0054	-0.0021	-0.0001	-0.0001	0.0018	0.0018
0.4000	-0.0109	-0.0172	-0.0199	-0.0176	-0.0131	-0.0089	-0.0044	-0.0015	-0.0015	0.0013	0.0013
0.5000	-0.0162	-0.0258	-0.0278	-0.0246	-0.0187	-0.0129	-0.0071	-0.0031	-0.0031	0.0007	0.0007
0.6000	-0.0218	-0.0354	-0.0365	-0.0324	-0.0248	-0.0173	-0.0102	-0.0049	-0.0049	-0.0001	-0.0001
0.7000	-0.0257	-0.0422	-0.0428	-0.0380	-0.0292	-0.0206	-0.0124	-0.0063	-0.0063	-0.0008	-0.0008
0.8000	-0.0292	-0.0486	-0.0466	-0.0433	-0.0334	-0.0236	-0.0145	-0.0076	-0.0076	-0.0014	-0.0014

NOTES: 1. Calculation based on one blade

2. Calculated camber in inches

TABLE 8
Calculated Induced Velocities and Camber Distributions for
Propeller 3916K, Sinusoidal Chordwise Load Distribution

PROPELLER 3916K		1ST TERM OF SINE										XPLA(1-12-65)	
INPUT DATA													
18													
Card 1 (see Appendix A for explanation)													
Card 2													
Card 3													
Card 5													
Card 6													
Card 7													
Card 8													
r													
L ₁ (r)/D													
L ₂ (r)/D													
tan β ₁ (r)													
Γ(r)													
r ₀													
V _H (r ₀)													
u ₁ (r ₀)													
u ₂ (r ₀)													
C ₀ (r)													
A ₀ (r)													
C ₈ (r)													
A ₁ (r)													
A ₂ (r)													
A ₃ (r)													
A ₄ (r)													
A ₅ (r)													
Card 9													
CURRNT DATA													
AXIAL INDUCED VELOCITY COMPONENT													
RX/RQ													
0.2500													
0.3000													
0.4000													
0.5000													
0.6000													
0.7000													
0.8000													
0.9000													
0.9500													
R/LT													
0.0199													
0.0423													
0.0450													
0.1113													
0.1316													
0.1346													
0.1263													
0.1165													
0.0964													
0.0769													
0.1017													
0.0359													
0.0723													
0.0908													
0.1070													
0.1095													
0.1025													
0.0938													
0.0816													
0.0692													
0.0412													
0.2272													
0.0241													
0.0483													
0.0585													
0.0685													
0.0699													
0.0647													
0.0592													
0.0509													
0.0412													
0.4083													
0.0085													
0.0170													
0.0201													
0.0234													
0.0238													
0.0214													
0.0198													
0.0162													
0.0122													
0.5917													
-0.0085													
-0.0170													
-0.0201													
-0.0234													
-0.0238													
-0.0218													
-0.0198													
-0.0162													
-0.0122													
0.7628													
-0.0241													
-0.0483													
-0.0585													
-0.0685													
-0.0699													
-0.0647													
-0.0592													
-0.0509													
-0.0412													
0.8983													
-0.0359													
-0.0723													
-0.0908													
-0.1070													
-0.1095													
-0.1025													
-0.0938													
-0.0816													
-0.0692													
0.9801													
-0.0423													
-0.0860													
-0.1113													
-0.1316													
-0.1346													
-0.1263													
-0.1165													
-0.0964													
-0.0769													
TANGENTIAL INDUCED VELOCITY COMPONENT													
RX/RQ													
0.2500													
0.3000													
0.4000													
0.5000													
0.6000													
0.7000													
0.8000													
0.9000													
0.9500													
R/LT													
0.0199													
-0.0736													
-0.1121													
-0.1026													
-0.0913													
-0.0736													
-0.0560													
-0.0429													
-0.0303													
-0.0222													
0.1017													
-0.0639													
-0.0956													
-0.0848													
-0.0750													
-0.0604													
-0.0457													
-0.0347													
-0.0257													
-0.0201													
0.2272													
-0.0441													
-0.0650													
-0.0557													
-0.0488													
-0.0391													
-0.0292													
-0.0221													
-0.0161													
-0.0120													
0.4083													
-0.0158													
-0.0231													
-0.0194													
-0.0169													
-0.0134													
-0.0100													
-0.0074													
-0.0052													
-0.0036													
0.5917													
0.0158													
0.0231													
0.0194													
0.0169													
0.0134													
0.0100													
0.0074													
0.0052													
0.0036													
0.7628													
0.0441													
0.0650													
0.0557													
0.0488													
0.0391													
0.0292													
0.0221													
0.0161													
0.0120													
0.8983													
0.0639													
0.0956													
0.0848													
0.0750													
0.0604													
0.0457													
0.0347													
0.0257													
0.0201													
0.9801													
0.0736													
0.1121													
0.1026													
0.0913													
0.0736													
0.0560													
0.0429													
0.0303													
0.0222													
INDUCED DOWNWASH DUE TO FIRST BLADE ONLY													
RX/RQ													
0.2500													
0.3000													
0.4000													
0.5000													
0.6000													
0.7000													
0.8000													
0.9000													
0.9500													
R/LT													
0.0199													
0.0847													
0.1413													
0.1514													
0.1602													
0.1534													
0.1381													
0.1242													
0.1011													
0.0800													
0.1017													
0.0731													
0.1198													
0.1242													
0.1307													
0.1250													
0.1122													
0.1000													
0.0856													
0.0720													
0.2272													
0.0501													
0.0809													
0.0808													
0.0841													
0.0800													
0.0710													
0.0632													
0.0534													
0.0429													
0.4083													
0.0178													
0.0286													
0.0279													
0.0288													
0.0273													
0.0240													
0.0211													
0.0171													
0.0127													
0.5917													
-0.0178													
-0.0286													
-0.0279													
-0.0288													
-0.0273													
-0.0240													
-0.0211													
-0.0171													
-0.0127													
0.7628													
-0.0501													
-0.0809													
-0.0808													
-0.0841													
-0.0800													
-0.0710													
-0.0632													
-0.0534													
-0.0429													
0.8983													
-0.0731													
-0.1198													
-0.1242													
-0.1307													
-0.1250													
-0.1122													
-0.1000													
-0.0856													
-0.0720													
0.9801													
-0.0847													
-0.1413													
-0.1514													
-0.1602													
-0.1534													
-0.1381													
-0.1242													
-0.1011													
-0.0800													
RX/PO													
0.2500													
0.3000													
0.4000													
0.5000													
0.6000													
0.7000													
0.8000													
0.9000													
0.9500													
P/D													
1.1560													
1.1577													
1.1406													
1.1063													
1.0673													
1.0202													
0.9726													
0.9252													
0.8976													
L/E													
1.3607													
1.4860													
1.7200													
1.8480													
1.8560													
1.7400													
1.4800													
1.0720													
0.7472													
CHORD													
2.7213													
2.9760													
3.4400													
3.6960													
3.7120													
3.4800													
2.9600													
2.1440													
1.4943													
CAMBER DISTRIBUTION													
R/LT													
0.0100													
0.0017													
0.0028													
0.0030													
0.0029													
0.0024													
0.0017													
0.0012													
0.0006													
0.0003													
0.1000													
0.0158													
0.0261													
0.0267													
0.0257													
0.0213													
0.0157													
0.0106													
0.0058													
0.0031													
0.2000													
0.0285													
0.0469													
0.0472													
0.0453													
0.0375													
0.0276													
0.0186													
0.0102													
0.0056													
0.3000													
0.0411													
0.0672													
0.0668													
0.0638													
0.0528													
0.0387													
0.0261													
0.0143													
0.0077													
0.4000													
0.0454													
0.0741													
0.0733													
0.0699													
0.0578													
0.0423													
0.0285													
0.0155													
0.0083													
0.5000													
0.0411													
0.0672													
0.0668													
0.0638													
0.0528													
0.0387													
0.0261													
0.0143													
0.0077													
0.6000													
0.0285													
0.0469													
0.0472													
0.0453													
0.0375													
0.0276													
0.0186													
0.0102													
0.0056													
0.7000													
0.0158													
0.0261													
0.0267													
0.0257													
0.0213													
0.0157													
0.0106													
0.0058													
0.0031													
0.8000													
0.0017													
0.0028													
0.0030													
0.0029													
0.0024													
0.0017													
0.0012													
0.0006													
0.0003													
CAMBER RATIO													
R/LT													
0.0100													
0.0004													
0.0010													
0.0009													
0.0008													
0.0004													
0.0005													
0.0004													
0.0003													
0.0002													
0.1000													
0.0058													
0.0088													
0.0078													
0.0070													
0.0057													
0.0045													
0.0036													
0.0027													
0.0021													
0.2000													
0.0175													
0.0157													
0.0137													
0.0123													
0.0101													
0.0079													
0.0063													
0.0048													
0.0037													
0.3000													
0.0151													
0.0228													
0.0194													
0.0173													
0.0142													
0.0111													
0.0088													
0.0067													
0.0052													
0.4000													
0.0167													
0.0249													
0.0213													
0.0189													
0.0156													
0.0122													
0.0096													
0.0072													
0.0056													
0.5000													
0.0151													
0.0228													
0.0194													
0.0173													
0.0142													
0.0111													
0.0088													
0.0067													
0.0052													
0.6000													
0.0103													
0.0157													
0.0137													
0.0123													
0.0101													
0.0079													
0.0063													
0.0048													
0.0037													
0.7000													
0.0058													
0.0088													
0.0078													
0.0070													
0.0057													
0.0045													
0.0036													
0.0027													
0.0021													
0.8000													
0.0004													
0.0010													
0.0009													
0.0008													
0.0004													
0.0005													
0.0004													
0.0003													
0.0002													

NOTES: 1. Calculation based on one blade
2. Calculated camber in inches

TABLE 9
Calculated Induced Velocities and Camber Distribution for a
Rectangular Supercavitating Blade at Zero Cavitation Number
with Tulin-Burkhard 2-Term Chordwise Load Distribution

CAMBER DISTRIBUTION SUP-CAV TULIN 2-TERM SECTION XPLA(2-1) -65)

INPUT DATA
10
0.00000 0.10000 2.00000 150.00000
0.00000 0.01000 0.01000 0.02400 0.0316 0.03000 0.07000 0.09400 0.12900
0.17000 0.22000 0.24000 0.35200 0.44000 0.55200 0.70900 0.94300 1.00000
0.01000 0.10100 0.23724 0.40828 0.59172 0.76276 0.89834 0.98014
0.01000 0.10000 0.20000 0.35000 0.50000 0.65000 0.80000 0.90000 0.99000
0.20000 0.30000 0.40000 0.50000 0.60000 0.70000 0.80000 0.90000 1.00000
0.05000 0.05000 0.05000 0.05000 0.05000 0.05000 0.05000 0.05000 0.05000
0.10000 0.10000 0.10000 0.10000 0.10000 0.10000 0.10000 0.10000 0.10000

Card 1 (see Appendix A for explanation)
Card 2
Card 3

Card 5
Card 6
Card 7
Card 8

x
 $L_1(r)/D$
 $L_2(r)/D$
 $\tan \beta_1(r)$
 $\Gamma(r)$
 r_0
 $V_0(r_0)$
 $u_0(r_0)$
 $u_1(r_0)$
 $C_D(r)$
 $A_0(r)$
 $C_L(r)$
 $A_1(r)$
 $A_2(r)$
 $A_3(r)$
 $A_4(r)$
 $A_5(r)$

0. -0. -0. -0. -0. -0. -0. -0. -0.
0.10000 0.10000 0.10000 0.10000 0.10000 0.10000 0.10000 0.10000 0.10000
0.20000 0.30000 0.40000 0.50000 0.60000 0.70000 0.80000 0.90000 0.95000
1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000
0. -0. -0. -0. -0. -0. -0. -0. -0.
0. -0. -0. -0. -0. -0. -0. -0. -0.
0. -0. -0. -0. -0. -0. -0. -0. -0.
0. -0. -0. -0. -0. -0. -0. -0. -0.
1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000
1.27324 1.27324 1.27324 1.27324 1.27324 1.27324 1.27324 1.27324 1.27324

Card 8A

0.63662-0.63662-0.63662-0.63662-0.63662-0.63662-0.63662-0.63662-0.63662
0. -0. -0. -0. -0. -0. -0. -0. -0.
0. -0. -0. -0. -0. -0. -0. -0. -0.
0. -0. -0. -0. -0. -0. -0. -0. -0.
1.00000 0.80000 1.00000 0. -1.00000 0. -1.00000 0. -1.00000 0.

Card 9

OUTPUT DATA

DUE TO BOUND CIRCULATION ONLY

AXIAL INDUCED VELOCITY COMPONENT

RX/RD	0.2500	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9000	0.9500
0.0199	0.7295	0.8822	1.0014	1.0277	1.0338	1.0269	1.0006	0.9141	0.7976
0.1017	0.9716	1.1352	1.2446	1.2760	1.2881	1.2819	1.2688	1.1739	1.0322
0.2372	1.1786	1.3365	1.4340	1.4608	1.4680	1.4650	1.4458	1.3592	1.2063
0.4083	1.0614	1.1891	1.2583	1.2753	1.2825	1.2809	1.2682	1.2110	1.0787
0.5917	0.4614	0.5221	0.5529	0.5619	0.5622	0.5619	0.5603	0.5457	0.5124
0.7628	-0.5343	-0.5672	-0.5815	-0.5910	-0.5905	-0.5845	-0.5938	-0.5389	-0.4594
0.8983	-1.6081	-1.7347	-1.7990	-1.8164	-1.8504	-1.8200	-1.8971	-1.7633	-1.5892
0.9801	-2.4713	-2.5796	-3.0920	-2.7427	-2.5897	-2.5078	-2.2973	-2.2585	-2.0955

TANGENTIAL INDUCED VELOCITY COMPONENT

RX/RD	0.2500	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9000	0.9500
0.0199	0.	0.	0.	0.	0.	0.	0.	0.	-0.
0.1017	0.	0.	0.	0.	0.	0.	-0.	-0.	-0.
0.2372	0.	0.	0.	0.	0.	-0.	-0.	-0.	-0.
0.4083	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.
0.5917	-0.	0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.
0.7628	-0.	0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.
0.8983	-0.	0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.
0.9801	-0.	0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.

INDUCED DOWNWASH DUE TO FIRST BLADE ONLY

RX/RD	0.2500	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9000	0.9500
0.0199	0.7295	0.8822	1.0014	1.0277	1.0338	1.0269	1.0006	0.9141	0.7976
0.1017	0.9716	1.1352	1.2446	1.2760	1.2881	1.2819	1.2688	1.1739	1.0322
0.2372	1.1786	1.3365	1.4340	1.4608	1.4680	1.4650	1.4458	1.3592	1.2063
0.4083	1.0614	1.1891	1.2583	1.2753	1.2825	1.2809	1.2682	1.2110	1.0787
0.5917	0.4614	0.5221	0.5529	0.5619	0.5622	0.5619	0.5603	0.5457	0.5124
0.7628	-0.5343	-0.5672	-0.5815	-0.5910	-0.5905	-0.5845	-0.5938	-0.5389	-0.4594
0.8983	-1.6081	-1.7347	-1.7990	-1.8164	-1.8504	-1.8200	-1.8971	-1.7633	-1.5892
0.9801	-2.4713	-2.5796	-3.0920	-2.7427	-2.5897	-2.5078	-2.2973	-2.2585	-2.0955

P/D

P/D	0.2500	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9000	0.9500
0.0100	0.0048	0.0053	0.0051	0.0044	0.0038	0.0033	0.0028	0.0023	0.0019
0.1000	0.0587	0.0635	0.0587	0.0510	0.0443	0.0386	0.0337	0.0277	0.0231
0.2000	0.1350	0.1432	0.1308	0.1132	0.0981	0.0855	0.0747	0.0621	0.0519
0.3000	0.2606	0.2722	0.2450	0.2115	0.1833	0.1599	0.1400	0.1173	0.0986
0.4000	0.3691	0.3824	0.3419	0.2944	0.2550	0.2225	0.1950	0.1645	0.1386
0.5000	0.4251	0.4397	0.3923	0.3376	0.2922	0.2550	0.2237	0.1895	0.1607
0.6000	0.3937	0.4103	0.3672	0.3163	0.2741	0.2394	0.2098	0.1785	0.1524
0.7000	0.3083	0.3265	0.2965	0.2550	0.2201	0.1928	0.1665	0.1427	0.1220
0.8000	0.1745	0.1980	0.1767	0.1598	0.1398	0.1243	0.1069	0.0915	0.0775

CHORD

CHORD	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
-------	--------	--------	--------	--------	--------	--------	--------	--------	--------

CAMBER DISTRIBUTION

X/LT	0.0100	0.0587	0.0635	0.0587	0.0510	0.0443	0.0386	0.0337	0.0277	0.0231
0.0100	0.0048	0.0053	0.0051	0.0044	0.0038	0.0033	0.0028	0.0023	0.0019	0.0019
0.1000	0.0587	0.0635	0.0587	0.0510	0.0443	0.0386	0.0337	0.0277	0.0231	0.0231
0.2000	0.1350	0.1432	0.1308	0.1132	0.0981	0.0855	0.0747	0.0621	0.0519	0.0519
0.3000	0.2606	0.2722	0.2450	0.2115	0.1833	0.1599	0.1400	0.1173	0.0986	0.0986
0.4000	0.3691	0.3824	0.3419	0.2944	0.2550	0.2225	0.1950	0.1645	0.1386	0.1386
0.5000	0.4251	0.4397	0.3923	0.3376	0.2922	0.2550	0.2237	0.1895	0.1607	0.1607
0.6000	0.3937	0.4103	0.3672	0.3163	0.2741	0.2394	0.2098	0.1785	0.1524	0.1524
0.7000	0.3083	0.3265	0.2965	0.2550	0.2201	0.1928	0.1665	0.1427	0.1220	0.1220
0.8000	0.1745	0.1980	0.1767	0.1598	0.1398	0.1243	0.1069	0.0915	0.0775	0.0775

CAMBER RATIO

X/LT	0.0100	0.0587	0.0635	0.0587	0.0510	0.0443	0.0386	0.0337	0.0277	0.0231
0.0100	0.0048	0.0053	0.0051	0.0044	0.0038	0.0033	0.0028	0.0023	0.0019	0.0019
0.1000	0.0587	0.0635	0.0587	0.0510	0.0443	0.0386	0.0337	0.0277	0.0231	0.0231
0.2000	0.1350	0.1432	0.1308	0.1132	0.0981	0.0855	0.0747	0.0621	0.0519	0.0519
0.3000	0.2606	0.2722	0.2450	0.2115	0.1833	0.1599	0.1400	0.1173	0.0986	0.0986
0.4000	0.3691	0.3824	0.3419	0.2944	0.2550	0.2225	0.1950	0.1645	0.1386	0.1386
0.5000	0.4251	0.4397	0.3923	0.3376	0.2922	0.2550	0.2237	0.1895	0.1607	0.1607
0.6000	0.3937	0.4103	0.3672	0.3163	0.2741	0.2394	0.2098	0.1785	0.1524	0.1524
0.7000	0.3083	0.3265	0.2965	0.2550	0.2201	0.1928	0.1665	0.1427	0.1220	0.1220
0.8000	0.1745	0.1980	0.1767	0.1598	0.1398	0.1243	0.1069	0.0915	0.0775	0.0775

CAMBER RATIO FOR SUPERCAVITATING BLADE (CN/LT)/A1

X/LT	0.0100	0.0587	0.0635	0.0587	0.0510	0.0443	0.0386	0.0337	0.0277	0.0231
0.0100	0.0048	0.0053	0.0051	0.0044	0.0038	0.0033	0.0028	0.0023	0.0019	0.0019
0.1000	0.0587	0.0635	0.0587	0.0510	0.0443	0.0386	0.0337	0.0277	0.0231	0.0231
0.2000	0.1350	0.1432	0.1308	0.1132	0.0981	0.0855	0.0747	0.0621	0.0519	0.0519
0.3000	0.2606	0.2722	0.2450	0.2115	0.1833	0.1599	0.1400	0.1173	0.0986	0.0986
0.4000	0.3691	0.3824	0.3419	0.2944	0.2550	0.2225	0.1950	0.1645	0.1386	0.1386
0.5000	0.4251	0.4397	0.3923	0.3376	0.2922	0.2550	0.2237	0.1895	0.1607	0.1607
0.6000	0.3937	0.4103	0.3672	0.3163	0.2741	0.2394	0.2098	0.1785	0.1524	0.1524
0.7000	0.3083	0.3265	0.2965	0.2550	0.2201	0.1928	0.1665	0.1427	0.1220	0.1220
0.8000	0.1745	0.1980	0.1767	0.1598	0.1398	0.1243	0.1069	0.0915	0.0775	0.0775

TABLE 10
Calculated Induced Velocities and Camber Distribution for a
Rectangular Supercavitating Blade at Zero Cavitation Number
with Johnson 3-Term Chordwise Load Distribution

CAMBER DISTRIBUTION SUP-CAV JOHNSON 3-TERM SECTION XPLA(X-1 -65)

INPUT DATA

```

16
0.00000 0.10000 2.00000150.00000
0.00000 0.01000 0.01000 0.02000 0.03510 0.05000 0.07000 0.09000 0.12000
0.17000 0.22000 0.28000 0.35200 0.44000 0.55200 0.70000 0.94500 1.00000
0.01000 0.10000 0.20000 0.30000 0.50000 0.60000 0.80000 0.90000 0.99000
0.01000 0.10000 0.20000 0.30000 0.50000 0.60000 0.80000 0.90000 0.99000
0.20000 0.30000 0.40000 0.50000 0.60000 0.70000 0.80000 0.90000 1.00000
0.00000 0.05000 0.05000 0.05000 0.05000 0.05000 0.05000 0.05000 0.05000
0.10000 0.10000 0.10000 0.10000 0.10000 0.10000 0.10000 0.10000 0.10000
0. -0. -0. -0. -0. -0. -0. -0. -0.
0.10000 0.10000 0.10000 0.10000 0.10000 0.10000 0.10000 0.10000 0.10000
0.20000 0.30000 0.40000 0.50000 0.60000 0.70000 0.80000 0.90000 0.95000
1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000
0. -0. -0. -0. -0. -0. -0. -0. -0.
0. -0. -0. -0. -0. -0. -0. -0. -0.
0. -0. -0. -0. -0. -0. -0. -0. -0.
0. -0. -0. -0. -0. -0. -0. -0. -0.
1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000
1.27324 1.27324 1.27324 1.27324 1.27324 1.27324 1.27324 1.27324 1.27324

1.27324-1.27324-1.27324-1.27324-1.27324-1.27324-1.27324-1.27324-1.27324
0.63662 0.63662 0.63662 0.63662 0.63662 0.63662 0.63662 0.63662 0.63662
0. -0. -0. -0. -0. -0. -0. -0. -0.
0. -0. -0. -0. -0. -0. -0. -0. -0.
1.00000 0.0000010.00000 0. 1.00000 0.

```

Card 1 (see Appendix A for explanation)

Card 2

Card 3

Card 5

Card 6

Card 7

Card 8

r

$L_z(r)/D$

$L_z(r)/D$

$\sum m \phi_i(r)$

$\Gamma(r)$

Γ_0

$\Gamma_0(r_0)$

$\Gamma_0(r_0)$

$\Gamma_0(r_0)$

$C_p(r)$

$A_1(r)$

$A_2(r)$

$A_3(r)$

$A_4(r)$

$A_5(r)$

Card 8A

Card 9

OUTPUT DATA

DUE TO BOUND CIRCULATION ONLY

AXIAL INDUCED VELOCITY COMPONENT

W/RT	0.2500	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9000	0.9500
0.0100	0.6367	0.7244	0.7893	0.8451	0.8693	0.8729	0.8510	0.7704	0.6814
0.1000	0.3765	0.5029	0.6190	0.6604	0.6787	0.6753	0.6653	0.5715	0.4646
0.2000	0.4942	0.6403	0.7587	0.8006	0.8145	0.8136	0.7905	0.7023	0.5771
0.3000	1.0068	1.2668	1.3671	1.4206	1.4297	1.4300	1.4107	1.3131	1.1523
0.4000	1.6463	1.8430	1.9482	1.9708	1.9783	1.9726	1.9575	1.8812	1.7006
0.5000	1.5465	1.7151	1.7898	1.8042	1.8042	1.8023	1.7878	1.7488	1.6300
0.6000	0.1895	0.2542	0.2834	0.2796	0.2814	0.2842	0.2842	0.2674	0.3125
0.7000	-1.6865	-1.7393	-1.7687	-1.7827	-1.8360	-1.7939	-1.9577	-1.7829	-1.6131
0.8000	-4.3176	-4.2344	-3.8521	-4.0037	-4.0742	-4.1166	-4.1237	-4.0552	-3.8262

TANGENTIAL INDUCED VELOCITY COMPONENT

W/RT	0.2500	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9000	0.9500
0.0100	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.1000	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.2000	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.3000	0.	-0.	-0.	-0.	-0.	-0.	-0.	0.	0.
0.4000	0.	-0.	0.	0.	0.	0.	0.	0.	0.
0.5000	0.	-0.	0.	0.	0.	0.	0.	0.	0.
0.6000	0.	-0.	0.	0.	0.	0.	0.	0.	0.
0.7000	0.	-0.	0.	0.	0.	0.	0.	0.	0.
0.8000	0.	-0.	0.	0.	0.	0.	0.	0.	0.
0.9000	0.	-0.	0.	0.	0.	0.	0.	0.	0.
0.9500	0.	-0.	0.	0.	0.	0.	0.	0.	0.

INDUCED DOWNWASH DUE TO FIRST BLADE ONLY

W/RT	0.2500	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9000	0.9500
0.0100	0.6367	0.7244	0.7893	0.8451	0.8693	0.8729	0.8510	0.7704	0.6814
0.1000	0.3765	0.5029	0.6190	0.6604	0.6787	0.6753	0.6653	0.5715	0.4646
0.2000	0.4942	0.6403	0.7587	0.8006	0.8145	0.8136	0.7905	0.7023	0.5771
0.3000	1.0068	1.2668	1.3671	1.4206	1.4297	1.4300	1.4107	1.3131	1.1523
0.4000	1.6463	1.8430	1.9482	1.9708	1.9783	1.9726	1.9575	1.8812	1.7006
0.5000	1.5465	1.7151	1.7898	1.8042	1.8042	1.8023	1.7878	1.7488	1.6300
0.6000	0.1895	0.2542	0.2834	0.2796	0.2814	0.2842	0.2842	0.2674	0.3125
0.7000	-1.6865	-1.7393	-1.7687	-1.7827	-1.8360	-1.7939	-1.9577	-1.7829	-1.6131
0.8000	-4.3176	-4.2344	-3.8521	-4.0037	-4.0742	-4.1166	-4.1237	-4.0552	-3.8262

W/RT	0.2500	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9000	0.9500
0.0100	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.1000	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.2000	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.3000	0.	-0.	-0.	-0.	-0.	-0.	-0.	0.	0.
0.4000	0.	-0.	0.	0.	0.	0.	0.	0.	0.
0.5000	0.	-0.	0.	0.	0.	0.	0.	0.	0.
0.6000	0.	-0.	0.	0.	0.	0.	0.	0.	0.
0.7000	0.	-0.	0.	0.	0.	0.	0.	0.	0.
0.8000	0.	-0.	0.	0.	0.	0.	0.	0.	0.
0.9000	0.	-0.	0.	0.	0.	0.	0.	0.	0.
0.9500	0.	-0.	0.	0.	0.	0.	0.	0.	0.

CAMBER DISTRIBUTION

W/RT	0.0047	0.0048	0.0043	0.0039	0.0035	0.0031	0.0027	0.0022	0.0018
0.0100	0.0047	0.0048	0.0043	0.0039	0.0035	0.0031	0.0027	0.0022	0.0018
0.1000	0.0350	0.0387	0.0370	0.0335	0.0294	0.0260	0.0225	0.0178	0.0144
0.2000	0.0641	0.0739	0.0727	0.0655	0.0578	0.0505	0.0438	0.0345	0.0273
0.3000	0.1463	0.1643	0.1571	0.1395	0.1221	0.1069	0.0926	0.0746	0.0599
0.4000	0.2956	0.3185	0.2943	0.2573	0.2240	0.1959	0.1710	0.1412	0.1164
0.5000	0.4752	0.4994	0.4516	0.3916	0.3397	0.2970	0.2597	0.2187	0.1840
0.6000	0.5817	0.6083	0.5467	0.4724	0.4094	0.3575	0.3140	0.2657	0.2270
0.7000	0.5337	0.5650	0.5104	0.4414	0.3820	0.3337	0.2912	0.2471	0.2121
0.8000	0.3468	0.3938	0.3728	0.3226	0.2770	0.2430	0.2059	0.1754	0.1487

CAMBER RATIO

W/RT	0.0047	0.0048	0.0043	0.0039	0.0035	0.0031	0.0027	0.0022	0.0018
0.0100	0.0047	0.0048	0.0043	0.0039	0.0035	0.0031	0.0027	0.0022	0.0018
0.1000	0.0350	0.0387	0.0370	0.0335	0.0294	0.0260	0.0225	0.0178	0.0144
0.2000	0.0641	0.0739	0.0727	0.0655	0.0578	0.0505	0.0438	0.0345	0.0273
0.3000	0.1463	0.1643	0.1571	0.1395	0.1221	0.1069	0.0926	0.0746	0.0599
0.4000	0.2956	0.3185	0.2943	0.2573	0.2240	0.1959	0.1710	0.1412	0.1164
0.5000	0.4752	0.4994	0.4516	0.3916	0.3397	0.2970	0.2597	0.2187	0.1840
0.6000	0.5817	0.6083	0.5467	0.4724	0.4094	0.3575	0.3140	0.2657	0.2270
0.7000	0.5337	0.5650	0.5104	0.4414	0.3820	0.3337	0.2912	0.2471	0.2121
0.8000	0.3468	0.3938	0.3728	0.3226	0.2770	0.2430	0.2059	0.1754	0.1487

CAMBER RATIO FOR SUPERCAVITATING BLADE (CM/LT)/A1

W/RT	0.0025	0.0028	0.0028	0.0025	0.0022	0.0019	0.0017	0.0013	0.0010
0.0100	0.0025	0.0028	0.0028	0.0025	0.0022	0.0019	0.0017	0.0013	0.0010
0.1000	0.0334	0.0379	0.0363	0.0322	0.0281	0.0246	0.0213	0.0172	0.0137
0.2000	0.0629	0.0705	0.0683	0.0603	0.0527	0.0461	0.0396	0.0326	0.0262
0.3000	0.1428	0.1518	0.1451	0.1251	0.1065	0.0917	0.0786	0.0659	0.0536
0.4000	0.2895	0.3097	0.2860	0.2462	0.2092	0.1777	0.1512	0.1242	0.1012
0.5000	0.4683	0.4918	0.4418	0.3742	0.3208	0.2718	0.2272	0.1908	0.1604
0.6000	0.5770	0.5999	0.5463	0.4697	0.3967	0.3333	0.2798	0.2363	0.1984
0.7000	0.5241	0.5721	0.5193	0.4439	0.3822	0.3262	0.2742	0.2342	0.1984
0.8000	0.3678	0.4029	0.3713	0.3226	0.2770	0.2430	0.2059	0.1754	0.1487

CAMBER DISTRIBUTION SUP-CAY JOHNSON 5-TERM SECTION XPLA(2-1 -69)
INPUT DATA

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APPENDIX A PREPARATION OF INPUT DATA

The input data are essentially identical to those outlined in Appendix B of Reference 2, with the following exceptions:

Revise

Card 5 Format 918

Column

1- 8	NKN	
9-16	NCL	
17-24	NCTR	
25-32	KRN	
33-40	NPT	
41-48	KSP	
49-56	NSIN	Number of terms in sine series, M
57-64	LFCW	Chordwise load factor, percent of chord from leading edge with uniform loading, a Specify LFCW = 100 for a = 1.0 mean line uniform loading = 80 for a = 0.8 mean line, etc. = 0 for all other cases.
65-72	NSC	Control for supercavitating hydrofoil at zero cavitation number Specify NSC = 1 for two-dimensional supercavitating case = 0 for all other cases

Between Card 8 and Card 9 add;

Card 8A (8 cards) Format 9F8.5

At specified input radii of the first card of Card 8

1st card - $C_o(r)$, coefficient of uniform loading term

Specify $C_o = 1.0$ for uniform (wholly or partially) chordwise loading
= 0.0 for all other cases.

2nd card - $A_o(r)$, coefficient for angle of attack term

Specify $A_o = 0.0$ for all cases with no angle of attack term

3rd card - $C_2(r)$, control for sine series term

Specify $C_2 = 1.0$ for loading with sine series term
 $= 0.0$ for all other cases

4th card	$A_1(r)$	}	coefficients for sine series terms
5th card	$A_2(r)$		
6th card	$A_3(r)$		
7th card	$A_4(r)$		
8th card	$A_5(r)$		

Revise

Card 9 Format (I8, 8F8.5)

Column

1- 8	NN
9-16	VM
17-24	AJ
25-32	DIA
33-40	SM
41-48	SW

APPENDIX B
FORTRAN LISTING OF COMPUTER PROGRAM

The FORTRAN listing of the computer program follows. The computer also uses the subroutine MATINV and the functions ASINF and ACOSF.

38

```

C
LH=LH
INTERPOLATE INPUT DATA AT RADIAL STATIONS OF FIELD POINTS
ERASE BB,CC
CALL SUB4
DO 1405 K=1,3
1405 BP(K,KP1)=BB(K,LTH1)
ERASE DSA,DSAT
SET UP CHORDWISE STATIONS OF FIELD POINTS
NN=1
N=1
7601 L=N
760 Y=XY(N)
ALT=ABSF(BB(6,LTH1))-BB(6,N)+BB(7,N))
ATL=ABSF(BB(6,N))-BB(6,LTH1)+BB(7,LTH1))
ACT=ALT
IF(ALT-ATL) 700,701,701
700 ACT=ATL
701 DO 411 J=1,16
CV(J)=CC(J,N)
411 BV(J)=BB(J,N)
ERASE Z
M7=1
M=1
231 FAP=6.283185307179586/FLOATF(NN)
FMPS=1/(FAP*FAP)
FMPC=CV(1,FMPS)
J=1
702 SX=AS(L,J)*FMPC+AC(L,J)*FMPS
CX=AC(L,J)*FMPC-AS(L,J)*FMPS
S=A(L,J)
VRPS=ABSF(Y*Y+RP*RP-2.*Y*RP*CX+(BV(3)*S/3.1416)**2)
VP(J)=VRPS*.1.5
Z(1,J)=Z(1,J)-SX*RP/VP(J)
Z(5,J)=Z(5,J)+S*CX/VP(J)
Z(2,J)=Z(2,J)+S*(RP-Y*CX)/VP(J)
Z(3,J)=Z(3,J)+(RP-Y*(CX+S*CX))/VP(J)
Z(4,J)=Z(4,J)+Y*(Y-RP*CX)/VP(J)
GO TO (704,705,706),M7
704 J=J+1
710 IF(AL,J)-ACT)702,710
M=M+1
IF(M-NN) 231,231,730
730 DO 719 K=1,5
719 P(K)=Z(K,1)
P(6)=AS(L,1)
P(7)=AC(L,1)
P(8)=A(L,1)
P(9)=VP(1)
K5=1
758 FP=BB(6,LTH1)-SX(AS)*BB(7,LTH1)
C
CONVERT THETASUBO TO PSISUBO
CPSIO(KS,KR)=1.-2.*(BB(6,LTH1)-FP)/BB(7,LTH1)
TP=CPSIO(KS,KR)
CALL CHECK(TP,PT)
PSIO(KS,KR)=PT
YL=BV(6,1)-FP
YT=CP-BV(5)
SL=ABSF(YL)
ST=ABSF(YT)
SL1=SL

```

```

SL2=ST
IF(SL-ST) 520,520,521
521 SL1=ST
SL2=SL
520 J=1
523 DO 703 K=1,5
703 R(K,J)=Z(K,J)
SY(J)=A(L,J)
J=J+1
IF(A(L,J)-SL1) 523,523,5241
5241 JS1=J-1
SL1A=SL1-A(L,JS1)
IF(SL1A-DPH1) 1714,524,524
1714 SL1=SL1+DPH1
524 M7=2
J1=J
DO 708 K=1,5
708 Z(K,1)=0.
AS(L,1)=SINF(SL1)
AC(L,1)=COSF(SL1)
A(L,1)=SL1
SY(J1)=SL1
M=1
GO TO 231
705 M=M+1
IF(M-NN)231,231,712
712 DO 713 K=1,5
713 R(K,J1)=Z(K,1)
JK=J1
IF(SL-ST)525,526,525
525 J=J1+1
5251 IF(A(L,J)-SL2)527,527,5281
5281 JS2=J-1
SL2A=SL2-A(L,JS2)
IF(SL2A-DPH1) 1716,528,528
1716 SL2=SL2+DPH1
GO TO 523
527 DO 714 K=1,5
714 R(K,J)=Z(K,J)
SY(J)=A(L,J)
J=J+1
GO TO 5251
528 M7=3
J2=J
DO 715 K=1,5
715 Z(K,1)=0.
SY(J2)=SL2
AS(L,1)=SINF(SL2)
AC(L,1)=COSF(SL2)
A(L,1)=SL2
M=1
JK=J2
GO TO 231
706 M=M+1
IF(M-NN)231,231,720
720 DO 721 K=1,5
721 R(K,J2)=Z(K,1)
526 J2=JK
DO 1721 K=1,5
1721 Z(K,1)=P(K)

```

```

VP(1)=P(9)
AS(L,1)=P(6)
AC(L,1)=P(7)
AL(1)=P(8)
IF(NPT-KR) 711,2009,711
2009 IF(KSP-KS) 711,2004,711
2004 PRINT 4104, FP
4104 FORMAT(11H THETASUBO=F8.5)
4102 PRINT 4102, RP,XY(H)
4102 FORMAT(11H PHI AT RO=F8.5,3X,2HR=F8.5)
PRINT 2000,(SY(JP),JP=1,J2)
711 CONTINUE
C CALCULATE INDUCED VELOCITY COMPONENTS IN TIP AND HUB ZONES
C CONVERT CHORDWISE STATIONS FROM PHI-COORD TO PSI-COORD
CALL CONVRT
ERASE UHL,VHL,UHT,VHT,UBL,VBL,UBT,VBT,UHH,VHH
CHORDWISE INTEGRATION
CALL KERNEL
KS=KS+1
IF(KS-NKN)758,758,7591
7591 CONTINUE
IF(NPT)759,759,2994
2994 PRINT 2989,Y
2989 FORMAT(3H R=F5.4)
PRINT 2000,(DSA (KS,N),KS=1,NKN)
PRINT 2000,(DSAT(KS,N),KS=1,NKN)
759 N=N+1
GO TO (770,771),NM
770 IF(N-L)7601,7601,773
771 IF(N-LTH)772,772,761
773 NM=2
IF(NPT)772,772,2990
2990 PRINT 2991
2991 FORMAT(9H HUB ZONE)
772 L=N-LT
GO TO 760
761 CONTINUE
DO 5392 KS=1,NKN
DO 539 J=1,LH
K=LT+J
YX(J)=XY(K)
AGS(J)=DSA(KS,K)
AGST(J)=DSAT(KS,K)
539 CONTINUE
DO 5391 J=1,LT
SAG(J)=DSA (KS,J)
SAGT(J)=DSAT(KS,J)
DWSH(KR,KS)=SIMPUN(XY,SAG,LT)-SIMPUN(YX,AGS,LH)
DWSHT(KR,KS)=SIMPUN(XY,SAGT,LT)-SIMPUN(YX,AGST,LH)
DWSH(KR,KS)=DWSH(KR,KS)/12.5664
DWSHT(KR,KS)=DWSHT(KR,KS)/12.5664
5392 CONTINUE
C CALCULATE INDUCED VELOCITY COMPONENTS IN MID ZONE OF THE FIRST
C BLADE
ERASE Z,R,SYC,SYS,SY,SYS
ERASE UHL,VHL,UHT,VHT,UBL,VBL,UBT,VBT,UHH,VHH
ERASE SUHL,SVHL,SUHT,SVHT,SUBL,SVBL,SUBT,SVBT,SUHH,SVHH
CALL MIDZON
DO 5393 KS=1,NKN
DWSH (KR,KS)= DWSH (KR,KS)+WT(KS)
DWSHT(KR,KS)= DWSHT(KR,KS)+QT(KS)
5393 CONTINUE
KR=KR+1
IF(KR-KRN)20,20,57
57 DO 60J=1,NKN
XX(J,1)=1.
XX(J,2)=DK(J)
DO 60 K=3,NKN
DO XX(J,K)=XX(J,K-1)*XX(J,2)
IF(SM)2017,2018,2017
2018 PRINT 2019
2019 FORMAT(30HODUE TO BOUND CIRCULATION ONLY)
GO TO 12017
2017 IF(SM)12017,12018,12017
12018 PRINT 12019
12019 FORMAT(29HODUE TO FREE CIRCULATION ONLY )
12017 PRINT 2020
2020 FORMAT(33HODAXIAL INDUCED VELOCITY COMPONENT)
PRINT 262,(B(6,J),J=1,KRN)
PRINT 263
DO 2021 J=1,NKN
2021 PRINT 264,DK(J),(DWSH(K,J),K=1,KRN)
PRINT 2022
2022 FORMAT(38HOTANGENTIAL INDUCED VELOCITY COMPONENT)
PRINT 262,(B(6,J),J=1,KRN)
PRINT 263
DO 2023 J=1,NKN
2023 PRINT 264,DK(J),(DWSHT(K,J),K=1,KRN)
82 JS=KRN
83 DO 63J=1,KRN
CCAA =3.1416*B(6,J)/SORTF((3.1416*B(6,J))*2+B(6,J)**2)
SBI= SORTF(ABSF(1.-CCAA*CCAA))
JJKN=J+KRN
DO 63K=1,NKN
63 ZZ(K,J)=DWSH(J,K)*CCAA-DWSHT(J,K)*SBI
IF(NN-1)12025,12024,12025
12024 PRINT 2024
2024 FORMAT(41HINDUCED DOWNWASH DUE TO FIRST BLADE ONLY)
GO TO 12026
12025 PRINT 2026
2026 FORMAT(35HINDUCED DOWNWASH DUE TO ALL BLADES)
12026 PRINT 262,(B(6,J),J=1,KRN)
PRINT 263
DO 2027 J=1,NKN
2027 PRINT 264,DK(J),(ZZ(J,K),K=1,KRN)
CALL MATINV(XX,NKN,ZZ,JS,V,LD)
GOTO (1001,183),IU
183 PRINT 1002
GOTO 84
1001 ERASE CM
DO 65 J=1,NKN
65 XX(J,19)=FLOATF(J)
DO 67J=1,JS
DO 67K=1,NKN
67 XX(K,J)=ZZ(K,J)/XX(K,19)
DO 70J=1,NCL
XX(1,20)=XL(J)
DO 73K=2,NKN
73 XX(K,20)=XX(K-1,20)*XL(J)
DO 75JJ=1,JS

```

```

DO 75KK=1,NKN
75 CM(J,JJ)=XX(KK,JJ)*XX(KK,20)+CM(J,JJ)
70 CONTINUE
DO 78J=1,KRN
  BPP(J)=BP(2,J)
  VRE(J)=
  X  SQRTF(13.1416*8(6,J)/AJ-8(9,J))*2+(8(7,J)+B(8,J))*2)
78 CONTINUE
DO 77 J=1,JS
DO 77K=1,NCL
  CMR(K,J)=CM(K,J)/VRE(J)
  77 CH(K,J)=CMR(K,J)*BPP(J)*DIA
  PRINT 262,(B(6,J),J=1,KRN)
262 FORMAT( /12H RX/RO ,9F12.4)
266 PRINT 266,(BP(3,J),J=1,KRN)
266 FORMAT( 12H P/D ,9F12.4)
DO 2010 J=1,KRN
  BP(1,J)=DIA*BP(1,J)
2010 BP(2,J)=DIA*BP(2,J)
90 PRINT 267,(BP(1,J),J=1,KRN)
267 FORMAT( 12H L.E. ,9F12.4)
268 PRINT 268,(BP(2,J),J=1,KRN)
268 FORMAT( 12H CHORD ,9F12.4)
2711 PRINT 2711
  FORMAT(20HOCAMBER DISTRIBUTION)
263 PRINT 263
263 FORMAT(5H X/LT)
DO 261J=1,NCL
261 PRINT 264,XL(J),(CH(J,K),K=1,KRN)
270 PRINT 270
270 FORMAT(13HOCAMBER RATIO)
  PRINT 263
DO 265 J=1,NCL
265 PRINT 264,XL(J),(CMR(J,K),K=1,KRN)
264 FORMAT(F8.4,F16.4,8F12.4)
1002 FORMAT(19H MATRIX IS SINGULAR)
  IF(NSC) 84,84,85
85 CALL SUPCAV
84 IF(NCTR)102,100,101
102 READ 104,NN, NCTR, NPT,KSP,LFCW
104 FORMAT(5I8)
  READ 4,VM,DY,SM,SW
  PRINT 108
108 FORMAT(53H1CAMBER LINES FOR THE SAME INPUT DATA AS ABOVE EXCEPT)
  PRINT 107,NCTR,NN, VM,DY,SM, NPT,KSP,LFCW,SW
107 FORMAT(6HONCTR=12,2X,3HNN=12,2X, 3HVM=F8.5,2X,3HDY=F8.5,2X,3HSM=F8
  X.5,2X,4HNPT=12,2X,4HKSP=12,2X,5HLFCW=13,2X,3HSW=F8.5)
  GO TO 1061
100 CALL END JOB
  STOP
  END

```

```

FOR
SUBROUTINE SUB1
A SUBROUTINE FOR XPLA
CALCULATE ANGLE FE,SIN(FE),AND COS(FE) TABLES
COMMON J1,J2,YL,YT,SL,ST,N,MID
DF=DFD/57.295
FDF=DFD/57.295
DFF=DFFD/57.295
K=1
  A(K,1)=0.
  AS(K,1)=0.
  AC(K,1)=1.
  I=2
173 FD=FLOATF(I-1)*DF
  IF(FD-FDF)171,172,172
172 FD=FDF
171 A(K,1)=A(K,I-1)+FD
  SS=SINF(FD)
  CS=COSF(FD)
  AC(K,I)=CS*AC(K,I-1)-SS*AS(K,I-1)
  AS(K,I)=CS*AS(K,I-1)+SS*AC(K,I-1)
  I=I+1
  IF(A(K,I-1)-DFF)173,174,174
174 NF(1)=I
  NFN=NF(1)
  DO 170 K=2,NL
  DO 176 J=K,NFN
  N=J-K+1
  A(K,N)=A(1,J)-A(1,K)
  AS(K,N)=AS(1,J)*AC(1,K)-AC(1,J)*AS(1,K)
  AC(K,N)=AC(1,J)*AC(1,K)+AS(1,J)*AS(1,K)
176 CONTINUE
  NF(K)=N
170 CONTINUE
  RETURN
  END

```



```

C
C
SUBROUTINE SUB4
A SUBROUTINE FOR XPLA
INTERPOLATE INPUT DATA AT RADIAL STATIONS OF FIELD POINTS
DIMENSION DK(20),XL(20),B(9,9),CO(9),AH(10,9),CD(10,9),FAH(20,20),
XDB(9,16),DC(9),HA(9),BP( 3,9),DE(9),BV(16),DWSH(9,20),EAH(20,18),
X XX(20,20),ZZ(20,18),TIT(12),CM(20,18),CHRI(20,18),
XCC(16,50),XY(50),YX(50),8B(16,50),SY(90), SAG(50),
IAGS(50),AB(9,9),DD(9,16), DWSHT(9,20), BPPI(20),CQ(16),YS(90),
XAGST(50),8Q(16 ),CV(16), VRE(20), BPP(20),CQ(16),YS(90),
XR(5,90), H(25),T(25),SPR(20),A(25,90),NF(25),AS(25,90),AC(25,90),
XSYS(90),SYC(90),UHH(90),VHH(90),UHL(90),UHT(90),VHL(90),VHT(90),
XUBL(90),UBT(90),VRL(90),VBT(90),DSA(10,35),DSAT(10,35),
X WT(20),QT(20),Z(5,90),P(9),VP(90)
DIMENSION PSIL(90),CPSIL(90),SPSIL(90),PSIT(90),SPSIT(90),
XCPSIT(90),CPSIO(9,9),PSIO(9,9)
DIMENSION C(8,9),FHA(20,20)
COMMON DK,XL,B,CO,AH,CD,FAH,DB,DC,HA,8P,DE,BV,DWSH,EAH,XX,ZZ,TIT,
1CH,CHR,CC,CY,YX,BB,SY,SAG,AGS,AB,DD,DWSHT,SAGT,AGST,BQ,CV,VRE,BPP,
2CQ,Y5,R,H,T,SPR,A,NF,AS,AC,SY,S,YC,UHH,VHH,UHL,UHT,VHL,VHT,
3 UBL,UBT,VBL,VBT,DSA,DSAT,WT,QT,Z,P,VP
COMMON PSIL,CPSIL,SPSIL,PS,T,SPSIT,CPSIT,CPSIO,PSIO
COMMON C,SW
COMMON DFD,DFDD,DFDD,NL,*P,OY,LT,LH,LTH,LTH,XH,PI,FP,S,NSIN,
XGTT,KR,KS,SM,NKN,NPT,KSP,LFCW
COMMON J1,J2,YL,YT,SL,ST,N,MID
DO 405 L=1,LTH1
X=XY(L)
21 CY=(1.+XH-2.*X)/(1.-XH)
SZ=SORTF(1.-CY*CY)
HA(1)=1.
HA(2)=CY
DC(1)=0.
DC(2)=SZ
DO 17J=3,9
I=J-1
HA(J)=HA(I)*HA(2)-DC(I)*DC(2)
17 DC(J)=DC(I)*HA(2)+HA(I)*DC(2)
DO 19 J=1,9
19 DE(J)=-FLOATF(J-1)*DC(J)
DO 22J=1,9
DO 22K=1,8
DD(J,K+8)=DD(J,K)*DE(J)
22 DB(J,K+8)=DB(J,K)*DE(J)
23 DO 25 K=1,8
DO 25J=1,9
CC(K,L)=CC(K,L)+DD(J,K)*HA(J)
CC(K+8,L)=CC(K+8,L)+DD(J,K+8)*2./((1.-XH)*DC(2))
BB(K+8,L)=BB(K+8,L)+DB(J,K+8)*2./((1.-XH)*DC(2))
25 BB(K,L)=BB(K,L)+DB(J,K)*HA(J)
405 CONTINUE
RETURN
END

FOR
FUNCTION SIMPUN(X,Y,N)
DIMENSION X(200 ),Y( 200 )
SIMPUN=0.
T=0.
DX1=X(2)-X(1)
Q1=(Y(2)-Y(1))/DX1
IF(N-2)20,21,5
21 SIMPUN=(Y(2)+Y(1))*DX1/2.
GO TO 20
5 DO 18 I=3,N
DX2=X(I)-X(I-1)
Q2=(Y(I)-Y(I-1))/DX2
A=(Q2-Q1)/(DX1+DX2)
B2=.5*(Q1+A*DX1)
A3=A/3.
S=((A3*DX1-B2)*DX1+Y(I-1))*DX1
SIMPUN=SIMPUN+(T+S)*.5
T=((A3*DX2+B2)*DX2+Y(I-1))*DX2
DX1=DX2
Q1=Q2
IF(I-3)18,17,18
17 SIMPUN=SIMPUN+SIMPUN
18 CONTINUE
SIMPUN=SIMPUN+T
20 RETURN
END

FOR
SUBROUTINE CHECK(X,Y)
CHECK SIGN GF ARGUMENT FOR ACOS FUNCTION
IF(X) 1,3,3
1 X=ABS(X)
Y=ASINF(X)
Y=Y+1.570795
GO TO 2
3 Y=ACOSF(X)
2 RETURN
END

```

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FOR
SUBROUTINE CONVRT
A SUBROUTINE FOR XPLA
CONVERT CHOROWISE STATIONS FROM PHI-COORD TO PSI-COORD
DIMENSION DK(20),XL(20),B(9,9),CO(9),AH(10,9),CD(10,9),FAH(20,20),
XDB(9,16),DC(9),HA(9),BPI(3,9),DE(9),BV(15),DWSH(9,20),EAH(20,18),
X XX(20,20),ZZ(20,18),TIT(12),CM(20,18),CHR(20,18),
XCCI(16,50),XY(50),YX(50),BB(16,50),SY(90), SAG(50),
LAGS(50),AB(9,9),DD(9,16), DWSHT(9,20), SAGT(50),
XAGST(50),BQ(16),CV(16), VRE(20), BPI(20),CQ(16),YS(90),
XR(5,90), H(25),T(25),SPR(20),A(25,90),NF(25),AS(25,90),AC(25,90),
XSYS(90),SYC(90),UHH(90),VHH(90),UHL(90),UHT(90),VHL(90),VHT(9C),
XUBL(90),UBT(90),VBL(90),VBT(90),DSA(10,35),DSAT(10,35),
X WT(20),QT(20),Z(5,90),P(9),VP(90)
DIMENSION PSIL(90),CPSIL(90),SPSIL(90),PSIT(90),SPSIT(90),
XCPSIT(90),CPSIO(9,9),PSIO(9,9)
DIMENSION C(8,9),PHA(20,20)
COMMON DK,XL,B,CO,AH,CD,FAH,DB,DC,HA,BP,DE,BV,DWSH,EAH,XX,ZZ,TIT,
1CM,CHR,CC,XY,YX,BB,SY,SAG,AGS,AU,DD,DWSHT,SAGT,AGST,BQ,CV,AVRE,BPP,
2CO,Y5,R,H,T,SPR,A,NF,AS,AC,SY,SYC,UHH,VHH,UHL,UHT,VHL,VHT,
3 UBL,UBT,VBL,VBT,DSA,DSAT,WT,QT,Z,P,VP
COMMON PSIL,CPSIL,SPSIL,PSIT,SPSIT,CPSIT,CPSIO,PSIO
COMMON C,SW
COMMON DFD,DFED,DFED,NL,RP,DY,LT,LH,LTH,LTH1,XH,PI,FP,S,NSIN,
XGTT,KR,KS,SM,MKN,NPT,KSP,LFCW
COMMON J1,J2,YL,YT,SL,ST,N,MID
ERASE PSIL,CPSIL,SPSIL,PSIT,SPSIT,CPSIT,SPSIT
JK=0
JS=1
JE=J1
IF(YL) 10,11,11
11 IF(YT) 12,12,14
14 IF(SL-ST) 1,1,2
1 JET=J2
GO TO 13
2 JE=J2
JET=J1
GO TO 13
10 JK=J1-1
JET=J2-J1+1
GO TO 21
12 JK=J1-1
JE=J2-J1+1
JET=J1
GO TO 27
13 DO 15 J=JS,JE
CPSIL(J)=1-(2./BV(7))*(BV(6)-BB(6,LTH1))- SY(J)+BB(7,LTH1))/2.*
X(1.-CPSIO(KS,KR)))
TP=CPSIL(J)
CALL CHECK(TP,PT)
PSIL(J)=PT
15 SPSIL(J)=SORTF(1.-CPSIL(J)*CPSIL(J))
26 DO 25 J=1,JET
CPSIT(J)=1-(2./BV(7))*(BV(6)-BB(6,LTH1)+ SY(J)+BB(7,LTH1))/2.*
X(1.-CPSIO(KS,KR)))
TP=CPSIT(J)
CALL CHECK(TP,PT)
PSIT(J)=PT
25 SPSIT(J)=SORTF(1.-CPSIT(J)*CPSIT(J))
GO TO 29

```

```

21 DO 22 J=1,JE
CPSIL(J)=1.-2.*SY(J)/SL
TP=CPSIL(J)
CALL CHECK(TP,PT)
PSIL(J)=PT
22 SPSIL(J)=SORTF(1.-CPSIL(J)*CPSIL(J))
DO 31 J=1,JET
JJ=J+JK
CPSIT(J)=1.-2.*(SY(JJ)-SL)/(ST-SL)
TP=CPSIT(J)
CALL CHECK(TP,PT)
PSIT(J)=PT
31 SPSIT(J)=SORTF(1.-CPSIT(J)*CPSIT(J))
GO TO 29
27 DO 28 J=1,JET
CPSIT(J)=1.-SY(J)*2./ST)
TP=CPSIT(J)
CALL CHECK(TP,PT)
PSIT(J)=PT
28 SPSIT(J)=SORTF(1.-CPSIT(J)*CPSIT(J))
DO 33 J=1,JE
JJ=J+JK
CPSIL(J)=1.+2.*(SY(JJ)-ST)/(SL-ST)
TP=CPSIL(J)
CALL CHECK(TP,PT)
PSIL(J)=PT
33 SPSIL(J)=SORTF(1.-CPSIL(J)*CPSIL(J))
29 IF(KR-NPT) 197,39,197
39 IF(KS-KSP) 197,195,197
195 PRINT 199
199 FORMAT(20H PSI IN L.E. PORTION)
PRINT 198
198 FORMAT(20H PSI IN T.E. PORTION)
PRINT 200H,PSIT(J),J=1,JET)
197 CONTINUE
2000 FORMAT(9E13,5)
RETURN
END

```



```

54  FN=FMSH/FLOATF(IM)-FSPS/FLOATF(IP)
   FNP=PSIPS*O*(FMC-FSPC)
   SUM2=SUM2+((CV(K3)*BV(12)+CV(K11)*BV(4))*FN*OS+CV(K3)*BV(4)*FNP)
6   CONTINUE
   GAMAS=BV(8)*SUM1*OS
   GSP=.25*(GS1+SUM2)
   GO TO 911
905  GAMAS=O.
   GSP=O.
911  IF(CV(12)) 906,917,906
917  GAMAA=O.
   GAP=O.
   GO TO 9071
906  GAMAA=CV(2)*BV(4)*(1.-AQ)
   GAP=(CV(2)*BV(12)+CV(10)*BV(4))*5*(S+X)*OS+CV(2)*BV(4)*(1.-AQ)
   X
9071 IF(CV(1)) 908,909,908
908  IF(LFCW-100) 918,907,918
918  AF=O1*FLOATF(LFCW)
   CPSIA=1.-2.*AF
   TP=CPSIA
   CALL CHECK(IP,PT)
   PSIA=PT
   SPSIA=SINF(PSIA)
9091 IF(S-PSIA) 919,919,916
919  GCP=1./(1.+AF)*BV(12)*(1.-CX)+BV(4)*2./BV(7)*(BV(14)-BV(15)*AQ))
   GCP=GCP*QS
   GAMAC=2./(1.+AF)*BV(8)*QS
   GO TO 910
916  GC1=BV(12)*2.*AF/(1.+AF)
   GC2=BV(12)/12.*(1.-AF*AF)*(CX-CPSIA)+5*(SPSIA*SPSIA-SX*SX))
   GC3=-BV(4)/12.*(1.-AF*AF)*2./BV(7)*(BV(14)-BV(15)*AQ)*(1.-CX)
   GCP=GC1-GC2-GC3
   GCP=GCP*QS
   GAMAC=(1.-CX)/(1.-AF*AF)*BV(8)*QS
   GO TO 910
907  GAMAC=CV(1)*BV(8)*QS
   GCP=(CV(1)*BV(12)+CV(9)*BV(4))*AQ+CV(1)*BV(4)/BV(7)*(BV(14)
   X -BV(15)*AQ)
   GCP=GCP*QS
   GO TO 910
909  GAMAC=O.
   GCP=O.
910  GAMAR=(GAMAC+GAMAA+GAMAS)
   GT=GCP+GAP+GSP
   GO TO (7,8),MLT
7   UHL(J)=GT*UH
   VHL(J)=GT*VH
   VBL(J)=VB*GAMAR
   UBL(J)=UB*GAMAR
   GO TO 90
8   UHT(J)=GT*UH
   VHT(J)=GT*VH
   VBT(J)=VB*GAMAR
   UBT(J)=UB*GAMAR
   UHH(J)=UB*SLM*QS
   VHH(J)=VB*SLM*QS
90  CONTINUE
   IF(MLT-1) 200,300,200
300  IF(KL) 200,200,201

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FOR
SUBROUTINE MIDZON
C CALCULATE MIDZON OF FIRST BLADE
C A SUBROUTINE FOR XPLA
XDB(9,16),DC(9),HA(9),BP( 3,9),DE(9),BV(16),DWSH(9,20),EAH(20,18),
X(20,20),Z(20,18),T(12),CM(20,18),CHM(20,18),
XCC(16,50),XY(50),B(16,50),SY(90),SAG(50),
LAGS(50),AB(9,9),DD(9,16),DWSH(9,20),SAGT(50),
XAGST(50),BQ(16),CV(16),VRE(20),BPP(20),CO(16),YS(90),
XR(5,90),H(25),T(25),SPR(20),A(25,90),NF(25),AS(25,90),AC(25,90),
XSY(90),SYC(90),UHH(90),VHH(90),UHL(90),UHT(90),VHL(90),VHT(90),
XUBL(90),UBT(90),VBL(90),VBT(90),DSA(10,35),DSAT(10,35),
XWT(20),QT(20),Z(5,90),P(9),VP(90)
X DIMENSION PSIL(90),CPSIL(90),SPSIL(90),PSIT(90),SPSIT(90),
XCPSIT(90),CPSIO(9),PSIO(9,9)
DIMENSION C(8,9),FHA(20,20)
COMMON DK,XL,B,CO,AH,CD,FAM,DB,DC,HA,BP,DE,BV,DWSH,EAH,XX,ZZ,TIT,
1CH,CHR,CC,XY,YX,BP,SY,SAG,AGS,AB,DD,DWSHT,SAGT,AGST,BQ,CV,VRE,BPP,
2CO,YS,R,H,T,SPR,A,NF,AS,AC,SY,SYC,UHH,VHH,UHL,UHT,VHL,VHT,
3UBL,UBT,VBL,VBT,DSA,DSAT,WT,QT,Z,P,VP
COMMON PSIL,CPSIL,SPSIL,PSIT,SPSIT,CPSIT,CPSIO,PSIO
COMMON C,SW
COMMON DFD,DFDD,DFDD,NL,RP,DY,LT,LH,LTH,LTH1,XH,PI,FP,S,NSIN,
XGTT,KR,KS,SM,NKN,NPT,KSP,LFCW
COMMON J1,J2,YL,YT,SL,ST,N,MID
N=LTH1
QT=0.
NT=0.
DO 811 K=1,16
CO(K)=CV(K)
CV(K)=CC(K,LTH1)
BO(K)=BV(K)
811 BV(K)=BB(K,LTH1)
811 KS=1
4501 FP=BV(6)-DX(KS)*BV(7)
YL=BV(6)-FP
YT=FP+BV(7)-BV(6)
R1=RP-DY
R2=RP+DY
M8=1
J=2
731 S=A(1,J)
SY(J)=S
CX=AC(1,J)
SX=AS(1,J)
SYS(J)=SX
SYC(J)=CX
733 PP=(BV(3)*S/3.1416)**2
ZP=(RP*SX)**2+PP
S01=SORTF(ABS(F(RP*RP+R1*R1-2.*RP*R1*CX+PP)))
S02=SORTF(ABS(F(RP*RP+R2*R2-2.*RP*R2*CX+PP)))
Z(4,J)=((R2-RP*CX)/S02-(R1-RP*CX)/S01)/ZP
Z(1,J)=LOGF(ABS(F((R2-RP*CX+S02)/(R1-RP*CX+S01)))-R2/S02+R1/S01
Z(2,J)=(RP*(SX*SX-SX*SX)*(R2/S02-R1/S01)+(RP*RP*S*SX+(CX*SX)
X*PP)/(1./S02-1./S01))/ZP
Z(3,J)=BV(3)*CX*Z(4,J)+ (RP=BV(10)*Z(4,J)+(BV(10)*CX*(RP*RP+PP
X)/(1./S02-1./S01)-RP*CX*(R2/S02-R1/S01))/ZP))
GO TO (735,736,750),M8
735 J=J+1
IF(A(1,J)-BV(7)) 731,732,732
732 SY(J)=BV(7)
SL=YL
SL2=YT
IF(YL-YT)741,742,742
742 SL=YT
SL2=YL
741 J=2
1741 IF(SY(J)-SL)744,745,745
744 DO 743 K=1,4
743 R(K,J)=Z(K,J)
Z(5,J)=SY(J)
J=J+1
GO TO 1741
745 J1=J
DO 1745 K=1,4
1745 P(K)=Z(K,J1)
M8=2
Z(5,J1)=SL1
S=SL1
CX=COF(S)
SX=SINF(S)
SYS(J1)=SX
SYC(J1)=CX
GO TO 733
736 DO 746 K=1,4
R(K,J1)=Z(K,J1)
Z(K,J1)=P(K)
746 IF(YL-YT)1748,1750,1748
1748 J=J1+1
7481 IF(SY(J)-SL2)748,749,749
748 DO 747 K=1,4
747 R(K,J)=Z(K,J)
Z(5,J)=SY(J)
J=J+1
GO TO 7481
749 J2=J
DO 1749 K=1,4
1749 P(K)=Z(K,J2)
M8=3
Z(5,J2)=SL2
S=SL2
CX=COF(S)
SX=SINF(S)
SYS(J2)=SX
SYC(J2)=CX
GO TO 733
750 DO 751 K=1,4
R(K,J2)=Z(K,J2)
Z(K,J2)=P(K)
1750 J2=J
SL=YL
ST=YT
DO 1 K=1,4
DO 1 J=2,J2
I=J-1
1 R(K,I)=R(K,J)
DO 2 J=2,J2
I=J-1
SY(I)=Z(5,J)

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      SYS(1)=SYS(J)
      SYC(1)=SYC(J)
      2 Z(5,1)=Z(5,J)
      J1=J1-1
      J2=J2-1
      IF(NPT-KR) 4682,4683,4682
      4683 IF(KSP-KS) 4682,4681,4682
      4681 PRINT 4104,RP
      4104 FORMAT(19H MID ZONE PHI AT R=F5.4)
      PRINT 2000,(SY(JP),JP=1,J2)
      4682 CONTINUE
      2000 FORMAT(9E13.5)
      C
      CONVERT CHORDWISE STATIONS FROM PHI-COORD TO PSI-COORD
      CALL CONVRT
      CHORDWISE INTEGRATION
      MID=2
      CALL KERNEL
      KS=KS+1
      IF(KS-NKN)4501,4501,450
      450 CONTINUE
      IF (NPT) 467,467,4671
      4671 PRINT 4693
      4693 FORMAT(29H INTEGRATED VA,VT IN MID ZONE)
      PRINT 2000,(WT(KS),KS=1,NKN)
      PRINT 2000,(QT(KS),KS=1,NKN)
      467 CONTINUE
      DO 8113 K=1,16
      CV(K)=CQ(K)
      8113 BV(K)=BQ(K)
      MID=1
      RETURN
      END

FOR
SUBROUTINE SUPCAV
A SUBROUTINE FOR TRANSFORMING CAMBER RATIO FROM EQUIVALENT
AIRFOIL TO SUPERCavitating FOIL
C
DIMENSION DK(20),XL(20),B(9,9),CO(9),AH(10,9),CD(10,9),FAH(20,20),
XDB(9,16),DC(9),HA(9),BP( 3,9),DE(9),BV(16),DWSH(9,20),EAH(20,18),
XX(20,20),ZZ(20,18),TIT(12),CM(20,18),CHR(20,18),
XCC(16,50),XY(50),YA(50),BB(15,50),SY(90),
SAGT(50),
LAGS(50),AB(9,9),DD(9,16),DWSHT(9,20),
XAGST(50),BQ(16 ),CV(16),VRE(20),BPP(20),CQ(16),YS(90),
XR(5,90),H(25),T(25),SPR(20),A(25,90),NF(25),AS(25,90),AC(25,90),
XSYS(90),SYC(90),UHH(90),VHH(90),UHL(90),UHT(90),VHL(90),VHT(90),
XUBL(90),UBT(90),VBL(90),VBT(90),DSA(10,35),DSAT(10,35),
X
WT(20),QT(20),Z(5,90),P(9),VP(90)
DIMENSION PSIL(90),CPSIL(90),SPSIL(90),PSIT(90),SPSIT(90),
XCPSIT(90),CPSIO(9,9),PSIO(9,9)
DIMENSION C(8,9),FHA(20,20)
COMMON DK,XL,B,CO,AH,CD,FAH,DB,DC,HA,BP,DE,BV,DWSH,EAH,XX,ZZ,TIT,
1CM,CHR,CC,XY,YX,BB,SY,SAG,AGS,AB,DD,DWSHT,SAGT,AGST,BQ,CV,VRE,BPP,
2CQ,YS,R,H,T,SPR,A,NF,AS,AC,SYC,UHH,VHH,UHL,UHT,VHL,VHT,
3UBL,UBT,VBL,VBT,DSA,DSAT,WT,QT,Z,P,VP
COMMON PSIL,CPSIL,SPSIL,PSIT,SPSIT,CPSIT,CPSIO,PSIO
COMMON C,SW
COMMON DFD,DFDD,DFDD,NL,RP,DY,LT,LH,LTH,LH1,XH,PI,FP,S,NSIN,
XGTT,XKR,KS,SM,NKN,NPT,KSP,LFCW
COMMON J1,J2,YL,YT,SL,ST,N,MID,N5C,KRN,NCL
ERASE CM,XX,ZZ
NCL=1+NCL
DO 2 J=1,NCL
XX(J,1)=XL(J)
XX(J,11)=(XL(J))*5
DO 2 K=2,NCL1
KK=K+10
XX(J,K)=XX(J,K-1)*XX(J,1)
XX(J,KK)=XX(J,KK-1)*XX(J,11)
2 CONTINUE
DO 3 K=1,KRN
DO 3 J=1,NCL
ZZ(J,K)=CMR(J,K)/C(4,K)
3 CONTINUE
CALL MATINV(XX,NCL,ZZ,KRN,V,ID)
DO 4 K=1,KRN
DO 4 J=1,NCL
DO 4 I=1,NCL
II=I+1
X=2.*FLOATF(1)/(FLOATF(1)+1.)
CM(J,K)=ZZ(I,K)*XX(J,II)*X+CM(J,K)
4 CONTINUE
PRINT 7
7 FORMAT(55H0CAMBER RATIO FOR SUPERCavitating BLADE,(CM/LT)/A1
DO 5 J=1,NCL
5 PRINT 6,XL(J),(CM(J,K),K=1,KRN)
6 FORMAT(F8.4,F16.4,8F12.4)
RETURN
END

```

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END

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