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AFFDL-TR-72-40
Volume III

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V/STOL DYNAMICS AND AEROELASTIC ROTOR-AIRFRAME TECHNOLOGY

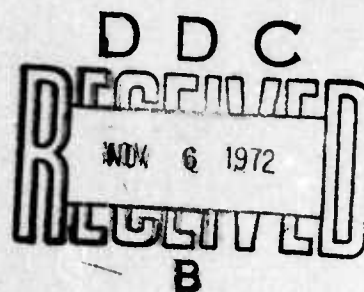
Volume III. User's Manuals – Computer
Programs for Aeroelastic Stability Analysis
and Aeroelastic Prop/Rotor Loads Analysis

A. K. Amos
F. J. Tarzanin

The Boeing Company, Vertol Division

TECHNICAL REPORT AFFDL-TR-72-40,
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V/STOL DYNAMICS AND AEROELASTIC
ROTOR-AIRFRAME TECHNOLOGY

Volume III. User's Manuals - Computer Programs
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Patterson Air Force Base, Ohio 45433.

FOREWORD

This report was prepared by The Boeing Company, Vertol Division of Philadelphia, Pennsylvania, for the Aerospace Dynamics Branch, Vehicle Dynamics Division, Air Force Flight Dynamics Laboratory, Wright-Patterson Air Force Base, Ohio, under Contract F33615-71-C-1310. This research is part of a continuing effort to develop new and improved techniques for defining dynamic and aeroelastic phenomena for rotor/propeller-powered V/STOL flight vehicles under the Air Force Systems Command's exploratory development program. This contract was initiated under Project 1370, "Dynamic Problems in Military Flight Vehicles," Task 137005, "Prediction and Control of Flight Vehicle Vibration." Mr. A. R. Basso of the Aerospace Dynamics Branch was the Project Engineer.

The final report is presented in three volumes. The first volume contains a state-of-the-art review of stability and blade vibratory loads in V/STOL aircraft. The second volume contains the development of the analytical methods, the correlation of analytical results with experimental data, and the results of parametric investigations. The third volume contains a user's guide to the digital computer programs including input and output formats. The third volume is not being distributed; however, it is available upon request from the Air Force Flight Dynamics Laboratory/FYS, Wright-Patterson Air Force Base, Ohio 45433.

Mr. H. R. Alexander was The Boeing Company, Vertol Division Project Engineer.

This report covers work conducted from February 1971 through February 1972. The manuscript was released by the authors in February 1972 for publication as an AFFDL Technical Report.

This Technical Report has been reviewed and is approved.

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ABSTRACT

This report provides user's instructions for two computer programs, one for aeroelastic stability analysis and one for aeroelastic prop/rotor loads analysis. These programs are commonly identified by Boeing-Vertol as C-39 and C-70, respectively. Each program is carefully described and explained, symbols and sign conventions are identified, and input and output data are presented. A sample program run for each analysis is then given. In addition, sample programs for subroutines D-01 and A-97, which are used in support of C-70, are provided. Notes and suggestions on program usage are presented.

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Part I. User's Manual: Computer Program
for Aeroelastic Stability Analysis

A. K. Amos

INTRODUCTION

The program is designed to generate and solve a set of equations representing flutter and vibration states of dynamic equilibrium of a general rotored aircraft system following an arbitrary perturbation from a known steady state configuration. In matrix notation, these equations are represented by

$$[-[M] + i\lambda([C] + \Gamma_I[A_I]) + \lambda^2([K] + \Gamma_R[A_R])] \{q\} = \{0\}$$

where $[M]$, $[C]$, and $[K]$ are generalized inertia, damping and stiffness matrices arising from the structural dynamics of the entire system and the aerodynamics of the rotor blades;

$[A_R]$ and $[A_I]$ are coefficient matrices arising from the aerodynamics of the airframe lifting surfaces; $\{q\}$ is a vector of system freedoms (generalized coordinates);

λ is a complex scalar parameter;
 Γ_R and Γ_I are real scaling factors; and
 i is the imaginary number $\sqrt{-1}$.

The aircraft model on which the program is based comprises three major subsystems identified as (i) Rotor, (ii) Airframe, and (iii) Landing Gear Subsystems.

The rotor subsystem is made up of two rotor-nacelle units. Each rotor has three or more non-articulated flexible blades attached to a teetering hub. Steady state rotor configurations are presumed to involve large blade deflections in flap, lag and twist, and any arbitrary inclination of the shaft axis with the direction of flight. This last feature permits treatment of tilt rotor configurations ranging from hover to forward flight conditions. Physically the rotors may be supported anywhere in the airframe and coordinates are provided for specifying the support locations for each application. Thus both helicopter and rotored conventional aircraft systems are represented by the general model of the program.

The airframe subsystem has the following components: - right wing, left wing, fuselage, right tail, left tail, and fin. Except for the fuselage, all the components are treated as lifting surfaces. The steady state airframe configuration is specified by sets of coordinates capable of representing a wide variety of practical aircraft systems. For example wing "tilt" and "sweepback" angles

of aircraft systems having these features will be reflected in the coordinates for the wing components. Wing or tail dihedral angle has, however, not been provided for.

The landing gear subsystem consists of four linearized oleo-strut-tire units. Their points of attachment in the airframe are identified by sets of coordinates to be specified for the particular systems being analyzed.

The analytical basis of the program lies in

- (i) Modal representation of system deviations from steady state equilibrium configurations;
- (ii) A basically conservative system under such deviations;
- (iii) Two-dimensional quasi-static aerodynamic theory for the rotor blades;
- (iv) Two-dimensional oscillatory aerodynamic theory for the airframe lifting bodies; and
- (v) Linearly visco-elastic oleo struts and tires.

PROGRAM FEATURES

SYSTEM DEFINITION

The aircraft model previously described has been devised to furnish a general framework representative of a large class of practical systems. To this end the system components and their steady state configurations have been characterized by general coordinates with wide ranges of specification. In addition, a number of bi-valued parameters (option indices) have been provided for eliminating from or retaining in the model entire components or subsystems in adapting it to specific cases.

Each of the two rotors can be retained or deleted to provide representation of systems with fewer than two rotors. For programming purposes the rotors have been numbered 1 and 2 respectively with the first having a higher priority of retention over the second. Thus for a single rotoed system ROTOR #1 (rather than #2) MUST be specified as RETAINED (see "Input Data" Section).

The airframe components can each be specified as present or not present depending on the particular system being analyzed. A half aircraft analysis, for example, is achieved by specifying one wing and one tail (both being either right or left) as absent, and by supplying fuselage and fin characteristics representative of half the items.

The actual number (not exceeding four) of landing gears in the particular system being analyzed is specified as input to the program which then limits the analysis to just that many gears.

MODES AND SYSTEM FREEDOMS

Perturbations of the system about its steady state equilibrium configuration are represented by a number of modes falling into three basic categories. The first is made up of BLADE VIBRATORY MODES. They are characterized by flap, lag and twist components at all points of the blades; frequencies of natural vibration at specified rotational speeds; and optionally, some measure of modal damping. Each mode is associated with a COLLECTIVE and 1P CYCLIC ROTOR FREEDOMS. There are thus three rotor freedoms per blade mode.

AIRFRAME MODES constitute the second category. They are defined for each point of the system including the rotor blades (after blade modes have been accounted for). Each is associated with a single airframe modal freedom. The third category of modes arises from the landing gears with each mode defined to produce no displacements

anywhere except at one of the gear sprung masses where it gives rise to a vertical displacement of unit magnitude. Each of the gears is thus affected by only one mode and hence one degree of freedom.

LOOPING

The program features automatic cycling (looping) through the analysis for several problem cases representing parametric variations in some of the system characterizations. In usage, a full set of input data is supplied for the first case and only updates of a group of pre-established data items for all subsequent cases. Five such groups of data as described below are available for optional selection.

- OPTION 1: Aircraft velocity components as well as air density and the speed of sound vary from case to case.
- OPTION 2: Rotor RPM and steady state blade deflections for all rotors present are updated for each case.
- OPTION 3: The items in options 1 and 2 together are updated for each case.
- OPTION 4: Updated items consist of the modal frequencies and damping factors for the elastic modes of the system.
- OPTION 5: The landing gear properties are updated for each case.

INPUT DATA

The program accepts data on cards only. All data items must be based on a slug-foot-second set of units. However, rotational velocities and frequency items are input as either RPM or radians per second as indicated later in this section.

The input data has been arranged in groups as described below:

- Data Group A: Program Definition: Specifies the problem title, the six components of rigid displacement, and a series of logical data to define the general features of the current program application. This group is required for all runs.
- Data Group BI: Rotor Configuration Definition: Includes parameters for defining the rotor subsystem as to the number of rotors involved, their mode of operation, and the blade mode freedoms to be considered in the analysis. Each of the three modal freedoms (collective, cyclic yaw, cyclic pitch) for any of the blade modes provided can be arbitrarily eliminated from the analysis where this is desirable in obtaining a realistic representation of the rotor system. The group must be specified for all runs.
- Data Group BII: Rotor Data Set No. 1: This group is not required if no rotors are involved in the analysis. It contains numerical data for all the characteristics of the first (and for identical rotors, the second) rotor in the system.
- Data Group BIII: Rotor Data Set No. 2: This group of data is required only when two dissimilar rotors are involved in the analysis. It is not required for a single rotor or a pair of geometrically identical and operationally similar rotors. In the later case the first set applies to both rotors.
- Data Group BIV: Nacelle No. 1 Parameters: Geometrical and basic dynamic properties of the first nacelle in the system are here defined. It is presumed that this nacelle and Rotor No. 1 are parts of the same physical unit and a nacelle-rotor coupling between them is automatically generated using data specified separately for each.

- Data Group BV: Nacelle No. 2 Parameters: Repetition of the previous group for the second nacelle if present. Otherwise this group must be eliminated.
- Data Group CI: Airframe Configuration Definition: Required for all runs, it specifies the airframe components present in the analysis.
- Data Group CII: Right Wing Parameters: Required if this component has been specified present in CI. Otherwise omit entire group.
- Data Groups CIII Through CVII: Parameters for Other Airframe Components: Same items (with some modifications) as defined for Group CII but applicable to the other airframe components in order. However, they are included in the data package only if the components they apply to have been specified in CI as present.
- Data Group CVIII: Airframe Modal Frequencies and Damping Factors: The modal frequencies of the airframe elastic modes and the corresponding damping factors due to the airframe structure are specified here. Entire group must be eliminated if no elastic modes are present.
- Data Group D: Landing Gear Properties: Not required if no landing gears are involved in the analysis.
- Data Group E: Airframe Aerodynamics Supplemental Data: Comprises sweepback angles for the airframe lifting bodies and a reduced frequency for the first solution case.
- When airframe aerodynamics are being ignored in the analysis, this group of data must be eliminated.
- Data Groups FI, FII...FV: Data Updates for Looping Options 1 Through 5: The group of data appropriate to the looping option previously selected is repeated for each solution case following the first.

Following is a tabulation and description of the input data items and their governing input formats.

DATA GROUP A: Required for all runs

A-1

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		CARD NO	ENTRY DESCRIPTION	
			NO.	FORMAT		ENTRY NO.	DESCRIPTION
1	1	1	1	72 Alpha-Numeric Characters: Cols 1-72	1	1	Problem Title
2	1	6	1 Thru 6	Floating Pt. Numbers in Successive Fields of 13 Cols Each Starting From Col 1	1	1 2 3 4 5 6	Rigid Mode Shape: Long.Transl. Rigid Mode Shape: Lat.Transl. See Note #1 p. 40 Rigid Mode Shape: Vert.Transl. Rigid Mode Shape: Roll Rigid Mode Shape: Pitch Rigid Mode Shape: Yaw
3	1	16	1	Fixed Pt. numbers right justified in succ.fields of 5 Cols. each starting from Col 1	1	1 thru 6 7 8 9 10 11	Retention indices for the rigid modes in the order specified above. Enter 1 : to retain, 0 : to delete corresp. mode No. of rotor data sets(0, 1 or 2) No. of elastic modes(0 to 6 incl.) No. of landing gears(0 to 4 incl.) Looping option number(1 to 5 incl.) Continuation index Enter 0 : to terminate after 1st case 1 : to continue after 1st case

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		E N T R Y D E S C R I P T I O N		
			NO.	FORMAT	CARD NO.	ENTRY NO.	DESCRIPTION
							Print Option: Rotor contributions to coeff. matrices Print Option: Airframe contributions Print Option: Landing Gear Contribu- tions Print Option: Final Coeff. Matrices Enter 1 : to print, } Entries 0 : not to print } 12 - 15 Solution Mode Selector Enter 1 : for flutter solution, 0 : n vibration solution
						12	
						13	
						14	
						15	
						16	

DATA GROUP BI: Required for all runs

BI-1

CARD GRP. NO.	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION		
		NO.	FORMAT	CARD NO.	ENTRY NO.	DESCRIPTION
1	3	1 thru 14	Fixed point right justified in succ. fields of 5 Cols. each starting in Col. 1	1	1	No. of Blade Modes (0 thru 4 incl.)
					2	Retention Index for
					3	Collective Freedom; Blade Mode #1
					4	Collective Freedom; Blade Mode #2
					5	Collective Freedom; Blade Mode #3
					6	Collective Freedom; Blade Mode #4
					7	LP Cyclic Yaw Freedom; Blade Mode #1
					8	LP Cyclic Yaw Freedom; Blade Mode #2
					9	LP Cyclic Yaw Freedom; Blade Mode #3
					10	LP Cyclic Yaw Freedom; Blade Mode #4
					11	LP Cyclic Pitch Freedom; Blade Mode #1
					12	LP Cyclic Pitch Freedom; Blade Mode #2
					13	LP Cyclic Pitch Freedom; Blade Mode #3
					14	LP Cyclic Pitch Freedom; Blade Mode #4
						Enter 1: to retain } Entries 2 - 13 0: to delete
						Induced velocity option: Enter 1: to include 0: to exclude
				2	1	Retention Index:
					2	Rotor Teetering Pitch Freedom
					3	Rotor Teetering Yaw Freedom
						Roll Perturbation Freedom
						Enter 1: to retain } Entries 1 - 3 0: to delete

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY NO.		DESCRIPTION
			NO.	FORMAT	CARD NO.	ENTRY NO.	
					3	1 2 3 4 5 6	Rotor 1 present/absent index } 1=Present Rotor 2 present/absent index } 2=Absent Rotor 1 operative/inoperative index } Rotor 2 operative/inoperative index } 1=Oper. Rotor 1 direction of rotation } 2=Inop. Rotor 2 direction of rotation } 1 = Clockwise Rotor 2 direction of rotation } 2 = Counter-clockwise viewed from behind.
						7	Print option for rotor derivatives Enter 1 : to print 2 : not to print
2	1 OR 2	1	1	40 Alpha-numeric characters: Cols 1-40	1	1 2	Rotor 1 Description } omit if only Rotor 2 Description } 1 rotor pre-sent
3	1	5 (MAX)	1	Floating pt. in succ. fields of 13 cols ea. starting in Col. 1	1	1 2 3	Air density in slugs/ft. ³ Speed of sound in ft/sec A/C speed component parallel to A/C X axis (ft/sec) } See Fig. 1

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION		
			NO.	FORMAT	CARD NO.	ENTRY NO.	DESCRIPTION
				This format will henceforth be designated standard		4	A/C speed component parallel to A/C Y axis (ft/sec) See Fig. 1
						5	A/C speed component parallel to A/C Z axis (ft/sec)
4	1	2	1 & 2	Fixed pt. right justified numbers in fields of 5 Cols. ea starting in Col. 1	1	1	Index pertaining to "ALPHA DOT" terms in Rotor Aerodynamics 1 = Include 0 = Exclude terms
						2	Index pertaining to compressibility correction in Rotor Aerodynamics 0 = Correction applied as necessary 1 = Correction not applied.

DATA GROUP BII: Omit if Entry No. 7 on Card 3 of Data Group A is zero.

BII-1

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION		
			NO.	FORMAT	CARD NO.	ENTRY NO.	DESCRIPTION
1	1	2	1 & 2	Fixed pt. right justified numbers in fields of 5 Cols. ea starting in Col. 1	1	1	No. of blades
						2	No. of blade segments (10 maximum)
2	1	5	1 thru 5	Standard (See Card Group 3, Data Group BI)	1	1	Blade length in ft.
						2	Blade mount eccentricity, ex (ft)
						3	Blade "rigid root" length ey (ft)
						4	Blade mount eccentricity, ez (ft)
						5	Steady state upwash angle (degrees)
3	1 OR 2	6 (MAX) thru 6	1	Standard (See Card Group 3, Data Group BI)	1	1 thru 6	Distances from blade root point to "mass points" of 1st 6 blade segments (ft).
					2	1 thru 4	Distances as above for } NOTE: Omit 2nd card if No. of blade segments is 6 or less

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION	
			NO.	FORMAT	CARD NO.	ENTRY NO.
4 thru 19	1 or 2	6 (MAX)	1 thru 6	Standard	1	1 thru 6
					2	1 thru 4

Items, as described on the following pages, pertaining to 1st six blade segments

Same items as above } Note: Same for segments 7 thru as on previous page. 10.

BII-3		
GRP. NO.	ITEM DESCRIPTION	UNITS
4	Mass per unit length	slugs/ft
5	C.G. location aft of elastic axis	ft.
6	Mass moment of inertia per unit length about local chord axis (assumed to pass through elastic center)	slug-ft ² /ft
7	Mass moment of inertia per unit length about normal to chord axis passing through elastic center	slug-ft ² /ft
8	Average chord length over segment length	ft.
9	Aerodynamic center location ahead of quarter-chord at a representative section as ratio of average chord length	N.D.
10	Quarter-chord location ahead of elastic axis at a representative section as ratio of average chord length	N.D.
11	Lift curve slope	N.D.
12	Drag coefficient d_0	} See Note #2, p. 40 N.D.
13	Drag coefficient d_1	
14	Drag coefficient d_2	
15a	Lag components of four blade modes successively.	} ft.
15b	<u>Note:</u> If less than 4 blade modes are involved, the items here must be accordingly limited.	
15c		
15d		
16a		Flap components of four blade modes in succession
16b	<u>Note:</u> As above.	
16c		
16d		
17a		Rate of increase with blade length of lag components
17b	of blade modes.	
17c	<u>Note:</u> As for 15	
17d		
18a	Rate of increase with blade length of flap	} N.D.
18b	components of blade modes.	
18c	<u>Note:</u> As for 15.	
18d		
19a	Twist components of four blade modes in	} Radians
19b	succession.	
19c	<u>Note:</u> As for 15.	
19d		

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY NO.		DESCRIPTION
			NO.	FORMAT	CARD NO.		
20	1	3	1 thru 3	Standard	1	1	Rotor angular velocity (RPM)
21 thru 25	1 or 2	6 MAX	1 thru 6	Standard	1	1 thru 6	Pitch component of steady state hub teetered angle (degrees)
					2	1 thru 4	Yaw component of steady state hub teetered angle (degrees)
							Items, as described below, pertaining to 1st six blade segments Same items as above for } Note: As segments 7 thru 10. } for Grp. 3
							GP. --- DESCRIPTION --- UNITS
							21 Lag components (collective) ft. of steady state blade displacements.
							22 Flap components of above ft. displacements.
							23 Rate of increase with blade length of lag components in 21. N.D.
							24 Rate of increase with blade length of flap components in 22. N.D.
							25 Steady state twist angles (including geometric twist and collective pitch) Degs

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION		
			NO.	FORMAT	CARD NO.	ENTRY NO.	DESCRIPTION
26	4	4	1 thru 4	Standard	1	1 thru 4	Blade modal frequencies (rotating) in radians/sec.
					2	1 thru 4	Structural damping coefficients for the blade modes (N.D.)
					3	1 thru 4	Fractional critical viscous damping in the blade modes.
					4	1 only	Rotor RPM corresponding to the blade modal frequencies above (RPM)
27A	5	3	1 thru 3	Standard	1	1 thru 3	Induced velocity components for 1st blade segment. Note: See Note #3 p. 40 for definition of symbols. Omit all cards if induced velocities are excluded i.e., Entry #14 on first card of Data Grp. BI is zero.
					2	1 thru 3	
					3	1 thru 3	
					4	1 thru 3	
					5	1 thru 3	
27B thru 27J			Repeat Card Group 27A for 2nd and subsequent blade segments.				

DATA GROUP BIII: Required only if a second rotor is present.

BIII-1

CARD GRP. NO.	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION		
		NO.	FORMAT	CARD NO.	ENTRY NO.	DESCRIPTION
1 thru 26	Same items as of Data Group BII.		in the correspondingly		numbered card groups	<u>Note:</u> Omit if No. of Data Sets (entry no. 7 on Card 3 of Data Group A) is less than 2.
27A thru 27J	The correspondingly BII are repeated here		numbered card groups from Data Group			<u>Note:</u> Omit if induced velocities are not included; i.e. entry No. 14 on first card of Data Group BI is zero.

DATA GROUP BIV: Omit if rotor 1 is absent, i.e., Entry No. 1,
 Card no. 3 in Group 1 of Data Group BI is 2. BIV-1

CARD GRP. NO.	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		E N T R Y D E S C R I P T I O N	
		NO.	FORMAT	CARD NO.	ENTRY NO. DESCRIPTION
1	6	1 thru 6	Standard	1	.1 2 3 4 5 6
					<p>X coordinate (A/C axes) of nacelle axis at its root in the airframe (ft.)</p> <p>Y coordinate corresp. to above (ft.)</p> <p>Z coordinate corresp. to above (ft.)</p> <p>"Tilt" angle of airframe component (e.g. wing) at nacelle root (degrees)</p> <p>"Tilt" angle of nacelle axis relative to airframe component at nacelle root (degrees).</p> <p>Number of nacelle "mass" points (10 max)</p> <p>Note: The last "mass" point must apply to the rotor hub and is considered massless. ANY MASS SPECIFIED FOR LAST MASS POINT WILL BE IGNORED. To account for a hub mass, the mass points should be specified such that the last two BOTH REPRESENT THE HUB POINT. The hub mass is then specified for the last but one mass point.</p>

CARD GRP. NO.	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION		
		NO.	FORMAT	CARD NO.	ENTRY NO.	DESCRIPTION
2	Var. 1 to 5	1 thru 6	Standard	1	1 thru 3	Coords. in rotor axes of mass point 1
				2	4 thru 6	Coords. in rotor axes of mass point 2.
				3	1 thru 3	Coords. of mass point 3
				4	4 thru 6	Coords. of mass point 4
				5	1 thru 3	Coords. of mass point 5
3a	Var. 1 to 10	1 thru 6	Standard	1	4 thru 6	Coords. of mass point 6
				2	1 thru 3	Coords. of mass point 7
				3	4 thru 6	Coords. of mass point 8
				4	1 thru 3	Coords. of mass point 9
				5	4 thru 6	Coords. of mass point 10
3a	Var. 1 to 10	1 thru 6	Standard	1	1 thru 3	Displacement components (rotor axes) of 1st elastic mode at 1st mass point(ft.)
				2	4 thru 6	Rotation components(rotor axes) of 1st elastic mode at 1st mass point (radians)
				2 thru 10	1 thru 3 4 thru 6	Same items as for card 1 but pertaining to 2nd, 3rd,....10th mass points successively

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION		
			NO.	FORMAT	CARD NO.	ENTRY NO.	DESCRIPTION
3b 3c 3d 3e 3f	SAME	AS FOR	3a				Items specified in 3a for 1st elastic mode are repeated for 2nd, 3rd,.....6th elastic modes as applicable.
4	Var. 1 to 10	4	1 thru 4	Standard	1	1 2 3 4	Mass at mass point 1 (SLUGS) Mass moments of inertia at mass point 1 about rotor coordinate axes. (SLUG-FT ²)
					2 thru 10	Repeat 10 as applicable	Card 1 data for mass points 2 through applicable

DATA GROUP CI: Required for all runs.

CI-1

CARD GRP. NO.	CARD NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		CARD NO.	ENTRY NO.		DESCRIPTION
			NO.	FORMAT		ENTRY NO.	DESCRIPTION	
1	1	7	1 thru 7	Fixed point numbers in succ.fields of 5 cols. each starting from col. 1	1	1 thru 6	Indices pertaining to the following airframe components in order: - 1. Right Wing 2. Left Wing 3. Fuselage 4. Right Tail 5. Left Tail 6. Fin They define the presence or absence of the corresponding components in the system being analyzed. Enter 1: if component is present; 0: if component is absent.	
						7		Index referring to airframe aerodynamics. Enter 1: if aerodynamics are to be included in analysis; 0: if aerodynamics are to be neglected in analysis
2	1	2	1 & 2	Standard	1	1 2	Reference semi-chord (ft.) Reference panel width (ft.) <u>Note:</u> This card must be eliminated if entry 7 on previous card is zero.	

DATA GROUP CII: Omit if right wing is absent, i.e., Entry No. 1
on Card 1 of Data Group CI is zero. CII-1

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY NO.		DESCRIPTION	
			NO.	FORMAT	CARD NO.			
1	1	1	1	Fixed point right justified in cols 1-5	1	1	Number of panels (N.D.)	
2a	Var. 1 to 20	6	1 thru 6	Standard	1	1 thru 3	Displacement components (local axes) of 1st elastic mode at first panel (ft.) Rotation components (radians) of 1st elastic mode at 1st panel For local axes, see Fig. 4	
					2 thru 20	4 thru 6		Same items as for card 1 but pertaining to panels 2 through 20 as applicable.
2b	Same as for 2a						Items specified in 2a for 1st elastic mode are repeated for 2nd through 6th elastic modes as required.	
2c								
2d								
2e								
2f								
3	Var. 2 to 40	6 MAX.	1 thru 6	Standard	1	1 thru 3	Coordinates (aircraft axes) of panel reference point (i.e., pt. at which mode shapes are specified) for 1st panel (ft.) Panel "TILT" angle (about A/C pitch axis) (Degrees) 1st 2 coordinates (local axes) of panel c.g. relative to panel ref.pt.	

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION		
			NO.	FORMAT	CARD NO.	ENTRY NO.	DESCRIPTION
					2	1	Third coordinate (local axes) of panel c.g. relative to panel ref. point (ft.)
					3 & 4	Same as	1 & 2 above but for panel no. 2
					5 & 6	Same as	1 & 2 above but for panel no. 3
					.	.	.
					.	.	.
					.	.	.
					39 & 40	Same as	1 & 2 above but for panel no. 20
4	Var. 1 to 20	4	1 thru 4	Standard	1	1	Mass of Panel 1 (SLUGS)
						2	Mass moments of inertia of panel 1 about local axes passing through panel c.g.
						3	
						4	
						4	
						2 thru 20	Repeat card 1 data for panels 2 through 20 as applicable
5	Var. 1 to 4	6 MAX.	1 thru 6	Standard	1	1 thru 6	Widths (ft.) of 1st 6 panels
					2	1 thru 6	Widths (ft.) of panels 7 thru 12 as applicable
					3	1 thru 6	Widths (ft.) of panels 13 thru 18 as applicable
					4	1 and 2	Widths (ft.) of panels 19 and 20 as applicable
							<u>Note:</u> As for Grp. 7. See Below

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION		
			NO.	FORMAT	CARD NO.	ENTRY NO.	DESCRIPTION
6	Var. 1 to 4	6 MAX.	1 thru 6	Standard	1	1 thru 6	Semi-chord lengths (ft.) Panels 1 through 6
					2	1 thru 6	Semi-chord lengths (ft.) Panels 7 through 12
					3	1 thru 6	Semi-chord lengths (ft.) Panels 13 through 18
					4	1 and 2	Semi-chord lengths (ft.) Panels 19 and 20
<p><u>Note:</u> As for Grp. 7 below.</p>							
7	Var. 1 to 4	6 MAX.	1 thru 6	Standard	1	1 thru 6	"ab" distances (ft.), Panels 1 through 6
					2	1 thru 6	"ab" distances (ft.), Panels 7 through 12
					3	1 thru 6	"ab" distances (ft.), Panels 13 through 18
						1 and 2	"ab" distances (ft.), Panels 19 and 20
<p><u>Note:</u> All entry items in Groups 5, 6, and 7 should be omitted if airframe aerodynamics are not being considered in analysis, i.e. entry No. 7 on Card 1, Group CI is zero.</p>							

<u>DATA GROUP CIII:</u>	Required if left wing is present, i.e. entry number 2 on Card 1 of Data Group CI is <u>1</u> .	The entry items described for Data Group CII are repeated for the left wing.
<u>DATA GROUP CIV:</u>	Required if fuselage is present; i.e., entry number 3 on Card 1 of Data Group CI is <u>1</u> .	The entry items described for Data Group C-II under Card Groups 1 through 4 are repeated for the fuselage.
<u>DATA GROUP CV:</u>	Required if right tail is present; i.e., entry number 4 on Card 1 of Data Group CI is <u>1</u> .	Entry items described for Data Group CII are repeated for right tail.
<u>DATA GROUP CVI:</u>	Required if left tail is present; i.e., entry number 5 on Card 1 of Data Group CI is <u>1</u> .	As above for left tail.
<u>DATA GROUP CVII:</u>	Required if fin is present; i.e., entry number on Card 1 of Data Group CI is <u>1</u> .	As above for the fin.

DATA GROUP CVIII: Omit if number of elastic modes (Entry No. 8 on Card 3 of Data Group A) is zero. CVIII-1

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION		
			NO.	FORMAT	CARD NO.	ENTRY NO.	DESCRIPTION
1	1	1	1	Fixed point right justified in 1st 5 cols.	1	1	Damping type selector Enter 1: if airframe damping is to be treated as viscous; 2: if it is to be treated as structural; or 3: if it is a combination of both types.
2	3	6	1 thru 6	Standard	1	1 thru 6	Modal frequencies (Radians/Sec) for the six elastic modes as applicable Fractional critical viscous damping in elastic modes (N.D.) Structural damping coefficients (N.D.)

DATA GROUP D: Omit if no landing gears are involved in analysis
 i.e., Entry No. 9 on Card 3 of Data Group A is zero. D-1

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION	
			NO.	FORMAT	CARD NO.	ENTRY NO.
1a	Var. 1 to 4	6	1 thru 6	Standard	1	1 thru 3
					4 thru 6	4 thru 6
1b 1c 1d 1e 1f	Same as for 1a				2	Same items as for Card 1 but relating to landing gears 2, 3, 4, as applicable.
					3	
					4	
2	Var. 1 to 4	4	1 thru 4	Standard	1	1 thru 3
						4
					2	Coordinates (A/C axes) of landing gear 1 attachment point in airframe (ft.) Distance (ft.) of Gear 1 wheel mass location below attachment point in airframe items as for card 1 but relating to landing gears 2, 3, 4, as applicable.
					3	
					4	

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		E N T R Y D E S C R I P T I O N		
			NO.	FORMAT	CARD NO.	ENTRY NO.	DESCRIPTION
3	Var. 1 to 4	1	1	Standard	1	1	Wheel mass for landing gear 1 Wheel masses for gears 2, 3, 4, as required.
4	Var. 1 to 4	4	1 thru 4	Standard	1 2 3 4	1 thru 4 thru 4 thru 4 thru 4	Damping coefficients for Gear 1 Damping coefficients for Gear 2 Damping coefficients for Gear 3 Damping coefficients for Gear 4 (lb-sec/ft. units) See typ. gear represe- tation, Fig. 5
5	Var. 1 to 4	4	1 thru 4	Standard	1 2 3 4	1 thru 4 thru 4 thru 4 thru 4	Stiffness coefficients for Gear 1 Stiffness coefficients for Gear 2 Stiffness coefficients for Gear 3 Stiffness coefficients for Gear 4 See typ. gear represe- tation, Fig. 5

DATA GROUP E: Omit if airframe aerodynamics are not being considered in analysis, i.e., Entry No. 7 on Card 1, Group CI is zero.

CARD GRP: NO.	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		E N T R Y D E S C R I P T I O N E-1		
		NO.	FORMAT	CARD NO.	ENTRY NO.	DESCRIPTION
1	5 MAX.	1 thru 5	Standard	1	1	"Sweepback" angle (degrees) of first airframe component (excluding fuselage) specified present in <u>Data Group CI</u> .
					2 3 4 5	"Sweepback" angles (degrees) of 2nd, 3rd, 4th, 5th airframe components (excluding fuselage) specified present in <u>Data Group CI</u> .
2	1	1	Standard	1	1	Reduced frequency

DATA GROUP FI: Required for multi-case runs under Looping Option 1
 i.e., Entries 10 and 11 on Card 3, Data Group A are
 respectively 1 and 1.

FI-1

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY NO.		DESCRIPTION
			NO.	FORMAT	CARD NO.	ENTRY NO.	
1	1	2	1 & 2	Fixed point right justified in Cols. 1-5 and Cols. 6-10	1	1	Program continuation/termination index: Enter 1: to continue, 0: to terminate after this case
						2	Induced velocity index: 1 = read new values 0 = retain values from pre- vious case
2	1	5	1 thru 5	Standard	1	1 2 3 4 5	Air density in slugs/ft ³ Speed of sound ft/sec A/C speed component parallel to X axis, ft/sec A/C speed component parallel to Y axis, ft/sec A/C speed component parallel to Z axis, ft/sec
3A thru 3J	As	in Data Group BII, Card Groups 27A thru 27J					Omit all card groups if induced velo- city index above is zero.
4A thru 4J	As	in Data Group BIII, Card Groups 27A thru 27J					

DATA GROUP FIII: Required for multi-case runs under Looping Option 3 i.e., Entries 10 and 11 on Card 3, Data Group A are respectively 3 and 1. FIII-1									
CARD GRP. NO.	NO. OF OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION				
			NO.	FCRMT	CARD NO.	ENTRY NO.	DESCRIPTION		
1	1	2	1 & 2	Fixed point right jus- tified in Cols. 1-5 and Cols. 6-10	1	1	1	Program continuation/termination index: Enter 1: to continue 0: to terminate after this case	
2	1	5	1 thru 5	Standard	1	1	1 2 3 4 5	Induced velocity index: 1 = read new values 0 = retain values from previous case	
3	1	3	1 thru 3	Standard	1	1	1 2 3	As for data group FI, Card Grp. 2	
4 thru 8	1 OR 2	6 MAX.	1 thru 6	Standard	1 2	1	1 thru 6 1 thru 4	As for data group FII, Card groups 3 through 7 respectively.	
9A thru 9J	As in	Data Group BII		Card Groups	27A		through 27J	Omit all card groups if induced velocity index above is zero.	
10 thru 14	1 OR 2	6 MAX.	1 thru 6	Standard	1 2	1	1 thru 6 1 thru 4	As for data group FII, Card groups 9 through 13 respectively.	

FI-2

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		E N T R Y D E S C R I P T I O N		
			NO.	FORMAT	CARD NO.	ENTRY NO.	DESCRIPTION
5	1	1	1	Standard	1	1	<p>Reduced frequency for this case <u>Note:</u> Omit if airframe aerodynamics are being neglected, i.e. Entry 7, Card Group 1 of Data Group CI is zero.</p>

DATA GROUP FII: Required for multi-case runs under Looping Option 2
 i.e., Entries 10 and 11 on Card 3, Data Group A are
 respectively 2 and 1.

FII-1

CARD GRP. NO.	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION		
		NO.	FORMAT	CARD NO.	ENTRY NO.	
1	2	1 & 2	Fixed point right jus- tified in Cols. 1-5 and Cols. 6-10.	1	1	Program continuation/termination index: Enter 1: to continue 0: to terminate after this case
2	3	1 thru 3	Standard	1	1	Induced velocity index: 1 = read new values 0 = retain values from previous case
3 thru 7	6 MAX.	1 thru 6	Standard	1	1 thru 6	Rotor angular velocity (RPM) Pitch component of hub teetered angle (°) Yaw component of hub teetered angle(°)
				2	1 thru 4	Items, as described below, pertaining to 1st six blade segments. Same items as above for segments 7 through 10 as necessary.
						GP --- DESCRIPTION --- UNITS 3 Lag components (collective) ft. of steady state blade dis- placements. 4 Flap components of above ft. displacements. 5 Rate of increase with blade N.D. length of lag components 3. 6 Rate of increase with blade N.D. length of flap components 4. 7 Steady state twist angles Degs (including geometric twist and collective pitch).

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION		
			NO.	FORMAT	CARD NO.	ENTRY NO	DESCRIPTION
8A thru 8J	As	in Data Group	Group	BII, Card Groups	27A through 27J	Omit all card groups if induced velocity index above is zero.	
9 thru 13	1 or 2	6 MAX.	1 thru 6	Standard	1	1 thru 6	As described above for Groups 3 through 7 but pertaining to second rotor data set. Note: These groups must be eliminated if number of rotor data sets (Entry No. 7, Card Group 3 of Data Group A) is less than 2.
14A thru 14J	As in	Data Group	BIII, Card Groups	27A	Omit if second rotor is absent or induced velocity index is zero.		
15	1	1	1	Standard	1	1	Reduced frequency for this case. Note: Omit if airframe aerodynamics are being neglected, i.e. Entry 7, Card Group 1 of Data Group CI is zero.

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION		
			NO.	FORMAT	CARD NO.	ENTRY NO.	
15A thru 15J	As in	Data Group BIII, Card Groups 27A				through 27J	Omit if second rotor is absent or induced velocity index above is zero.
16	1	1	Standard	1	1	Reduced frequency for this case. Note: Omit if airframe aerodynamics are being neglected i.e., Entry 7, Card Group 1 of Data Group CI is zero.	

DATA GROUP FIV: Required for multi-case runs under Looping Option 4
i.e., Entries 10 and 11 on Card 3, Data Group A are
respectively 4 and 1.

FIV-1

CARD GRP. NO.	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		E N T R Y D E S C R I P T I O N		
		NO.	FORMAT	CARD NO.	ENTRY NO.	DESCRIPTION
1	1	1	Fixed point right jus- tified in cols 1-5	1	1	Program continuation/termination index Enter 1: to continue 0: to terminate after this case
2	6	1 thru 6	Standard	1	1 thru 6	Modal frequencies (radians/sec) for the six elastic modes as applicable
				2	1 thru 6	Fractional critical viscous damping in elastic modes (N.D.)
				3	1 thru 6	Structural damping coefficients (N.D.)
3	1	1	Standard	1	1	Reduced frequency for this case. <u>Note:</u> Omit if airframe aerodynamics are being neglected, i.e. Entry 7, Card Group 1 of Data Group CI is zero.

DATA GROUP FV: Required for multi-case runs under Looping Option 5
i.e., Entries 10 and 11 on Card 3, Data Group A are
respectively 5 and 1.

FV-1

CARD GRP. NO.	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		E N T R Y D E S C R I P T I O N		
		NO.	FORMAT	CARD NO.	ENTRY NO.	DESCRIPTION
1	1	1	Fixed point right jus- tified in cols. 1-5	1	1	Program continuation/termination index Enter 1: to continue, 0: to terminate after this case
2 thru 6						As for Data Group D, Card Groups 1 through 5 respectively.
7	1	1	Standard	1	1	Reduced frequency for this case. <u>Note:</u> Omit if airframe aero- dynamics are being ignored, i.e., if Entry 7, Card Group 1 of Data Group CI is zero.

NOTES:-

1. Sign Convention for Rigid Modes is:

Longitudinal translation positive FORWARD
Lateral translation positive to the RIGHT
Vertical translation positive DOWNWARD
Roll translation positive RIGHT SIDE DOWN
Pitch translation positive NOSE UP
Yaw translation positive RIGHT SIDE BACKWARD

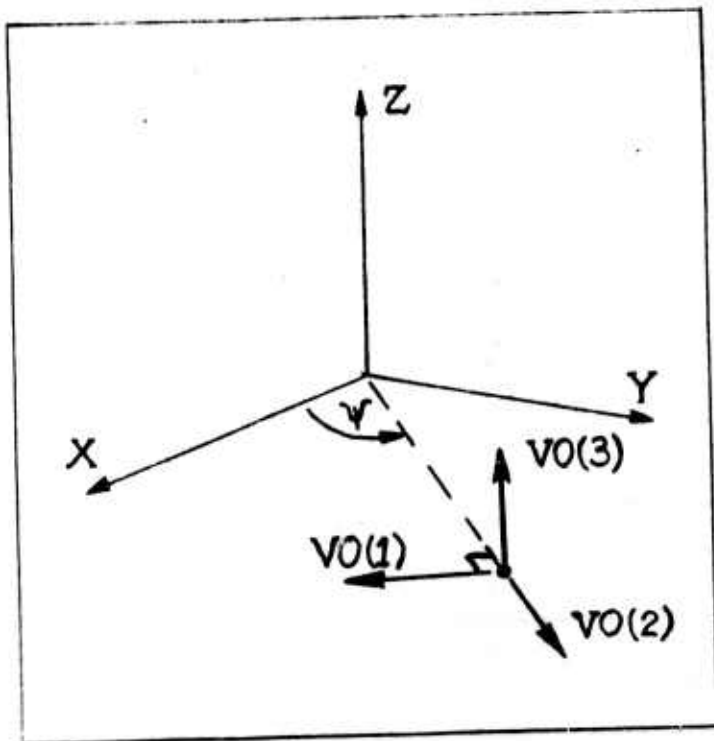
2. Drag coefficients d_0, d_1, d_2 are components of the Net Drag coefficient (C_D) according to the formula

$$C_D = d_0 + d_1 \alpha + d_2 \alpha^2$$

where α represents aerodynamic angle of attack.

3. The induced velocity vector $\{VI\}$ at a given blade segment is represented by a truncated harmonic series of the azimuth angle ψ :

$$\{VI\} = \{VO\} + \{V1C\} \cos \psi + \{V1S\} \sin \psi + \{V2C\} \cos 2\psi + \{V2S\} \sin 2\psi$$



Each of the above coefficient vectors is made up of a tangential and a radial component each parallel to the hub-disc-plane, and a normal component as illustrated in the adjoining sketch for $\{VO\}$

PROGRAM OUTPUT

The program generates a printed output of several items which fall into three major classes as described below.

1. **Basic Data:** A number of selected input data and program options are printed out with adequate descriptive headings and/or other qualifications to help identify them.
2. **Coefficient Matrices:** Contributions to the coefficient matrices by the various subsystems and the final matrices resulting therefrom are optionally printed out by rows with row number identifications and a descriptive heading for each complete matrix. The rows and columns are associated with generalized forces and displacements, velocities or accelerations corresponding to the system freedoms ordered in the following sequence:
 - (i) System rigid body freedoms, if any;
 - (ii) Airframe elastic mode freedoms, if any;
 - (iii) Teetering freedoms in pitch, yaw and roll for the first rotor, as present;
 - (iv) Blade mode freedoms for the first rotor, as present;
 - (v) Teetering freedoms for the second rotor, if any;
 - (vi) Blade mode freedoms for the second rotor, as present; and
 - (vii) Landing gear freedoms, if any.

The blade mode freedoms are arranged with the collective freedoms of all modes occurring first, followed by the cyclic yaw and finally the cyclic pitch freedoms.
3. **Problem Solutions:** Both the vibration and flutter solutions for a given case consist of a table of complex roots of the matrix equations and their related physical quantities, and optionally the corresponding vectors.

The physical quantities related to the roots include frequencies, a measure of damping (defined differently for the two solution types), and in the case of the flutter solution, the flutter velocities.

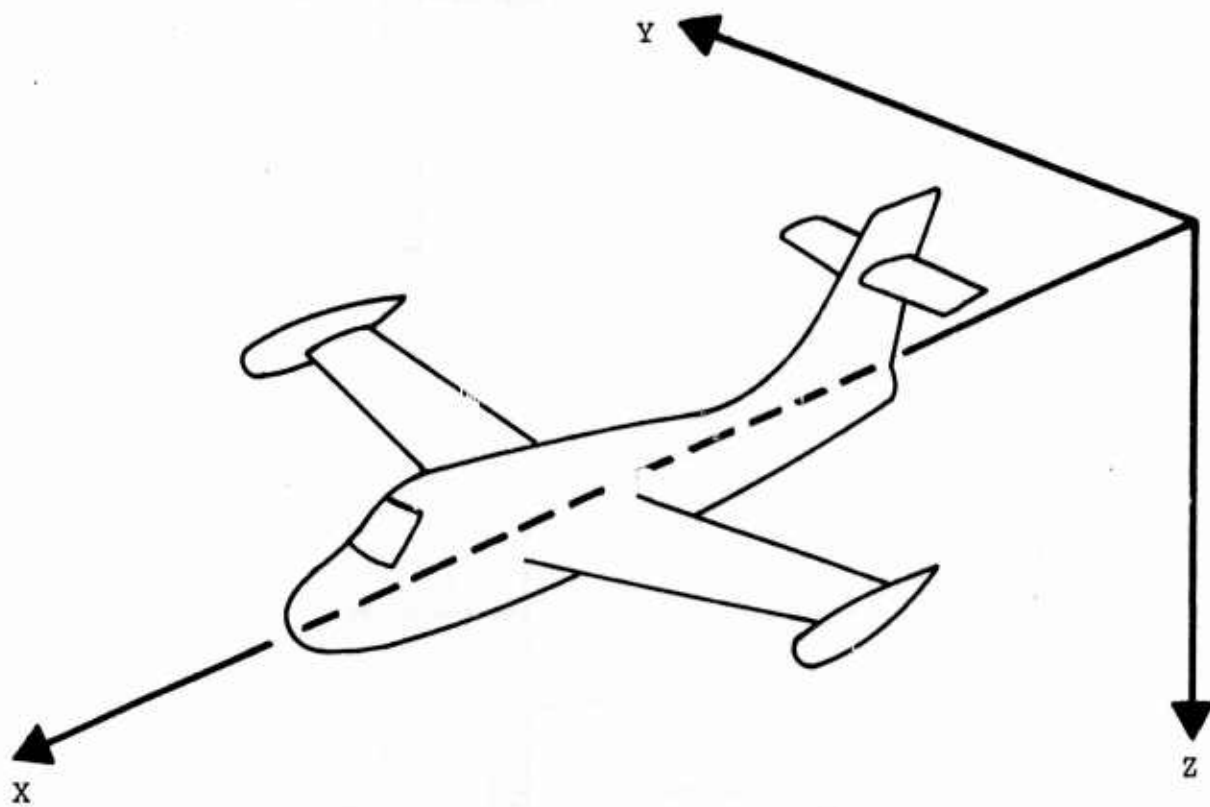


Figure 1. Aircraft Coordinate Axes (Fixed-Coordinate System)

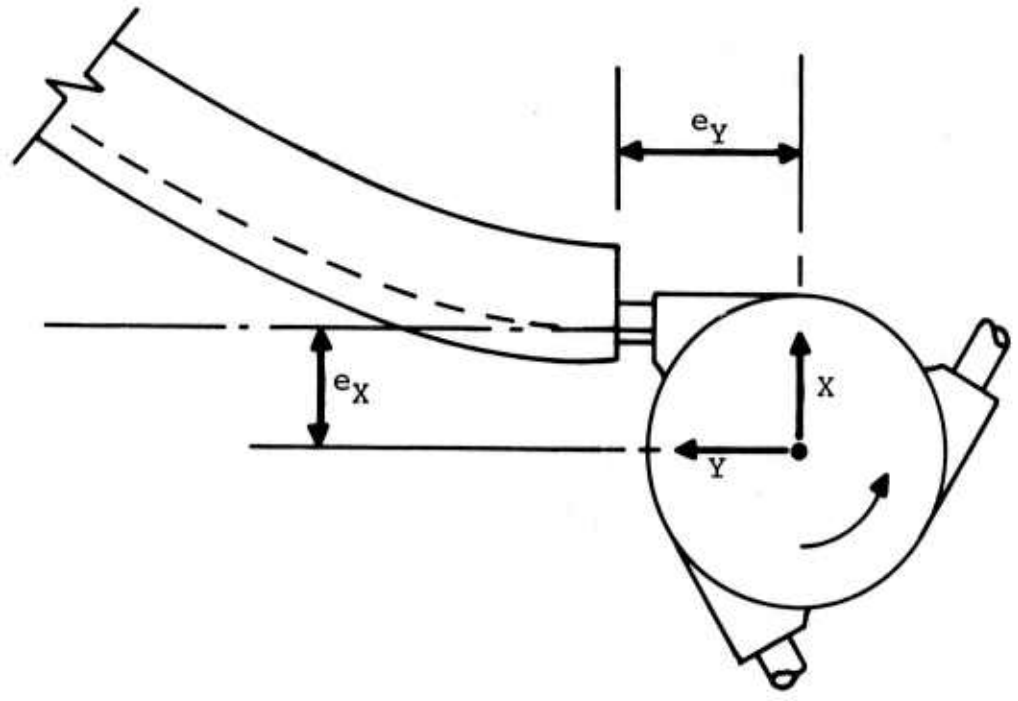
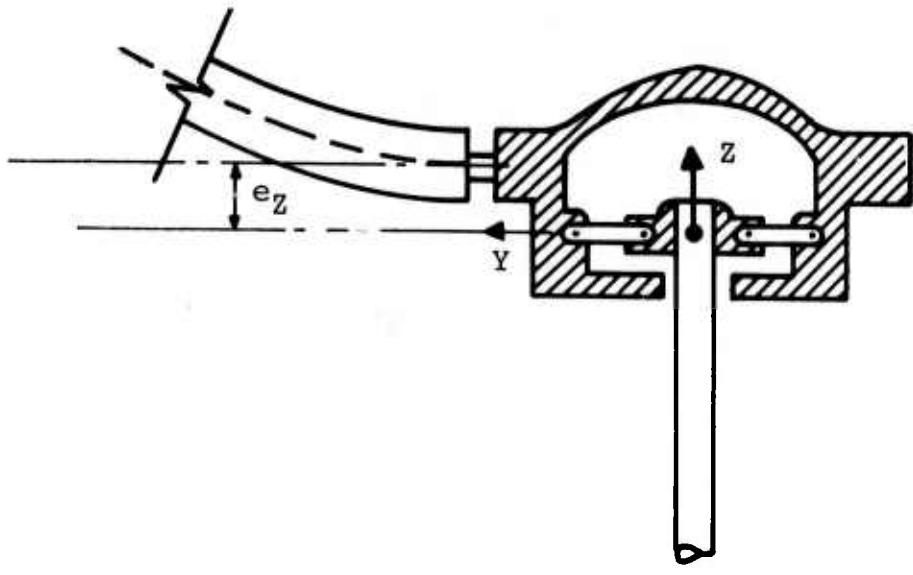


Figure 2. Schematic Diagram of Rotor Hub Showing Blade Mount Eccentricities

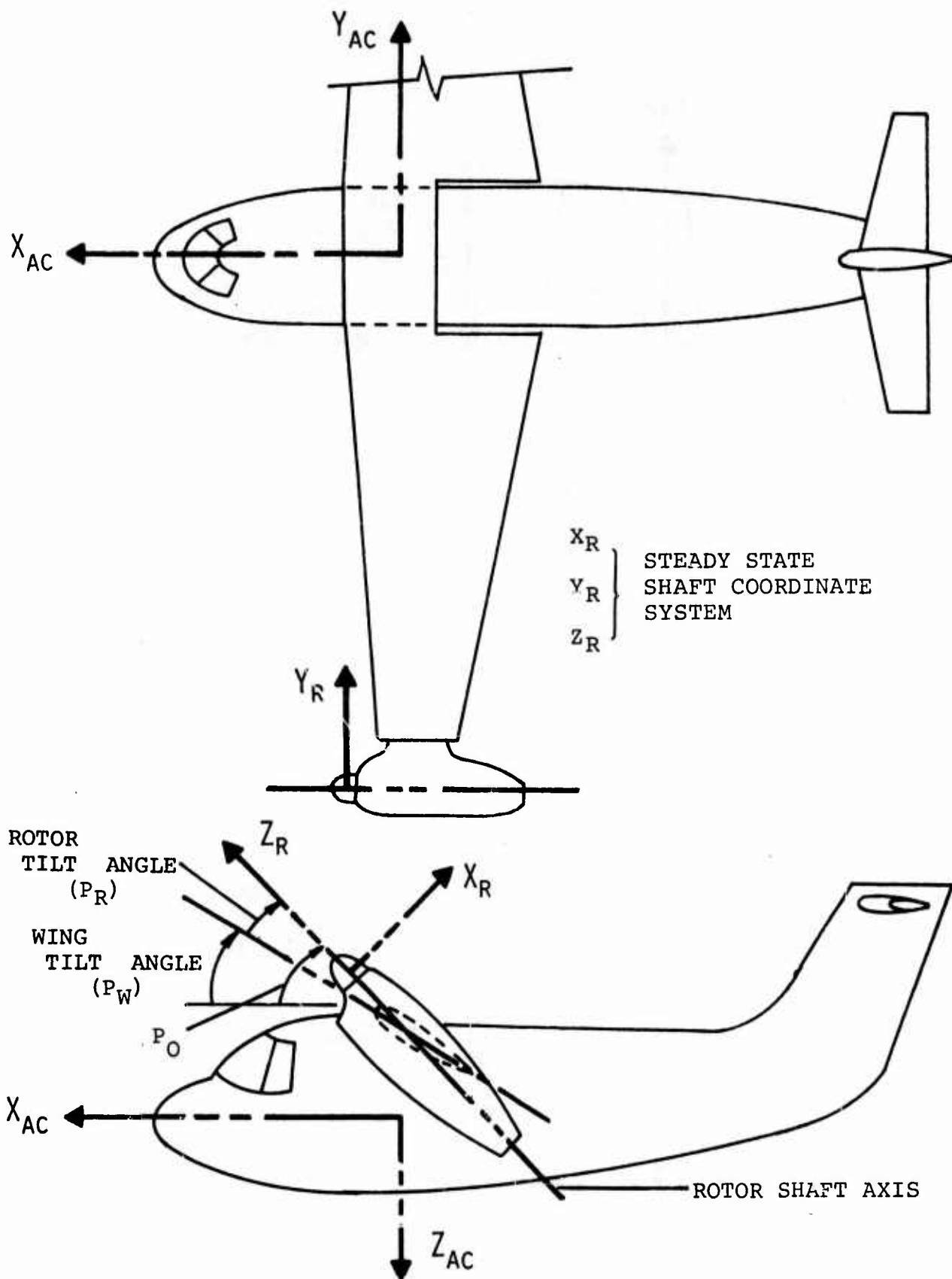


Figure 3. Rotor and Aircraft Coordinate Axes

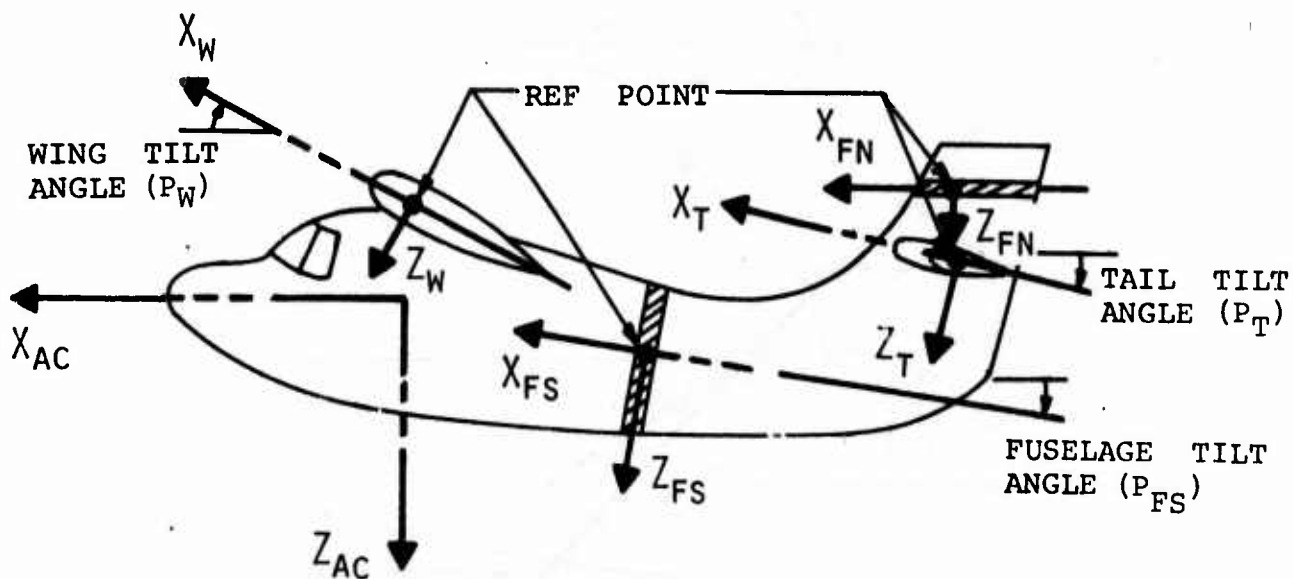
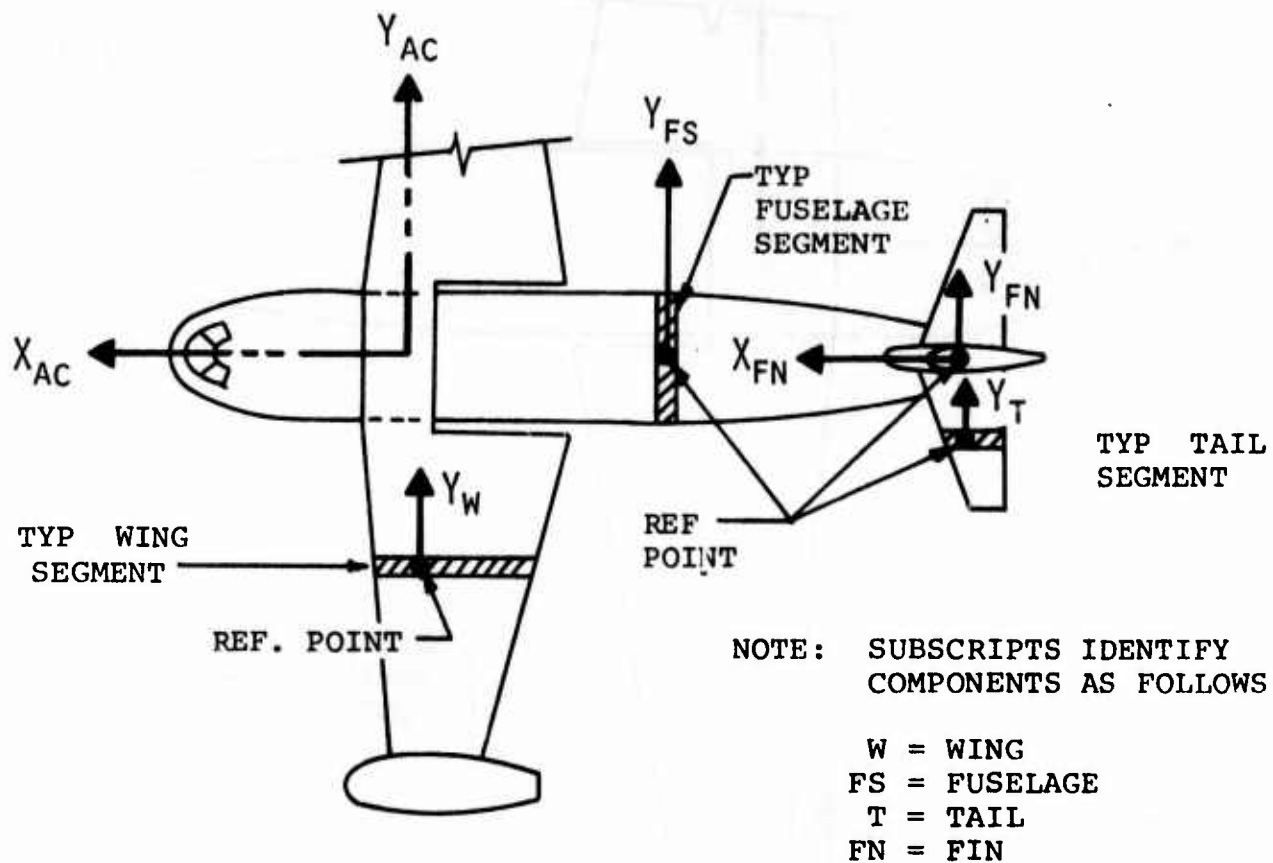


Figure 4. Local Coordinate Axes for Typical Segment of Various Airframe Components

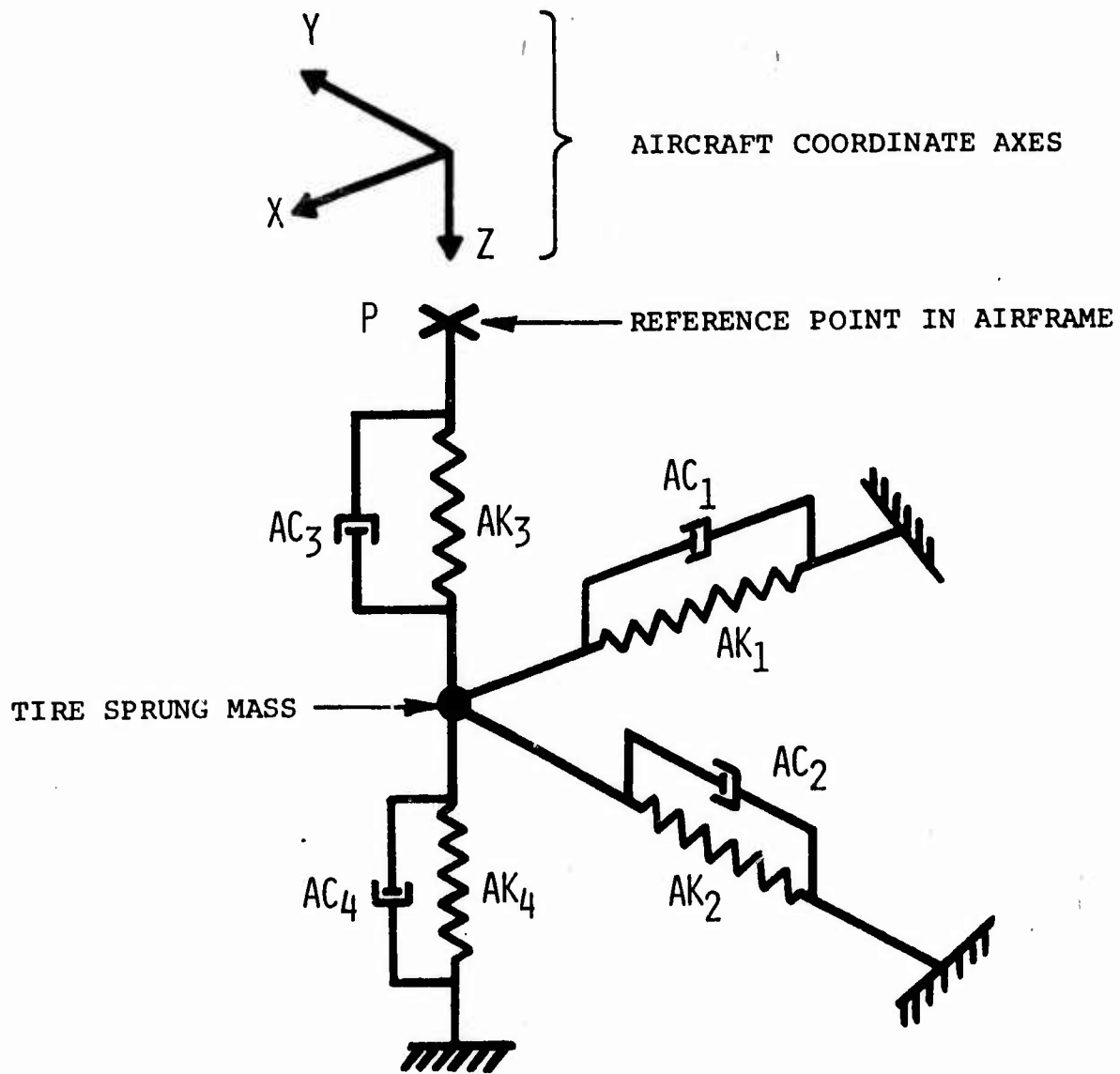


Figure 5. Typical Landing Gear Representation

SAMPLE PROBLEM

INPUT DATA

See following sheets.

C-39 INPUT DATA

SHEET 2 of 6

Data Gp	Card Gp	Card No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
BII	11	2	5.73	5.73																		
BII	12	1	0.																			
BII	12	2	0.																			
BII	13	1	0.																			
BII	13	2	0.																			
BII	14	1	0.																			
BII	14	2	0.																			
BII	15a	1	0.																			
BII	15a	2	5.73	5.73																		
BII	15b	1	0.																			
BII	15b	2	0.																			
BII	16a	1	0.																			
BII	16a	2	0.																			
BII	16b	1	0.																			
BII	16b	2	0.																			
BII	17a	1	0.																			
BII	17a	2	0.																			
BII	17b	1	0.																			
BII	17b	2	0.																			
BII	18a	1	0.																			
BII	18a	2	0.																			
BII	18b	1	0.																			
BII	18b	2	0.																			
BII	19a	1	0.																			
BII	19a	2	0.																			
BII	19b	1	0.																			
BII	19b	2	0.																			
BII	20	1	0.																			

C-39 INPUT DATA

SHEET 3 of 6

Card No.	Data Gp	Card Gp	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	
1	BII	21																					
2	BII	21																					
1	BII	22																					
2	BII	22																					
1	BII	23																					
2	BII	23																					
1	BII	24																					
2	BII	24																					
1	BII	25																					
2	BII	25	43.21																				
1	BII	26	47.21																				
2	BII	26	44.21																				
1	BII	26	57.60																				
2	BII	26																					
3	BII	26																					
4	BII	26																					
1	BIV	1																					
2	BIV	2																					
1	BIV	3a																					
2	BIV	3a																					
1	BIV	3b																					
2	BIV	3b																					
1	BIV	3c																					
2	BIV	3c																					
1	BIV	4																					
2	BIV	4																					
1	CI	1																					
2	CI	1																					
1	CIII	2a																					
2	CIII	2a																					

C-39 INPUT DATA

SHEET 4 OF 6

Card No.	Data Gp	Card Gp	1	2	3	4	5	6	7	8	9	10	11	12
3	CIII	2a												
4	CIII	2a												
5	CIII	2a												
6	CIII	2a												
1	CIII	2b												
2	CIII	2b												
3	CIII	2b												
4	CIII	2b												
5	CIII	2b												
6	CIII	2b												
1	CIII	2c												
2	CIII	2c												
3	CIII	2c												
4	CIII	2c												
5	CIII	2c												
6	CIII	2c												
1	CIII	3												
2	CIII	3												
3	CIII	3												
4	CIII	3												
5	CIII	3												
6	CIII	3												
7	CIII	3												
8	CIII	3												
9	CIII	3												
10	CIII	3												
11	CIII	3												
12	CIII	3												

C-39 INPUT DATA

SHEET 6 of 6

Card No.	Data Gp	Card Gp	Value
1	FII	5	0.
2	FII	5	0.
1	FII	6	0.
2	FII	6	0.
1	FII	7	0.
2	FII	7	35.94
1	FII	1	0.
1	FII	2	1200.
1	FII	3	0.
2	FII	3	0.
1	FII	4	0.
2	FII	4	0.
1	FII	5	0.
2	FII	5	0.
1	FII	6	0.
2	FII	6	0.
1	FII	7	0.
2	FII	7	3173
1	FII	1	47.54
2	FII	1	30.04
1	FII	2	44.74
2	FII	2	47.04
1	FII	3	41.74
2	FII	3	47.53
1	FII	4	40.54
2	FII	4	41.93
1	FII	5	43.30
2	FII	5	45.20
1	FII	6	44.93
2	FII	6	48.93
1	FII	7	43.57
2	FII	7	44.57

Card No. 1 2 1 2 1 2 1 1 1 1 2 3 3 4 4 5 5 6 6 7 2

Card Gp 5 5 6 6 7 7 1 2 3 3 4 4 5 6 6 7 7

Data Gp FII

PROGRAM OUTPUT

See following sheets.

C39 FINITE DEFLECTION STABILITY ANALYSIS

SAMPLE PROBLEM

RIGID MODE FREEDOMS

LONGITUDINAL TRANSLATION (POS. FORWARD)	DELETED
LATERAL TRANSLATION (POS. TO RIGHT)	DELETED
VERTICAL TRANSLATION (POS. DOWNWARD)	DELETED
ROLL (POS. RIGHT SIDE DOWN)	DELETED
PITCH (POS. NOSE UP)	DELETED
YAW (POS. NOSE TO THE RIGHT)	DELETED

RIGID MODE SHAPES	0.0	0.0	0.0	0.0
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NO. OF ELASTIC MODES = 3

NO. OF LANDING GEARS = 0

C39 FINITE DEFLECTION STABILITY ANALYSIS

SAMPLE PROBLEM

BLADE MODE FREEDOMS

BLADE 1ST. MODE, COLLECTIVE	RETAINED
BLADE 1ST. MODE, CYCLIC YAW	RETAINED
BLADE 1ST. MODE, CYCLIC PITCH	RETAINED
BLADE 2ND. MODE, COLLECTIVE	RETAINED
BLADE 2ND. MODE, CYCLIC YAW	RETAINED
BLADE 2ND. MODE, CYCLIC PITCH	RETAINED
BLADE 3RD. MODE, COLLECTIVE	DELETED
BLADE 3RD. MODE, CYCLIC YAW	DELETED
BLADE 3RD. MODE, CYCLIC PITCH	DELETED
BLADE 4TH. MODE, COLLECTIVE	DELETED
BLADE 4TH. MODE, CYCLIC YAW	DELETED
BLADE 4TH. MODE, CYCLIC PITCH	DELETED

C39 FINITE DEFLECTION STABILITY ANALYSIS

SAMPLE PROBLEM

AIR DENSITY 0.002378 SLUGS/CU.FT.

SPEED OF SOUND 1116.000 FT./SEC.

AIRSPEED COMPONENTS

VX 140.000 FT./SEC.

VY 0.0 FT./SEC.

VZ 0.0 FT./SEC.

C39 FINITE DEFLECTION STABILITY ANALYSIS

SAMPLE PROGRAM

BLADE DATA FOR ROTOR 1

NO. OF BLADES= 4
 BLADE LENGTH= 2.733 FT.
 BLADE ECCENTRICITIES AT HUB
 ECCX= 0.0 FT.
 ECCY= 0.0 FT.
 ECCZ= 0.0 FT.

BLADE GEOMETRY SEGMENT	R (FT.)	EX (FT.)	LAMBDA A	LAMBDA F	C (FT.)
1	0.137	0.0	0.0	0.0	0.0
2	0.410	0.0	0.0	0.0	0.213
3	0.683	0.0	0.0	0.0	0.213
4	0.957	0.0	0.0	0.0	0.213
5	1.230	0.0	0.0	0.0	0.213
6	1.503	0.0	0.0	0.0	0.213
7	1.777	0.0	0.0	0.0	0.213
8	2.050	0.0	0.0	0.0	0.213
9	2.323	0.0	0.0	0.0	0.213
10	2.597	0.0	0.0	0.0	0.213

BLADE INERTIAS AND LIFT CURVE SLOPES			
SEGMENT	M (SLUGS/FT.)	IX (SLUGS/FT.)	IZ (SLUGS/FT.)
1	0.0	0.0	0.0
2	0.006	0.0	0.0
3	0.006	0.0	0.0
4	0.005	0.0	0.0
5	0.005	0.0	0.0
6	0.005	0.0	0.0
7	0.005	0.0	0.0
8	0.005	0.0	0.0
9	0.005	0.0	0.0
10	0.005	0.0	0.0

C CLZ	
ALPHA	CLZ
5.730	0.0
5.730	0.0
5.730	0.0
5.730	0.0
5.730	0.0
5.730	0.0
5.730	0.0
5.730	0.0
5.730	0.0
5.730	0.0

C39 FINITE DEFLECTION STABILITY ANALYSIS

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SAMPLE PROBLEM

BLADE MODE SHAPES FOR ROTOR 1

MODE 1	LAG(FT.)	LAG GRADIENT	FLAP(FT.)	FLAP GRADIENT	TWIST(RAD.)
	0.0	0.0	0.0	0.0	0.0
	-0.007	-0.099	0.000	0.004	0.0
	-0.062	-0.285	0.002	0.015	0.0
	-0.157	-0.392	0.007	0.007	0.0
	-0.271	-0.435	0.003	-0.029	0.0
	-0.395	-0.468	-0.006	-0.040	0.0
	-0.526	-0.433	-0.017	-0.037	0.0
	-0.659	-0.494	-0.027	-0.033	0.0
	-0.792	-0.498	-0.035	-0.026	0.0
	-0.931	-0.498	-0.041	-0.018	0.0

MODE 2

LAG(FT.)	LAG GRADIENT	FLAP(FT.)	FLAP GRADIENT	TWIST(KAJ.)
0.0	0.0	0.0	0.0	0.0
0.001	0.007	-0.006	-0.060	0.0
0.007	0.003	-0.050	-0.223	0.0
0.018	0.037	-0.124	-0.322	0.0
0.024	0.007	-0.228	-0.428	0.0
0.025	0.004	-0.354	-0.487	0.0
0.025	0.0	-0.493	-0.523	0.0
0.025	0.0	-0.638	-0.538	0.0
0.025	0.0	-0.785	-0.534	0.0
0.025	0.0	-0.930	-0.520	0.0

C39 FINITE DEFLECTION STABILITY ANALYSIS

SAMPLE PROBLEM

ANGULAR SPEED FOR ROTOR 1 600.000 RPM, CLOCKWISE

STEADY STATE DEFLECTIONS FOR ROTOR 1

HUB TEEETER ANGLES (DEG.)
 PITCH 0.0
 YAW 0.0

BLADE DEFLECTIONS LAG(FT.)	LAG GRADIENT	FLAP(FT.)	FLAP GRADIENT	PITCH(DEG.)
0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	63.210
0.0	0.0	0.0	0.0	61.710
0.0	0.0	0.0	0.0	58.910
0.0	0.0	0.0	0.0	55.910
0.0	0.0	0.0	0.0	52.960
0.0	0.0	0.0	0.0	50.110
0.0	0.0	0.0	0.0	47.210
0.0	0.0	0.0	0.0	44.210
0.0	0.0	0.0	0.0	41.210

C39 FINITE DEFLECTION STABILITY ANALYSIS

SAMPLE PROBLEM

BLADE MODAL FREQUENCIES AND DAMPING FACTORS FOR ROTOR 1

MODE	FREQUENCY (RAD./SEC.)	VISCOUS DAMPING	STRUCTURAL DAMPING	REF. ANGULAR SPEED (RPM)
1	57.600	0.005	0.0	600.000
2	86.920	0.005	0.0	600.000

C39 FINITE DEFLECTION STABILITY ANALYSIS

SAMPLE PROBLEM

NACELLE NG. 1 PARAMETERS

COORDS. OF REF. POINT ON NACELLE AXIS
X (FT.) Y (FT.) Z (FT.)

-0.111000E 00 -0.340000E 01 0.0

TILT ANGLES AT REF. POINT

0.0 0.0

NO. OF SECTIONS = 2

MASS POINT LOCATIONS ON AXIS RELATIVE TO REF. POINT (POS. FORWARD OF REF. POINT)

0.0 0.0 0.667000E 00 0.0

0.000000E 00

ELASTIC MODE SHAPE

0.674800E 00	0.0	0.0	0.0	0.0	0.0	0.0
0.674800E 00	0.0	0.0	0.0	0.0	0.0	0.0
0.364000E 00	0.0	0.0	0.0	0.0	0.654400E 00	0.0
0.455000E 00	0.0	0.0	0.0	0.0	0.654400E 00	0.0
0.0	-0.412500E 00	-0.100000E 01	0.850000E 00	0.0	0.0	0.0
0.0	-0.521300E 00	-0.100000E 01	0.850000E 00	0.0	0.0	0.0

MASS (SLUGS) MASS MOMENTS OF INERTIA (SLUGS-FT.**2)

0.137000E 00	0.203000E 00	0.203000E -01
0.0	0.0	0.0

C39 FINITE DEFLECTION STABILITY ANALYSIS

SAMPLE PROBLEM

ROTOR INERTIA DERIVATIVES

ROW 1

0.497472E-01	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	-0.102797E-01	0.473879E-03	0.0	0.0	0.0

ROW 2

0.0	0.497472E-01	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	-0.102797E-01	0.473879E-03	0.0

ROW 3

0.0	0.0	0.497472E-01	0.0	0.0	0.0	0.0
-0.612019E-03	-0.145184E-01	0.0	0.0	0.0	0.0	0.0

ROW 4	0.0	0.0	0.573447E-01	0.0	0.0	0.0	0.0
	0.0	-0.733135E-03	-0.200475E-01	0.0	0.0	0.0	0.0
ROW 5	0.0	0.0	0.0	0.673447E-01	0.0	0.0	0.0
	0.0	0.0	0.0	-0.733135E-03	-0.200475E-01	0.0	0.0
ROW 6	0.0	0.0	0.0	0.0	0.0	0.134689E-01	0.0
	0.415744E-01	-0.166479E-02	0.0	0.0	0.0	0.0	0.0
ROW 7	0.0	0.0	-0.012019E-03	0.0	0.0	0.415744E-01	0.0
	0.134034E-01	0.222237E-06	0.0	0.0	0.0	0.0	0.0
ROW 8	0.0	0.0	-0.195184E-01	0.0	0.0	-0.166479E-02	0.0
	0.222237E-06	0.120742E-01	0.0	0.0	0.0	0.0	0.0
ROW 9	-0.102797E-01	0.0	-0.733135E-03	0.0	0.0	0.0	0.0
	0.0	0.0	0.111116E-06	0.0	0.0	0.0	0.0
ROW 10	0.473079E-03	0.0	-0.200475E-01	0.0	0.0	0.0	0.0
	0.0	0.0	0.633712E-02	0.0	0.0	0.0	0.0

ROW 4	0.837655E 00	0.0	0.0	0.176857E 01	0.846273E 01	0.0
	0.0	0.0	-0.595620E 00	-0.545867E 00	-0.921283E-01	-0.251925E 01
ROW 5						
	0.0	0.337635E 00	0.0	-0.846273E 01	0.176857E 01	0.0
	0.0	0.0	0.921283E-01	0.251925E 01	-0.595620E 00	-0.545867E 00
ROW 6						
	0.0	0.0	-0.209071E 01	0.0	0.0	0.404194E 01
	0.126987E 01	0.110718E 01	0.0	0.0	0.0	0.0
ROW 7						
	0.0	0.0	-0.608883E 00	0.0	0.0	0.127153E 01
	0.428356E 00	0.376376E 00	0.0	0.0	0.0	0.0
ROW 8						
	0.0	0.0	-0.486722E 00	0.0	0.0	0.106497E 01
	0.370616E 00	0.357485E 00	0.0	0.0	0.0	0.0
ROW 9						

-0.320505E 00	0.0	0.0	-0.622692E 00	-0.921283E-01	0.0
0.0	0.0	0.214178E 00	0.188188E 00	0.842158E 00	0.139635E-04
ROW 10					
-0.241604E 00	0.0	0.0	-0.542852E 00	-0.251925E 01	0.0
0.0	0.0	0.185409E 00	0.178743E 00	0.139635E-04	0.796345E 00
ROW 11					
0.0	-0.320505E 00	0.0	0.921283E-01	-0.622602E 00	0.0
0.0	0.0	-0.842158E 00	-0.139635E-04	0.214178E 00	0.188188E 00
ROW 12					
0.0	-0.241604E 00	0.0	0.251925E 01	-0.542852E 00	0.0
0.0	0.0	-0.139635E-04	-0.796345E 00	0.185409E 00	0.178743E 00

C39 FINITE DEFLECTION STABILITY ANALYSIS

SAMPLE PROBLEM

ROTOR STIFFNESS DERIVATIVES

ROW 1	0.0	0.0	0.0	0.0	0.0	0.0	-0.103216E 03	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	-0.236224E 02	-0.178333E 02	
ROW 2	0.0	0.0	0.0	0.0	0.0	0.0	0.103216E 03	0.0	0.0
	0.0	0.0	0.0	0.236224E 02	0.0	0.0	0.178333E 02	0.0	0.0
ROW 3	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
ROW 4	0.0	0.869261E 01	0.0	0.0	0.0	0.0	-0.126981E 03	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	-0.380174E 02	-0.331242E 02	
ROW 5	-0.369261E 01	0.0	0.0	0.0	0.0	0.0	0.126981E 03	0.0	0.0
	0.0	0.0	0.0	0.380174E 02	0.0	0.0	0.331242E 02	0.0	0.0

ROW 6	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
ROW 7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.444692E 02	0.575722E 01	0.0	0.0	0.0	0.0	0.0
ROW 8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.575722E 01	0.957550E 02	0.0	0.0	0.0	0.0	0.0
ROW 9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	-0.352277E 01	0.0	0.0	0.449032E 02	0.0	0.0
	0.0	0.0	-0.422256E 01	0.287817E 01	0.134572E 02	0.118242E 02	0.0
ROW 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	-0.115782E 01	0.0	0.0	0.352738E 02	0.0	0.0
	0.0	0.0	0.287817E 01	0.228596E 02	0.116496E 02	0.112307E 02	0.0
ROW 11	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.352277E 01	0.0	-0.449082E 02	0.0	0.0	0.0	0.0
	0.0	0.0	-0.134572E 02	-0.118242E 02	-0.422256E 01	0.287817E 01	0.0
ROW 12	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.115782E 01	0.0	-0.352738E 02	0.0	0.0	0.0	0.0
	0.0	0.0	-0.116496E 02	-0.112307E 02	0.287817E 01	0.228596E 02	0.0

ROW 6 -0.693677E-02 -0.467728E-02 -0.623165E-03 0.0 0.0 0.670169E-02

0.111118E-06 0.0 0.0

ROW 7 0.319774E-03 0.215615E-03 -0.170404E-01 0.0 0.0 0.111118E-06

0.633712E-02 0.0 0.0

ROW 8 0.0 -0.479764E-03 0.535663E-02 0.0 0.0 0.0

0.0 0.570169E-02 0.111118E-06

71 ROW 9 0.0 -0.131191E-01 -0.247035E-03 0.0 0.0 0.0

0.0 0.111118E-06 0.633712E-02

C39 FINITE DEFLECTION STABILITY ANALYSIS

SAMPLE PROBLEM

ROTOR CONTRIBUTIONS TO THE DAMPING MATRIX

ROW 1 0.363987E 00 0.245427E 00 0.599595E 00 0.0 0.0 -0.215865E 00

-0.179092E 00 0.0 0.0

ROW 2	0.245427E 00	0.422857E 00	-0.458886E 01	0.0	0.0	-0.852636E-01
	0.152784E 01	-0.389774E 00	-0.357215E 00			
ROW 3	0.480565E 00	0.467475E 01	0.237123E 01	0.550902E 00	0.492519E 00	-0.506277E 00
	-0.463957E 00	0.884524E-01	-0.200301E 01			
ROW 4	0.0	0.0	0.608883E 00	0.428356E 00	0.376376E 00	0.0
	0.0	0.0	0.0			
72 ROW 5	0.0	0.0	0.486722E 00	0.370818E 00	0.357485E 00	0.0
	0.0	0.0	0.0			
ROW 6	-0.216277E 00	-0.206119E 00	-0.529212E 00	0.0	0.0	0.214178E 00
	0.188189E 00	0.842158E 00	0.139635E-04			
ROW 7	-0.163035E 00	-0.175852E 01	-0.461424E 00	0.0	0.0	0.185409E 00
	0.178743E 00	0.139635E-04	0.796345E 00			

ROW 0	0.0	-0.407451E 00	0.243358E 00	0.0	0.0	-0.842158E 00
	-0.139635E-04	0.214178E 00	0.168188E 00			
ROW 9	0.0	-0.355242E 00	0.220731E 01	0.0	0.0	-0.139635E-04
	-0.796345E 00	0.165409E 00	0.178743E 00			

C39 FINITE DEFLECTION STABILITY ANALYSIS

SAMPLE PROBLEM

ROTOR CONTRIBUTIONS TO THE STIFFNESS MATRIX

ROW 1	0.0	-0.455791E 02	0.0	0.0	0.0	0.0
	0.0	-0.159404E 02	-0.120339E 02			
ROW 2	-0.363856E 01	-0.333210E 02	0.706319E 02	0.0	0.0	0.249786E 02
	0.216765E 02	-0.107482E 02	-0.811417E 01			
ROW 3	0.0	-0.706319E 02	-0.495873E 02	0.0	0.0	-0.123143E 02
	-0.929652E 01	-0.323148E 02	-0.281555E 02			

ROW 4	0.0	0.0	0.444692E 02	0.575722E 01	0.0
	0.0	0.0			
ROW 5	0.0	0.0	0.575722E 01	0.957550E 02	0.0
	0.0	0.0			
ROW 6	0.0	0.293879E 02	0.0	0.183642E 01	-0.422256E 01
	0.287817E 01	0.134572E 02	0.0	0.118242E 02	
ROW 7	0.0	0.230932E 02	0.0	0.603571E 00	0.287817E 01
	0.228596E 02	0.116496E 02	0.0	0.112307E 02	
ROW 8	0.237716E 01	0.160286E 01	0.0	0.381719E 02	-0.134572E 02
	-0.118242E 02	-0.422256E 01	0.0	0.287817E 01	
ROW 9	0.781297E 00	0.526308E 00	0.0	0.299828E 02	-0.116496E 02
	-0.112307E 02	0.287817E 01	0.0	0.228596E 02	

C39 FINITE DEFLECTION STABILITY ANALYSIS

SAMPLE PROBLEM

AIRFRAME COMPONENTS

RIGHT WING	NOT PRESENT
LEFT WING	PRESENT
FUSELAGE	NOT PRESENT
RIGHT TAIL	NOT PRESENT
LEFT TAIL	NOT PRESENT
FIN	NOT PRESENT

AIRFRAME AERODYNAMICS NOT INCLUDED

COORDS. OF SEGMENT REF. POINTS IN A/C AXES
 X (FT.) Y (FT.) Z (FT.)

0.0	-0.458300E 00	0.0
0.0	-0.875000E 00	0.0
0.0	-0.170800E 01	0.0
0.0	-0.275000E 01	0.0
0.0	-0.316700E 01	0.0
0.0	-0.339400E 01	0.0

LOCAL 'PITCH' SETTINGS (DEGREES)

0.0	0.0	0.0	0.0
0.0			0.0

MASS POINT COORDS. IN LOCAL AXES
 X (FT.) Y (FT.) Z (FT.)

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
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MASS (SLUGS) MASS MOMENTS OF INERTIA (SLUGS-FT.**2)

0.572000E-01	0.700000E-03	0.710000E-02	0.700000E-03
0.530000E-01	0.130000E-02	0.132000E-01	0.130000E-02
0.107100E 00	0.200000E-02	0.179000E-01	0.200000E-02
0.130000E 00	0.150000E-02	0.146000E-01	0.150000E-02
0.576000E-01	0.500000E-03	0.530000E-02	0.500000E-03
0.0	0.0	0.0	0.0

C39 FINITE DEFLECTION STABILITY ANALYSIS

SAMPLE PROBLEM

AIRFRAME CONTRIBUTIONS TO THE INERTIA MATRIX

ROW 1	0.109092E 00	0.336509E-01	0.0
ROW 2	0.336509E-01	0.110686E 00	0.0
ROW 3	0.0	0.0	0.407307E 00

DAMPING OPTION SELECTED

VISCOUS

AIRFRAME FREQUENCIES

0.487800E 02 0.584500E 02 0.891900E 02

VISCOUS DAMPING COEFFICIENTS (AS FRACTIONS OF MODAL CRITICAL DAMPING COEFFS.)

0.200000E-01 0.200000E-01 0.200000E-01

STRUCTURAL DAMPING COEFFICIENTS (AS FRACTIONS OF DIRECT MODAL STIFFNESSES)

0.0 0.0 0.0

C39 FINITE DEFLECTION STABILITY ANALYSIS
SAMPLE PROBLEM

AIRFRAME CONTRIBUTIONS TO THE STIFFNESS MATRIX

ROW 1	0.259583E 03	0.0	0.0
ROW 2	0.0	0.378149E 03	0.0
ROW 3	0.0	0.0	0.324006E 04

AIRFRAME CONTRIBUTIONS TO THE DAMPING MATRIX

ROW 1	0.212560E 00	0.0	0.0
ROW 2	0.0	0.258785E 00	0.0
ROW 3	0.0	0.0	0.145311E 01

C39 FINITE DEFLECTION STABILITY ANALYSIS

SAMPLE PROBLEM

FINAL INERTIA MATRIX

ROW 1	0.131745E 00	0.489250E-01	0.00	0.00	0.00	0.00	-0.693677E-02
	0.319774E-03	0.00	0.00				
ROW 2	0.489250E-01	0.14425E 00	0.00	0.00	0.00	0.00	-0.467728E-02
	0.215615E-03	-0.479764E-03	-0.131191E-01				
ROW 3	0.00	0.00	0.519229E 00	0.612019E-03	0.195184E-01	-0.623165E-03	
	-0.170404E-01	0.535883E-02	-0.247033E-03				
ROW 4	0.00	0.00	0.612019E-03	0.134034E-01	0.222237E-06	0.00	
	0.00	0.00	0.00				
ROW 5	0.00	0.00	0.195184E-01	0.222237E-06	0.126742E-01	0.00	
	0.00	0.00	0.00				

ROW 6	-0.693677E-02	-0.467725E-02	-0.623165E-03	0.0	0.0	0.670169E-02
	0.111118E-06	0.0	0.0			
ROW 7	0.319774E-05	0.215615E-03	-0.170404E-01	0.0	0.0	0.111118E-06
	0.633712E-02	0.0	0.0			
ROW 8	0.0	-0.479764E-03	0.535683E-02	0.0	0.0	0.0
	0.0	0.670169E-02	0.111118E-06			
ROW 9	0.0	-0.131191E-01	-0.247033E-03	0.0	0.0	0.0
	0.0	0.111118E-06	0.633712E-02			

C39 FINITE DEFLECTION STABILITY ANALYSIS

SAMPLE PROBLEM

FINAL DAMPING MATRIX

ROW 1	0.576848E 00	0.245427E 00	0.599595E 00	0.0	0.0	-0.215865E 00
	-0.179092E 00	0.0	0.0			

ROW 2	0.245427E 00	0.118164E 01	-0.458886E 01	0.0	0.0	-0.852636E-01
	0.152784E 01	-0.389774E 00	-0.357215E 00			
ROW 3	0.480565E 00	0.467475E 01	0.382434E 01	0.550802E 00	0.492519E 00	-0.506277E 00
	-0.463987E 00	0.884524E-01	-0.200301E 01			
ROW 4	0.0	0.0	0.608883E 00	0.428356E 00	0.376376E 00	0.0
	0.0	0.0	0.0			
ROW 5	0.0	0.0	0.486722E 00	0.370618E 00	0.357485E 00	0.0
	0.0	0.0	0.0			
ROW 6	-0.210277E 00	-0.206119E 00	-0.529212E 00	0.0	0.0	0.214178E 00
	0.188188E 00	0.842158E 00	0.139635E-04			
ROW 7	-0.163035E 00	-0.175852E 01	-0.461424E 00	0.0	0.0	0.185409E 00
	0.178743E 00	0.135635E-04	0.796345E 00			

ROW 8	0.0	-0.407431E 00	0.245368E 00	0.0	0.0	-0.842158E 00
	-0.139635E-04	0.214178E 00	0.198188E 00			
ROW 9	0.0	-0.355242E 00	0.226731E 01	0.0	0.0	-0.139635E-04
	-0.796345E 00	0.185409E 00	0.176743E 00			

C39 FINITE DEFLECTION STABILITY ANALYSIS

SAMPLE PROBLEM

FINAL STIFFNESS MATRIX

ROW 1	0.259583E 03	-0.455791E 02	0.0	0.0	0.0	0.0
	0.0	-0.159404E 02	-0.120339E 02			
ROW 2	-0.363856E 01	0.344828E 03	0.706319E 02	0.0	0.0	0.248786E 02
	0.216765E 02	-0.107482E 02	-0.811417E 01			
ROW 3	0.0	-0.706319E 02	0.519048E 04	0.0	0.0	-0.123143E 02
	-0.929652E 01	-0.325148E 02	-0.281555E 02			

ROW 4	0.0	0.0	0.0	0.0	0.444692E 02	0.575722E 01	0.0
	0.0	0.0	0.0	0.0			
ROW 5	0.0	0.0	0.0	0.0	0.575722E 01	0.957550E 02	0.0
	0.0	0.0	0.0	0.0			
ROW 6	0.0	0.293679E 02	0.183642E 01	0.0	0.0	0.0	-0.422256E 01
	0.287817E 01	0.134572E 02	0.118242E 02				
ROW 7	0.0	0.230832E 02	0.603571E 00	0.0	0.0	0.0	0.287817E 01
	0.228596E 02	0.116496E 02	0.112307E 02				
ROW 8	0.237716E 01	0.160286E 01	-0.381719E 02	0.0	0.0	0.0	-0.134572E 02
	-0.118242E 02	-0.422256E 01	0.287817E 01				
ROW 9	0.781297E 00	0.526606E 00	-0.259628E 02	0.0	0.0	0.0	-0.116496E 02
	-0.112307E 02	0.287817E 01	0.228596E 02				

VIBRATION MATRIX SOLUTION

SAMPLE PROBLEM

COMPLEX ROOTS
OF THE MATRIX

ROOT NO.	REAL PART	IMAGINARY PART	FREQUENCY IN CPS	PER CENT CRITICAL DAMPING	NO. OF ITERATIONS	ROOT NO.
1	-0.79184747E-03	-0.10586504E-01	14.950	-7.46	8	1
2	-0.10885147E-02	-0.72808526E-02	21.381	-14.79	5	2
3	-0.41828537E-03	-0.72467402E-02	21.889	-5.76	3	3
4	-0.92555094E-03	-0.14188442E-01	11.170	-6.51	6	4
5	-0.11724816E-02	-0.14539778E-01	10.875	-8.04	3	5
6	-0.47974735E-02	-0.14423348E-01	9.935	-31.56	3	6
7	-0.10883764E-02	0.72807893E-02	21.382	-14.78	5	7
8	-0.41853637E-03	0.72467290E-02	21.889	-5.77	3	8
9	-0.79194293E-03	0.10586645E-01	14.950	-7.46	3	9
10	-0.92568481E-03	0.14187332E-01	11.171	-6.51	6	10
11	-0.11725884E-02	0.14540628E-01	10.875	-8.04	3	11
12	-0.47972053E-02	0.14423396E-01	9.935	-31.56	2	12
13	-0.10099267E-02	-0.25522720E-01	6.226	-3.95	3	13
14	-0.10098401E-02	0.25522433E-01	6.226	-3.95	2	14
15	-0.50953884E-01	-0.21306892E-06	0.000	-100.00	4	15
16	-0.54431979E-01	0.15531532E-06	0.000	-100.00	2	16
17	-0.38124356E-01	-0.52732792E-01	1.982	-58.59	3	17
18	-0.38124841E-01	0.52732863E-01	1.982	-58.59	0	18

REAL TRACE OF INPUT MATRIX= 0.0

IMAG TRACE OF INPUT MATRIX= -0.20204353E 00

REAL TRACE OF HESS MATRIX = 0.0

IMAG TRACE OF HESS MATRIX = -0.20204288E 00

REAL TRACE OF FINAL MATRIX= 0.46566129E-06

IMAG TRACE OF FINAL MATRIX= -0.20204276E 00

VECTOR FOR ROOT NO. 1 WHICH IS (-0.79184747E-03 -0.10580504E-01) FOLLOWS

UNREDUCED MATRIX ROW NUMBER	REAL PART	IMAGINARY PART	AMPLITUDE	PHASE ANGLE IN DEGREES
1	-0.20909980E-01	-0.35925791E-01	0.0415679	239.79
1	-0.18660367E-01	-0.68387948E-02	0.0198741	200.12
1	-0.17272174E 00	0.66337738E-01	0.1852028	158.86
1	-0.77050507E-01	0.30510986E 00	0.3146883	104.18
1	0.10000000E 01	0.0	1.0000000	0.0
1	-0.37121522E 00	-0.61352062E 00	0.7170831	238.81
1	-0.51774812E 00	0.53092957E-01	0.5204632	174.16
1	-0.43687272E 00	0.29119649E 00	0.5250279	146.33
1	-0.86401701E-01	-0.76582551E-01	0.1154562	221.54

VECTOR FOR ROOT NO. 2 WHICH IS (-0.10885147E-02 -0.72808526E-02) FOLLOWS

UNREDUCED MATRIX ROW NUMBER	REAL PART	IMAGINARY PART	AMPLITUDE	PHASE ANGLE IN DEGREES
1	0.56419712E-01	-0.25919843E-02	0.0564792	357.37
1	-0.51769167E-02	-0.82396157E-02	0.0097310	237.85
1	0.63911900E-02	0.75487792E-02	0.0098910	49.75
1	0.10260437E-02	-0.24717208E-02	0.0026762	292.54
1	-0.16499925E-01	-0.18785634E-01	0.0250031	228.70
1	0.10000000E 01	0.0	1.0000000	0.0
1	0.32745177E 00	-0.70655868E 00	0.7787490	294.86
1	0.82354271E-03	-0.97885579E 00	0.9788561	270.04
1	-0.73963565E 00	-0.33167201E 00	0.8105967	204.14

VECTORS FOR ROOT NO. 3 WHICH IS (-0.41625537E-02 -0.72467402E-02) FOLLOWS

UNREDUCED MATRIX ROW NUMBER	REAL PART	IMAGINARY PART	AMPLITUDE	PHASE ANGLE IN DEGREES
1	-0.48054598E-01	-0.22410735E-01	0.0530234	204.99
1	0.12078784E-01	-0.10224450E-01	0.0158252	319.75
1	0.92322901E-02	-0.37964315E-02	0.0099824	337.65
1	-0.10827994E-02	-0.16120597E-02	0.0021109	239.13
1	-0.23284614E-01	0.73383152E-02	0.0244136	162.52
1	-0.77794760E 00	-0.48295093E 00	0.9156659	211.82
1	0.83173774E-02	0.96346092E 00	0.9634968	89.51
1	-0.47185057E 00	0.76173860E 00	0.6960406	121.78
1	0.10000000E 01	0.0	1.0000000	0.0

VECTOR FOR ROOT NO. 4 WHICH IS (-0.92555094E-03 -0.14188442E-01) FOLLOWS

UNREDUCED MATRIX ROW NUMBER	REAL PART	IMAGINARY PART	AMPLITUDE	PHASE ANGLE IN DEGREES
1	-0.37559959E 00	0.21962887E 00	0.4349272	149.68
1	0.44677138E 00	-0.23148632E 00	0.5031804	332.61
1	0.47895964E-01	-0.44742264E-01	0.0655431	316.95
1	0.30835211E 00	0.46379024E 00	0.5569402	56.39
1	0.15676540E 00	-0.56261611E 00	0.5840482	285.56
1	-0.24555558E 00	0.36639041E 00	0.4410661	123.84
1	-0.18502608E-01	-0.32298434E 00	0.3235134	266.71
1	0.33520412E 00	0.57119679E 00	0.6622895	59.60
1	0.10000000E 01	0.0	1.0000000	0.0

VECTOR FOR ROOT NO. 5 WHICH IS (-0.11724816E-02 -0.14539778E-01) FOLLOWS

UNREDUCED MATRIX ROW NUMBER	REAL PART	IMAGINARY PART	AMPLITUDE	PHASE ANGLE IN DEGREES
1	0.73533535E-01	-0.41576696E-01	0.0844737	330.51
1	-0.58649234E-01	0.21904331E-01	0.0626062	159.53
1	-0.50145496E-01	-0.94969511E-01	0.1073954	242.16
1	0.1000000E 01	0.0	1.0000000	0.0
1	-0.58800632E 00	-0.70046771E 00	0.9145526	229.98
1	0.30581790E 00	-0.15334839E 00	0.3421115	333.37
1	0.11712571E-02	-0.24297035E 00	0.2429731	270.27
1	-0.10881203E 00	-0.21942836E 00	0.2449262	243.62
1	-0.47393315E-01	-0.53638209E-01	0.0715764	228.53

VECTOR FOR POINT NO. 6 WHICH IS (-0.47974735E-02 -0.14423348E-01) FOLLOWS

UNREDUCED MATRIX ROW NUMBER	REAL PART	IMAGINARY PART	AMPLITUDE	PHASE ANGLE IN DEGREES
1	0.62988259E-02	0.97973062E-02	0.0116390	57.24
1	0.29021096E-02	-0.42418577E-02	0.0051396	304.37
1	0.37090093E-01	-0.17201930E-01	0.0408850	335.12
1	0.10000000E 01	0.0	1.0000000	0.0
1	0.23041499E 00	-0.47979802E 00	0.5322566	295.65
1	0.33963103E-01	0.11381853E 00	0.1187777	73.39
1	0.11151850E 00	-0.16555376E-02	0.1115308	359.15
1	0.64563453E-01	-0.50957575E-02	0.0647642	355.49
1	0.35417207E-01	0.31100318E-01	0.0471339	41.29

VECTOR FOR ROOT NO. 7 WHICH IS (-0.10099267E-02 -0.25522720E-01) FOLLOWS

UNREDUCED MATRIX ROW NUMBER	REAL PART	IMAGINARY PART	AMPLITUDE	PHASE ANGLE IN DEGREES
1	-0.26312929E-02	-0.01249434E 00	0.8124986	269.81
1	-0.80735207E-01	-0.28863335E 00	0.2997121	254.37
1	0.63240603E-02	0.10462345E-02	0.0064100	9.39
1	-0.27268801E-02	-0.56545809E-02	0.0062777	244.25
1	0.18253713E-02	-0.36020530E-03	0.0018606	348.84
1	0.10432506E 00	0.42262304E 00	0.4353091	76.14
1	-0.21306330E 00	-0.15862143E 00	0.2656251	216.66
1	0.10000000E 01	0.0	1.0000000	0.0
1	0.27796543E 00	-0.54746532E 00	0.6144531	296.89

VECTOR FOR ROOT NO. 8 WHICH IS (-0.50953384E-01 -0.21306692E-06) FOLLOWS

UNREDUCED MATRIX ROW NUMBER	REAL PART	IMAGINARY PART	AMPLITUDE	PHASE ANGLE IN DEGREES
1	0.63915431E-01	0.65269188E-06	0.0639154	0.00
1	0.12639698E-01	-0.27770784E-06	0.0126397	360.00
1	0.09880563E-02	0.25775950E-07	0.0089861	0.00
1	0.25633895E-02	-0.58276061E-07	0.0025634	360.00
1	0.23711230E-03	0.10310380E-07	0.0002371	0.00
1	-0.34274209E 00	0.11475901E-04	0.3427421	180.01
1	-0.59139216E 00	0.40165656E-06	0.5913922	180.01
1	0.10000000E 01	0.0	1.0000000	0.0
1	-0.19373617E-02	-0.11026504E-04	0.0019374	180.31

VECTOR FOR ROOT NO. 9 WHICH IS (-0.33124356E-01 -0.52732792E-01) FOLLOWS

UNREDUCED MATRIX ROW NUMBER	REAL PART	IMAGINARY PART	AMPLITUDE	PHASE ANGLE IN DEGREES
1	0.22383489E-01	0.33937313E-01	0.0406542	56.60
1	-0.11707902E 00	-0.44796802E-02	0.1171647	182.18
1	0.46122517E-03	0.16470674E-01	0.0164771	88.40
1	0.33470000E-02	0.19236912E-02	0.0038612	29.88
1	0.35512098E-03	0.81352983E-03	0.0008877	66.42
1	0.78233379E 00	0.42259026E 00	0.8891729	28.38
1	-0.20935554E-01	-0.97274244E 00	0.9729677	268.76
1	0.11738636E-01	0.47225112E 00	0.4723970	88.58
1	0.10000000E 01	0.0	1.0000000	0.0

NOTE: Output sheets for subsequent cases have been deliberately omitted from this document.

DISCUSSION OF PROGRAM USAGE

The rotor airloads calculations make use of lift curve slopes input to the program. It is well-known from test data that the theoretical value of 2π is generally too high. A value of 5.73 appears to be a more realistic average and is recommended as a starting trial value when no test data for the particular blade profile is available. Where reliable test data exists, it should form the basis of the input lift curve slopes.

The induced airflow through the rotor disc does influence the airloads calculations, especially at low advance ratios. Where no significant interference exists between the airframe components and the airflow at the rotor disc, it has been found adequate to include only the airscrew-induced velocity as a uniform axial velocity field calculated from a simple momentum theory.

The looping options provide for changes to some of the input data without affecting others. The concept involves some basic assumptions which must be borne in mind when the features are used. In the rotor system, for example, the blade modes do not change when airspeed and/or blade steady deflections are varied under options 1, 2, or 3. This is obviously an approximation whose validity must be critically examined in each application.

The routine used in solving the equations of motion involves inversion of the stiffness matrix. When rigid aircraft translational modes are included in the analysis but no airframe aerodynamics are specified, the resulting stiffness matrix is singular and no solution can be obtained. In such circumstances it is advisable to specify the rigid translational modes as airframe ELASTIC MODES, with the mode shapes at each discrete point reflecting the actual motion under the rigid mode. Small insignificant modal frequencies can then be specified for these modes to keep the stiffness matrix non-singular. Alternatively, the landing gear facilities can be used to provide stiffness terms in the rigid translational modes without affecting the overall dynamics of the system.

**Part II. User's Manual: Computer Program
for Aeroelastic Prop/Rotor Loads Analysis**

F. J. Tarzanin

INTRODUCTION

The Aeroelastic Prop/Rotor Analysis Program calculates the following for a single- or tandem-rotor aircraft in hover, axial flight, or edgewise flight (i.e., helicopter configuration):

- o Blade Airloads - Including downwash, lift, drag, aerodynamic pitching moment, angle of attack, and unsteady aerodynamic parameters, all as a function of blade azimuth and radial position
- o Aerodynamic Performance Parameters - Including shaft angle relation to free stream; advance ratio; rotor thrust, drag, propulsive force, lift, torque, and horsepower; and nondimensionalized rotor thrust, drag, propulsive force, lift, torque, and horsepower.
- o Blade Response - Including linear and angular deflections, velocities and accelerations, and shear and bending moment distributions
- o Rotating and Fixed System Hub Loads
- o Pitch Link and Control System Actuator Loads

The method used employs an iterative technique between the airloads calculations and the blade response. Indicators of program convergence are given on the last two pages of the output.

The required input data consists of:

- o Blade Physical Properties
- o Blade Airfoil Characteristics
- o Trim Data
- o Specification of Program Controls

BLADE PHYSICAL PROPERTIES

The analysis idealizes the blade into a series of bays. The bay boundaries are defined in input locations 290-310. The total mass of each bay is located midway between the boundaries. The masses are assumed to be connected by massless beams which possess flap, lag, and torsional stiffness. Blade property curves specify the spanwise distributions of blade weight, chordwise centroid location, polar moment of inertia, and flap, lag, and torsional stiffness distribution. The lumped blade properties are obtained by inputting the distributed properties into the D-01 computer program and running subroutine WICK. A brief description of D-01, including a description of the input and a sample case based on the distributed properties, is given in a later section. The output of D-01 subroutine WICK may be directly input into the program.

BLADE AIRFOIL CHARACTERISTICS

Blade airfoil characteristics for each blade cross section are defined by C_L , C_D , and C_M airfoil decks. The appropriate deck must be added to the front of the input data at all times, even when the linear aero option is used. A dummy deck should be used since the program reads the tables before the linear aero controls. If a blade with a variable airfoil section is analyzed, more than one set of airfoil tables will be needed (see input description of locations 221-223). A detailed discussion of the airfoil tables is presented later.

Lift and moment γ function values associated with each airfoil section are input into locations 145-180. If only a single airfoil table is used, locations 157 to 180 and 221 to 223 may be set equal to 0.

TRIM DATA

Trim data is usually obtained from either a description of wind tunnel operating conditions or by inputting flight test conditions into the Y-14 trim program for a single-rotor helicopter or the A-97 trim program for a tandem-rotor helicopter. Program A-97 is described in a subsequent section. Included is a sample input and output which serves as the basis for the sample C-70 case presented later. The program input description (see locations 1-21) illustrates how trim is obtained from the A-97 output. For a single-rotor helicopter, locations 15-21 may be set equal to 0.

SPECIFICATION OF PROGRAM CONTROLS

The computer program contains a large number of computational options; many of these options are used for special purposes only. For this reason a detailed discussion of all available options is not presented. The input sheets presented later indicate usual values for the program controls. Deviation from the suggested values should be done with due consideration. The other input locations indicate the usual source of the input data.

Location 46 specifies which rotor of a tandem helicopter is to be analyzed. When analyzing the forward rotor set location 46 equal to 1. For the aft rotor set location 46 equal to 2. Locations 282 and 283 are used to locate one rotor with respect to the other (see input description). For a single-rotor helicopter, set location 46 equal to 1 and locations 282 and 283 equal to 0.

The most basic option in this program is a choice between uniform downwash and nonuniform downwash. The type of downwash used by the program is controlled by locations 92 and

93 (location 93 has no effect in the case of uniform downwash). Most users will utilize either location 92 equal to 0 (nonuniform downwash) or location 92 equal to 2 (uniform downwash). When location 92 equals 1, the program reads the downwash as input from locations 586 to 1165. This option is useful for analyzing prop/rotors in axial flow, where the wing circulation generates a downwash field through the rotor.

If uniform downwash is used, set locations 93 to 115 equal to 0 EXCEPT LOCATION 94 WHICH MUST BE SET EQUAL TO 1.

If the nonuniform downwash option is used then the controls in locations 93 to 115 must be carefully specified. When a tandem-rotor helicopter is being analyzed, the downwash from each rotor interferes with the other. Therefore, the downwash of both rotors must be calculated (deflections and loads are calculated only for the rotor specified in location 46). If a single rotor is being analyzed, set location 93 equal to 1 and only one rotor is analyzed. For a tandem-rotor helicopter set location 93 equal to 2.

Locations 94 and 95 are not operational at the time of this writing and must be set equal to 1 and 0, respectively.

The program calculates nonuniform downwash by an iterative process; these downwash iterations are referred to as loops. The looping process is used to insure compatibility between downwash, lift, and vortex circulation strength. The looping is performed separately for each rotor. Location 96 specifies the number of loops performed on the rotor being analyzed (as specified in location 46) and location 97 specifies the number of loops performed on the interfering rotor. Note that location 97 equals the number of loops for the interfering rotor and that location 96 MINUS 1 is the number of loops for the rotor being analyzed. Generally the same number of loops are required for both rotors; hence, location 96 must be 1 larger than location 97. For a single-rotor helicopter location 97 is set equal to 0. When the convergence factors described in locations 108 to 111 are used, most users should be able to set location 96 equal to 1 and location 97 equal to 0 and achieve sufficiently accurate values of circulation strength. Do not input values larger than 10 in locations 96 and 97. A tabulation of circulation strengths for each downwash loop and a summary of the thrust routines is provided to indicate the convergence of the looping process.

The program calculates nonuniform downwash by assuming that each blade trails vortices in space. These vortices are idealized into a series of straight-line segments. The downwash at a given point is calculated by applying the Biot-Savart law to each straight-line segment and then summing for all segments. Location 98 specifies the length of vortex (in

rotor revolutions) which is considered effective in producing downwash. The input description gives an equation by which this input value may be calculated.

Locations 99 and 100 specify the inboard and outboard radial positions respectively from which the vortices are trailed. Usually (but not necessarily) the vortices are trailed from the blade cutout and tip.

Locations 101 and 102 are not operational at the time of this writing and must be set equal to 0.

In order to speed the convergence of the downwash looping process, values of circulation strength obtained in successive loops are modified: i.e., only a portion of the change is added to the value obtained in the previous loop. Locations 103 and 104 control the amount of the change which is added. Usually locations 103 and 104 are set equal to 90. This means that 10 percent of the change in circulation strength is added to the value obtained in the previous loop. If a single rotor is being analyzed, only location 103 must be specified; for a tandem both locations 103 and 104 must be specified.

The magnitude of the circulation strength depends on lift. Locations 105 and 106 indicate the number of blade bays which are used to obtain the lift for the outboard and inboard trailed vortices respectively. Usually both locations 105 and 106 are set equal to 1. This means that only the aerodynamic bays at the extremes of the airfoil (blade tip and cutout) are used to determine lift. If both locations are set equal to 2, then the lift used will be the average over two bays and so on. Locations 105 and 106 do not have to be equal.

The Biot-Savart law predicts a $1/R^2$ relationship between the downwash at a given point and the distance, R , to a vortex segment. Thus if a blade intersected a vortex very large values of downwash would result. In order to avoid this the program limits the downwash velocity obtained in any individual blade-vortex interaction to 0.1 of the blade tip speed. When location 107 is set equal to 1, no upper limit is imposed. The user is advised to set location 107 equal to 0.

Experience has shown that the circulation strengths obtained from the initial lift distribution are significantly higher than the values needed for lift-circulation strength-downwash compatibility. Therefore, in order to speed convergence a set of empirical factors has been found which, when applied to the zero-loop circulation strengths, give the approximate values. (In this way the number of downwash loops can be reduced.) These factors are plotted as a function of airspeed and are input into locations 108 to 111. If zeros are input into these locations, then the factors are taken to be 0.1.

Locations 112 to 115 specify factors which modify the circulation strengths in all (including the zeroth) loops. Usually it is unnecessary to further modify the circulation strengths and these factors should be set equal to 1. Do not set locations 112 to 115 equal to 0 as this will zero out the downwash.

The input sheets give the source for the required data and indicate suggested values for the program controls. Locations 40, 41, and 61 show two values. The values on the left are to be used with uniform downwash (location 92 equal to 2) and those on the right should be used with nonuniform downwash (location 92 equal to 0).

The computer program uses an iterative technique between the airloads and coupled flap-pitch response. The number of iterations performed is specified in location 48. It is suggested that 10 iterations be used (the maximum) to provide the greatest likelihood of program convergence. Indicators of convergence are printed on the last two pages of output.

Locations 65 to 69 control which parameters are included in the program printout. For most users the values suggested on the input sheet will provide sufficient information regarding the intermediate iterations (see sample output). Setting location 65 equal to 1 will provide complete output for all iterations. Note that lag and hub load calculations are performed in the last iteration only.

The options specified in locations 586 to 1300 are not needed by most users and so should be left blank; i.e., only input sheets 1 and 2 need to be completed. In general, zeros need not be filled in; the program will insert zeros in all blank input locations.

AIRFOIL DECKS

When large-scale, high-speed electronic computers became available for engineering use, it became possible to remove many of the rather dubious and extreme simplifying assumptions which had been necessary in the analysis of rotors. One of the first tasks undertaken in making rotor calculations more rigorous was to replace linearized airfoil behavior with experimental data, including all the awkward irregularities associated with stall and operation above the critical Mach number.

This was done by using airfoil decks, consisting of IBM cards, that defined an airfoil's C_L , C_D , and C_M characteristics versus angle of attack and Mach number. A description of the airfoil decks and a sample deck are presented later.

Characteristics of Airfoil Tables

Lift, drag, and pitching moment coefficients for airfoils vary widely with details of section geometry in the range of moderate positive or negative angles of attack. For angles outside the range of -20 to +20 degrees angle of attack, however, most profiles of interest to the blade designer behave very much alike. It is therefore convenient to specify a single function to be used for all different airfoil sections in that range of angles. Within the moderate angle-of-attack range, aerodynamic coefficients will be specified in tabular form against the two arguments: angle of attack (α) and Mach number (M), which defines the airfoil deck. Outside this range simplified equations that are written into the rotor analysis are used to define C_L , C_D , and C_M as a function of angle of attack.

The range for which tabulated data is required for lift coefficient (C_L) is ± 20 degrees; for drag coefficient (C_D), from negative stall to positive stall, where the stall angles are input as $\alpha_{\text{NEG STALL}}$ and α_{STALL} .

Lift Coefficient Deck

Lift data in the moderate angle-of-attack range is specified by α - C_L pairs at fixed Mach number. Up to 10 Mach numbers may be used with 15 C_L - α pairs per Mach number.

The following formulae and the curve in Figure 6 define the single C_L - α relation used for all airfoils in the range not covered by the tables discussed above. The formulae are part of the computer program, but it will be noted that four constants (K_1, K_2, K_3, K_4) are also required. These are normally taken as one, but may be adjusted to suit the needs of unusual configurations. Note that K_2 is related to another input constant (C_{L180}) and that they must be mutually consistent. Figure 6 shows the C_L - α relation from +20 to 340 degrees (-20 degrees) for all K 's = 1 and $C_{L180} = 0$.

The following are equations of line segments defining the airfoil lift coefficient at large angles of attack:

The value δ equals α from 20 degrees through 180 degrees and equals $(360 \text{ degrees} - \alpha)$ above 180 degrees up to 340 degrees.

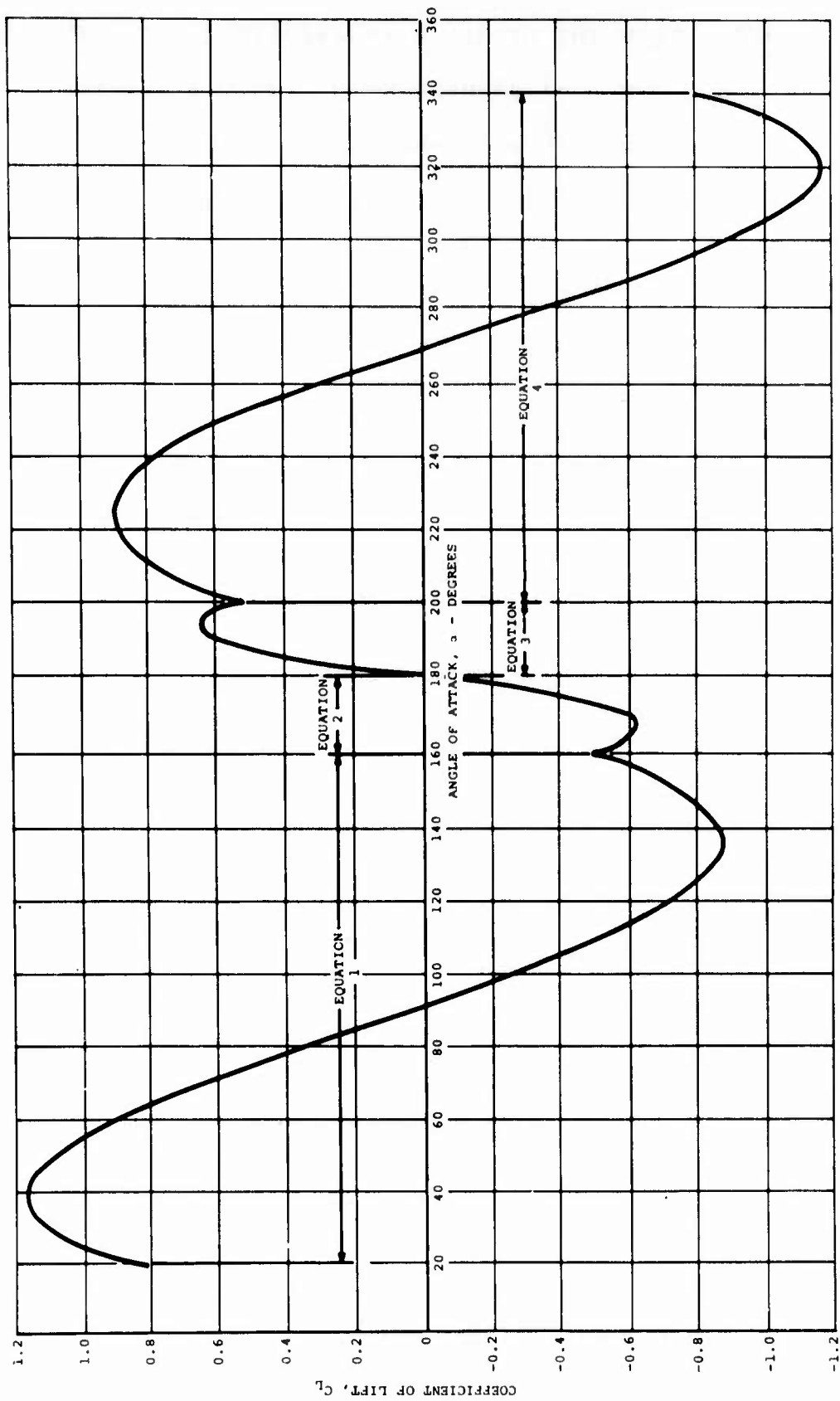


Figure 6. Lift Coefficient Versus Angle of Attack for All Airfoils

- (1) $20^\circ < \alpha \leq 160^\circ$ $C_L = (K_1 \text{ or } K_2) \times (-0.42045519 + 0.08899219$
 $\times \delta - 1.5350914 \times 10^{-3} \times \delta^2 + 7.4254402$
 $\times 10^{-6} \times \delta^3 - 8.2868165 \times 10^{-9} \times \delta^4)$
 $(K_1 \text{ for } 20^\circ < \alpha \leq 90^\circ, K_2 \text{ for } 90^\circ < \alpha \leq 160^\circ)$
- (2) $160^\circ < \alpha \leq 180^\circ$ $C_L = (K_2) \times (99.79237 - 1.2027941 \times \delta$
 $+ 0.0036020154 \times \delta^2) + C_{L180} \frac{(\delta - 160)}{20}$
- (3) $180^\circ < \alpha \leq 200^\circ$ $C_L = (K_3) \times (-99.79237 + 1.2027941$
 $\times \delta - 0.0036020154 \times \delta^2) + C_{L180} \frac{(\delta - 160)}{20}$
- (4) $200^\circ < \alpha < 340^\circ$ $C_L = (K_3 \text{ or } K_4) \times (0.42045519 - 0.08899219$
 $\times \delta + 1.5350914 \times 10^{-3} \times \delta^2 - 7.4254402$
 $\times 10^{-6} \times \delta^3 + 8.2868165 \times 10^{-9} \times \delta^4)$
 $(K_3 \text{ for } 200^\circ < \alpha \leq 270^\circ, K_4 \text{ for } 270^\circ < \alpha < 340^\circ)$

Drag Coefficient Deck

In the unstalled range, drag data are specified in the form C_D -M pairs for constant values of α . Up to 15 values of α may be used, each with up to 7 C_D -M pairs. In addition, α 's for negative and positive stall must be specified.

The function applicable between the stall angles is given in the following equations and the curve in Figure 7.

The following are equations of line segments defining the air-foil drag coefficient at large angles of attack:

$$(5) C_D = -1.0783242 + 0.10546602 \times v - 0.0022458297 \times v^2$$

$$+ 2.543888 \times 10^{-5} \times v^3 - 1.0989072 \times 10^{-7} \times v^4$$

where $v = \alpha + (15^\circ - \alpha_{\text{stall}}) \left(\frac{90^\circ - \alpha}{90^\circ - \alpha_{\text{stall}}} \right)$ for $\alpha_{\text{stall}} < \alpha \leq 90^\circ$

and $v = (180^\circ - \alpha)$ for $90^\circ < \alpha \leq 166^\circ$

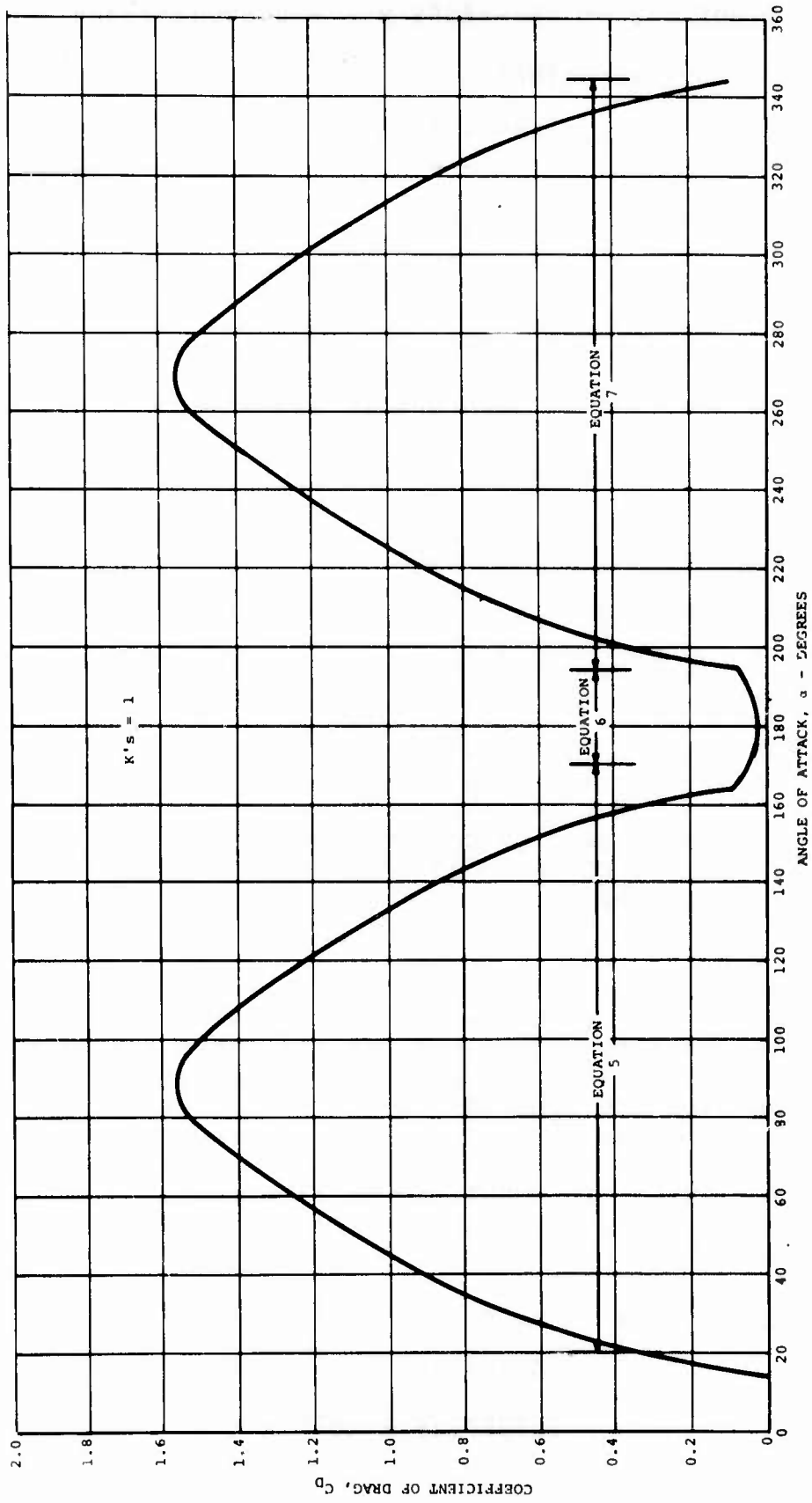


Figure 7. Section Drag Characteristics at Large Angles of Attack

$$(6) C_D = 5.5012552 - 0.060345598 \times \delta + 0.00016618434 \times \delta^2$$

where $\delta = \alpha$ for $166 < \alpha < 180^\circ$

and $\delta = (360^\circ - \alpha)$ for $180^\circ < \alpha < 194^\circ$

$$(7) C_D = -1.0783242 + 0.10546602 \times v - 0.0022458297 \times v^2 \\ + 2.543888 \times 10^{-5} \times v^3 - 1.0989072 \times 10^{-7} \times v^4$$

where $v = (\alpha - 180^\circ)$ for $194^\circ \leq \alpha < 270^\circ$

and $v = 360^\circ - \alpha - (345^\circ - \alpha_{\text{neg stall}}) \left(\frac{\alpha - 270^\circ}{\alpha_{\text{neg stall}} - 270^\circ} \right)$
for $270^\circ \leq \alpha < \alpha_{\text{neg stall}}$

Pitching Moment Coefficient Deck

Moderate α Range

For $-16^\circ < \alpha < 16^\circ$, tabulated data must be provided, as follows:

C_m at $\alpha = -16^\circ$ (344°), one value

C_m at $\alpha = 16^\circ$, one value

Up to 13 sets of C_m -Mach number pairs, corresponding to a set of up to 13 α 's. Up to 10 pairs per set may be provided.

High α Range

The curve for C_m between $16^\circ \leq \alpha \leq 344^\circ$ is presented in Figure 8 and the equations for the curve are given below. The first term in the equation for C_m between 16° and 30° and between 330° and 344° is zero for a symmetrical airfoil and not equal to zero for cambered airfoils.

The following are equations of line segments defining the airfoil pitching moment coefficient at large angles of attack:

$$(8) 16^\circ < \alpha \leq 30^\circ \quad C_m = (C_{m16^\circ} + 0.0955) \left(\frac{30 - \alpha}{14} \right) + (0.22140169 \\ - 0.037698898 \times \alpha + 0.0014700305 \times \alpha^2 \\ - 2.1980119 \times 10^{-5} \times \alpha^3)$$

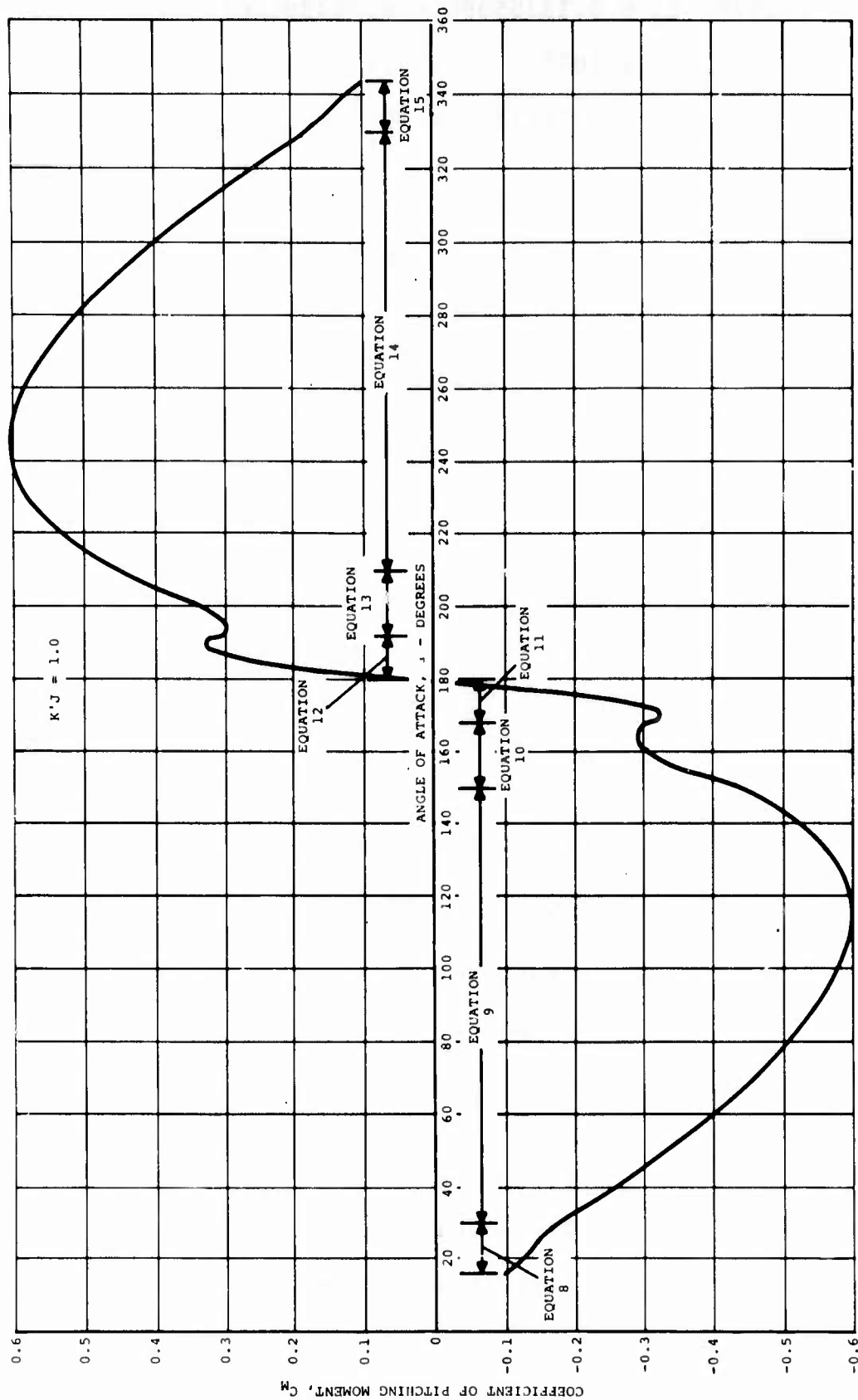


Figure 8. Section Pitching Moment Characteristics at Large Angles of Attack

$$(9) \quad 30^\circ < \alpha < 150^\circ \quad C_m = 0.16285396 - 0.014395669 \times \alpha + 1.2695044 \\ \times 10^{-4} \times \alpha^2 - 9.4724852 \times 10^{-7} \times \alpha^3 \\ + 3.7413282 \times 10^{-9} \times \alpha^4$$

$$(10) \quad 150^\circ < \alpha \leq 168^\circ \quad C_m = (-9.8201326 + 0.051520593 \times \alpha \\ + 4.2809828 \times 10^{-4} \times \alpha^2 - 2.3662806 \\ \times 10^{-6} \times \alpha^3)$$

$$(11) \quad 168^\circ < \alpha \leq 180^\circ \quad C_m = 46.119316 - 0.42395661 \times \alpha + 0.0011007744 \\ \times \alpha^2 - 6.7548054 \times 10^{-6} \times \alpha^3 + 3.2327550 \\ \times 10^{-8} \times \alpha^4$$

$\delta = 360^\circ - \alpha$ and is applicable between 180° and 344° .

$$(12) \quad 180^\circ < \alpha \leq 192^\circ \quad C_m = -46.119316 + 0.42395661 \times \delta - 0.0011007744 \\ \times \delta^2 + 6.7548054 \times 10^{-6} \times \delta^3 - 3.2327550 \\ \times 10^{-8} \times \delta^4$$

$$(13) \quad 192^\circ \leq \alpha < 210^\circ \quad C_m = 9.8201326 - 0.051520593 \times \delta - 4.2809828 \\ \times 10^{-4} \times \delta^2 + 2.3662806 \times 10^{-6} \times \delta^3$$

$$(14) \quad 210^\circ \leq \alpha < 330^\circ \quad C_m = -0.16285396 + 0.014395669 \times \delta - 1.2695044 \\ \times 10^{-4} \times \delta^2 + 9.4724852 \times 10^{-7} \times \delta^3 \\ - 3.7413282 \times 10^{-9} \times \delta^4$$

$$(15) \quad 330^\circ \leq \alpha < 344^\circ \quad C_m = (C_{m344^\circ} - 0.0955) \left(\frac{\alpha - 330}{14} \right) + (-0.2214069 \\ + 0.037698898 \times \delta - 0.0014700305 \times \delta^2 \\ + 2.1980119 \times 10^{-5} \times \delta^3)$$

A typical C_L , C_D , and C_M airfoil deck is defined below. This example is shown only to indicate how to define the decks and is not meant to indicate actual airfoil data.

C_L Deck

Title Card

180. 180.MAX POS ALPHA,MAX NEG ALPHA
 0.0 1.0000 1.0000 1.0000 1.0000CONTROL NOS.

10 NO.OF MACH NUMBERS FOR CL VS ALPHA
 MACH NUMBERS

0.0 0.300 0.400 0.550 0.650 0.750 0.800
 0.850 0.900 1.000

***** LIFT TABLE *****

5 NM.OF ALPHA-CL PAIRS FOR MACH NUM. = 0.0

ALPHA 0.0 6.00 20.000 340.000 360.000

CL -0.010000 0.640000 2.040000 -2.240000 -0.010000

5 NM.OF ALPHA-CL PAIRS FOR MACH NUM.= 0.300

ALPHA 0.0 7.400 20.000 340.000 360.000

CL -0.020000 0.825000 2.146999 -2.219999 -0.020000

5 NM.OF ALPHA-CL PAIRS FOR MACH NUM.= 0.400

ALPHA 0.0 6.500 20.000 340.000 360.000

CL -0.015000 0.755000 2.266999 -2.410000 -0.015000

5 NM.OF ALPHA-CL PAIRS FOR MACH NUM.= 0.550

ALPHA 0.0 3.000 20.000 340.000 360.000

CL -0.025000 0.360000 2.485000 -2.525000 -0.025000

6 NM.OF ALPHA-CL PAIRS FOR MACH NUM.= 0.650

ALPHA 0.0 2.000 4.000 20.000 340.000 360.000

CL -0.020000 0.280000 0.555000 2.714999 -3.020000 -0.020000

5 NM.OF ALPHA-CL PAIRS FOR MACH NUM.= 0.750

ALPHA 0.0 1.000 20.000 340.000 360.000

CL -0.020000 0.160000 2.990000 -3.620000 -0.020000

6 NM.OF ALPHA-CL PAIRS FOR MACH NUM.= 0.800

ALPHA 0.0 1.200 20.000 340.000 358.800 360.000

CL -0.045000 0.225000 3.134999 -3.195000 -0.285000 -0.045000

5 NM.OF ALPHA-CL PAIRS FOR MACH NUM.= 0.850

ALPHA
 0.0 3.600 20.000 340.000 360.000
 CL
 -0.045000 0.795000 2.106999 -2.540000 -0.045000
 7 NM.OF ALPHA-CL PAIRS FOR MACH NUM.= 0.900
 ALPHA
 0.0 1.200 6.200 20.000 340.000 358.900 360.000
 CL
 -0.015000 0.075000 0.800000 1.766000 -1.480000 -0.095000 -0.015000
 4 NM.OF ALPHA-CL PAIRS FOR MACH NUM.= 1.000
 ALPHA
 0.0 20.000 340.000 360.000
 CL
 -0.010000 0.190000 -1.209999 -0.010000

C_D Deck

(No title card required, attached to C_L deck)

POS-NEG STALL ANGLES IN CD-M TABLES

12.000 350.000
 14 NO.OF ALPHA VALUES FOR CD VS M
 ALPHA
 0.0 1.000 2.000 4.000 6.000 8.000 10.000
 12.000 14.000 350.000 357.000 358.000 359.000 360.000
 7 NUM OF M-CD PAIRS FOR ALPHA = 0.0
 MACH
 0.0 0.400 0.700 0.810 0.840 0.877 1.000
 CD
 0.011600 0.008600 0.009200 0.010100 0.014900 0.032800 0.105700
 7 NUM OF M-CD PAIRS FOR ALPHA = 1.000
 MACH
 0.0 0.400 0.750 0.775 0.810 0.850 1.000
 CD
 0.011600 0.008800 0.009300 0.010300 0.013900 0.024400 0.112700
 7 NUM OF M-CD PAIRS FOR ALPHA = 2.000
 MACH
 0.0 0.400 0.625 0.700 0.765 0.800 1.000
 CD
 0.011600 0.008700 0.009100 0.010000 0.014000 0.023400 0.132200
 7 NUM OF M-CD PAIRS FOR ALPHA = 4.000
 MACH
 0.0 0.300 0.625 0.675 0.725 0.800 1.000
 CD
 0.011600 0.009200 0.011100 0.015300 0.029000 0.062900 0.202700
 7 NUM OF M-CD PAIRS FOR ALPHA = 6.000
 MACH
 0.0 0.300 0.400 0.530 0.600 0.650 1.000
 CD
 0.011600 0.009200 0.010550 0.013500 0.022100 0.043100 0.277700
 7 NUM OF M-CD PAIRS FOR ALPHA = 8.000

MACH	0.0	0.300	0.400	0.450	0.500	0.600	1.000
CD	0.013700	0.011700	0.015800	0.022980	0.034300	0.080100	0.351200
	7 NUM OF M-CD PAIRS FOR ALPHA = 10.000						
MACH	0.0	0.200	0.250	0.300	0.350	0.400	1.000
CD	0.018600	0.017400	0.017700	0.023200	0.034400	0.052700	0.427700
	7 NUM OF M-CD PAIRS FOR ALPHA = 12.000						
MACH	0.0	0.150	0.200	0.250	0.300	0.400	1.000
CD	0.024600	0.024600	0.027400	0.038700	0.058200	0.114200	0.477500
	7 NUM OF M-CD PAIRS FOR ALPHA = 14.000						
MACH	0.0	0.100	0.125	0.150	0.175	0.200	1.000
CD	0.031600	0.031600	0.032100	0.034600	0.038900	0.048900	0.533700
	7 NUM OF M-CD PAIRS FOR ALPHA = 350.000						
MACH	0.0	0.250	0.300	0.360	0.410	0.450	1.000
CD	0.024100	0.022200	0.022400	0.025300	0.030800	0.040400	0.259500
	7 NUM OF M-CD PAIRS FOR ALPHA = 357.000						
MACH	0.0	0.500	0.650	0.700	0.750	0.825	1.000
CD	0.012100	0.008800	0.010600	0.016100	0.027000	0.053900	0.152700
	7 NUM OF M-CD PAIRS FOR ALPHA = 358.000						
MACH	0.0	0.400	0.700	0.750	0.800	0.825	1.000
CD	0.011600	0.008700	0.010100	0.014500	0.025000	0.036400	0.137700
	7 NUM OF M-CD PAIRS FOR ALPHA = 359.000						
MACH	0.0	0.400	0.750	0.775	0.810	0.850	1.000
CD	0.011600	0.008800	0.009300	0.010500	0.015400	0.025900	0.117700
	7 NUM OF M-CD PAIRS FOR ALPHA = 360.000						
MACH	0.0	0.400	0.700	0.810	0.840	0.877	1.000
CD	0.011600	0.008600	0.009200	0.010120	0.014900	0.032800	0.105700

C_M DECK

CM ALPHA=16 DEG and 344 DEG

-0.096 0.096

15 NO.OF ALPHA VALUES FOR CM VS M

ALPHA

0.0	2.000	4.000	6.000	8.000	10.000	11.000
13.000	16.000	344.000	349.000	352.000	356.000	359.000
360.000						

10 NO.OF M-CM PAIRS FOR ALPHA = 0.0

MACH

0.0	0.100	0.200	0.300	0.500	0.600	0.800
0.900	0.950	1.000				

CM

0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	-0.001500	-0.002000				

10 NO.OF -CM PAIRS FOR ALPHA = 2.000

MACH

0.0	0.300	0.600	0.700	0.750	0.800	0.850
0.900	0.950	1.000				

CM

-0.002000	-0.001100	-0.001000	0.000500	0.002200	-0.001200	-0.061000
-0.049000	-0.035000	-0.039500				

10 NO.OF M-CM PAIRS FOR ALPHA = 4.000

MACH

0.0	0.300	0.500	0.600	0.650	0.750	0.800
0.850	0.900	1.000				

CM

-0.006000	-0.004800	-0.003000	0.003000	0.004000	-0.014000	-0.055500
-0.072000	-0.049000	-0.012000				

10 NO.OF M-CM PAIRS FOR ALPHA = 6.000

MACH

0.0	0.500	0.600	0.650	0.750	0.800	0.850
0.900	0.925	1.000				

CM

-0.010000	-0.008000	0.001000	0.001500	-0.050000	-0.070000	-0.079000
-0.071000	-0.046500	-0.080000				

10 NO.OF M-CM PAIRS FOR ALPHA = 8.000

MACH

0.0	0.300	0.400	0.500	0.600	0.700	0.800
0.900	0.925	1.000				

CM

-0.016000	-0.014000	-0.016500	-0.017000	-0.012000	-0.033500	-0.069000
-0.077000	-0.056000	-0.077500				

10 NO.OF M-CM PAIRS FOR ALPHA = 10.000

MACH

0.0	0.150	0.400	0.500	0.600	0.700	0.800
0.900	0.925	1.000				

CM
 -0.015000 -0.020000 -0.032000 -0.032000 -0.031000 -0.047000 -0.067500
 -0.078500 -0.057000 -0.074000
 10 NO.OF M-CM PAIRS FOR ALPHA = 11.000
 MACH
 0.0 0.150 0.300 0.400 0.600 0.700 0.800
 0.900 0.925 1.000

CM
 -0.022500 -0.025500 -0.046500 -0.053000 -0.052500 -0.066000 -0.081000
 -0.092000 -0.073000 -0.086000
 10 NO.OF M-CM PAIRS FOR ALPHA = 13.000
 MACH
 0.0 0.150 0.300 0.400 0.600 0.700 0.800
 0.900 0.925 1.000

CM
 -0.071000 -0.072000 -0.078000 -0.088000 -0.088000 -0.096500 -0.105500
 -0.112000 -0.099000 -0.105500
 2 NO.OF M-CM PAIRS FOR ALPHA = 16.000
 MACH
 0.0 1.000

CM
 -0.096000 -0.096000
 2 NO. OF M-CM PAIRS FOR ALPHA = 344.000
 MACH
 0.0 1.000

CM
 0.096000 0.096000
 10 NO.OF M-CM PAIRS FOR ALPHA = 349.000
 MACH
 0.0 0.150 0.300 0.400 0.600 0.700 0.800
 0.900 0.925 1.000

CM
 0.022500 0.025500 0.046500 0.053000 0.052500 0.066000 0.081000
 0.092000 0.073000 0.086000
 10 NO.OF M-CM PAIRS FOR ALPHA = 352.000
 MACH
 0.000 0.300 0.400 0.500 0.600 0.700 0.800
 0.900 0.925 1.000

CM
 0.016000 0.014000 0.016500 0.017000 0.012000 0.033500 0.069000
 0.077000 0.056000 0.077500
 10 NO.OF M-CM PAIRS FOR ALPHA = 356.000

MACH
 0.0 0.800 0.500 0.600 0.650 0.750 0.800
 0.850 0.900 1.000

CM
 0.006000 0.004800 0.003000 -0.003000 -0.004000 0.014000 0.055300
 0.072000 0.049000 0.012000

10 NO.OF M-CM PAIRS FOR ALPHA = 359.000

MACH
 0.0 0.300 0.500 0.600 0.750 0.800 0.850
 0.900 0.950 1.000

CM
 -0.001000 0.001000 -0.001500 -0.003800 0.002000 0.000500 0.035000
 0.012500 0.010000 0.019000

10 NO.OF M-CM PAIRS FOR ALPHA = 360.000

MACH
 0.0 0.100 0.200 0.300 0.500 0.600 0.800
 0.900 0.950 1.000

CM
 0.0 0.0 0.0 0.0 0.0 0.0 0.0
 0.0 -0.001500 -0.002000

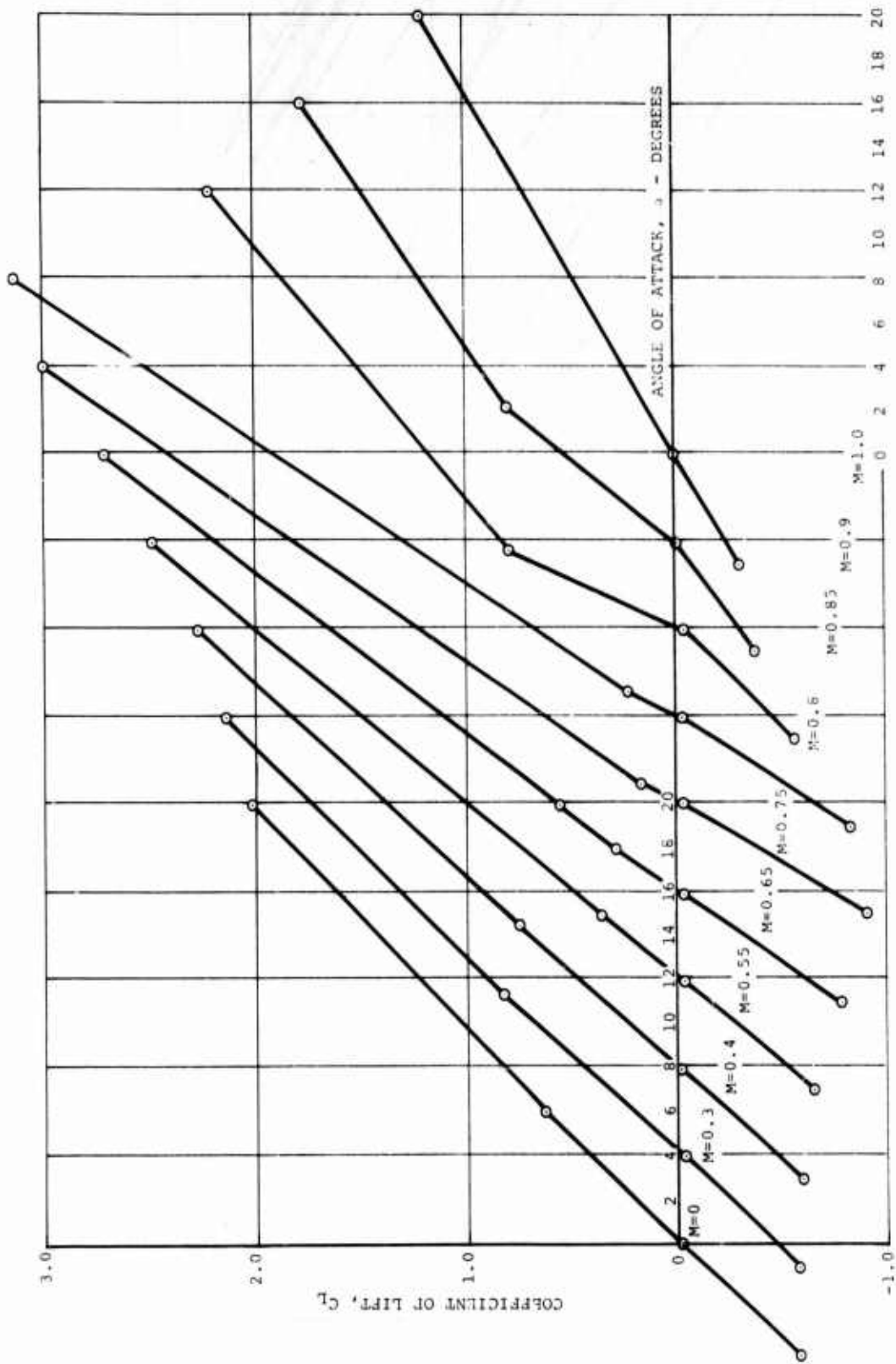


Figure 9. Coefficient of Lift for NACA 0011 (Mod) Airfoil Section

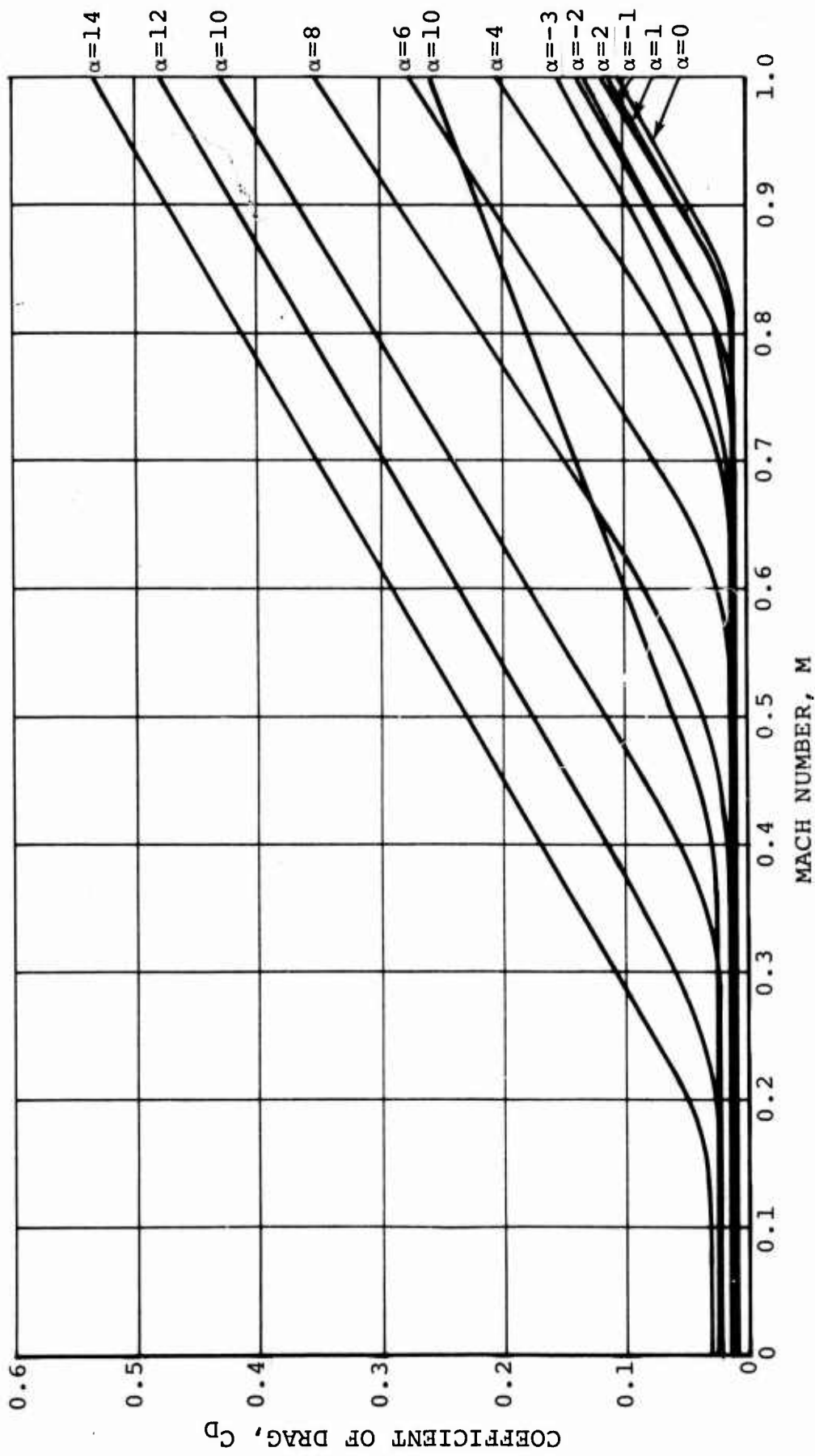


Figure 10. Coefficient of Drag for NACA 0011 (Mod) Airfoil Section

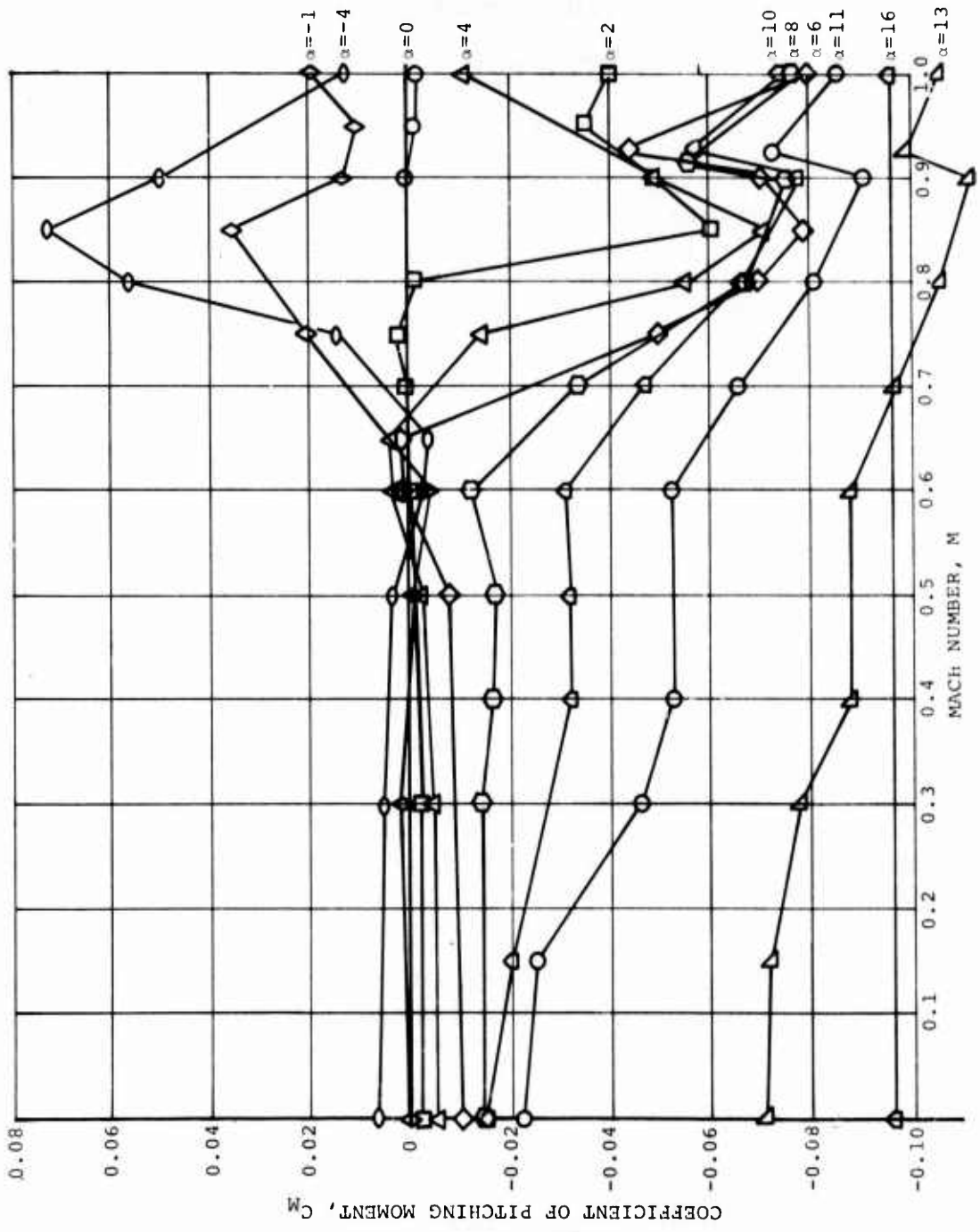


Figure 11. Coefficient of Pitching Moment for NACA 0011 (Mod) Airfoil Section

PROGRAM INPUT

Dimension Code N-D Nondimensional
 SL Slug - mass unit = Lb-Sec²/Ft

<u>LOCATION</u>	<u>SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
1	V	Flight path velocity (knots), TAS	kts
2	α	Fuselage water line angle of attack - measured from direction of free stream velocity, not horizon (positive nose up) - same units and sign convention as aero trim output.	deg
3	Ω	Rotor speed.	rpm
4	ρ	Air mass density.	sl/ft ³
5	S	Speed of sound, $S = 49.1 \sqrt{459.6 + T}$ where T = Temperature in degrees F.	ft/sec
6	-	Not used	---

Locations 7 thru 13 define the thrust, collective, cyclic and flapping for the forward rotor. These locations are also used for an isolated rotor analysis (as in a single rotor helicopter). Aft rotor data (Locs. 15-21) are required when a forward rotor is being analyzed and non-uniform rotor interference downwash is considered (i.e., when Loc. 46 = 1, Loc. 92 = 0 or 3 and Loc. 93 = 3 or 2).

7	T_{of}	Thrust of the forward rotor along the rotor shaft. Same units and sign convention as aero trim output. $T_{of} = TF$ in aero trim output, A97.	lbs
8	θ_{of}	Collective pitch angle for the forward rotor. Equal to the mean mechanical angle of attack at the 0.75 r/R radial position - measured from the disc plane (positive nose up). Same units and sign convention as aero trim program.	deg

ROTOR ANALYSIS PROGRAM C-70

TITLE

1 C_L C_D C_M
 2 C_L C_D C_M

AIRFOIL TABLES

3 C_L C_D C_M
 4 C_L C_D C_M
 5 C_L C_D C_M

DEF.	LOC.	VALUE	DIM.	DEF.	LOC.	VALUE	DIM.	DEF.	LOC.	VALUE	DIM.	DEF.	LOC.	VALUE	DIM.	DEF.	LOC.	VALUE	DIM.					
V	1	TRIM A-97	fts.	46	A	ROTOR		91	3	V_0 Calculation		136		0.0		181		0.0						
α	2	TRIM A-97	deg.	47	B	No. of blades		92	*	N/D, D, ODD		137		0.0		182		0.0						
β	3	TRIM A-97	deg.	48	IO.	No. of iterations		93	*	N/D, D, TYPE		138		0.0		183		0.0						
ρ	4	TRIM A-97	ft ³ /sec	49	I.	Thrust Routine		94	I.	Veres. TYPE		139		0.0		184		0.0						
S	5	TRIM A-97	sec	50	0.	Linear Acc		95	0.	Near Wake (hr)		140		0.0		185		0.0						
Forward Rotor																								
T ₀	7	TRIM A-97	sec.	51	5.73	DRAD.		96	1.	F.W. Iter-1		141		0.0		186		0.0						
ζ_0	8	TRIM A-97	deg.	52	0	N.D.		97	0.	F.W. Iter-R1		142		0.0		187		0.0						
θ_C	9	TRIM A-97	deg.	53	0	RAD.		98	2.	Veres. Serial		143		0.0		188		0.0						
θ_S	10	TRIM A-97	deg.	54	0	RAD.		99	A	Inclined Veres		144		0.0		189		0.0						
β_0	11	TRIM A-97	deg.	55	0			100	1.0	Outboard Veres		145		0.0		190		0.0						
β_C	12	TRIM A-97	deg.	56	0			101	0.	V_{opt}		146		A		191		0.0						
β_S	13	TRIM A-97	deg.	57	0	N.D.		102	0.	\bar{a}		147		A		192		0.0						
Alt Rotor																								
T ₀	15	TRIM A-97	sec.	58	0	N.D.		103	90.			148		A		193		0.0						
ρ_0	16	TRIM A-97	deg.	59	0	N.D.		104	90.			149		A		194		0.0						
θ_C	17	TRIM A-97	deg.	60	0.0	deg.		105	1.			150		A		195		0.0						
θ_S	18	TRIM A-97	deg.	61	2.10			106	1.			151		A		196		0.0						
ρ_C	19	TRIM A-97	deg.	62	32.2			107	0.			152		A		197		0.0						
ρ_S	20	TRIM A-97	deg.	63	0.			108	A			153		A		198		0.0						
β_C	21	TRIM A-97	deg.	64	0.			109	A			154		A		199		0.0						
β_S	22	TRIM A-97	deg.	65	2.	Inertion Output		110	A			155		A		200		0.0						
CONTROLS																								
2C	23	0.0		66	1.	Face Output		111	A			156		A		201		0.0						
3C	24	0.0		67	1.	Flap Output		112	1.			157		A		202		0.0						
4C	25	0.0		68	1.	Leg Output		113	1.			158		A		203		0.0						
5C	26	0.0		69	1.	Hub Load Output		114	1.			159		A		204		0.0						
6C	27	0.0		70	0.	Hub Motion		115	1.			160		A		205		0.0						
7C	28	0.0		71	0.0	n=1		116	0.			161		A		206		0.0						
8C	29	0.0		72	0.0	n=2		117	0.			162		A		207		0.0						
9C	30	0.0		73	0.0	n=3		118	0.			163		A		208		0.0						
10C	31	0.0		74	0.0	n=4		119	0.			164		A		209		0.0						
11C	32	0.0		75	0.0	n=5		120	0.			165		A		210		0.0						
12C	33	0.0		76	0.0	n=6		121	0.			166		A		211		0.0						
13C	34	0.0		77	0.0	n=7		122	0.			167		A		212		0.0						
14C	35	0.0		78	0.0	n=8		123	0.			168		A		213		0.0						
15C	36	0.0		79	0.0	n=9		124	0.			169		A		214		0.0						
16C	37	0.0		80	0.0	n=10		125	0.			170		A		215		0.0						
17C	38	0.0		81	0.0	n=11		126	0.			171		A		216		0.0						
18C	39	0.0		82	0.0	n=12		127	0.			172		A		217		0.0						
19C	40	0.0		83	0.0	n=13		128	0.			173		A		218		0.0						
20C	41	0.0		84	0.0	n=14		129	0.			174		A		219		0.0						
21C	42	0.0		85	0.0	n=15		130	0.			175		A		220		0.0						
22C	43	0.0		86	0.0	n=16		131	0.			176		A		221		0.0						
23C	44	0.0		87	0.0	n=17		132	0.			177		A		222		0.0						
24C	45	0.0		88	0.0	n=18		133	0.			178		A		223		0.0						
25C	46	0.0		89	0.0	n=19		134	0.			179		A		224		0.0						
26C	47	0.0		90	0.0	n=20		135	0.			180		A		225		0.0						
CONTROLS																								
10	0.	1.		85	0.0	% opt.		136	0.			181		0.0		226		0.0						
11	0.	1.		86	0.0	Curv		137	0.			182		0.0		227		0.0						
12	0.	0.		87	0.0	opt.		138	0.			183		0.0		228		0.0						
13	0.	0.		88	0.0	upping		139	0.			184		0.0		229		0.0						
14	0.	0.		89	0.0	upping		140	0.			185		0.0		230		0.0						
15	0.	0.		90	0.0	n=20		141	0.			186		0.0		231		0.0						
TORS DAMPING COEFF																								
															187	0.0		232	0.0					
															188	0.0		233	0.0					
															189	0.0		234	0.0					
															190	0.0		235	0.0					
															191	0.0		236	0.0					
															192	0.0		237	0.0					
															193	0.0		238	0.0					
															194	0.0		239	0.0					
															195	0.0		240	0.0					
															196	0.0		241	0.0					
															197	0.0		242	0.0					
															198	0.0		243	0.0					
															199	0.0		244	0.0					
															200	0.0		245	0.0					
															201	0.0		246	0.0					
															202	0.0		247	0.0					
															203	0.0		248	0.0					
															204	0.0		249	0.0					
															205	0.0		250	0.0					
															206	0.0		251	0.0					
															207	0.0		252	0.0					
															208	0.0		253	0.0					
															209	0.0		254	0.0					
															210	0.0		255	0.0					
															211	0.0		256	0.0					
															212	0.0		257	0.0					
															213	0.0		258	0.0					
															214	0.0		259	0.0					
															215	0.0		260	0.0					
															216	0.0		261	0.0					
															217	0.0		262	0.0					
															218	0.0		263	0.0					
															219	0.0		264	0.0					
															220	0.0		265	0.0					
															221	0.0		266	0.0					
															222	0.0		267	0.0					
															223	0.0		268	0.0					
															224	0.0		269	0.0					
															225	0.0		270	0.0					

FORM 32717-711 A = See C-70 writeup B = Basic data * = User's decision

**MOTOR ANALYSIS
PROGRAM C-70**

BLADE TITLE:

TITLE:

DEF.	LOC.	VALUE	DIM.	DEF.	LOC.	VALUE	DEF.	LOC.	VALUE	DEF.	LOC.	VALUE	DEF.	LOC.	VALUE	DEF.	LOC.	VALUE
R	271	B	FT.		316	B		406	A		451	D-01		496	D-01		541	D-01
C ₀	272	B	N.		317	B		407	A		452	D-01		497	D-01		542	D-01
NO. AERO.	273	*			318	B		408	A		453	D-01		498	D-01		543	D-01
MASS	274	*			319	B		409	A		454	D-01		499	D-01		544	D-01
FLAP	275	A			320	B		410	A		455	D-01		500	D-01		545	D-01
LAC	276	A			321	B		411	A		456	D-01		501	D-01		546	D-01
B ₀	277	B	IN.		322	B		412	A		457	D-01		502	D-01		547	D-01
b	278	B	IN.		323	B		413	A		458	D-01		503	D-01		548	D-01
b ₁	279	B	DEG.		324	B		414	A		459	D-01		504	D-01		549	D-01
I _{IND}	280	B	DEG.		325	B		415	A		460	D-01		505	D-01		550	D-01
I _{WT}	281	B	DEG.		326	B		416	A		461	D-01		506	D-01		551	D-01
ΔI _r	282	B	N.D.		327	B		417	A		462	D-01		507	D-01		552	D-01
Δh/a	283	B	N.D.		328	B		418	A		463	D-01		508	D-01		553	D-01
k ₁	284	B	IN-IN.		329	B		419	A		464	D-01		509	D-01		554	D-01
C ₀	285	B	IN-IN.		330	B		420	A		465	D-01		510	D-01		555	D-01
k ₂	286	B	IN-IN.		331	B		421	A		466	D-01		511	D-01		556	D-01
C ₁	287	B	IN-IN.		332	B		422	A		467	D-01		512	D-01		557	D-01
q ₀	288	B	N.D.		333	B		423	A		468	D-01		513	D-01		558	D-01
q ₁	289	B	N.D.		334	B		424	A		469	D-01		514	D-01		559	D-01
	290	A	I=1		335	B		425	A		470	D-01		515	D-01		560	D-01
	291	A	I=2		336	D-01		426	D-01		471	D-01		516	D-01		561	D-01
	292	A	I=3		337	D-01		427	D-01		472	D-01		517	D-01		562	D-01
	293	A	I=4		338	D-01		428	D-01		473	D-01		518	D-01		563	D-01
	294	A	I=5		339	D-01		429	D-01		474	D-01		519	D-01		564	D-01
	295	A	I=6		340	D-01		430	D-01		475	D-01		520	D-01		565	D-01
	296	A	I=7		341	D-01		431	D-01		476	B		521	D-01		566	D-01
	297	A	I=8		342	D-01		432	D-01		477	B		522	D-01		567	D-01
	298	A	I=9		343	D-01		433	D-01		478	B		523	D-01		568	D-01
	299	A	I=10		344	D-01		434	D-01		479	B		524	D-01		569	D-01
	300	A	I=11		345	D-01		435	D-01		480	B		525	D-01		570	D-01
X ₁	301	A	I=12		346	D-01		436	D-01		481	B		526	D-01		571	D-01
R	302	A	I=13		347	D-01		437	D-01		482	B		527	D-01		572	D-01
N.D.	303	A	I=14		348	D-01		438	D-01		483	B		528	D-01		573	D-01
	304	A	I=15		349	D-01		439	D-01		484	B		529	D-01		574	D-01
	305	A	I=16		350	D-01		440	D-01		485	B		530	D-01		575	D-01
	306	A	I=17		351	D-01		441	D-01		486	B		531	D-01		576	D-01
	307	A	I=18		352	D-01		442	D-01		487	B		532	D-01		577	D-01
	308	A	I=19		353	D-01		443	D-01		488	B		533	D-01		578	D-01
	309	A	I=20		354	D-01		444	D-01		489	B		534	D-01		579	D-01
	310	A	I=21		355	D-01		445	D-01		490	B		535	D-01		580	D-01
	311	A	I=22		356	D-01		446	D-01		491	B		536	D-01		581	D-01
	312	A	I=23		357	D-01		447	D-01		492	B		537	D-01		582	D-01
	313	A	I=24		358	D-01		448	D-01		493	B		538	D-01		583	D-01
	314	A	I=25		359	D-01		449	D-01		494	B		539	D-01		584	D-01
	315	A	I=26		360	D-01		450	D-01		495	B		540	D-01		585	D-01

<u>LOCATION</u>	<u>SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
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Note: Aero trim program A97 prints the collective angle at the blade's center of rotation, THEOF. Therefore

$$\theta_{of} = \text{THEOF} - [\text{amount of blade twist from center of rotation to } .75 \text{ r/R}]$$

or for linearly twisted blades

$$\theta_{of} = \text{THEOF} - 0.75 \theta_t$$

where θ_t is the blade's linear twist defined positive - nose down at the tip.

Note: If thrust routine is used (Loc. 49 = 1, or 2) program will use θ_{of} as a starting point for thrust match. If thrust routine is not used (Loc. 49 = 0) the forward rotor collective is set at θ_{of} .

First harmonic coefficients of control system pitch angle for the forward rotor (Locs. 9 & 10) - zero degree azimuth position is trail aft.

9	θ_{lcf}	Lateral cyclic pitch angle for the forward rotor - cosine coefficient of cyclic pitch (positive - nose up at $\psi = 0$). Same units and opposite sign convention as aero trim output. $\theta_{lcf} = -\text{AICF}$ in aero trim output, A97.	deg
10	θ_{lsf}	Longitudinal cyclic pitch angle for the forward rotor - sine coefficient of cyclic pitch (positive - nose up, at $\psi = 90$). Same units and opposite sign convention as aero trim output. $\theta_{lsf} = -\text{BITF}$ in aero trim output, A97. $\theta_f = \theta_{of} + \theta_{lcf} \sin \psi + \theta_{lsf} \cos \psi$.	
11	β_{of}	Coning angle of forward rotor - steady flapping angle (positive - tip up). Same units and sign convention as aero trim program.	deg

<u>LOCATION</u>	<u>SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
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β_{of} = AOF in aero trim output, A97.

First harmonic coefficients of blade flapping angle for the forward rotor (Locs. 12 & 13). Zero degree azimuth position is trail aft.

12	β_{lcf}	Longitudinal flapping of the forward rotor - cosine coefficient of flapping (positive - tip up at $\psi = 0$). Same units and opposite sign convention as aero trim output.	deg
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β_{lcf} = -AIF in aero trim output, A97.

13	β_{lsf}	Lateral flapping of the forward rotor - sine coefficient of flapping (positive - tip up at $\psi = 90$). Same units and opposite sign convention as aero trim output.	deg
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β_{lsf} = -BIF in aero trim output, A97.

$\beta_f = \beta_{of} + \beta_{lcf} \cos \psi + \beta_{lsf} \sin \psi$

14	-	Not used.	---
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Locations 15 thru 21 define the thrust, collective, cyclic and flapping for the aft rotor. Forward rotor data (Locs. 7 - 13) are required when an aft rotor is being analyzed and non-uniform rotor interference downwash is considered (i.e., when Loc. 46 = 2, Loc. 92 = 0 or 3 and Loc. 93 = 2 or 3).

15	T_{oa}	Thrust of the aft rotor along the rotor shaft. Same units and sign convention as aero trim output.	lbs
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T_{oa} = TR in aero trim output, A97.

16	θ_{oa}	Collective pitch angle for the aft rotor. Equal to the mean mechanical angle of attack at the 0.75 r/R radial position - measured from the disc plane (positive nose up). Same units and sign convention as aero trim program.	deg
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LOCATIONSYMBOLDESCRIPTIONDIMENSION

Note: Aero trim program A97 prints the collective angle at the blade's center of rotation, THEOR. Therefore

$$\theta_{oa} = \text{THEOR} - [\text{amount of blade twist from center of rotation to } .75 \text{ r/R}]$$

or for linearly twisted blades

$$\theta_{oa} = \text{THEOR} - 0.75 \theta_t$$

where θ_t is the blade's linear twist defined positive - nose down at the tip.

Note: If thrust routine is used (Loc. 49 = 1, or 2) program will use θ_{oa} as a starting point for thrust match. If thrust routine is not used (Loc. 49 = 0) the aft rotor collective is set at θ_{oa} .

First harmonic coefficients of control system pitch angle for the aft rotor (Locs. 17 & 18) - zero degree azimuth position is trail aft.

17	θ_{lca}	Lateral cyclic pitch angle for the aft rotor - cosine coefficient of cyclic pitch (positive - nose up at $\psi = 0$). Same units and opposite sign convention as aero trim output.	deg
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$$\theta_{lca} = -\text{AICR in aero trim output, A97.}$$

18	θ_{lsa}	Longitudinal cyclic pitch angle for the aft rotor - sine coefficient of cyclic pitch (positive - nose up, at $\psi = 90$). Same units and opposite sign convention as aero trim output.	deg
----	----------------	--	-----

$$\theta_{lsa} = -\text{BITR in aero trim output, A97.}$$

$$\theta_a = \theta_{oa} + \theta_{lca} \cos \psi + \theta_{lsa} \sin \psi$$

<u>LOCATION</u>	<u>SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
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19	β_{oa}	Coning angle of aft rotor - steady flapping angle (positive - tip up). Same units and sign convention as aero trim program.	deg
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$$\beta_{oa} = \text{AOR in aero trim output, A97.}$$

First harmonic coefficients of blade flapping angle for the aft rotor (Locs. 20 & 21). Zero degree azimuth position is trail aft.

20	β_{1ca}	Longitudinal flapping of the aft rotor - cosine coefficient of flapping (positive - tip up at $\psi = 0$). Same units and opposite sign convention as aero trim output.	deg
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$$\beta_{1ca} = \text{-AIR in aero trim output, A97.}$$

21	β_{1sa}	Lateral flapping of the aft rotor - sine coefficient of flapping (positive - tip up at $\psi = 90$). Same units and opposite sign convention as aero trim output.	deg
----	---------------	--	-----

$$\beta_{1sa} = \text{-BIR in aero trim output, A97.}$$

22 to 39	θ_{2C} to θ_{10S}	Higher harmonic coefficients of control system pitch angle (positive - nose up).	deg
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Higher harmonic control applied to forward rotor only when Loc. 46 = 1 and to aft rotor only when Loc. 42 = 2.

$$\theta = \sum_{k=2}^{10} (\theta_{kc} \cos k\psi + \theta_{ks} \sin k\psi)$$

40	\dot{v}_A opt	Control for \dot{v}_A term in $\dot{\alpha}_{BE}$ 0 = include \dot{v}_A term 1 = omit \dot{v}_A term	---
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v_A option is used only with non-uniform downwash (Loc. 92 = 0, 1 or 3).

41	C_M opt	Control for C_M option 0 = use C_M ref 1 = use $\left(\frac{C_{Mref} - C_{ML=0}}{C_{Lref}} \right) \bar{C}_L + C_{ML=0}$	
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<u>LOCATION</u>	<u>SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
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42

Γ

Control for the calculation of zeroth lift-downwash iteration vortex circulation strengths, Γ_ψ

$$\Gamma_\psi = \frac{K \sum_{i=1}^{b_n} L_{i\psi}}{\Omega R^2 \rho U_i \sum_{i=1}^{b_n} l_i}$$

=1 use $\Gamma_o = \frac{4\pi C_T}{bl(2-3\mu^2)}$

$$\Gamma_{1c} = 0$$

$$\Gamma_{1s} = \frac{-6\pi\mu C_T}{bl(2-3\mu^2)}$$

=2 use $\Gamma_o = \frac{4\pi C_T}{bl(2-3\mu^2)}$

$$\Gamma_{1c} = \frac{3 a_\infty C_o}{8R} \beta_{1s}$$

$$\Gamma_{1s} = - \left[\frac{3 a_\infty C_o}{4R(2-3\mu^2)} \beta_{1c} - \frac{6\pi\mu C_T}{bl(2-3\mu^2)} \right]$$

where $\Gamma_\psi = K(\Gamma_o + \Gamma_{1c} \cos \psi + \Gamma_{1s} \sin \psi)$ and

b_n = number of aerodynamic blade elements over which lift is averaged = Loc. 105 or Loc. 106 (depending on whether Γ_ψ for tip or root)

$L_{i\psi}$ = lift over the i th aerodynamic blade element at azimuth ψ

$U_{i\psi}$ = total velocity at the i th station at azimuth ψ

l_i = length of the i th aerodynamic blade element

<u>LOCATION</u>	<u>SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
		<p>k = a constant factor = Loc. 108, Loc. 109, Loc. 110, or Loc. 111 depending on whether Γ_ψ is outboard or inboard or for the forward or aft rotor</p> <p>bl = number of blades</p> <p>β_{1c}, β_{1s} = 1st harmonic coefficients of flapping = Loc. 12 and 13 for forward rotor and Loc. 20 and 21 for an aft rotor</p>	
44	H	Control to account for blade deflections resulting from bending-torsion coupling	
	= 0	Deflections are calculated without bending-torsion coupling applied	
	= 1 or 3	<p>Torsional deflections resulting from incremental changes in blade torsion due to bending of the torsion axis are calculated and added to the pitch deflections. These deflections are proportional to</p> $M_y M_z \frac{1}{EI_\xi} - \frac{1}{EI_\zeta}$ <p>and hence are not present for a symmetric section</p>	
	= 2 or 3	Incremental flap and lag deflections resulting from bending of the torsion axis and calculated and added to the blade deflections	
45	C_{ELA}	Control for equivalent linear aerodynamics	
	= 0	<p>a_∞ = Loc. 51</p> <p>b_∞ = 0</p>	
	= 1	a_∞ and b_∞ are calculated from airload routine	

<u>LOCATION</u>	<u>SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
46	Rotor	1 = analyze forward rotor 2 = analyze aft rotor	---
		Set equal to 1 when analyzing an isolated rotor (as in a single rotor helicopter)	
47	b1	Number of blades per rotor	---
48	---	Number of iterations between the airload and coupled flap pitch routines - input values from 0 to 10	---
49	---	Control for thrust routine option. 0 - do not perform a thrust routine 1 - perform a thrust routine. The smallest value of collective will be found. 2 - perform a thrust routine. Choose collective nearest the initial value of θ .	---
50	L.A.	Control for aerodynamic option 0 - use non-linear, compressible aerodynamics from table look up 1 - use linear aerodynamics where $C_L = a_\infty \alpha$ $C_D = .012 + \frac{\alpha^2 a_\infty^2 (.8)}{\pi (R/C_o)}$ $C_M = 0$	---
51	a_∞	Two dimensional lift curve slope. Set equal to 5.73	1/rad
52	T.L.	Tip loss - The ineffective length of the blade tip, non-dimensionalized by the blade radius Note: Be sure that this length does not exceed the length of the tip bay.	N.D.

<u>LOCATION</u>	<u>SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
53	Δ_L	Constant subtraction from $\Delta\alpha_L$ to reduce stall delay (negative values increase the stall delay)	rad
54	Δ_M	Constant subtraction from $\Delta\alpha_{CM}$ to reduce stall delay (negative values increase the stall delay)	rad
55	Λ	Yaw angle control 0 - calculate $\cos \Lambda$ 1 - set $\cos \Lambda = 1$	---
56	FGC	Controls selection of F&G functions 0 - calculate F and G 1 - F = Loc. 57, G = Loc. 58	---
57	F	Constant value of F function, used when Loc. 56 = 1	N.D.
58	G	Constant value of G function, used when Loc. 56 = 1	N.D.
59	K	Controls calculation of reduced frequency 0, - Use $k = C_O \Omega / 2V$ 1, - Use $k = C_O \sqrt{-\dot{\theta}/\theta} / 2V$	---
60	AT	Used to limit $\Delta\alpha$ (i.e., dynamic stall delay angle) in the unsteady aero routine 0, - Sets limit of π radians. Any other number, - Sets limit as defined by the input value.	deg
61	\bar{L}	Control to modify the slope used to calculate the \bar{L} term. Set equal to 0, - slope is π 1, - use the equivalent slope i.e., $.5(C_{LREF} - C_{LO}) / (\alpha_{REF(L)} \cos \Lambda)$	---

<u>LOCATION</u>	<u>SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
		2, - use the local slope i.e., $(C_{LREF+.01} - C_{LREF}) 50$.	
		3, - use the local slope plus yawed flow, i.e., $(C_{LREF+.01} - C_{LREF}) 50 / \cos \Lambda$	
		4, - slope is zero	
62	g	Gravity acceleration. For 1g field use 32.2	$\frac{ft}{sec^2}$
63	V_{of}	Steady induced velocity of forward rotor, positive down. Used when Loc. 91 = 0 or 2	ft/sec
64	V_{oa}	Steady induced velocity of the aft rotor, positive down. Used when Loc. 91 = 0 or 1	---
65	---	Controls iteration output 0, - Only the final iteration will be printed 1, - All iterations will be printed 2, - Abbreviated output. The thrust routine, aerodynamic parameters and pitch link loads are printed out for each iteration, with complete printout for the last iteration	---

Note: If Loc. 65 = 1 (all iterations printed) then Locs. 66 and 67 will affect output in all iterations. If Loc. 65 = 0 or 2, then Loc. 66 and 67 will affect output for the last iteration only.

<u>LOCATION</u>	<u>SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
66	---	Controls airload and coriolis output. 0, - No output for these loads 1, - Complete output (airloads, coriolis, C_L and P) 2, - Only coriolis, C_L and P 3, - Only C_L and P 4, - Only airloads, C_L and P (P = airloads perpendicular to the chord)	
67	---	Not used Set = 1	---
68	---	Not used Set = 1	---
69	---	Control for hub load output 0, - No output 1, - Complete hub load output	
70	---	Not used	---
71 to 90	ΔC_M	Pitching moment coefficient correction applied at each aerodynamic blade element (from the tip to the cut-out) to account for trailing edge or tab bend. This term shifts the C_M vs α curve by the ΔC_M specified. A positive ΔC_M increases the nose up pitching moment.	---

Locations 91 to 115 control the type and magnitude of the downwash. When the non-uniform downwash is input, Loc. 92 = 1, from the table in Loc. 586 to Loc. 1065, or when uniform downwash is used, Loc. 92 = 2, then Loc. 93 to 115 have no effect and may be set equal to zero, except Loc. 94 which must be equal to 1.

<u>LOCATION</u>	<u>SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
91	Cal V _o (Table)	Option for the calculation of uniform downwash 0, - Obtain V_{of} and V_{oa} from input 1, - Calculate V_{of} , obtain V_{oa} from input 2, - Obtain V_{of} from input and calculate V_{oa} 3, - Calculate V_{of} and V_{oa}	---
92	Down Wash	Control specifying type of induced velocity to be used 0, - Calculate non-uniform downwash 1, - Input downwash from a table in Locs. 586 to 1065 2, - Uniform downwash only 3, - Calculate non-uniform downwash and add uniform downwash	---
93	D.W.	Controls type of non-uniform downwash used 1, - Self-induced downwash only (single rotor) 2, - Total downwash (=sum of self induced and rotor interference) 3, - Rotor interference downwash only	---
94	NODWLP	Control to determine detail of vortex structure for subsequent airload response iterations. 0, - Calculate far wake for 0 iteration only. Calculate 11 filament mid and near wake every iteration. 1, - Calculate downwash for tip and root vortex only, for the 0 iteration. 2, - Calculate far wake for 0 iterations only. Calculate 11 filament mid and near wake for 0 iterations only. 3, - Calculate far wake for every iteration. Calculate 11 filament mid and near wake for every iteration. Do not use. Set equal to 1.	---
95	NWI	Number of near wake iteration loops for the first to tenth iteration.	---

<u>LOCATION</u>	<u>SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
95(Cont.)		<p>Note: If equal to zero, the near wake iteration loops may be performed for the zero flap-pitch iteration only. Do not use. Set equal to zero.</p>	
96	LOOPSI	Number of lift-downwash compatibility iterations for self-induced downwash. Minus one. Do not exceed 10.	
97	LOOPRI	Number of lift-downwash compatibility iterations for rotor interference downwash. Do not exceed 10.	---
98	M	<p>Length of trailed vortex used in non-uniform downwash calculations, expressed in rotor revolutions.</p> $M = (2 + \Delta l/R)/2\pi \mu$ <p>where $\frac{\Delta l}{R} = \text{Loc. 282}$ for tandem rotors</p> $\frac{\Delta l}{R} = 0$ for single rotor <p>Note: Enter the value of M obtained from the above equation raised to the next higher 1/10. Example: Calculate M = 1.62 Use Loc. 98 = 1.7</p> <p>Do not use values of M larger than 2.0</p>	N-D
99	a_i	Distance from center line of hub to inboard trailed vortex, non-dimensional w.r.t. blade radius.	N-D
100	a_o	Distance from center line of hub to outboard trailed vortex, non-dimensional w.r.t. blade radius.	N-D
101	V_t	<p>Tangential and radial velocity option. If control equals</p> <p>0, - Omit tangential and radial velocity components</p> <p>1, - Include tangential and radial component of the downwash in the airload calculations.</p>	---

<u>LOCATION</u>	<u>SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
102	\bar{a}	Not used Set = 0	
103	DAMPSI	Damping factor applied to vortex circulation strengths, $\Gamma\psi$, to speed convergence of lift-downwash iterations for the self-induced downwash. Set equal to 90 (defined as a percent).	pct
104	DAMPRI	Damping factor applied to vortex circulation strengths, $\Gamma\psi$, to speed convergence of lift-downwash iterations for the rotor interference downwash. Set equal to 90 (defined as a percent).	pct
		Example: DAMPRI = 90. means 0.1 of the change in circulation strength, $\Gamma\psi$, will be added to the previous Γ .	
		$\Gamma(n+1) \text{ after damping} = \Gamma_n \text{ after damping} + 0.1 \times \left[\Gamma_{n+1} \text{ before damping} - \Gamma_n \text{ after damping} \right]$	
105	b_T	Number of outboard aerodynamic blade elements which the lift is averaged to determine the outboard vortex circulation strength.	---
106	b_R	Number of inboard aerodynamic blade elements over which the lift is averaged to determine inboard trailed vortex circulation strength.	---
107	PRTEST	Control to limit non-uniform downwash to a maximum value of .1R Ω . 0, - Apply .1R Ω limit to downwash 1, - Do not apply limit	---
108	XKINTF	Factor applied to outboard vortex circulation strength, $\Gamma\psi$, in the zeroth lift - downwash iteration of the forward rotor.	---

<u>LOCATION</u>	<u>SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
109	XKINTRF	Factor applied to inboard vortex circulation strength, $\Gamma\psi$, in the zeroth lift-downwash iteration for the forward rotor.	---
110	XKINTA	Factor applied to outboard vortex circulation strength $\Gamma\psi$, in the zeroth lift-vortex downwash iterations for the aft rotor.	---
111	XKINRA	Factor applied to inboard vortex circulation strength, $\Gamma\psi$, in the zeroth lift-vortex-downwash iteration for the aft rotor.	---
		Note: When location 108 and 111 are set equal to 0, the program sets the value at .1. If any other value is desired, simply put the value into the proper location. See Figures 12 and 13.	
112	K_{TF}	Multiplication factor to modify outboard vortex circulation strength for the forward rotor.	---
113	K_{RF}	Multiplication factor to modify inboard vortex circulation strength for the forward rotor.	---
114	K_{TS}	Multiplication factor to modify outboard vortex circulation strength for the aft rotor.	---
115	K_{RS}	Multiplication factor to modify inboard vortex circulation strength for the aft rotor.	---
		If non-uniform downwash is calculated (Loc. 92 = 0 or 3) do <u>not</u> set Locs. 112 to Loc. 115 equal to zero. Doing so will zero out the non-uniform downwash.	
116 to 133	β_{kc} β_{ks}	Second through tenth harmonic flap angle (positive - tip up) Loc. 116 = β_{2c} Loc. 117 = β_{2s} , etc. Loc. 118 = β_{3c} Loc. 119 = β_{3s} , etc.	deg

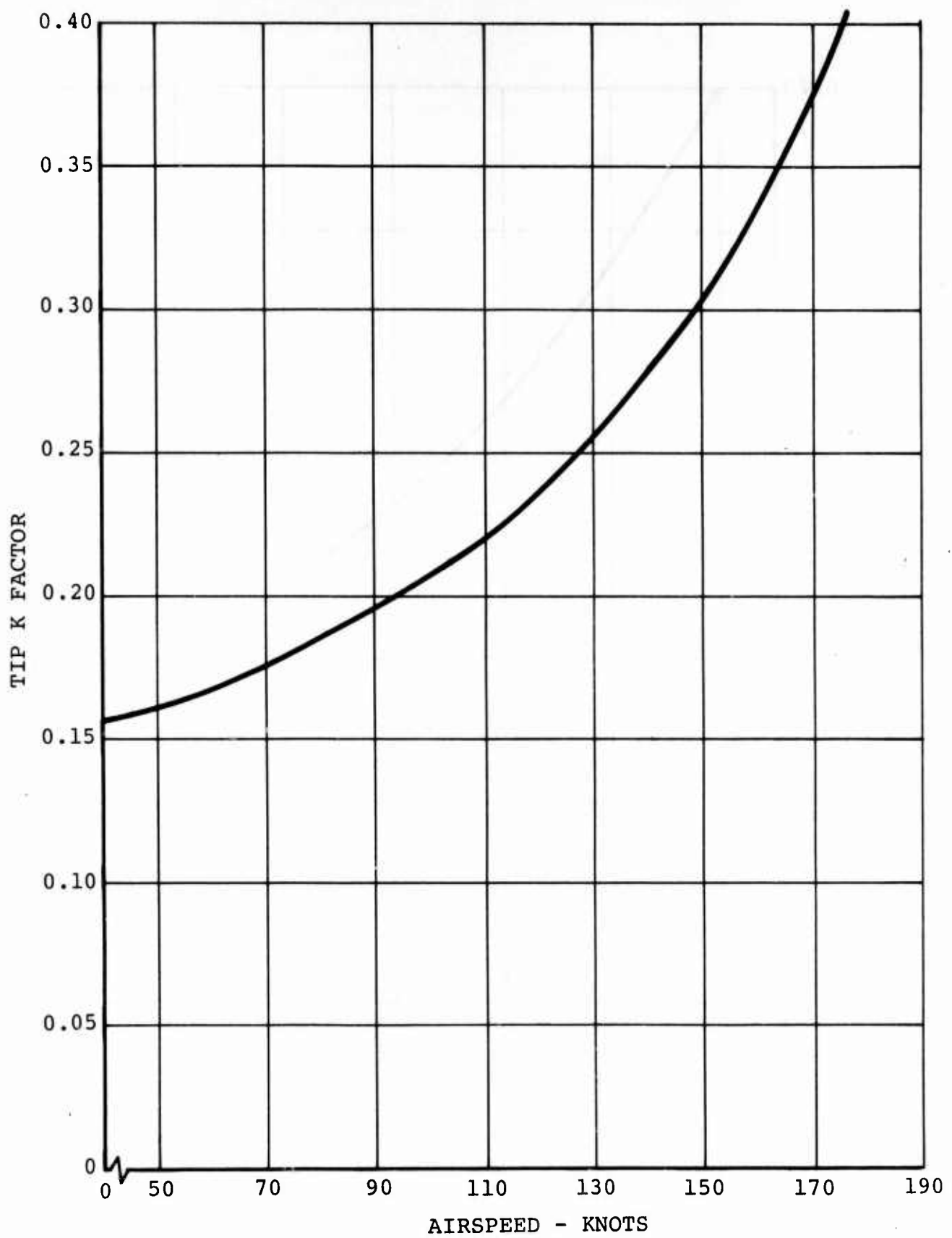


Figure 12. Circulation Strength Factor at Blade Tip

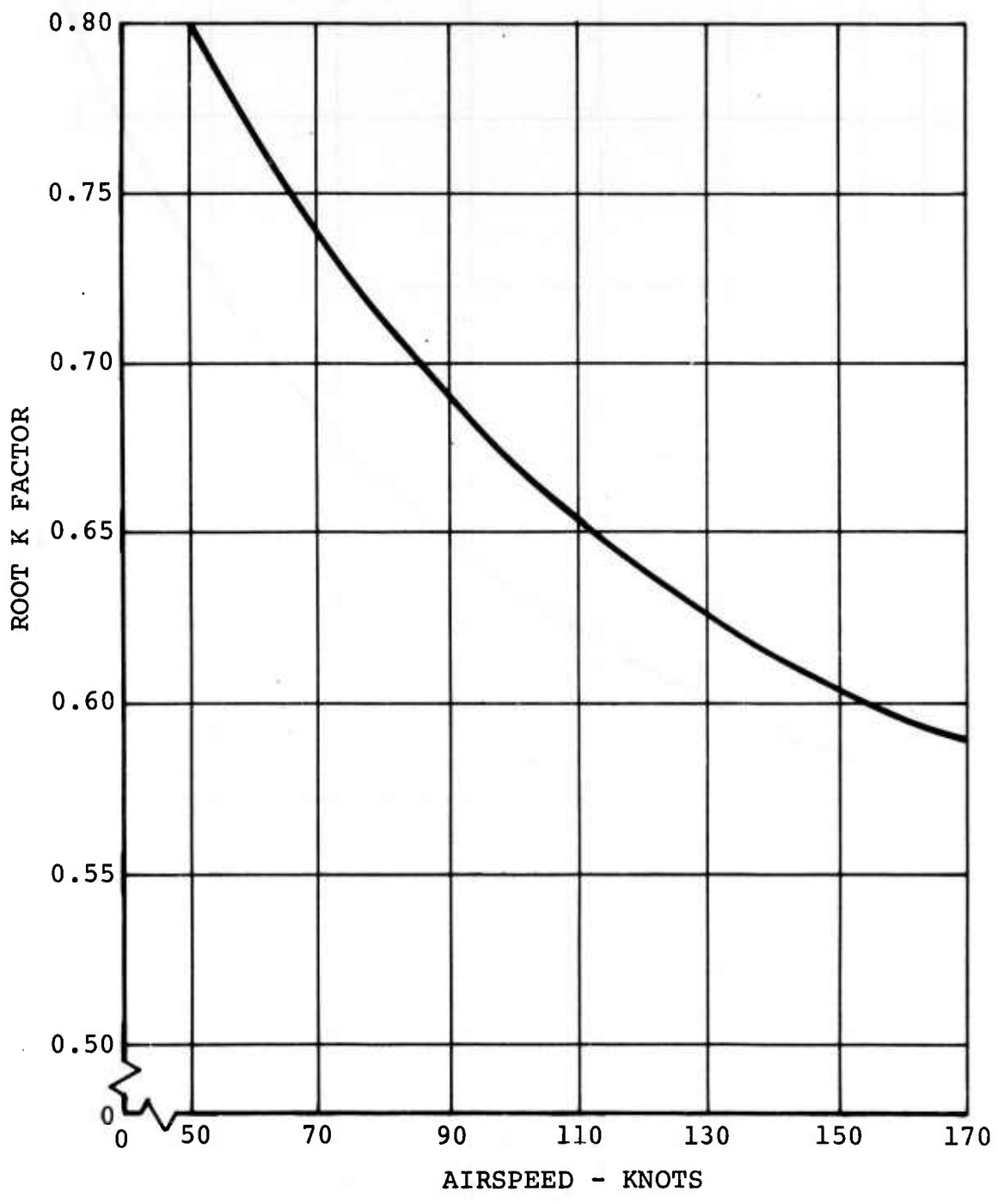


Figure 13. Circulation Strength Factor at Blade Root

<u>LOCATION</u>	<u>SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
116 to 133 (Continued)		Note: Use these locations only when Loc. 275 = 8 or 9. The steady (coning) and first harmonic are defined in Locs. 11, 12 and 13 for a forward rotor and in Locs. 19, 20, 21 for an aft rotor. The higher harmonic flapping coefficients are only applied to the rotor being analyzed; i.e., forward rotor when Loc. 46 = 1 and aft rotor when Loc. 46 = 2.	
134	ξ_0	Pre-lag angle	deg
135	α_V	Angle between forward speed and horizontal plane; positive when aircraft is climbing	deg
136 to 140	---	Free	---
141	K	Forced convergence factor used to speed convergence of airloads response iterations $D'_N = D_N + (D'_{N-1} - D_N) K$ where D'_N = displacement used to calculate N + 1 iteration airloads D_N = displacement based on Nth iteration airloads D'_{N-1} = displacements used to calculate Nth iteration airloads When $K = 1$ forced convergence is not employed	---
142	F	Damping factor - the factor (1 + F) is applied to the aero pitch damping in the force matrix. This factor is used to speed convergence.	---
143, 144	--	Free	---

<u>LOCATION</u>	<u>SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
145 to 150	$\gamma_L^{(1)}$	Lift γ function values of first airfoil table (most inboard) for Mach numbers from 0 to 1.	N.D.
151 to 156	$\gamma_M^{(1)}$	Moment γ function values of first airfoil table (most inboard) for Mach numbers from 0 to 1.	N.D.
157 to 162	$\gamma_L^{(2)}$	Lift γ function values of second airfoil table for Mach numbers from 0 to 1.	N.D.
163 to 168	$\gamma_M^{(2)}$	Moment γ function values of second airfoil table for Mach numbers from 0 to 1.	N.D.
169 to 174	$\gamma_L^{(3)}$	Lift γ function values of third airfoil table (most outboard) for Mach numbers from 0 to 1.	N.D.
175 to 180	$\gamma_M^{(3)}$	Moment γ function values of third airfoil table (most outboard) for Mach numbers from 0 to 1.	N.D.
181 to 210	---	Free	---
211 to 220	---	Free	---

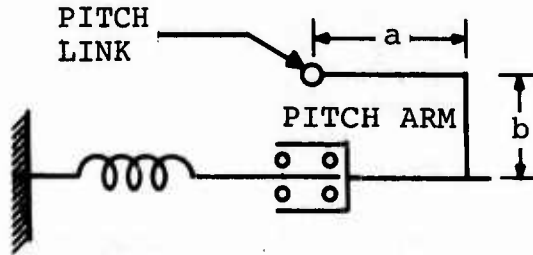
C-70 has the capability of analyzing blades with non-constant airfoil sections. This is done by specifying up to 3 airfoil tables and the radial positions at which they apply. The program performs the double table lookup for each airfoil table and then linearly interpolates to obtain the coefficients for the aerodynamic blade elements in the intermediate positions. If a single airfoil section is used or if linear aerodynamics is used (Loc. 50 = 1) set Loc. 221 to 223 = 0.

221	$\frac{k_1}{R}$	Radial position at which most inboard airfoil table is applied. Set equal to r/R of cutout.	N.D.
222	$\frac{k_2}{R}$	Radial position at which second airfoil table is applied.	N.D.
223	$\frac{k_3}{R}$	Radial position at which most outboard airfoil table is applied. Set equal to 1.	N.D.

<u>LOCATION</u>	<u>SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
		Enter the airfoil tables corresponding to these radial positions in boxes at the top of input sheet No. 1	
224	--	Free	---
225	--	Free	---
226 to 265	--	Free	---
266	ΔC_{D1}	Increments of drag coefficient which are added to drag coefficient obtained in double table lookup. ΔC_{D1} applies to the most outboard table, ΔC_{D2} to the second table, etc.	---
267	ΔC_{D2}		
268	ΔC_{D3}		
		Note: The ΔC_D 's are added to the drag coefficients before any interpolation is performed for aerodynamic blade elements between the positions where the tables are applied (Locs. 221 to 223).	
269	--	Free	---
270	--	Free	---
271	R	Blade radius	ft.
272	C_o	Reference chord	in.
273	N.A.	Number of aerodynamic blade elements (up to 20)	N.D.
274	N.M.	Total number of blade elements (up to 20)	N.D.
275	F.B.B.	Blade boundary control	---
	=1	Rigid blade	
	=2	Articulated blade - pitch housing between flap and lag hinge - flap hinge inboard	
	=3	Articulated blade - pitch housing outboard of lag hinge - flap hinge inboard	

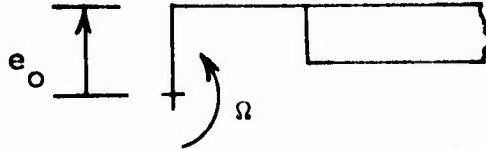
<u>LOCATION</u>	<u>SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
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276	a	Distance from pitch arm to pitch link	in.
-----	---	---------------------------------------	-----

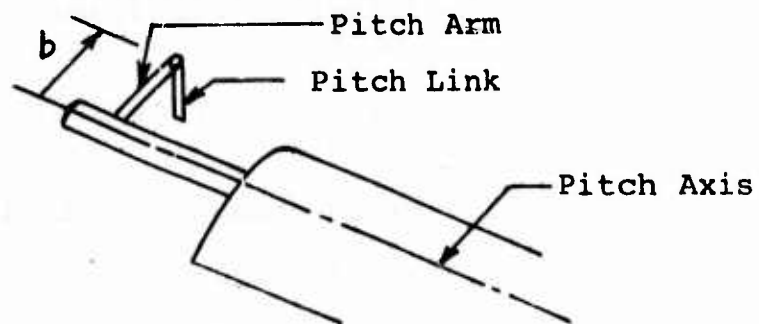


Positive toward center of rotation

277	e_o	Horizontal hub offset (positive in the direction of rotation).	in.
-----	-------	--	-----

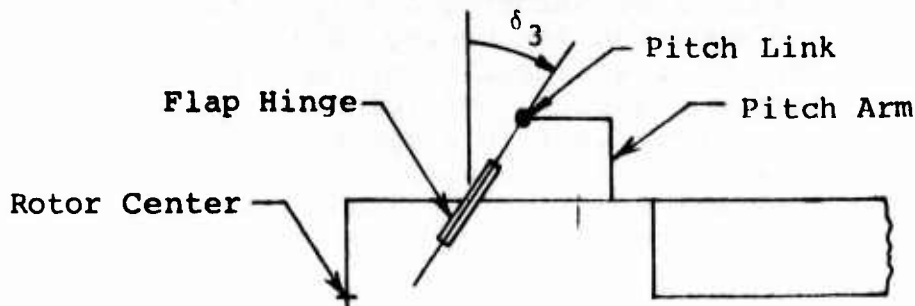


278	b	Pitch arm, measured perpendicular to the pitch axis from the pitch axis to the pitch link (positive in the direction of rotation).	in.
-----	---	--	-----



<u>LOCATION</u>	<u>SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
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279	δ_3	Flap-pitch coupling angle - angle through which the "flap" hinge is rotated.	deg
-----	------------	--	-----



280	i_{fwd}	Shaft tilt of forward rotor - positive tilted forward	deg
-----	-----------	---	-----

281	i_{aft}	Shaft tilt of aft rotor - positive tilted forward	
-----	-----------	---	--

282	$\Delta l/R$	Longitudinal distance between rotors, non-dimensional with respect to blade radius	N.D.
-----	--------------	--	------

283	$\Delta h/R$	Vertical distance between rotors, non-dimensional with respect to blade radius measured from forward rotor to aft rotor, positive up	N.D.
-----	--------------	--	------

284	k_β	Equivalent flap spring	lb-in/rad
-----	-----------	------------------------	-----------

285	C_β	Equivalent flap viscous damping	$\frac{\text{lb-in-sec}}{\text{rad}}$
-----	-----------	---------------------------------	---------------------------------------

286	K_ζ	Lag spring rate	$\frac{\text{lb-in}}{\text{rad}}$
-----	-----------	-----------------	-----------------------------------

287	C_ζ	Equivalent lag torsional damping coefficient	$\frac{\text{lb-in-sec}}{\text{rad}}$
-----	-----------	--	---------------------------------------

$$C_\zeta = \frac{4 M_p}{\pi \omega \zeta_{\max}} + \bar{C}$$

where \bar{C} viscous torsional damping rate in $\frac{\text{in-lb-sec}}{\text{rad}}$

M_p pre load moment in damper in-lb

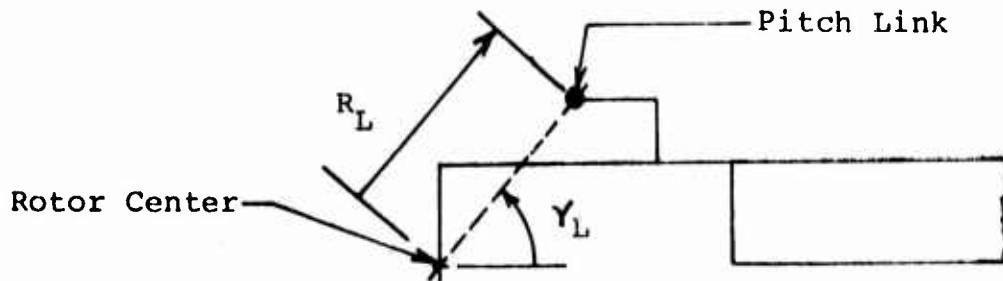
ω lag natural frequency rad/sec

ζ_{\max} amplitude of lagging motion radians

<u>LOCATION</u>	<u>SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
287 (Cont'd)		Note: The above relation was obtained by assuming $\zeta = \zeta_{\max} \sin \omega t$ and equating the energy lost in one cycle for an ideal torsional viscous damper (damping coefficient = C_ζ) to the energy lost in 1 cycle for a torsional viscous damper with a constant coulomb (pre load) damper of M_p superimposed and solving for C_ζ .	
288, 289	---	Not used	---
290-315	$\frac{x_i}{R}$	Distance from rotor center to blade element boundaries non-dimensionalized by blade radius, Loc. 271. Any number of boundaries may be used up to a maximum of 21; i.e., maximum of 20 elements. Location of boundaries must satisfy the following conditions: <ul style="list-style-type: none"> -Must have a boundary at blade tip; i.e., Loc. 290 = 1. -Must have boundary at cutout. -Must have boundary at flap hinge which is innermost boundary. For a teetering rotor flap hinge at $x/R = 0$. -Must have boundary at lag hinge which is adjacent to flap hinge. -Number of blade elements between blade tip and cutout must equal value in Loc. 273. -Total number of blade elements must equal value in Loc. 274. 	
316-330	C_n / C_o	Blade chord non-dimensionalized by reference chord, Loc. 272.	N.D.
331-335	---	Free	---

<u>LOCATION</u>	<u>SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
336-360	M_n	Lumped blade element masses for each blade element starting from the blade tip. Must have a number of entries equal to value in Loc. 274.	
361-380	$\Delta\theta_{tn}$	Incremental blade twist between masses (masses are located at centers of blade elements). $\Delta\theta_{tn} = \theta_{t(n+1)} - \theta_{tn}$ where θ_{tn} is the built in twist angle at the nth mass measured from the disc plane in degrees, positive nose up. Only masses on the airfoil portion of the blade are considered; therefore, n ranges from 1 to (NA-1) where NA = Loc. 273. The last $\Delta\theta_{tn}$; i.e., $\Delta\theta_{t(NA)}$ is defined as $\Delta\theta_{t(NA)} = \theta_{t(.75)} - \theta_{t(NA)}$ where $\theta_{t(.75)}$ and $\theta_{t(NA)}$ are the built in twist angles at the .75 r/R and Nth mass respectively.	
381-405	Y_{on}	Distance from the pitch axis to the mass center of gravity (positive towards the trailing edge) for each blade element, starting from the blade tip.	in.
406-420	ϵ_n	Distance from mid-chord to the pitch axis (positive-forward) for each aerodynamic blade element, starting from the blade tip. Normalized by blade element chord, C_n . $C_n = \text{Loc. 316 to Loc. 335} \times \text{Loc. 272}$	N.D.
421-425	--	Free	---
426-450	$I_{\theta n}$	Blade pitch inertia about the pitch axis, for each blade element starting from the blade tip.	lbs-sec-in
451-475	GJ_n	Torsional rigidity between masses. When set equal to 0, the GJ is assumed infinite.	lb-in ²

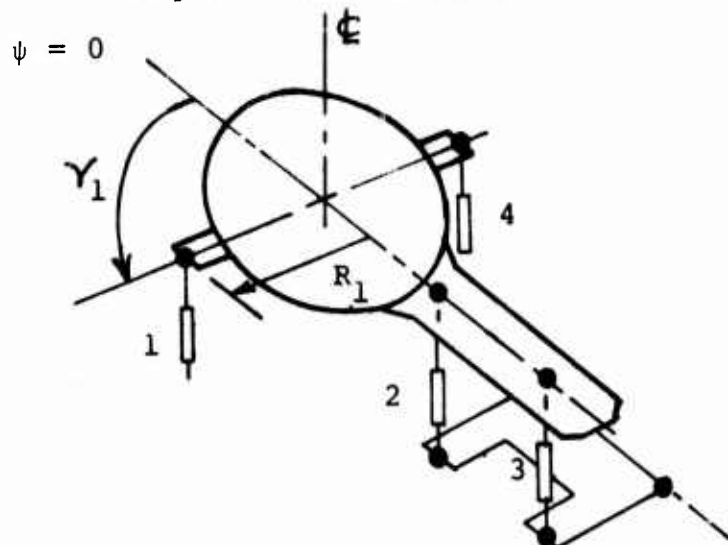
<u>LOCATION</u>	<u>SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
476	R_L	Radial distance to the pitch link, measured from the center of rotation.	in.
477	γ_L	Angular displacement of the pitch link relative to the blade azimuth position, positive in the direction of rotation.	deg



478-481	R_1, R_2, R_3, R_4	Radial distance to fixed system control actuators, measured from center of rotation.	in.
482-485	$\gamma_1, \gamma_2, \gamma_3, \gamma_4$	Azimuth position of the fixed system control actuators.	deg

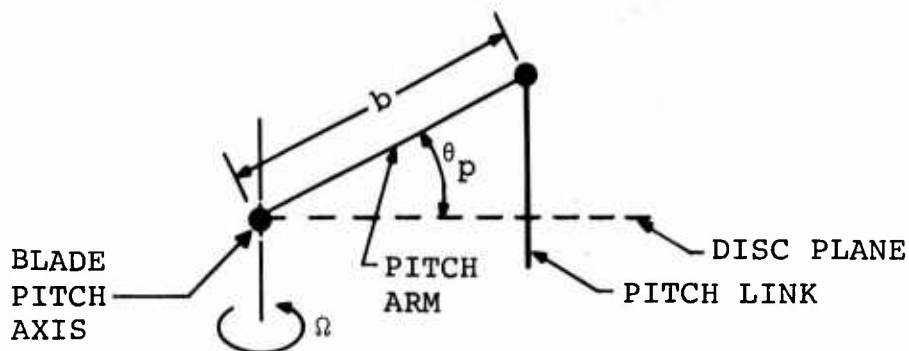
Note: Loc. 481 and 485 are used only for a 4 actuator control system, with pivoting double actuators. If both locations are zero, a three actuator fixed control system is assumed.

When the 4 actuator system is analyzed, 1 and 4 are the single actuators, 2 and 3 are the pivoting double actuators.

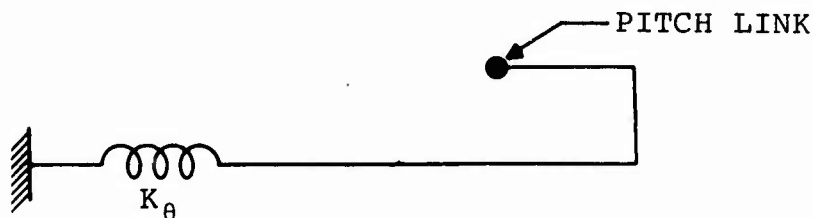


<u>LOCATION</u>	<u>SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
486, 487	a, b	<p>Parameters used to expand the region of detailed aerodynamic coefficients defined in the short form C_L airfoil deck.</p> <p>a - is the low angle of attack limit (tables currently stop at 20 degrees). b - is the high angle of attack limit (tables currently stop at 340 (-20) degrees).</p> <p>Note: Detailed C_L are currently defined from $\alpha = 340 (-20)$ to 20 degrees. The airfoil deck must be expanded to include the new limits, but the maximum number of data points in the table may not be exceeded.</p>	deg
488, 489	c, d	<p>Parameters used to expand the region of detailed aerodynamic coefficients defined in the short form C_M airfoil deck.</p> <p>c - is the low angle of attack limit (tables currently stop at 16 degrees). d - is the high angle of attack limit (tables currently stop at 344 (-16) degrees).</p> <p>Note: Detailed C_M are currently defined from $\alpha = 344 (-16)$ to 16 degrees. The airfoil deck must be expanded to include the new limits, but the maximum number of data points in the table may not be exceeded.</p>	deg
490	K_z	Control system spring rate. When set equal to zero, K_z is assumed infinite.	lb/in

<u>LOCATION</u>	<u>SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
491	θ_p	Angle between the pitch arm and the disc plane for zero collective at $r/R = 0.75$ - positive nose up	deg



492	K_θ	Stiffness of torsional spring between pitch housing and hub	in.-lb/rad
-----	------------	---	------------

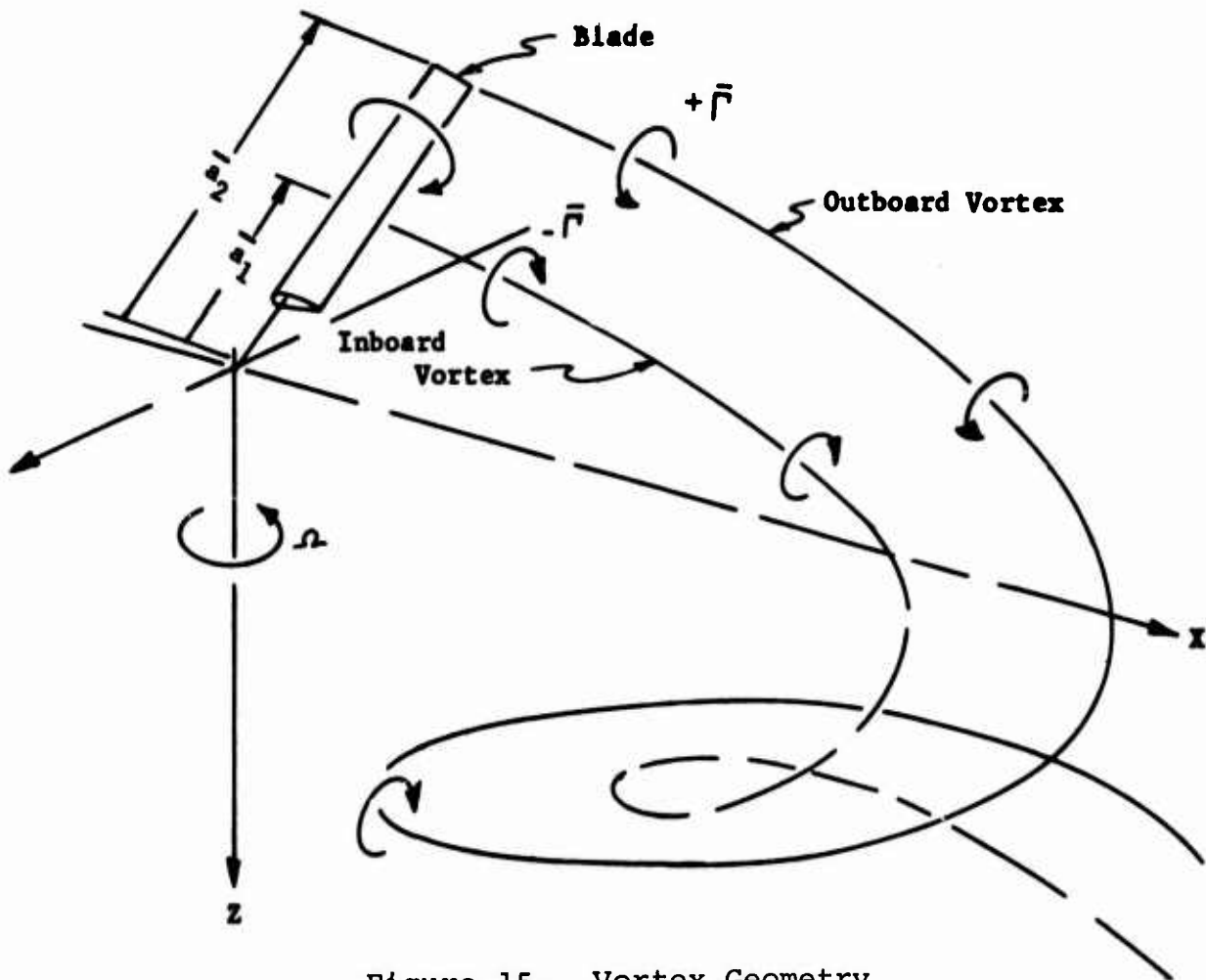
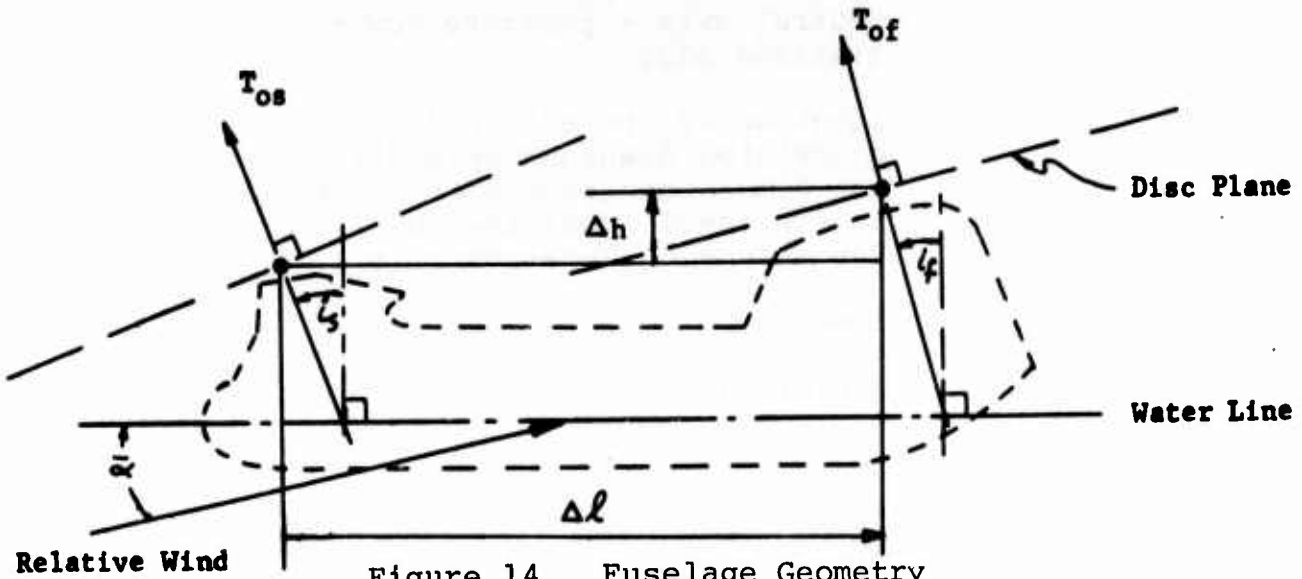


493	C_θ	Torsional root damper	$\frac{\text{in-lb-sec}}{\text{rad}}$
494	l_θ	Distance from root boundary to pitch bearing	in
495	---	Not used	---
496-520	$EI_{\xi n}$	Flapwise bending rigidity between masses. When set equal to 0, the EI is assumed infinite.	lb-in ²
521-540	\bar{e}	Distance from pitch axis to elastic axis - positive toward trailing edge	in
541-565	$EI_{\zeta n}$	Lagwise bending rigidity. When set equal to 0, the EI is assumed infinite.	lb-in ²

<u>LOCATION</u>	<u>SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
566-585	\bar{e}_n	Distance from pitch axis to vertical neutral axis - positive toward trailing edge	in
586-1065	$\frac{v}{R\Omega}$	Input array for externally calculated downwash velocity, non-dimensionalized with respect to tip speed (positive down). Use only when location 92 = 1.	N.D.
1066-1085	---	Free	---
1086-1110	Δm_n	Cabled mass.	lb-sec ² / in

SIGN CONVENTIONS

a. Sign Convention for Rotor Hub Separation
(Aft Rotor shown as First Rotor)



c. Airload and Coriolis Sign Convention

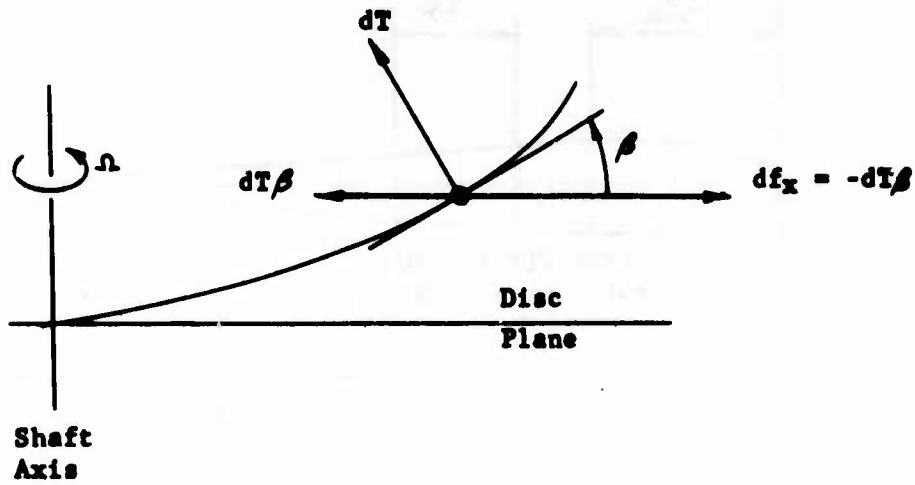


Figure 18. Radial Thrust Component Sign Convention

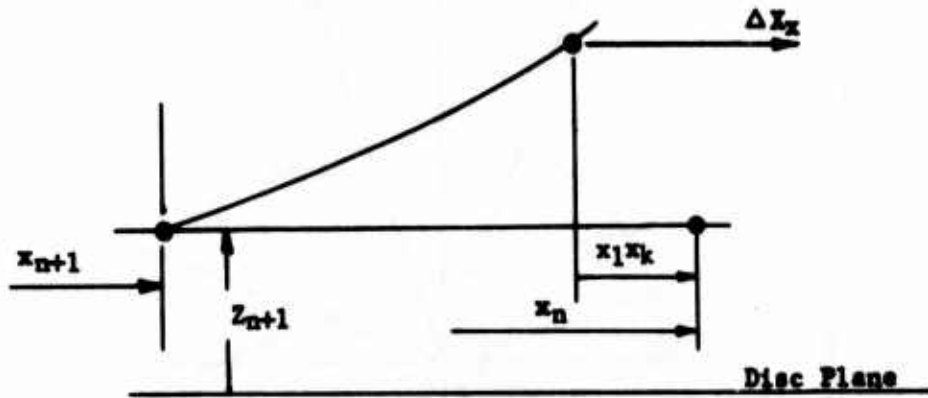


Figure 19. Radial Force Component From Flap Foreshortening Sign Convention

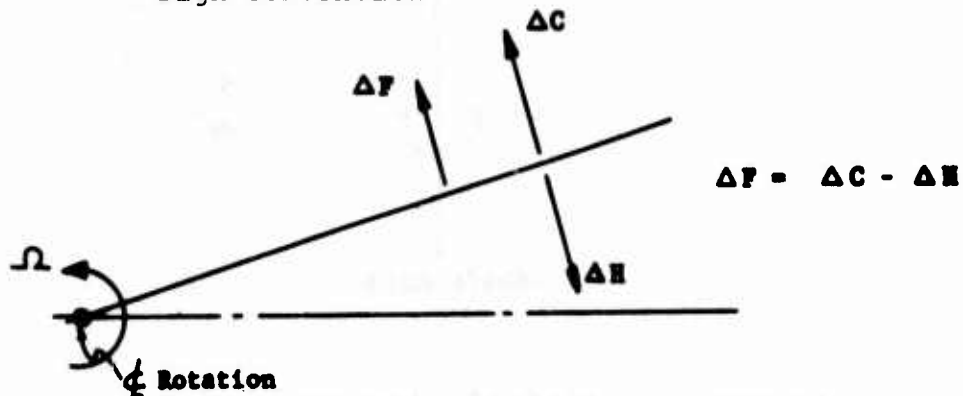


Figure 20. Coriolis and Horizontal Loads

- d. **Response Conventions:** The sign conventions for the forces and displacements in coupled flap-pitch and uncoupled lag are shown below:

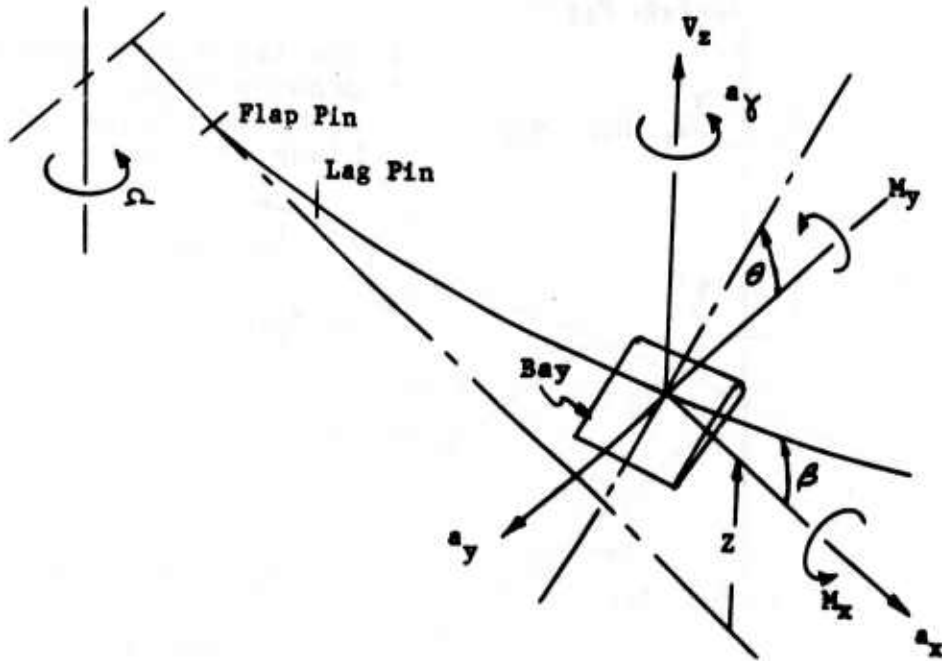


Figure 21. Coupled Flap-Pitch Sign Convention

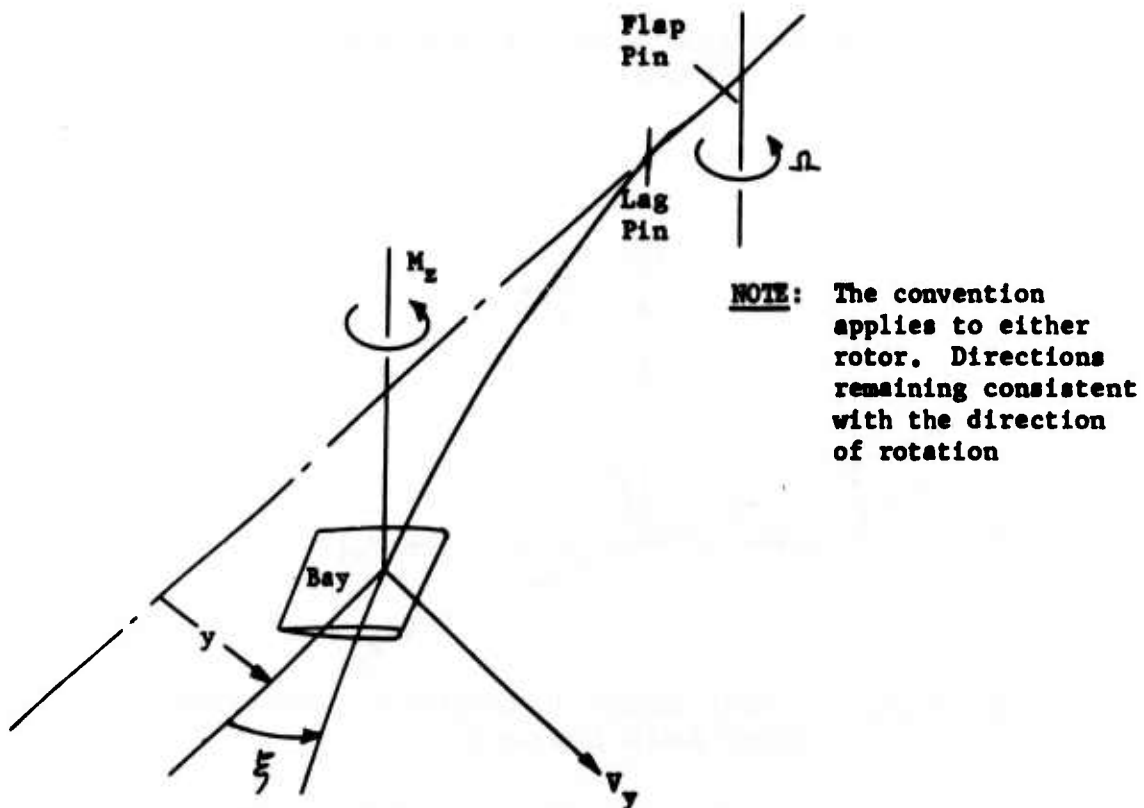


Figure 22. Uncoupled Lag Sign Convention

e. Hub Load Sign Convention

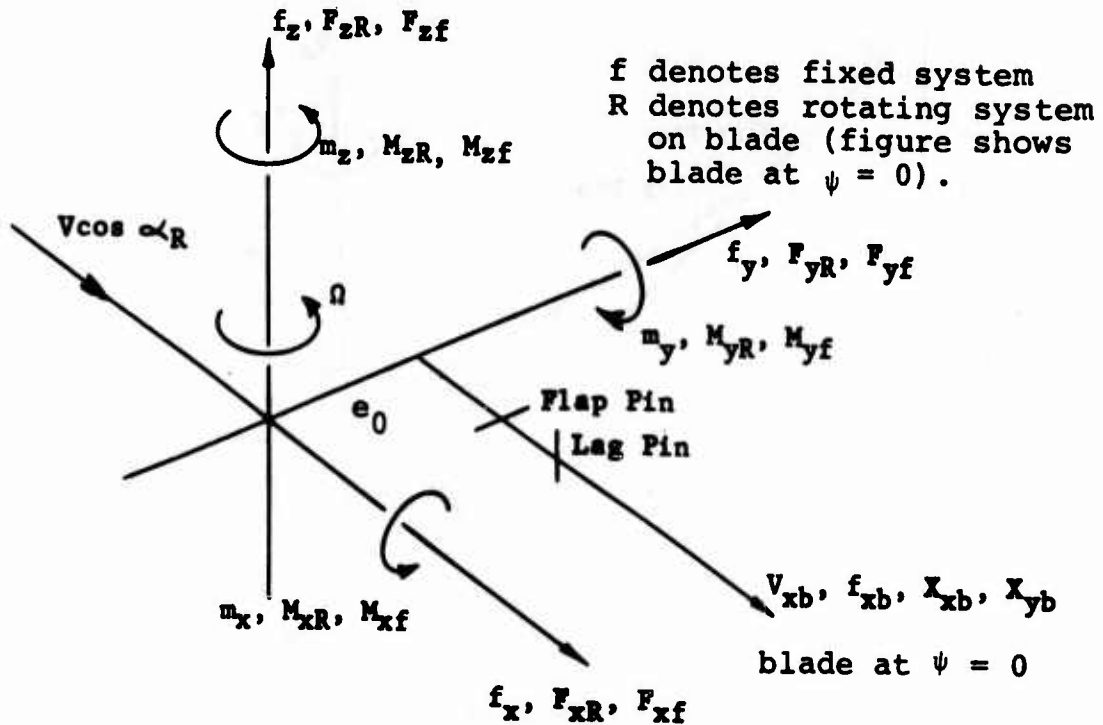


Figure 23. Rotating and Fixed-System Hub Loads Sign Convention (Shaft Axis System)

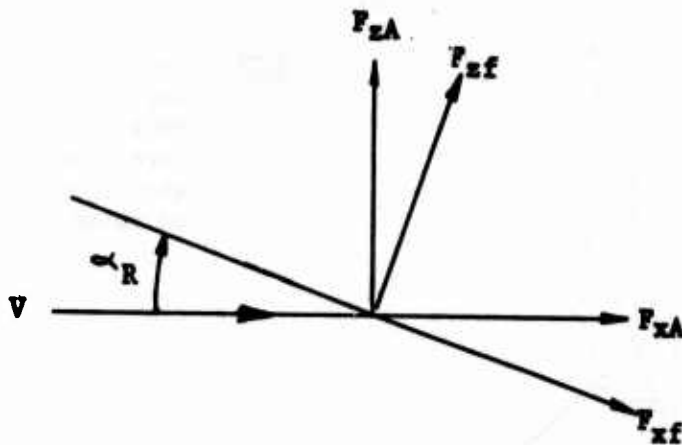


Figure 24. Steady Loads Relative to Airstream (Wind Axis System)

DESCRIPTION OF OUTPUT DATA

The program output is available in several versions depending on problem requirements. See locations 65 to 69. Described below is the output data in each of the program sections.

I Input Data - The input location number, n, and the value are printed out.

ANALYSIS SYMBOL	OUTPUT NAME	DESCRIPTION	DIMENSION
Loc n	Item n	Input location number n	--
--	Value	Value input in location n	See input description

II Initial Deflection - No printout.

III Downwash - The uniform downwash velocity normalized by the tip speed for both rotors is printed. This is done for all downwash options.

If the program internally calculates nonuniform downwash (Location 92 = 0 or 3), then the following is printed:

1. Tip and root circulation strength normalized by rotor angular velocity versus blade station and azimuth position for one or both rotors, depending on location 93.
2. Downwash velocity normalized by tip speed versus blade station and azimuth position for one or both rotors, depending on location 93.
3. Tip and root circulation strengths normalized by rotor angular velocity for the last downwash loop, before and after damping, versus azimuth position for one or both rotors, depending on location 93.
4. The total downwash velocity normalized by the tip speed versus blade station and azimuth position for the rotor being analyzed.
Total downwash = self-induced downwash
+ rotor interference downwash
5. A summary of the thrust routines used in the downwash calculations with complete details for thrust routine used in the zeroth and last downwash loops.

If nonuniform downwash is specified in locations 586 to 1065; i.e., location 92 = 1, then the following is printed:

1. Downwash velocity normalized by tip speed versus blade station and azimuth for the rotor being analyzed.

Following the downwash routine output, the program prints the results of the airloads and coupled flap-pitch routines for each iteration. The specific airload parameters which are printed are controlled by the values in locations 65-67. Use of the thrust routine is controlled by locations 49 and 275.

IV Airloads - Complete output of the airloads routine includes:

1. Thrust routine.
2. Unsteady aerodynamics parameters at each blade station and azimuth position.
3. Airload perpendicular to the blade chord at each blade station and azimuth.
4. Vibratory aerodynamic pitching moment per unit length about the pitch axis.
5. Classical aerodynamic parameters (lift, drag, angles of attack, etc.) at each blade station and azimuth position.
6. Normal and radial components of thrust in harmonic form at each blade station.
7. Component of drag in the disc plane and the total aerodynamic pitching moment in harmonic form for each blade station.
8. Aerodynamic coefficients, C_L , C_D , C_M , as obtained from the double table look-up routine (after interpolation) at each blade station and azimuth.

THRUST ROUTINE

<u>ANALYSIS</u> <u>SYMBOL</u>	<u>OUTPUT</u> <u>SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
i	STA	Blade station number	---
ΔT_n	1st DEL T	Steady thrust along the rotor shaft at blade station n for the first value of collective used by the thrust routine. Positive up	lb

<u>ANALYSIS SYMBOL</u>	<u>OUTPUT SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
ΔT_n	Last DEL T	Steady thrust along the rotor shaft at blade station n for the last value of collective used by the thrust routine. Positive up	lb
θ_4	THETA AT STA. 4	Blade mechanical angle of attack at station 4 Positive leading edge up	radians
T_o	THRUST	Total rotor thrust along rotor shaft Positive up	lb

UNSTEADY AERODYNAMICS

x	PSI	Blade azimuth - positive in direction of blade rotation	deg
F	F	Value of in-phase Theodorsen deficiency function	ND
G	G	Value of Theodorsen deficiency function phased 90° behind F	ND
α_{EQUIV}	ALPHA EQUIV	Dynamic angle of attack - angle of attack including Theodorsen deficiency functions F and G	radians
$\alpha_{REF L}$	ALPHA REF (L)	Quasi-static angle of attack adjusted for dynamic lift stall delay	radians
$\alpha_{REF M}$	ALPHA REF (M)	Quasi-static angle of attack adjusted for dynamic moment stall delay	radians
CL_{REF}	CL(REF)	Quasi-static lift coefficient based on $\alpha_{REF L}$	---
CL_{0-180}	CL(0-180)	Static lift coefficient at zero angle of attack, if in reverse-flow region angle of attack at 180°	---
\bar{L}	L BAR	Lift due to blade pitching velocity Positive up	lb

<u>ANALYSIS SYMBOL</u>	<u>OUTPUT SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
$\dot{\alpha}_{BE}$	ALPHA DOT	Time derivative of ALPHA BE Positive leading edge up	$\frac{\text{rad}}{\text{sec}}$
\dot{H}	H DOT	Velocity of air normal to disc plane Positive up	$\frac{17}{\text{sec}}$
Note: If uniform downwash only is used; i.e., location 92 = 2, the downwash table versus blade station and azimuth is filed with the value of the uniform downwash.			
v_{of}	VZF	Uniform downwash velocity for forward rotor Positive down	ND WRT tipspeed
v_{os}	VZS	Uniform downwash velocity for aft rotor Positive down	ND WRT tipspeed
x	PSI	Blade azimuth position Positive in direction of rotation	deg
	LOOP	Number of lift-downwash compatibility iterations	---
Γ	GAMMA	Vortex circulation strength BEFORE refers to before damping AFTER refers to after damping Positive counterclockwise looking in direction of blade velocity	ND WRT blade angular velocity
i	STA	Blade station number	
v	VA	Downwash velocity Positive down	ND WRT tipspeed
θ_4	THETA	Blade mechanical angle of attack at station 4 Positive leading edge up	radians —
T_0	THRUST	Total rotor thrust Positive up	lb
	NO ITER	Number of attempts required	---

<u>ANALYSIS SYMBOL</u>	<u>OUTPUT SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
ΔT_n	DELT	Steady thrust at blade station n along rotor shaft. FIRST DELT designates conditions for the first value of collective used by the thrust routine. LAST DELT designates conditions for last value of collection used by thrust routine. Positive up	lb
SL	L-B	One-half of the lift slope for the \bar{L} term. $\frac{d}{d\alpha} CL$	$\frac{1}{\text{rad}}$
cos	COS (YAW)	Cosine of yaw angle	---
$\bar{\phi}$	PHI	Dynamic induced blade angle of attack Positive leading edge up	
$\frac{d C_L}{d\alpha} \alpha=0$	REF SLOPE	Lift slope for α equal to zero	$\frac{1}{\text{rad}}$
<u>AIRLOAD PERPENDICULAR TO CHORD</u>			
AL	---	Total airload perpendicular to blade chord Positive up	lb
r/R	RAD	Radial position of mass	ND WKT blade radians
AL ₀	STDY	Steady value of total airload perpendicular to blade chord Positive up	
l	BAYL	Length of aerodynamic bay	in.
$\frac{AL-AL_0}{l}$	---	Vibratory airload perpendicular to blade chord per unit length Positive up	lb/in.
AMPL	AMPL	Amplitude of airload perpendicular to chord per unit length - equal to half peak-to-peak value	lb/in.

<u>ANALYSIS SYMBOL</u>	<u>OUTPUT SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
$\frac{AL}{l}$ o	STDY	Steady value of total airload perpendicular to chord line per unit length Positive up	lb/in.
Q	---	Vibratory aerodynamic pitching moment about the pitch axis per unit length Positive leading edge up	$\frac{\text{in.}-\text{lb}}{\text{in.}}$
AMPL	AMPL	Amplitude of the aerodynamic pitching moment about pitch axis per unit length	$\frac{\text{in.}-\text{lb}}{\text{in.}}$
Q _o /l	STDY	Steady value of aerodynamic pitching moment about the pitch axis per unit length Positive leading edge up	$\frac{\text{in.}-\text{lb}}{\text{in.}}$

CLASSICAL AERODYNAMICS

i_n	STATION	Blade station	---
r/R	x/R	Radial position for station n	ND to blade radius
x	PSI	Blade azimuth position Positive in direction of blade rotation	deg
θ	THETA	Blade mechanical angle of attack Positive leading edge up	rad
α	ALPHA	Blade total angle of attack Positive leading edge up	rad
ϕ	PHI	Induced blade angle of attack Positive leading edge up	rad
λ_p	LAMBP	Velocity component of the air normal to disc plane Positive up	ND to tip speed
λ_t	LAMBT	Velocity component of the air in the disc plane Positive toward trailing edge	ND to tip speed
MACH	MACH	Mach number based on U	---

<u>ANALYSIS SYMBOL</u>	<u>OUTPUT SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
U	U	Blade resultant velocity	ND to tip speed
dfx	DFX	Bay radial force due to thrust Positive away from hub	lb
dT	T	Bay thrust along rotor shaft Positive up	lb
dH	H	Bay horizontal force Positive toward trailing edge	lb
dQ	Q	Total aerodynamic pitching moment about pitch axis Positive nose up	in.-lb
dL	L	Bay lift perpendicular to relative wind Positive up	lb
dD	D	Bay drag force parallel to relative wind Positive in direction of wind	lb
dM	M	Aerodynamic pitching moment about aerodynamic center Positive leading edge up	in.-lb

NORMAL AND RADIAL COMPONENTS OF THRUST IN HARMONIC FORM

K	K	Harmonic number	
fx _n	FXN	Total aerodynamic radial force at nth bay Positive away from hub	lb
dT	DEL T	Bay thrust perpendicular to disc plane Positive up	lb
dH	DEL H	Component of the aerodynamic force in the disc plane perpendicular to the pitch axis Positive toward trailing edge	lb
dQ	DEL Q	Aerodynamic pitching moment about the pitch axis Positive leading edge up	in.-lb

<u>ANALYSIS SYMBOL</u>	<u>OUTPUT SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
-	RESULTANT THRUST	Resultant (of harmonic analysis) of bay thrust	
-	RESULTANT DRAG	Resultant (of harmonic analysis) of component of aerodynamic force in disc plane perpendicular to pitch axis Positive toward trailing edge	lb
CL	CL	Dynamic lift coefficient obtained by multiplying dynamic lift slope, $\frac{d CL}{d \alpha}$ by α_{EQUIV}	ND
CD	CD	Coefficient of drag obtained from double table look-up including Mach number and $\alpha_{REF} M$	ND
CM	CM	Dynamic pitching moment coefficient obtained by using $\alpha_{REF} M$ and accounting for the shift in center of pressure due to stall	ND

V Aerodynamic Performance Parameters - Following the airloads certain aerodynamic performance parameters are printed out. Listed below are the aerodynamic parameters and their corresponding symbols.

<u>ANALYSIS SYMBOL</u>	<u>OUTPUT SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
α_R	ALPHA R	Shaft angle relative to stream velocity	deg
V	VKNOTS	Freestream velocity	knots
$\frac{V}{R\Omega}$	V/R*OMEGA	Nondimensional freestream velocity	-
μ	MU	Advance ratio	-
α_{270}	ALPHA AT 270	Angle of attack at $\psi = 270^\circ$	
T_O	TS	Rotor thrust perpendicular to disc plane	lb

<u>ANALYSIS SYMBOL</u>	<u>OUTPUT SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
τ_s	TAU S	Steady torque	lb-ft
RHP	RHP	Rotor horsepower	hp
H	H	Drag in disc plane	lb
X	X	Propulsive force	lb
L	L	Lift force	lb
$\frac{X}{L}$	$\frac{X}{L}$	Ratio of propulsive force to lift force	-
$\frac{L}{D_e}$	$\frac{L}{D_e}$	Lift force nondimensional to equivalent drag	-
$\frac{L}{q d^2 \sigma}$	$\frac{L}{Q D^2 SIG}$	Nondimensionalized lift	-
$\frac{X}{q d^2 \sigma}$	$\frac{X}{Q D^2 SIG}$	Nondimensionalized propulsive force	-
$\frac{P}{q d^2 \sigma}$	$\frac{P}{Q D^2 SIG V}$	Nondimensionalized rotor horsepower	-
$\frac{C_J}{\sigma}$	$\frac{C_T}{SIG}$	Nondimensionalized steady thrust	-
$\frac{C_T}{\sigma}$	$\frac{C_T P}{SIG}$	Nondimensionalized lift	-
$\frac{C_H}{\sigma}$	$\frac{C_H}{SIG}$	Nondimensionalized drag	-
$\frac{C_P}{\sigma}$	$\frac{C_P}{SIG}$	Nondimensionalized rotor horsepower	-
Δx	X	Radial foreshortening due to flap and lag motion Positive toward tip In i-x form for aerodynamic stations	in.
ΔC	C	Coriolis inertia force Positive toward leading edge	lb

<u>ANALYSIS SYMBOL</u>	<u>OUTPUT SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
Δx	XK	Radial foreshortening due to flap and lag motion Positive toward tip In harmonic form for aerodynamic stations only	in.

VI After the airloads, the program performs the response calculations. The coupled flap-lag-pitch routine results include blade linear and angular deflections in both the undeflected blade and disc plane coordinate systems. It also produces the blade shears and moments in both the undeflected blade and blade coordinate systems.

COUPLED FLAP-PITCH RESPONSE in harmonic form in undeflected blade coordinate system (cosine coefficients on top)

<u>ANALYSIS SYMBOL</u>	<u>OUTPUT SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
V_z	VZ	Vertical shear in Z direction in undeflected blade coordinate system Positive up	lb
M_y	MY	Flap bending moment about Y axis in undeflected blade coordinate system Positive blade tip up	in.-lb
β	BETA	Blade flap angle in undeflected blade coordinate system Positive blade tip up	radians
Z	Z	Blade flap deflection in undeflected blade coordinate system Positive up	in.
M_x	MX	Torsional moment about X axis in undeflected blade coordinate system Positive leading edge up	in.-lb
θ	THETA	Blade pitch angle in undeflected blade coordinate system Positive leading edge up	radians

<u>ANALYSIS SYMBOL</u>	<u>OUTPUT SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
V _Y	VY	Chordwise shear in Y direction in undeflected blade coordinate system Positive toward leading edge	lb
M _Z	MZ	Lag bending moment about Z axis in undeflected blade coordinate system Positive trailing edge in tension	lb
ζ	ZETA	Blade lag angle in undeflected blade coordinate system Positive blade leading	radians
Y	Y	Blade lag deflection in undeflected blade coordinate system Positive toward leading edge	in.

Note: For a blade which is articulated in lag, the lag boundary is at the lag hinge and so one less mass station is considered.

COUPLED FLAP-LAG-PITCH RESPONSE as a function of blade station and azimuth in the undeflected blade coordinate system including amplitudes and steadies. The transformation from harmonic to time history form is done in the last iteration only.

<u>ANALYSIS SYMBOL</u>	<u>OUTPUT SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
V _Z	VZ	Vibratory vertical shear in Z direction in undeflected blade coordinate system Positive up	lb
M _Y	MY	Vibratory flap bending moment about Y axis in undeflected blade coordinate system Positive blade tip up	in.-lb
β	BETA	Vibratory flap angle in undeflected blade coordinate system Positive tip up	radians

<u>ANALYSIS SYMBOL</u>	<u>OUTPUT SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
Z	Z	Vibratory flap deflection in undeflected blade coordinate system Positive tip up	in.
M _x	MX	Vibratory torsional moment about X axis in undeflected blade coordinate system Positive leading edge up	in.-lb
θ	THETA	Vibratory pitch angle in undeflected blade coordinate system Positive leading edge up	radians
V _y	VY	Vibratory chordwise shear in Y direction in undeflected blade coordinate system Positive toward leading edge	lb
M _z	MZ	Vibratory lag bending moment about Z axis in undeflected blade coordinate system Positive trailing edge in tension	in.-lb
ζ	ZETA	Vibratory lag angle in undeflected blade coordinate system Positive blade leading	radians
Y	Y	Vibratory lag deflection in the undeflected blade coordinate system Positive toward trailing edge	in.
V _x	VX	Vibratory radial shear in X direction in undeflected blade coordinate system Positive away from hub	lb
Δθ	DELTA THETA	Incremental torsional deflection due to bending of the torsional axis in undeflected blade coordinate system Positive leading edge up	rad

<u>ANALYSIS SYMBOL</u>	<u>OUTPUT SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
ΔY	DELTA Y	Incremental lag deflection due to bending of the torsional axis in undeflected blade coordinate system Positive toward trailing edge	in.
ΔZ	DELTA Z	Incremental flap deflection due to bending of the torsional axis in undeflected blade coordinate system Positive up	in.

COUPLED FLAP-LAG-PITCH RESPONSE as a function of blade station and azimuth in the blade coordinate system including amplitudes and steadies. Only stations outboard of the lag hinge are considered. These results are calculated in the last iteration only.

<u>ANALYSIS SYMBOL</u>	<u>OUTPUT SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
V_{xr}	VXB	Vibratory radial shear in X direction in blade coordinate system Positive away from hub	lb
V_{yr}	VYB	Vibratory chordwise shear in Y direction in blade coordinate system Positive toward leading edge	lb
V_{zr}	VZB	Vibratory vertical shear in Z direction in blade coordinate system Positive up	lb
M_{xr}	MXB	Vibratory torsional moment about X axis in blade coordinate system Positive leading edge up	in.-lb
M_{yr}	MYB	Vibratory flap bending moment about Y axis in blade coordinate system Positive leading edge up	in.-lb
M_{zr}	MZB	Vibratory lag bending moment about Z axis in blade coordinate system Positive trailing edge in tension	in.-lb

COUPLED FLAP-LAG-PITCH linear and angular deflections, velocities, and accelerations in disc plane coordinate system as a function of blade station and azimuth.

<u>ANALYSIS SYMBOL</u>	<u>OUTPUT SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
Y	Y	Lag deflection in disc plane coordinate system Positive toward trailing edge	in.
Z	Z	Flap deflection in disc plane coordinate system Positive up	in.
θ	THETA	Torsional angular deflection in disc plane coordinate system Positive leading edge up	rad
β	BETA	Flap angular deflection in disc plane coordinate system Positive tip up	rad
ζ	ZETA	Lag angular deflection in disc plane coordinate system Positive blade leading	rad

VII After the response for the last iteration is printed the program calculates the hub and control loads. The calculated quantities include hub loads due to one blade expressed in the rotating disc plane coordinate systems and the total hub loads due to all blades expressed in both the fixed and rotating disc plane coordinate systems. Also calculated are the pitch link and actuator loads.

HUB LOADS FOR ONE BLADE ONLY

<u>ANALYSIS SYMBOL</u>	<u>OUTPUT SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
k	K	Harmonic number	
X_{xb}	X XB	Root radial force due to flap foreshortening in rotating disc plane coordinate system Positive away from hub	lb

<u>ANALYSIS SYMBOL</u>	<u>OUTPUT SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
X _y b	X YB	Root radial force due to coriolis acceleration in rotating disc plane coordinate system Positive away from hub	lb
f _x b	F XB	Root radial force due to thrust in rotating disc plane coordinate system Positive away from hub	lb
V _x b	V XB	Total root radial force (XXB + XYB + FXB) in rotating disc plane coordinate system (steady value also contains a _x) Positive away from hub	lb
F _x	FX	Radial hub load for one blade in rotating disc plane coordinate system Positive away from hub	lb
F _y	FY	Tangential hub load for one blade in rotating disc plane coordinate system Positive toward leading edge	lb
F _z	FZ	Axial hub load for one blade in rotating disc plane coordinate system, in direction of rotor shaft axis Positive in the direction of positive thrust	lb
M _x	MX	Pitching moment at center of rotation for one blade in rotating disc plane coordinate system Positive leading edge up	in.-lb
M _y	MY	Flapping moment of center of rotation for one blade in rotating disc plane coordinate system Positive blade tip up	in.-lb

<u>ANALYSIS SYMBOL</u>	<u>OUTPUT SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
M _z	MZ	Torque at center of rotation for one blade in rotating disc plane coordinate system (same as fixed disc plane system torque) Positive trailing edge in torsion	in.-lb

TOTAL ROTATING HUB LOADS AT ROTOR CENTER FOR ALL BLADES

<u>ANALYSIS SYMBOL</u>	<u>OUTPUT SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
F _{xr}	FXR	X component of load transmitted to hub by all blades in rotating disc plane coordinate system (X axis rotates with blade being analyzed) Positive away from hub	lb
F _{yr}	FYR	Y component of load transmitted to hub by all blades in rotating disc plane coordinate system Positive toward leading edge	lb
F _{zr}	FZR	Axial component of load transmitted to hub by all blades in rotating disc plane coordinate system Positive in direction of positive thrust	lb
M _{xr}	MXR	Moment about X axis transmitted to hub by all blades in rotating disc plane coordinate system (X axis rotates with blade being analyzed) Positive leading edge up	in.-lb
M _{yr}	MYR	Moment about Y axis transmitted to hub by all blades in rotating disc plane coordinate system Positive blade tip up	in.-lb
M _{zr}	MZR	Torque at center of rotation due to all blades in rotating disc plane coordinate system (same as fixed disc plane system) Positive trailing edge in tension	in.-lb

<u>ANALYSIS SYMBOL</u>	<u>OUTPUT SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
F _{xf}	FXF	X component of load transmitted to hub by all blades in fixed disc plane coordinate system Positive in direction zero degree azimuth position	lb
F _{yf}	FYF	Y component of load transmitted to hub by all blades in fixed disc plane coordinate system Positive in direction of 90-degree azimuth position	lb
F _{zf}	FZF	Axial component of load transmitted to hub by all blades in fixed disc plane coordinate system Positive in direction of positive thrust	lb
M _{xf}	MXF	Moment due to all blades about Y axis in fixed disc plane coordinate system Positive using right-hand rule	in.-lb
M _{yf}	MYF	Moment due to all blades about Y axis in fixed disc plane coordinate system Positive using right-hand rule	in.-lb
M _{zf}	MZF	Torque at center of rotation due to all blades about Z axis in fixed disc plane system Positive using right-hand rule	in.-lb
F _x	FXF A	Steady force in X direction of wind axis coordinate system (X axis is downwind) Positive in direction of positive X	lb
F _y	FYF A	Steady force in Y direction of wind axis coordinate system (same as force in Y direction of fixed disc plane coordinate system) Positive in direction of positive Y	lb

<u>ANALYSIS SYMBOL</u>	<u>OUTPUT SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
F _Z	FZF A	Steady force in Z direction of wind axis coordinate system Positive in direction of positive Z	lb
M _X	MXF A	Steady moment about X axis in wind axis coordinate system Positive using right-hand rule	in.-lb
M _Y	MYF A	Steady moment about Y axis in wind axis coordinate system (same as moment about Y axis in fixed disc plane coordinate system) Positive using right-hand rule	in.-lb
M _Z	MZF A	Steady moment about Z axis in wind axis coordinate system Positive using right-hand rule	in.-lb
RHP	RHP	Rotor horsepower	

PITCH LINK AND ACTUATOR LOADS

<u>ANALYSIS SYMBOL</u>	<u>OUTPUT SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
k	K	Harmonic number C denotes cosine coefficient S denotes sine coefficient Plane number denotes resultant	
P	FLB	Harmonic coefficients of pitch link load Positive in compression	lb
P ₁	P1 LB	Load in first actuator in harmonic form Positive in compression	lb
P ₂	P2 LB	Load in second actuator in harmonic form Positive in compression	lb
P ₃	P3 LB	Load in third actuator in harmonic form Positive in compression	lb

<u>ANALYSIS SYMBOL</u>	<u>OUTPUT SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
ψ	PSI	Blade azimuth position	deg
P	F	Vibratory pitch link load in time history form Positive in compression	lb
P ₁	P1	Vibratory load in first actuator in time history form Positive in compression	lb
P ₂	P2	Vibratory load in second actuator in time history form Positive in compression	lb
P ₃	P3	Vibratory load in third actuator in time history form Positive in compression	lb

Note: Maximum positive, maximum negative, and the amplitude (= 1/2 MAX POS - MAX NEG) are also indicated for the time histories of the vibratory pitch link and actuator loads.

PERFORMANCE PARAMETERS BASED ON HUB LOADS

Following the hub loads calculation, the program reevaluates some of the performance parameters in terms of the hub loads.

VIII PITCH LINK LOAD SUMMARY PAGE

For all output options a summary of the pitch link loads is provided. The vibratory pitch link loads are printed in time history form in 15-degree azimuth increments for all iterations. The corresponding amplitudes and steady values are given. In addition, the last iteration vibratory pitch link loads in time history form are given in 5-degree azimuth increments.

IX CONVERGENCE SUMMARY PAGE

For all output options a summary of the program convergence is given on the last page of the output. The quantities described are given in the table below and are listed for each iteration.

<u>ANALYSIS SYMBOL</u>	<u>OUTPUT SYMBOL</u>	<u>DESCRIPTION</u>	<u>DIMENSION</u>
θ_4	COLLECTIVE	Blade mechanical angle of attack at station 4	deg
x/R	X/R	Radial position at which θ_4 is specified	ND with respect to radius
To	THRUST	Total rotor thrust	lb
$\alpha_4 0$	PSI = 0	Blade angle of attack at station 4 and 0-degree azimuth position Positive leading edge up	deg
$\alpha_4 90$	PSI = 90	Blade angle of attack at station 4 and 90-degree azimuth position Positive leading edge up	deg
$\alpha_4 180$	PSI = 180	Blade angle of attack at station 4 and 180-degree azimuth position Positive leading edge up	deg
$\alpha_4 270$	PSI = 270	Blade angle of attack at station 4 and 270-degree azimuth position Positive leading edge up	deg
Z	Z TIP AMPL	Blade tip flapping deflection amplitude Always positive	in.
θ	THETA TIP AMPL	Blade tip torsional deflection amplitude Always positive	deg
M_y	ROOT FBM AMPL	Root flap bending moment amplitude Always positive	in.-lb

SAMPLE PROGRAM
INPUT AND OUTPUT

ROTOR ANALYSIS PROGRAM 6-70

TITLE BO-105 TEST CASE

1 C_L 269 C_D 269 C_M 502
2 C_L C_D C_M

3 C_L C_D C_M

4 C_L C_D C_M
5 C_L C_D C_M

AIRFOIL TABLES

DEF. LOC.	VALUE	DIM.	DEF. LOC.	VALUE	DIM.	DEF. LOC.	VALUE	DIM.	DEF. LOC.	VALUE	DIM.	DEF. LOC.	VALUE	DIM.
V	1	100	46	1	ROTOR	91	1	V_0 Calculation	136	181				
a	2	-10	47	4	No. of blades	92	2	NUB-UD ODT	137	182				
ρ	3	425	48	10	No. of iterations	93	1	N.U.D. TYPE	138	183				
P	4	0.002378	49	1	Thrust Routine	94	1	Verax TYPE	139	184				
S	5	117	50	0	Linear Aero	95		Mean Wake Item	140	185				
			51	5.73	ω/RAD	96		F.W. Item-SI	141	186				
T_0	7	4400	52		N.D.	97		F.W. Item-RI	142	187				
ϕ_0	8	12.3	53		RAD.	98		Verax Spiral	143	188				
β_0	9	0	54		RAD.	99		Inboard Verax	144	189				
β_{1s}	10	0	55		RAD.	100		Outboard Verax	145	190				
β_{2c}	11	2.5	56		N.D.	101		V_{opt}	146	191				
β_{3c}	12	0	57		N.D.	102		\bar{m}	147	192				
β_{4s}	13	0	58		N.D.	103			148	193				
			59		N.D.	104			149	194				
			60		DEG.	105			150	195				
θ_0	16		61		DEG.	106			151	196				
β_c	17		62	32.2	$^{\circ}/SEC^2$	107			152	197				
β_s	18		63		$^{\circ}/SEC^2$	108			153	198				
β_0	19		64		$^{\circ}/SEC^2$	109			154	199				
β_{2c}	20		65	1	Inboard Output	110			155	200				
β_{3c}	21		66	1	Force Output	111			156	201				
			67	1	Flap Output	112			157	202				
			68	1	Leg Output	113			158	203				
			69	1	Hull Load Output	114			159	204				
			70	0	Hull Motion	115			160	205				
			71		n=1	116			161	206				
			72		n=2	117			162	207				
			73		n=3	118			163	208				
			74		n=4	119			164	209				
			75		n=5	120			165	210				
			76		n=6	121			166	211				
			77		n=7	122			167	212				
			78		n=8	123			168	213				
			79		n=9	124			169	214				
			80		n=10	125			170	215				
			81		n=11	126			171	216				
			82		n=12	127			172	217				
			83		n=13	128			173	218				
			84		n=14	129			174	219				
			85		n=15	130			175	220				
			86		n=16	131			176	221				
			87		n=17	132			177	222				
			88		n=18	133			178	223				
			89		n=19	134			179	224				
			90		n=20	135			180	225				
					n=21									
					n=22									
					n=23									
					n=24									
					n=25									
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					n=27									
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					n=37									
					n=38									
					n=39									
					n=40									
					n=41									
					n=42									
					n=43									
					n=44									
					n=45									

ROTOR ANALYSIS
PROGRAM C-70

BLADE TITLE:

TITLE
BO-105

DEF.	LOC.	VALUE	DIM.	DEF.	LOC.	VALUE	DEF.	LOC.	VALUE	DEF.	LOC.	VALUE	DEF.	LOC.	VALUE	DEF.	LOC.	VALUE		
R	271	16.11	FT.		316	1.		361	0.4		406	0.25		451	1.36 E6		496	4%	541	59.4 E6
C ₀	272	10.93	IN.		317	1.		362	0.6		407	0.25		452	1.36 E6		497		542	59.4 E6
N.O.	273	10.			318	1.		363	0.8		408	0.25		453	1.36 E6		498		543	59.4 E6
N.O.	274	15.			319	1.		364	0.8		409	0.25		454	1.36 E6		499		544	59.4 E6
LAG	275	4.			320	1.		365	0.8		410	0.25		455	1.36 E6		500		545	59.4 E6
LAG	276	2.			321	1.		366	0.8		411	0.25		456	1.36 E6		501		546	59.4 E6
b	277	0.	IN.		322	1.		367	0.8		412	0.25		457	1.36 E6		502		547	59.4 E6
b	278	6.45	IN.		323	1.		368	0.6		413	0.25		458	1.36 E6		503		548	59.4 E6
s	279	0.	DEG.		324	1.		369	0.38		414	0.25		459	1.4076 E6		504		549	59.4 E6
i _{wp}	280	3.	DEG.		325	1.		370	-4.12		415	0.25		460	1.6742 E6		505		550	49.102 E6
i _{wp}	281		DEG.		326			371			416			461	2.719 E6		506		551	29.486 E6
ΔM ₁	282		N.D.		327			372			417			462	4.0285 E6		507		552	33.909 E6
ΔM ₂	283		N.D.		328			373			418			463	4.1 E6		508		553	260. E6
K _B	284		IN.		329			374			419			464	4.1 E6		509		554	335.23 E6
C _B	285		IN.		330			375			420			465	4.1 E6		510		555	335.23 E6
K _E	286		IN.		331			376			421			466			511		556	
C _E	287		IN.		332			377			422			467			512		557	
q ₁	288		N.D.		333			378			423			468			513		558	
q ₂	289		N.D.		334			379			424			469			514		559	
	290	1.0	1° 1'		335			380			425			470			515		560	
	291	0.9	1° 2'		336	.01126		381	0.		426	.04839		471			516		561	
	292	0.9	1° 3'		337	.00773		382	0.		427	.04839		472			517		562	
	293	0.8	1° 4'		338	.01546		383	0.		428	.09678		473			518		563	
	294	0.7	1° 5'		339	.01494		384	0.		429	.09678		474			519		564	
	295	0.6	1° 6'		340	.01491		385	0.		430	.09678		475			520		565	
	296	0.5	1° 7'		341	.01491		386	0.		431	.09678	R _L	476	9.	IN.	521		566	
	297	0.4	1° 8'		342	.01491		387	0.		432	.09678	Y _L	477	0.	DEG.	522		567	
	298	0.3	1° 9'		343	.01491		388	0.		433	.09678	R ₁	478	5.	IN.	523		568	
	299	0.25	1° 10'		344	.00746		389	0.		434	.04839	R ₂	479	5.	IN.	524		569	
	300	0.22	1° 11'		345	.00447		390	0.		435	.02903	R ₃	480	5.	IN.	525		570	
X _L	301	0.16	1° 12'		346	.00900	Y _{0n}	391	0.		436	.04992	R ₄	481	0.	IN.	526		571	
R	302	0.1	1° 13'		347	.01129	IN	392	0.		437	.02986	Y ₁	482	10.	DEG.	527		572	
N.D.	303	0.05	1° 14'		348	.07913		393	0.		438	.99162	Y ₂	483	130.	DEG.	528		573	
	304	0.001	1° 15'		349	.07694		394	0.		439	.02083	Y ₃	484	250.	DEG.	529		574	
	305	0.	1° 16'		350	.00115		395	0.		440	.00043	Y ₄	485	0.	DEG.	530		575	
	306		1° 17'		351			396			441		a	486		DEG.	531		576	
	307		1° 18'		352			397			442		b	487		DEG.	532		577	
	308		1° 19'		353			398			443		c	488		DEG.	533		578	
	309		1° 20'		354			399			444		d	489		DEG.	534		579	
	310		1° 21'		355			400			445		k	490	1680.	DEG.	535		580	
	311		1° 22'		356			401			446		kz	491		L _R /IN.	536		581	
	312		1° 23'		357			402			447			492			537		582	
	313		1° 24'		358			403			448			493			538		583	
	314		1° 25'		359			404			449			494			539		584	
	315		1° 26'		360			405			450			495			540		585	

FORM 5417Z (7/73)

269 269 V23010-1.58 STALLABLE CL-IOM 8-7441-1-363,CD-TABLE 502 E.AU

PRINT OUT OF INPUT VALUES

ITEM	VALUE	ITEM	VALUE	ITEM	VALUE	ITEM	VALUE	ITEM	VALUE	ITEM	VALUE	ITEM	VALUE	ITEM	VALUE
1	1.0000E 02	9	0.0	11	2.5000E 00	13	0.0	15	0.0	17	0.0	19	0.0	21	0.0
8	8.5000E 00	16	0.0	18	0.0	20	0.0	22	0.0	24	0.0	26	0.0	28	0.0
15	0.0	23	0.0	25	0.0	27	0.0	29	0.0	31	0.0	33	0.0	35	0.0
22	0.0	30	0.0	32	0.0	34	0.0	36	0.0	38	0.0	40	0.0	42	0.0
29	0.0	37	0.0	39	0.0	41	0.0	43	0.0	45	0.0	47	4.0000E 00	49	1.0000E 00
36	0.0	44	0.0	46	1.0000E 00	48	0.0	50	0.0	51	5.7300E 00	53	0.0	55	0.0
43	0.0	51	5.7300E 00	52	0.0	54	0.0	56	0.0	57	0.0	59	0.0	61	0.0
50	0.0	58	0.0	60	0.0	62	3.2200E 01	64	0.0	65	1.0000E 00	67	0.0	69	1.0000E 00
57	0.0	65	1.0000E 00	66	1.0000E 00	68	1.0000E 00	70	0.0	71	0.0	73	0.0	75	0.0
64	0.0	72	0.0	74	0.0	76	0.0	78	0.0	79	0.0	81	0.0	83	0.0
71	0.0	80	0.0	82	0.0	84	0.0	86	0.0	87	0.0	89	0.0	91	1.0000E 00
78	0.0	86	0.0	88	0.0	90	0.0	92	2.0000E 00	93	1.0000E 00	95	0.0	97	0.0
85	0.0	93	1.0000E 00	94	1.0000E 00	96	0.0	98	0.0	99	0.0	101	0.0	103	0.0
92	2.0000E 00	100	0.0	102	0.0	104	0.0	106	0.0	107	0.0	109	0.0	111	0.0
99	0.0	107	0.0	108	0.0	110	0.0	112	0.0	113	0.0	115	0.0	117	0.0
106	0.0	114	0.0	116	0.0	118	0.0	120	0.0	121	0.0	123	0.0	125	0.0
113	0.0	121	0.0	122	0.0	124	0.0	126	0.0	127	0.0	129	0.0	131	0.0
120	0.0	128	0.0	130	0.0	132	0.0	134	0.0	135	0.0	137	0.0	139	0.0
127	0.0	135	0.0	136	0.0	138	0.0	140	0.0	141	2.5000E-01	143	0.0	145	1.5000E 00
134	0.0	142	1.0000E 00	144	0.0	146	1.5000E 00	148	0.0	149	0.0	151	1.0000E 00	153	7.5000E-01
141	2.5000E-01	149	0.0	150	0.0	152	1.0000E 00	154	0.0	155	0.0	157	0.0	159	0.0
148	0.0	156	0.0	158	0.0	160	0.0	162	0.0	163	0.0	165	0.0	167	0.0
155	0.0	163	0.0	164	0.0	166	0.0	168	0.0	169	0.0	171	0.0	173	0.0
162	0.0	170	0.0	172	0.0	174	0.0	176	0.0	177	0.0	179	0.0	181	0.0
169	0.0	177	0.0	178	0.0	180	0.0	182	0.0	183	0.0	185	0.0	187	0.0
176	0.0	184	0.0	186	0.0	188	0.0	190	0.0	191	0.0	193	0.0	195	0.0
183	0.0	191	0.0	192	0.0	194	0.0	196	0.0	197	0.0	199	0.0	201	0.0
190	0.0	198	0.0	200	0.0	202	0.0	204	0.0	205	0.0	207	0.0	209	0.0
197	0.0	205	0.0	206	0.0	208	0.0	210	0.0	211	0.0	213	0.0	215	0.0
204	0.0	212	0.0	214	0.0	216	0.0	218	0.0	219	0.0	221	0.0	223	0.0
211	0.0	219	0.0	220	0.0	222	0.0	224	0.0	225	0.0	227	0.0	229	0.0
218	0.0	226	0.0	228	0.0	230	0.0	232	0.0	233	0.0	235	0.0	237	0.0
225	0.0	233	0.0	234	0.0	236	0.0	238	0.0	239	0.0	241	0.0	243	0.0
232	0.0	240	0.0	242	0.0	244	0.0	246	0.0	247	0.0	249	0.0	251	0.0
239	0.0	249	0.0	250	0.0	252	0.0	253	0.0	254	0.0	256	0.0	258	0.0
246	0.0	254	0.0	255	0.0	257	0.0	259	0.0	260	0.0	262	0.0	264	0.0
253	0.0	261	0.0	263	0.0	265	0.0	267	0.0	268	0.0	270	0.0	272	1.0930E 01
260	0.0	268	0.0	270	0.0	272	1.6110E 01	274	1.5000E 01	275	1.0000E 00	277	0.0	279	0.0
267	0.0	274	1.5000E 01	276	1.0000E 00	278	6.4500E 00	280	0.0	281	0.0	283	0.0	285	0.0
274	1.5000E 01	277	0.0	279	0.0	281	0.0	283	0.0	284	0.0	286	0.0	288	0.0
281	0.0	282	0.0	284	0.0	286	0.0	288	0.0	289	0.0	291	9.5000E-01	293	8.0000E-01
288	0.0	289	0.0	290	1.0000E 00	292	9.0000E-01	294	7.0000E-01	295	6.0000E-01	297	4.0000E-01	299	2.5000E-01
295	6.0000E-01	296	5.0000E-01	298	3.0000E-01	299	2.5000E-01	300	2.2000E-01	301	1.6000E-01	302	1.0000E-01	303	4.4000E 03

PRINT OUT OF INPUT VALUES

ITEM	VALUE,	ITEM	VALUE,	ITEM	VALUE,	ITEM	VALUE,	ITEM	VALUE,	ITEM	VALUE,	ITEM	VALUE,	ITEM	VALUE,
302	1.0000E-01	303	5.0000E-02	304	1.0000E-03	305	0.0	306	0.0	307	0.0	308	0.0	309	0.0
309	0.0	310	0.0	311	0.0	312	0.0	313	0.0	314	0.0	315	0.0	316	1.0000E 00
316	1.0000E 00	317	1.0000E 00	318	1.0000E 00	319	1.0000E 00	320	1.0000E 00	321	1.0000E 00	322	1.0000E 00	323	0.0
323	1.0000E 00	324	1.0000E 00	325	1.0000E 00	326	0.0	327	0.0	328	0.0	329	0.0	330	0.0
330	0.0	331	0.0	332	0.0	333	0.0	334	0.0	335	0.0	336	1.1260E-02	337	0.0
337	7.7300E-03	338	1.5460E-02	339	1.4940E-02	340	1.4910E-02	341	1.4910E-02	342	1.4910E-02	343	1.4910E-02	344	0.0
344	7.4600E-03	345	6.4700E-03	346	9.0000E-03	347	1.1290E-02	348	7.9130E-02	349	7.6940E-02	350	1.1500E-03	351	0.0
351	0.0	352	0.0	353	0.0	354	0.0	355	0.0	356	0.0	357	0.0	358	0.0
358	0.0	359	0.0	360	0.0	361	4.0000E-01	362	6.3000E-01	363	8.0000E-01	364	8.0000E-01	365	0.0
365	8.0000E-01	366	8.0000E-01	367	8.0000E-01	368	6.0000E-01	369	3.8000E-01	370	3.8000E-01	371	0.0	372	0.0
372	0.0	373	0.0	374	0.0	375	0.0	376	0.0	377	0.0	378	0.0	379	0.0
379	0.0	380	0.0	381	0.0	382	0.0	383	0.0	384	0.0	385	0.0	386	0.0
386	0.0	387	0.0	388	0.0	389	0.0	390	0.0	391	0.0	392	0.0	393	0.0
393	0.0	394	0.0	395	0.0	396	0.0	397	0.0	398	0.0	399	0.0	400	0.0
400	0.0	401	0.0	402	0.0	403	0.0	404	0.0	405	0.0	406	2.5000E-01	407	0.0
407	2.5000E-01	408	2.5000E-01	409	2.5000E-01	410	2.5000E-01	411	2.5000E-01	412	2.5000E-01	413	2.5000E-01	414	0.0
414	2.5000E-01	415	2.5000E-01	416	0.0	417	0.0	418	0.0	419	0.0	420	0.0	421	0.0
421	0.0	422	0.0	423	0.0	424	0.0	425	0.0	426	4.8390E-02	427	4.8390E-02	428	0.0
428	5.6780E-02	429	9.6780E-02	430	9.6780E-02	431	9.6780E-02	432	9.6780E-02	433	9.6780E-02	434	9.6780E-02	435	0.0
435	2.9030E-02	436	6.9920E-02	437	2.9840E-02	438	9.9162E-01	439	2.9830E-02	440	4.3000E-04	441	0.0	442	0.0
442	0.0	443	0.0	444	0.0	445	0.0	446	0.0	447	0.0	448	0.0	449	0.0
449	0.0	450	0.0	451	1.3600E 06	452	1.3600E 06	453	1.3600E 06	454	1.3600E 06	455	1.3600E 06	456	0.0
456	1.3600E 06	457	1.3600E 06	458	1.3600E 06	459	1.4076E 06	460	1.6742E 06	461	2.7190E 06	462	4.0285E 06	463	0.0
463	4.1000E 06	464	4.1000E 06	465	4.1000E 06	466	0.0	467	0.0	468	0.0	469	0.0	470	0.0
470	0.0	471	0.0	472	0.0	473	0.0	474	0.0	475	0.0	476	9.0000E 00	477	0.0
477	0.0	478	5.0000E 00	479	5.0000E 00	480	5.0000E 00	481	0.0	482	1.0000E 01	483	1.3000E 01	484	0.0
484	2.5000E 01	485	0.0	486	0.0	487	0.0	488	0.0	489	0.0	490	1.6800E 03	491	0.0
491	0.0	492	0.0	493	0.0	494	0.0	495	0.0	496	2.3800E 06	497	2.3800E 06	498	0.0
498	2.3800E 06	499	2.3800E 06	500	2.3800E 06	501	2.3800E 06	502	2.3800E 06	503	2.3800E 06	504	2.3800E 06	505	0.0
505	2.3953E 06	506	2.9209E 06	507	5.9924E 06	508	2.3076E 08	509	3.3163E 08	510	8.5000E 08	511	0.0	512	0.0
512	0.0	513	0.0	514	0.0	515	0.0	516	0.0	517	0.0	518	0.0	519	0.0
519	0.0	520	0.0	521	0.0	522	0.0	523	0.0	524	0.0	525	0.0	526	0.0
526	0.0	527	0.0	528	0.0	529	0.0	530	0.0	531	0.0	532	0.0	533	0.0
533	0.0	534	0.0	535	0.0	536	0.0	537	0.0	538	0.0	539	0.0	540	0.0
540	0.0	541	5.9400E 07	542	5.9400E 07	543	5.9400E 07	544	5.9400E 07	545	5.9400E 07	546	5.9400E 07	547	0.0
547	5.9400E 07	548	5.9400E 07	549	5.9400E 07	550	4.9102E 07	551	2.9486E 07	552	3.3909E 07	553	2.6000E 08	554	0.0
554	3.3523E 08	555	3.3523E 08	556	0.0	557	0.0	558	0.0	559	0.0	560	0.0	561	0.0
561	0.0	562	0.0	563	0.0	564	0.0	565	0.0	566	0.0	567	0.0	568	0.0
568	0.0	569	0.0	570	0.0	571	0.0	572	0.0	573	0.0	574	0.0	575	0.0
575	0.0	576	0.0	577	0.0	578	0.0	579	0.0	580	0.0	581	0.0	582	0.0
582	0.0	583	0.0	584	0.0	585	0.0	586	0.0	587	0.0	588	0.0	589	0.0
589	0.0	590	0.0	591	0.0	592	0.0	593	0.0	594	0.0	595	0.0	596	0.0
596	0.0	597	0.0	598	0.0	599	0.0	600	0.0	601	0.0	602	0.0		

Locs 603 to 1200 equal 0

COMPREHENSIVE ROTOR ANALYSIS
FORCE CALCULATION

ITERATION NO. 0

REQUIRED THRUST ROUTINE

STA	1ST DEL T	LAST DEL T	THETA AT STA4	THRUST
1	-4.42948E 01	1.40196E 02	7.74248E-02	-3.74636E 02
2	-2.69724E 01	1.34480E 02	7.84248E-02	-2.82955E 02
3	-1.85565E 01	2.47673E 02	8.84247E-02	6.38284E 02
4	5.03874E 00	2.04440E 02	9.84247E-02	1.56214E 03
5	9.93758E 00	1.54684E 02	1.08425E-01	2.48730E 03
6	4.66229E 00	1.06808E 02	1.18425E-01	3.41201E 03
7	-3.86976E 00	6.56752E 01	1.28425E-01	4.33184E 03
8	-9.34867E 00	3.44547E 01	1.38425E-01	5.24705E 03
9	-6.30269E 00	8.41802E 00	1.29169E-01	4.40033E 03
10	-3.95794E 00	3.05505E 00	0.0	0.0

AERODYNAMIC FORCE CALCULATION

STATION 1		STATION 2		STATION 3		STATION 4		STATION 5		STATION 6		STATION 7		STATION 8		STATION 9		STATION 10																
PSI F	PSI G	ALPHA EQUIV. ALPHA REF(H)	CL(O-180) L BAR	ALPHA DOT H DOT L-B SL/2	COS(YAW) PHI BAR	PSI F	PSI G	ALPHA EQUIV. ALPHA REF(H)	CL(O-180) L BAR	ALPHA DOT H DOT L-B SL/2	COS(YAW) PHI BAR	PSI F	PSI G	ALPHA EQUIV. ALPHA REF(H)	CL(O-180) L BAR	ALPHA DOT H DOT L-B SL/2	COS(YAW) PHI BAR	PSI F	PSI G	ALPHA EQUIV. ALPHA REF(H)	CL(O-180) L BAR	ALPHA DOT H DOT L-B SL/2	COS(YAW) PHI BAR											
0.0	2.66167E-02	1.64623E-01	7.74479E-01	9.73930E-01	9.73930E-01	1.50000E 01	1.50000E 01	3.08191E-02	2.02529E-01	7.72260E-01	9.78254E-01	9.53005E-01	9.53005E-01	2.49094E-02	-3.36743E-02	-6.20979E 02	-7.23336E-02	9.57010E-01	9.57010E-01	2.94823E-02	4.00000E-02	-6.18102E 02	-6.81313E-02	-9.66759E-02	2.49094E-02	1.66168E 00	3.14159E 00	7.95077E 00	9.57010E-01	9.57010E-01	2.94823E-02	4.00000E-02	-6.18102E 02	-6.81313E-02
9.00000E 01	3.49323E-02	2.44182E-01	7.29820E-01	9.84145E-01	9.84145E-01	4.50000E 01	4.50000E 01	3.87695E-02	2.83537E-01	6.60796E-01	9.90257E-01	8.57964E-01	8.57964E-01	3.39161E-02	-4.00000E-02	-6.09646E 02	-6.10181E-02	9.59722E-01	9.59722E-01	3.80166E-02	4.00000E-02	-6.01808E-02	-6.51043E 00	-9.15573E-02	3.39161E-02	1.85695E 00	3.14159E 00	8.37896E 00	9.59722E-01	9.59722E-01	3.80166E-02	4.00000E-02	-6.01808E-02	-6.51043E 00
6.00000E 01	4.22109E-02	3.22218E-01	5.74228E-01	9.95446E-01	9.95446E-01	7.50000E 01	7.50000E 01	4.51550E-02	3.63040E-01	4.75140E-01	9.98864E-01	9.60985E-01	9.60985E-01	4.16540E-02	-4.16112E-02	-5.78756E 02	-5.67394E-02	9.61770E-01	9.61770E-01	4.47478E-02	4.75782E-02	-5.58389E 02	-5.37953E-02	-8.66339E-02	4.16540E-02	2.00063E 00	3.14159E 00	8.77899E 00	9.61770E-01	9.61770E-01	4.47478E-02	4.75782E-02	-5.58389E 02	-5.37953E-02
9.00000E 01	4.75302E-02	3.88082E-01	3.65482E-01	9.99988E-01	9.99988E-01	1.05000E 02	1.05000E 02	4.92721E-02	3.98387E-01	2.45054E-01	9.98679E-01	9.62006E-01	9.62006E-01	4.72253E-02	-4.96814E-02	-5.36533E 02	-5.14201E-02	9.61770E-01	9.61770E-01	4.90266E-02	4.77748E-02	-5.14677E 02	-4.96782E-02	-8.43763E-02	4.72253E-02	2.05416E 00	3.14159E 00	9.70376E 00	9.61770E-01	9.61770E-01	4.90266E-02	4.77748E-02	-5.14677E 02	-4.96782E-02
8.61884E-01	5.03144E-02	3.94674E-01	1.12323E-01	9.95086E-01	9.95086E-01	1.35000E 02	1.35000E 02	5.05836E-02	3.88529E-01	-3.47046E-02	9.89742E-01	8.61884E-01	8.61884E-01	5.00843E-02	-4.18878E-02	-4.94310E 02	-4.86389E-02	9.59798E-01	9.59798E-01	4.90266E-02	2.04151E 00	-3.14159E 00	9.48529E 00	-8.85259E-02	5.00843E-02	2.00313E 00	3.14159E 00	8.82215E 00	9.59798E-01	9.59798E-01	4.90266E-02	2.04151E 00	-3.14159E 00	9.48529E 00
9.58051E-01	5.00077E-02	3.76313E-01	-1.67335E-01	9.83496E-01	9.83496E-01	1.65000E 02	1.65000E 02	4.84948E-02	3.54964E-01	-3.74621E-01	9.77491E-01	9.58051E-01	9.58051E-01	4.96451E-02	-1.00000E-02	-4.89400E 02	-4.84964E-02	9.55816E-01	9.55816E-01	4.79492E-02	4.00000E-02	-4.54964E 02	-5.04535E-02	-9.14587E-01	4.96451E-02	1.86116E 00	3.14159E 00	8.38570E 00	9.55816E-01	9.55816E-01	4.79492E-02	4.00000E-02	-4.54964E 02	-5.04535E-02
1.80000E 02	4.59844E-02	3.26525E-01	5.60706E-01	9.73067E-01	9.73067E-01	1.95000E 02	1.95000E 02	4.24601E-02	3.01247E-01	-7.41982E-01	9.71566E-01	9.53135E-01	9.53135E-01	4.52201E-02	-3.41399E-02	-4.52084E 02	-5.29659E-02	9.50108E-01	9.50108E-01	4.25226E-02	1.56521E 00	-4.54964E 02	-5.64902E-02	-6.85408E-02	4.52201E-02	1.64631E 00	3.14159E 00	7.97577E 00	9.50108E-01	9.50108E-01	4.25226E-02	1.56521E 00	-4.54964E 02	-5.64902E-02
2.10000E 02	3.80194E-02	2.96828E-01	8.94405E-01	9.73980E-01	9.73980E-01	2.25000E 02	2.25000E 02	3.28983E-02	2.87685E-01	-9.84067E-01	9.80264E-01	2.10000E 02	2.10000E 02	4.23992E-02	-1.44964E-02	-4.63400E 02	-6.89349E-02	9.43823E-01	9.43823E-01	3.15299E-02	-6.34053E-03	-4.76820E 02	-6.60520E-02	-1.02991E-01	4.09361E-02	1.47086E 00	3.14159E 00	7.36269E 00	9.43823E-01	9.43823E-01	3.15299E-02	-6.34053E-03	-4.76820E 02	-6.60520E-02
2.40000E 02	2.75459E-02	2.69678E-01	-9.74473E-01	9.88913E-01	9.88913E-01	2.55000E 02	2.55000E 02	2.5580E-02	2.39173E-01	-8.41775E-01	9.96691E-01	2.40000E 02	2.40000E 02	2.75459E-02	-6.9002E-05	-4.94310E 02	-7.14045E-02	9.39405E-01	9.39405E-01	3.11898E-02	1.28785E 00	-5.14677E 02	-7.63923E-02	-1.08999E-01	3.57086E-02	1.32725E 00	3.14159E 00	6.87764E 00	9.39405E-01	9.39405E-01	3.11898E-02	1.28785E 00	-5.14677E 02	-7.63923E-02
1.08999E-01	1.85851E-02	1.97217E-01	5.91768E-01	9.99996E-01	9.99996E-01	2.85000E 02	2.85000E 02	1.61546E-02	1.47181E-01	-2.65545E-01	9.97153E-01	9.38754E-01	9.38754E-01	2.89229E-02	0.0	-5.36533E 02	-8.03652E-02	9.39357E-01	9.39357E-01	2.15413E-02	0.0	-5.58389E 02	-8.27957E-02	-1.11485E-01	2.55657E-02	1.27405E 00	3.14159E 00	6.81872E 00	9.39357E-01	9.39357E-01	2.15413E-02	0.0	-5.58389E 02	-8.27957E-02
3.00000E 02	1.55202E-02	5.82677E-02	7.45439E-02	9.89711E-01	9.89711E-01	3.15000E 02	3.15000E 02	1.66133E-02	4.46114E-02	3.70478E-01	9.81228E-01	3.00000E 02	3.00000E 02	8.47653E-03	0.0	-9.78754E 02	-8.34301E-02	9.43703E-01	9.43703E-01	7.16432E-03	-6.04180E-03	-5.96246E 02	-8.23370E-02	-1.09033E-01	9.45665E-03	1.32525E 00	3.14159E 00	6.87400E 00	9.43703E-01	9.43703E-01	7.16432E-03	-6.04180E-03	-5.96246E 02	-8.23370E-02
3.30000E 02	1.91164E-02	7.16581E-02	5.87833E-01	9.74955E-01	9.74955E-01	3.45000E 02	3.45000E 02	2.25953E-02	1.22856E-01	7.18968E-01	9.72513E-01	3.30000E 02	3.30000E 02	1.17013E-02	-1.41184E-02	-6.09666E 02	-7.98337E-02	9.49969E-01	9.49969E-01	1.91785E-02	-2.35427E-02	-5.18102E 02	-7.63550E-02	-1.03135E-01	1.29259E-02	1.46710E 00	3.14159E 00	7.33050E 00	9.49969E-01	9.49969E-01	1.91785E-02	-2.35427E-02	-5.18102E 02	-7.63550E-02
9.46777E-01	1.17013E-02	1.46710E 00	3.14159E 00	7.33050E 00	7.33050E 00	9.98196E-02	9.98196E-02	1.95034E-02	1.56087E 00	3.14159E 00	7.63424E 00	9.46777E-01	9.46777E-01	1.29259E-02	1.46710E 00	3.14159E 00	7.33050E 00	9.98196E-02	9.98196E-02	1.95034E-02	1.56087E 00	3.14159E 00	7.63424E 00	-1.03135E-01	1.29259E-02	1.46710E 00	3.14159E 00	7.33050E 00	9.98196E-02	9.98196E-02	1.95034E-02	1.56087E 00	3.14159E 00	7.63424E 00

Similar output for stations 2 to 10

AIRLOAD PERPENDICULAR TO CHORD LINE

PSI	RAD. 0.975	RAD. 0.925	RAD. 0.850	RAD. 0.750	RAD. 0.650	RAD. 0.550	RAD. 0.450	RAD. 0.350	RAD. 0.275	RAD. 0.255
0	0.9219E 02	0.8918E 02	0.1594E 03	0.1249E 03	0.8846E 02	0.5052E 02	0.1578E 02	-0.1198E 02	-0.1283E 02	-0.4575E 01
15	0.1236E 03	0.1212E 03	0.2209E 03	0.1784E 03	0.1341E 03	0.8939E 02	0.4682E 02	0.1043E 02	-0.5466E 01	-0.5791E 01
30	0.1581E 03	0.1569E 03	0.2293E 03	0.2432E 03	0.1866E 03	0.1353E 03	0.8476E 02	0.3956E 02	0.5706E 01	-0.1633E 00
45	0.1938E 03	0.1927E 03	0.3672E 03	0.3119E 03	0.2455E 03	0.1838E 03	0.1258E 03	0.7255E 02	0.1893E 02	0.6789E 01
60	0.2314E 03	0.2260E 03	0.4325E 03	0.3763E 03	0.3024E 03	0.2290E 03	0.1648E 03	0.1045E 03	0.3180E 02	0.1373E 02
75	0.2685E 03	0.2530E 03	0.4846E 03	0.4275E 03	0.3475E 03	0.2646E 03	0.1958E 03	0.1302E 03	0.4300E 02	0.1935E 02
90	0.2885E 03	0.2701E 03	0.5168E 03	0.4577E 03	0.2858E 03	0.2858E 03	0.2136E 03	0.1451E 03	0.4529E 02	0.2315E 02
105	0.2906E 03	0.2751E 03	0.5248E 03	0.4622E 03	0.2881E 03	0.2881E 03	0.2155E 03	0.1464E 03	0.4981E 02	0.2344E 02
120	0.2757E 03	0.2675E 03	0.5077E 03	0.4407E 03	0.2726E 03	0.2726E 03	0.2012E 03	0.1342E 03	0.4459E 02	0.2062E 02
135	0.2534E 03	0.2486E 03	0.4685E 03	0.3969E 03	0.2417E 03	0.2417E 03	0.1737E 03	0.1112E 03	0.3496E 02	0.1541E 02
150	0.2266E 03	0.2212E 03	0.4066E 03	0.3382E 03	0.2640E 03	0.2640E 03	0.1380E 03	0.8167E 02	0.2293E 02	0.8983E 01
165	0.1947E 03	0.1871E 03	0.3361E 03	0.2730E 03	0.2127E 03	0.1944E 03	0.9224E 02	0.5107E 02	0.1074E 02	0.2689E 01
180	0.1591E 03	0.1504E 03	0.2657E 03	0.2121E 03	0.1614E 03	0.1140E 03	0.6264E 02	0.2335E 02	0.4576E 00	-0.2302E 01
195	0.1246E 03	0.1166E 03	0.2017E 03	0.1600E 03	0.1150E 03	0.7081E 02	0.3188E 02	0.1630E 01	-0.6602E 01	-0.5288E 01
210	0.9490E 02	0.8780E 02	0.1515E 03	0.1155E 03	0.7650E 02	0.3936E 02	0.8412E 01	-0.1283E 02	-0.1013E 02	-0.6192E 01
225	0.7100E 02	0.6535E 02	0.1118E 03	0.8019E 02	0.6660E 02	0.1603E 02	-0.7654E 01	-0.2070E 02	-0.1078E 02	-0.5573E 01
240	0.5298E 02	0.4916E 02	0.8159E 02	0.5395E 02	0.2538E 02	-0.5568E-01	-0.1761E 02	-0.2398E 02	-0.9931E 01	-0.3446E 01
255	0.4086E 02	0.3758E 02	0.6040E 02	0.3592E 02	0.1076E 02	-0.1035E 02	-0.2343E 02	-0.2515E 02	-0.4927E 01	-0.1839E 01
270	0.3111E 02	0.3033E 02	0.4750E 02	0.2523E 02	0.2402E 01	-0.1632E 02	-0.2493E 02	-0.2567E 02	-0.4381E 01	-0.1643E 01
285	0.2358E 02	0.2722E 02	0.4238E 02	0.2128E 02	-0.6845E 00	-0.1828E 02	-0.2879E 02	-0.1315E 02	-0.4200E 01	-0.1745E 01
300	0.3033E 02	0.2832E 02	0.4517E 02	0.2398E 02	0.1604E 01	-0.1779E 02	-0.5035E 02	-0.1552E 02	-0.6240E 01	-0.2475E 01
315	0.3635E 02	0.3398E 02	0.5665E 02	0.3471E 02	0.1022E 02	-0.1196E 02	-0.2794E 02	-0.1761E 02	-0.8834E 01	-0.4297E 01
330	0.4815E 02	0.4350E 02	0.7801E 02	0.5424E 02	0.3024E 00	0.3024E 00	-0.2081E 02	-0.1678E 02	-0.1027E 02	-0.6049E 01
345	0.6660E 02	0.6381E 02	0.1110E 03	0.8417E 02	0.5247E 02	0.2072E 02	-0.6692E 01	-0.2653E 02	-0.9337E 01	-0.6336E 01
STDY	1.4103E 02	1.3520E 02	2.4879E 02	2.0552E 02	1.0742E 02	1.0742E 02	6.6156E 01	3.5083E 01	8.6781E 00	3.1682E 00
DAYL	9.665993	9.665993	19.331985	19.331970	19.331985	19.331970	19.331985	19.331985	9.665981	5.799601

AERODYNAMIC FORCE CALCULATION

STATION 1			X/R=0.975			MACH			PHI			PSI			T			L														
PSI	THETA	ALPHA	PHI	LAMB	LAMBT	MACH	U	DFX	MACH	U	DFX	PHI	LAMB	LAMBT	PSI	THETA	ALPHA	T	H	Q	L	D	M									
0			-4.24223E 00	6.26279E-01	9.15539E 01	9.21174E 01	180		-3.07852E 00	6.28025E-01	1.58644E 02	1.59111E 02	5.66944E 00	-7.21745E-02	8.39664E 03	1.10091E 01	4.20635E 00	5.66944E 00	-5.25446E-02	8.41804E 03	1.29572E 01	4.41863E 00	1.42720E 00	9.73009E-01	-3.91508E 00	-5.00351E 01	-4.09568E 01	2.59092E 00	9.76991E-01	-6.78405E 00	-4.22416E 01	-3.31445E 01
15			-3.98022E 00	6.64338E-01	1.22894E 02	1.23547E 02	195		-3.29848E 00	5.89921E-01	1.24145E 02	1.24571E 02	5.66944E 00	-7.18400E-02	8.90479E 03	1.36829E 01	5.11956E 00	5.66944E 00	-5.28790E-02	7.90730E 03	1.09802E 01	3.81904E 00	1.68921E 00	1.03248E 00	-5.25526E 00	-5.43134E 01	-4.46846E 01	2.37098E 00	9.17518E-01	-5.30975E 00	-3.86409E 01	-3.00943E 01
30			-3.72618E 00	6.99876E-01	1.57111E 02	1.57903E 02	210		-3.5754C 00	5.54362E-01	9.44435E 01	9.48379E 01	5.66944E 00	-7.08596E-02	9.38114E 03	1.72852E 01	7.03821E 00	5.66944E 00	-5.38595E-02	7.43087E 03	9.27161E 00	3.36377E 00	1.94325E 00	1.08804E 00	-6.71850E 00	-5.74204E 01	-4.72780E 01	2.09397E 00	8.61963E-01	-4.03865E 00	-3.37174E 01	-2.56845E 01
45			-3.49125E 00	7.30469E-01	1.92589E 02	1.93555E 02	225		-3.79431E 00	5.23777E-01	7.05688E 01	7.09371E 01	5.66944E 00	-6.92998E-02	9.79120E 03	2.17559E 01	9.90762E 00	5.66944E 00	-5.54193E-02	7.02071E 03	7.82173E 00	3.01090E 00	-2.17819E 00	1.13589E 00	-8.23561E 00	-7.16956E 01	-6.11114E 01	1.77513E 00	8.14111E-01	-3.61077E 00	-3.00946E 01	-2.25034E 01
60			-3.28272E 00	7.54028E-01	2.29873E 02	2.31038E 02	240		-4.22759E 00	5.00231E-01	5.25804E 01	5.29289E 01	5.66944E 00	-6.72670E-02	1.01870E 04	2.69261E 01	1.37187E 01	5.66944E 00	-5.74520E-02	6.70536E 03	6.66884E 00	2.77455E 00	2.38671E 00	1.17278E 00	-9.82999E 00	-1.03474E 02	-9.25503E 01	1.44185E 00	7.77223E-01	-2.24847E 00	-2.78935E 01	-2.06422E 01
75			-3.10557E 00	7.68945E-01	2.64571E 02	2.67947E 02	255		-4.53722E 00	4.85385E-01	4.04812E 01	4.08168E 01	5.66944E 00	-6.48998E-02	1.03069E 04	3.26244E 01	1.81367E 01	5.66944E 00	-5.98192E-02	6.50610E 03	5.84611E 00	2.62946E 00	2.56386E 00	1.19619E 00	-1.13993E 01	-1.53716E 02	-1.42578E 02	1.13221E 00	7.53813E-01	-1.73108E 00	-2.68941E 01	-1.98574E 01
90			-2.96362E 00	7.74203E-01	2.86385E 02	2.87851E 02	270		-4.78168E 00	4.80184E-01	3.27487E 01	3.30775E 01	5.66944E 00	-6.23595E-02	1.03774E 04	3.57512E 01	2.09868E 01	5.66944E 00	-6.43639E-02	6.43639E 03	5.31157E 00	2.56317E 00	2.70581E 00	1.20452E 00	-1.22446E 01	-1.80893E 02	-1.49679E 02	8.87750E-01	7.45477E-01	-1.40042E 00	-2.72051E 01	-2.02433E 01
105			-2.86042E 00	7.69437E-01	2.88563E 02	2.89958E 02	285		-4.92747E 00	4.84995E-01	2.92129E 01	2.95449E 01	5.66944E 00	-6.50087E-02	1.03135E 04	3.51521E 01	2.37081E 01	5.66944E 00	-6.89998E-02	6.50087E 03	5.12193E 00	2.59377E 00	2.80901E 00	1.19722E 00	-1.23397E 01	-1.78075E 02	-1.66932E 02	7.41970E-01	7.52783E-01	-1.24922E 00	-2.88982E 01	-2.18664E 01
120			-2.79982E 00	7.54970E-01	2.73957E 02	2.75144E 02	300		-4.95916E 00	4.99482E-01	2.99496E 01	3.02946E 01	5.66944E 00	-6.72670E-02	1.01196E 04	3.09844E 01	1.75655E 01	5.66944E 00	-6.72670E-02	6.69055E 03	5.28758E 00	2.67878E 00	2.86961E 00	1.17477E 00	-1.17151E 01	-1.45378E 02	-1.36444E 02	7.10299E-01	7.75232E-01	-1.28072E 00	-3.27602E 01	-2.55183E 01
135			-2.78632E 00	7.31785E-01	2.52053E 02	2.53019E 02	315		-4.86228E 00	5.22657E-01	3.59267E 01	3.63098E 01	5.66944E 00	-5.54193E-02	9.80884E 03	2.60127E 01	1.37293F 01	5.66944E 00	-6.92998E-02	7.00569E 03	6.03347E 00	2.95391E 00	2.88312E 00	1.13870E 00	-1.07784E 01	-1.13935E 02	-1.03338E 02	7.87159E-01	8.11295E-01	-1.53632E 00	-3.65175E 01	-2.89397E 01
150			-2.82498E 00	7.01462E-01	2.25706E 02	2.26446E 02	330		-4.71835E 00	5.52944E-01	4.76663E 01	4.81006E 01	5.66944E 00	-5.74521E-02	9.40240E 03	2.05883E 01	9.43936E 00	5.66944E 00	-7.08596E-02	7.41166E 03	7.24265E 00	3.29719E 00	2.84445E 00	1.09148E 00	-9.65177E 00	-8.29144E 01	-7.27597E 01	9.51090E-01	8.58514E-01	-2.03834E 00	-4.06844E 01	-3.26679E 01
165			-2.92100E 00	6.66071E-01	1.94019E 02	1.94582E 02	345		-4.49579E 00	5.88285E-01	6.60490E 01	6.65368E 01	5.66944E 00	-5.28790E-02	8.92802E 03	1.59944E 01	6.08652E 00	5.66944E 00	-7.18400E-02	7.86453E 03	8.81505E 00	3.61063E 00	2.74843E 00	1.03633E 00	-8.29678E 00	-5.38582E 01	-4.42113E 01	1.17365E 00	9.13672E-01	-2.82443E 00	-4.53001E 01	-3.67718E 01

Similar output for stations 2 to 10

COMPREHENSIVE ROTOR ANALYSIS
FORCE CALCULATION

ITERATION NO. 0

STA	HARMONIC	1	2	3	4	5	6	7	8	9	10					
1	1.27737E	02	1.79010E	01	2.29405E	00	2.38425E	00	1.50618E	00	6.31618E-01	1.26583E-01	1.69350E-01	1.55638E-01	1.55638E-01	2.01893E-01
2	1.23762E	02	1.60620E	01	9.33825E-01	2.33376E-01	3.07831E-01	1.10971E-01	2.28106E-02	1.14982E-01	3.63666E-02	4.25365E-02	4.25365E-02	4.25365E-02	4.25365E-02	4.25365E-02
3	2.40517E	02	3.65757E	01	1.05026E	00	1.89984E	00	2.26060E-01	1.03538E-02	9.36310E-02	9.36310E-02	4.27977E-01	2.99237E-01	2.99237E-01	1.18448E-01
4	2.17408E	02	3.76795E	01	3.74791E	00	4.80402E-01	5.29043E-01	1.94070E-01	1.94070E-01	2.28690E-01	2.28690E-01	7.00670E-02	1.25719E-01	1.25719E-01	9.39419E-03
5	1.85366E	02	3.30374E	01	3.80025E	00	1.10296E	00	1.14424E-01	3.93528E-01	2.76892E-01	2.76892E-01	5.29037E-02	1.87829E-01	1.87829E-01	1.20498E-01
6	1.52455E	02	2.84474E	01	9.98385E-01	1.12068E-01	7.52121E-02	8.60029E-02	8.73217E-02	8.73217E-02	8.73217E-02	8.73217E-02	5.58237E-02	7.67542E-02	7.67542E-02	2.90647E-02
7	1.21112E	02	2.81606E	01	8.96789E-01	2.57961E-01	1.08485E-01	7.91250E-02	7.09265E-02	8.35199E-02	8.35199E-02	8.35199E-02	9.84599E-02	9.84599E-02	9.84599E-02	7.84731E-02
8	8.19432E	01	2.99830E	01	2.83697E	00	1.83740E	00	9.64766E-01	1.65469E-01	7.25643E-01	1.10109E	00	1.21705E	00	9.92021E-01
9	2.64995E	01	1.46393E	01	6.98746E-01	3.85244E-01	5.44980E-01	4.26612E-01	2.75954E-01	2.75954E-01	2.75954E-01	2.75954E-01	4.53532E-01	3.89863E-01	3.89863E-01	1.60743E-01
10	1.17395E	01	8.10025E	00	7.18555E-01	2.84364E-01	8.65758E-02	2.47201E-01	3.21026E-01	1.86949E-01	1.86949E-01	1.86949E-01	1.43336E-01	1.43336E-01	1.43336E-01	1.45928E-01

RESULTANT THRUST

Similar output for Resultant Drag

PSI	COMPREHENSIVE ROTOR ANALYSIS													
	STA 1	2	3	4	CL VALUES					6	7	8	9	10
					5									
0	0.2118993	0.2277159	0.2407854	0.2414187	0.2259773	0.1772902	0.0769615	-0.1151386	-0.3597993	-0.2897971				
15	0.2535253	0.2745757	0.2929156	0.2978168	0.2901767	0.2599339	0.1910638	0.0586537	-0.1151859	-0.2459919				
30	0.2826981	0.3193722	0.3454188	0.3572253	0.3492453	0.3334534	0.2845967	0.1926443	0.0719668	-0.0152342				
45	0.3299451	0.3591189	0.3950114	0.4126235	0.4087714	0.3964856	0.3649879	0.2967786	0.2078778	0.1465254				
60	0.3701174	0.3945326	0.4336425	0.4609303	0.4619592	0.4482802	0.4276873	0.3758294	0.3028404	0.2570100				
75	0.4131868	0.4241195	0.4654133	0.4995095	0.5037456	0.4882002	0.4748887	0.4330661	0.3752927	0.3303238				
90	0.4380819	0.4465584	0.4890792	0.5262694	0.5320082	0.5169907	0.4748086	0.4179951	0.3752927	0.3303238				
105	0.4668149	0.4688826	0.5036841	0.5397488	0.5452863	0.5313599	0.5226345	0.4870681	0.4355737	0.4015406				
120	0.4402876	0.4663610	0.5085456	0.5391799	0.5428403	0.5333343	0.5223432	0.4835369	0.4271185	0.3900065				
135	0.4307738	0.4627149	0.5032440	0.5245090	0.5246592	0.5213289	0.5047992	0.4575282	0.3903276	0.3440225				
150	0.4193533	0.4497159	0.4801562	0.4943885	0.4942943	0.4943995	0.4689826	0.4051250	0.3176880	0.2531495				
165	0.3993080	0.4238802	0.4457047	0.4561353	0.4611664	0.4515746	0.4115965	0.3218502	0.1952217	0.0975007				
180	0.3667613	0.3849816	0.4021063	0.4112537	0.4148996	0.3922542	0.3289050	0.1946514	-0.0006440	-0.1605779				
195	0.3247473	0.3397318	0.3517155	0.3644401	0.3560903	0.3140070	0.2168055	0.0077806	-0.3105671	-0.5947424				
210	0.2791353	0.2908179	0.3040420	0.3091314	0.2856857	0.2175768	0.0693310	-0.2576389	-0.8031951	-1.3528872				
225	0.2329145	0.2431123	0.2551171	0.2487503	0.2064853	0.1059332	-0.1111736	-0.6158043	-1.5742435	-2.6955566				
240	0.1894506	0.2005961	0.2081906	0.1880856	0.1260590	-0.0110498	-0.3078699	-1.0481720	-2.6658812	-3.2307549				
255	0.1541529	0.1624074	0.1628021	0.1341145	0.0551914	-0.1144399	-0.4839814	-1.4598351	-1.8047675	-2.0540323				
270	0.1267264	0.1331223	0.1299344	0.0950234	0.0059474	-0.1820341	-0.5905712	-1.6292086	-1.5378628	-1.0170660				
285	0.1103765	0.1163415	0.1124743	0.0767074	-0.0127402	-0.1933302	-0.5836655	-0.5766997	-0.7642530	-0.1902400				
300	0.1066859	0.1136951	0.1119218	0.0800685	0.0003610	-0.1655760	-0.5092540	-0.5221912	-0.9786962	-0.8753277				
315	0.1174594	0.1245770	0.1271132	0.1044956	0.0394461	-0.0956292	-0.3674843	-0.4314473	-0.9008372	-1.2377672				
330	0.1401341	0.1491999	0.1548474	0.1427034	0.0955353	-0.0067596	-0.2085364	-0.2934110	-0.6307746	-0.9575401				
345	0.1724983	0.1848843	0.1924257	0.1900696	0.1597475	0.0868945	-0.0586187	-0.3394217	-0.3685544	-0.5670315				

Similar output for CD and CH

AERODYNAMIC PARAMETERS

ALPHA R	V KNOTS	V/R*OMEGA	MU	ALPHA AT 270
-1.30000E-01	1.00000E 02	2.35560E-01	2.29523E-01	6.68260E 00
T S	TAU S	RHP	M	X
4.40000E 03	6.22779E 03	5.03951E 02	9.35979E 01	8.98585E 02
L	X/L	L/DE	L/QD2SIG	X/QD2SIG
6.30028E 03	2.08572E-01	-9.00223E 00	1.69977E 00	3.54524E-01
P/QD2SIG	CT/SIG	CTP/SIG	CH/SIG	CP/SIG
6.47675E-01	6.13229E-02	-6.00446E-02	1.30447E-03	5.38776E-03
V YIP	SIG	LAMBDA		
7.18909E-02	7.19870E-02	-6.23995E-02		

COMPREHENSIVE ROTOR ANALYSIS
 ROTOR BLADE FORCED VIBRATIONS
 COUPLED FLAP---LAG---TORSION

ITERATION NO. 0

VZ	K=0	1	2	3	4	5	6	7	8	9	10
STA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	2.0865E 02	-1.4717E 01	-3.4382E 00	-4.9933E-01	-1.6424E 00	-2.2498E 00	3.3332E-01	-3.1358E-01	-3.7379E-02	4.213E-02	2.117E-01
		-1.7708E 00	2.1148E-01	-5.1115E 00	8.3590E-01	-2.9276E-01	1.2345E-01	5.1665E-01	6.6006E-01	2.956E-01	1.011E-01
3	3.9072E 02	-2.5170E 01	5.8852E 00	-2.8297E 00	-2.8213E 00	-2.7247E 00	6.3543E-01	3.0602E-01	-1.0434E-01	2.749E-02	1.095E-01
		-2.9092E 00	3.2208E 01	-6.1147E 00	6.6887E-01	-5.8358E-01	1.5240E-01	5.0315E-01	6.3368E-01	2.467E-01	7.042E-02
4	6.8822E 02	-5.0923E 01	1.2712E 00	-3.2112E 00	-4.7364E 00	-7.7946E-01	3.5386E-01	-3.8711E-02	3.9836E-01	-7.901E-02	-2.427E-01
		2.5665E 01	4.1746E 01	-5.2417E 00	9.6519E-01	-8.8583E-01	-1.1830E-01	-3.5869E-01	-5.6025E-01	-1.836E-01	-1.769E-01
5	9.0618E 02	-7.9250E 01	-2.2910E 01	1.3112E-01	-3.1259E 00	2.1668E 00	-6.9141E-01	-3.6883E-01	-6.9789E-02	1.643E-02	-3.532E-01
		7.7821E 01	3.7816E 01	-4.4697E 00	1.3678E 00	-6.8102E-01	-3.7621E-01	-9.4927E-01	-1.0679E 00	-7.085E-01	-1.127E-01
6	1.0553E 03	-1.0764E 02	-5.8303E 01	5.6153E 00	3.0822E-01	3.6571E 00	-8.4746E-01	-4.3791E-01	-4.2958E-01	2.794E-02	-1.302E-02
		1.3977E 02	2.5677E 01	-8.0741E-01	1.4261E 00	1.1898E-02	-4.3775E-01	-6.2469E-02	-2.0554E-01	4.913E-02	1.107E-01
7	1.1490E 03	-1.3413E 02	-9.9733E 01	1.2071E 01	1.5330E 00	3.2493E 00	-8.2381E-01	-6.5759E-02	-2.1294E-01	3.208E-02	3.904E-01
		2.0518E 02	9.4773E 00	7.1287E 00	7.1273E-01	1.8952E-01	-2.8907E-01	6.7475E-01	1.0334E 00	6.672E-01	1.314E-01
8	1.2008E 03	-1.5718E 02	-1.4600E 02	1.8570E 01	1.7675E 00	1.1322E 00	-2.6595E-01	4.0682E-01	2.9493E-01	2.318E-02	1.720E-01
		2.8990E 02	-7.1831E 00	1.4634E 01	-2.8267E-01	-1.6200E-01	4.9085E-02	8.0894E-01	1.0769E 00	3.307E-01	-8.226E-02
9	1.2230E 03	-1.7227E 02	-1.9223E 02	2.0638E 01	-9.8957E-01	-1.7966E 00	4.6828E-01	-8.4228E-02	9.7679E-02	3.711E-01	4.797E-01
		3.1936E 02	-2.4829E 01	1.8918E 01	-8.3078E-02	4.6967E-01	3.9665E-01	3.8260E-01	7.7664E-01	5.325E-01	1.073E-01
10	1.2270E 03	-1.7751E 02	-2.1269E 02	2.2103E 01	-1.3454E 00	-3.1969E 00	3.3878E-01	-1.3129E-01	-1.1058E-01	-2.410E-01	-1.836E-01
		3.3625E 02	-3.3326E 01	2.8229E 01	-9.3075E-01	-3.7005E-01	1.8840E-01	-3.5534E-01	-5.7339E-01	-2.020E-01	6.848E-02
11	1.2287E 03	-1.7982E 02	-2.2317E 02	2.3220E 01	-1.8334E 00	-3.6166E 00	7.4162E-01	2.0596E-01	9.7675E-02	-1.849E-01	-3.130E-01
		3.4383E 02	-3.7046E 01	2.0487E 01	-1.4524E 00	-6.7107E-01	5.1955E-02	-8.4531E-01	-1.2330E 00	-6.168E-01	-5.445E-02
12	1.2268E 03	-1.8110E 02	-2.2939E 02	2.4720E 01	-1.6037E 00	-4.3119E 00	9.5800E-01	2.8810E-01	1.5867E-01	-3.572E-01	-7.588E-01
		3.4613E 02	-3.8072E 01	2.1818E 01	-1.8167E 00	-7.9182E-01	7.8102E-02	-1.1953E 00	-1.9917E 00	-1.179E 00	-1.218E-01
13	1.2238E 03	-1.8157E 02	-2.3169E 02	2.3276E 01	-1.5590E 00	-4.5807E 00	1.0440E 00	3.2256E-01	1.8429E-01	-4.313E-01	-9.569E-01
		3.4664E 02	-3.8454E 01	2.2311E 01	-1.6803E 00	-8.4011E-01	8.4318E-02	-1.3401E 00	-2.3118E 00	-1.423E 00	-1.530E-01
14	1.1987E 03	-1.8181E 02	-2.3284E 02	2.5550E 01	-1.7045E 00	-4.7223E 00	1.0901E 00	3.4173E-01	1.9866E-01	-4.740E-01	-1.074E 00
		3.4593E 02	-3.8450E 01	2.2563E 01	-1.7140E 00	-8.6638E-01	8.8357E-02	-1.4202E 00	-2.4924E-01	-1.563E 00	-1.717E-01
15	1.1716E 03	-1.8183E 02	-2.3297E 02	2.5589E 01	-1.708E 00	-4.7377E 00	1.0952E 00	3.4383E-01	2.0024E-01	-4.787E-01	-1.087E 00
		3.4465E 02	-3.8672E 01	2.2590E 01	-1.7177E 00	-8.6526E-01	8.8792E-02	-1.4290E 00	-2.3123E 00	-1.579E 00	-1.738E-01
16	1.1712E 03	-1.8183E 02	-2.3297E 02	2.5589E 01	-1.7083E 00	-4.7377E 00	1.0952E 00	3.4383E-01	2.0024E-01	-4.787E-01	-1.087E 00
		3.4463E 02	-3.8672E 01	2.2590E 01	-1.7177E 00	-8.6926E-01	8.8792E-02	-1.4290E 00	-2.5123E 00	-1.579E 00	-1.738E-01
17	1.4186E 03	-2.3772E 02	-3.1749E 02	4.2795E 01	1.6371E 00	-6.9670E 00	2.2924E 00	4.7062E-01	2.6722E-01	-2.641E-01	-1.155E 00
		4.1037E 02	-5.1382E 01	3.5702E 01	1.1374E 00	-1.4650E-02	1.9948E 00	-1.9900E 00	-2.5058E 00	-1.729E 00	-4.775E-01

Similar output for MY, BETA, Z, MX, THETA, VY, MZ, ZETA, Y

COMPREHENSIVE ROTOR ANALYSIS
FORCE CALCULATION

ITERATION NO. 1

STA	1ST DEL T	LAST DEL T	REQUIRED THRUST ROUTINE	THEYA AT STA4	THRUST
1	1.60288E 02	1.96289E 02	*	1.30151E-01	4.19269E 03
2	1.61309E 02	1.68330E 02	*	1.31151E-01	4.28496E 03
3	2.57843E 02	2.69409E 02	*	1.41151E-01	5.20631E 03
4	1.85037E 02	1.93709E 02	*	1.32399E-01	4.40018E 03
5	1.24331E 02	1.30815E 02	*	0.0	0.0
6	7.62607E 01	8.04952E 01	*	0.0	0.0
7	3.93395E 01	4.23681E 01	*	0.0	0.0
8	1.45513E 01	1.64508E 01	*	0.0	0.0
9	1.41704E 00	2.07578E 00	*	0.0	0.0
10	-4.03358E-01	-9.55707E-02	*	0.0	0.0

Output similar to iteration 0 is repeated for iterations 1 to 9

COMPREHENSIVE ROTOR ANALYSIS
FORCE CALCULATION

ITERATION NO. 10

REQUIRED THRUST ROUTINE

STA	1ST DEL T	LAST DEL T	THETA AT STA4	THRUST
1	2.17312E 02	2.18251E 02	1.39692E-01	4.37497E 03
2	1.81247E 02	1.82097E 02	1.40692E-01	4.46682E 03
3	2.77922E 02	2.79324E 02	1.39864E-01	4.40000E 03
4	1.88333E 02	1.89385E 02	0.0	0.0
5	1.19453E 02	1.20215E 02	0.0	0.0
6	6.85637E 01	6.91012E 01	0.0	0.0
7	3.84884E 01	3.88844E 01	0.0	0.0
8	9.63071E 00	9.84341E 00	0.0	0.0
9	-1.51228E-01	-7.25628E-02	0.0	0.0
10	-1.00633E 00	-9.68990E-01	0.0	0.0

AERODYNAMIC FORCE CALCULATION

STATION 1									
X/R=0.975									
PSI	ALPHA EQUIV.	CL(REF)	ALPHA DOT	COS(YAW)	PSI	ALPHA EQUIV.	CL(REF)	ALPHA DOT	COS(YAW)
F	ALPHA REF(L)	CL(180)	H DOT	PHI BAR	F	ALPHA REF(L)	CL(180)	H DOT	PHI BAR
G	ALPHA REF(M)	L BAR	L-B SL/Z	REF. SLOPE	G	ALPHA REF(M)	L BAR	L-B SL/Z	REF. SLOPE
0.0	6.66265E-02	4.53087E-01	-1.04082E 00	9.74110E-01	1.50000E 01	6.09150E-02	4.17718E-01	-8.32206E-01	9.78397E-01
9.53002E-01	6.11462E-02	3.36641E-02	-6.25297E 02	7.40614E-02	9.55704E-01	5.56394E-02	-4.00000E-02	-6.07394E 02	-6.79643E-02
-4.66789E-02	6.11462E-02	3.89276E-01	3.14159E 00	7.96044E 00	-9.38834E-02	5.56394E-02	6.15229E-01	3.14159E 00	8.22650E 00
3.00000E 01	5.63448E-02	3.70930E-01	-6.22344E-01	9.64244E 01	4.50000E 01	5.25189E-02	3.68908E-01	-5.15709E-01	9.90312E-01
9.57963E-01	5.14291E-02	-4.00000E-02	-5.87971E 02	-6.24873E-02	9.58731E-01	4.80442E-02	-4.00000E-02	-5.69810E 02	-5.80099E-02
-9.15494E-02	5.14291E-02	8.96423E-01	3.14159E 00	8.37950E 00	-8.94094E-02	4.80442E-02	1.11787E 00	3.14159E 00	8.51108E 00
6.00000E 01	4.96800E-02	3.56147E-01	-3.22923E-01	9.95449E-01	7.50000E 01	4.69214E-02	3.52521E-01	-4.70105E-01	9.98870E-01
9.60991E-01	4.56347E-02	-4.18340E-02	-5.57365E 02	-5.47894E-02	9.61747E-01	4.34545E-02	-4.75919E-02	-5.54942E 02	-5.84437E-02
-8.66216E-02	4.56347E-02	1.50935E 00	3.14159E 00	8.78389E 00	-8.49494E-02	4.34545E-02	1.55637E 00	3.14159E 00	9.46433E 00
9.00000E 01	4.34134E-02	3.33999E-01	-4.39885E-01	9.99998E-01	1.05000E 02	4.12204E-02	3.15946E-01	-9.88103E-02	9.98675E-01
9.62003E-01	4.05063E-02	-4.96571E-02	-5.57405E 02	-5.33163E-02	9.61747E-01	3.89354E-02	-4.77048E-02	-5.54157E 02	-5.33061E-02
-8.63829E-02	4.05063E-02	1.65338E 00	3.14159E 00	9.70098E 00	-8.49177E-02	3.89354E-02	1.99189E 00	3.14159E 00	9.87749E 00
1.20000E 02	4.06940E-02	3.01698E-01	1.76382E-01	9.95048E-01	1.35000E 02	4.17517E-02	3.09206E-01	4.28349E-01	9.89698E-01
9.68821E-01	3.91542E-02	-4.18837E-02	-5.40082E 02	-5.29900E-02	9.58731E-01	4.10113E-02	-4.00000E-02	-5.17166E 02	-5.23479E-02
-8.65537E-02	3.91542E-02	2.24212E 00	3.14159E 00	8.81022E 00	-8.93018E-02	4.10113E-02	2.51671E 00	3.14159E 00	8.51487E 00
1.50000E 02	4.38423E-02	3.28485E-01	5.96134E-01	9.83417E-01	1.65000E 02	4.78836E-02	3.61345E-01	1.07119E 00	9.77370E-01
9.53147E-01	4.39456E-02	-4.00000E-02	-4.89901E 02	-5.18914E-02	9.58731E-01	4.87444E-02	-4.00000E-02	-4.59606E 02	-5.07282E-02
-9.14699E-02	4.39456E-02	2.70089E 00	3.14159E 00	8.38501E 00	-9.37684E-02	4.87444E-02	3.16228E 00	3.14159E 00	8.23367E 00
1.80000E 02	5.45610E-02	4.14023E-01	1.40532E 00	9.72907E-01	1.95000E 02	6.30531E-02	4.62504E-01	1.75440E 00	9.71377E-01
9.46828E-01	5.61862E-02	-3.41821E-02	-4.32826E 02	-5.03856E-02	9.50125E-01	6.35991E-02	-2.40339E-02	-4.14910E 02	-5.03596E-02
-9.65284E-02	5.61862E-02	3.52524E 00	3.14159E 00	7.87713E 00	-9.96578E-02	6.40288E-02	3.86624E 00	3.14159E 00	7.95007E 00
2.10000E 02	7.45342E-02	4.84304E-01	2.24395E 00	9.75762E-01	2.50000E 02	8.84354E-02	5.20536E-01	2.65902E 00	9.80088E-01
9.46828E-01	6.79242E-02	-1.48414E-02	-4.11998E 02	-5.20305E-02	9.43895E-01	7.44886E-02	-6.37033E-03	-6.27428E 02	-5.60412E-02
-1.02797E-01	7.02328E-02	4.31336E 00	3.14159E 00	7.34414E 00	-1.06189E-01	7.86505E-02	4.49056E 00	3.14159E 00	7.08080E 00
2.60000E 02	1.02615E-01	5.80163E-01	2.11467E 00	9.88779E-01	2.50000E 02	1.12272E-01	6.71433E-01	9.19180E-01	9.96413E-01
9.41204E-01	8.43644E-02	-8.91368E-05	-4.57993E 02	-6.24237E-02	9.39414E-01	9.82510E-02	0.0	-4.97650E 02	-7.06097E-02
-1.08929E-01	8.95340E-02	4.19323E 00	3.14159E 00	6.67836E 00	-1.10794E-01	1.02229E-01	3.24777E 00	3.14159E 00	6.83387E 00
2.70000E 02	1.15928E-01	7.72263E-01	3.11422E-02	9.99991E-01	2.85000E 02	1.15504E-01	8.78395E-01	-7.84625E-01	9.97234E-01
9.38755E-01	1.13553E-01	0.0	-5.38204E 02	-7.81358E-02	9.39351E-01	1.29444E-01	0.0	-5.76497E 02	-8.39715E-02
-1.11484E-01	1.14333E-01	2.44042E 00	3.14159E 00	6.81876E 00	-1.10862E-01	1.25751E-01	1.68058E 00	3.14159E 00	6.83234E 00
3.00000E 02	1.09038E-01	6.62229E-01	-1.85349E 00	9.89866E-01	3.13000E 02	9.77986E-02	7.56607E-01	-2.33006E 00	9.81433E-01
9.41897E-01	1.26332E-01	0.0	-8.10751E 02	-8.79393E-02	9.43649E-01	1.10670E-01	-6.01592E-03	-6.33977E 02	-8.85803E-01
-1.09060E-01	1.21441E-01	6.65011E-01	3.14159E 00	6.87383E 00	-1.06337E-01	1.06542E-01	-3.87181E-02	3.14159E 00	7.06937E 00
3.30000E 02	8.49558E-02	6.37051E-01	-2.28750E 00	9.75176E-01	3.45000E 02	7.39621E-02	5.15023E-01	-1.60128E 00	9.72722E-01
9.46768E-01	8.99786E-02	-1.40942E-02	-6.42910E 02	-8.58064E-02	9.49962E-01	7.05926E-02	-2.35217E-02	-6.38771E 02	-8.04148E-02
-1.05141E-01	8.75561E-02	-3.41521E-01	3.14159E 00	7.32973E 00	-9.98265E-02	7.01014E-02	-1.96049E-02	3.14159E 00	7.63356E 00

Similar output for stations 2 to 10

AIRLOAD PERPENDICULAR TO CHORD LINE

PSI	RAD. 0.975	RAD. 0.925	RAD. 0.850	RAD. 0.750	RAD. 0.650	RAD. 0.550	RAD. 0.450	RAD. 0.350	RAD. 0.275	RAD. 0.235
0	0.2267E 03	0.1850E 03	0.2697E 03	0.1701E 03	0.1008E 03	0.5797E 02	0.8687E 01	-0.1816E 02	-0.1550E 02	-0.5661E 01
15	0.2414E 03	0.2016E 03	0.2998E 03	0.1960E 03	0.1246E 03	0.7076E 02	0.2851E 02	-0.3247E 01	-0.1013E 02	-0.8146E 01
30	0.2522E 03	0.2154E 03	0.3311E 03	0.2262E 03	0.1492E 03	0.9499E 02	0.5101E 02	0.1571E 02	0.2459E 01	0.4223E 01
45	0.2611E 03	0.2244E 03	0.3664E 03	0.2517E 03	0.1732E 03	0.1170E 03	0.1255E 02	0.3538E 02	0.6139E 01	0.4410E 00
60	0.2708E 03	0.2314E 03	0.3755E 03	0.2761E 03	0.1943E 03	0.1343E 03	0.8965E 02	0.5137E 02	0.1354E 02	0.4694E 01
75	0.2794E 03	0.2310E 03	0.3781E 03	0.2850E 03	0.2055E 03	0.1435E 03	0.9969E 02	0.6247E 02	0.1874E 02	0.7747E 01
90	0.2894E 03	0.2185E 03	0.3616E 03	0.2779E 03	0.2042E 03	0.1455E 03	0.1040E 03	0.6831E 02	0.2210E 02	0.9694E 01
105	0.2902E 03	0.2049E 03	0.3400E 03	0.2627E 03	0.1948E 03	0.1406E 03	0.1021E 03	0.6838E 02	0.2302E 02	0.1041E 02
120	0.2248E 03	0.1929E 03	0.3192E 03	0.2445E 03	0.1816E 03	0.1326E 03	0.9570E 02	0.6282E 02	0.2044E 02	0.8953E 01
135	0.2098E 03	0.1836E 03	0.3023E 03	0.2257E 03	0.1646E 03	0.1196E 03	0.8320E 02	0.5125E 02	0.1509E 02	0.5906E 01
150	0.1997E 03	0.1744E 03	0.2811E 03	0.2057E 03	0.1461E 03	0.1033E 03	0.8683E 02	0.3587E 02	0.8065E 01	0.1989E 01
165	0.1936E 03	0.1668E 03	0.2622E 03	0.1863E 03	0.1302E 03	0.8584E 02	0.8928E 02	0.1956E 02	0.8471E 00	-0.1874E 01
180	0.1904E 03	0.1610E 03	0.2478E 03	0.1712E 03	0.1152E 03	0.6929E 02	0.3299E 02	0.5018E 01	-0.5085E 01	-0.4800E 01
195	0.1864E 03	0.1558E 03	0.2361E 03	0.1599E 03	0.1011E 03	0.5471E 02	0.1914E 02	-0.6338E 01	-0.8958E 01	-0.6324E 01
210	0.1872E 03	0.1543E 03	0.2307E 03	0.1518E 03	0.8944E 02	0.4179E 02	0.7070E 01	-0.1476E 02	-0.1084E 02	-0.6532E 01
225	0.1910E 03	0.1568E 03	0.2342E 03	0.1481E 03	0.8134E 02	0.3171E 02	-0.2193E 01	-0.1485E 02	-0.1090E 02	-0.5700E 01
240	0.1957E 03	0.1626E 03	0.2389E 03	0.1457E 03	0.7432E 02	0.2316E 02	-0.9061E 01	-0.2218E 02	-0.9902E 01	-0.3489E 01
255	0.1990E 03	0.1644E 03	0.2385E 03	0.1415E 03	0.6820E 02	0.1699E 02	-0.1328E 02	-0.2297E 02	-0.8652E 01	-0.1870E 01
270	0.1993E 03	0.1639E 03	0.2361E 03	0.1375E 03	0.6384E 02	0.1306E 02	-0.1601E 02	-0.2334E 02	-0.4317E 01	-0.1649E 01
285	0.2019E 03	0.1660E 03	0.2376E 03	0.1370E 03	0.6237E 02	0.1131E 02	-0.1773E 02	-0.1209E 02	-0.4171E 01	-0.1729E 01
300	0.2033E 03	0.1669E 03	0.2391E 03	0.1385E 03	0.6347E 02	0.1205E 02	-0.1839E 02	-0.1447E 02	-0.8233E 01	-0.2467E 01
315	0.2034E 03	0.1654E 03	0.2380E 03	0.1395E 03	0.6569E 02	0.1425E 02	-0.1756E 02	-0.1653E 02	-0.8804E 01	-0.4308E 01
330	0.2065E 03	0.1661E 03	0.2370E 03	0.1424E 03	0.7155E 02	0.2037E 02	-0.1331E 02	-0.2716E 02	-0.1028E 02	-0.6107E 01
345	0.2124E 03	0.1723E 03	0.2451E 03	0.1525E 03	0.8330E 02	0.3161E 02	-0.4618E 01	-0.2705E 02	-0.9798E 01	-0.6569E 01
STBY	2.1002E 02	1.8274E 02	2.8050E 02	1.9048E 02	1.2120E 02	6.9850E 01	3.3260E 01	1.0333E 01	8.1323E 02	-9.0068E 01
DAYL	9.665993	9.665993	19.331985	19.331970	19.331985	19.331970	19.331985	19.331985	9.685981	5.799601

ITERATION NO. 10

VIBRATORY AIRLOADS PERPENDICULAR TO CHORD LIVE PER UNIT LENGTH

PSI	RAD. 0.975	RAD. 0.925	RAD. 0.850	RAD. 0.750	RAD. 0.650	RAD. 0.550	RAD. 0.450	RAD. 0.350	RAD. 0.275	RAD. 0.235
0	0.7901E 00	0.3109E 00	0.5574E 00	0.1054E 01	-0.1055E 01	-0.1132E 01	-0.1271E 01	-0.1474E 01	-0.1612E 01	-0.1620E 00
15	0.2312E 01	0.1951E 01	0.5961E 00	0.2667E 00	0.1749E 00	0.4699E-01	0.2455E 00	-0.7024E 00	-0.1056E 01	-0.1249E 01
30	0.3510E 01	0.3394E 01	0.2619E 01	0.1847E 01	0.1449E 01	0.1300E 01	0.9100E 00	0.2780E 00	-0.2628E 00	-0.5778E 00
45	0.4358E 01	0.4313E 01	0.3928E 01	0.3164E 01	0.2691E 01	0.2440E 01	0.2032E 01	0.1294E 01	0.6267E 00	0.2313E 00
60	0.5358E 01	0.5028E 01	0.4810E 01	0.4323E 01	0.3780E 01	0.3335E 01	0.2917E 01	0.2152E 01	0.1392E 01	0.9447E 00
75	0.6248E 01	0.4991E 01	0.5051E 01	0.4889E 01	0.4361E 01	0.3812E 01	0.3436E 01	0.2697E 01	0.1930E 01	0.1491E 01
90	0.5221E 01	0.3701E 01	0.4199E 01	0.4521E 01	0.4291E 01	0.3912E 01	0.3541E 01	0.2999E 01	0.2278E 01	0.1827E 01
105	0.3221E 01	0.2287E 01	0.3077E 01	0.2734E 01	0.2807E 01	0.3441E 01	0.3541E 01	0.3099E 01	0.2375E 01	0.1950E 01
120	0.6014E 00	0.1044E 01	0.2004E 01	0.2794E 01	0.3125E 01	0.3248E 01	0.3298E 01	0.2719E 01	0.2107E 01	0.1699E 01
135	-0.9495E 00	0.9148E-01	0.1130E 01	0.1822E 01	0.2244E 01	0.2573E 01	0.2583E 01	0.2116E 01	0.1552E 01	0.1174E 01
150	-0.7002E 01	0.8628E 00	0.2913E-01	0.7864E 00	0.1286E 01	0.1732E 01	0.1738E 01	0.1321E 01	0.8260E 00	0.4982E 00
165	-0.2429E 01	0.1658E 01	0.9457E 00	0.2141E 00	0.4652E 00	0.8273E 00	0.8285E 00	0.4774E 00	0.7923E-01	-0.1679E 00
180	-0.3950E 01	0.2294E 01	0.1697E 01	0.9960E 00	-0.3127E 00	-0.2889E-01	-0.1494E-01	-0.2749E 00	-0.5345E 00	-0.6729E 00
195	-0.3598E 01	0.2791E 01	0.2401E 01	0.1582E 01	0.1801E 01	0.7828E 00	0.7304E 00	-0.8453E 00	-0.9352E 00	-0.9355E 00
210	-0.3808E 01	0.3949E 01	0.2579E 01	0.1955E 01	-0.1842E 01	-0.1452E 01	-0.1358E 01	-0.1294E 01	-0.1150E 01	-0.9709E 00
225	-0.2895E 01	0.2689E 01	0.2395E 01	0.2191E 01	-0.2082E 01	-0.1973E 01	-0.1834E 01	-0.1561E 01	-0.1138E 01	-0.8275E 00
240	-0.2412E 01	0.2090E 01	0.2154E 01	0.2317E 01	-0.2425E 01	-0.2415E 01	-0.2189E 01	-0.1642E 01	-0.1033E 01	-0.4433E 00
255	-0.2021E 01	0.1901E 01	0.2174E 01	0.2534E 01	-0.2742E 01	-0.2734E 01	-0.2497E 01	-0.1723E 01	-0.9035E 00	-0.1672E 00
270	-0.2045E 01	0.1951E 01	0.2296E 01	0.2738E 01	-0.2907E 01	-0.2938E 01	-0.2549E 01	-0.1748E 01	-0.4551E 00	-0.1290E 00
285	-0.1798E 01	0.1739E 01	0.2288E 01	0.2764E 01	-0.3043E 01	-0.3028E 01	-0.2638E 01	-0.1160E 01	-0.4486E 00	-0.1487E 00
300	-0.1649E 01	0.1649E 01	0.2188E 01	0.2699E 01	-0.2807E 01	-0.2800E 01	-0.2672E 01	-0.1289E 01	-0.6532E 00	-0.2701E 00
315	-0.1614E 01	0.1798E 01	0.2197E 01	0.2639E 01	-0.2872E 01	-0.2874E 01	-0.2672E 01	-0.1390E 01	-0.9153E 00	-0.5875E 00
330	-0.1299E 01	0.1727E 01	0.2251E 01	0.2488E 01	-0.2548E 01	-0.2559E 01	-0.2409E 01	-0.1940E 01	-0.1072E 01	-0.8977E 00
345	-0.6861E 00	-0.1677E 01	-0.1833E 01	-0.1864E 01	-0.1961E 01	-0.1978E 01	-0.1959E 01	-0.1934E 01	-0.1822E 01	-0.9772E 00
AMPL	4.8022E 00	3.9865E 00	3.8130E 00	3.8264E 00	3.7019E 00	3.4708E 00	3.1632E 00	2.4712E 00	1.9927E 00	1.5995E 00
STAY	2.8050E 01	4.8907E 01	4.4510E 01	6.9932E 00	6.2649E 00	5.6132E 00	1.7284E 00	5.9448E-01	8.4133E-03	-1.5530E-01
BAYL	9.645993	9.645993	19.331985	19.331970	19.331985	19.331970	19.331985	19.331985	9.665901	5.799401

ITERATION NO. 10

BAY AERODYNAMIC VIBRATORY PITCHING MOMENT ABOUT PITCH AXIS PER UNIT LENGTH

291	RAD. 0.975	RAD. 0.925	RAD. 0.850	RAD. 0.750	RAD. 0.650	RAD. 0.550	RAD. 0.450	RAD. 0.350	RAD. 0.275	RAD. 0.235
292	0.3100E 01	0.1513E 01	0.1041E 01	0.1229E 01	0.1144E 01	0.5511E 00	0.4172E 00	0.1098E 01	0.2631E 01	0.3259E 01
293	0.1162E 01	0.8208E 00	0.1537E 00	0.4908E 00	0.8817E 00	0.4130E 00	0.1293E 00	0.2667E 00	0.9647E 00	0.1849E 01
30	-0.2178E 01	-0.8861E 00	-0.5592E 00	-0.1554E 00	-0.1885E 00	-0.2535E 00	-0.3324E 00	-0.5155E 00	-0.4428E 00	0.2260E 00
45	-0.4378E 01	-0.2881E 01	-0.1106E 01	-0.7980E 00	-0.2573E 00	-0.6477E 01	-0.3663E 00	-0.8752E 00	-0.9080E 00	-0.1206E 01
40	-0.6346E 01	-0.4208E 01	-0.2280E 01	-0.1326E 01	-0.5689E 00	-0.3057E 00	-0.4024E 00	-0.1188E 01	-0.1120E 01	-0.9387E 00
79A1	0.0802E 01	0.4544E 01	0.2780E 01	0.1530E 01	0.8308E 00	0.4704E 00	0.5304E 00	0.1222E 01	-0.1531E 01	-0.1423E 01
79	0.8917E 01	0.3807E 01	0.2711E 01	0.1660E 01	0.9532E 00	0.5663E 00	0.6249E 00	0.1267E 01	-0.1772E 01	-0.1773E 01
120	-0.3737E 01	-0.2943E 01	-0.2570E 01	-0.1752E 01	-0.1048E 01	-0.6253E 00	-0.6435E 00	-0.1348E 01	-0.1821E 01	-0.1941E 01
135	-0.2790E 01	-0.2701E 01	-0.2404E 01	-0.1702E 01	-0.9956E 00	-0.5873E 00	-0.5810E 00	-0.1412E 01	-0.1915E 01	-0.2078E 01
150	-0.1949E 01	-0.1772E 01	-0.1573E 01	-0.1123E 01	-0.7882E 00	-0.3662E 00	-0.5810E 00	-0.1457E 01	-0.1897E 01	-0.2021E 01
165	-0.1397E 00	-0.7979E 00	-0.1230E 01	-0.8142E 00	-0.5284E 00	-0.1573E 00	-0.2584E 00	-0.1550E 01	-0.1838E 01	-0.1833E 01
180	1.0999E 01	0.3259E 00	0.8352E 00	0.4243E 00	0.3976E 01	0.6311E 00	0.1034E 01	0.1387E 01	-0.1157E 01	-0.1470E 01
195	0.8164E 01	0.8185E 00	0.4840E 00	0.2540E 00	0.1187E 00	0.5433E 00	0.9784E 00	0.1002E 01	-0.1017E 00	-0.9955E 00
210	0.1892E 01	0.3998E 00	0.2404E 00	0.8081E 01	0.4044E 00	0.5834E 00	0.7272E 00	0.5091E 00	-0.3384E 00	-0.3800E 00
225	0.2259E 01	0.7782E 00	0.4162E 01	0.2193E 00	0.4761E 00	0.4763E 00	0.3761E 00	0.1735E 00	-0.1232E 00	0.3137E 01
240	0.2832E 01	0.1362E 01	0.5379E 00	0.1808E 00	0.3337E 00	0.2379E 00	0.8371E 02	0.7151E 01	0.2281E 00	0.4187E 00
255	0.8829E 01	0.8249E 01	0.1982E 01	0.1982E 00	0.2491E 01	0.2965E 01	0.2984E 00	0.3847E 00	0.8052E 00	0.6855E 00
270	0.8743E 01	0.3197E 01	0.2647E 01	0.1031E 01	0.4211E 01	0.3030E 00	0.6722E 00	0.7430E 00	0.7977E 00	0.9014E 00
285	0.4854E 01	0.3871E 01	0.3284E 01	0.1528E 01	0.4877E 00	0.5015E 00	0.1383E 01	0.2095E 01	0.1568E 01	0.1222E 01
300	0.4919E 01	0.3903E 01	0.3544E 01	0.2044E 01	0.9195E 00	0.6756E 00	0.1756E 01	0.2597E 01	0.1864E 01	0.1343E 01
315	0.5293E 01	0.3954E 01	0.3322E 01	0.2527E 01	0.1146E 01	0.8303E 00	0.1770E 01	0.3156E 01	0.2348E 01	0.1695E 01
330	0.4851E 01	0.3663E 01	0.2800E 01	0.2652E 01	0.1246E 01	0.1052E 01	0.1428E 01	0.3282E 01	0.2740E 01	0.2290E 01
345	0.3872E 01	0.2587E 01	0.1959E 01	0.1944E 01	0.1402E 01	0.8271E 00	0.5549E 00	0.2298E 01	0.3333E 01	0.2761E 01
AMP 7.0	0.8838E 00	0.4249E 00	0.1488E 00	0.8402E 00	0.1224E 00	0.3879E 01	0.2215E 00	0.4181E 00	0.2424E 00	0.6483E 00
STDY	-0.0357E 00	-0.4329E 00	-0.3105E 00	-0.9182E 00	-0.6599E 00	-0.2157E 00	-1.5055E 00	-7.3777E 01	-3.0378E 01	-8.8180E 02

AERODYNAMIC FORCE CALCULATION

STATION 1		X/R=0.975		MACH		PHI		PSI		MACH		PHI		PSI		T		L						
PSI	ETA	ALPHA	L	D	M	U	DFX	U	DFX	L	D	M	L	D	M	U	DFX	L	D	M				
0	-4.27204E 00	6.26241E-01	2.25787E 02	2.26780E 02	180	-2.94378E 00	6.28183E-01	1.89966E 02	1.90461E 02	6.16301E 00	-5.02595E-02	6.42016E 03	1.45314E 01	4.75631E 00	6.16301E 00	-5.02595E-02	6.42016E 03	1.45314E 01	4.75631E 00	6.16301E 00	-5.02595E-02	6.42016E 03	1.45314E 01	4.75631E 00
7.77466E 00	-2.26762E-02	8.39413E 03	2.17437E 01	4.86711E 00	3.21923E 00	9.77358E-01	-1.08901E 01	-4.77212E 01	-2.84862E-01	3.21923E 00	9.77358E-01	-1.08901E 01	-4.77212E 01	-2.84862E-01	3.21923E 00	9.77358E-01	-1.08901E 01	-4.77212E 01	-2.84862E-01	3.21923E 00	9.77358E-01	-1.08901E 01	-4.77212E 01	-2.84862E-01
15	-3.91083E 00	6.64395E-01	2.40371E 02	2.41375E 02	195	-3.00674E 00	5.90127E-01	1.86222E 02	1.86699E 02	6.74917E 00	-4.82237E-02	7.91007E 03	1.39845E 01	4.19724E 00	6.74917E 00	-4.82237E-02	7.91007E 03	1.39845E 01	4.19724E 00	6.74917E 00	-4.82237E-02	7.91007E 03	1.39845E 01	4.19724E 00
2.09039E 00	-2.06954E-02	8.96555E 03	2.29189E 01	6.47131E 00	3.74243E 00	9.18096E-01	-1.09757E 01	-4.34489E 01	-2.23650E 01	3.74243E 00	9.18096E-01	-1.09757E 01	-4.34489E 01	-2.23650E 01	3.74243E 00	9.18096E-01	-1.09757E 01	-4.34489E 01	-2.23650E 01	3.74243E 00	9.18096E-01	-1.09757E 01	-4.34489E 01	-2.23650E 01
3.18790E 00	1.03265E 00	-1.35751E 01	-4.71071E 01	-6.37501E 01	210	-3.17744E 00	5.54530E-01	1.87032E 02	1.87519E-02	210	-3.17744E 00	5.54530E-01	1.87032E 02	1.87519E-02	210	-3.17744E 00	5.54530E-01	1.87032E 02	1.87519E-02	210	-3.17744E 00	5.54530E-01	1.87032E 02	1.87519E-02
8.59949E 00	-6.83380E-02	9.38280E 03	2.53400E 01	9.51785E 00	7.59834E 00	-4.70852E-02	7.43292E 03	1.39722E 01	3.58374E 00	7.59834E 00	-4.70852E-02	7.43292E 03	1.39722E 01	3.58374E 00	7.59834E 00	-4.70852E-02	7.43292E 03	1.39722E 01	3.58374E 00	7.59834E 00	-4.70852E-02	7.43292E 03	1.39722E 01	3.58374E 00
2.94467E 00	1.08839E 00	-1.35893E 01	-7.9393E 01	-7.45010E 01	4.42087E 00	8.62577E-01	-1.10183E 01	-4.00558E 01	-1.65534E 01	4.42087E 00	8.62577E-01	-1.10183E 01	-4.00558E 01	-1.65534E 01	4.42087E 00	8.62577E-01	-1.10183E 01	-4.00558E 01	-1.65534E 01	4.42087E 00	8.62577E-01	-1.10183E 01	-4.00558E 01	-1.65534E 01
45	-3.33558E 00	7.30621E-01	2.59626E 02	2.60819E 02	225	-3.48961E 00	5.23889E-01	1.91006E 02	1.91550E 02	4.08831E 00	-6.62272E-02	9.79325E 03	1.47481E 01	3.09466E 00	4.08831E 00	-6.62272E-02	9.79325E 03	1.47481E 01	3.09466E 00	4.08831E 00	-6.62272E-02	9.79325E 03	1.47481E 01	3.09466E 00
2.78328E 00	-1.13631E-06	-1.38260E 01	-1.00658E 03	-9.45557E 01	5.32173E 00	8.14655E-01	-1.10209E 01	-3.65089E 01	-1.20699E 01	5.32173E 00	8.14655E-01	-1.10209E 01	-3.65089E 01	-1.20699E 01	5.32173E 00	8.14655E-01	-1.10209E 01	-3.65089E 01	-1.20699E 01	5.32173E 00	8.14655E-01	-1.10209E 01	-3.65089E 01	-1.20699E 01
60	-3.16082E 00	7.54135E-01	2.89119E 02	2.70383E 02	240	-3.91584E 00	5.00334E-01	1.95867E 02	1.96505E 02	9.99469E 00	-5.92311E-02	6.70648E 03	1.60495E 01	2.6589E 00	9.99469E 00	-5.92311E-02	6.70648E 03	1.60495E 01	2.6589E 00	9.99469E 00	-5.92311E-02	6.70648E 03	1.60495E 01	2.6589E 00
9.79999E 00	-5.47808E-02	1.01884E 04	3.93377E 01	1.54275E 01	6.01085E 00	7.77653E-01	-1.10969E 01	-3.05141E 01	-7.72440E 00	6.01085E 00	7.77653E-01	-1.10969E 01	-3.05141E 01	-7.72440E 00	6.01085E 00	7.77653E-01	-1.10969E 01	-3.05141E 01	-7.72440E 00	6.01085E 00	7.77653E-01	-1.10969E 01	-3.05141E 01	-7.72440E 00
2.61448E 00	1.17308E 00	-1.28727E 01	-1.19668E 02	-1.11446E 02	75	-3.08625E 00	7.68880E-01	2.77579E 02	2.78918E 02	5.97609E 00	-6.44991E-02	1.03074E 04	3.23988E 01	1.74071E 01	5.97609E 00	-6.44991E-02	1.03074E 04	3.23988E 01	1.74071E 01	5.97609E 00	-6.44991E-02	1.03074E 04	3.23988E 01	1.74071E 01
2.48976E 00	1.19626E 00	-1.25490E 01	-1.44194E 02	-1.35656E 02	90	-3.07927E 00	7.74143E-01	2.67637E 02	2.68925E 02	5.40011E 00	-6.47854E-02	1.03766E 04	3.11569E 01	1.67351E 01	5.40011E 00	-6.47854E-02	1.03766E 04	3.11569E 01	1.67351E 01	5.40011E 00	-6.47854E-02	1.03766E 04	3.11569E 01	1.67351E 01
2.33084E 00	1.20430E 00	-1.17629E 01	-1.40666E 02	-1.31637E 02	105	-3.08073E 00	7.69267E-01	2.68604E 02	2.69764E 02	9.31856E 00	-6.44079E-02	1.03113E 04	3.02831E 01	1.48815E 01	9.31856E 00	-6.44079E-02	1.03113E 04	3.02831E 01	1.48815E 01	9.31856E 00	-6.44079E-02	1.03113E 04	3.02831E 01	1.48815E 01
2.23084E 00	1.19671E 00	-1.10475E 01	-1.22862E 02	-1.11964E 02	120	-3.04037E 00	7.54709E-01	2.23506E 02	2.24506E 02	5.20374E 00	-6.27720E-02	1.01161E 04	2.46897E 01	1.27219E 01	5.20374E 00	-6.27720E-02	1.01161E 04	2.46897E 01	1.27219E 01	5.20374E 00	-6.27720E-02	1.01161E 04	2.46897E 01	1.27219E 01
2.24337E 00	1.17409E 00	-1.02991E 01	-9.44659E 01	-8.2221E 01	135	-3.02346E 00	7.31502E-01	2.06697E 02	2.09266E 02	5.37323E 00	-6.01085E-02	9.80505E 03	2.19932E 01	1.09553E 01	5.37323E 00	-6.01085E-02	9.80505E 03	2.19932E 01	1.09553E 01	5.37323E 00	-6.01085E-02	9.80505E 03	2.19932E 01	1.09553E 01
2.34077E 00	1.13802E 00	-1.00816E 01	-8.53101E 01	-7.15678E 01	150	-2.98745E 00	7.01283E-01	1.98761E 02	1.99478E 02	5.80934E 00	-6.49394E-02	9.39999E 03	1.89934E 01	8.54969E 00	5.80934E 00	-6.49394E-02	9.39999E 03	1.89934E 01	8.54969E 00	5.80934E 00	-6.49394E-02	9.39999E 03	1.89934E 01	8.54969E 00
2.51790E 00	1.09105E 00	-1.01641E 01	-7.73729E 01	-6.26268E 01	165	-2.95087E 00	6.66064E-01	1.92962E 02	1.93334E 02	5.74371E 00	-5.34185E-02	8.92792E 03	1.60959E 01	6.14086E 00	5.74371E 00	-5.34185E-02	8.92792E 03	1.60959E 01	6.14086E 00	5.74371E 00	-5.34185E-02	8.92792E 03	1.60959E 01	6.14086E 00
2.76285E 00	1.03624E 00	-1.09109E 01	-8.15856E 01	-4.43242E 01	2.76285E 00	1.03624E 00	-1.09109E 01	-8.15856E 01	-4.43242E 01	2.76285E 00	1.03624E 00	-1.09109E 01	-8.15856E 01	-4.43242E 01	2.76285E 00	1.03624E 00	-1.09109E 01	-8.15856E 01	-4.43242E 01	2.76285E 00	1.03624E 00	-1.09109E 01	-8.15856E 01	-4.43242E 01

Similar output for stations 2 to 10

STA	K=0	FXN	1	2	3	4	5	6	7	8	9	10
RADIAL COMPONENT OF THRUST (LBS)												
1	-1.1740E 01	-1.3666E 00	-1.8009E-01	1.9694E-01	-1.0025E-01	4.5845E-03	3.8365E-03	1.5202E-02	3.6887E-03	5.602E-03	3.255E-02	3.255E-02
		-9.3933E-02	-5.2542E-01	-3.6883E-03	-1.0754E-02	-8.0188E-02	-4.0488E-02	-1.2337E-02	2.2761E-04	2.533E-03	2.085E-03	2.085E-03
2	-2.1501E 01	-2.3830E 00	-3.7674E-01	4.0377E-01	-7.0545E-02	6.4965E-03	-3.3182E-02	3.0485E-02	1.8476E-02	4.083E-03	4.423E-02	4.423E-02
		-3.5559E-01	-9.9501E-01	-2.2386E-01	-9.0760E-02	-1.1094E-01	-8.4108E-02	-1.3900E-02	4.8516E-03	5.441E-03	1.150E-02	1.150E-02
3	-3.6665E 01	-3.4315E 00	-3.0938E-01	7.7082E-01	1.1081E-01	6.2140E-03	-9.4418E-02	5.4302E-02	-1.2487E-03	1.951E-03	-7.377E-02	-7.377E-02
		-1.9077E 00	-1.7440E 00	-5.9905E-01	-9.2375E-02	-1.7676E-01	-1.4407E-01	-1.7695E-02	1.0788E-02	2.301E-03	1.908E-02	1.908E-02
4	-4.6561E 01	-3.5383E 00	-3.1724E-02	1.0012E 00	2.3522E-01	-8.0604E-03	-1.1442E-01	7.1636E-02	1.1012E-02	4.931E-03	-7.739E-02	-7.739E-02
		-4.3906E 00	-2.2181E 00	-7.2662E-01	-5.8973E-02	-1.9823E-01	-1.7542E-01	5.6434E-04	1.8231E-02	1.762E-02	2.216E-02	2.216E-02
5	-5.2458E 01	-2.1595E 00	1.9591E-01	1.1174E 00	2.7133E-01	-1.7815E-02	-1.3730E-01	8.6519E-02	1.5204E-02	1.042E-02	-7.100E-02	-7.100E-02
		-7.2639E 00	-2.8703E 00	-7.9259E-01	-4.2963E-02	-2.1143E-01	-1.8675E-01	-2.7864E-03	2.2896E-02	1.725E-02	2.220E-02	2.220E-02
6	-5.5608E 01	-2.4021E 00	4.3560E-01	1.1756E 00	3.2121E-01	-2.3635E-02	-1.3567E-01	9.1494E-02	1.8028E-02	1.493E-02	-6.371E-02	-6.371E-02
		-1.0129E 01	-2.5465E 00	-9.0579E-01	-4.9590E-02	-2.1237E-01	-1.9101E-01	-6.2036E-04	2.4944E-02	1.833E-02	1.956E-02	1.956E-02
7	-5.7013E 01	-2.0391E 00	8.4425E-01	1.1978E 00	3.6099E-01	-2.2522E-02	-1.3361E-01	9.3474E-02	1.9996E-02	1.681E-02	-5.844E-02	-5.844E-02
		-1.2670E 01	-2.4918E 00	-1.0038E 00	-6.8820E-02	-1.5918E-01	-1.9264E-01	1.1730E-03	2.6047E-02	1.836E-02	1.787E-02	1.787E-02
8	-5.7432E 01	-1.6223E 00	1.6808E 00	1.2804E 00	4.3902E-01	-3.9950E-02	-1.5909E-01	8.8886E-02	1.9655E-02	4.716E-04	-7.111E-02	-7.111E-02
		-1.4432E 01	-2.2664E 00	-1.0747E 00	-1.4504E-01	-2.2874E-01	-1.9602E-01	1.1566E-02	2.1589E-02	1.511E-02	3.459E-02	3.459E-02
9	-5.7441E 01	-1.4802E 00	1.8348E 00	1.2892E 00	4.5961E-01	-2.5589E-02	-1.4560E-01	1.0295E-01	2.8649E-02	1.177E-02	-5.401E-02	-5.401E-02
		-1.4968E 01	-2.1325E 00	-1.0799E 00	-1.4701E-01	-2.0424E-01	-1.7589E-01	1.7773E-02	2.4830E-02	2.430E-02	3.900E-02	3.900E-02
10	-5.7409E 01	-1.4159E 00	2.0431E 00	1.2721E 00	4.6432E-01	-2.6832E-02	-1.5709E-01	9.1956E-02	2.3334E-02	5.341E-03	-6.135E-02	-6.135E-02
		-1.5178E 01	-2.0621E 00	-1.0731E 00	-1.4022E-01	-1.9579E-01	-1.7137E-01	2.4402E-02	2.9033E-02	2.707E-02	4.159E-02	4.159E-02

Similar output for DEL T, DEL H and DEL Q

COMPREHENSIVE ROTOR ANALYSIS
FORCE CALCULATION

ITERATION NO. 10

RESULTANT THRUST

STA	HARMONIC	1	2	3	4	5	6	7	8	9	10					
1	3.64503E	01	1.69037E	01	3.21245E	00	2.53629E	00	8.23606E-01	4.18713E-01	1.27594E-01	1.49040E-01	6.51406E-01			
2	3.19773E	01	1.33784E	01	3.93108E	00	2.77124E	00	1.03342E	00	4.27586E-01	3.42668E-01	3.24938E-02	2.77165E-01		
3	6.57186E	01	2.57133E	01	6.36465E	00	2.57123E	00	1.94921E	00	1.59061E	00	5.98085E-01	3.28632E-01	5.87553E-02	5.92623E-01
4	6.86096E	01	2.11322E	01	3.96334E	00	1.56165E	00	9.16479E-01	8.02421E-01	4.86536E-01	3.21123E-01	3.31264E-01	3.31264E-01	1.53869E-01	
5	6.89696E	01	1.47689E	01	2.77872E	00	4.95173E-01	4.22287E-01	5.77907E-01	3.86368E-01	1.65871E-01	9.59660E-02	1.08425E-01	1.08425E-01		
6	6.70475E	01	1.08441E	01	2.00695E	00	8.67388E-01	1.34703E-01	1.49572E-01	1.62012E-01	8.28921E-02	8.27107E-02	1.71879E-01	1.71879E-01		
7	6.13345E	01	1.16099E	01	1.59891E	00	7.47753E-01	4.38422E-01	3.01931E-02	6.60405E-02	3.98692E-02	4.62792E-02	1.29381E-01	1.29381E-01		
8	4.44918E	01	1.63890E	01	3.31840E	00	2.24571E	00	8.31283E-01	6.92318E-01	2.96060E-01	1.24403E-01	4.30463E-01	5.51445E-01		
9	1.41067E	01	9.38770E	00	8.03468E-01	4.89991E-01	6.75072E-01	6.44912E-01	4.04155E-01	2.46200E-01	1.87499E-01	3.82464E-01	4.71473E-01	4.71473E-01		
10	5.65494E	00	5.56390E	00	2.63799E-01	3.03735E-01	2.25809E-01	3.37962E-01	3.52393E-01	1.86411E-01	1.86411E-01	1.86411E-01	2.07519E-01	2.07519E-01		

Similar output for Resultant Drag

COMPREHENSIVE ROTOR ANALYSIS
15 STATION CORIOLIS FORCE CALCULATION

ITERATION NO. 10

X = RADIAL FORESHORTENING DUE TO FLAP MOTION (IM) POSITIVE TOWARD TIP

PSI	STA. 1	STA. 2	STA. 3	STA. 4	STA. 5	STA. 6	STA. 7	STA. 8	STA. 9	STA. 10
0	-2.4166E-01	-2.2409E-01	-1.9747E-01	-1.6229E-01	-1.2991E-01	-1.0174E-01	-7.7720E-02	-5.7339E-02	-4.4341E-02	-3.8104E-02
15	-2.2942E-01	-2.1323E-01	-1.8836E-01	-1.5535E-01	-1.2489E-01	-9.8370E-02	-7.5673E-02	-5.6242E-02	-4.3699E-02	-3.7631E-02
30	-2.1847E-01	-2.0354E-01	-1.7794E-01	-1.4733E-01	-1.1923E-01	-9.4443E-02	-7.3209E-02	-5.4901E-02	-4.2948E-02	-3.7096E-02
45	-2.0161E-01	-1.8827E-01	-1.6794E-01	-1.4045E-01	-1.1443E-01	-9.1424E-02	-7.1518E-02	-5.4152E-02	-4.2611E-02	-3.6879E-02
60	-1.8972E-01	-1.7794E-01	-1.5996E-01	-1.3549E-01	-1.1107E-01	-9.0465E-02	-7.1508E-02	-5.4616E-02	-4.3125E-02	-3.7314E-02
75	-1.8290E-01	-1.7235E-01	-1.5435E-01	-1.3421E-01	-1.1247E-01	-9.2133E-02	-7.3548E-02	-5.6488E-02	-4.4560E-02	-3.8435E-02
90	-1.8020E-01	-1.7344E-01	-1.5842E-01	-1.3749E-01	-1.1646E-01	-9.6251E-02	-7.7282E-02	-5.9444E-02	-4.6710E-02	-4.0095E-02
105	-1.8170E-01	-1.8131E-01	-1.6596E-01	-1.4457E-01	-1.2295E-01	-1.0195E-01	-8.1936E-02	-6.2854E-02	-4.9081E-02	-4.1896E-02
120	-1.8485E-01	-1.9391E-01	-1.7718E-01	-1.5405E-01	-1.3066E-01	-1.0803E-01	-8.6505E-02	-6.5956E-02	-5.1136E-02	-4.3433E-02
135	-2.2078E-01	-2.0825E-01	-1.8986E-01	-1.6431E-01	-1.3841E-01	-1.1353E-01	-9.0097E-02	-6.8028E-02	-5.2358E-02	-4.4309E-02
150	-2.3592E-01	-2.2745E-01	-2.0197E-01	-1.7406E-01	-1.4476E-01	-1.1748E-01	-9.2152E-02	-6.8766E-02	-5.2566E-02	-4.4396E-02
165	-2.4838E-01	-2.3451E-01	-2.1123E-01	-1.7947E-01	-1.4823E-01	-1.1903E-01	-9.2368E-02	-6.8268E-02	-5.1970E-02	-4.3890E-02
180	-2.5924E-01	-2.4232E-01	-2.1659E-01	-1.8105E-01	-1.4944E-01	-1.1794E-01	-9.0800E-02	-6.6770E-02	-5.0818E-02	-4.2994E-02
195	-2.6899E-01	-2.4444E-01	-2.1747E-01	-1.8095E-01	-1.4625E-01	-1.1511E-01	-8.7946E-02	-6.4443E-02	-4.9151E-02	-4.1725E-02
210	-2.7798E-01	-2.4144E-01	-2.1419E-01	-1.7745E-01	-1.4237E-01	-1.1144E-01	-8.4595E-02	-6.1780E-02	-4.7235E-02	-4.0250E-02
225	-2.8598E-01	-2.3668E-01	-2.0832E-01	-1.7249E-01	-1.3810E-01	-1.0747E-01	-8.1331E-02	-5.9435E-02	-4.5637E-02	-3.9078E-02
240	-2.9459E-01	-2.2786E-01	-2.0228E-01	-1.6733E-01	-1.3368E-01	-1.0384E-01	-7.8623E-02	-5.7706E-02	-4.4586E-02	-3.8299E-02
255	-3.0405E-01	-2.2382E-01	-1.9420E-01	-1.6335E-01	-1.3016E-01	-1.0110E-01	-7.6732E-02	-5.6588E-02	-4.3886E-02	-3.7744E-02
270	-3.1473E-01	-2.2343E-01	-1.9708E-01	-1.6198E-01	-1.2832E-01	-9.9520E-02	-7.5547E-02	-5.5809E-02	-4.3440E-02	-3.7474E-02
285	-3.2338E-01	-2.2562E-01	-1.9858E-01	-1.6217E-01	-1.2821E-01	-9.9058E-02	-7.5093E-02	-5.5571E-02	-4.3328E-02	-3.7393E-02
300	-3.2778E-01	-2.2944E-01	-2.0162E-01	-1.6426E-01	-1.2952E-01	-9.9855E-02	-7.5597E-02	-5.5907E-02	-4.3561E-02	-3.7570E-02
315	-3.2778E-01	-2.3315E-01	-2.0457E-01	-1.6658E-01	-1.3160E-01	-1.0165E-01	-7.6892E-02	-5.6613E-02	-4.3918E-02	-3.7809E-02
330	-3.2523E-01	-2.3439E-01	-2.0585E-01	-1.6802E-01	-1.3318E-01	-1.0316E-01	-7.8118E-02	-5.7331E-02	-4.4388E-02	-3.8153E-02
345	-3.2493E-01	-2.3154E-01	-2.0348E-01	-1.6684E-01	-1.3286E-01	-1.0339E-01	-7.8516E-02	-5.7731E-02	-4.4633E-02	-3.8349E-02

Similar output for C

COMPREHENSIVE ROTOR ANALYSIS
15 STATION CORIOLIS FORCE CALCULATION

XK = RADIAL FORESHORTENING DUE TO FLAP MOTION (IN)

POSITIVE TOWARD TIP

	STA. 1	STA. 2	STA. 3	STA. 4	STA. 5	STA. 6	STA. 7	STA. 8	STA. 9	STA. 10
STBY	-2.3124E-01	-2.1507E-01	-1.9233E-01	-1.6089E-01	-1.3072E-01	-1.0368E-01	-8.0137E-02	-5.9699E-02	-4.6238E-02	-3.9599E-02
COS 1	7.7421E-03	8.5941E-03	9.3300E-03	1.0137E-02	1.0040E-02	9.0144E-03	7.3510E-03	5.3014E-03	3.6315E-03	2.7431E-03
SIN 1	-1.8224E-02	-2.5022E-02	-1.9428E-02	-1.2128E-02	-8.4300E-03	-5.9420E-03	-1.0572E-03	-1.9849E-03	-1.7516E-03	-1.3976E-03
COS 2	4.6842E-03	4.6614E-03	4.6354E-03	4.5997E-03	4.4495E-03	4.0976E-03	3.5298E-03	2.7391E-03	1.9817E-03	1.5250E-03
SIN 2	9.4622E-04	6.4822E-04	2.0241E-04	-3.5273E-04	-7.3417E-04	-8.7946E-04	-8.1931E-04	-6.2198E-04	-4.3559E-04	-3.3545E-04
COS 3	6.6911E-04	4.8941E-04	2.5844E-04	6.9896E-05	-1.2611E-05	-9.7707E-05	-1.5331E-04	-1.4554E-04	-1.0209E-04	-7.3783E-05
SIN 3	7.4317E-05	1.0789E-04	1.3969E-04	7.7774E-05	-7.2703E-05	-1.7544E-04	-1.8855E-04	-1.4141E-04	-9.5451E-05	-7.4127E-05
COS 4	-5.9478E-04	-4.0767E-04	-1.3973E-04	1.2741E-04	2.1342E-04	1.6738E-04	7.2946E-05	9.7426E-06	-3.0800E-05	-2.6771E-05
SIN 4	1.8342E-04	1.0682E-04	4.1789E-05	-1.6615E-05	-2.3645E-05	-1.5246E-04	2.0741E-05	2.8237E-05	2.4558E-05	2.0138E-05
COS 5	6.3737E-04	3.3050E-04	1.7742E-04	2.6910E-05	-2.6342E-05	-1.7290E-05	1.2810E-05	2.9959E-05	3.4090E-05	3.1364E-05
SIN 5	6.3263E-05	4.2203E-05	1.5983E-05	1.6039E-05	3.6044E-05	3.5453E-05	1.2516E-05	-1.6862E-05	-2.3321E-05	-2.0271E-05
COS 6	-3.9479E-05	5.3252E-05	8.1489E-05	1.0343E-05	6.3864E-05	3.5370E-05	-1.0341E-05	-3.0304E-05	-2.4222E-05	-1.8078E-05
SIN 6	-6.1408E-05	-2.6142E-05	-1.6938E-05	-1.3932E-05	-1.7211E-05	-1.6296E-05	-7.5223E-06	4.1298E-06	8.9236E-06	8.0171E-06
COS 7	2.5685E-05	-1.2664E-05	3.2379E-06	1.4330E-05	6.2635E-06	-9.640E-06	-1.0421E-05	-2.4835E-07	6.0368E-06	6.2274E-06
SIN 7	8.6291E-06	1.6342E-06	-4.2717E-06	-7.4685E-06	-3.3279E-06	1.0381E-06	1.6143E-06	-2.3966E-07	4.5573E-07	1.2434E-06
COS 8	-1.0179E-05	-7.8933E-06	4.6591E-06	8.6129E-06	-2.1704E-06	-8.9705E-06	-4.2319E-06	4.2145E-06	9.1844E-06	9.2645E-06
SIN 8	4.1987E-05	9.5944E-06	-6.2684E-06	-6.1991E-06	2.6921E-06	2.5902E-06	-1.2682E-06	-2.1365E-06	1.5376E-06	2.8741E-06
COS 9	2.2774E-05	1.9504E-05	1.4380E-05	9.0152E-06	4.7833E-06	-2.1855E-06	-5.0416E-06	-7.1650E-07	6.2461E-06	7.4838E-06
SIN 9	1.7941E-05	5.4389E-06	-9.7503E-06	-9.8596E-06	7.8877E-06	1.0130E-05	-1.2113E-06	-5.8314E-06	-3.9088E-06	-3.0454E-06

COMPREHENSIVE ROTOR ANALYSIS ITERATION NO. 10

PSI	STA 1	2	3	4	CL VALUES	5	6	7	8	9	10
0	0.5303766	0.4826893	0.4146039	0.3354146	0.2642149	0.1749769	0.0466083	-0.1612621	-0.4277620	-0.3220495	
15	0.5011169	0.4420116	0.4019180	0.3311042	0.2732249	0.2091801	0.1189302	-0.0242471	-0.1988466	-0.3357927	
30	0.4729083	0.4420745	0.3938448	0.3342432	0.2813244	0.2301671	0.1742113	0.0764281	-0.0399311	-0.1298040	
45	0.4449895	0.4207722	0.3847293	0.3337552	0.2890064	0.2530300	0.2110393	0.1448963	0.0658212	0.0049131	
60	0.4343677	0.4066795	0.3747008	0.3353081	0.2963302	0.2625768	0.2325640	0.1844361	0.1283134	0.0862970	
75	0.4309481	0.3877679	0.3630696	0.3322864	0.2968919	0.2638606	0.2408780	0.2067114	0.1621407	0.1302919	
90	0.4097503	0.3614874	0.3417528	0.3184932	0.2892659	0.2614407	0.2446678	0.2190304	0.1845835	0.1572446	
105	0.3846866	0.3426872	0.3251792	0.3049750	0.2800974	0.2567844	0.2446420	0.2239967	0.1972362	0.1737880	
120	0.3595229	0.3351256	0.3179010	0.2965996	0.2740529	0.2537769	0.2441302	0.2214835	0.1905620	0.1636211	
135	0.3555101	0.3399383	0.3220595	0.2946714	0.2696446	0.2532320	0.2364501	0.2049561	0.1618448	0.1246323	
150	0.3678179	0.3521817	0.3284495	0.2973423	0.2680056	0.2488729	0.2292081	0.1701674	0.1028972	0.0454657	
165	0.3942575	0.3740574	0.3429655	0.3053787	0.2753282	0.2430542	0.1939990	0.1128102	0.0013912	-0.0921264	
180	0.4332404	0.4073787	0.3690840	0.3245033	0.2871257	0.2366364	0.1610848	0.0258422	-0.1617070	-0.3218448	
195	0.4823605	0.4487898	0.4012620	0.3552133	0.3020383	0.2299175	0.1148466	-0.1032415	-0.4224605	-0.7108312	
210	0.5473890	0.5060323	0.4357159	0.3963946	0.3219923	0.2172140	0.0419032	-0.3062302	-0.8611091	-1.4167347	
225	0.6261933	0.5806747	0.5288317	0.4509467	0.3502015	0.2014682	-0.0384684	-0.6029868	-1.5811987	-2.7066355	
240	0.7058206	0.6467987	0.6041542	0.5062286	0.3743517	0.1743927	-0.1828675	-0.9801102	-2.6260319	-3.2049561	
255	0.7671121	0.7241306	0.6531894	0.5399849	0.3844931	0.1438567	-0.2962775	-1.3420954	-3.4003601	-2.0948143	
270	0.7894232	0.7426692	0.6878476	0.5659912	0.3787451	0.1180732	-0.3646814	-1.4900513	-1.5375252	-1.1315327	
285	0.7396449	0.6599764	0.6399764	0.5332193	0.3425534	0.1020332	-0.3654897	-0.5501916	-0.7951809	-0.2166957	
300	0.7495111	0.7016947	0.6230509	0.5005446	0.3386247	0.1020341	-0.3096505	-0.4978380	-1.0058212	-0.2145508	
315	0.685402	0.6331980	0.5595717	0.4479703	0.3053006	0.1031314	-0.2236820	-0.4067099	-0.9118266	-1.2774839	
330	0.6227024	0.5643882	0.4886624	0.3927338	0.2775249	0.1198317	-0.1299329	-0.4874957	-0.6337989	-0.9601991	
345	0.5645940	0.5124087	0.4363625	0.3554096	0.2651187	0.1456807	-0.0320956	-0.3391269	-0.3814902	-0.5870019	

Similar output for CD and CH

AERODYNAMIC PARAMETERS

ALPHA R	V KNOTS	V/R*OMEGA	MU	ALPHA AT 270
-1.30000E-01	1.00000E-02	2.39560E-01	2.29523E-01	6.68260E-00
T S	TAU S	RMP	H	X
4.40000E-03	6.22779E-03	5.03951E-02	9.35974E-01	8.98595E-02
L	X/L	L/DE	L/00251G	X/00251G
9.30820E-03	2.08572E-01	5.80223E-00	1.69977E-00	3.54524E-01
P/00251G	CT/SIG	CTP/SIG	CM/SIG	CP/SIG
6.47475E-01	6.13229E-02	6.00444E-02	1.30447E-03	5.30776E-03
V TIP	SIG	LAMBDA		
-7.18989E-02	7.19870E-02	-6.28595E-02		

COMPREHENSIVE ROTOR ANALYSIS
 ROTOR BLADE FORCED VIBRATIONS
 COUPLED FLAP---LAG---TORSION

ITERATION NO. 10

VZ	K=0	1	2	3	4	5	6	7	8	9	10
STA											
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	2.2500E 02	8.6290E 00	1.8719E 01	-1.6189E 00	1.5262E 00	-9.2991E-01	-6.0818E-01	1.6305E-01	2.0902E-01	1.211E-01	6.869E-03
		-2.9944E 01	-1.0151E 00	-2.6191E 00	2.4066E 00	-1.1214E 00	8.7956E-02	6.0503E-01	-4.6943E-02	-2.111E-01	-2.242E-01
3	4.1312E 02	1.3014E 01	2.7772E 01	-3.2772E 00	4.6932E-01	-9.7298E-01	-3.1097E-02	6.4344E-02	-3.1711E-02	1.448E-01	-8.997E-02
		-5.4597E 01	2.4716E-01	-5.4181E-01	2.8898E 00	-1.7284E 00	3.8032E-01	5.2497E-01	-9.5054E-02	-1.643F-01	-2.203E-01
4	7.0375E 02	7.9326E 00	3.8569E 01	-4.5895E 00	2.8991E 00	-2.8002E-01	6.9501E-01	-8.7938E-02	1.3486E-01	-1.059E-01	4.984E-02
		-8.3892E 01	-1.0620E 00	2.1469E 00	1.6274E 00	-1.1852E 00	8.6439E-02	-2.5337E-01	3.3170E-02	2.997E-01	3.227E-01
5	9.0362E 02	-7.3142E 00	4.4569E 01	-2.9183E 00	-3.6980E 00	7.2593E-01	1.7907E-01	-6.5029E-02	-3.1277E-01	-2.429E-01	-9.072E-02
		-8.9494E 01	-5.7345E 00	7.2184E-01	-5.8215E-01	-1.9371E-01	-6.8666E-01	-9.8396E-01	8.9178E-02	4.188E-02	2.711E-01
6	1.0333E 03	-2.6058E 01	5.0632E 01	8.1278E-01	-1.7599E 00	1.1259E 00	-3.8726E-01	5.0703E-02	-2.2098E-01	-4.307E-02	-1.698E-01
		-7.5931E 01	-1.2534E 01	-9.6523E-01	-2.0377E 00	6.7060E-01	-1.1791E 00	-3.1494E-01	5.4403E-02	-9.726E-02	-2.538E-01
7	1.1104E 03	-4.4901E 01	5.4909E 01	5.0215E 00	3.1377E-01	7.6919E-01	-1.0677E 00	2.5655E-01	1.9317E-01	2.391E-01	1.413E-02
		-4.6713E 01	-2.0956E 01	-8.0148E-01	-2.2519E 00	7.4319E-01	-8.9612E-01	5.8259E-01	-1.8911E-02	-1.374E-01	-3.244E-01
8	1.1494E 03	-6.2067E 01	5.3525E 01	8.6128E 00	2.4535E 00	-1.4045E-01	-1.0516E 00	2.7311E-01	-6.0111E-02	1.923E-01	1.832E-01
		-7.7159E 00	-2.9295E 01	-3.0811E-01	-1.5366E 00	5.2105E-02	-2.4808E-02	9.7356E-01	4.0111E-02	2.283E-02	1.347E-01
9	1.1628E 03	-7.4413E 01	4.3566E 01	8.2884E 00	2.7949E 00	-5.4358E-01	3.8489E-01	1.5770E-01	1.5809E-01	3.061E-01	5.124E-01
		2.6949E 01	-4.1038E 01	1.5894F-01	1.2921E 00	6.1292E-01	8.9948E-01	2.8880E-01	1.7639E-01	3.522E-01	4.153E-02
10	1.1643E 03	-7.8552E 01	3.6333E 01	8.4901E 00	3.1440E 00	-9.9557E-01	2.7049E-01	-4.1547E-01	-2.3984E-01	-2.738E-01	-2.364E-01
		3.9316E 01	-4.6867E 01	-9.1175E-02	1.5417E 00	-4.1612E-01	5.4027E-01	-1.9973E-01	7.6208E-02	1.517E-02	6.575E-02
11	1.1649E 03	-8.0400E 01	3.1815E 01	9.1639E 00	3.5428E 00	-1.0373E 00	7.5944E-01	-1.6150E-01	-1.8204E-01	-2.341E-01	-1.749E-01
		4.4387E 01	-4.9803E 01	-3.2908E-01	1.3988E 00	-8.5903F-01	5.0002E-01	-6.0136E-01	-8.6946E-02	-1.055E-01	4.482E-02
12	1.1630E 03	-8.0948E 01	3.2751E 01	9.7552F 00	3.9630E 00	-1.2387E 00	9.7523E-01	-2.3546E-01	-2.9763E-01	-4.568E-01	-4.227E-01
		4.4418E 01	-5.1189E 01	-3.4095E-01	1.5590E 00	-1.0140E 00	6.6265E-01	-8.4800E-01	-1.3405E-01	-1.902E-01	1.247E-01
13	1.1599E 03	-8.1176E 01	3.3090E 01	9.9747E 00	4.1214E 00	-1.3163E 00	1.0618E 00	-2.6473E-01	3.4601E-01	-5.526E-01	-5.334E-01
		4.4288E 01	-5.1703E 01	-3.4485F-01	1.5340E 00	-1.0770E 00	7.2944E-01	-9.5124E-01	-1.5919E-01	-2.289F-01	1.589E-01
14	1.1348E 03	-8.1281E 01	3.3259E 01	1.0087E 01	4.2030E 00	-1.3587E 00	1.1090E 00	-2.8099E-01	-3.7372E-01	-6.095E-01	-6.014E-01
		4.2928E 01	-5.1973E 01	-3.4427E-01	1.6596E 00	-1.1157E 00	7.6130E-01	-1.0116E 00	-1.6845E-01	-2.536E-01	1.785E-01
15	1.1077E 03	-8.1294E 01	3.3277E 01	1.0099E 01	4.2116E 00	-1.3638E 00	1.1142E 00	-2.8286E-01	-3.7689E-01	-6.163E-01	-6.096E-01
		4.1601E 01	-5.2005E 01	-3.4356E-01	1.4738E 00	-1.1211E 00	7.6589E-01	-1.0190E 00	-1.7019E-01	-2.568F-01	1.809E-01
16	1.1073E 03	-8.1294E 01	3.3277E 01	1.0099E 01	4.2118F 00	-1.3638E 00	1.1142E 00	-2.8286E-01	-3.7689E-01	-6.163E-01	-6.096E-01
		4.1581E 01	-5.2005E 01	-3.4356E-01	1.6738E 00	-1.1211E 00	7.6589E-01	-1.0190E 00	-1.7019E-01	-2.568E-01	1.809E-01
17	1.3738E 03	-1.2094E 02	6.9583E 01	1.4660F 01	5.2339E 00	-3.6072E 00	3.2017E 00	-1.7941E-01	-4.4272E-01	-6.163E-01	-6.074E-01
		1.7062E 02	-4.2474F 01	-6.0638E 00	-2.6732F 00	3.0859F 00	3.6264E 00	-1.6902E 00	-2.9443E-01	-3.485F-01	8.542E-02

Similar output for MY, BETA, Z, MX, THETA, VY, MZ, ZETA, Y

VZ VERTICAL SHEAR IN Z DIRECTION IN UNDEFLECTED BLADE SYSTEM (LBS) POSITIVE UP

PSI	STA	2	3	4	5	6	7	8	9	10						
0	2.62169E	01	3.79618E	01	3.94212E	01	2.39722E	01	1.57447E	01	2.18478E	00	-1.90105E	01	-3.24756E	01
15	1.49471E	01	2.12823E	01	1.60658E	01	-1.04161E	01	-1.70475E	01	-2.42363E	01	-3.81110E	01	-4.83980E	01
30	4.37184E	-01	-1.00053E	-01	-1.31990E	-01	-3.22957E	-01	-4.77602E	-01	-5.49049E	-01	-6.52409E	-01	-8.30746E	-01
45	1.73493E	01	-2.67544E	01	-4.54477E	01	-8.71400E	01	-9.02276E	01	-8.71104E	01	-8.34759E	01	-8.30746E	01
60	3.26566E	01	-5.24160E	01	-8.11808E	01	-1.03028E	02	-1.13268E	02	-1.12144E	02	-9.90983E	01	-8.25422E	01
75	-4.27695E	01	-7.36645E	01	-1.14495E	02	-1.29437E	02	-1.15459E	02	-8.76131E	01	-5.63087E	01	-4.34572E	01
90	-4.58445E	01	-8.36885E	01	-1.28747E	02	-1.38052E	02	-1.28143E	02	-9.92394E	01	-5.78940E	01	-1.38163E	00
105	-4.28351E	01	-7.91857E	01	-1.21329E	02	-1.59429E	02	-1.05104E	02	-6.77320E	01	-1.45440E	01	3.65860E	01
120	-3.78947E	01	-6.64270E	01	-9.49769E	01	-9.34579E	01	-6.92012E	01	-2.66036E	01	-2.88439E	01	8.26016E	01
135	-3.09045E	01	-5.07592E	01	-2.17938E	01	-4.99078E	01	-2.17452E	01	2.07275E	01	1.15772E	02	1.33472E	02
150	-1.87166E	01	-3.01951E	01	-2.79388E	01	-6.91775E	00	2.43060E	01	6.35787E	01	1.02335E	02	1.32270E	02
165	-1.72011E	00	-4.11134E	00	4.87118E	00	5.58202E	01	5.47377E	01	8.92983E	01	1.15938E	02	1.31336E	02
180	1.34884E	01	1.91149E	01	3.36827E	01	5.04505E	01	7.21955E	01	9.29734E	01	1.08443E	02	1.13403E	02
195	2.18036E	01	3.31047E	01	4.99280E	01	6.56503E	01	7.82773E	01	8.56122E	01	8.63699E	01	7.83234E	01
210	2.04493E	01	3.33860E	01	5.35532E	01	6.88614E	01	7.60929E	01	7.25224E	01	5.81317E	01	3.60876E	01
225	1.20609E	01	2.50454E	01	4.98677E	01	6.43371E	01	6.44253E	01	5.00247E	01	2.47608E	01	-5.50960E	00
240	5.35982E	00	1.98749E	01	4.35542E	01	5.36799E	01	4.63762E	01	2.34376E	01	-7.76838E	00	-6.6528E	01
255	6.5243E	00	2.18543E	01	4.14994E	01	4.31667E	01	2.81856E	01	1.78482E	00	-2.88112E	01	-5.69451E	01
270	1.28602E	01	2.92819E	01	4.45943E	01	4.07160E	01	2.20118E	01	-7.46297E	00	-4.13031E	01	-6.87639E	01
285	1.64928E	01	3.56818E	01	5.50176E	01	5.06747E	01	2.72754E	01	-8.51903E	00	-4.72128E	01	-6.64077E	01
300	2.18271E	01	4.26054E	01	6.56644E	01	6.25882E	01	3.76014E	01	1.87473E	-01	-3.89146E	01	-5.54593E	01
315	3.09245E	01	5.04641E	01	6.93504E	01	6.62315E	01	4.80407E	01	1.90047E	01	-1.60886E	01	-3.73337E	01
330	3.40435E	01	5.15220E	01	6.75674E	01	6.66130E	01	5.38140E	01	3.19122E	01	3.91179E	00	-2.28442E	01
345	3.24234E	01	4.72422E	01	5.65509E	01	5.95369E	01	4.82849E	01	3.25324E	01	1.01252E	01	-1.78960E	01
AMPL	3.98440E	01	6.76052E	01	9.90488E	01	1.03450E	02	1.03857E	02	1.04216E	02	1.07518E	02	1.07873E	02
STDY	2.25000E	02	4.13119E	02	7.03747E	02	9.03620E	02	1.33327E	03	1.11035E	03	1.14940E	03	1.16283E	03

PSI	STA	11	12	13	14	15	16	17						
0	-3.69090E	01	-3.61745E	01	-3.59410E	01	-3.58483E	01	-3.58408E	01	-3.58408E	01	-3.58408E	01
15	-5.51481E	01	-5.46924E	01	-5.45334E	01	-5.45130E	01	-5.45130E	01	-5.45130E	01	-5.45130E	01
30	-7.52518E	01	-7.44760E	01	-7.40007E	01	-7.37917E	01	-7.37917E	01	-7.37917E	01	-7.37917E	01
45	-9.47689E	01	-9.4027E	01	-9.34924E	01	-9.31718E	01	-9.29690E	01	-9.29690E	01	-9.29690E	01
60	-7.24831E	01	-7.48440E	01	-7.59037E	01	-7.75811E	01	-7.87649E	01	-7.87649E	01	-7.87649E	01
75	-3.68537E	01	-3.90591E	01	-4.00224E	01	-4.17757E	01	-4.31079E	01	-4.31079E	01	-4.31079E	01
90	1.53136E	01	1.47649E	01	1.44351E	01	1.29777E	01	1.16383E	01	1.16383E	01	1.16383E	01
105	1.16107E	02	1.18023E	02	1.18622E	02	1.17826E	02	1.16722E	02	1.16722E	02	1.16722E	02
120	1.41522E	02	1.43580E	02	1.44247E	02	1.43691E	02	1.42801E	02	1.42801E	02	1.42801E	02
135	1.45694E	02	1.47139E	02	1.47589E	02	1.47171E	02	1.46538E	02	1.46538E	02	1.46538E	02
150	1.39021E	02	1.39050E	02	1.39050E	02	1.39050E	02	1.39050E	02	1.39050E	02	1.39050E	02
165	1.08430E	02	1.10112E	02	1.10729E	02	1.11039E	02	1.11074E	02	1.11074E	02	1.11074E	02
180	6.77953E	01	6.91580E	01	6.97279E	01	7.03704E	01	7.07485E	01	7.07485E	01	7.07485E	01
195	1.82471E	01	1.72600E	01	1.69314E	01	1.73825E	01	1.80188E	01	1.80188E	01	1.80188E	01
210	-2.32165E	01	-2.45727E	01	-2.49812E	01	-2.42828E	01	-2.33873E	01	-2.33873E	01	-2.33873E	01
225	-5.01306E	01	-5.10273E	01	-5.12296E	01	-5.02200E	01	-4.90908E	01	-4.90908E	01	-4.90908E	01
240	-6.58596E	01	-6.63639E	01	-6.64028E	01	-6.61672E	01	-6.38931E	01	-6.38931E	01	-6.38931E	01
255	-7.33913E	01	-7.40411E	01	-7.41214E	01	-7.28514E	01	-7.15322E	01	-7.15322E	01	-7.15322E	01
270	-7.14305E	01	-7.24310E	01	-7.26875E	01	-7.15783E	01	-7.03192E	01	-7.03192E	01	-7.03192E	01
285	-6.06773E	01	-6.02378E	01	-5.99060E	01	-5.85824E	01	-5.74144E	01	-5.74144E	01	-5.74144E	01
300	-4.84558E	01	-4.86672E	01	-4.86433E	01	-4.77329E	01	-4.67995E	01	-4.67995E	01	-4.67995E	01
315	-3.51684E	01	-3.44982E	01	-3.42042E	01	-3.34152E	01	-3.27298E	01	-3.27298E	01	-3.27298E	01
330	-2.82027E	01	-2.60830E	01	-2.52172E	01	-2.44121E	01	-2.40168E	01	-2.40168E	01	-2.40168E	01
345	1.1521E	02	1.17271E	02	1.18041E	02	1.18571E	02	1.18756E	02	1.18756E	02	1.18756E	02
AMPL	1.16488E	03	1.14480E	03	1.15992E	03	1.13480E	03	1.10730E	03	1.10730E	03	1.10730E	03

Similar output for MY, BETA, Z, MX, THETA, VY, MZ, ZETA, Y.

Y - VIBRATORY LAG DEFLECTION IN DISC PLANE SYSTEM (IN)		POSITIVE TOWARD LEADING EDGE									
PSI	STA	2	3	4	5	6	7	8	9	10	
0	4.05961E-03	9.02563E-03	1.35543E-02	1.54590E-02	1.54229E-02	1.39116E-02	1.08932E-02	7.50349E-03	5.42647E-03		
15	1.42026E-01	1.31437E-01	1.15649E-01	9.78098E-02	7.87522E-02	5.94525E-02	6.3070E-02	4.07527E-02	1.89419E-02		
30	2.74240E-01	2.46885E-01	2.11708E-01	1.75110E-01	1.37062E-01	1.01594E-01	6.70114E-02	4.27673E-02	3.04712E-02		
45	3.84824E-01	3.45774E-01	2.93440E-01	2.40539E-01	1.87739E-01	1.36663E-01	8.89131E-02	5.62495E-02	4.02243E-02		
60	4.69770E-01	4.19523E-01	3.52849E-01	2.86849E-01	2.22261E-01	1.60478E-01	1.03419E-01	6.49924E-02	4.63940E-02		
75	5.19099E-01	4.60809E-01	3.83816E-01	3.08723E-01	2.36545E-01	1.68720E-01	1.07342E-01	6.69322E-02	4.76587E-02		
90	5.28672E-01	4.65681E-01	3.82973E-01	3.03655E-01	2.29140E-01	1.60799E-01	1.00563E-01	6.20053E-02	4.39827E-02		
105	4.98612E-01	4.35838E-01	3.5703E-01	2.75763E-01	2.03917E-01	1.39769E-01	8.51761E-02	5.16032E-02	3.63514E-02		
120	4.32764E-01	3.75334E-01	3.00901E-01	2.30968E-01	1.67441E-01	1.12082E-01	6.65119E-02	3.95740E-02	2.78889E-02		
135	3.37654E-01	2.90913E-01	2.31051E-01	1.7576E-01	1.25759E-01	8.29318E-02	4.83647E-02	2.84346E-02	1.98223E-02		
150	2.23082E-01	1.90969E-01	1.50357E-01	1.13447E-01	8.0619E-02	5.32301E-02	3.11262E-02	1.84044E-02	1.29083E-02		
165	9.98150E-02	8.42023E-02	6.45277E-02	4.70590E-02	3.24105E-02	2.07302E-02	1.19031E-02	7.04997E-03	5.01671E-03		
180	-2.37802E-02	-2.32879E-02	-2.25319E-02	-2.12258E-02	-1.88479E-02	-1.52312E-02	-1.05886E-02	-6.81087E-03	-4.83451E-03		
195	-1.43618E-01	-1.28550E-01	-1.08808E-01	-8.91758E-02	-6.95692E-02	-5.03228E-02	-3.05775E-02	-1.99995E-02	-1.41704E-02		
210	-2.57616E-01	-2.28530E-01	-1.90040E-01	-1.52100E-01	-1.15359E-01	-8.08901E-02	-5.01774E-02	-3.06080E-02	-2.15503E-02		
225	-3.59855E-01	-3.18319E-01	-2.62572E-01	-2.07487E-01	-1.56873E-01	-1.06749E-01	-6.51372E-02	-3.93421E-02	-2.75749E-02		
240	-4.41047E-01	-3.89778E-01	-3.20900E-01	-2.53109E-01	-1.98827E-01	-1.30482E-01	-8.01709E-02	-4.87305E-02	-3.42710E-02		
255	-4.91610E-01	-4.35462E-01	-3.60344E-01	-2.86552E-01	-2.16184E-01	-1.51358E-01	-9.42784E-02	-5.79087E-02	-4.09473E-02		
270	-5.08284E-01	-4.51161E-01	-3.75197E-01	-3.00627E-01	-2.28936E-01	-1.62032E-01	-1.02311E-01	-6.35411E-02	-4.51740E-02		
285	-4.92359E-01	-4.35992E-01	-3.61420E-01	-2.89135E-01	-2.20774E-01	-1.57783E-01	-1.01323E-01	-6.36858E-02	-4.55459E-02		
300	-4.42963E-01	-3.91219E-01	-3.22934E-01	-2.57165E-01	-1.95636E-01	-1.39611E-01	-8.97651E-02	-5.64843E-02	-4.04194E-02		
315	-3.62894E-01	-3.18594E-01	-2.61195E-01	-2.06864E-01	-1.56663E-01	-1.10824E-01	-7.06362E-02	-4.2083E-02	-3.15861E-02		
330	-2.57056E-01	-2.23461E-01	-1.80737E-01	-1.4253E-01	-1.05488E-01	-7.58022E-02	-6.65122E-02	-2.90721E-02	-2.08221E-02		
345	-1.31692E-01	-1.12051E-01	-8.78673E-02	-6.62562E-02	-4.72598E-02	-3.12004E-02	-1.85335E-02	-1.13778E-02	-8.19064E-03		
AMPL	5.18478E-01	4.58421E-01	3.79507E-01	3.06675E-01	2.32740E-01	1.65380E-01	1.04692E-01	6.53090E-02	4.66022E-02		
STDY	-3.20188E-00	-2.88795E-00	-2.47074E-00	-2.06049E-00	-1.66230E-00	-1.28045E-00	-9.19792E-01	-6.67156E-01	-5.39872E-01		
PSI	STA	11	12	13	14	15	16	17			
0	3.14450E-03	8.66799E-04	5.35767E-05	6.69752E-06	3.22808E-08	-9.22979E-18	-4.91971E-28				
15	1.12702E-02	3.53860E-03	4.87709E-04	5.55291E-05	6.62802E-08	-1.56632E-55	-4.11110E-28				
30	1.82196E-02	5.76359E-03	8.27214E-04	9.33242E-05	8.69113E-08	2.21511E-55	-2.12327E-28				
45	2.30886E-02	7.60688E-03	1.12625E-04	1.26425E-04	1.03059E-07	-1.56632E-55	1.16114E-28				
60	2.75766E-02	8.88013E-03	1.38251E-03	1.59152E-04	1.14461E-07	-4.17219E-49	1.24257E-28				
75	2.83228E-02	9.23049E-03	1.52551E-03	1.70715E-04	1.14544E-07	-1.56632E-55	1.10925E-28				
90	2.61158E-02	8.64994E-03	1.54541E-03	1.72365E-04	1.02179E-07	-2.21511E-55	1.20688E-25				
105	2.14997E-02	7.24598E-03	1.41878E-03	1.57300E-04	7.81295E-08	1.56630E-55	-1.11148E-28				
120	1.63277E-02	5.65285E-03	1.24039E-03	1.36846E-04	4.84163E-08	1.67943E-50	-1.24128E-28				
135	1.16944E-02	4.20208E-03	1.04293E-03	1.16244E-04	2.81597E-08	-1.56634E-55	1.16165E-26				
150	7.70494E-03	2.93644E-03	8.34120E-04	9.11847E-05	1.88181E-08	2.21511E-55	2.12198E-28				
165	3.10251E-03	1.41765E-03	5.46002E-03	5.94945E-05	9.02736E-09	-1.56629E-55	6.11333E-28				
180	-2.78574E-03	-6.05481E-04	1.35775E-04	1.39412E-05	-1.15720E-08	-2.51914E-50	4.91714E-28				
195	-8.34522E-03	-2.54346E-03	-2.89222E-04	-3.30201E-05	-3.15053E-08	1.56633E-55	4.11333E-28				
210	-1.26652E-02	-4.07399E-03	-6.63661E-04	-7.40580E-05	-4.39439E-08	-2.21511E-55	2.12199E-28				
225	-1.61261E-02	-5.25232E-03	-9.44174E-04	-1.04414E-04	-5.31716E-04	1.56631E-55	-1.16076E-26				
240	-2.01023E-02	-6.61047E-03	-1.23130E-03	-1.36142E-04	-7.24797E-08	3.35805E-50	-1.24128E-28				
255	-2.41375E-02	-8.01349E-03	-1.51284E-03	-1.67749E-04	-9.84193E-08	1.56633E-55	-1.1148E-28				
270	-2.68118E-02	-8.97209E-03	-1.70959E-03	-1.90063E-04	-1.18182E-07	2.21511E-55	1.28302E-25				
285	-2.72289E-02	-9.20747E-03	-1.76974E-03	-1.97330E-04	-1.25099E-07	1.56630E-55	1.09257E-28				
300	-2.41842E-02	-8.17806E-03	-1.56603E-03	-1.74545E-04	-1.09632E-07	-4.19857E-50	1.24257E-28				
315	-1.89012E-02	-6.41286E-03	-1.23808E-03	-1.37940E-04	-8.13072E-08	1.56634E-55	1.16406E-26				
330	-1.25389E-02	-4.31179E-03	-8.48416E-04	-9.49027E-05	-4.72533E-08	-2.21511E-55	-2.12324E-28				
345	-5.02120E-03	-1.811204E-03	-3.93156E-03	-6.34536E-05	-7.69389E-09	1.56630E-55	-4.91842E-28				
AMPL	2.77759E-02	9.21898E-03	1.65757E-03	1.84848E-04	1.19822E-07	2.21511E-55	4.91842E-28				
STDY	-4.04543E-01	-2.46215E-01	-1.30883E-01	-4.33228E-02	-8.38682E-04	2.69029E-19	3.16495E-57				

Similar output for z, THETA, BETA, ZETA.

COMPREHENSIVE ROTOR ANALYSIS
ROTATING HUB LOADS AND CONTROL FORCES

ROTATING HUB LOADS AT ROTOR CENTER FOR 4 BLADES

K	F XR LB	F YR LB	F ZR LB	M XR LB-IN	M YR LB-IN	M ZR LB-IN
0			7.0181E 04			-1.6799E 06
1C	1.1305E 04	-1.0659E 04		1.2079E 06	1.2415E 06	
1S	-1.0659E 04	1.1305E 04		1.2415E 06	-1.2079E 06	
1	1.5538E 04	1.5538E 04		1.7321E 06	1.7321E 06	
2C						
2S						
2						
3C	-2.6621E 03	1.5988E 03		2.0452E 04	2.1156E 05	
3S	-1.5988E 03	-2.6621E 03		-2.1156E 05	2.0452E 04	
3	2.1033E 03	3.1033E 03		2.1235E 05	2.1235E 05	
4C			-1.3894E 03			-5.4678E 04
4S			-6.6245E 03			-8.8428E 04
4			6.7687E 03			1.0397E 03
5C	-1.7187E 03	1.8225E 03		5.1657E 04	-2.7596E 04	
5S	1.8225E 03	-1.7187E 03		-2.7596E 04	5.1657E 04	
5	2.5050E 03	2.5050E 03		5.8566E 04	5.8566E 04	
6C						
6S						
6						
7C	4.7186E 02	1.0461E 02		-2.9836E 02	1.6766E 04	
7S	-1.0461E 02	4.7186E 02		-1.6766E 04	-2.9836E 02	
7	4.8331E 02	4.8331E 02		1.6766E 04	1.6766E 04	
8C			4.5912E 02			-5.2784E 03
8S			-7.8547E 02			-2.6281E 03
8			9.0981E 02			5.8965E 03
9C	-5.4649E 01	-3.3680E 02		2.9461E 04	3.3339E 04	
9S	-3.3680E 02	5.4649E 01		3.3339E 04	-2.9461E 04	
9	3.4121E 02	3.4121E 02		4.4491E 04	4.4491E 04	
10C						
10S						
10						

FIXED HUB LOADS AT ROTOR CENTER FOR 4 BLADES

K	F XF LB	F YF LB	F ZF LB	M XF LB-IN	M YF LB-IN	M ZF LB-IN
0						
1C	1.1305E 04	-1.0659E 04	7.0181E 04	1.2079E 06	1.2415E 06	-1.6799E 06
1S	-1.0659E 04	1.1305E 04		1.2415E 06	-1.2079E 06	
1	1.5538E 04	1.5538E 04		1.7321E 06	1.7321E 06	
2C						
2S						
2						
3C	-2.6621E 03	1.5988E 03		2.0452E 04	2.1156E 05	
3S	-1.5988E 03	-2.6621E 03		-2.1156E 05	2.0452E 04	
3	2.1033E 03	3.1033E 03		2.1235E 05	2.1235E 05	
4C			-1.3894E 03			-5.4678E 04
4S			-6.6245E 03			-8.8428E 04
4			6.7687E 03			1.0397E 03
5C	-1.7187E 03	1.8225E 03		5.1657E 04	-2.7596E 04	
5S	1.8225E 03	-1.7187E 03		-2.7596E 04	5.1657E 04	
5	2.5050E 03	2.5050E 03		5.8566E 04	5.8566E 04	
6C						
6S						
6						
7C	4.7186E 02	1.0461E 02		-2.9836E 02	1.6766E 04	
7S	-1.0461E 02	4.7186E 02		-1.6766E 04	-2.9836E 02	
7	4.8331E 02	4.8331E 02		1.6766E 04	1.6766E 04	
8C			4.5912E 02			-5.2784E 03
8S			-7.8547E 02			-2.6281E 03
8			9.0981E 02			5.8965E 03
9C	-5.4649E 01	-3.3680E 02		2.9461E 04	3.3339E 04	
9S	-3.3680E 02	5.4649E 01		3.3339E 04	-2.9461E 04	
9	3.4121E 02	3.4121E 02		4.4491E 04	4.4491E 04	
10C						
10S						
10						

K FXF A FZF A MXF A MYF A MZF A
 LB LB LB LB-IN LB-IN LB-IN
 0 -1.4379E 03 -1.0659E 04 7.1071E 04 1.4890E 06 1.2415E 06 -1.4366E 06

RHP = 4.1580E 03

COMPREHENSIVE ROTOR ANALYSIS

POTATING HUB LOADS AND CONTROL FORCES

STEADY LOADS RELATIVE TO FORWARD VELOCITY

K	F LB	P1 LB	P2 LB	P3 LB
0	2.4258E 03	-3.7463E 03	-8.7588E 03	2.8040E 03
1C	-1.8558E 03			
1S	2.6575E 03			
1	3.2414E 03			
2C	-1.4970E 03			
2S	-8.6439E 02			
2	1.7287E 03			
3C	-6.6785E 02			
3S	-2.0879E 02			
3	6.9973E 02			
4C	4.3542E 01	1.6178E 01	-1.1262E 03	9.3390E 02
4S	-1.1638E 03	2.6179E 03	2.5153E 03	-4.7811E 02
4	1.1646E 03	2.6180E 03	2.7560E 03	1.0492E 03
5C	2.2244E 02			
5S	2.4331E 02			
5	3.2967E 02			
6C	-3.7559E 02			
6S	9.1523E 01			
6	3.8658E 02			
7C	4.9693E 01			
7S	8.2638E 01			
7	9.6429E 01			
8C	7.5911E 01	2.8551E 02	-4.6072E 01	-5.4309E 02
8S	1.0113E 02	-2.5523E 02	-3.4316E 02	1.9389E 02
8	1.2645E 02	3.8257E 02	3.4624E 02	5.7666E 02
9C	-9.8101E 01			
9S	-1.3063E 02			
9	1.6338E 02			
10C	8.9840E 01			
10S	4.1793E 01			
10	9.5085E 01			

COMPREHENSIVE ROTOR ANALYSIS
 ROTATING HUB LOADS AND CONTROL FORCES

VIBRATORY CONTROL FORCES

PSI DEG	F LB	P1 LB	P2 LB	P3 LB
0	-4.0130E 03	3.0369E 02	-1.1723E 03	3.9081E 02
15	-4.0186E 03	1.9125E 03	1.3411E 03	4.5235E 02
30	-2.7799E 03	2.3344E 03	3.0617E 03	-7.7738E 02
45	5.0463E 02	2.6734E 02	1.0802E 03	-1.4770E 03
60	2.7134E 03	-2.6401E 03	-1.8894E 03	3.8657E 02
75	4.9393E 03	-2.1758E 03	-2.4213E 03	9.8464E 02
90	4.7985E 03	3.0369E 02	-1.1723E 03	3.5081E 02
105	3.5595E 03	1.9125E 03	1.3411E 03	4.5235E 02
120	2.1458E 03	2.3344E 03	3.0617E 03	-7.7738E 02
135	3.3867E 03	2.6734E 02	1.0802E 03	-1.4770E 03
150	4.6683E 03	-2.6401E 03	-1.8894E 03	3.8656E 02
165	2.7630E 03	-2.1758E 03	-2.4213E 03	9.8464E 02
180	5.8631E 02	3.0369E 02	-1.1723E 03	3.9081E 02
195	-1.2424E 03	1.9125E 03	1.3411E 03	4.5235E 02
210	-1.7560E 03	2.3344E 03	3.0617E 03	-7.7737E 02
225	-1.2589E 03	2.6735E 02	1.0802E 03	-1.4770E 03
240	-1.5575E 03	-2.6401E 03	-1.8894E 03	3.8656E 02
255	-1.0221E 03	-2.1758E 03	-2.4213E 03	9.8464E 02
270	-9.9410E 02	3.0368E 02	-1.1723E 03	3.9081E 02
285	-2.0443E 03	1.9125E 03	1.3411E 03	4.5235E 02
300	-2.2306E 03	2.3364E 03	3.0617E 03	-7.7737E 02
315	-1.4937E 03	2.6738E 02	1.0802E 03	-1.4770E 03
330	-1.6813E 03	-2.6400E 03	-1.8894E 03	3.8655E 02
345	-3.0638E 03	-2.1758E 03	-2.4213E 03	9.8464E 02
MAX POS	4.9393E 03	2.3364E 03	3.0617E 03	9.8464E 02
MAX NEG	-4.0186E 03	-2.6401E 03	-2.4213E 03	-1.4770E 03
APPLTD	4.4789E 03	2.4882E 03	2.7413E 03	1.2308E 03

TS	RMP	X	L	L/DE
7.39287E 04	4.15757E 03	2.10873E 03	7.47583E 04	1.17656E 01
X/L	L/QD2SIG	X/QD2SIG	P/QD2SIG	CT/SIG
2.82072E-02	1.24151E 00	3.50197E-02	1.40541E-01	1.01072E-01
CTP/SIG	CM/SIG	CP/SIG	CY/SIG	
1.02207E-01	1.54599E-02	4.16056E-03	-1.45124E-02	

VIB PITCH LINK LOADS FOR EACH ITERATION--LBS (POSITIVE IN COMPRESSION)

	ITER 0	ITER 1	ITER 2	ITER 3	ITER 4	ITER 5	ITER 6	ITER 7	ITER 8	ITER 9	ITER 10
0	-7.208E 03	-5.096E 03	-4.765E 03	-5.292E 03	-5.434E 03	-5.866E 03	-5.116E 03	-4.853E 03	-4.259E 03	-3.662E 03	-4.013E 03
15	-5.968E 03	7.035E 03	-4.765E 03	-6.463E 03	-6.732E 03	-7.051E 03	-5.775E 03	-4.898E 03	-4.674E 03	-4.284E 03	-4.019E 03
30	-4.468E 03	1.117E 04	-2.926E 03	-5.431E 03	-5.759E 03	-5.423E 03	-3.992E 03	-3.168E 03	-3.168E 03	-2.784E 03	-2.780E 03
45	-6.028E 03	1.809E 04	-8.238E 02	-9.989E 02	-1.834E 03	-2.282E 03	-2.045E 02	-9.083E 02	-2.654E 02	-4.480E 02	-5.046E 02
60	-1.461E 03	1.778E 04	1.645E 03	3.119E 03	1.988E 03	1.379E 03	3.359E 03	2.853E 03	2.782E 03	2.523E 03	2.715E 03
75	1.258E 04	1.395E 04	2.278E 03	5.452E 03	5.028E 03	6.149E 03	6.988E 03	3.777E 03	4.588E 03	4.997E 03	4.939E 03
90	2.595E 04	6.819E 03	1.143E 03	9.255E 03	6.056E 03	6.070E 03	7.212E 03	3.508E 03	4.701E 03	4.938E 03	4.799E 03
105	3.038E 04	3.394E 03	7.744E 03	1.057E 04	4.950E 03	6.592E 03	5.193E 03	2.614E 03	5.208E 03	4.623E 03	3.559E 03
120	2.861E 04	1.633E 03	1.355E 04	1.156E 04	1.763E 03	1.104E 04	4.901E 03	2.643E 03	8.055E 03	3.695E 03	2.146E 03
135	2.114E 04	-4.175E 03	1.730E 04	8.272E 03	2.499E 03	1.549E 03	3.342E 03	3.798E 03	5.964E 03	2.339E 03	3.387E 03
150	1.105E 04	-4.705E 03	1.505E 04	4.421E 02	9.344E 03	1.271E 04	3.342E 03	3.828E 03	1.456E 03	2.538E 03	4.666E 03
165	-6.458E 02	-2.196E 03	4.254E 03	-2.420E 03	1.279E 04	3.345E 03	1.321E 03	4.764E 03	1.415E 03	2.135E 03	2.763E 03
180	-1.356E 04	5.529E 02	-7.309E 02	-3.139E 03	1.095E 04	-1.310E 03	3.659E 02	4.307E 03	5.389E 02	8.094E 02	6.863E 02
195	-1.848E 04	4.305E 02	-2.372E 03	-3.173E 02	6.638E 03	-3.828E 03	4.644E 02	1.835E 03	-7.685E 02	7.349E 02	-1.242E 03
210	-1.688E 04	-5.549E 02	-5.190E 03	1.853E 03	7.094E 02	-6.601E 03	9.710E 01	-3.261E 02	-2.071E 03	-2.051E 03	-1.754E 03
225	-1.121E 04	-9.353E 03	-8.321E 03	-1.919E 03	-6.231E 03	-7.794E 03	-1.555E 03	-2.328E 03	-3.603E 03	-2.466E 03	-1.259E 03
240	-6.122E 03	-1.015E 04	-9.140E 03	-4.559E 03	-1.031E 04	-8.147E 03	-4.055E 03	-3.013E 03	-3.406E 03	-2.506E 03	-1.557E 03
255	-3.098E 03	-4.709E 03	-5.084E 03	-4.528E 03	-8.512E 03	-4.651E 03	-3.799E 03	-1.253E 03	-1.786E 03	-1.139E 03	-1.022E 03
270	-7.896E 02	-3.581E 03	-2.019E 03	-1.424E 03	-4.744E 03	-6.929E 02	-1.548E 03	-2.287E 02	-5.566E 02	-1.343E 02	-9.941E 02
285	-6.485E 02	-4.219E 03	-2.119E 03	-9.355E 02	-1.851E 03	-6.160E 02	-1.169E 03	-1.852E 03	-2.447E 03	-1.602E 03	-2.044E 03
300	-3.636E 03	-5.115E 03	-2.517E 03	-2.349E 03	-2.312E 03	-2.056E 03	-1.962E 03	-2.680E 03	-2.588E 03	-2.056E 03	-2.231E 03
315	-7.422E 03	-5.208E 03	-2.608E 03	-2.885E 03	-3.073E 03	-1.359E 03	-2.044E 03	-2.266E 03	-8.886E 02	-9.474E 02	-1.494E 03
330	-1.039E 04	-8.269E 03	-3.643E 03	-3.634E 03	-2.221E 03	-1.104E 03	-2.603E 03	-2.483E 03	-1.528E 03	-1.309E 03	-1.681E 03
345	-1.047E 04	-8.580E 03	-4.288E 03	-3.932E 03	-3.673E 03	-3.189E 03	-4.087E 03	-3.082E 03	-2.721E 03	-2.473E 03	-3.064E 03
AMPL	2.443E 04	1.412E 04	1.322E 04	9.011E 03	1.155E 04	1.182E 04	6.494E 03	4.831E 03	6.365E 03	4.641E 03	4.479E 03
SDY	6.034E 03	7.159E 03	4.636E 03	3.329E 03	4.118E 03	3.704E 03	3.082E 03	3.185E 03	2.647E 03	2.296E 03	2.426E 03

VIBRATORY PITCH LINK LOADS EVERY 5 DEGREES FOR THE LAST ITERATION ONLY

PSI	PSI	PSI	PSI	PSI	PSI	PSI	PSI	PSI	PSI	PSI	PSI				
0	-4.013E 03	45	-5.046E 02	90	4.799E 03	135	3.387E 03	180	6.863E 02	225	-1.259E 03	270	-9.941E 02	315	-1.494E 03
5	-4.134E 03	50	4.960E 02	95	4.482E 03	140	4.130E 03	185	3.738E 01	230	-1.336E 03	275	-1.322E 03	320	-1.368E 03
10	-4.143E 03	55	1.598E 03	100	4.072E 03	145	4.615E 03	190	-6.318E 02	235	-1.477E 03	280	-1.705E 03	325	-1.426E 03
15	-4.019E 03	60	2.715E 03	105	3.559E 03	150	4.666E 03	195	-1.242E 03	240	-1.557E 03	285	-2.044E 03	330	-1.681E 03
20	-3.745E 03	65	3.720E 03	110	2.981E 03	155	4.273E 03	200	-1.674E 03	245	-1.492E 03	290	-2.264E 03	335	-2.093E 03
25	-3.329E 03	70	4.485E 03	115	2.453E 03	160	3.572E 03	205	-1.841E 03	250	-1.284E 03	295	-2.326E 03	340	-2.582E 03
30	-2.780E 03	75	4.939E 03	120	2.146E 03	165	2.763E 03	210	-1.756E 03	255	-1.022E 03	300	-2.231E 03	345	-3.064E 03
35	-2.129E 03	80	5.093E 03	125	2.204E 03	170	1.977E 03	215	-1.533E 03	260	-8.334E 02	305	-2.013E 03	350	-3.476E 03
40	-1.376E 03	85	5.018E 03	130	2.461E 03	175	1.319E 03	220	-1.329E 03	265	-8.152E 02	310	-1.738E 03	355	-3.794E 03

C O N V E R G E N C E S U M M A R Y

ITER	COLLECTIVE X/R=0.800	THRUST	ANGLE OF ATTACK				Z TIP AMPL	THETA TIP AMPL	ROOT FBM AMPL
			PSI=0	STA 4 PSI=90	X/R=0.800 PSI=180	PSI=270			
0	6.775	72664.00	-0.685	13.213	3.646	-12.867	47.533	16.772	175262.69
1	12.276	72667.31	17.795	-2.771	13.568	-6.280	71.115	10.815	101255.38
2	8.221	72707.50	4.672	3.710	2.144	1.710	96.355	15.110	94805.69
3	8.320	72665.00	5.853	5.829	11.995	3.808	110.592	11.525	64646.97
4	9.132	72684.13	5.106	-3.511	14.025	9.976	96.759	14.605	82844.13
5	8.636	72703.69	3.959	3.091	2.332	2.739	94.586	14.874	84806.31
6	8.499	72687.56	6.875	1.818	11.612	4.429	101.897	10.408	46580.78
7	8.058	72721.94	4.719	0.106	7.695	7.780	99.989	11.738	34666.78
8	7.178	72661.19	5.103	3.551	2.206	9.563	97.537	9.963	45664.91
9	7.532	72662.75	6.041	1.642	7.649	6.808	97.764	10.181	33261.38
10	7.333	72731.00	5.109	0.472	5.280	7.172	90.432	10.418	32123.22

SAMPLE BLADE PROPERTY IDEALIZATION PROGRAM
INPUT AND OUTPUT

The Blade Property Idealization Program converts the continuous blade property distributions into a system of discrete point masses connected by massless elastic elements. The blade properties considered are blade mass, chordwise centroid, polar mass moment of inertia, flapwise flexural stiffness, chordwise flexural stiffness, and torsional rigidity.

A sample input and output are presented. This output was used to obtain the input for the sample C-70 program. Also presented are the distributed blade property curves. (Figures 25 through 32) which provided the input data.

Complete sheets 1, 1A, 2, 3, 4, and 5.

1. Basic Control Sheet - Locs 1 through 30.

LOC	DEF	DIM.	DESCRIPTION
01	Prog	-	Not used. Set equal to 1
02	Flap Bdry	-	Not used. Set equal to 1
03	Lag Bdry	-	Not used. Set equal to 1
04	R	ft	Blade radius
05	C ₀	in.	Blade constant chord
06	e ₀	in.	Not used. Set equal to 0
07	b	in.	Not used. Set equal to 1
08	K _Z	lb/in.	Not used. Set equal to 0
09	K _θ	$\frac{\text{lb-in.}}{\text{rad}}$	Not used. Set equal to 0
10	Ω	rpm	Not used. Set equal to 1
11	ω _s	HZ	Not used. Set equal to 0

LOC	DEF	DIM.	DESCRIPTION
12	ω_f	Hz	Not used. Set equal to 1
13	$\Delta\omega$	Hz	Not used. Set equal to 1
14	n	-	Number of mass stations
15	Inp	-	Set equal to 1
16	D.O.F.	-	Not used. Set equal to 1
17	n_B	-	Total number of blade masses
18	E	-	Not used. Set equal to 0
19	K_ξ	lb-in./rad	Not used. Set equal to 0
20	e_β	in.	Flap hinge offset
21	e_ξ	in.	Lag hinge offset
22	C_ξ	$\frac{\text{lb-sec}}{\text{in.}}$	Not used. Set equal to 0
23	I_F	chug in. ²	Not used. Set equal to 1
24	I_L	chug in. ²	Not used. Set equal to 1
25	BL	-	Not used. Set equal to 1
26	M_{H_β}	chugs	Not used. Set equal to 0
27	M_{H_L}	chugs	Not used. Set equal to 0
28	K_β	$\frac{\text{in. lb}}{\text{rad}}$	Not used. Set equal to 0
29	C_β	chugs/sec	Not used. Set equal to 0

2. Subroutine WICK Input Description - Locs 100-1000

LOC	DEF	DIM.	DESCRIPTION
100	Wick	-	Control for use of subroutine WICK. Set equal to 0
101	M	chugs	Mass at bay centers Set equal to 1
102	\bar{M}	chugs	Cabled mass Set equal to 0
103	I	chug-in. ²	Pitch inertia Set equal to 1
104	Y	in.	Distance from pitch axis to bay mass center Set equal to 1
105	Blank	-	Not used. Set equal to 0
106	EI_{β}	lb-in. ²	Flapwise flexural rigidity Set equal to 1
107	EI_{ξ}	lb.-in. ²	Lagwise flexural rigidity Set equal to 1
108	GJ	lb-in.	Torsional rigidity of bay Set equal to 1
109	EA	lb	Elastic axis rigidity Set equal to 0
110	-	-	Use for numbering cases Set equal to 1
111	R	in.	Blade radius
112-161	r or r/R	in. or N.D.	Blade boundary locations

NOTE: These blade boundaries must correspond to those used in C-70 Locs 290-315. Therefore, last boundary is flap hinge location and must be in inches; i.e., same as Locs 20, 171, 371, 471, 581, 681, and 901. The next to the last boundary is lag hinge location and must be in inches; i.e., same as Locs 21 and 791.

LOC	DEF	DIM.	DESCRIPTION
162	e_{ξ}	in.	Lag hinge location
170	-	-	Use for numbering cases Set equal to 1
171	e_{β}	in.	Flap hinge location
172-269	r or r/R	in. or N.D.	Blade boundary locations
271-369	ω	lb/in.	Running weight
370	-	-	Cabled weight case Use for numbering cases Set equal to 1
371	e_{β}	in.	Flap hinge location Set equal to zero if not using cabled weight
372-419	r or r/R	in. or N.D.	Blade boundary locations
421-469	$\bar{\omega}$	lb/in.	Running cabled weight
470	-	-	Pitch inertia case Using for numbering cases Set equal to 1
471	e_{β}	in.	Flap hinge location
472-519	r or r/R	in. or N.D.	Blade boundary locations
521-569	$I_p \times 10^2$	lb-sec ² -in.	Running pitch inertia
571	-	-	Chordwise centroid case Use for numbering cases Set equal to 1
572	C_0	in.	Blade constant chord
573	-	in.	Pitch axis offset (aft of L.E.)
581	e_{β}	in.	Flap hinge location
582-629	r or r/R	in. or N.D.	Blade boundary locations
631-679	$\bar{\gamma}$	in.	Mass offset from leading edge
680	-	-	Flap EI case Use for numbering cases Set equal to 1

LOC	DEF	DIM.	DESCRIPTION
681	e_{β}	in.	Flap hinge location
682-730	r or r/R	in. or N.D.	Blade boundary locations
731-780	EI_{β} $\times 10^{-6}$	lb-in. ²	Flap rigidity (running)
790	-	-	Lag EI case Use for numbering cases Set equal to 1
791	e_{ξ}	in.	Lag hinge location
792-840	r or r/R	in. or N.D.	Blade boundary locations
841-890	EI_{ξ} $\times 10^{-6}$	lb-in. ²	Lag rigidity (running)
900	-	-	Torsional rigidity case Use for numbering cases Set equal to 1
901	e_{β}	in.	Flap hinge location
902-950	r or r/R	in. or N.D.	Blade boundary locations
951-1000	GJ $\times 10^{-6}$	lb-in. ²	Torsional rigidity (running)

NOTE: Input 9999999. in the location immediately following the last entry in each group of input data. See sample input sheet. Distributed properties are input beginning at the inboard end of the blade.

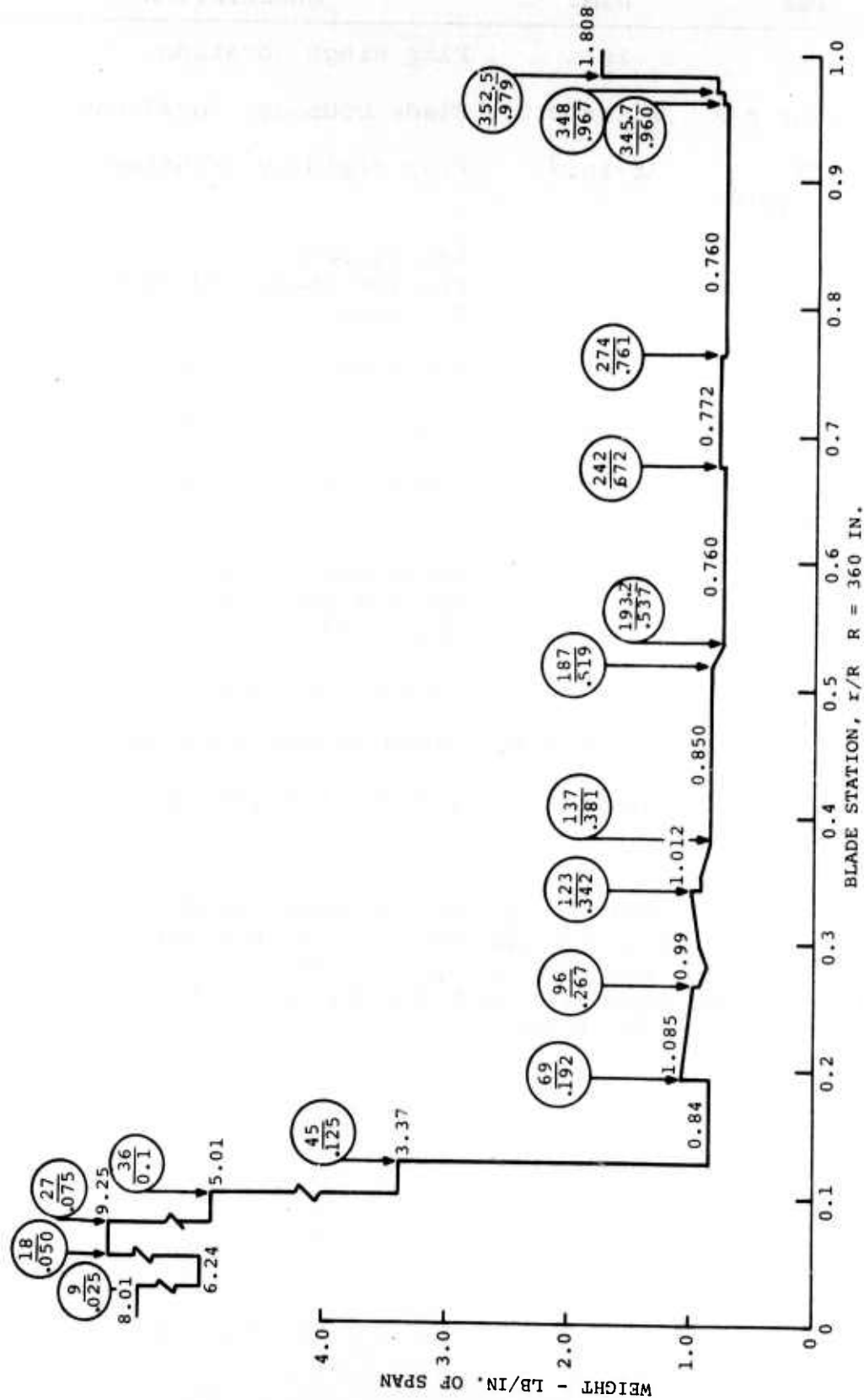


Figure 25. Spanwise Weight Distribution of CH-47 Rotor Blade

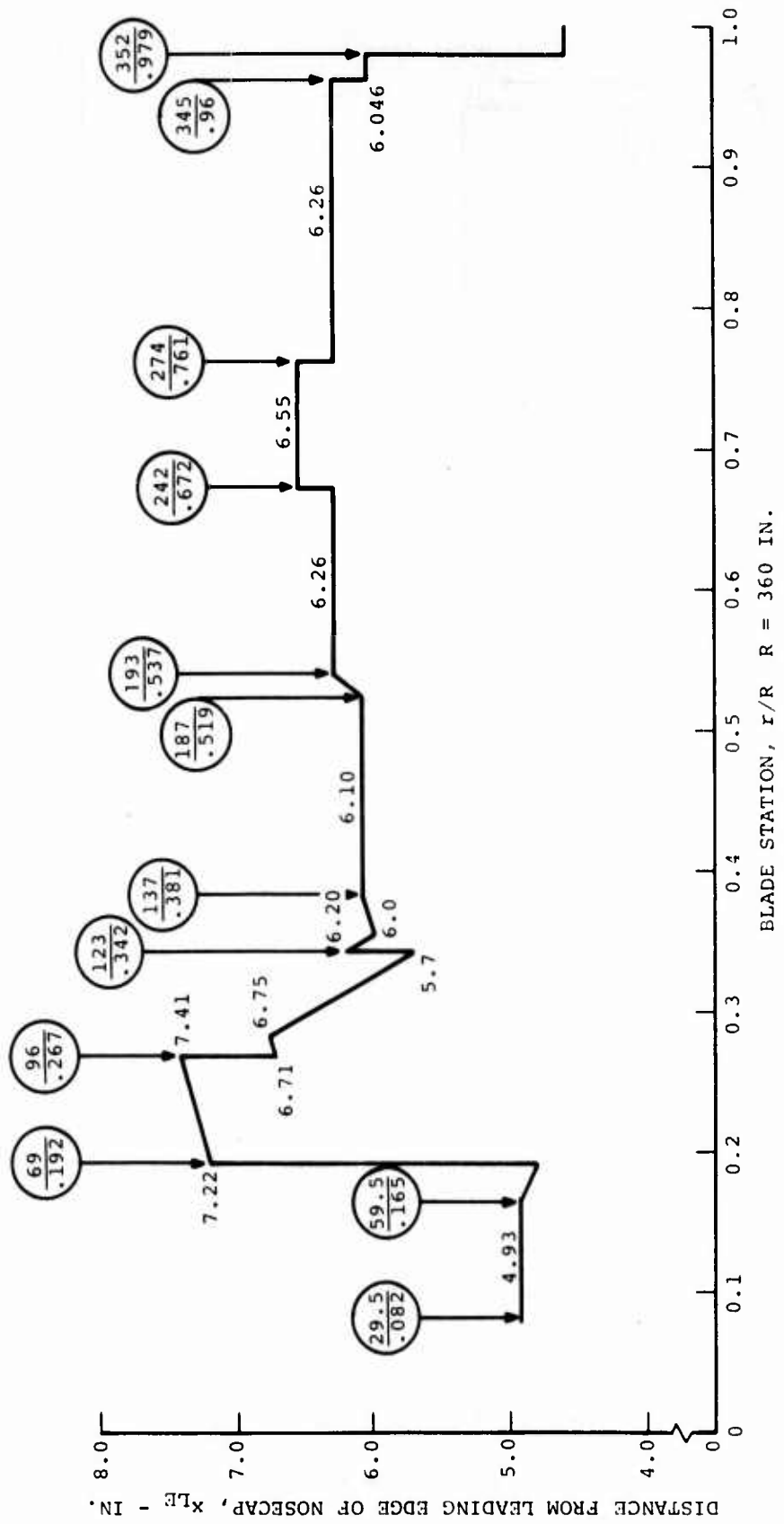


Figure 26. Effective Centroidal Axis Location of CH-47 Rotor Blade

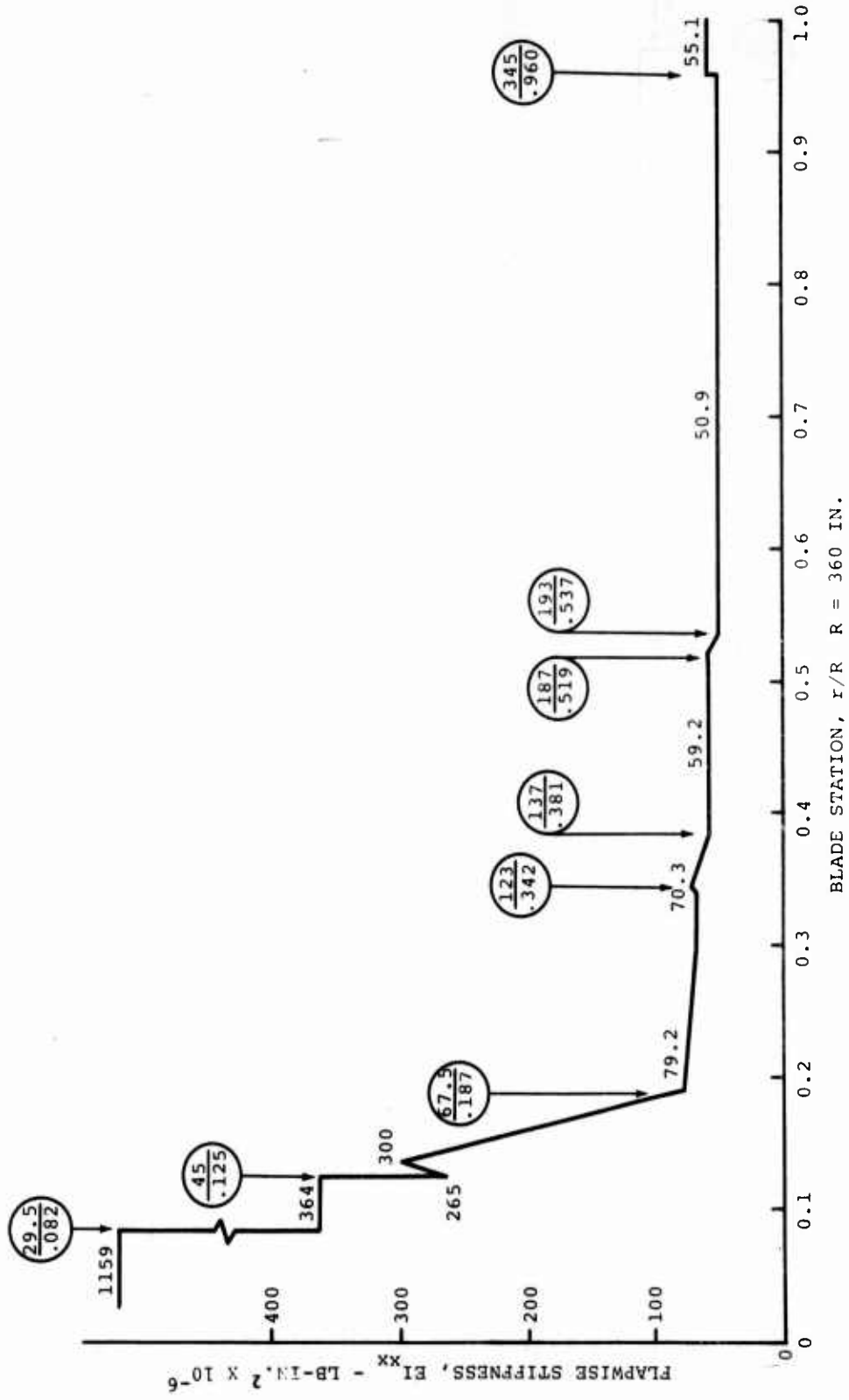


Figure 28. Effective Flapwise Stiffness Distribution of CH-47 Rotor Blade

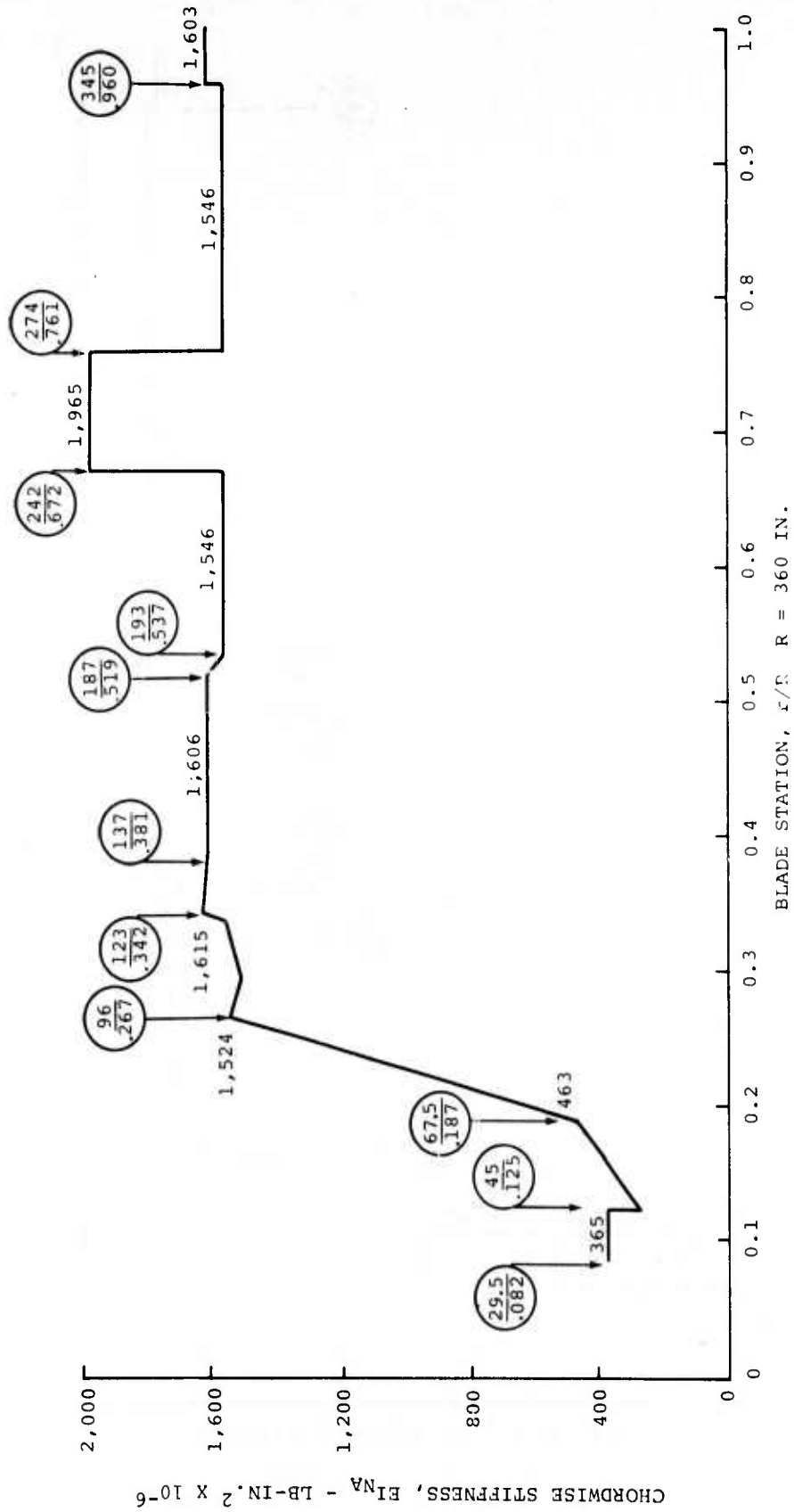


Figure 29. Effective Chordwise Stiffness Distribution of CH-47 Rotor Blade

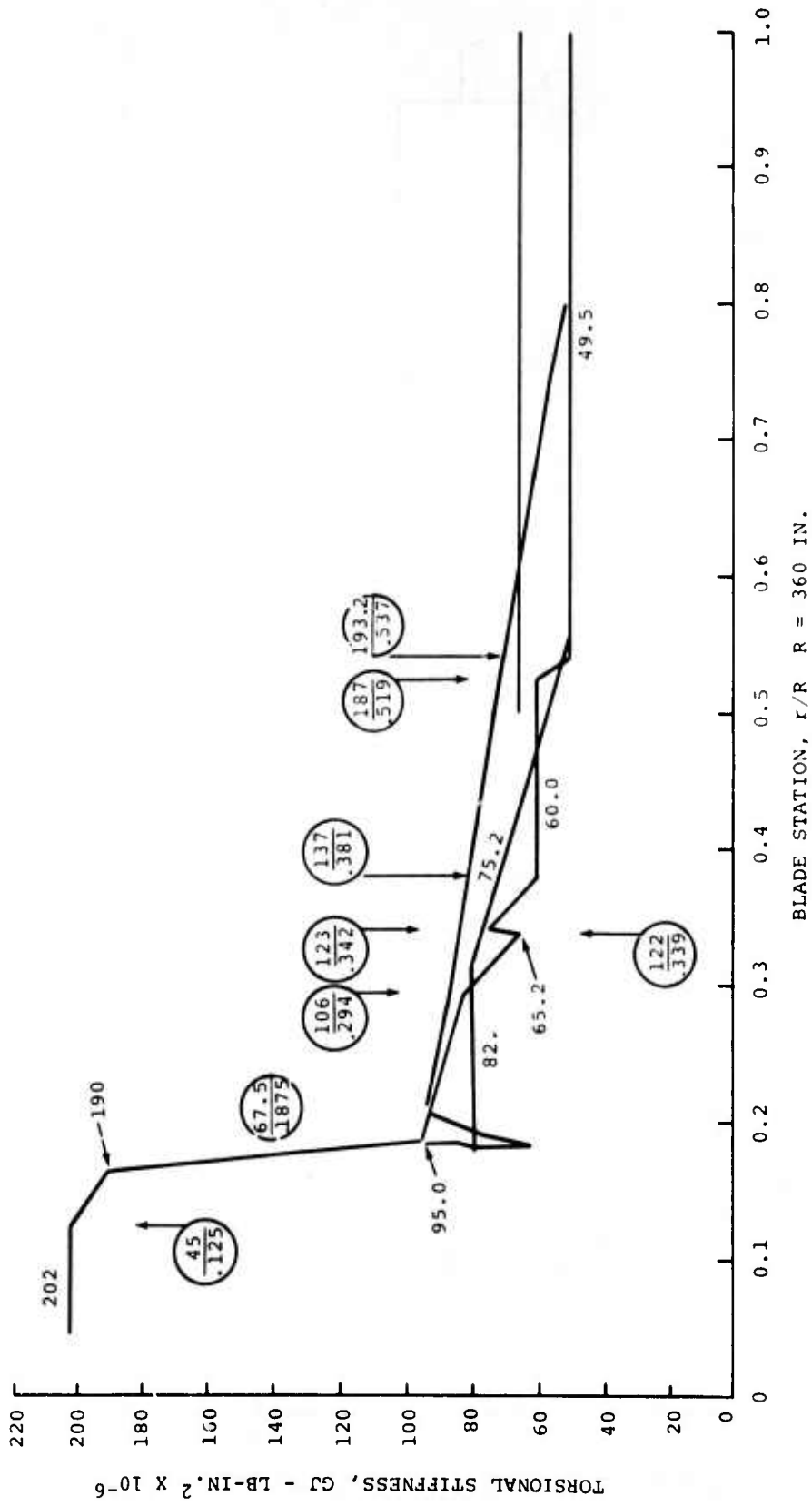


Figure 30. Torsional Stiffness Distribution of CH-47 Rotor Blade

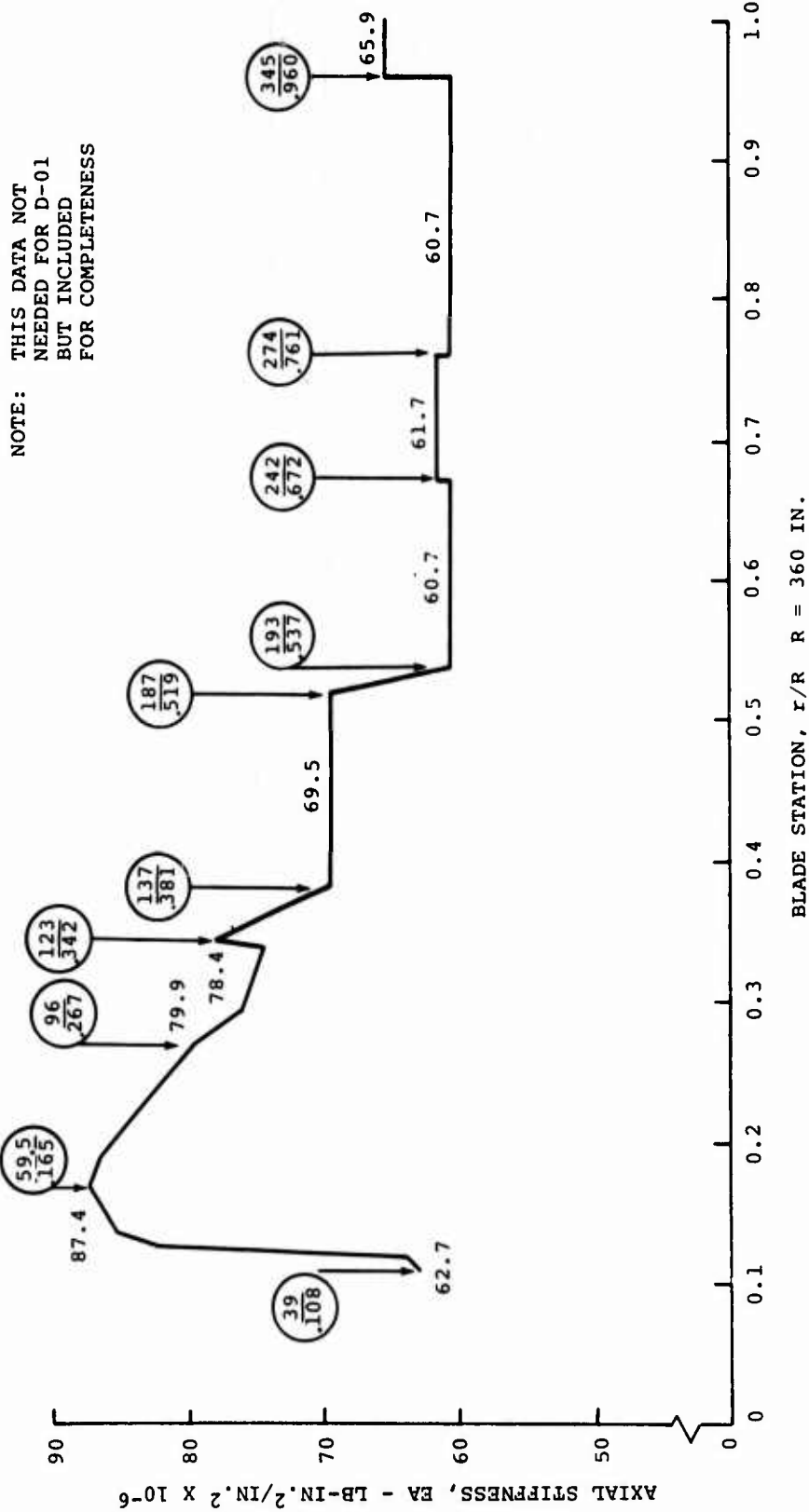
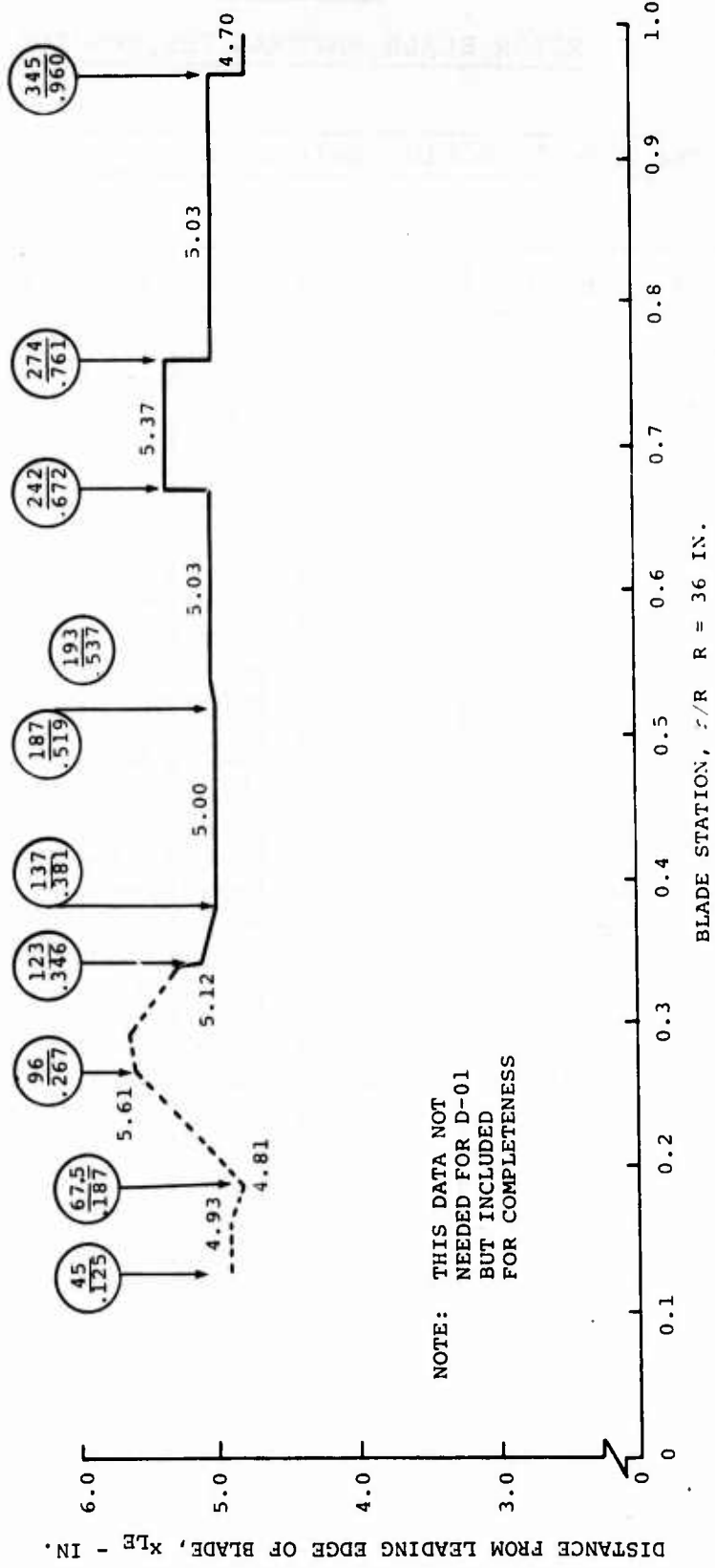


Figure 31. Effective Axial Stiffness Distribution of CH-47 Rotor Blade



NOTE: THIS DATA NOT
NEEDED FOR D-01
BUT INCLUDED
FOR COMPLETENESS

Figure 32. Effective Neutral Axis Location of CH-47 Rotor Blade

PROGRAM D-01ROTOR BLADE NATURAL FREQUENCIES

TITLE CH-47C SOLID TRAILING EDGE

DEF	DIM.	LOC	VALUE	DEF	DIM.	LOC	VALUE
Prog.	-	01	1.	D.O.F.	-	16	1.
Flap Bdry	-	02	1.	n_B	-	17	10.
Lag Bdry	-	03	1.	ϵ	-	18	0.
R	ft	04	30.	K_ϵ	$\frac{Lb}{In.}$	19	0.
c_o	in.	05	25.25	e_θ	-in.	20	8.
e_o	in.	06	1.58	e_ϵ	In.	21	29.5
b	in.	07	10.25	C_ϵ	$\frac{Chug.}{Sec}$	22	70,000.
K_z	$\frac{lb}{in.}$	08	11,850.	I_F	Ch. In ²	23	0.
K_θ	$\frac{lb-in.}{rad}$	09	0.	I_L	Ch. In ²	24	0.
Ω	rpm	10	230.	BL	-	25	3.
ω_s	Hz	11	0.	$M_{H\theta}$	Chug	26	0.
ω_f	Hz	12	49.8	M_{HL}	Chug	27	0.
$\Delta\omega$	Hz	13	0.2			28	0.
n	-	14	15.			29	0.
Inp	-	15	1.			30	0.

PROGRAM D-01 - SUBROUTINE WICK
BLADE PROPERTIES DISTRIBUTION

Required Distribution

Control		0	100	0.
Blade Weight.	m	1	101	1.
Cabled Weight.	Δm	2	102	0.
Pitch Inertia.	I	3	103	1.
Chordwise Centroid.	y	4	104	1.
		5	105	0.
Flap EI	EI _e	6	106	1.
Lag EI	EI _s	7	107	1.
Torsion GJ	GJ	8	108	1.
Elastic Axis.	EA	9	109	0.

Boundary Case No.	Loc.	
	110	1.

Boundary	Loc	r(in) or r/R
b 0.1	111	360.
b 1.2	112	0.99
b 2.3	113	0.95
b.3.4	114	0.9
b 4.5	115	0.8
b 5.6	116	0.7
b 6.7	117	0.6
b 7.8	118	0.5
b 8.9	119	0.4
b 9.10	120	0.3
b10.11	121	0.195
b11.12	122	0.18
b12.13	123	0.16
b13.14	124	0.132
b14.15	125	29.5
b15.16	126	8.0
b16.17	127	9999999.
b17.18	128	
b18.19	129	
b19.20	130	
b20.21	131	
b21.22	132	
b22.23	133	
b23.24	134	
b24.25	135	
b25.26	136	

Boundary	Loc	r(in) or r/R
b26.27	137	
b27.28	138	
b28.29	139	
b29.30	140	
b30.31	141	
b31.32	142	
b32.33	143	
b33.34	144	
b34.35	145	
b35.36	146	
b36.37	147	
b37.38	148	
b38.39	149	
b39.40	150	
b40.41	151	
b41.42	152	
b42.43	153	
b43.44	154	
b44.45	155	
b45.46	156	
b46.47	157	
b47.48	158	
b48.49	159	
b49.50	160	
b50.51	161	

Use the same dimension at Loc. 162
as the dimension of e input at
Loc. bx.y

Lag Hinge	162	29.5	ins. or N.D.
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PROGRAM D01

LOC CASE
170 1

BLADE WEIGHT

Point	Loc	r(in) or r/R	Loc	lb/in run
1	171	8.	271	8.01
2	172	0.025	272	8.01
3	173	0.025	273	6.24
4	174	0.05	274	6.24
5	175	0.05	275	9.25
6	176	0.075	276	9.25
7	177	0.075	277	5.01
8	178	0.10	278	5.01
9	179	0.10	279	3.37
10	180	0.125	280	3.37
11	181	0.125	281	0.84
12	182	0.192	282	0.84
13	183	0.192	283	1.085
14	184	0.267	284	0.99
15	185	0.267	285	0.92
16	186	0.342	286	1.012
17	187	0.342	287	0.90
18	188	0.381	288	0.85
19	189	0.519	289	0.85
20	190	0.537	290	0.76
21	191	0.672	291	0.76
22	192	0.672	292	0.772
23	193	0.761	293	0.772
24	194	0.761	294	0.760
25	195	0.96	295	0.760
26	196	0.96	296	0.78
27	197	0.967	297	0.78
28	198	0.967	298	0.83
29	199	0.979	299	0.83
30	200	0.979	300	1.808
31	201	1.0	301	1.808
32	202	9999999.	302	9999999.
33	203		303	
34	204		304	
35	205		305	
36	206		306	
37	207		307	
38	208		308	
39	209		309	
40	210		310	
41	211		311	
42	212		312	
43	213		313	
44	214		314	
45	215		315	
46	216		316	
47	217		317	
48	218		318	
49	219		319	
50	220		320	

Point	Loc	r(in) or r/R	Loc	lb/in run
51	221		321	
52	222		322	
53	223		323	
54	224		324	
55	225		325	
56	226		326	
57	227		327	
58	228		328	
59	229		329	
60	230		330	
61	231		331	
62	232		332	
63	233		333	
64	234		334	
65	235		335	
66	236		336	
67	237		337	
68	238		338	
69	239		339	
70	240		340	
71	241		341	
72	242		342	
73	243		343	
74	244		344	
75	245		345	
76	246		346	
77	247		347	
78	248		348	
79	249		349	
80	250		350	
81	251		351	
82	252		352	
83	253		353	
84	254		354	
85	255		355	
86	256		356	
87	257		357	
88	258		358	
89	259		359	
90	260		360	
91	261		361	
92	262		362	
93	263		363	
94	264		364	
95	265		365	
96	266		366	
97	267		367	
98	268		368	
99	269		369	

	Loc	No.
Cabled Weight Case	370	0.

	Loc	No.
Pitch Inertia Case No.	470	1.

Point	Loc	r(in) or r/R	Loc	lb/in run
1	371		421	
2	372		422	
3	373		423	
4	374		424	
5	375		425	
6	376		426	
7	377		427	
8	378		428	
9	379		429	
10	380		430	
11	381		431	
12	382		432	
13	383		433	
14	384		434	
15	385		435	
16	386		436	
17	387		437	
18	388		438	
19	389		439	
20	390		440	
21	391		441	
22	392		442	
23	393		443	
24	394		444	
25	395		445	
26	396		446	
27	397		447	
28	398		448	
29	399		449	
30	400		450	
31	401		451	
32	402		452	
33	403		453	
34	404		454	
35	405		455	
36	406		456	
37	407		457	
38	408		458	
39	409		459	
40	410		460	
41	411		461	
42	412		462	
43	413		463	
44	414		464	
45	415		465	
46	416		466	
47	417		467	
48	418		468	
49	419		469	

Point	Loc	r(in) or r/R	Loc	$I_p \times 10^2$ lb sec ² in
1	471	8.0	521	18.87
2	472	0.043	522	18.87
3	473	0.043	523	15.84
4	474	0.092	524	15.84
5	475	0.092	525	6.96
6	476	0.125	526	6.96
7	477	0.125	527	1.35
8	478	0.140	528	1.553
9	479	0.192	529	1.377
10	480	0.192	530	10.48
11	481	0.267	531	10.3
12	482	0.267	532	7.4
13	483	0.342	533	7.97
14	484	0.381	534	7.61
15	485	0.519	535	7.61
16	486	0.537	536	7.48
17	487	0.672	537	7.48
18	488	0.672	538	8.75
19	489	0.761	539	8.75
20	490	0.761	540	7.48
21	491	0.96	541	7.61
22	492	0.979	542	7.61
23	493	0.979	543	11.34
24	494	1.0	544	11.34
25	495	9999999.	545	9999999.
26	496		546	
27	497		547	
28	498		548	
29	499		549	
30	500		550	
31	501		551	
32	502		552	
33	503		553	
34	504		554	
35	505		555	
36	506		556	
37	507		557	
38	508		558	
39	509		559	
40	510		560	
41	511		561	
42	512		562	
43	513		563	
44	514		564	
45	515		565	
46	516		566	
47	517		567	
48	518		568	
49	519		569	

	Loc	No.
Chordwise Centroid Case	571	1.
Blade Constant Chord	572	25.25
Pitch Axis (aft of L.E.)	573	4.924

	Loc	No.
Flap EI Case	680	1.

Point	Loc	r(in)or r/R	Loc	inches aft of L.E.
1	581	29.5	631	4.93
2	582	0.165	632	4.93
3	583	0.192	633	4.77
4	584	0.192	634	7.22
5	585	0.267	635	7.41
6	586	0.267	636	6.71
7	587	0.283	637	6.75
8	588	0.342	638	5.7
9	589	0.342	639	6.2
10	590	0.355	640	6.0
11	591	0.381	641	6.1
12	592	0.519	642	6.1
13	593	0.537	643	6.26
14	594	0.672	644	6.26
15	595	0.672	645	6.55
16	596	0.761	646	6.55
17	597	0.761	647	6.26
18	598	0.96	648	6.26
19	599	0.96	649	6.04
20	600	0.979	650	6.04
21	601	0.979	651	4.58
22	602	1.0	652	4.58
23	603	9999999	653	9999999.
24	604		654	
25	605		655	
26	606		656	
27	607		657	
28	608		658	
29	609		659	
30	610		660	
31	611		661	
32	612		662	
33	613		663	
34	614		664	
35	615		665	
36	616		666	
37	617		667	
38	618		668	
39	619		669	
40	620		670	
41	621		671	
42	622		672	
43	623		673	
44	624		674	
45	625		675	
46	626		676	
47	627		677	
48	628		678	
49	629		679	

Point	Loc	r(in)or r/R	Loc	EI $\times 10^{-6}$ lb in ²
1	681	8.	731	1159.
2	682	0.082	732	1159.
3	683	0.082	733	364.
4	684	0.125	734	364.
5	685	0.125	735	265.
6	686	0.135	736	300.
7	687	0.187	737	79.2
8	688	0.342	738	70.3
9	689	0.381	739	59.2
10	690	0.519	740	59.2
11	691	0.537	741	50.9
12	692	0.96	742	50.9
13	693	0.96	743	55.1
14	694	1.0	744	55.1
15	695	9999999.	745	9999999.
16	696		746	
17	697		747	
18	698		748	
19	699		749	
20	700		750	
21	701		751	
22	702		752	
23	703		753	
24	704		754	
25	705		755	
26	706		756	
27	707		757	
28	708		758	
29	709		759	
30	710		760	
31	711		761	
32	712		762	
33	713		763	
34	714		764	
35	715		765	
36	716		766	
37	717		767	
38	718		768	
39	719		769	
40	720		770	
41	721		771	
42	722		772	
43	723		773	
44	724		774	
45	725		775	
46	726		776	
47	727		777	
48	728		778	
49	729		779	
50	730		780	

PROGRAM D01

SHEET 5

	Loc	No.
Lag EI Case No.	790	1.

	Loc	No.
Torsional Rigidity Case	900	1.

Point	Loc	r(in)or r/R	Loc	EI $\times 10^{-6}$ lb in ²
1	791	29.5	841	365.
2	792	0.125	842	365.
3	793	0.125	843	270.
4	794	0.187	844	403.
5	795	0.267	845	1524.
6	796	0.295	846	1500.
7	797	0.342	847	1615.
8	798	0.381	848	1606.
9	799	0.519	849	1606.
10	800	0.537	850	1546.
11	801	0.672	851	1546.
12	802	0.672	852	1965.
13	803	0.761	853	1965.
14	804	0.761	854	1546.
15	805	0.960	855	1546.
16	806	0.960	856	1603.
17	807	1.0	857	1603.
18	808	9999999.	858	9999999.
19	809		859	
20	810		860	
21	811		861	
22	812		862	
23	813		863	
24	814		864	
25	815		865	
26	816		866	
27	817		867	
28	818		868	
29	819		869	
30	820		870	
31	821		871	
32	822		872	
33	823		873	
34	824		874	
35	825		875	
36	826		876	
37	827		877	
38	828		878	
39	829		879	
40	830		880	
41	831		881	
42	832		882	
43	833		883	
44	834		884	
45	835		885	
46	836		886	
47	837		887	
48	838		888	
49	839		889	
50	840		890	

Point	Loc	r(in)or r/R	Loc	GJ $\times 10^{-6}$ lb in ²
1	901	8.	951	202.
2	902	0.125	952	202.
3	903	0.165	953	190.
4	904	0.1875	954	95.
5	905	0.294	955	82.1
6	906	0.339	956	65.2
7	907	0.342	957	75.2
8	908	0.381	958	60.0
9	909	0.519	959	60.0
10	910	0.537	960	49.5
11	911	1.0	961	49.5
12	912	9999999.	962	9999999.
13	913		963	
14	914		964	
15	915		965	
16	916		966	
17	917		967	
18	918		968	
19	919		969	
20	920		970	
21	921		971	
22	922		972	
23	923		973	
24	924		974	
25	925		975	
26	926		976	
27	927		977	
28	928		978	
29	929		979	
30	930		980	
31	931		981	
32	932		982	
33	933		983	
34	934		984	
35	935		985	
36	936		986	
37	937		987	
38	938		988	
39	939		989	
40	940		990	
41	941		991	
42	942		992	
43	943		993	
44	944		994	
45	945		995	
46	946		996	
47	947		997	
48	948		998	
49	949		999	
50	950		1000	

CASE 1

PROG CTL= 1. KQ= 0.0 MB= 10. CN= 3.
 FLAP BNDY= 1. CM= 0.2300000E 03 E= 0.0 MHB= 0.0
 TRG BNDY= 1. WS= 0.0 KZETA= 0.0 MHZ= 0.0
 R= 0.9000000E 02 WF= 0.4979999E 02 EBETA= 0.8000000E 01 KB= 0.0
 CZ= 0.2525000E 02 DM= 0.2000000E 00 EZETA= 0.2950000E 02
 RR= 0.1900000E 01 N= 15. CS= 0.7000000E 03
 G= 0.1025000E 02 INPUT FMB= 1. IP= 0.0
 KZ= 0.1185000E 05 DOF= 1. IL= 0.0

PRINCIPAL DIMENSIONS

CASE I. IN FT ILR/R
 R RAD 360.000 30.00000 1.00000000
 LAG 29.500 2.45833 0.08196441
 FLAP 8.000 0.66667 0.02222222
 SECTION DETAILS

CASE I.0 MASS WT ILR/R
 SECTN R IN RBETA RZETA

1	0.1684517E-01	0.6508975E 01	0.9949998E 00
	0.3582000E 03	0.3502000E 03	0.3287000E 03
2	0.3957659E-01	0.1544695F 02	0.9699991E 00
	0.3491997E 03	0.3411997E 03	0.3196997E 03
3	0.3560371E-01	0.1367999E 02	0.9249993E 00
	0.3329998E 03	0.3249998E 03	0.3034998E 03
4	0.7080740E-01	0.2735999E 02	0.8499993E 00
	0.3059998E 03	0.2979998E 03	0.2764998E 03
5	0.7148992E-01	0.2762332E 02	0.7499993E 00
	0.2699998E 03	0.2619998E 03	0.2464998E 03
6	0.7112044E-01	0.2748094E 02	0.6499996E 00
	0.2339999E 03	0.2259999E 03	0.2044999E 03
7	0.7315516E-01	0.2826715E 02	0.5499997E 00
	0.1974999E 03	0.1899999E 03	0.1684999E 03
8	0.7919258E-01	0.3060001E 02	0.4499996E 00
	0.1619399E 03	0.1539999E 03	0.1324999E 03
9	0.8543159E-01	0.3301093E 02	0.3499997E 00
	0.1260000E 03	0.1180000E 03	0.9649997E 02
10	0.9837663E-01	0.3801274E 02	0.2474999E 00
	0.8909998E 02	0.8109998E 02	0.5959998E 02
11	0.1241866E-01	0.4798569E 01	0.1874999E 00
	0.6749998E 02	0.5949998E 02	0.3799998E 02
12	0.1565216E-01	0.6647995E 01	0.1699999E 00
	0.6119997E 02	0.5319997E 02	0.3169997E 02
13	0.2151299E-01	0.8467178E 01	0.1459999E 00
	0.5255998E 02	0.4455998E 02	0.2365998E 02
14	0.1682498E 00	0.6501173E 02	0.1065722E 00
	0.3850999E 02	0.3050999E 02	0.9009995E 01
15	0.4139363E 00	0.1594449E 03	0.5204333E-01
	0.1875000E 02	0.1075000E 02	-0.1075000E 02

HUB	PS2	PS2	2 ND
FLAP	0.4922598E 03	0.1273965E 01	PS21
LAG	0.3323162E 03	0.8600321E 00	0.3444515E 05
	G=386.4 1/52		0.3266186E 05
			0.2642786E 05

First Mass Moment about Flap Hinge
 (Multiply by 12 and input in A97
 Locs. 37 & 58)

Second Mass Moment about Flap Hinge
 (Divide by 12 and input in A97
 Locs. 36 & 57)

CH47C SOLID TRAILING EDGE

PITCH INERTIA DISTRIBUTION
PRINCIPAL DIMENSIONS

CASE	I. IN	FT	ILR/R	R IN	R&ETA
R RAD	360.000	30.00000	1.00000000		
FLAP	8.000	0.66667	0.02222222		
CASE	I-O	ILR/R	R IN <td>R&ETA</td> <td></td>	R&ETA	
SECTN	PITCH				
1	0.4082510	0.9949998	358.1999512	350.1999512	
2	1.2434387	0.9699991	349.1997070	341.1997070	
3	1.3656826	0.9249993	332.9997559	324.9997559	
4	2.7137280	0.8499993	305.9997559	297.9997559	
5	2.9734612	0.7499993	269.9997559	261.9997559	
6	2.8208132	0.6499996	233.9998779	225.9998779	
7	2.7059002	0.5499997	197.9998779	189.9998779	
8	2.7396002	0.4499996	161.9998779	153.9998779	
9	2.7951708	0.3499999	125.9999695	117.9999695	
10	3.5861673	0.2474999	89.0999756	81.0999756	
11	0.1735106	0.1874999	67.4999847	59.4999847	
12	0.1045051	0.1699999	61.1999664	53.1999664	
13	0.1525461	0.1459999	52.5599823	44.5599823	
14	1.4354658	0.1069722	38.5099945	30.5099945	
15	3.6322412	0.0520833	18.7500000	10.7500000	
		PITCH INERTIA TOTAL			
			0.2885043E 02		

CH47C SOLID TRAILING EDGE

CHORD CENTROID IN AFT LE
PRINCIPAL DIMENSIONS

CASE	L IN	FT	ILR/R	ILR/R	ILR/R	ILR/R
R RAD	360.000	30.00000	1.00000000			
FLAP	8.000	0.66667	0.02222222			
CASE	1-0					
BLCRD	25.250	2.10417				
PITCH	4.924	0.41033				
SECTN	YNAFT					
	YN	K	IN	(AFT	ILR/R
1	0.6579996E 01	-0.1362390E 01	0.9945998E 00	0.3502000E 03	0.3502000E 03	0.9945998E 00
2	0.5693506E 01	0.3047549E 01	0.9695991E 00	0.3491997E 03	0.3491997E 03	0.9695991E 00
3	0.7695065E 00	0.5291082E 01	0.9249993E 00	0.3329998E 03	0.3329998E 03	0.9249993E 00
4	0.6259995E 01	0.5291071E 01	0.8499993E 00	0.3059998E 03	0.3059998E 03	0.8499993E 00
5	0.6436898E 01	0.5991676E 01	0.7499953E 00	0.2599998E 03	0.2599998E 03	0.7499953E 00
6	0.6341198E 01	0.5612665E 01	0.6499996E 00	0.2339999E 03	0.2339999E 03	0.6499996E 00
7	0.6215199E 01	0.5113653E 01	0.5499997E 00	0.1979999E 03	0.1979999E 03	0.5499997E 00
8	0.6099997E 01	0.4657413E 01	0.4499956E 00	0.1619999E 03	0.1619999E 03	0.4499956E 00
9	0.6075965E 01	0.4562237E 01	0.3499959E 00	0.1260000E 03	0.1260000E 03	0.3499959E 00
10	0.7112493E 01	0.8667297E 01	0.2474999E 00	0.8909998E 02	0.8909998E 02	0.2474999E 00
11	0.5289206E 01	0.1446359E 01	0.1874999E 00	0.6749998E 02	0.6749998E 02	0.1874999E 00
12	0.4896664E 01	-0.1082618E 00	0.1699999E 00	0.6119997E 02	0.6119997E 02	0.1699999E 00
13	-0.2733612E -01	0.2375668E -01	0.1459569E 00	0.5255998E 02	0.5255998E 02	0.1459569E 00
14	0.4929598E 01	0.2375668E -01	0.4455998E 02	0.3850999E 02	0.3850999E 02	0.4455998E 02
15	0.5998611E -02	0.2375668E -01	0.3050999E 02	0.2375668E -01	0.2375668E -01	0.3050999E 02
	0.5998611E -02	0.1875000E 02	0.1075000E 02			0.1075000E 02

CH47C SOLID TRAILING EDGE

FLAP EI
PRINCIPAL DIMENSIONS

CASE 1. IN FT ILR/R
R RAD 360.000 30.00000 1.00000C00
FLAP 3.000 0.66667 0.02222222
SECTION DETAILS

CASE SECTN	EIPIZ ILR/R INNER	DL IN R IN INNER	ILR/R OUTER	R IN OUTER
1- 2	0.551000E 08	0.9000244E 01	0.9949998E 00	0.3582000E 03
2- 3	0.9699991E 00	0.3491997E 03	0.9699991E 00	0.3491997E 03
3- 4	0.9249993E 00	0.3329998E 03	0.9249993E 00	0.3329998E 03
4- 5	0.8499993E 00	0.3059998E 03	0.8499993E 00	0.3059998E 03
5- 6	0.7499993E 00	0.2699998E 03	0.7499993E 00	0.2699998E 03
6- 7	0.6499993E 00	0.2339999E 03	0.6499993E 00	0.2339999E 03
7- 8	0.5499997E 00	0.1979999E 03	0.5499997E 00	0.1979999E 03
8- 9	0.4499996E 00	0.1619999E 03	0.4499996E 00	0.1619999E 03
9-10	0.3499999E 00	0.1260000E 03	0.3499999E 00	0.1260000E 03
10-11	0.2474999E 00	0.8909998E 02	0.2474999E 00	0.8909998E 02
11-12	0.1874999E 00	0.6749998E 02	0.1874999E 00	0.6749998E 02
12-13	0.1649994E 00	0.6119997E 02	0.1649994E 00	0.6119997E 02
13-14	0.1459999E 00	0.5255998E 02	0.1459999E 00	0.5255998E 02
14-15	0.1069722E 00	0.3850999E 02	0.1069722E 00	0.3850999E 02
15-16	0.5208333E-01	0.1875000E 02	0.5208333E-01	0.1875000E 02
	0.1159000E 10	0.1075000E 02		
	0.2222222E-C1	0.8000000E 01		
		INVERSE MEAN EI=		
			0.6571522E 08	

Similar Output for Leg EI and GJ

CM47C SOLID TRAILING EDGE

PAGE 8

N	XN	V	DM	I	YZ	EI FLAP	GJ	EI LAG
1	360.00000	0.01685	0.0	0.40825	-0.34420	0.55100E 08	0.49500E 08	0.16030E 10
2	356.39990	0.03998	0.0	1.24344	0.76931	0.51777E 08	0.49500E 08	0.15583E 10
3	341.99976	0.03540	0.0	1.36568	1.33660	0.50900E 08	0.49500E 08	0.15460E 10
4	323.99976	0.07081	0.0	2.71373	1.34650	0.50900E 08	0.49500E 08	0.15931E 10
5	287.99976	0.07149	0.0	2.97346	1.51220	0.50900E 08	0.49500E 08	0.18544E 10
6	251.99998	0.07112	0.0	2.82081	1.41720	0.50900E 08	0.49500E 08	0.15460E 10
7	215.99998	0.07316	0.0	2.70590	1.29120	0.57191E 08	0.57392E 08	0.15425E 10
8	180.00000	0.07919	0.0	2.73960	1.17600	0.60872E 08	0.61701E 08	0.16071E 10
9	143.99998	0.08543	0.0	2.79517	1.15197	0.72666E 08	0.76668E 08	0.15143E 10
10	107.99997	0.09838	0.0	3.58617	2.18889	0.77436E 08	0.91318E 08	0.80783E 10
11	70.20000	0.01242	0.0	0.17351	0.36521	0.11014E 09	0.12842E 09	0.53682E 10
12	64.79997	0.01565	0.0	0.17451	-0.02734	0.19799E 09	0.18084E 09	0.37148E 10
13	57.59998	0.02191	0.0	0.15255	0.00600	0.31265E 09	0.20028E 09	0.32789E 10
14	47.51999	0.16825	0.0	1.43547	0.00600	0.58134E 09	0.20200E 09	0.36500E 10
15	29.50000	0.41394	0.0	3.63224	0.06600	0.11590E 10	0.20200E 09	0.36500E 10
16	8.00000							

AX	AY	ACAMMA	SIGMA I	I I
3500.46743	-18.80156	-1204.13910	-0.00579	0.00199
11598.63281	-37.59766	5196.74219	0.03076	0.02367
18437.87203	-42.60899	14942.57556	0.04730	0.06519
31007.16016	-52.63177	32885.98438	0.09460	0.12638
42204.49219	-55.41458	51721.15234	0.10816	0.14363
51858.82813	-62.13142	67398.12500	0.10079	0.14284
60261.59765	-74.38768	80484.43750	0.09446	0.12146
67703.93750	-92.94783	91914.56250	0.09313	0.10952
73948.50000	-114.16132	102454.12500	0.09841	0.11337
79033.37500	-79.43491	117794.87500	0.21530	0.47117
79519.62500	-88.18655	119688.18750	0.00454	0.00166
80075.31250	-102.78119	120228.56250	-0.00043	0.00001
80743.43750	-122.78990	121120.56250	0.00013	0.00000
84502.12500	-276.41846	122868.25000	0.00101	0.00001
89004.50000	-654.38306	128357.25000	0.00248	0.00001

ARB= 135391.81250

UNCOUPLED FLAP BENDING

FREQUENCY SWEEP		KK=250		OMEGA RAD.		OMEGA		CPS		OMEGA RAD.		DUMEGA	
M	W	M	W	M	W	M	W	M	W	M	W	M	W
1	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
2	0.2	0.1256637E 01	0.1256637E 01	0.6822207E 10	0.6822207E 10	51	10.0	0.6283130E 02	0.6283130E 02	0.1431674E 09	0.1431674E 09	0.1431674E 09	0.1431674E 09
3	0.4	0.2513273E 01	0.2513273E 01	-0.6800167E 10	-0.6800167E 10	52	10.2	0.6408792E 02	0.6408792E 02	-0.1060790E 10	-0.1060790E 10	-0.1060790E 10	-0.1060790E 10
4	0.6	0.3769910E 01	0.3769910E 01	-0.6734328E 10	-0.6734328E 10	53	10.4	0.6534454E 02	0.6534454E 02	-0.2032696E 10	-0.2032696E 10	-0.2032696E 10	-0.2032696E 10
5	0.8	0.5026546E 01	0.5026546E 01	-0.6625030E 10	-0.6625030E 10	54	10.6	0.6660117E 02	0.6660117E 02	-0.3054670E 10	-0.3054670E 10	-0.3054670E 10	-0.3054670E 10
6	1.0	0.6283133E 01	0.6283133E 01	-0.6472950E 10	-0.6472950E 10	55	10.8	0.6785779E 02	0.6785779E 02	-0.4123154E 10	-0.4123154E 10	-0.4123154E 10	-0.4123154E 10
7	1.2	0.7539820E 01	0.7539820E 01	-0.6279074E 10	-0.6279074E 10	56	11.0	0.6911441E 02	0.6911441E 02	-0.5233533E 10	-0.5233533E 10	-0.5233533E 10	-0.5233533E 10
8	1.4	0.8794456E 01	0.8794456E 01	-0.6044561E 10	-0.6044561E 10	57	11.2	0.7037103E 02	0.7037103E 02	-0.6380786E 10	-0.6380786E 10	-0.6380786E 10	-0.6380786E 10
9	1.6	0.1005309E 02	0.1005309E 02	-0.5770887E 10	-0.5770887E 10	58	11.4	0.7162776E 02	0.7162776E 02	-0.7559537E 10	-0.7559537E 10	-0.7559537E 10	-0.7559537E 10
10	1.8	0.1130973E 02	0.1130973E 02	-0.5459755E 10	-0.5459755E 10	59	11.6	0.7289428E 02	0.7289428E 02	-0.9981875E 10	-0.9981875E 10	-0.9981875E 10	-0.9981875E 10
11	2.0	0.1256637E 02	0.1256637E 02	-0.5113131E 10	-0.5113131E 10	60	11.8	0.7414090E 02	0.7414090E 02	-0.1122454E 11	-0.1122454E 11	-0.1122454E 11	-0.1122454E 11
12	2.2	0.1382300E 02	0.1382300E 02	-0.4733219E 10	-0.4733219E 10	61	12.0	0.7539752E 02	0.7539752E 02	-0.1246694E 11	-0.1246694E 11	-0.1246694E 11	-0.1246694E 11
13	2.4	0.1507964E 02	0.1507964E 02	-0.4322386E 10	-0.4322386E 10	62	12.2	0.7665414E 02	0.7665414E 02	-0.1370765E 11	-0.1370765E 11	-0.1370765E 11	-0.1370765E 11
14	2.6	0.1633627E 02	0.1633627E 02	-0.3883371E 10	-0.3883371E 10	63	12.4	0.7791077E 02	0.7791077E 02	-0.1493882E 11	-0.1493882E 11	-0.1493882E 11	-0.1493882E 11
15	2.8	0.1759290E 02	0.1759290E 02	-0.341887E 10	-0.341887E 10	64	12.6	0.7916739E 02	0.7916739E 02	-0.1615231E 11	-0.1615231E 11	-0.1615231E 11	-0.1615231E 11
16	3.0	0.1884952E 02	0.1884952E 02	-0.2931872E 10	-0.2931872E 10	65	12.8	0.8042401E 02	0.8042401E 02	-0.1733957E 11	-0.1733957E 11	-0.1733957E 11	-0.1733957E 11
17	3.2	0.2010614E 02	0.2010614E 02	-0.2425723E 10	-0.2425723E 10	66	13.0	0.8168063E 02	0.8168063E 02	-0.1849179E 11	-0.1849179E 11	-0.1849179E 11	-0.1849179E 11
18	3.4	0.2136276E 02	0.2136276E 02	-0.1903725E 10	-0.1903725E 10	67	13.2	0.8293726E 02	0.8293726E 02	-0.1959986E 11	-0.1959986E 11	-0.1959986E 11	-0.1959986E 11
19	3.6	0.2261938E 02	0.2261938E 02	-0.1369373E 10	-0.1369373E 10	68	13.4	0.8419388E 02	0.8419388E 02	-0.2065440E 11	-0.2065440E 11	-0.2065440E 11	-0.2065440E 11
20	3.8	0.2387601E 02	0.2387601E 02	-0.8262835E 09	-0.8262835E 09	69	13.6	0.8545050E 02	0.8545050E 02	-0.2164566E 11	-0.2164566E 11	-0.2164566E 11	-0.2164566E 11
21	4.0	0.2513263E 02	0.2513263E 02	-0.2782164E 09	-0.2782164E 09	70	13.8	0.8670712E 02	0.8670712E 02	-0.2256393E 11	-0.2256393E 11	-0.2256393E 11	-0.2256393E 11
22	4.2	0.2638925E 02	0.2638925E 02	0.270929E 09	0.270929E 09	71	14.0	0.8796375E 02	0.8796375E 02	-0.2339918E 11	-0.2339918E 11	-0.2339918E 11	-0.2339918E 11
23	4.4	0.2764587E 02	0.2764587E 02	0.8174234E 09	0.8174234E 09	72	14.2	0.8922377E 02	0.8922377E 02	-0.2414105E 11	-0.2414105E 11	-0.2414105E 11	-0.2414105E 11
24	4.6	0.2890250E 02	0.2890250E 02	0.1357095E 10	0.1357095E 10	73	14.4	0.9047699E 02	0.9047699E 02	-0.2477935E 11	-0.2477935E 11	-0.2477935E 11	-0.2477935E 11
25	4.8	0.3015912E 02	0.3015912E 02	0.1886002E 10	0.1886002E 10	74	14.6	0.9173361E 02	0.9173361E 02	-0.2530369E 11	-0.2530369E 11	-0.2530369E 11	-0.2530369E 11
26	5.0	0.3141574E 02	0.3141574E 02	0.2400108E 10	0.2400108E 10	75	14.8	0.9299023E 02	0.9299023E 02	-0.2570354E 11	-0.2570354E 11	-0.2570354E 11	-0.2570354E 11
27	5.2	0.3267236E 02	0.3267236E 02	0.2895385E 10	0.2895385E 10	76	15.0	0.9424686E 02	0.9424686E 02	-0.2596852E 11	-0.2596852E 11	-0.2596852E 11	-0.2596852E 11
28	5.4	0.3392899E 02	0.3392899E 02	0.3367818E 10	0.3367818E 10	77	15.2	0.9550348E 02	0.9550348E 02	-0.2638812E 11	-0.2638812E 11	-0.2638812E 11	-0.2638812E 11
29	5.6	0.3518561E 02	0.3518561E 02	0.3813443E 10	0.3813443E 10	78	15.4	0.9676010E 02	0.9676010E 02	-0.2690797E 11	-0.2690797E 11	-0.2690797E 11	-0.2690797E 11
30	5.8	0.3644223E 02	0.3644223E 02	0.4228363E 10	0.4228363E 10	79	15.6	0.9801672E 02	0.9801672E 02	-0.2741839E 11	-0.2741839E 11	-0.2741839E 11	-0.2741839E 11
31	6.0	0.3769885E 02	0.3769885E 02	0.4608737E 10	0.4608737E 10	80	15.8	0.9927335E 02	0.9927335E 02	-0.2784698E 11	-0.2784698E 11	-0.2784698E 11	-0.2784698E 11
32	6.2	0.3895547E 02	0.3895547E 02	0.4950895E 10	0.4950895E 10	81	16.0	0.1005300E 03	0.1005300E 03	-0.2849079E 11	-0.2849079E 11	-0.2849079E 11	-0.2849079E 11
33	6.4	0.4021210E 02	0.4021210E 02	0.5251215E 10	0.5251215E 10	82	16.2	0.1017866E 03	0.1017866E 03	-0.2914839E 11	-0.2914839E 11	-0.2914839E 11	-0.2914839E 11
34	6.6	0.4146872E 02	0.4146872E 02	0.5506281E 10	0.5506281E 10	83	16.4	0.1030432E 03	0.1030432E 03	-0.2981839E 11	-0.2981839E 11	-0.2981839E 11	-0.2981839E 11
35	6.8	0.4272534E 02	0.4272534E 02	0.5712835E 10	0.5712835E 10	84	16.6	0.1042998E 03	0.1042998E 03	-0.3050556E 11	-0.3050556E 11	-0.3050556E 11	-0.3050556E 11
36	7.0	0.4398196E 02	0.4398196E 02	0.5867794E 10	0.5867794E 10	85	16.8	0.1055565E 03	0.1055565E 03	-0.3120055E 11	-0.3120055E 11	-0.3120055E 11	-0.3120055E 11
37	7.2	0.4523859E 02	0.4523859E 02	0.5968286E 10	0.5968286E 10	86	17.0	0.1068131E 03	0.1068131E 03	-0.3190471E 11	-0.3190471E 11	-0.3190471E 11	-0.3190471E 11
38	7.4	0.4649521E 02	0.4649521E 02	0.6011703E 10	0.6011703E 10	87	17.2	0.1080697E 03	0.1080697E 03	-0.3261839E 11	-0.3261839E 11	-0.3261839E 11	-0.3261839E 11
39	7.6	0.4775183E 02	0.4775183E 02	0.5995639E 10	0.5995639E 10	88	17.4	0.1093263E 03	0.1093263E 03	-0.333427E 11	-0.333427E 11	-0.333427E 11	-0.333427E 11
40	7.8	0.4900845E 02	0.4900845E 02	0.5917995E 10	0.5917995E 10	89	17.6	0.1105829E 03	0.1105829E 03	-0.340782E 11	-0.340782E 11	-0.340782E 11	-0.340782E 11
41	8.0	0.5026508E 02	0.5026508E 02	0.5776953E 10	0.5776953E 10	90	17.8	0.1118396E 03	0.1118396E 03	-0.348247E 11	-0.348247E 11	-0.348247E 11	-0.348247E 11
42	8.2	0.5152170E 02	0.5152170E 02	0.5570966E 10	0.5570966E 10	91	18.0	0.1130962E 03	0.1130962E 03	-0.355823E 11	-0.355823E 11	-0.355823E 11	-0.355823E 11
43	8.4	0.5277832E 02	0.5277832E 02	0.5258913E 10	0.5258913E 10	92	18.2	0.1143528E 03	0.1143528E 03	-0.363519E 11	-0.363519E 11	-0.363519E 11	-0.363519E 11
44	8.6	0.5403494E 02	0.5403494E 02	0.4959846E 10	0.4959846E 10	93	18.4	0.1156094E 03	0.1156094E 03	-0.371336E 11	-0.371336E 11	-0.371336E 11	-0.371336E 11
45	8.8	0.5529156E 02	0.5529156E 02	0.4553327E 10	0.4553327E 10	94	18.6	0.1168661E 03	0.1168661E 03	-0.379274E 11	-0.379274E 11	-0.379274E 11	-0.379274E 11
46	9.0	0.5654819E 02	0.5654819E 02	0.4079209E 10	0.4079209E 10	95	18.8	0.1181227E 03	0.1181227E 03	-0.387336E 11	-0.387336E 11	-0.387336E 11	-0.387336E 11
47	9.2	0.5780481E 02	0.5780481E 02	0.353710E 10	0.353710E 10	96	19.0	0.1193793E 03	0.1193793E 03	-0.395523E 11	-0.395523E 11	-0.395523E 11	-0.395523E 11
48	9.4	0.5906143E 02	0.5906143E 02	0.292924E 10	0.292924E 10	97	19.2	0.1206359E 03	0.1206359E 03	-0.403836E 11	-0.403836E 11	-0.403836E 11	-0.403836E 11
49	9.6	0.6031805E 02	0.6031805E 02	0.2255670E 10	0.2255670E 10	98	19.4	0.1218925E 03	0.1218925E 03	-0.412274E 11	-0.412274E 11	-0.412274E 11	-0.412274E 11
50	9.8	0.6157468E 02	0.6157468E 02	0.15172175E 04	0.15172175E 04	99	19.6	0.1231492E 03	0.1231492E 03	-0.420836E 11	-0.420836E 11	-0.420836E 11	-0.420836E 11
						100	19.8	0.1244058E 03	0.1244058E 03	-0.429523E 11	-0.429523E 11	-0.429523E 11	-0.429523E 11

Similar Output up to W250

CHK7C SOLID TRAILING EDGE

PAGE 13

INDICATOR FOR ITERATION IS 3
W 20 OMEGA= 0.2387601E 02 OMEGA=-0.2782164E 04
W 21 OMEGA= 0.2513263E 02 OMEGA= 0.270929E 04
ARRAY OF ITERATED W AND DW BETWEEN W 20 AND W 21

	OMEGA	DCOMEGA
W 1	0.2451257E 02	0.1050271E 06
W 2	0.2451231E 02	-0.1005135E 05
W 3	0.2451233E 02	-0.3445204E 04

FINAL COLLAPS MATRIX

-0.2817675D 08	0.8143195D 05	0.0
-0.8414707D 10	0.2426077D 08	0.0
0.1459301D 04	-0.4204556D 01	0.0
-0.9676938D 05	0.2789996D 03	0.0
0.0	0.0	-0.1239377D 07
0.0	0.0	0.9966716D 00

FREQUENCY PER REV. = 0.1017719E 01

VZ	MY	BETA	Z	MX	THETA
0.0	0.0	0.28831390-02	0.11307000 01	0.0	0.0
0.10121490 02	0.26525350 00	0.28831150-02	0.97605070 00	0.0	0.0
0.33518290 02	0.1505770 01	0.28628330-02	0.92734550 00	0.0	0.0
0.53245210 02	0.43490910 01	0.28813490-02	0.84952560 00	0.0	0.0
0.83388210 02	0.79318600 01	0.28776840-02	0.74535910 00	0.0	0.0
0.12142610 03	0.11122960 02	0.28724000-02	0.64235920 00	0.0	0.0
0.14887610 03	0.14812950 02	0.28655930-02	0.53939160 00	0.0	0.0
0.17257170 03	0.19913390 02	0.28575520-02	0.43607210 00	0.0	0.0
0.19332140 03	0.27829930 02	0.28472610-02	0.3339480 00	0.0	0.0
0.21043590 03	0.41870940 02	0.28342790-02	0.22857810 00	0.0	0.0
0.22394660 03	0.50661910 02	0.28226820-02	0.16748410 00	0.0	0.0
0.22519630 03	0.56057390 02	0.28190490-02	0.14971050 00	0.0	0.0
0.22660430 03	0.64024020 02	0.28170400-02	0.12930970 00	0.0	0.0
0.22825480 03	0.76945160 02	0.28139170-02	0.85901550-01	0.0	0.0
0.23692880 03	0.62112390 02	0.28115870-02	0.30222510-01	0.0	0.0
0.24444560 03	-0.35602220-01	0.28112980-02	-0.11330950-12	0.0	0.0
0.24444560 03	-0.35602220-01	0.28112980-02	-0.11330950-12	0.0	0.0

GEN. FLAP MASS = 0.25905150E 00

GEN. PITCH INERTIA = 0.0

Similar Output for Other Natural Frequencies

CM47C SOLID TRAILING EDGE

PAGE 23

COUPLED FLAP BENDING TORSION.

MOTOR SPEED = 230. RPM

MODE NUMBER	RPS	FREQUENCY		PEK REV
		CPM		
1	2.4512329E 01	2.3407550E 02	1.0177193E 00	
2	6.2527945E 01	5.5805273E 02	2.6302233E 03	
3	1.1705135E 02	1.1177576E 03	4.8756175E 03	
4	1.9555931E 02	1.8674539E 03	3.1193647E 00	
5	3.0094556E 02	2.8738179E 03	1.2494804E 01	

NERR=0 5 MODES.

CHK7C SOLID TRAILING EDGE

PAGE 24

RESULTANT MATRIX FOR ORTHOGONALITY CHECK

0.2590515E 00	0.3984431E-05	0.3106659E-05	-0.1739711E-05	0.1533778E-05
0.3980938E-05	0.1908155E 00	0.2114880E-02	0.1723805E-04	0.1407494E-03
0.3099442E-05	0.2114880E-02	0.2223307E 00	0.9941395E-02	0.3102896E-04
-0.1486274E-05	0.1729954E-04	0.9941395E-02	0.2503014E 00	0.2745440E-01
0.1520384E-05	0.1407717E-04	0.3106659E-05	0.84934959E-01	0.2630276E 00

CH47C SOLID TRAILING EDGE

PAGE 25

NORMALIZED MATRIX FOR ORTHOGONALITY CHECK.

0.5999799E 00	0.1792111E-04	0.1294490E-04	-0.746770E-05	0.5894974E-04
0.1790539E-04	0.9999992E 00	0.1026781E-01	0.7576654E-03	0.62R2572E-03
0.1291488E-04	0.1026781E-01	0.9999999E 00	0.4216755E-01	0.3351974E-02
-0.7805046E-05	0.7874334E-03	0.4216755E-01	0.9794996E 00	0.9375538E-01
0.5824509E-05	0.6283568E-03	0.3352020E-02	0.9375568E-01	0.9999999E 00

EFFECTIVE MASS, DAMPING, AND MOMENT OF INERTIA IN FLAP REACTION FORMS.

#2	CPS	M3AK	CM24	IAAR	CM21
M 1	0.0	0.2433943E 01	0.373762E 32	-0.2061839E 08	0.0000000E 00
M 2	0.2	0.2430550E 01	0.376962E 32	-0.1562218E 08	-0.170445E 07
M 3	0.4	0.2420612E 01	0.410570E 32	-0.4848626E 07	-0.1100000E 07
M 4	0.6	0.2403335E 01	0.430660E 32	-0.1061939E 07	-0.1100000E 07
M 5	0.8	0.2378126E 01	0.433747E 32	-0.1060659E 07	-0.1100000E 07
M 6	1.0	0.2344378E 01	0.435217E 32	-0.6492859E 06	-0.1100000E 07
M 7	1.2	0.2298916E 01	0.435750E 32	-0.4821041E 06	-0.1100000E 07
M 8	1.4	0.2241784E 01	0.434901E 32	-0.3348737E 06	-0.1100000E 07
M 9	1.6	0.2170858E 01	0.4325859E 32	-0.2252246E 06	-0.1100000E 07
M 10	1.8	0.2082484E 01	0.428540E 32	-0.1725348E 06	-0.1100000E 07
M 11	2.0	0.1977531E 01	0.422872E 32	-0.1130349E 06	-0.1100000E 07
M 12	2.2	0.1853214E 01	0.4157394E 32	-0.1104576E 06	-0.1100000E 07
M 13	2.4	0.1710382E 01	0.4068795E 32	-0.9131146E 05	-0.1100000E 07
M 14	2.6	0.1551583E 01	0.3957975E 32	-0.7678626E 05	-0.1100000E 07
M 15	2.8	0.1382141E 01	0.3823234E 32	-0.629494E 05	-0.1100000E 07
M 16	3.0	0.1210361E 01	0.3675942E 32	-0.5653144E 05	-0.1100000E 07
M 17	3.2	0.1046852E 01	0.3527912E 32	-0.5620633E 05	-0.1100000E 07
M 18	3.4	0.9029245E 00	0.338424E 32	-0.5233775E 05	-0.1100000E 07
M 19	3.6	0.783444E 00	0.3248856E 32	-0.3878659E 05	-0.1100000E 07
M 20	3.8	0.7094412E 00	0.3121074E 32	-0.302731E 05	-0.1100000E 07
M 21	4.0	0.667611E 00	0.3006989E 32	-0.2727278E 05	-0.1100000E 07
M 22	4.2	0.6416077E 00	0.2905584E 32	-0.245631E 05	-0.1100000E 07
M 23	4.4	0.6285204E 00	0.281574E 32	-0.2276726E 05	-0.1100000E 07
M 24	4.6	0.624170E 00	0.273620E 32	-0.2170726E 05	-0.1100000E 07
M 25	4.8	0.626564E 00	0.266729E 32	-0.2135113E 05	-0.1100000E 07
M 26	5.0	0.6321828E 00	0.2615930E 32	-0.1845113E 05	-0.1100000E 07
M 27	5.2	0.6506835E 00	0.2571869E 32	-0.1740930E 05	-0.1100000E 07
M 28	5.4	0.1041282E 01	0.2540943E 32	-0.1606153E 05	-0.1100000E 07
M 29	5.6	0.1129240E 01	0.2526625E 32	-0.1503152E 05	-0.1100000E 07
M 30	5.8	0.1217309E 01	0.2518042E 32	-0.138943E 05	-0.1100000E 07
M 31	6.0	0.1304693E 01	0.2515099E 32	-0.1317710E 05	-0.1100000E 07
M 32	6.2	0.1391052E 01	0.2516831E 32	-0.1268569E 05	-0.1100000E 07
M 33	6.4	0.1476334E 01	0.25210077E 32	-0.1238238E 05	-0.1100000E 07
M 34	6.6	0.1560697E 01	0.25270099E 32	-0.1225003E 05	-0.1100000E 07
M 35	6.8	0.164403E 01	0.2534863E 32	-0.1225003E 05	-0.1100000E 07
M 36	7.0	0.1727753E 01	0.2543859E 32	-0.1225003E 05	-0.1100000E 07
M 37	7.2	0.1811009E 01	0.2553354E 32	-0.1225003E 05	-0.1100000E 07
M 38	7.4	0.1894318E 01	0.2563341E 32	-0.1225003E 05	-0.1100000E 07
M 39	7.6	0.1977599E 01	0.2573815E 32	-0.1225003E 05	-0.1100000E 07
M 40	7.8	0.2060358E 01	0.2584859E 32	-0.1225003E 05	-0.1100000E 07
M 41	8.0	0.2141673E 01	0.2596529E 32	-0.1225003E 05	-0.1100000E 07
M 42	8.2	0.2220801E 01	0.2608792E 32	-0.1225003E 05	-0.1100000E 07
M 43	8.4	0.2298712E 01	0.2621673E 32	-0.1225003E 05	-0.1100000E 07
M 44	8.6	0.2375424E 01	0.2635199E 32	-0.1225003E 05	-0.1100000E 07
M 45	8.8	0.2450339E 01	0.2649399E 32	-0.1225003E 05	-0.1100000E 07
M 46	9.0	0.2523204E 01	0.2664270E 32	-0.1225003E 05	-0.1100000E 07
M 47	9.2	0.2594553E 01	0.2679815E 32	-0.1225003E 05	-0.1100000E 07
M 48	9.4	0.2663754E 01	0.2696031E 32	-0.1225003E 05	-0.1100000E 07
M 49	9.6	0.2731417E 01	0.2712925E 32	-0.1225003E 05	-0.1100000E 07
M 50	9.8	0.2797606E 01	0.2730499E 32	-0.1225003E 05	-0.1100000E 07

Similar Output up to W250

TABLE OF AMPLITUDE AND PHASE ANGLE -- FLAP BENDING TORSION

MZ	CPS	RI	PHI	TAO	PHI
W 1	0.0	0.3745279E 02	-0.0999976F 02	0.2-72451F 08	-0.8005570F 02
W 2	0.2	0.2993581E 02	-0.9465723E 02	0.14664181E 08	0.2673774E 01
W 3	0.4	0.1525609E 02	-0.9912939E 02	0.4567866E 01	0.5667866E 01
W 4	0.6	0.1043238E 02	-0.1032544E 03	0.1977184E 07	0.7125518E 01
W 5	0.8	0.8176332E 01	-0.1066079E 03	0.1072733E 07	0.4672913E 01
W 6	1.0	0.6648459E 01	-0.1100129E 03	0.6591744E 06	0.5659162E 01
W 7	1.2	0.6301115E 01	-0.1125247E 03	0.45387763E 06	0.1008109E 02
W 8	1.4	0.5420159E 01	-0.1144312E 03	0.3094139E 06	0.9820938E 01
W 9	1.6	0.4997663E 01	-0.1157402E 03	0.2281478E 06	0.9163701E 01
W 10	1.8	0.4672864E 01	-0.1168477E 03	0.1744186E 06	0.8201416E 01
W 11	2.0	0.4407417E 01	-0.1166592E 03	0.1374076E 06	0.6584772E 01
W 12	2.2	0.4176649E 01	-0.1163406E 03	0.1109378E 06	0.5629059E 01
W 13	2.4	0.3962381E 01	-0.1155725E 03	0.9159856E 05	0.4206825E 01
W 14	2.6	0.3751844E 01	-0.1144307E 03	0.7637558E 05	0.2765182E 01
W 15	2.8	0.3534590E 01	-0.1130163E 03	0.6251265E 05	0.1332489E 01
W 16	3.0	0.3306201E 01	-0.1114744E 03	0.5653149E 05	-0.8152771E -01
W 17	3.2	0.3064692E 01	-0.1099734E 03	0.4932281E 05	-0.1477173E 01
W 18	3.4	0.2812498E 01	-0.1087258E 03	0.4439194E 05	-0.2803815E 01
W 19	3.6	0.2555683E 01	-0.1079673E 03	0.3442791E 05	-0.6250051E 01
W 20	3.8	0.2302934E 01	-0.1074621E 03	0.3348945E 05	-0.5668350E 01
W 21	4.0	0.2064390E 01	-0.1068813E 03	0.3093938E 05	-0.7122360E 01
W 22	4.2	0.1948777E 01	-0.1109888E 03	0.2794432E 05	-0.8637680E 01
W 23	4.4	0.1665184E 01	-0.1142933E 03	0.2540102E 05	-0.1074512E 02
W 24	4.6	0.1513185E 01	-0.1184191E 03	0.2322105E 05	-0.1163813E 02
W 25	4.8	0.1413654E 01	-0.1242937E 03	0.2131990E 05	-0.1377133E 02
W 26	5.0	0.1348079E 01	-0.1303132E 03	0.1969153E 05	-0.1576173E 02
W 27	5.2	0.1318746E 01	-0.1365901E 03	0.1829915E 05	-0.1793941E 02
W 28	5.4	0.1319726E 01	-0.1420933E 03	0.1712372E 05	-0.2032855E 02
W 29	5.6	0.1344300E 01	-0.1471421E 03	0.1617961E 05	-0.2292854E 02
W 30	5.8	0.1386216E 01	-0.1541499E 03	0.1544066E 05	-0.2567113E 02
W 31	6.0	0.1443393E 01	-0.1649297E 03	0.1499070E 05	-0.2839377E 02
W 32	6.2	0.1503095E 01	-0.1773733E 03	0.1473011E 05	-0.3085219E 02
W 33	6.4	0.1571763E 01	-0.1949316E 03	0.1467698E 05	-0.3274174E 02
W 34	6.6	0.1644800E 01	-0.2161596E 03	0.1472209E 05	-0.3385670E 02
W 35	6.8	0.1721292E 01	-0.2424101E 03	0.1483691E 05	-0.3411806E 02
W 36	7.0	0.1800811E 01	-0.2736230E 03	0.1500307E 05	-0.3357455E 02
W 37	7.2	0.1883269E 01	-0.3040707E 03	0.1504362E 05	-0.3236574E 02
W 38	7.4	0.1963759E 01	-0.33641936E 03	0.1501578E 05	-0.3064455E 02
W 39	7.6	0.2057472E 01	-0.3698277E 03	0.1485121E 05	-0.2860362E 02
W 40	7.8	0.2149540E 01	-0.4034377E 03	0.1457368E 05	-0.2639508E 02
W 41	8.0	0.2244907E 01	-0.4362536E 03	0.141916F 05	-0.2414778E 02
W 42	8.2	0.2343071E 01	-0.4681259E 03	0.1376000E 05	-0.2156676E 02
W 43	8.4	0.2442784E 01	-0.5045415E 03	0.1325058E 05	-0.1898255E 02
W 44	8.6	0.2541542E 01	-0.5436400E 03	0.1272185E 05	-0.1796236E 02
W 45	8.8	0.2634969E 01	-0.5866360E 03	0.1218252E 05	-0.1670990E 02
W 46	9.0	0.2716147E 01	-0.6342117E 03	0.1164634E 05	-0.1462447E 02
W 47	9.2	0.279228E 01	-0.6867577E 03	0.1112276E 05	-0.1319942E 02
W 48	9.4	0.2863000E 01	-0.7442345E 03	0.1061409E 05	-0.1142001E 02
W 49	9.6	0.2778249E 01	-0.8080033E 03	0.1013629E 05	-0.1077449E 02
W 50	9.8	0.2701979E 01	-0.8779954E 03	0.9673289E 04	-0.9743027E 01

Similar Output up to W250

• PRECEDING PAGE BLANK - NOT FILMED. •

EXHIBIT

1945

100

100

FOR THE YEAR ENDED 31st DECEMBER 1945
STATEMENT OF INCOME AND EXPENDITURE
OF THE ...

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<u>NO.</u>	<u>SYM</u>	<u>UNIT</u>	<u>DEFINITION</u>
27	C_F	ft	Forward rotor blade chord length - obtained from the projection of the leading-edge and trailing-edge span lines to the center of rotation
28	b_F	-	Number of blades in the front rotor
29	e_F	ft	Front rotor blade flapping hinge offset (usually written as $e_{\beta F}$)
30	σ_{1F}	-	Increment in solidity at the tip (forward rotor) based on a linear variation from the reference root (input 27, C_F) to the tip: $\sigma_{1F} = b_F (C_{TIP} - C_F) / \kappa R_F$
31	θ_{TWF}	deg	Angle of total twist of forward rotor blade from reference root at the centerline of rotation to the tip Positive leading edge up at blade tip
32	X_{CF}	-	Forward rotor radius ratio for blade cutout
33	$k_{\beta F}$	-	Rate of change of front rotor blade pitch angle with rotor blade flap angle. Equal to $-\tan \delta_3$
34	i_F	deg	Angle of incidence of the front rotor shaft in the helicopter X - Z plane Positive into the wind
35	V_{TF}	ft/sec	Front rotor blade tip speed
36	I_F	slugs-ft ²	Mass moment of inertia of the forward rotor blade about the flapping hinge (usually written as $I_{\beta F}$). Obtain from D-01
37	M_{WF}	ft-lb	Weight moment of the forward rotor blade about the flapping hinge in a horizontal position (gM_{β}). Obtain from D-01

<u>NO.</u>	<u>SYM</u>	<u>UNIT</u>	<u>DEFINITION</u>
38	B_{ITF}	deg	Front rotor longitudinal cyclic pitch angle due to trim devices other than longitudinal control. Generally a function of dynamic pressure
44	l_F	ft	Distance from the helicopter cg to the projection of the front rotor hub on the X axis
45	h_F	ft	Distance from the helicopter cg to the front rotor hub measured parallel to the helicopter Z axis
46	d_F	ft	Lateral distance from helicopter cg to the front rotor shaft
47	R_R	ft	Rear rotor blade radius measured from the center of rotation
48	C_R	ft	Rear rotor blade chord length - obtained from the projection of the leading-edge and trailing-edge span lines to the center of rotation
49	b_R	-	Number of blades in the rear rotor
50	e_R	ft	Rear rotor blade flapping hinge offset (usually written as $e_{\beta R}$)
51	σ_{1R}	-	Increment in solidity at the tip (rear rotor) based on a linear variation from the reference root (input 48, C_R)
52	θ_{TWR}	deg	Angle of total twist of rear rotor blade from reference root at the centerline of rotation to the tip. Positive leading edge up at blade tip.
53	X_{CR}	-	Rear rotor radius ratio for blade cutout
54	$k_{\beta R}$	-	Rate of change of rear rotor blade pitch angle with rotor blade flap angle. Equal to $-\tan \delta_3$

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<u>NO.</u>	<u>SYM</u>	<u>UNIT</u>	<u>DEFINITION</u>
117 to 125	σ_1 to σ_9	-	The solidity (based on local chord $bc_\eta/\pi R$) value corresponding to the above X_η stations. Leave blank if solidity is input in equation form.
126 to 134	θ_{TW1} to θ_{TW9}	-	The twist value ($\theta_{TW\eta}$) corresponding to the specified X_η location. Leave blank if twist is input in equation form.

NOTE: C-70 input descriptions indicate how to calculate the required trim data and identify the appropriate A-97 output needed.

RETURN TO:	
PROGRAM A-97	HELICOPTER MODEL CH-47C
BOMAC	

**TRIM AND STABILITY
ANALYSIS FOR
TANDEM HELICOPTERS**

AIRFOIL DATA $C_L + C_D$	TABLE 2	TABLE 4
TABLE 1	TABLE 3	TABLE 5

INPUT			CASE NO.	INPUT			CASE NO.	INPUT			CASE NO.
NO.	SYM	UNIT		NO.	SYM	UNIT		NO.	SYM	UNIT	
1	V	KNOTS	123.	49	b _R	—	3.	97	δ_{AICF}	DEG.	0.
2	R/C	FT./MIN	0.	50	e _R	FT.	0.6667	98	δ_{BICR}	DEG.	0.
3	G.W.	LBS.	38865.	51	σ_{IR}	—	0.	99	δ_{AICR}	DEG.	0.
4	H _P	FT.	6476.	52	θ_{TWR}	DEG.	-9.137	100	N _{TABES}	—	1.
5	T	° F	46.	53	X _{CR}	—	0.195	101	X _{TAB1}	—	
6	β_F	DEG.	0.	54	k _{BR}	—	0.	102	X _{TAB2}	—	
7	α_{FF}	LBS/HR	0.	55	i _R	DEG.	4.	103	X _{TAB3}	—	
8	β_{FF}	LBS/HR SHP	0.	56	V _{TR}	FT./SEC	722.6	104	X _{TAB4}	—	
9	K _{FF}	—	1.05	57	I _R	SLUGS -FT ²	2671.8	105	X _{TAB5}	—	
10	N _{FF}	—	1.	58	M _{WR}	FT-LBS	4612.2	106	θ_{TW1}	—	
11	η_F	—	0.94	59	B _{ITR}	DEG.	1.1	107	N _X	—	
12	η_R	—	0.94	60	B _{ICR_B}	DEG./IN	0.	108	X ₁	—	
13	B _{IP}	ACC HP	0.	61	A _{ICR_L}	DEG./IN	0.	109	X ₂	—	
14	V _{HW}	KNOTS	0.	62	A _{ICR_R}	DEG./IN	0.	110	X ₃	—	
15	f _e	FT ²	46.5	63	θ_{TR}	DEG.	0.	111	X ₄	—	
16	Δu	FT/SEC	0.	64	θ_{RB	DEG./IN	0.	112	X ₅	—	
17	Δv	FT/SEC	0.	65	l _R	FT.	18.1	113	X ₆	—	
18	Δw	FT/SEC	0.	66	h _R	FT.	11.95	114	X ₇	—	
19	Δp	DEG/SEC	0.	67	d _R	FT.	0.	115	X ₈	—	
20	Δq	DEG/SEC	0.	68	l _C	FT.	-1.	116	X ₉	—	
21	Δr	DEG/SEC	0.	69	h _C	FT.	-1.2	117	σ_1	—	
22	$\Delta \delta_c$	DEG.	0.	70	d _C	FT.	0.	118	σ_2	—	
23	$\Delta \delta_b$	IN.	0.	71	INT	—	0.	119	σ_3	—	
24	$\Delta \delta_L$	IN.	0.	72	DER	—	0.	120	σ_4	—	
25	$\Delta \delta_R$	IN.	0.	73	F	LBS.	0.	121	σ_5	—	
26	R _F	FT.	30.	74	X _{FF}	FT.	0.	122	σ_6	—	
27	C _F	FT.	2.1042	75	Y _{FF}	FT.	0.	123	σ_7	—	
28	b _F	—	3.	76	Z _{FF}	FT.	0.	124	σ_8	—	
29	e _F	FT.	0.6667	77	ψ_{FF}	DEG.	0.	125	σ_9	—	
30	ψ_{IF}	—	0.	78	θ_{FF}	DEG.	0.	126	θ_{TW1}	DEG.	
31	θ_{TAF}	DEG.	-9.137	79	I _{XX}	SLUGS -FT ²	0.	127	θ_{TW2}	DEG.	
32	α_{CF}	—	0.195	80	I _{YY}	SLUGS -FT ²	0.	128	θ_{TW3}	DEG.	
33	k _{BF}	—	0.	81	I _{ZZ}	SLUGS -FT ²	0.	129	θ_{TW4}	DEG.	
34	I _I	DEG. FT/SEC	9.	82	I _{XZ}	SLUGS -FT ²	0.	130	θ_{TW5}	DEG.	
35	V _{IF}	FT/SEC	722.6	83	T _{CHAR}	—	0.	131	θ_{TW6}	DEG.	
36	I _F	SLUGS -FT ²	2671.8	84	—	—	0.0	132	θ_{TW7}	DEG.	
37	M _{WF}	FT-LBS	4612.2	85	U	DEG.	0.	133	θ_{TW8}	DEG.	
38	θ_{ITF}	DEG.	0.5	86	T _{θ}	—	0.	134	θ_{TW9}	DEG.	
39	B _{ICR_B}	DEG/IN	0.	87	T _{LD}	—	0.	135	IN- PUT		1.0
40	A _{ICR_L}	DEG/IN	0.	88	T _T	LBS.	0.				
41	A _{ICR_R}	DEG/IN	0.	89	θ_T	DEG.	0.				
42	θ_{TF}	DEG.	0.	90	ψ_T	DEG.	0.				
43	θ_{fB	DEG/IN	0.	91	X _T	FT.	0.				
44	l _F	FT.	20.8	92	Y _T	FT.	0.				
45	h _F	FT.	7.35	93	Z _T	FT.	0.				
46	d _F	FT.	0.	94	σ_{fC	DEG./IN	0.				
47	R _R	FT.	30.	95	σ_{fC	DEG./IN	0.				
48	C _R	FT.	2.1042	96	β_{BICF}	DEG.	0.				

NOTE:
LOC 106 = 1 σ -TAB θ_{tw} -EQU
 = 2 σ -EQU θ_{tw} -TAB
 = 3 σ -TAB θ_{tw} -TAB
 = 4 σ -EQU θ_{tw} -EQU

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13. ABSTRACT This report provides user's instructions for two computer programs, one for aeroelastic stability analysis and one for aeroelastic prop/rotor loads analysis. These programs are commonly identified by Boeing-Vertol as C-39 and C-70, respective- ly. Each program is carefully described and explained, symbols and sign conventions are identified, and input and output data are presented. A sample program run for each analysis is then given. In addition, sample programs for subroutines D-01 and A-97, which are used in support of C-70, are provided. Notes and suggestions on program usage are presented. The methods contained in this report are intended to be used by designers to calculate with improved accuracy, the dynamic and aeroelastic response characteris- tics of rotor powered V/STOL aircraft. The essential new feature of these methods is that the coupled flap-pitch-lag blade deflections are taken into account. These calculations are essential if a high level of confidence is to be had in the results.		

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