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REPORT NO. E-SAF-MX1016-1
MODEL B-29 - F-84

C O N F I D E N T I A L

Report No. E-SAF-MX-1016-1
VIBRATION AND FLUTTER ANALYSIS OF THE
B-29 - F-84 TIP-TO-TIP CONFIGURATION

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B-29 - F-84 Tip-to-Tip Configuration

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REFERENCES

1. Ackerman, W. E. "Design Data for Flutter Analysis - Model XB-29," Boeing Report D-3755 dated 6-43.
2. Rosenbaum, R. "Vibration and Flutter Analysis - XP-84," R.A.C. Report ERS-58.
3. Smilg, B., Wasserman, L. "Application of Three Dimensions Flutter Theory to Aircraft Structure," AFTh 4798, dated 7-42.



NOTATION

<u>SYMBOL</u>	<u>DEFINITION</u>	<u>UNITS</u>
h_i	Vertical deflection of wing elastic axis at station i	in.
a_{ij}	Bending or torsion influence coefficient. Deflection at station i due to unit force at station j	in./# or rad./in.#
F_j	Acceleration force at station j	#
ω	Natural frequency of the wing; also flutter frequency	rad./sec.
(K)	Symmetric matrix of influence coefficients	
(M)	Diagonal matrix of "lumped" masses	slugs
M_{29}	Tip mass of B-29 wing tip	slugs
K_x	Radius of gyration of F-84 in roll	in.
B	F-84 wing span	in.
$\{ \}$	Brackets indicate a column vector	
β_i	Flapping of the F-84 about attachment hinge in the i th bending mode	rad.
M_0	Half the mass of the B-29 fuselage	slugs
m_i	Lumped mass at station i	slugs
θ_i	Roll of the B-29 fuselage	rad.
x	Station along the elastic axis	in. & ft.
I_y	Rolling moment inertia of half the B-29 fuselage	slug. ft. ²
(I)	Unit matrix	
T_j	Acceleration torque at station j	# in.
$\mathcal{I}_i$	Lumped moment of inertia at station i	slug. ft. ²

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NOTATION

<u>SYMBOL</u>	<u>DEFINITION</u>	<u>UNIT</u>
α_i	Angle of attack at station i	rad.
$q(t)$	Generalized coordinate, assumed a harmonic function of time	
A_{ij}	Generalized mass due to inertia coupling of i th and j th degrees of freedom	slug. ft. ²
δ_i	Aileron deflection of the F-84 in the i th degree of freedom	rad.
ψ	Sweep-back angle of the skewed attachment hinge line	rad.
g	Percentage of critical structural damping	
V	True airspeed	ft./sec.



SUMMARY

The B-29 - F-84 tip-to-tip configuration, using a two point attachment, is shown to be free from flutter instability at an altitude of 20,000 ft. up to a speed of 300 mph (I.A.S.).

The aileron deflection, geared to the F-84 flapping at a ratio of $0.835:\beta$, plus the $3^{\circ}36'$ skewed axis of attachment are sufficient to supply flutter stability up to the design true airspeed of 300 mph at 20,000 ft. altitude.

INTRODUCTION

The purpose of the tip-to-tip project is to extend the action radius of protective fighters accompanying a B-29 bomber. At the suggestion of Republic Aviation and the Dynamics Branch of AMC it was agreed to determine the flutter characteristics of the Airborne tip-to-tip configuration.

Due to the low bending, torsion and F-84 flapping frequencies anticipated for the attached configuration it was decided that any flutter instability would of necessity be of the dynamic instability, low frequency type, rather than the classical higher frequency variety involving second and higher elastic vibration modes. In addition, the damping influence of the tail surfaces was neglected, and it was agreed to include these effects only if the basic wing-fuselage flutter analysis showed instability.



The admissible degrees of freedom were taken to be:

- a) Symmetric Case: B-29 bending (including the associated F-84 flap), B-29 torsion (including one attached F-84 wing panel), F-84 flapping.
- b) Anti-symmetric Case: B-29 rigid roll (including F-84 flap), B-29 bending (including F-84 flap), B-29 torsion (including one elastic F-84 wing panel), F-84 flapping.

The aileron deflection, geared to the flapping of the F-84 relative to the B-29 wing tip was included in the flutter analysis only in so far as air loads are concerned. The inertia effects of this degree of freedom were neglected as an insignificant contribution to the net kinetic energy of the configuration in flapping. The aerodynamic effect of the induced F-84 angle of attack resulting from flapping about a skewed axis, sweptback from the line of flight, was taken into account, although this contribution to the net aerodynamic work done was found to be negligible in all cases.

The influence of rigid translation of the B-29 was neglected for the symmetric case on the argument that this is a stabilizing influence, and would be included only if flutter instability was evidenced in the analysis.

The vibration analysis was carried out using the B-29 mass and flexibility data supplied by Boeing in Reference 1. The F-84 mass and flexibility data were obtained from Reference 2. Uncoupled bending and torsion modes were computed and used in the flutter analysis.

The analysis is limited to the following condition of flight:

- a. 97,500# B-29 bomber
- b. Two 14,450# F-84 fighters
- c. 20,000' altitude



VIBRATION ANALYSIS

a) Symmetric Modes (bending)

The vibration analysis employed in this report makes use of the usual matrix iteration methods.

The entire structural inertia is assumed to be concentrated along the elastic axis of the wing. For the purposes of this analysis, the e.a. was taken to be the 25% chord of the B-29 wing. Let a_{ij} be the cantilevered bending influence coefficient of the B-29 wing at station i , due to a unit (1 lb.) load at station j . Then, the symmetric mode deflection of station i , relative to the fuselage is given by

$$h_i - h_o = \sum_{j=1}^n a_{ij} F_j \quad (1)$$

Assuming zero structural damping, the acceleration force at station j is given by

$$F_j = \omega^2 m_j h_j \quad (2)$$

In matrix form, Eq.'s (1) and (2) become

$$\{h - h_o\} = \omega^2 (K)(M)\{h\} \quad (3)$$

For the B-29 wing tip mass, m_n , assuming that the attached F-84 does not experience elastic bending at these low frequencies, but merely flaps about the skewed axis, the tip force is given by

$$F_{tip} = \omega^2 [M_{29} + M_{eff}] h_n \quad (4)$$



The effective mass of the flapping F-84 is given by

$$M_{eff} = M_{84} + \frac{k_x^2}{B^2 + k_x^2} \quad (5)$$

and the flap angle, β , resulting from a unit deflection of the B-29 wing tip is given by

$$\beta = - \frac{1}{B + \frac{k_x^2}{B}} \quad (6)$$

The B-29 fuselage deflection, h_o , is obtained by requiring that the vibrating configuration be in equilibrium.

$$h_o = - \frac{1}{M_o} \sum_{i=1}^n m_i h_i \quad (7)$$

The matrix equation (Eq. 3) may be written in its characteristic form by eliminating h_o , or

$$\{h\} = \frac{\omega^2}{\Sigma} (\Sigma I - (M)) (K) (M) \{h\} \quad (8)$$

where,

$$\Sigma = \sum_{i=1}^n m_i$$

and

$$(\bar{M}) = \begin{pmatrix} m_1 & m_2 & \dots & m_n \\ m_1 & m_2 & \dots & m_n \\ \vdots & \vdots & \ddots & \vdots \\ m_1 & m_2 & \dots & m_n \end{pmatrix}$$

(9)

The first bending mode is obtained by iteration of Eq. (8).



b) Anti-symmetric Modes (bending)

For the anti-symmetric case, the cantilever bending mode is given

$$h_i - \theta_o x_i = \sum_{j=1}^n a_{ij} F_j \quad (10)$$

In matrix form this becomes

$$\{h - \theta_o x\} = \omega^2 (K)(M)\{h\} \quad (11)$$

To eliminate the $\theta_o x$ to obtain the characteristic form of Eq. (11), we require that the acceleration moments about the fuselage center line be in equilibrium.

$$\theta_o = - \frac{1}{I_y} \sum_{i=1}^n m_i x_i^2 h_i \quad (12)$$

Eq. (11) may then be written as

$$\{h\} = \omega^2 (I - \frac{1}{I_y} (x)(\bar{M})(x))(K)(M)\{h\} \quad (13)$$

where,

$$\Sigma' = I_y + \sum_{i=1}^n m_i x_i^2$$

and

$$(x) = \begin{pmatrix} x_1 & 0 & 0 & 0 & \dots & 0 \\ 0 & x_2 & 0 & 0 & \dots & 0 \\ 0 & 0 & x_3 & 0 & \dots & 0 \\ \vdots & \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & 0 & \dots & x_n \end{pmatrix} \quad (14)$$

The anti-symmetric mode is then obtained by iteration of Eq. (14).

Since no value was given for the B-29 fuselage rolling moment of inertia, an average value was obtained from similar airplanes using the formula

$$I_y = .03 \sum_{i=1}^n m_i x_i^2 \quad (15)$$



In Eq. (15) m_n was taken to be the true tip mass of the B-29 without the F-84 attachment.

c) Torsion Modes

For the torsional modes, the torsional influence coefficients were computed using the effective B-29 CTR data obtained from Reference 1. Since the F-84 is attached to the B-29 wing tip at two points, the flexibility of the F-84 wing panel in direct contact with the bomber wing was included in the torsional vibration analysis. The F-84 fuselage plus the outboard wing was taken as a rigid mass in torsion.

The symmetric wing torsion at station i , relative to the fuselage pitch is given by

$$\alpha_i - \alpha_o = \sum_{j=1}^n a_{ij} T_j \quad (16)$$

where

$$T_j = \omega^2 d_j \alpha_j \quad (17)$$

The index j runs from the first B-29 station to the F-84 fuselage.

In matrix form, Eq.'s (16) and (17) may be written as

$$\{\alpha - \alpha_o\} = \omega^2 (K)(d) \{\alpha\} \quad (18)$$

The bomber fuselage pitch, α_o , may be eliminated by making use of the condition for rotational equilibrium.

$$\alpha_o = - \frac{1}{d_o} \sum_{i=1}^n d_i \alpha_i \quad (19)$$

Eq. (18) may then be written as

$$\{\alpha\} = \frac{\omega^2}{2} (\Sigma I - (d)) (K)(d) \{\alpha\} \quad (20)$$



where $\Sigma = \alpha_0 + \sum_{i=1}^n \alpha_i$

and $(\bar{\alpha}) = \begin{pmatrix} \alpha_1 & \alpha_2 & \dots & \alpha_n \\ \alpha_1 & \alpha_2 & \dots & \alpha_n \\ \vdots & \vdots & \ddots & \vdots \\ \alpha_1 & \alpha_2 & \dots & \alpha_n \end{pmatrix}$ (21)

The symmetric torsion mode is then obtained by iteration of Eq. (20).

For the anti-symmetric torsion mode there is no B-29 fuselage pitch, so that $\alpha_0 = 0$. The appropriate characteristic equation is then given by

$$\{\alpha\} = \omega^2(k)(\bar{\alpha})\{\alpha\} \quad (22)$$

which can be solved as before by iteration.

The tables containing the computations for the elastic modes are listed below:

Mass data for B-29, F-84	TABLE 1
Bending and Torsional influence coefficients	TABLE 2
Matrix iteration for 1st sym. bending	TABLE 3
Matrix iteration for 1st anti-sym. bending	TABLE 4
Matrix iteration for 1st sym. torsion	TABLE 5
Matrix iteration for 1st anti-sym. torsion	TABLE 6

The plan form of the tip-to-tip configuration is shown in Figure 1. This figure also contains the location of the assumed elastic axes of both the B-29 and F-84, and the c.g. stations of the masses used in the vibration and flutter analysis.



FLUTTER ANALYSIS

a) Mechanical Terms

The flutter analysis is most conveniently carried out in terms of generalized coordinates. Let the admissible degrees of freedom be

Symmetric Case:

$$\left. \begin{aligned} h(x,t) &= h_n(x) q_n(t) + h_\beta(x) q_\beta(t) \\ \alpha(x,t) &= \alpha_1(x) q_\alpha(t) \end{aligned} \right\} \quad (23a)$$

Anti-Symmetric Case

$$\left. \begin{aligned} h(x,t) &= h_n(x) q_n(t) + h_R(x) q_R(t) + h_\beta(x) q_\beta(t) \\ \alpha(x,t) &= \alpha_1(x) q_\alpha(t) \end{aligned} \right\} \quad (23b)$$

The deflection modes $h_i(x)$, $\alpha_i(x)$ are defined over the entire coupled configuration as follows:

Symmetric Case

MODE

B-29

F-84

$h_n(x)$

1st sym. bending

$$1 - \frac{1}{8 + \frac{K_A}{8}} \left(x - \frac{650}{12} \right)$$

$h_\beta(x)$

0

$$\frac{x - \frac{650}{12}}{\frac{440}{12}}$$

$\alpha_1(x)$

1st sym. torsion

1st sym. torsion



Anti-Symmetric Case:

<u>MODE</u>	<u>B-29</u>	<u>F-84</u>
$h_n(x)$	1st anti-sym. bending	$1 - \frac{1}{B + \frac{K_x}{B}} \left(x - \frac{850}{12}\right)$
$h_R(x)$	$\frac{x-12}{850}$	$1 - \frac{1}{B + \frac{K_x}{B}} \left(x - \frac{850}{12}\right)$
$h_\beta(x)$	0	$\frac{x - \frac{850}{12}}{\frac{440}{12}}$
$\alpha_1(x)$	1st anti-sym. torsion	1st anti-sym. torsion

The kinetic energy for 1/2 of the entire configuration is given by

$$2T = \sum_{x=0}^{84 \text{ tip}} \left[m(x) \dot{h}^2(x,t) + 2A(x) \dot{h}(x,t) \dot{\alpha}(x,t) + J(x) \dot{\alpha}^2(x,t) \right] \quad (24)$$

In terms of the generalized coordinates Eq. (24) becomes

$$2T = \sum_i \sum_j A_{ij}(x,m) \dot{q}_i(t) \dot{q}_j(t) \quad (25)$$

The numerical tabulation of the kinetic energy integrals, A_{ij} , is listed in Tables 7 and 12.

Since the elastic modes are the only modes which store potential energy the quadratic form for the potential energy may be written

$$2U = A_{hh} \omega_h^2 q_h^2(t) + A_{\alpha\alpha} \omega_\alpha^2 q_\alpha^2(t) \quad (26)$$



b) Aerodynamic Forces

For the purposes of computing the aerodynamic work done during the virtual displacement of any of the generalized coordinates it is necessary to include the F-84 change in angle of attack and aileron deflection resulting from flapping of the attached fighter.

Symmetric Case:

$$\left. \begin{aligned} h(x,t) &= h_h(x) q_h(t) + h_\beta(x) q_\beta(t) \\ \alpha(x,t) &= \alpha_h(x) q_h(t) + \alpha_\beta(x) q_\beta(t) \\ \delta(x,t) &= \delta_h(x) q_h(t) + \delta_\beta(x) q_\beta(t) \end{aligned} \right\} \quad (27a)$$

Anti-Symmetric Case:

$$\left. \begin{aligned} h(x,t) &= h_h(x) q_h(t) + h_R(x) q_R(t) + h_\beta(x) q_\beta(t) \\ \alpha(x,t) &= \alpha_h(x) q_h(t) + \alpha_R(x) q_R(t) + \alpha_\beta(x) q_\beta(t) \\ \delta(x,t) &= \delta_h(x) q_h(t) + \delta_R(x) q_R(t) + \delta_\beta(x) q_\beta(t) \end{aligned} \right\} \quad (27b)$$

The aileron deflection of the F-84 is a function of both the F-84 flapping and the relative angle between the attached wing tips due to the bending slope of the bomber wing.

$$\delta_i(x) = 0.83 \left(-\beta_i + \frac{\partial h_i(x)}{\partial x} \Big|_{x=\frac{83}{12}} \right) \quad (28)$$

The aileron deflection is defined only over the F-84 aileron intervals and is taken as a constant positive value inboard and constant negative value outboard.



The F-84 induced angle of attack due to fighter flapping is given by

$$\alpha_i(x) = \beta_i \tan \psi \quad (29)$$

This is taken as a constant angle of attack over the entire fighter span. Figure 2 illustrates the sign convention and kinematic relationships between δ_i , α_i and the flapping of the F-84 wing.

The oscillatory aerodynamic forces used in the analysis are the usual strip theory forces given in Ref. 3, for a tapered wing. The reference chord, b_r , is taken at $3/4$ span of the bomber wing. The values of e and c_i for the F-84 aileron, are taken from Ref. 2. The elastic axis locations are defined as

$$\begin{aligned} a_{29} &= -\frac{1}{2} \\ a_{84} &= -.20 \end{aligned} \quad (30)$$

The work done by the aerodynamic forces is given by

$$W = \int L h(x,t) dx + \int m \alpha(x,t) dx + \int T \tilde{e}(x,t) dx \quad (31)$$

The generalized forces are given by

$$Q_i = \frac{\partial W}{\partial q_i(t)} \quad (32)$$

which may be written in terms of the generalized coordinates as

$$Q_i = \pi \rho \omega^2 \sum_j B_{ij} q_j(t) \quad (33)$$



where B_{ij} is given by

$$B_{ij} = \left\{ \begin{aligned} &\int L_h b^2 h_i(x) h_j(x) dx + \int L_\alpha b^3 h_i(x) \alpha_j(x) dx + \int L_\delta b^3 h_i(x) \delta_j(x) dx \\ &\int M_h b^3 \alpha_i(x) h_j(x) dx + \int M_\alpha b^4 \alpha_i(x) \alpha_j(x) dx + \int M_\delta b^4 \alpha_i(x) \delta_j(x) dx \\ &\int \tilde{J}_h b^3 \delta_i(x) h_j(x) dx + \int \tilde{J}_\alpha b^4 \delta_i(x) \alpha_j(x) dx + \int \tilde{J}_\delta b^4 \delta_i(x) \delta_j(x) dx \end{aligned} \right\} \quad (34)$$

The aerodynamic coefficients L_i , M_i , $\tilde{J}_i$ are given by

$$\left. \begin{aligned} L_h &= 1 + \frac{b_r}{b} K_2(L_h) \\ L_\alpha &= -a + \frac{b_r}{b} K_2(L_\alpha) + \left(\frac{b_r}{b}\right)^2 K_3(L_\alpha) - \left(\frac{1}{2} + a\right) \left(\frac{b_r}{b}\right) K_2(L_h) \\ L_\delta &= L_\beta - (c-e) L_z \\ M_h &= -a - \frac{b_r}{b} \left(\frac{1}{2} + a\right) K_2(L_h) \\ M_\alpha &= \frac{1}{2} + a^2 + \frac{b_r}{b} K_2(M_\alpha) - \left(\frac{1}{2} + a\right) \frac{b_r}{b} K_2(L_\alpha) - \left(\frac{1}{2} + a\right) \left(\frac{b_r}{b}\right)^2 K_3(L_\alpha) \\ &\quad + \left(\frac{1}{2} + a\right)^2 \frac{b_r}{b} K_2(L_h) \\ M_\delta &= M_\beta - \left(\frac{1}{2} + a\right) L_\beta - (c-e) M_z + (c-e) \left(\frac{1}{2} + a\right) L_z \\ \tilde{J}_h &= T_h - (c-e) P_h \\ \tilde{J}_\alpha &= T_\alpha - (c-e) P_\alpha - \left(\frac{1}{2} + a\right) T_h + (c-e) \left(\frac{1}{2} + a\right) P_h \\ \tilde{J}_\delta &= T_\beta - (c-e) P_\beta - (c-e) T_z + (c-e)^2 P_z \end{aligned} \right\} \quad (35)$$

The integrals are evaluated for fixed values of the reduced frequency, $\frac{1}{k}$.
 Under this convention the complex values of $K_1(L_h)$, etc., are assumed constant



and are taken outside the integral sign, however, the varying chord remains under the integral sign.

c) Flutter Determinant

The Lagrangian equations of motion may be written for a fixed value of

$$\frac{d}{dt} \frac{\partial T}{\partial \dot{q}_i(t)} + \frac{\partial U}{\partial q_i(t)} = Q_i \quad (36)$$

or, for the harmonic case where $\ddot{q}_i(t) = -\omega^2 q_i(t)$

$$-\omega^2 \sum_j A_{ij} q_j(t) + \omega_i^2 A_{ii} (1 + \sqrt{\pi} g) q_i(t) = \pi \rho \omega^2 \sum_j B_{ij} q_j(t) \quad (37)$$

The factor g is the structural damping which is taken proportional to the potential energy and in phase with the velocity for harmonic oscillations.

Eq. (37) represents as many equations as there are degrees of freedom.

For a non-trivial solution of these equations it is necessary and sufficient for the matrix of the coefficients of $q_i(t)$ to be singular. This places the condition on the flutter frequency, ω , to be a root of the polynomial of the determinant of the matrix.

Since the rigid body degrees of freedom are independent of ω , these coordinates may be solved for in terms of the elastic degrees of freedom. The equations may be reduced to a 2 x 2 determinant. The resulting quadratic polynomial is then solved for the critical flutter speed.

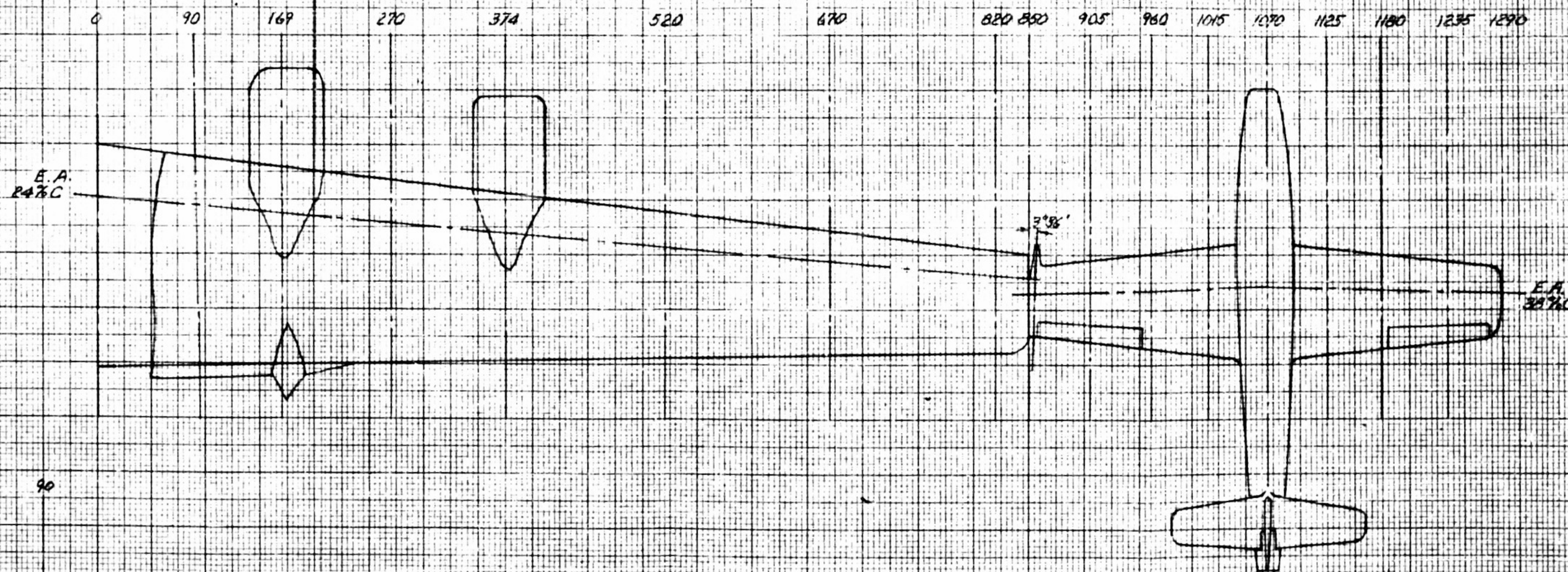
The flutter solution curves are plotted in the usual $\frac{V}{\omega_\alpha}$ vs. g coordinate system.



TABLE 1

MASS DATA FOR B-29 & F-84

INTERVAL	STA	MASS	STATIC	MOMENT	ROLLING				
			MOMENT	OF	MOMENT				
				INERTIA	OF				
IN.	IN.	SLUGS	SLUG IN.	SLUG IN. ²	SLUG IN. ²				
-45 - +45	0	31.53	7847	4736350	265630	}	B-29 TOTAL		
45 - 130	70	12.06	-492	17100			WEIGHT = 97,500 LBS.		
130 - 220	169	33.42	-1790	221590					
220 - 320	270	12.69	101.0	14510			REF. 1		
320 - 450	374	28.82	-1412	176450					
450 - 595	520	5.350	69.9	4920					
595 - 745	670	1.218	12.9	1040					
745 - 850	820	.363	2.6	260					
TIP WT.	850	.842	0	200					
850 - 877.5	850	.36	2.73	111		}	F-84 TOTAL		
877.5 - 932.5	905	1.38	12.40	585			WEIGHT = 14,450 LBS.		
932.5 - 987.5	960	3.87	40.0	1640			REF. 2		
987.5 - 1042.5	1015	1.43	17.3	1070					
1042.5 - 1290	1070	30.2	985	350000			INCLUDES F-84 FUSELAGE + ENTIRE OUTBOARD WING		
NOTES:									
MASSES USED IN VIBRATION ANALYSIS ARE IN IN.-SLUG SYSTEM.									
MASSES USED IN FLUTTER ANALYSIS ARE IN FT.-SLUG SYSTEM.									
FUSELAGE MASSES FOR 1/2 FUSELAGE.									
EFF. MASS OF F-84 IN FLAPPING - $M_{EFF} = \frac{K_x^2}{b^2 + K_x^2} M_{84} = 3.31$									
$b = 220$ IN.									
$K_x = 68.52$ IN.									
$M_{84} = 37.435$ SLUGS									

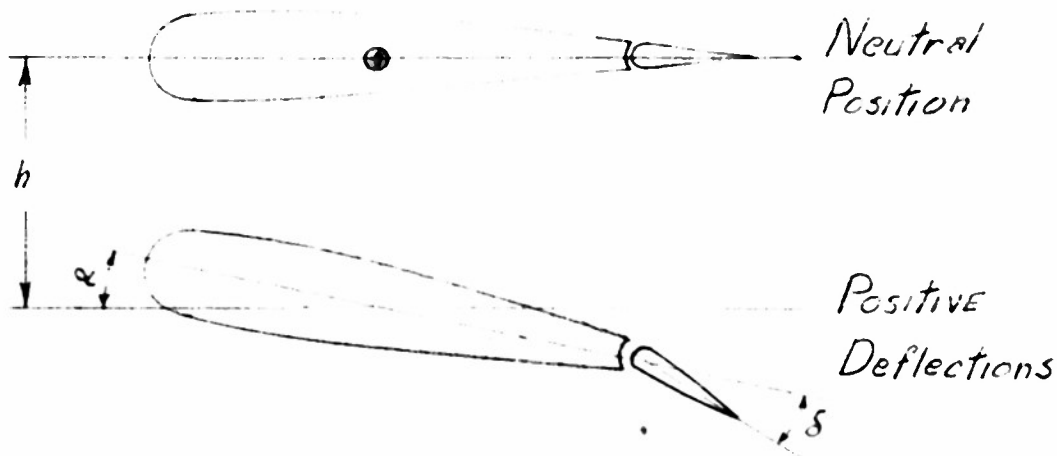


NOTE: C.G. LOCATION OF THE
MASSSES USED IN
FLUTTER & VIBRATION.

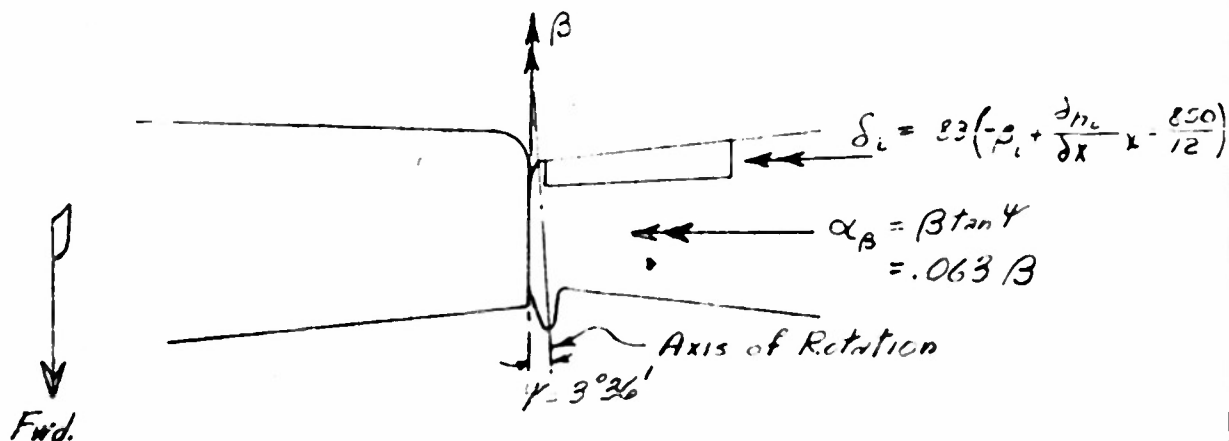
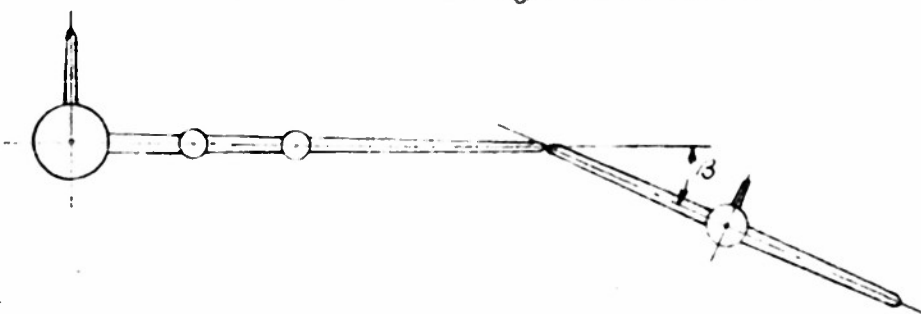


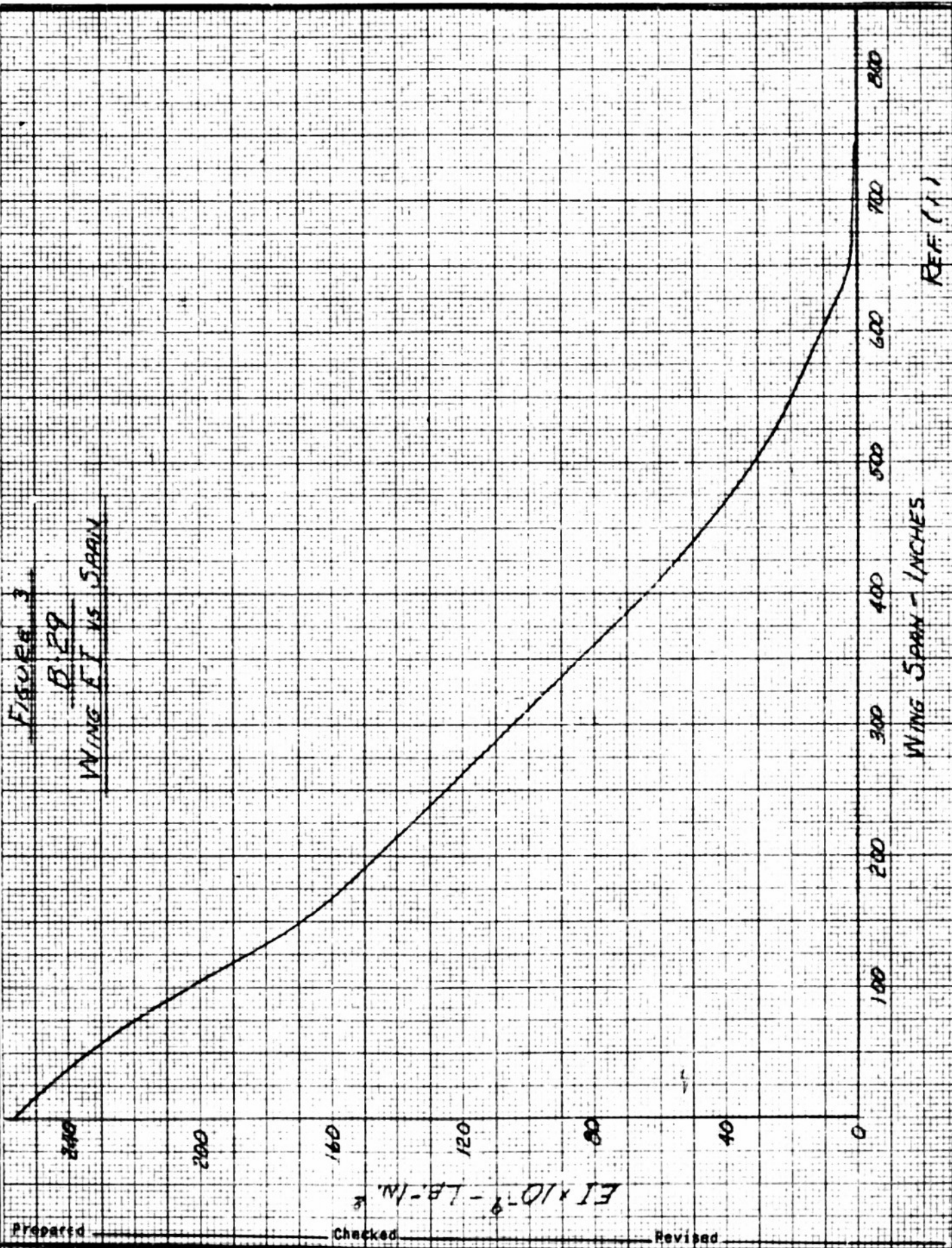
FIGURE 2

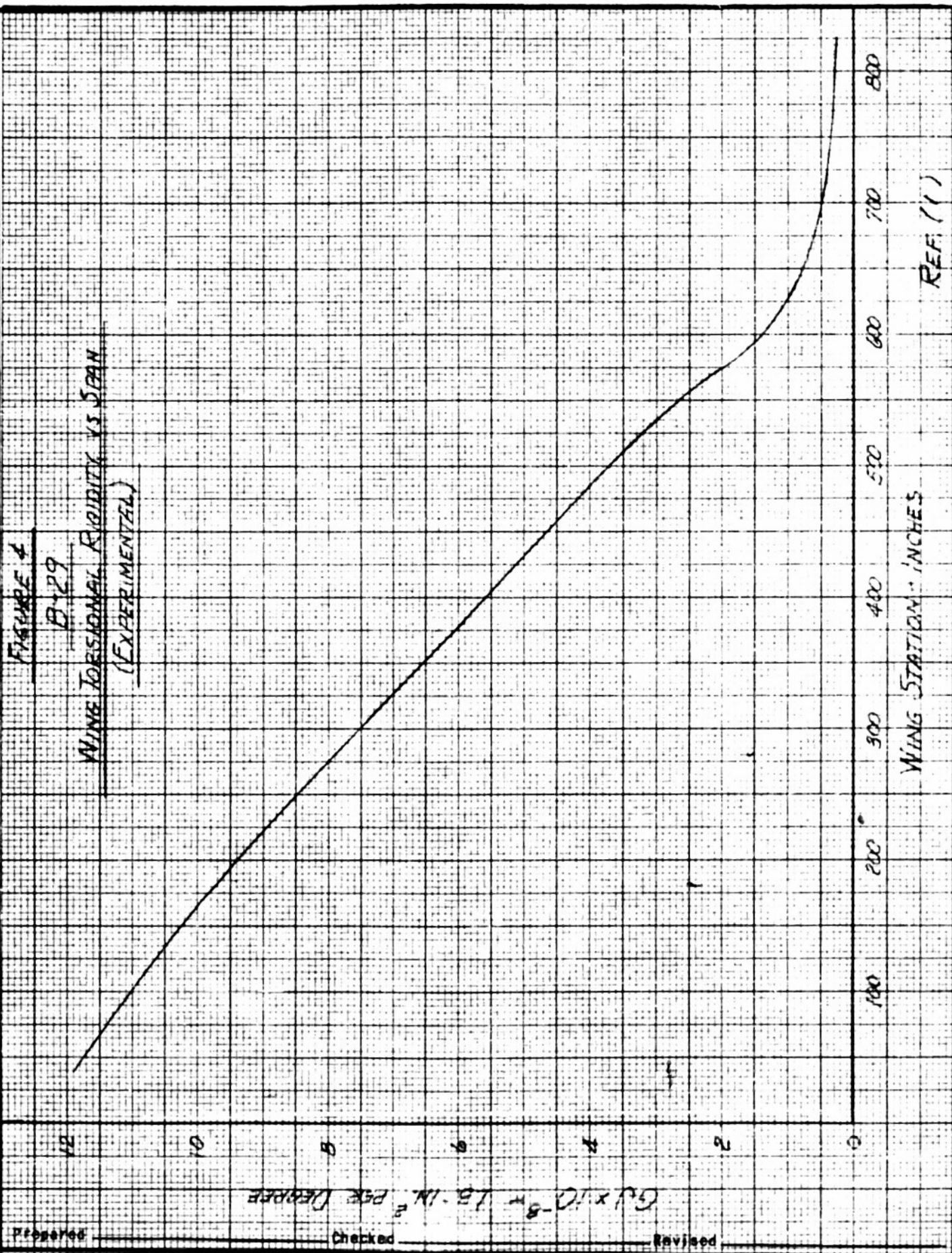
Wing Deflections



F-84 Flopping Deflection







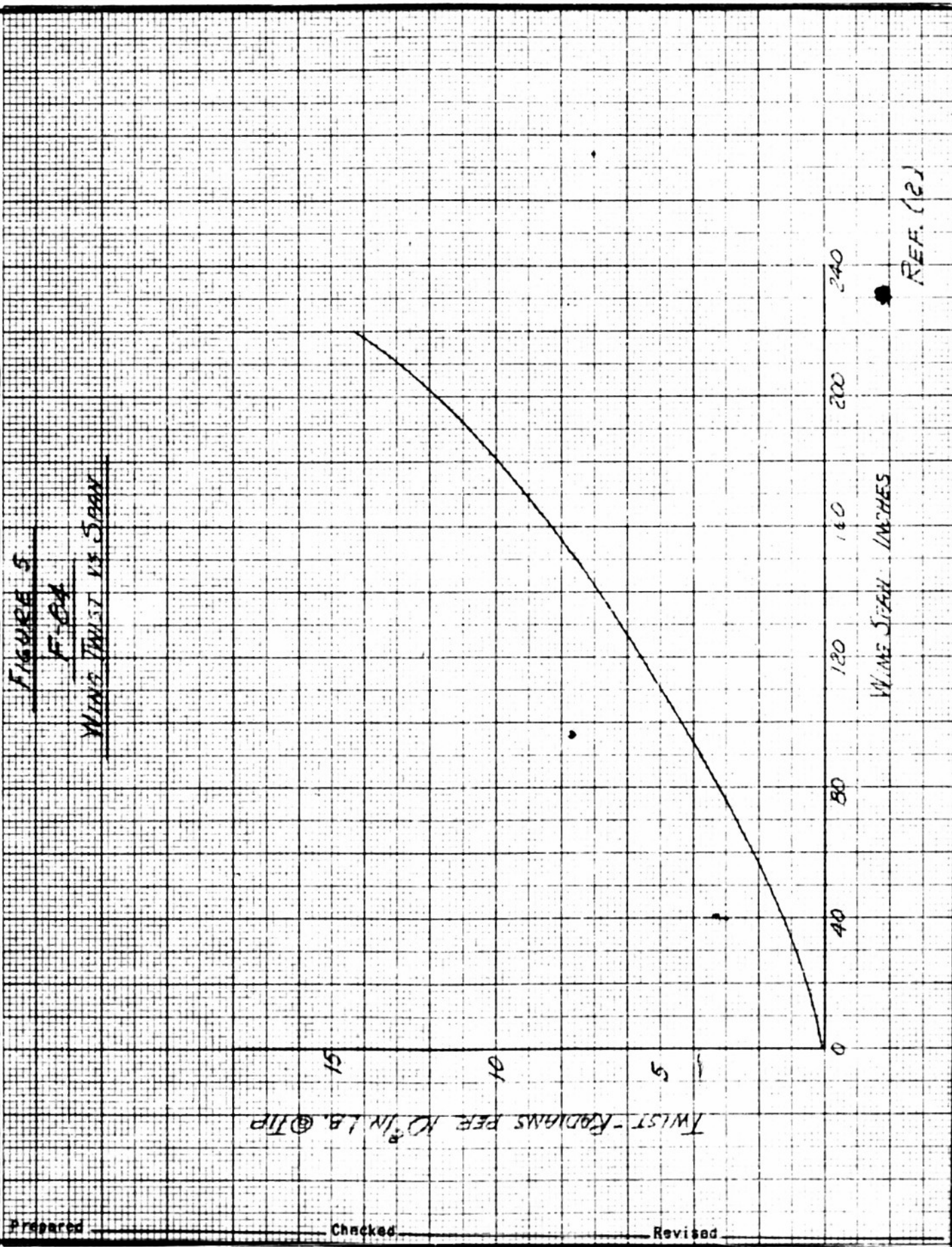




TABLE 2

BENDING INFLUENCE COEFFICIENTS

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TABLE 2 (CONT.)											
TORSIONAL INFLUENCE COEFFICIENTS											
1	2	3	4	5	6	7	8	9	10	11	12
	STA.										
	X	$\frac{\Delta X}{2}$	GJ	$\frac{1}{GJ}$	$\int_{45}^X \frac{dK}{GJ}$	$\frac{1}{GJ}/57.3$					
	IN.	IN.	$\times 10^{-7}$	$\times 10^{-7}$	PER °						
B-29	0										
	45	22.5	118.0	00847	1906	003326					
	90	22.5	111.6	00896	.5827	01017					
	130	20	105.5	00948	.9515	01661					
	169	19.5	99.0	.01010	1.3334	.02327					
	220	25.5	90.0	.01111	1.8742	.03271					
	270	25	80.5	.01242	2.4625	.04298					
	320	25	71.0	.01408	3.1250	.05454					
	374	27	60.3	.01658	3.9528	.06898					
	425	25.5	51.0	.01961	4.8756	.08509					
	475	25	41.5	.02410	5.9684	.1042					
	520	22.5	32.8	.03049	7.1967	.1256					
	570	25	21.0	.04762	9.1492	.1597					
	620	25	10.3	.09709	12.7672	.2228					
	670	25	6.0	.1667	19.3619	.3379					
	720	25	3.7	.2703	30.2869	.5286					
	770	25	2.8	.3571	45.9719	.8023					
	820	25	2.6	.3846	64.5144	1.1259					
B-29	850	15	10	.10	71.7834	1.2528					
				$\int_X^{850} \frac{dK}{GJ}$							
F-84	850			1.4311							
	905			.8726	72.3419	1.2625					
	960			.4991	72.7154	1.2690					
	1015			.1920	73.0225	1.2744					
F-84	1070			.0	73.2125	1.2777					

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TABLE 2 (CONT.)

BENDING & TORSIONAL INFLUENCE
COEFFICIENTS

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E-SAF-MX 1016-1
B-29 - F-84

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
BENDING INFLUENCE COEFFICIENTS - B-29																				
$K \times 10^{-7}$																				
α	90	169	270	374	520	670	820	850												
90	11.330	24.707	41.809	59.419	84.141	109.54	134.94	140.02												
169	24.707	71.914	136.61	203.23	296.75	372.83	488.91	508.13												
270	41.809	136.61	312.08	502.50	717.83	1044.5	1319.1	1374.1												
374	59.419	203.23	502.50	904.08	1487.1	2090.1	2691.1	2811.3												
520	84.141	296.75	767.83	1487.1	2873.5	4390.0	5906.6	6209.9												
670	109.54	372.83	1044.5	2090.1	4390.0	8543.6	13441	14420												
820	134.94	488.91	1319.1	2691.1	5906.6	13441	31995	36128												
850	140.02	508.13	1374.1	2811.3	6209.9	14420	36128	41256												
TORSIONAL INFLUENCE COEFFICIENTS - B-29 & F-84																				
	90	169	270	374	520	670	820	850	F-84 STA.											
		905	960	1015	1070															
90	.01017																			
169		.02327																		
270			.04298																	
374				.06898																
520					.1256															
670						.3379														
820							1.1259													
850								1.2528												
905									1.2625											
960	F-84 STA.									1.2690										
1015											1.2744									
1070												1.2777								

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TABLE 3

SYMMETRIC BENDING

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 MODEL B-29 - F-84

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
STA.																				
x	$M(x)$		h_1	Mh_1	$K M h_1$	$\frac{\Sigma}{\omega^2} (h_1)$	h_2	Mh_2	$K M h_2$	$\frac{\Sigma}{\omega^2} (h_2)$	h_3									
IN.	SLUG																			
90	12.06		-.0674	-.813	628.5	-1565545	-.06839	-.8248	640.8	-1571387	-.06837									
169	33.42		-.0586	-1.96	2364.3	-1244576	-.05864	-1.9597	2372.5	-1346953	-.05861									
270	12.67		-.03595	-.456	6524.1	-8657537	-.03513	-.4458	6544.6	-8062364	-.03508									
324	28.82		.00333	.0960	13503.4	9878435	.004307	.1241	13540.7	100505.1	.004373									
520	5.350		.09724	.521	29954.9	2230948	.09727	.5204	30020.9	2236363	.09730									
670	1.218		.316	.385	68505.3	7227196	.3151	.3838	68616.4	7238455	.3149									
820	.363		.865	.314	166817	19768746	.8706	.3160	167023	19972246	.8677									
850	4.152		1.0	4.15	189827	22957322	1.0	4.1520	190102	22983353	1.0									
						$.436 \times 10^{-1}$				$.4351 \times 10^{-1}$										
FUS.	31.53																			
Σ	129.603																			

$$\begin{aligned} \text{EFF. MASS @ B-29 TIP} &= M_{29} + \frac{K_x^2}{b^2 + K_x} M_{84} \\ &= .842 + (.0884)(37.455) \\ &= 4.152 \end{aligned}$$

$$\begin{aligned} B &= 220 \\ K_x &= 571(12) = 68.52 \\ M_{84} &= \frac{14450}{386} = 37.455 \end{aligned}$$

$$\begin{aligned} h_0 &= -\frac{1}{M_0} \Sigma M_i h_i = -.031715 \times 2.269 \\ &= -.07176 \\ \omega^2 &= \frac{10^7 \times 129.603}{22983353} = 56.39 \text{ RAD/SEC}^2 \\ \omega &= (9.55)(2\pi) = 72 \text{ CPM} \end{aligned}$$

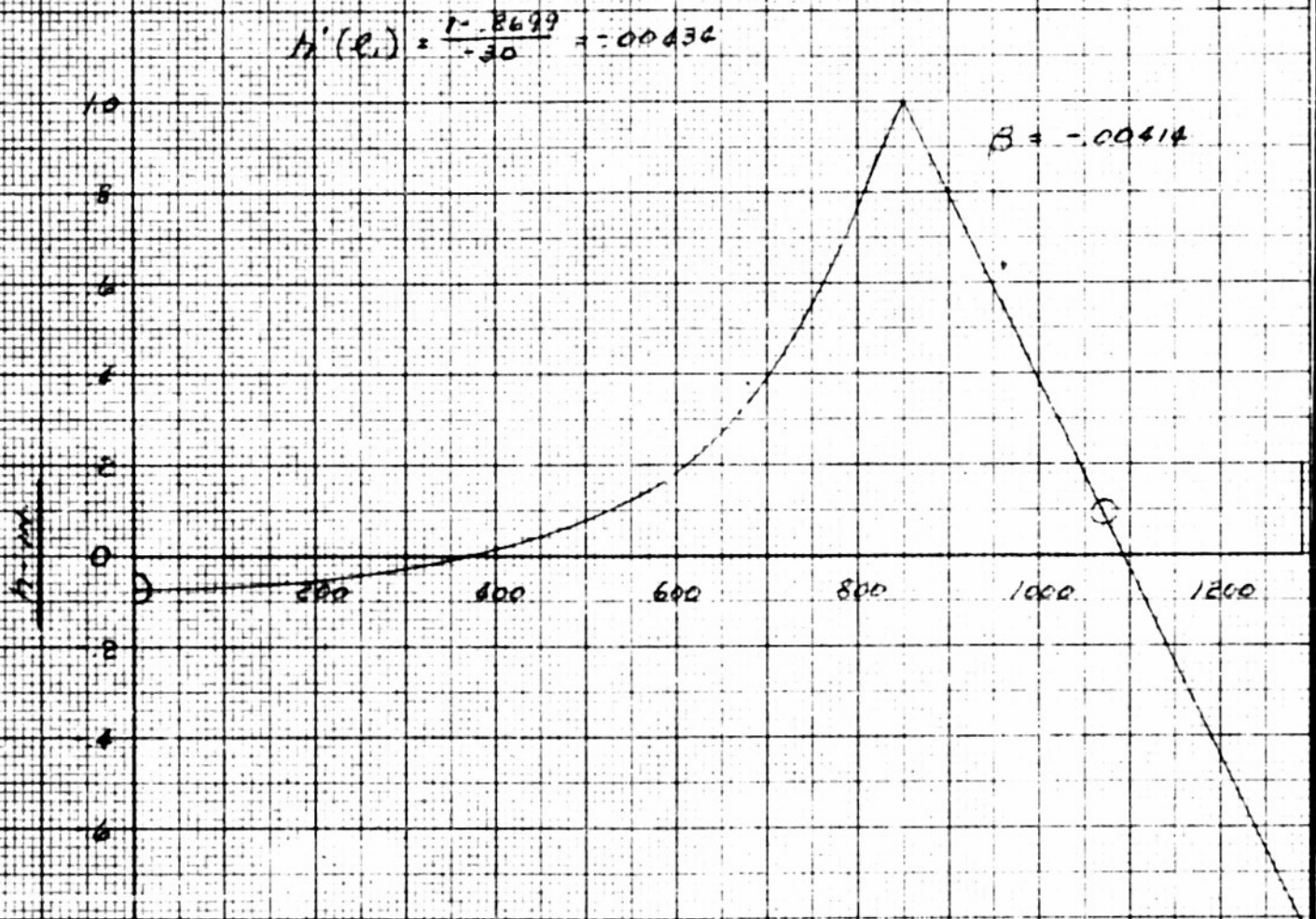
$$\begin{aligned} \beta &= -\frac{1}{B + \frac{K_x}{H}} = -\frac{1}{241} = -.00414 \\ \beta_{FT} &= -.04968 \end{aligned}$$

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FIGURE 6
1st BENDING - SYMMETRIC



1st FOOT SYSTEM:

$B_H = 12(-0.00414 - 0.00436) = -0.10176$

STA. - IN.

[illegible]

$$\Sigma' = I_{y(0)} + \Sigma Mx^2 = 245,630 + 11,245,820 = 11,511,450$$

$$\frac{1}{\Sigma} = .08687 \times 10^{-6}$$

$$B = 220$$

$$K_1 = 521(12) = 6852$$

$$M_{63} = \frac{12450}{386} = 32.435$$

$$\omega^2 = \frac{10^7}{60880} = 1643$$

$$\omega = (9.55)(10.72) = 102.7 \text{ rpm}$$

$$P = - \frac{1}{E' \frac{\Delta L}{L}} = - \frac{1}{2.1} = -0.00412$$

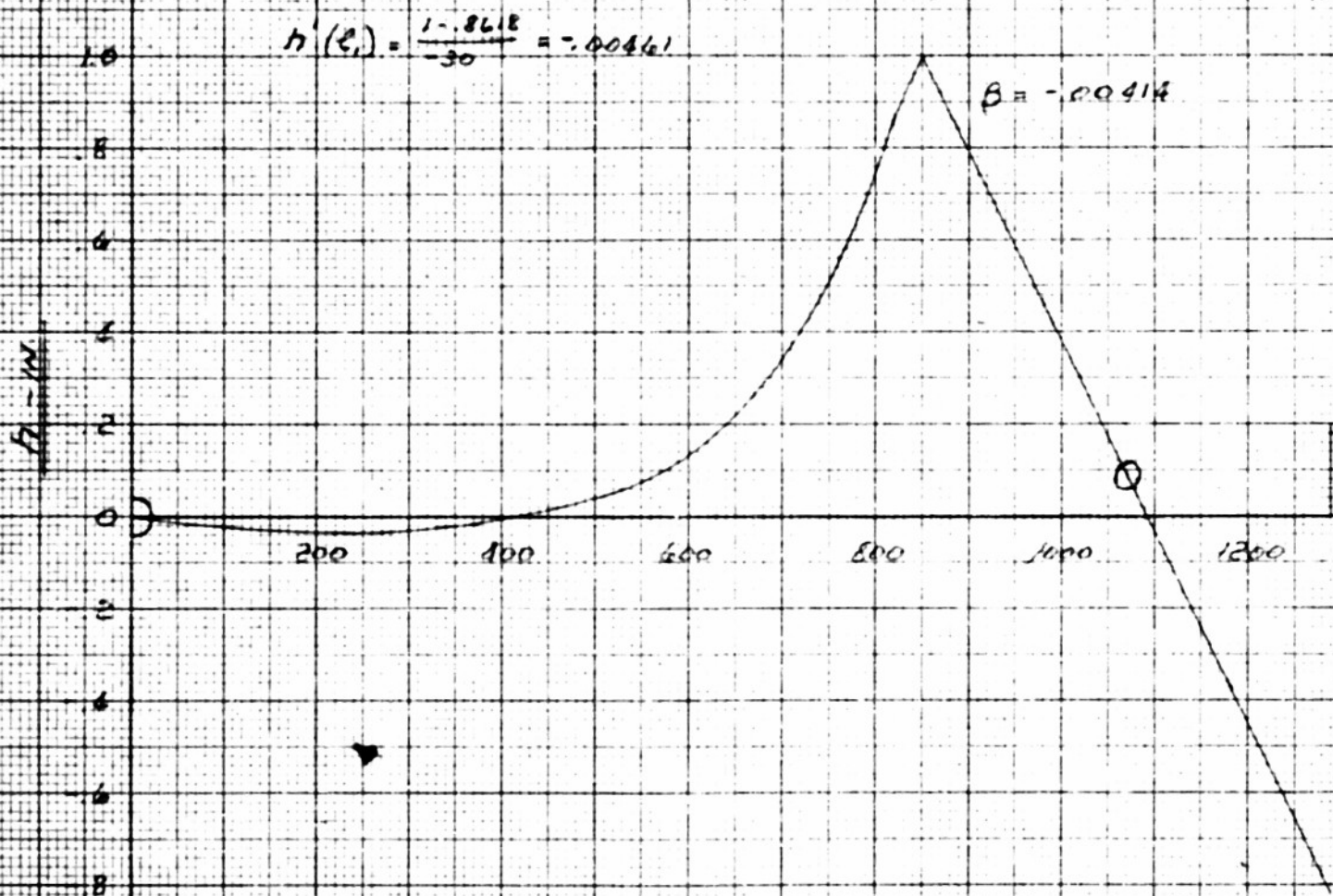
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FIGURE 8
1st BENDING - ANTI-SYMMETRIC



IN FOOT SYSTEM

$$B_H = 12(-.00418 - .00461) = -.1050$$

STR. - IN

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TABLE 5

SYMMETRIC TORSION

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
STA.																				
X	$\downarrow (x)$		α_1	$\downarrow \alpha_1$	$K \downarrow \alpha_1$	$\frac{\Sigma}{\omega^2} \alpha_2$	α_2	$\downarrow \alpha_2$	$K \downarrow \alpha_2$	$\frac{\Sigma}{\omega^2} \alpha_3$	α_3									
	$\times 10^{-3}$			$\times 10^{-3}$	$\times 10^{-3}$	$\times 10^{-6}$		$\times 10^{-3}$	$\times 10^{-3}$	$\times 10^{-6}$										
90	17.10		-.059	-1.01	3.73	-145.998	-.0626	-1.070	3.443	-147.246	-.06324									
169	221.53		-.047	-10.4	8.24	-121.077	-.0519	-11.50	2.892	-122.662	-.05268									
270	14.51		-.025	-.363	15.0	-83.723	-.0359	-.5209	14.81	-84.436	-.03627									
374	176.45		.0095	1.68	24.3	-32.335	-.0139	-2.453	23.95	-33.931	-.01457									
520	4.92		.057	.280	44.3	78.178	.0335	.1648	44.00	76.857	.03301									
670	1.04		.22	.229	119	490.945	.211	.2194	119.1	491.832	.2112									
820	.26		.83	.216	398	2032.602	.872	.2267	397.9	2032.376	.8729									
850	.20		1.0	.20	443	2281.257	.979	.1958	442.7	2279.924	.9792									
905	.585		1.0	.585	446	2297.834	.986	.5768	446.1	2298.711	.9873									
960	1.640		1.0	1.64	449	2314.411	.993	1.629	448.4	2311.420	.9928									
1015	1.070		1.0	1.07	451	2325.462	.998	1.068	450.3	2321.919	.9973									
1070	350.0		1.0	350.0	452	2330.988	1.0	350.0	451.5	2328.550	1.0									
						.429 $\times 10^{-6}$				.4295 $\times 10^{-6}$										
FUS.	4736.35																			
Σ	5525.659																			

$$\omega^2 = (10^7)(.4295 \times 10^{-12})(5525.655 \times 10^3) = 23.73$$

$$\omega = (9.55)(4.87) = 47 \text{ cpm}$$

$$\alpha_0 = -\frac{1}{I_0} \Sigma I_i \alpha_i = (-.00021113)(338.23)$$

$$= -.07141$$

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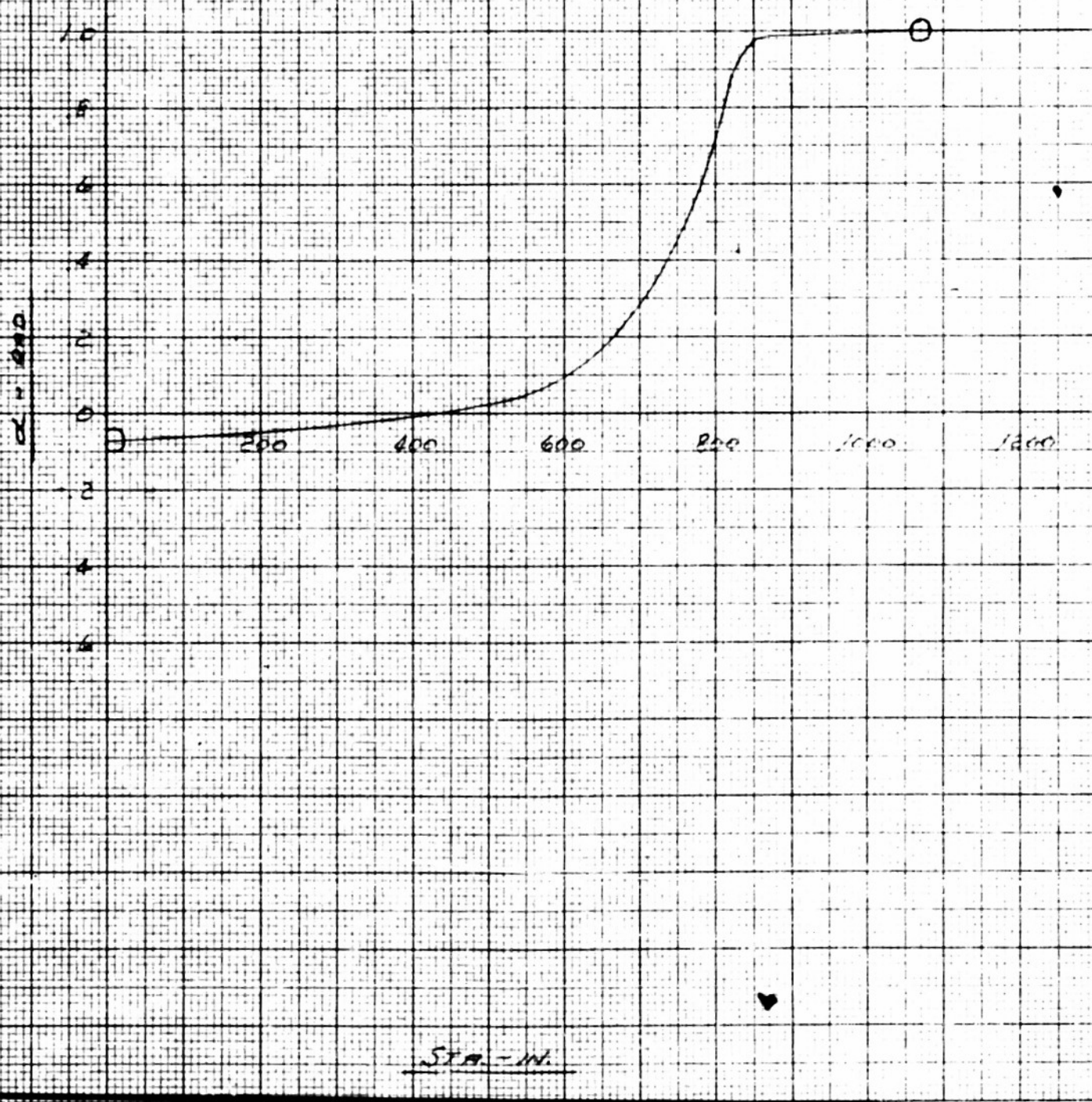
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MODEL

B-29-F-84

FIGURE 7
1" TORSION - SYMMETRIC



ST. - IN.

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TABLE 6

ANTI-SYMMETRIC TORSION

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B-29 - F-84

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
STA.																				
X	$\Delta(x)$		α_1	$\Delta\alpha_1$	$K\Delta\alpha_1$	α_2	$\Delta\alpha_2$	$K\Delta\alpha_2$	α_3											
	$\times 10^{-3}$			$\times 10^{-3}$	$\times 10^{-3}$		$\times 10^{-3}$	$\times 10^{-3}$												
90	17.10		.010	.171	3.783	.00835	.1428	3.755	.008293											
169	221.53		.023	.510	8.654	.0191	4.231	8.591	.01897											
270	14.51		.041	.595	15.88	.0351	.5093	15.78	.03485											
374	176.45		.066	11.6	25.40	.0561	9.899	25.26	.05579											
520	4.92		.11	.541	45.47	.100	.4920	45.33	.1001											
670	1.04		.28	.291	120.6	.266	.2766	120.5	.2661											
820	.26		.88	.229	399.3	.881	.2291	399.2	.8816											
850	.20		.98	.196	444.2	.981	.1962	444.0	.9806											
905	.585		.99	.579	447.6	.988	.5780	447.5	.9883											
960	1.640		.99	1.62	449.9	.993	1.629	449.8	.9934											
1015	1.070		1.0	1.07	451.8	.997	1.067	451.7	.9976											
1070	350.0		1.0	350	452.0	1.0	350	452.8	1.0											

$$\omega^2 = \frac{10^7}{452.8 \times 10^3} = 22.085$$

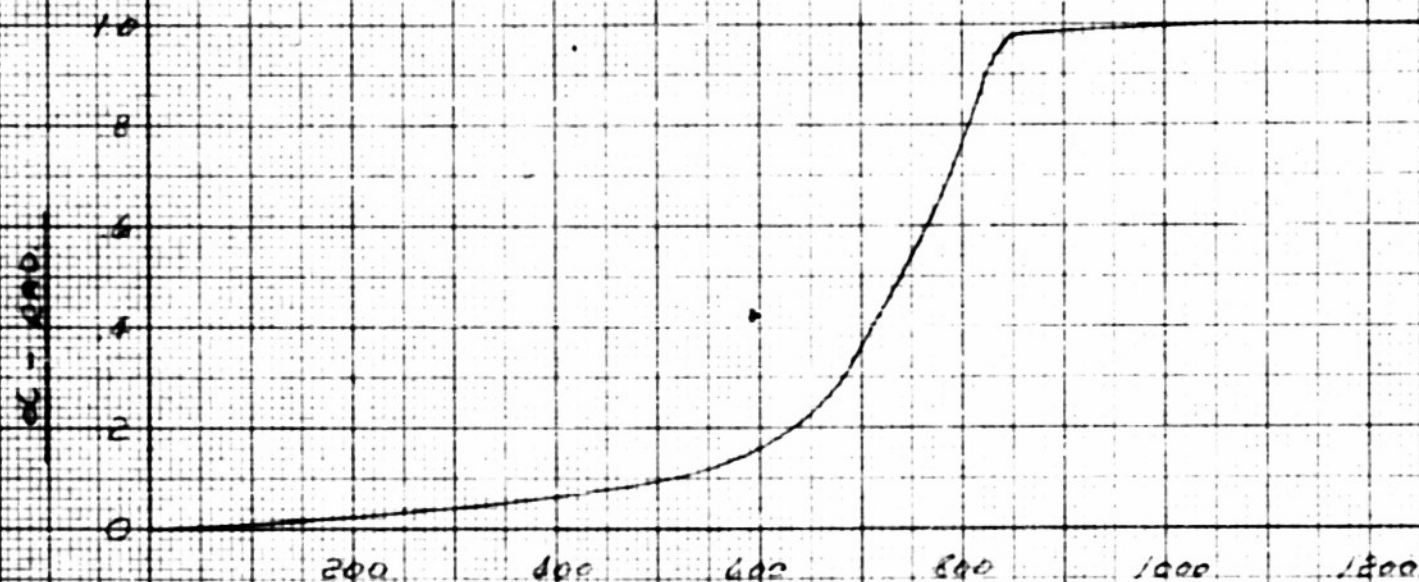
$$\omega = (9.55)(4.7) = 45 \text{ cpm}$$

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MODEL B-29-F-84

FIGURE 9
1ST TORSION - ANTI-SYMMETRIC



STA - IN

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TABLE 7

GENERALIZED MASSES - SYMMETRIC CASE

MODES: h, α, ρ

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E-SAF-MX 1016-1

B-29 - F-84

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
ELEMENT	INTERVAL	STA.	X_1 IN.	X_1 FT	$M(x)$	$S(x)$	$I(x)$	h_h	α_1	h_p	A_{hh}	A_{pp}	$A_{\alpha\alpha}$	A_{hp}	$A_{h\alpha}$	$A_{p\alpha}$				
			(3)-850	(4) ÷ 12	SLUGS	SLUG-FT.	SLUG-FT. ²	1-.04968(5)		(4) ÷ 440	(6)(9) ²	(6)(11) ²	(8)(10) ²	(6)(9)(11)	(7)(9)(10)	(7)(11)(10)				
1	FUS. -45	0	0		378.36	7847	394.696	-0.7196	-0.7141	0	1.959	0	2013	0	40.33	0				
2	45-130	90	↑		144.72	-49.2	1425	-0.6837	-0.6324	↑	.6765	↑	5.699	↑	-2.227	↑				
3	130-220	169	↑		401.04	-1790	18461	-0.5861	-0.5268	↑	1.378	↑	51.23	↑	-5.527	↑				
4	220-320	270	↑		152.28	101.0	1209	-0.3508	-0.3627	↑	.1874	↑	1.590	↑	.1285	↑				
5	320-450	374	↑		345.84	-1412	14704	.04373	.01457	↑	.00661	↑	3.121	↑	.08997	↑				
6	450-575	520	↑		64.20	69.9	410	.09730	.03301	↑	.6078	↑	.4468	↑	.2245	↑				
7	575-745	670	↑		14.62	12.9	86.6	.3149	.2112	↑	1.450	↑	3.863	↑	.8579	↑				
8	745-850	820	↓		4.36	2.6	21.7	.8699	.8729	↓	3.274	↓	16.53	↓	1.914	↓				
9	TIP WT.	850	0	0	14.4	2.7	25.9	1.0	.9792	0	14.40	0	24.83	0	2.644	0				
10	872.5-932.5	905	55	4.6	16.56	12.4	48.7	.7715	.9873	.1250	9.856	.2587	47.47	1.597	9.445	1.530				
11	932.5-982.5	960	110	9.2	46.44	40	137	.5429	.9928	.250	13.69	.2903	135.0	6.303	21.56	9.928				
12	982.5-1042.5	1015	165	13.7	17.16	17.3	89.2	.3194	.9973	.375	1.251	.2413	88.72	2.055	5.511	6.467				
13	1042.5-1092.5	1070	220	18.3	277.92	913	28883	.09086	1.0	.50	2.294	.6948	28883	12.63	82.96	456.5				
14	1092.5-1152.5	1125	275	22.9	17.16	17.3	89.2	-.1377	↑	.625	.3254	.6703	89.2	-1.477	-2.382	10.81				
15	1152.5-1207.5	1180	330	27.5	46.44	40	137	-.3662	↓	.75	6.228	.2612	137	-12.75	-14.65	30.0				
16	1207.5-1262.5	1235	385	32.1	16.56	12.4	48.7	-.5947	↓	.875	5.857	12.68	48.7	-8.617	-7.374	10.85				
17	1262.5-1290	1290	440	36.7	4.32	2.7	9.2	-.8233	1.0	1.0	2.928	4.32	9.2	-3.557	-2.223	2.7				
										Σ =	66.894	124.88	31.559	-3.816	133.36	528.79				

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TABLE 8

AERODYNAMIC INTEGRALS - SYMMETRIC CASE

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E-SAF-MX 1016-1

MODES: h, α, β

B-29 - F-84

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
STA.									B-29											
X	b	b^2	b^3	b^4	h_h FT.	h_p	α_1	h_h^2	$b h_h^2$	$b^2 h_h^2$	$\alpha, h_h b^3$	$\alpha, h_h b^2$	$\alpha, h_h b$	$b^4 \alpha,^2$	$b^3 \alpha,^2$					
IN.	FT.	(2) ²	(2)(3)	(2)(4)	$\frac{1-(.04968)}{X(K_1 FT)}$	$X_1 \div 440$		(6) ²	(2)(9)	(3)(9)	(8)(6)(4)	(8)(6)(3)	(8)(6)(2)	(5)(8) ²	(4)(8) ²					
90	7.84	61.466	481.89	3778.0	-.07	0	-.06	.0049	.038416	.30118	2.0239	.25816	.032928	13.601	1.2348					
170	7.41	54.908	406.87	3014.9	-.06	1	-.055	.0036	.026676	.19767	1.3427	.18120	.024453	9.1201	1.2308					
250	6.95	48.303	335.71	2333.2	-.045		-.04	.002025	.014074	.097814	.60428	.086945	.012510	3.7331	.53714					
330	6.50	42.250	274.63	1785.1	-.015		-.025	.000225	.001463	.009506	.10299	.015844	.002437	1.1157	.17164					
410	6.09	37.088	225.87	1375.5	.02		-.05	.0004	.002436	.014835	-.22587	-.037088	-.006090	3.4387	.56467					
490	5.62	31.584	177.50	992.55	.07		.02	.0049	.027538	.15476	.24850	.044218	.007868	.39902	.0710					
570	5.21	27.144	141.42	736.80	.145		.065	.021025	.10954	.57070	.19829	.25583	.049104	3.1130	.59750					
650	4.75	22.563	107.17	509.06	.27		.17	.0729	.34627	1.6448	4.9191	1.0356	.21803	14.712	3.0972					
730	4.33	18.749	81.183	351.52	.48	1	.375	.2304	.99763	4.3198	14.613	3.3748	.77940	49.433	11.416					
810	3.88	15.054	58.410	226.63	.815	0	.80	.66423	2.5772	9.9992	38.083	9.8152	2.5298	145.04	37.382					
B-29	Σ								4.14124	17.3103	63.0445	15.0307	3.65044	243.706	56.8027					
B-29	$\Sigma \Delta X =$								27.610	115.408	420.318	100.310	24.337	1624.8	378.704					
																$b^2 \alpha,^2$	$b^3 h_h$	$b^2 h_h$	$b h_h$	α, b^4
									F-84							(3)(8) ²	(4)(6)	(3)(6)	(2)(6)	(8)(5)
872.5	2.83	8.0089	22.665	64.142	.88615	.0625	.985	.78526	2.2223	6.2891	19.783	6.9906	2.4702	62.232	21.990	7.7704	20.065	7.0971	2.5078	63.180
932.5	3.33	11.089	36.926	122.96	.65845	.1875	.99	.43356	1.4438	4.8077	24.071	7.2286	2.1707	120.51	36.191	10.868	24.314	7.3016	2.1926	121.23
982.5	3.84	14.746	56.625	217.44	.43075	.3125	.995	.18555	.71251	2.7361	24.269	6.3201	1.6458	215.27	56.060	14.577	24.371	6.3518	1.6541	216.95
1042.5	4.33	18.749	81.183	351.52	.20305	.4375	.999	.041229	.17852	.77300	16.468	3.8032	.87834	350.82	81.021	18.712	16.484	3.8070	.87921	351.17
1092.5	4.33	18.749	81.183	351.52	-.02465	.5625	1.0	.0006076	.002631	.011392	-2.0012	-.46216	-.10673	351.52	81.183	18.749	-2.0012	-.46216	-.10673	351.52
1152.5	3.84	14.746	56.625	217.44	-.25234	.6875	1	.063675	.24451	.93895	-14.289	-3.7210	-.96899	217.44	56.625	14.746	-14.289	-3.7210	-.96899	217.44
1207.5	3.33	11.089	36.926	122.96	-.48004	.8125	1	.23044	.76737	2.5553	-17.726	-5.3232	-1.5985	122.96	36.926	11.089	-17.726	-5.3232	-1.5985	122.96
1262.5	2.83	8.0089	22.665	64.142	-.70775	.9375	1.0	.50091	1.4176	4.0117	-16.041	-5.6683	-2.0029	64.142	22.665	8.0089	-16.041	-5.6683	-2.0029	64.142
F-84	Σ	105.186	394.798	1512.12					6.98924	22.1232	34.5338	9.16784	2.48792	1504.89	392.661	104.542	35.2162	9.36284	2.55659	1506.47
F-84	$\Sigma \Delta X =$	482.067	1809.36	6930.05					32.032	101.391	158.268	42.016	11.402	6896.9	1799.6	479.116	161.319	42.001	11.217	6913.4

B-29 ~ $\Delta X = 6.667$

F-84 ~ $\Delta X = 4.583$

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TABLE 8 (CONT.)

F-84

AERODYNAMIC INTEGRALS - SYMMETRIC CASE

MODES: h, α, β

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
STA.	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)								
χ	α, b^3	α, b^2	$b^2 h_n h_p$	$b h_n h_p$	$b^3 h_p$	$b^2 h_p$	$\alpha, h_p b^3$	$\alpha, h_p b^2$	$\alpha, h_p b$	$b h_p$	$b h_p^2$	$b^2 h_p^2$								
	(8)(4)	(8)(3)	(3)(4)(7)	(2)(6)(7)	(4)(7)	(3)(7)	(8)(7)(4)	(8)(7)(3)	(8)(7)(2)	(2)(7)	(2)(7) ²	(3)(7) ²								
877.5	22.325	7.8888	.44357	.15673	1.4166	.50056	1.3954	.49305	.17422	.17687	.011055	.031285								
932.5	36.557	10.978	1.3690	.41112	6.9236	2.0792	6.8544	2.0584	.61813	.62437	.11707	.38985								
987.5	56.342	14.672	1.9849	.51670	17.675	4.6081	17.607	4.5851	1.194	1.2	.375	1.440								
1042.5	81.102	18.730	1.6656	.38446	35.518	8.2027	35.482	8.1945	1.8925	1.8944	.82879	3.9973								
1097.5	81.183	18.749	-.25996	-.060038	45.665	10.546	45.665	10.546	2.4356	2.4356	1.9700	5.9323								
1152.5	56.625	14.746	-.25582	-.66618	38.930	10.138	38.930	10.138	2.64	2.64	1.815	6.9698								
1207.5	36.926	11.089	-.43251	-.12788	30.002	9.0098	30.002	9.0098	2.7056	2.7056	2.1983	7.3205								
1262.5	22.665	8.0089	-.53140	-.18777	21.248	7.5083	21.248	7.5083	2.6531	2.6531	2.4873	7.0391								
Σ	393.725	104.862	-.69749	-.243351	197.398	52.5927	197.184	52.5927	14.3131	14.3299	9.20251	32.5201								
$\Sigma \Delta \chi$	1804.4	480.583	-32.054	-.11152	904.67	241.032	903.694	241.032	65.597	65.674	42.125	149.040								
AILERON COEFFICIENTS																				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)									
χ	b	b^2	b^3	b^4	h_n	h_p	α	$b^3 h_n$	α, b^4	$b^3 h_p$										
IN.	FT.	(2) ²	(2)(3)	(2)(4)	$\frac{1-(.04968)}{\chi(2.07)}$	$\chi \div 440$		(4)(6)	(8)(5)	(4)(7)										
INB'D.	876	2.82	7.9524	22.426	63.241	.89236	.059091	.985	20.012	62.292	1.3252									
"	909	3.12	9.7344	30.371	94.758	.75574	.13409	.988	22.953	93.621	4.0724									
"	942	3.42	11.696	40.0	136.80	.61912	.20909	.992	24.765	135.71	8.3636									
OUTB'D.	1198	3.42	11.696	40.0	136.80	-.44072	.79091	1.0	-17.629	136.80	31.636									
"	1251	3.12	9.7344	30.371	94.758	-.57734	.86591	1.0	-17.534	94.758	26.299									
"	1264	2.82	7.9524	22.426	63.241	-.71396	.94091	1.0	-16.011	63.241	21.101									
Σ				$\Sigma \delta_i \alpha_j$	0				118.904	-3.176	-65.2748									
$\Sigma \Delta \chi$				$\Sigma \delta_i \delta_j$	1621.4				326.99	-8.734	-179.506									

F-84 - $\Delta \chi = 4.583$

F-84 - AIL. $\Delta \chi = 2.750$

These summations actually include ail. defl. which is taken positive for inb'd. and negative for outb'd.



TABLE 9

AERODYNAMIC FORCES - SYMMETRIC

$$B_{hh} = \sum_{\theta} b^2 h_h^2 + b_r K_2(L_h) \sum_{\theta} D h_h^2 + \sum_{\theta} b^2 h_h^2 + L_r K_2(L_h) \sum_{\theta} L h_h^2 - a \alpha_h \sum_{\theta} b^3 h_h$$

$$+ b_r K_2(L_h) \alpha_h \sum_{\theta} b^2 h_h + b_r^2 K_3(L_h) \alpha_h \sum_{\theta} b h_h - (\frac{1}{2} + a) b_r K_2(L_h) \alpha_h \sum_{\theta} b^2 h_h$$

$$+ [L_r - (c-e) L_2] \delta_h \sum_{\theta} h_h D^2 - a \alpha_h \sum_{\theta} b^3 h_h - b_r (\frac{1}{2} + a) K_2(L_h) \alpha_h \sum_{\theta} D^2 h_h$$

$$+ (\frac{1}{2} + a^2) \alpha_h^2 \sum_{\theta} D^4 + L_r K_2(M_h) \alpha_h^2 \sum_{\theta} D^3 - (\frac{1}{2} + a) b_r K_2(L_h) \alpha_h^2 \sum_{\theta} b^3$$

$$- (\frac{1}{2} + a) b_r^2 K_3(L_h) \alpha_h^2 \sum_{\theta} b^2 + (\frac{1}{2} + a)^2 b_r K_2(L_h) \alpha_h^2 \sum_{\theta} b^3$$

$$+ [T_h - (c-e) P_h] \delta_h \sum_{\theta} b^3 h_h + [T_p - (c-e) P_p - (c-e) T_2 + (c-e)^2 P_2] \delta_h^2 \sum_{\theta} D^4$$

$$B_{hx} = \frac{1}{2} \sum_{\theta} \alpha_h h_h D^2 + b_r K_2(L_h) \sum_{\theta} \alpha_h h_h D^2 + b_r^2 K_3(L_h) \sum_{\theta} \alpha_h h_h D - a \sum_{\theta} \alpha_h h_h L^2$$

$$+ b_r K_2(L_h) \sum_{\theta} \alpha_h h_h D^2 + b_r^2 K_3(L_h) \sum_{\theta} \alpha_h h_h D - (\frac{1}{2} + a) b_r K_2(L_h) \sum_{\theta} \alpha_h h_h D^2$$

$$+ (\frac{1}{2} + a^2) \alpha_h \sum_{\theta} D^2 \alpha_h + b_r K_2(M_h) \alpha_h \sum_{\theta} D^3 \alpha_h - (\frac{1}{2} + a) b_r K_2(L_h) \alpha_h \sum_{\theta} D^2 \alpha_h$$

$$- (\frac{1}{2} + a) b_r^2 K_3(L_h) \alpha_h \sum_{\theta} b^2 \alpha_h + (\frac{1}{2} + a)^2 b_r K_2(L_h) \alpha_h \sum_{\theta} b^3 \alpha_h$$

$$+ [T_h - (c-e) P_h - (\frac{1}{2} + a) T_h + (\frac{1}{2} + a)(c-e) P_h] \delta_h \sum_{\theta} b^4 \alpha_h$$

$$B_{hp} = \sum_{\theta} b^2 h_h h_p + b_r K_2(L_h) \sum_{\theta} b h_h h_p - a \alpha_h \sum_{\theta} D^2 h_h + b_r K_2(L_h) \alpha_h \sum_{\theta} b^2 h_h$$

$$+ b_r^2 K_3(L_h) \alpha_h \sum_{\theta} b h_h - (\frac{1}{2} + a) b_r K_2(L_h) \alpha_h \sum_{\theta} D^2 h_h + [L_r - (c-e) L_2] \delta_h \sum_{\theta} b^3 h_h$$

$$- a \alpha_h \sum_{\theta} b^3 h_p - b_r (\frac{1}{2} + a) K_2(L_h) \alpha_h \sum_{\theta} b^2 h_p + (\frac{1}{2} + a^2) \alpha_h \alpha_p \sum_{\theta} b^4$$

$$+ b_r K_2(M_h) \alpha_h \alpha_p \sum_{\theta} b^3 - (\frac{1}{2} + a) b_r K_2(L_h) \alpha_h \alpha_p \sum_{\theta} D^3$$

$$- (\frac{1}{2} + a) b_r^2 K_3(L_h) \alpha_h \alpha_p \sum_{\theta} b^2 + (\frac{1}{2} + a)^2 b_r K_2(L_h) \alpha_h \alpha_p \sum_{\theta} b^3$$

$$+ [T_p - (c-e) P_p - (c-e) T_2 + (c-e)^2 P_2] \delta_h \sum_{\theta} P \sum_{\theta} L^4 + [T_h - (c-e) P_h] \delta_h \sum_{\theta} h_p b^3$$



TABLE 9 (CONT.)

$$B_{ah} = \frac{1}{2} \sum_{84} b^3 \alpha, h_h - a \sum_{84} b^3 \alpha, h_h - b_r (\frac{1}{2} + a) K_2 (L_h) \sum_{84} b^3 \alpha, h_h + (\frac{1}{2} + a^2) \alpha_h \sum_{84} b^3 \alpha, \\ + b_r K_2 (M_a) \alpha_h \sum_{84} b^3 \alpha_h - (\frac{1}{2} + a) b_r K_2 (L_a) \alpha_h \sum_{84} b^3 \alpha, \\ - (\frac{1}{2} + a) b_r^2 K_3 (L_a) \alpha_h \sum_{84} b^3 \alpha, + (\frac{1}{2} + a)^2 b_r K_2 (L_h) \alpha_h \sum_{84} b^3 \alpha, \\ + [M_0 - (\frac{1}{2} + a) L_p - (c \cdot c) M_2 + (c \cdot c) (\frac{1}{2} + a) L_2] \delta_h \sum_{84} b^4 \alpha,$$

$$B_{aa} = \frac{3}{8} \sum_{84} \alpha,^2 b^4 + b_r K_2 (M_a) \sum_{84} \alpha,^2 b^3 + (\frac{1}{2} + a^2) \sum_{84} \alpha,^2 b^4 + b_r K_2 (M_a) \sum_{84} \alpha,^2 b^3 \\ - (\frac{1}{2} + a) b_r K_2 (L_a) \sum_{84} \alpha,^2 b^3 - (\frac{1}{2} + a) b_r^2 K_3 (L_a) \sum_{84} \alpha,^2 b^2 \\ + (\frac{1}{2} + a)^2 b_r K_2 (L_h) \sum_{84} \alpha,^2 b^3$$

$$B_{ap} = -a \sum_{84} \alpha_a h_p b^3 - b_r (\frac{1}{2} + a) K_2 (L_h) \sum_{84} \alpha_a h_p b^2 + (\frac{1}{2} + a^2) \alpha_p \sum_{84} \alpha_a b^4 \\ + b_r K_2 (M_a) \alpha_p \sum_{84} b^3 \alpha_a - (\frac{1}{2} + a) b_r K_2 (L_a) \alpha_p \sum_{84} \alpha_a b^3 \\ - (\frac{1}{2} + a) b_r^2 K_3 (L_a) \alpha_p \sum_{84} \alpha_a b^2 + (\frac{1}{2} + a)^2 b_r K_2 (L_h) \alpha_p \sum_{84} \alpha_a b^3 \\ + [M_0 - (\frac{1}{2} + a) L_p - (c \cdot c) M_2 + (c \cdot c) (\frac{1}{2} + a) L_2] \delta_p \sum_{84} \alpha_a b^4$$

$$B_{bh} = \sum_{84} b^2 h_h h_p + b_r K_2 (L_h) \sum_{84} b h_h h_p - a \alpha_h \sum_{84} h_p b^3 + b_r K_2 (L_a) \alpha_h \sum_{84} h_p b^2 \\ + b_r^2 K_3 (L_a) \alpha_h \sum_{84} h_p b - (\frac{1}{2} + a) b_r K_2 (L_h) \alpha_h \sum_{84} h_p b^2 \\ + [L_p - (c \cdot c) L_2] \delta_h \sum_{84} b^3 h_p - a \alpha_p \sum_{84} h_h b^3 - b_r (\frac{1}{2} + a) K_2 (L_h) \alpha_p \sum_{84} h_h b^2 \\ + (\frac{1}{2} + a^2) \alpha_p \alpha_h \sum_{84} b^4 + b_r K_2 (M_a) \alpha_p \alpha_h \sum_{84} b^3 - (\frac{1}{2} + a) b_r K_2 (L_a) \alpha_p \alpha_h \sum_{84} b^3 \\ - (\frac{1}{2} + a) b_r^2 K_3 (L_a) \alpha_p \alpha_h \sum_{84} b^2 + (\frac{1}{2} + a)^2 b_r K_2 (L_h) \alpha_p \alpha_h \sum_{84} b^3 \\ + [T_0 - (c \cdot c) P_0 - (c \cdot c) T_2 + (c \cdot c)^2 P_2] \delta_0 \sum_{84} b^4 + [T_h - (c \cdot c) P_h] \delta_p \sum_{84} b^3 h_h$$



TABLE 9 (CONT.)

$$\begin{aligned}
 E_{pp} = & -a \sum_{\beta} \alpha_i h_{\beta} b^3 + b_r K_2(L_u) \sum_{\beta} \alpha_i h_{\beta} b^2 + b_r^2 K_1(L_u) \sum_{\beta} \alpha_i h_{\beta} b \\
 & - (\frac{1}{2} + a) b_r K_1(L_u) \sum_{\beta} \alpha_i h_{\beta} b^2 + (\frac{1}{8} + a^2) \alpha_{\beta} \sum_{\beta} \alpha_i b^4 + b_r K_2(M_u) \alpha_{\beta} \sum_{\beta} \alpha_i b^4 \\
 & - (\frac{1}{2} + a) b_r K_2(L_u) \alpha_{\beta} \sum_{\beta} \alpha_i b^3 - (\frac{1}{2} + a) b_r^2 K_3(L_u) \alpha_{\beta} \sum_{\beta} \alpha_i b^2 \\
 & + (\frac{1}{2} + a)^2 b_r K_2(L_u) \alpha_{\beta} \sum_{\beta} \alpha_i b^3 + [T_u - (c \cdot e) P_u - (\frac{1}{2} + a) T_h + (\frac{1}{2} + a)(c \cdot e) P_h] \times \\
 & \sum_{\beta} \alpha_i b^4
 \end{aligned}$$

$$\begin{aligned}
 E_{pp} = & \sum_{\beta} h_{\beta}^2 b^2 + b_r K_2(L_u) \sum_{\beta} h_{\beta}^2 b - a \alpha_{\beta} \sum_{\beta} h_{\beta} b^3 + b_r K_2(L_u) \alpha_{\beta} \sum_{\beta} h_{\beta} b^2 \\
 & + b_r^2 K_3(L_u) \alpha_{\beta} \sum_{\beta} h_{\beta} b - (\frac{1}{2} + a) b_r K_2(L_u) \alpha_{\beta} \sum_{\beta} h_{\beta} b^2 \\
 & + [L_{\beta} - (c \cdot e) L_z] \sum_{\beta} \alpha_i h_{\beta} b^3 - a \alpha_{\beta} \sum_{\beta} h_{\beta} b^3 - b_r (\frac{1}{2} + a) K_2(L_u) \alpha_{\beta} \sum_{\beta} h_{\beta} b^2 \\
 & + (\frac{1}{8} + a^2) \alpha_{\beta}^2 \sum_{\beta} b^4 + b_r K_2(M_u) \alpha_{\beta}^2 \sum_{\beta} b^3 - (\frac{1}{2} + a) b_r K_2(L_u) \alpha_{\beta}^2 \sum_{\beta} b^2 \\
 & - (\frac{1}{2} + a) b_r^2 K_3(L_u) \alpha_{\beta}^2 \sum_{\beta} b^2 + (\frac{1}{2} + a)^2 b_r K_2(L_u) \alpha_{\beta}^2 \sum_{\beta} b^3 \\
 & + [T_h - (c \cdot e) P_h] \sum_{\beta} \alpha_i b^3 h_{\beta} + [T_u - (c \cdot e) P_u - (c \cdot e) T_z + (c \cdot e)^2 P_z] \sum_{\beta} \alpha_i b^4
 \end{aligned}$$

$e = .4$

$b_r = 5.21$

$(c \cdot e) = .05$

$a_{B-29} = -.5$

$a_{F-84} = -.2$

TABLE 10

EVALUATION OF TABLE 9

$$B_{hh} = 216.433 + 310.616 K_2(L_h) - 1.54977 K_2(L_a) - 2.19645 K_3(L_a) \\ + .386499 K_2(M_a) + 27.5653 L_p - 1.37826 L_z + 27.5653 T_h \\ - 1.37826 P_h + 11.5217 T_p - .576083 P_p - .576083 T_z + .028804 P_z$$

$$B_{ha} = 234.512 - 71.0859 K_2(L_h) + 759.047 K_2(L_a) + 995.146 K_3(L_a) \\ - 60.1659 K_2(M_a) - .736276 T_a + .036814 P_a + .220883 T_h \\ - .011044 P_h$$

$$B_{hp} = -33.1693 - 56.5150 K_2(L_h) + .41405 K_2(L_a) + .58682 K_3(L_a) \\ - .10817 K_2(M_a) - 7.3867 L_p + .369335 L_z - 15.1324 T_h \\ + .756618 P_h - 3.08767 T_p + .15438 P_p + .15438 T_z - .0077192 P_z$$

$$B_{ah} = 228.53 - 71.0859 K_2(L_h) + 18.0498 K_2(L_a) + 25.0461 K_3(L_a) \\ - 60.1659 K_2(M_a) - .73628 M_p + .22088 L_p + .036814 M_z \\ - .011044 L_z$$

$$B_{aa} = 1747.29 + 843.83 K_2(L_h) - 2812.77 K_2(L_a) - 3701.54 K_3(L_a) \\ + 11,348.97 K_2(M_a)$$

$$B_{ap} = 182.69 - 374.859 K_2(L_h) - 4.88267 K_2(L_a) - 6.69208 K_3(L_a) \\ + 16.0756 K_2(M_a) + .197301 M_p - .05919 L_p - .009865 M_z \\ + .00296 L_z$$

$$B_{ph} = -33.2842 - 55.7001 K_2(L_h) - 8.00602 K_2(L_a) - 11.2560 K_3(L_a) \\ - .103166 K_2(M_a) - 15.1323 L_p + .256618 L_z - 7.38670 T_h \\ + .369335 P_h - 3.08769 T_p + .154385 P_p + .154385 T_z - .007719 P_z$$

$$B_{pa} = 182.69 - 374.859 K_2(L_h) + 1247.17 K_2(L_a) + 1773.87 K_3(L_a) \\ + 16.0756 K_2(M_a) + .197301 T_a - .059190 T_h - .009865 P_a \\ + .002960 P_h$$

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TABLE 10 (CONT.)

$$\begin{aligned} B_{99} = & 149662 + 218.446 K_2(L_n) + 2.1559 K_2(L_a) + 3.03656 K_3(L_a) \\ & + .02828 K_2(M_a) + 4.05504 T_H - .20275 P_H + 4.05504 L_P \\ & - .20275 L_2 + 82691 T_P - .041345 P_B - .041345 T_2 + .0020673 P_B \end{aligned}$$

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TABLE II

FLUTTER DETERMINANT

ALT. = 20000'

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MODES: n, α, β

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	$\frac{1}{K}$	$\rightarrow$	1.25		2.50		5.00		10.00		16.67									
			R	I	R	I	R	I	R	I	R	I								
(1)	$1 + .1894 \times 10^{-4}$	B_{hh}	1.00185	-.00535	.99676	-.01836	.98161	-.04121	.93213	-.09030	.82294	-.15581								
(2)	$.19936 + "$	B_{hx}	1.96161	-.027132	1.84004	-.034934	1.28778	.016752	-1.18514	.30032	-.740407	.88516								
(3)	$-.05205 + "$	B_{hp}	-.05223	.00154	-.05614	.00337	-.05260	.00243	-.04013	.01590	-.01149	.02693								
(4)	$.004226 + .4014 \times 10^{-7}$	B_{hh}	.00423	0	.00423	.00001	.00420	.00003	.00407	.00009	.00375	.00017								
(5)	$1 + "$	B_{xx}	1.00036	-.00037	1.00136	-.00093	1.00592	-.00261	1.02640	-.00751	1.02805	-.01572								
(6)	$.01675 + "$	B_{xp}	.01676	.00002	.01677	.00005	.01680	.00011	.01685	.00024	.01696	.00042								
(7)	$-.03056 + .1014 \times 10^{-4}$	B_{hh}	-.03033	.00102	-.02865	.00199	-.02121	.00354	.00762	.00513	.02976	.00518								
(8)	$4.2344 + "$	B_{px}	4.20252	-.02279	4.02541	-.02270	3.56516	.04093	.19864	.31749	-4.21951	.94740								
(9)	$1 + "$	B_{pp}	1.00077	-.00313	.99731	-.00698	.99517	-.01597	.98110	-.03573	.96202	-.06277								
(10)	(9) x (9)		1.00155	0	.99847	0	.99062	0	.96973	0	.92912	0								
(11)	(9) ÷ (10)		.99922	.00313	1.00074	.00699	1.00459	.01612	1.01382	.03685	1.03508	.06754								
(12)	(7) x (11)		-.030310	.000924	-.028685	.001791	-.021867	.003206	.007543	.005487	.029766	.011438								
(13)	(8) x (11)		4.19951	-.049618	4.09159	.005861	3.58086	.098588	.19357	.22797	-4.98906	.66188								
(14)	(12) x (3)		.001733	-.000100	.001604	-.000197	.001126	-.000331	-.000390	-.000100	-.001324	.002367								
(15)	(13) x (3)		-.24031	.002017	-.22972	.013460	-.18909	.021420	-.011393	-.006071	.039040	-.14088								
(16)	(1) - (14) = Q_{11}		1.00012	-.008250	.99516	-.018163	.98048	-.040879	.93252	-.09020	.82431	-.15818								
(17)	(2) - (15) = Q_{12}		2.20192	-.034789	2.06976	-.048394	1.47687	-.004668	-1.17175	.30639	-.745311	1.02604								
(18)	(12) x (6)		-.000508	.000015	-.000321	.000029	-.000368	.000051	.000126	.000094	.001569	.000233								
(19)	(13) x (6)		.020381	-.000077	.068616	.000303	.060148	.002050	.003207	.003888	-.084214	.009149								
(20)	(4) - (18) = Q_{21}		.004738	-.000015	.004711	-.000019	.004568	-.000021	.003944	-.000004	.002181	-.000063								
(21)	(5) - (19) = Q_{22}		.92998	-.000293	.93274	-.001233	.94577	-.004660	1.02319	-.011378	1.16226	-.024917								
(22)	$Q_{11} \times Q_{22}$		.92009	-.002745	.92825	-.018166	.92712	-.043231	.95312	-.10292	.95412	-.20437								
(23)	$Q_{21} \times Q_{12}$		.010432	-.000198	.009750	-.000267	.006746	-.000052	-.004630	.001213	-.016169	.002307								
(24)	(22) - (23)		.91966	-.002947	.91845	-.017899	.92037	-.043179	.95774	-.10413	.97029	-.20710								

$$\frac{\pi p}{A_{hh}} = .1894 \times 10^{-4}$$

$$\frac{\pi p}{A_{xx}} = .4014 \times 10^{-7}$$

$$\frac{\pi p}{A_{pp}} = .1014 \times 10^{-4}$$

$$\frac{A_{hx}}{A_{hh}} = 1.9936$$

$$\frac{A_{xh}}{A_{xx}} = .004226$$

$$\frac{A_{hr}}{A_{pp}} = -.03056$$

$$\frac{A_{hp}}{A_{hh}} = -.05705$$

$$\frac{A_{xp}}{A_{xx}} = .01675$$

$$\frac{A_{px}}{A_{pp}} = 4.2344$$

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P = 2.376

TABLE II (CONT.)

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	1/K	→	1.25		2.50		5.00		10.00		16.67									
			R	I	R	I	R	I	R	I	R	I								
(25)	(24) ÷ P = ?		.38708	-.003269	.38658	-.002534	.38738	-.018174	.40311	-.013828	.40840	-.082168								
(26)	Q ₁₁ ÷ 2P + Q ₂₂ ÷ 2 = λ		.67552	-.001883	.67585	-.004440	.67928	-.010935	.70789	-.024686	.75465	-.045755								
(27)	λ ²		.45632	-.002544	.45675	-.006002	.46130	-.014856	.50050	-.034950	.56740	-.069058								
(28)	λ ² - ?		.069240	.000725	.070170	.001532	.073920	.003318	.09739	.008878	.15900	.018110								
(29)	√(28)		.26314	.001378	.26491	.002892	.27195	.006102	.31240	.014224	.39940	.022708								
(30)	λ + (29) = λ ₁ + iγ ₁		.93866	-.000505	.94076	-.001548	.95123	-.004833	1.02029	-.010462	1.15405	-.023047								
(31)	.373 (1/K/√K ₁); iγ ₁ /λ ₁		.4812	-.00054	.9614	-.00165	1.912	-.00508	3.693	-.01025	5.788	-.01997								
(32)	λ - (29) = λ ₂ + iγ ₂		.41238	-.003261	.41094	-.007332	.40733	-.017037	.39549	-.038910	.35525	-.068463								
(33)	.373 (1/K/√K ₂); iγ ₂ /λ ₂		.7261	-.00791	1.455	-.01784	2.922	-.04183	5.931	-.09838	10.43	-.1927								
	P = 1.5																			
(25)	(24) ÷ P = ?		.61311	-.0051780	.61230	-.011933	.61358	-.028786	.63849	-.069420	.64686	-.13807								
(26)	Q ₁₁ ÷ 2P + Q ₂₂ ÷ 2 = λ		.79836	-.0028965	.79809	-.0066708	.79971	-.015956	.82243	-.035766	.85590	-.065185								
(27)	λ ²		.63737	-.0046249	.63690	-.010648	.63928	-.025520	.67511	-.058830	.72832	-.11158								
(28)	λ ² - ?		.02426	.0005531	.0246	.001285	.0257	.003266	.03662	.01059	.08146	.02649								
(29)	√(28)		.15527	.0017255	.15690	.0040964	.16063	.010166	.19331	.027371	.28907	.045820								
(30)	λ + (29) = λ ₁ + iγ ₁		.95413	-.0011210	.95499	-.0025744	.96034	-.00579	1.01574	-.00835	1.14497	-.019365								
(31)	.373 (1/K/√K ₁); iγ ₁ /λ ₁		.4773	-.001175	.9542	-.002696	1.903	-.006029	3.701	-.008245	5.811	-.01691								
(32)	λ - (29) = λ ₂ + iγ ₂		.64259	-.0046720	.64119	-.010767	.63908	-.026122	.62912	-.063157	.56683	-.11101								
(33)	.373 (1/K/√K ₂); iγ ₂ /λ ₂		.5816	-.007271	1.165	-.01679	2.333	-.04087	4.703	-.1004	8.259	-.1958								

$$\frac{V}{\omega_\alpha} = \frac{b_r}{14} \frac{1/K}{\sqrt{K}}$$

$$b_r = 5.21$$

$$P = \left(\frac{\omega_n}{\omega_\alpha} \right)^2$$

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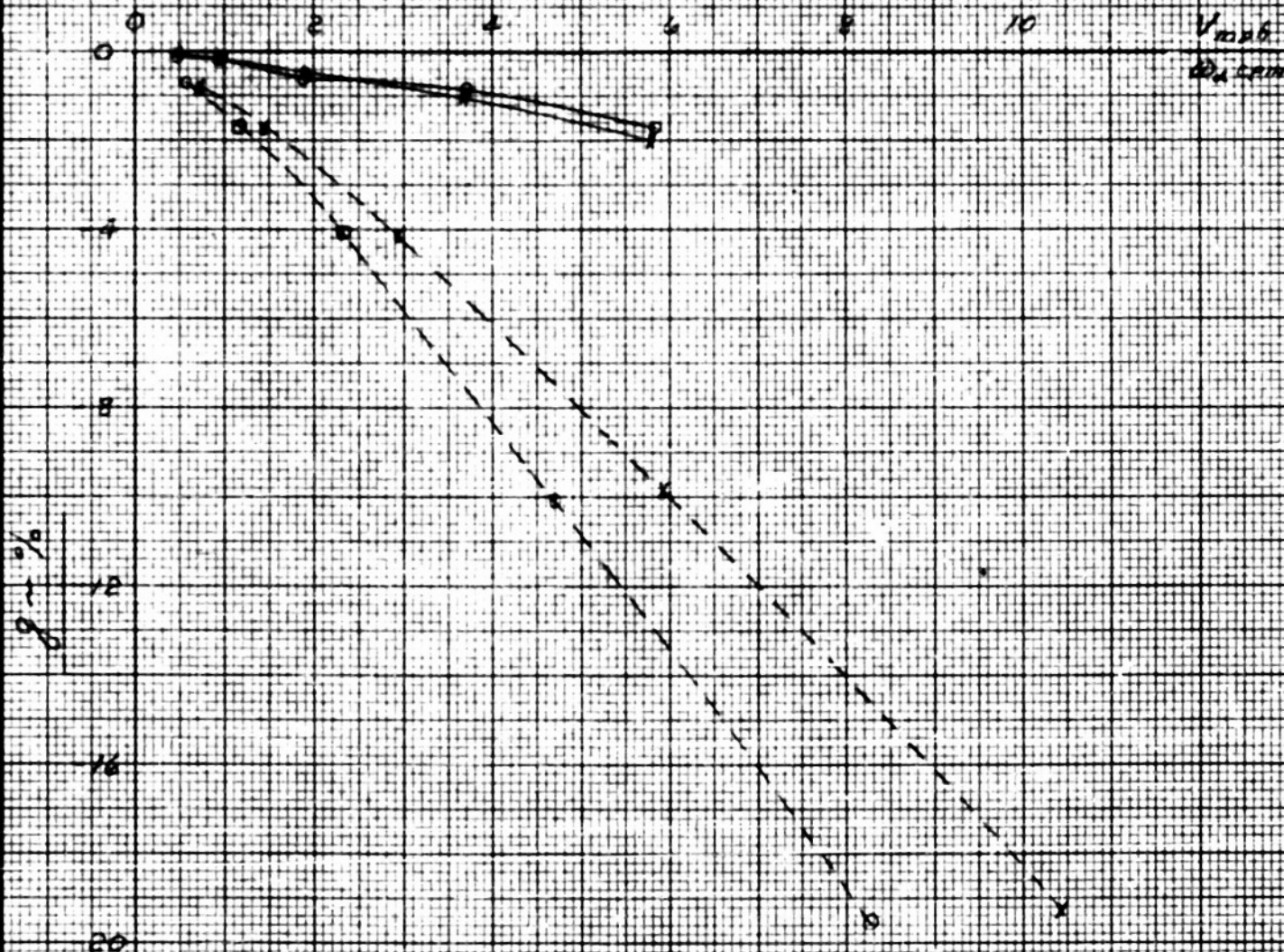
FIGURE 10
SYMMETRIC BENDING-TORSION-FLAPPING FLUTTER

ALT. = 20,000'

$Q_2 = 87 \text{ cm}$

$\times \times = P = 2.874$

$\circ \circ = P = 1.5$



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TABLE 12

GENERALIZED MASSES - ANTI-SYMMETRIC CASE

MODES: h, α, β, R

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E-SAF-MX1016-1

B-29-F-84

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
ELEMENT	STA.	M(x)	S(x)	I(x)	h_R	h_h	h_β	α_i	A_{RR}	A_{hh}	$A_{\beta\beta}$	$A_{\alpha\alpha}$	$A_{R\beta}$	$A_{h\beta}$	$A_{R\alpha}$	$A_{h\alpha}$	$A_{\beta\alpha}$			
		SLUGS	SLUG-FT.	SLUG-FT. ²	$(2) \div 850$				$(3)(6)^2$	$(3)(7)^2$	$(3)(8)^2$	$(5)(9)^2$	$(3)(6)(8)$	$(3)(7)(8)$	$(4)(6)(9)$	$(4)(7)(9)$	$(4)(8)(9)$			
1	0	378.36	7847	394 696	0	0	0	0	0	0	0	0	0	0	0	0	0			
2	90	144.72	-49.2	1425	08894	-.02229	↑	.008293	.96687	.0719	↑	.098003	↑	↑	-.036289	.009095	↑			
3	169	401.04	-1790	18461	.16701	-.03365		.01897	11.186	.4541		6.6434			-5.6710	1.1426				
4	270	152.28	101.0	1209	.26682	-.03497		.03485	10 841	.1862		1.4684			.93917	-12309				
5	374	345.84	-1412	14 704	.36960	-.01826		.05579	47.242	.11531		45.767			-29.115	1.4384				
6	520	64.20	69.9	410	.51388	.05003		.1001	16.953	1.6646		4.1082			3.5956	.35006				
7	670	14.62	12.9	86.6	.66212	.2655		.2661	6.4094	1.0306		6.1321			2.2729	.91138				
8	820	4.36	2.6	21.7	.81036	.8618	↓	.8816	2.86314	3.2381	↓	16.866	↓	↓	1.8575	1.9754	↓			
9	850	14.40	2.7	25.9	1.0	1.0	0	.9806	14 400	14.400	0	24.905	0	0	2.6476	2.6476	0			
10	905	16.56	12.4	48.7	.77147	.77147	.1250	.9883	9.8559	9.8559	.25875	47.567	1.5969	1.5969	9.4543	9.4543	1.5319			
11	960	46.44	40	137	.54294	.54294	.2500	.9934	13.690	13.690	2.9025	135.20	6.3035	6.3035	21.574	21.574	9.934			
12	1015	17.16	17.3	89.2	.31938	.31938	.375	.9976	1.7504	1.7504	2.4131	88.772	2.0552	2.0552	5.5120	5.5120	6.4719			
13	1070	277.92	913	28 883	.09086	.09086	.5	1.0	2.2944	2.2944	69.480	28 883	12.626	12.626	82.955	82.955	456.5			
14	1125	17.16	17.3	89.2	-.13767	-.13767	.625	↑	.32523	.32523	6.7031	89.2	-1.4765	-1.4765	-2.3817	-2.3817	10.813			
15	1180	46.44	40	137	-.36620	-.36620	.75	↓	6.2280	6.2280	26.123	137	-12.755	-12.755	-14.648	-14.648	30.0			
16	1235	16.56	12.4	48.7	-.59473	-.59473	.875	↓	5.8573	5.8573	12.679	48.7	-8.6176	-8.6176	-7.3747	-7.3747	10.85			
17	1290	4.32	2.7	9.2	-.82326	-.82326	1.0	1.0	2.9279	2.9279	4.32	9.2	-3.5565	-3.5565	-2.2228	-2.2228	2.7			
								Σ =	153.791	64.0899	124.879	29 544.6	-3.8240	-3.8240	69.5586	101.220	528.801			

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TABLE 13

AERODYNAMIC INTEGRALS - ANTI-SYMMETRIC CASE

MODES: h, α, β, R

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E-SAF-MX 1016-1

B-29 - F-84

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
STA.									B-29											
x	b	b^2	b^3	b^4	h_h	h_R	h_β	α_i	h_h^2	$b^2 h_h^2$	$b h_h^2$	$b^3 h_h \alpha_i$	$b^2 h_h \alpha_i$	$b h_h \alpha_i$	$b^2 h_R h_h$	$b h_R h_h$	$b^4 \alpha_i^2$	$b^3 \alpha_i^2$	$b^2 \alpha_i^2$	$b \alpha_i h_R$
IN.									(6) ²	(3)(10)	(2)(10)	(4)(6)(9)	(3)(6)(9)	(2)(6)(9)	(3)(2)(6)	(2)(7)(6)	(5)(9) ²	(4)(9) ²	(3)(9) ²	(4)(9)(7)
90					.02	.10588	0	.0083	.0004	.024586	.003136	-.079994	-.010203	-.001135	-.13016	-.016602	.26027	.033197	.004234	.42349
170					.03	.20		.0190	.0009	.049417	.006669	-.23192	-.031298	-.004224	-.36945	-.04446	1.08838	.14688	.019822	1.54611
250					.035	.29412		.035	.001225	.059171	.008514	-.41124	-.059171	-.008514	-.49724	-.071545	2.85817	.41124	.059171	3.45587
330					.025	.38823		.045	.000625	.026406	.004063	-.30896	-.047531	.007313	-.41007	-.063087	3.61483	.55613	.085556	4.62918
410	← SAME AS SYM CASE →				0	.48235		.065	0	0	0	0	0	0	0	0	5.81149	.95430	.15670	7.08165
490					.035	.57647		.090	.001225	.098690	.006885	.55913	.099490	.017703	.63725	.11339	8.08015	1.43775	.25583	9.20911
570					.095	.67059		.135	.009025	.26497	.047020	1.81371	.33530	.066818	1.66553	.33191	13.42818	2.57758	.49470	12.80270
650					.22	.76471		.225	.0484	1.09205	.22990	5.30491	1.11627	.22513	3.79591	.79712	25.77116	5.42548	1.16225	18.45464
730					.43	.85882		.470	.1849	3.46669	.80062	16.45708	3.78917	.87509	6.92387	1.59704	77.65077	17.93332	4.14165	32.76914
810					.80	.95294	0	.820	.64	9.63456	2.4832	38.31676	9.87542	2.54528	11.47645	2.95793	152.38601	37.27488	10.12231	45.64220
								B-29	$\Sigma =$	14.63654	3.59001	61.36968	15.06805	3.71883	23.13269	5.60570	290.94741	65.75056	16.48222	135.99209
								B-29	$\Sigma \Delta x =$	77.582	23.935	407.152	100.659	24.793	154.222	37.373	1939.260	458.360	109.887	906.666
877.5									F-84											
932.5																				
987.5																				
1042.5	← SAME AS SYM. CASE →																			
1097.5										TABLE 8										
1152.5																				
1207.5																				
1262.5																				
F-84	$\Sigma =$																			
F-84	$\Sigma \Delta x =$	482.067	1809.36	6930.05						101.391	32.032	158.268	42.016	11.402	101.391	32.032	6896.9	1799.6	479.116	158.268

B-29 ~ $\Delta x = 6.667$

NOTE: $h_R = h_h$ ALONG THE F-84 STATIONS

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TABLE 13 (CONT.)

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 E-SAF-MX 1016-1
 B-29 ~ F-84

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
STA	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)	(36)	(37)	(38)	(39)	(40)	(41)
χ	$b^2 \alpha_{hr}$	$b \alpha_{hr}$	$b h_r^2$	$b^2 h_r^2$					<u>B-29</u>											
$1/N$	(3)(9)(7)	(2)(7)(9)	(2)(7) ²	(3)(7) ²																
90	.054017	.006890	.087891	.68907																
170	.20865	.028158	.29630	2.19632																
250	.49724	.071545	.60122	4.17853																
330	.73812	.11354	.97970	6.36803																
410	1.16281	.19094	1.41691	8.28951																
490	1.63865	.29158	1.86763	10.4959																
570	2.45734	.47166	2.34289	12.2064																
650	3.88218	.81728	2.77771	13.1944																
730	7.56795	1.74778	3.19369	13.8287																
810	11.76336	3.03187	3.52331	13.6705																
B-29 Σ	29.97032	6.77126	17.08745	85.11736																
$\Sigma \Delta \chi$	199.812	45.144	113.922	567.477					<u>F-84</u>											
					$b^3 h_r$	$b^2 h_r$	$b h_r$					$b^2 h_r h_p$	$b h_r h_p$							
					$b^3 h_h$	$b^2 h_h$	$b h_h$	α, b^4	α, b^3	α, b^2	$b^2 h_h h_p$	$b h_h h_p$	$b^2 h_p$	$b^2 h_p$	α, h_p^2	α, h_p^2	$\alpha, h_p b$	$b h_p$	$b h_p$	$b^2 h_p^2$
877.5																				
932.5																				
987.5																				
1042.5																				
1097.5																				
1152.5																				
1207.5																				
1262.5																				
F-84 $\Sigma \Delta \chi$	42.016	11.402	32.032	101.391	161.399	43.001	11.717	6913.4	1804.4	480.583	-32.054	-11.152	704.67	241.032	703.672	240.157	65.597	65.674	42.175	149.060

B-29 ~ $\Delta \chi = 6.667$



TABLE 14

AERODYNAMIC FORCES - ANTI-SYMMETRIC

$B_{h\dot{h}}$ = SAME AS SYMMETRIC - SEE TABLE 9

$B_{h\alpha}$ = "

$B_{h\beta}$ = "

$$\begin{aligned} E_{hR} = & \sum_{\delta\delta} b^2 h_h h_R + b_r K_2(L_h) \sum_{\delta\delta} b h_h h_R + \sum_{\delta\delta} b^2 h_h h_R + b_r K_2(L_h) \sum_{\delta\delta} b h_h h_R \\ & - a \alpha_R \sum_{\delta\delta} b^3 h_h + b_r K_2(L_h) \alpha_R \sum_{\delta\delta} b^2 h_h - (\frac{1}{2} + a) b_r K_2(L_h) \alpha_R \sum_{\delta\delta} b^2 h_h \\ & + b_r^2 K_2(L_h) \alpha_R \sum_{\delta\delta} b h_h - a \alpha_h \sum_{\delta\delta} b^3 h_R - b_r (\frac{1}{2} + a) K_2(L_h) \alpha_h \sum_{\delta\delta} b^2 h_R \\ & + (\frac{1}{2} + a^2) \alpha_h \alpha_R \sum_{\delta\delta} b^4 + b_r K_2(M_h) \alpha_h \alpha_R \sum_{\delta\delta} b^3 - (\frac{1}{2} + a) b_r K_2(L_h) \alpha_h \alpha_R \sum_{\delta\delta} b^3 \\ & + (\frac{1}{2} + a)^2 b_r K_2(L_h) \alpha_h \alpha_R \sum_{\delta\delta} b^3 - (\frac{1}{2} + a) b_r^2 K_2(L_h) \alpha_h \alpha_R \sum_{\delta\delta} L^2 \\ & + [L_h - (c-e)L_z] \delta_R \sum_{\delta\delta} b^2 h_h + [T_h - (c-e)P_h - (c-e)T_z + (c-e)^2 P_z] \delta_h \sum_{\delta\delta} b^2 \\ & + [T_h - (c-e)P_h] \delta_h \sum_{\delta\delta} b^2 h_R \end{aligned}$$

$B_{\dot{h}h}$ = SAME AS SYMMETRIC - SEE TABLE 9

$B_{\alpha\alpha}$ = "

$B_{\alpha\beta}$ = "

$$\begin{aligned} B_{\alpha R} = & -a \sum_{\delta\delta} b^3 \alpha_h h_R - a \sum_{\delta\delta} b^3 \alpha_h h_R - b_r (\frac{1}{2} + a) K_2(L_h) \sum_{\delta\delta} b^2 \alpha_h h_R + (\frac{1}{2} + a) \alpha_R \sum_{\delta\delta} b^4 \alpha_h \\ & + b_r K_2(M_h) \alpha_R \sum_{\delta\delta} b^3 \alpha_h - (\frac{1}{2} + a) b_r K_2(L_h) \alpha_R \sum_{\delta\delta} L^2 \alpha_h \\ & + (\frac{1}{2} + a)^2 b_r K_2(L_h) \alpha_R \sum_{\delta\delta} b^3 \alpha_h - (\frac{1}{2} + a) b_r^2 K_2(L_h) \alpha_R \sum_{\delta\delta} b^2 \alpha_h \\ & + [M_h - (\frac{1}{2} + a)L_h - (c-e)M_z + (c-e)(\frac{1}{2} + a)L_z] \delta_R \sum_{\delta\delta} b^4 \alpha_h \end{aligned}$$



TABLE 14 (CONT)

$$B_{\beta h} = \text{SAME AS SYMMETRIC - SEE TABLE 9}$$

$$B_{\beta \alpha} = "$$

$$B_{\beta \beta} = "$$

$$\begin{aligned} B_{\beta R} = & \sum_{\beta h} b^2 h_{\beta} h_R + b_r K_2(L_h) \sum_{\beta h} b h_{\beta} h_R - \alpha \alpha_R \sum_{\beta h} b^3 h_{\beta} + b_r K_2(L_h) \alpha_R \sum_{\beta h} b^2 h_{\beta} \\ & - (\frac{1}{2} + a) b_r K_2(L_h) \alpha_R \sum_{\beta h} b^2 h_{\beta} + b_r^2 K_3(L_h) \alpha_R \sum_{\beta h} b h_{\beta} + [L_p \cdot (C \cdot S) L_e] \delta_R \sum_{\beta h} b^3 h_{\beta} \\ & - \alpha \alpha_{\beta} \sum_{\beta h} b^3 h_{\beta} - b_r (\frac{1}{2} + a) K_2(L_h) \alpha_{\beta} \sum_{\beta h} b^2 h_{\beta} + (\frac{1}{2} + a^2) \alpha_{\beta} \alpha_R \sum_{\beta h} b^4 \\ & + b_r K_2(M_h) \alpha_{\beta} \alpha_R \sum_{\beta h} b^3 - (\frac{1}{2} + a) b_r K_2(L_h) \alpha_{\beta} \alpha_R \sum_{\beta h} b^3 \\ & + (\frac{1}{2} + a^2) b_r K_2(L_h) \alpha_{\beta} \alpha_R \sum_{\beta h} b^3 - (\frac{1}{2} + a) b_r^2 K_3(L_h) \alpha_{\beta} \alpha_R \sum_{\beta h} b^2 \\ & + [T_h \cdot (C \cdot S) P_h] \delta_{\beta} \sum_{\beta h} b^3 h_{\beta} + [T_{\beta} \cdot (C \cdot S) P_{\beta} - (C \cdot S) T_{\beta} + (C \cdot S)^2 P_{\beta}] \delta_{\beta} \delta_R \sum_{\beta h} b^4 \end{aligned}$$

$$\begin{aligned} B_{R h} = & \sum_{\beta h} b^2 h_{\beta} h_h + b_r K_2(L_h) \sum_{\beta h} b h_{\beta} h_h + \sum_{\beta h} b^2 h_{\beta} h_h + b_r K_2(L_h) \sum_{\beta h} b h_{\beta} h_h \\ & + [L_p \cdot (C \cdot S) L_e] \delta_h \sum_{\beta h} b^2 h_{\beta} - \alpha \alpha_h \sum_{\beta h} b^3 h_{\beta} - b_r (\frac{1}{2} + a) K_2(L_h) \alpha_h \sum_{\beta h} b^2 h_{\beta} \\ & + (\frac{1}{2} + a^2) \alpha_h \alpha_h \sum_{\beta h} b^4 + b_r K_2(M_h) \alpha_h \alpha_h \sum_{\beta h} b^3 - (\frac{1}{2} + a) b_r K_2(L_h) \alpha_h \alpha_h \sum_{\beta h} b^3 \\ & + (\frac{1}{2} + a^2) b_r K_2(L_h) \alpha_h \alpha_h \sum_{\beta h} b^3 - (\frac{1}{2} + a) b_r^2 K_3(L_h) - \alpha \alpha_h \sum_{\beta h} b^3 h_{\beta} \\ & + b_r K_2(L_h) \alpha_h \sum_{\beta h} b^2 h_{\beta} - (\frac{1}{2} + a) b_r K_2(L_h) \alpha_h \sum_{\beta h} b^2 h_{\beta} + b_r^2 K_3(L_h) \alpha_h \sum_{\beta h} b h_{\beta} \\ & + [T_h \cdot (C \cdot S) P_h] \delta_R \sum_{\beta h} b^3 h_{\beta} + [T_{\beta} \cdot (C \cdot S) P_{\beta} - (C \cdot S) T_{\beta} + (C \cdot S)^2 P_{\beta}] \delta_R \delta_h \sum_{\beta h} b^4 \end{aligned}$$



TABLE 14 (CONT.)

$$\begin{aligned}
 B_{RE} = & -a \sum_{\beta\beta} b^3 h_R \alpha_1 + b_r K_2(L_R) \sum_{\beta\beta} b^2 h_R \alpha_1 + b_r^2 K_3(L_R) \sum_{\beta\beta} b h_R \alpha_1 - a \sum_{\beta\beta} b^3 h_R \alpha_1 \\
 & + b_r K_2(L_R) \sum_{\beta\beta} b^2 h_R \alpha_1 - (\frac{1}{2}+a) b_r K_2(L_R) \sum_{\beta\beta} b^2 h_R \alpha_1 + b_r^2 K_3(L_R) \sum_{\beta\beta} b h_R \alpha_1 \\
 & + (\frac{1}{8}+a^2) \alpha_R \sum_{\beta\beta} \alpha_1 b^4 + b_r K_2(M_R) \alpha_R \sum_{\beta\beta} \alpha_1 b^3 - (\frac{1}{2}+a) b_r K_2(L_R) \alpha_R \sum_{\beta\beta} \alpha_1 b^3 \\
 & + (\frac{1}{2}+a)^2 b_r K_2(L_R) \alpha_R \sum_{\beta\beta} \alpha_1 b^3 - (\frac{1}{2}+a) b_r^2 K_3(L_R) \alpha_R \sum_{\beta\beta} b^2 \alpha_1 \\
 & + [T_R - (C \cdot C) P_R - (\frac{1}{2}+a) T_R + (\frac{1}{2}+a)(C \cdot C) P_R] S_R \sum_{\beta\beta} b^4 \alpha_1
 \end{aligned}$$

$$\begin{aligned}
 B_{RP} = & \sum_{\beta\beta} b^2 h_R h_P + b_r K_2(L_R) \sum_{\beta\beta} b h_R h_P - a \alpha_P \sum_{\beta\beta} b^3 h_R + b_r K_2(L_R) \alpha_P \sum_{\beta\beta} b^2 h_R \\
 & - (\frac{1}{2}+a) b_r K_2(L_R) \alpha_P \sum_{\beta\beta} b^2 h_R + b_r^2 K_3(L_R) \alpha_P \sum_{\beta\beta} b h_R + [L_P - (C \cdot C) L_P] S_P \sum_{\beta\beta} b^2 h_R \\
 & - a \alpha_R \sum_{\beta\beta} b^3 h_P - b_r (\frac{1}{2}+a) K_2(L_R) \alpha_R \sum_{\beta\beta} b^2 h_P + (\frac{1}{8}+a^2) \alpha_R \alpha_P \sum_{\beta\beta} b^4 \\
 & + b_r K_2(M_R) \alpha_R \alpha_P \sum_{\beta\beta} b^3 - (\frac{1}{2}+a) b_r K_2(L_R) \alpha_R \alpha_P \sum_{\beta\beta} b^3 + (\frac{1}{2}+a)^2 b_r K_2(L_R) \alpha_R \alpha_P \sum_{\beta\beta} b^3 \\
 & - (\frac{1}{2}+a) b_r^2 K_3(L_R) \alpha_R \alpha_P \sum_{\beta\beta} b^2 + [T_P - (C \cdot C) P_P] S_R \sum_{\beta\beta} b^3 h_P \\
 & + [T_P - (C \cdot C) P_P - (C \cdot C) T_P + (C \cdot C)^2 P_P] S_P \sum_{\beta\beta} b^4
 \end{aligned}$$

$$\begin{aligned}
 B_{RR} = & \sum_{\beta\beta} b^3 h_R^2 + b_r K_2(L_R) \sum_{\beta\beta} b h_R^2 + \sum_{\beta\beta} b^2 h_R^2 + b_r K_2(L_R) \sum_{\beta\beta} b h_R^2 - a \alpha_R \sum_{\beta\beta} b^3 h_R \\
 & + b_r K_2(L_R) \alpha_R \sum_{\beta\beta} b^2 h_R - (\frac{1}{2}+a) b_r K_2(L_R) \alpha_R \sum_{\beta\beta} b^2 h_R + b_r^2 K_3(L_R) \alpha_R \sum_{\beta\beta} b h_R \\
 & + [L_R - (C \cdot C) L_R] S_R \sum_{\beta\beta} b^2 h_R - a \alpha_R \sum_{\beta\beta} b^3 h_R - b_r (\frac{1}{2}+a) K_2(L_R) \alpha_R \sum_{\beta\beta} b^2 h_R \\
 & + (\frac{1}{8}+a^2) \alpha_R^2 \sum_{\beta\beta} b^4 + b_r K_2(M_R) \alpha_R^2 \sum_{\beta\beta} b^3 - (\frac{1}{2}+a) b_r K_2(L_R) \alpha_R^2 \sum_{\beta\beta} b^3 \\
 & + (\frac{1}{2}+a)^2 b_r K_2(L_R) \alpha_R^2 \sum_{\beta\beta} b^3 - (\frac{1}{2}+a) b_r^2 K_3(L_R) \alpha_R^2 \sum_{\beta\beta} b^2 \\
 & + [T_R - (C \cdot C) P_R] S_R \sum_{\beta\beta} b^3 h_R + [T_P - (C \cdot C) P_P - (C \cdot C) T_P + (C \cdot C)^2 P_P] S_R^2 \sum_{\beta\beta} b^4
 \end{aligned}$$



TABLE 15

EVALUATION OF TABLE 14

$$B_{hh} = 198.4247 + 292.51368 K_2(L_h) - 160445 K_2(L_u) - 210229 K_3(L_u) \\ + .41185 K_2(M_u) + 28.44159 T_h - 1.42208 P_h + 12.26673 T_p \\ - .61334 P_p - .61334 T_2 + .03067 P_2 + 28.44159 L_p - 1.42208 L_2$$

$$B_{hx} = 234.512 - 21.0859 K_2(L_h) + 759.047 K_2(L_u) + 995.146 K_3(L_u) \\ - 60.1659 K_2(M_u) - .236276 T_u + .036814 P_u + .220883 T_h \\ - .011044 P_h$$

$$B_{hp} = -33.1693 - 56.8150 K_2(L_h) + .41405 K_2(L_u) + .58682 K_3(L_u) \\ - .10317 K_2(M_u) - 7.3867 L_p + .369335 L_2 - 15.1324 T_h + .756618 P_h \\ - 3.08769 T_p + .15438 P_p + .15438 T_2 - .007719 P_2$$

$$B_{hr} = 255.32225 + 362.27233 K_2(L_h) - 25973 K_2(L_u) - 107667 K_3(L_u) \\ + 19501 K_2(M_u) + 17.29777 L_p - .86489 L_2 + 7.46045 T_p - .37302 P_p \\ - 37302 T_2 + .01865 P_2 + 28.44159 T_h - 1.42208 P_h$$

$$B_{xh} = 228.53 - 21.0859 K_2(L_h) + 18.0498 K_2(L_u) + 250261 K_3(L_u) \\ - 60.1659 K_2(M_u) - .23628 M_p + .22088 L_p + 03614 M_2 - 011044 L_2$$

$$B_{dx} = 1458.05 + 1058.76 K_2(L_h) - 352919 K_2(L_u) - 390154 K_3(L_u) \\ + 11763.98 K_2(M_u)$$

$$B_{xp} = 18269 - 374.859 K_2(L_h) - 4.88267 K_2(L_u) - 667208 K_3(L_u) \\ + 160756 K_2(M_u) + .197301 M_p - .05919 L_p - .009865 M_2 + .00296 L_2$$

$$B_{xr} = 481.417 - 68.319 K_2(L_h) + 8.8225 K_2(L_u) + 12249 K_3(L_u) \\ - 29.425 K_2(M_u) - .46203 M_p + .13861 L_p + 023101 M_2 - .0067304 L_2$$

$$B_{ph} = -33.2842 - 55.2001 K_2(L_h) - 8.00602 K_2(L_u) - 11.5660 K_3(L_u) \\ - .103166 K_2(M_u) - 15.1324 L_p + .756618 L_2 - 7.38670 T_h + .369335 P_h \\ - 3.08769 T_p + .154385 P_p + .154385 T_2 - .007719 P_2$$



TABLE 15 (CONT.)

$$B_{px} = 182.69 - 324.859 K_2(L_h) + 1249.47 K_2(L_a) + 1773.87 K_3(L_a) \\ + 16.0756 K_2(M_a) + .197301 T_a - .05919 T_h - .009865 P_a + .00296 P_h$$

$$B_{pb} = 149.662 + 218.446 K_2(L_h) + 21559 K_2(L_a) + 2.8589 K_3(L_a) \\ + .02828 K_2(M_a) + 4.05504 T_h - .20275 P_h + 4.05504 L_p - .20275 L_a \\ + 82691 T_p - .041345 P_p - .041345 T_e + .0020673 P_e$$

$$B_{pr} = -32.6 - 57.042 K_2(L_h) - 3.9165 K_2(L_a) - 5.5608 K_3(L_a) - .047134 K_2(M_a) \\ - 7.3867 T_h + .36934 P_h - 9.4959 L_p + .47479 L_e - 1.9376 T_p \\ + .09688 P_p + .09688 T_e - .004844 P_e$$

$$B_{ch} = 255.323 + 362.272 K_2(L_h) - 1.5403 K_2(L_a) - 2.1847 K_3(L_a) + 19503 K_2(M_a) \\ + 17.298 T_h - .86489 P_h + 28.442 L_p - 1.4221 L_e + 7.4605 T_p \\ - 37302 P_p - 37302 T_e + .018651 P_e$$

$$B_{rx} = 481.417 - 68.319 K_2(L_h) + 1268.75 K_2(L_a) + 1547.13 K_3(L_a) - 29.425 K_2(M_a) \\ - 46203 T_a + .029101 P_a + .13861 T_h - .0069304 P_h$$

$$B_{rb} = -32.56512 - 57.03773 K_2(L_h) + .39724 K_2(L_a) + .56349 K_3(L_a) \\ - .04713 K_2(M_a) - 1.93759 T_p + .09688 P_p + .09688 T_e - .00484 P_e \\ - 7.38670 L_p + .36934 L_e - 9.49590 T_h + .47479 P_h$$

$$B_{rr} = 668.677 + 760.850 K_2(L_h) - .72951 K_2(L_a) - 1.0347 K_3(L_a) + 094268 K_2(M_a) \\ + 4.5373 T_p - .22687 P_p - .22687 T_e + .011343 P_e + 17.2978 L_p \\ - .86489 L_e + 17.2978 T_h - .86489 P_h$$

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TABLE 16

FLUTTER DETERMINANT

ALT. = 20000'

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MODES: h, α, β, R

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	$\frac{1}{K} \rightarrow$		1.25		2.50		5.00		10.00		16.67									
			R	I	R	I	R	I	R	I	R	I								
(1)	$1 + .1977 \times 10^{-4}$	B_{hh}	1.00168	-.0082078	.99649	-.018062	.98064	-.040407	.92783	-.087950	.80926	-.15110								
(2)	$1.5793 + "$	B_{hx}	1.54591	-.028748	1.41901	-.036465	.84255	.017486	-1.73666	.31349	-8.23019	.92394								
(3)	$-.05967 + "$	B_{hy}	-.059862	.0016102	-.058720	.0035154	-.055027	.0077616	-.042010	.016600	-.012117	.028113								
(4)	$.1977 \times 10^{-4}$	B_{hr}	.0025955	-.010191	-.0025888	-.022707	-.016322	-.051847	-.054811	-.11580	-.13284	-.20317								
(5)	$.003426 + .4288 \times 10^{-7}$	B_{hx}	.0034346	.0000058	.0034293	.0000139	.0034011	.0000358	.0032652	.0000932	.0029147	.0001834								
(6)	$1 + "$	B_{xx}	1.00038	-.0003555	1.00146	-.0008967	1.00635	-.0025724	1.028266	-.0025334	1.083472	-.015989								
(7)	$.01790 + "$	B_{xy}	.017913	.0000219	.017923	.0000491	.017949	.0001133	.018012	.0002562	.018127	.0001533								
(8)	$.002348 + "$	B_{xr}	.0023685	.0000048	.0023667	.0000113	.0023544	.0000251	.0022902	.0000676	.0021208	.0001326								
(9)	$-.03062 + .1014 \times 10^{-4}$	B_{hy}	-.030393	.0010212	-.028706	.0019752	-.021770	.0035410	.0025558	.0051251	.077895	.0051822								
(10)	$4.2345 + "$	B_{xx}	4.20262	-.022792	4.08851	-.022698	3.56526	.040926	.19874	.21743	-4.71941	.94740								
(11)	$1 + "$	B_{yy}	1.00077	-.0001338	.99923	-.0069892	.99523	-.015986	.98440	-.035786	.96292	-.062914								
(12)	$-.03062 + "$	B_{yr}	-.030560	.0009258	-.029490	.0019134	-.025368	.0038664	-.0086953	.0072055	.031280	.010656								
(13)	$.8237 \times 10^{-5}$	B_{hx}	.0009881	-.0042675	-.0014927	-.0094402	-.0087015	-.021302	-.031459	-.046871	-.080950	-.081265								
(14)	$.45099 + "$	B_{xx}	.43001	-.021818	.34724	-.030137	-.022309	-.0033759	-1.69966	.17253	-5.90204	.54545								
(15)	$-.02486 + "$	B_{xy}	-.024932	.00066926	-.024456	.0014654	-.022918	.0052363	-.017494	.0069298	-.0050442	.011729								
(16)	$1 + "$	B_{rr}	1.00354	-.0081327	.99965	-.019583	.99050	-.045114	.96943	-.10215	.93274	-.18097								
(17)	$(16) \times (16)$		1.007169	0	.999683	0	.983125	0	.950229	0	.902754	0								
(18)	$(16) \div (17)$		.99640	.00867	.99997	.01959	1.00750	.01588	1.02021	.10750	1.03322	.20017								
(19)	$(13) \times (18)$		.0010215	-.0042435	-.0013080	-.0094691	-.007790	-.0218610	-.02705	-.0512001	-.06735	-.1001926								
(20)	$(14) \times (18)$		.42865	-.0180113	.34782	-.0233337	-.02736	-.0046541	-1.75256	.0066966	-6.21283	.6206546								
(21)	$(15) \times (18)$		-.024848	.00045069	-.024484	.00098626	-.023238	.0022091	-.018593	.0051892	-.0075631	.011107								
(22)	$(4) \times (19)$		-.0000406	-.0000213	-.0002115	.0000542	-.0010063	.0007607	-.0044464	.0059587	-.0114094	.0269791								
(23)	$(4) \times (20)$		.0009290	-.0044151	-.0014303	-.0078376	.0002053	.0014945	.0952841	.2033155	.6992139	1.3447084								
(24)	$(4) \times (21)$		-.0000599	.0002544	.00006562	.0005534	.00049383	.0011688	.0016200	.0018686	.0032613	.00006114								

$$\frac{\pi P}{A_{hh}} = .1977 \times 10^{-4}$$

$$\frac{\pi P}{A_{xx}} = .4288 \times 10^{-7}$$

$$\frac{\pi P}{A_{yy}} = .1014 \times 10^{-4}$$

$$\frac{\pi P}{A_{rr}} = .8237 \times 10^{-5}$$

$$\frac{A_{hx}}{A_{hh}} = 1.5793$$

$$\frac{A_{hy}}{A_{hh}} = -.05967$$

$$\frac{A_{xh}}{A_{xx}} = .003426$$

$$\frac{A_{yh}}{A_{xx}} = .01790$$

$$\frac{A_{xr}}{A_{xx}} = .002348$$

$$\frac{A_{yr}}{A_{xx}} = -.03062$$

$$\frac{A_{yx}}{A_{yy}} = 4.2345$$

$$\frac{A_{yr}}{A_{yy}} = -.03062$$

$$\frac{A_{rx}}{A_{rr}} = 45099$$

$$\frac{A_{ry}}{A_{rr}} = -.02486$$

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TABLE 16 (CONT.)

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	$\frac{1}{K}$	→	1.25		2.50		5.00		10.00		16.67									
			R	I	R	I	R	I	R	I	R	I								
(25)	(1) -	(22)	1.00172	-0.0081865	.99670	-0.018116	.98165	-0.041168	.93228	-0.095869	.82117	-0.12809								
(26)	(2) -	(23)	1.54498	-0.024533	1.42044	-0.028627	.84234	-0.015991	-1.23194	.11018	-8.92940	-0.42077								
(27)	(3) -	(24)	-0.059802	.0013558	-0.058786	.0029620	-0.055521	.0065928	-0.043630	.014731	-0.015378	.028052								
(28)	(8) X	(19)	.0000024	-0.0000100	-0.000030	-0.000024	-0.0000177	-0.0000517	-0.0000584	-0.0001191	-0.0001296	-0.0002214								
(29)	(8) X	(20)	.0010153	-0.0000406	.0008234	-0.0000513	-0.0000642	-0.000116	-0.0040132	-0.001373	-0.030939	-0.021401								
(30)	(8) X	(21)	-0.00005825	.00000095	-0.00005796	.00000206	-0.00005477	.00000462	-0.00004294	.00001059	-0.0001751	.00002255								
(31)	(5) -	(28)	.0034322	.0000158	.0034323	.0000363	.0034188	.0000875	.0033236	.0002123	.0030445	.0004048								
(32)	(6) -	(29)	.99936	-0.000147	1.00064	-0.0008454	1.000641	-0.0028608	1.03228	-0.0073961	1.09656	-0.0138470								
(33)	(7) -	(30)	.017972	.00002095	.017981	.00004204	.018004	.00010868	.018055	.00024561	.018145	.00043075								
(34)	(12) X	(19)	-0.000273	.0001306	.0000567	.0002767	.0002821	.0005245	.0006041	.0002502	-0.010727	-0.0037018								
(35)	(12) X	(20)	-0.0130829	.0007473	-0.0102126	.0013536	.0007121	.0000123	.0152838	-0.025677	-0.008300	-0.0859283								
(36)	(12) X	(21)	.00075894	-0.00003678	.00072015	-0.00002593	.00058096	-0.0014589	.00012424	-0.0017918	-0.0025871	.00027237								
(37)	(9) -	(34)	-0.030366	.0008906	-0.028763	.0017185	-0.0220521	.0030165	.0069517	.0048747	.0809677	.0090840								
(38)	(10) -	(35)	4.21570	-0.023739	4.09272	-0.024052	3.56455	-0.040914	.18346	.23000	-4.52858	1.03223								
(39)	(11) -	(36)	1.00001	-0.030910	.99851	-0.0069133	.99465	-0.015840	.98428	-0.035607	.96328	-0.063186								
(40)	(37) X	(39)	1.00003	0	.99707	0	.98958	0	.97007	0	.93190	0								
(41)	(38) -	(40)	.99998	-0.030967	1.00144	.0069336	1.00512	.016007	1.01465	.036206	1.03367	.067803								
(42)	(41) X	(37)	-0.030368	.00074654	-0.028816	.0015215	-0.022213	.0026790	.0068746	.0052015	.083078	.014880								
(43)	(41) X	(38)	4.21569	-0.010683	4.10479	.0043323	3.58215	.098181	.17771	.24010	-4.75112	.76107								
(44)	(27) X	(42)	.0018150	-0.0008881	.0016895	-0.0017480	.0012156	-0.0029519	-0.0037656	-0.0012567	-0.016950	.0021017								
(45)	(27) X	(43)	-0.25209	.0063545	-0.24132	.011904	-0.19953	.018165	-0.011290	-0.0078577	.051713	-0.14498								
(46)	(25)-(44) =	a_{11}	.99991	-0.0080977	.99501	-0.017941	.98043	-0.040873	.93266	-0.093743	.82287	-0.18019								
(47)	(26)-(45) =	a_{12}	1.79707	-0.030887	1.66176	-0.040531	1.04187	-0.0021740	-1.82065	.11804	-8.98111	-0.27579								
(48)	(33) X	(42)	.00054577	.00001368	.00051821	.00002600	-0.0040021	.00004582	.00012284	.00008560	.0015010	.0030578								
(49)	(33) X	(43)	.075765	-0.0010368	.073208	.00027077	.064482	.0021570	.0031496	.0043787	-0.086537	.011763								

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$P = 2.439$

TABLE 16 (CONT.)

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	$1/K$	→	1.25	2.50	5.00	10.00	16.67													
			R	I	R	I	R	I	R	I	R	I								
(50)	(31)-(48) = C_{21}		.0039780	.00000212	.0039505	.00001030	.0038190	.00004168	.0032008	.00011670	.0015435	.00009902								
(51)	(32)-(49) = C_{22}		.92359	.00021122	.92683	.0011164	.94193	.0047178	1.02913	.011775	1.18310	.025612								
(52)	$a_{11} \times C_{22}$		.92351	.0026502	.92219	.017739	.92330	.043125	.95872	.10746	.96892	.23426								
(53)	$a_{21} \times C_{22}$		.0071488	.00011706	.0065652	.00014300	.0039790	.0003512	.0058413	.0016535	.013835	.0013150								
(54)	$[(52)-(53)] - P$		.12318	.0010178	.12308	.0023654	.12358	.0058019	.12966	.014468	.13211	.031314								
(55)	$a_{11} \div 2P + a_{22} \div 2 = \lambda$		.52900	.00064988	.53029	.0017641	.53687	.0051061	.57726	.012188	.64686	.024717								
(56)	λ^2		.27984	.00068757	.28120	.0018710	.28820	.0054826	.33308	.014071	.41781	.032236								
(57)	$\lambda^2 - (54)$		.15666	.00033023	.15812	.00049440	.16462	.00031930	.20342	.00039700	.28520	.10092200								
(58)	$\sqrt{(57)}$		.39580	.0041716	.39764	.0062166	.40573	.0039348	.45102	.0044011	.53451	.0086247								
(59)	$\lambda + (58) = \lambda_1 + i\lambda_1$		.9248	.00023272	.92793	.0011424	.94260	.0047126	1.02828	.011342	1.18137	.025779								
(60)	$373(\frac{1}{K} \sqrt{K_1})^{1/4} / K_1$		.4848	.0002516	.9680	.001231	1.921	.004999	3.678	.01142	5.721	.02182								
(61)	$\lambda - (58) = \lambda_2 + i\lambda_2$		.1332	.0010670	.13265	.0023858	.13114	.0054996	.12624	.012628	.11235	.024055								
(62)	$373(\frac{1}{K} \sqrt{K_2})^{1/4} / K_2$		1.278	.008011	2.560	.01799	5.150	.04194	10.50	.1000	18.55	.2141								
$P = 2.0$																				
(54)	$[(52)-(53)] \div P$		.45818	.0037856	.45781	.0087980	.45966	.021580	.48228	.053813	.49138	.11647								
(55)	$a_{11} \div 2P + a_{22} \div 2 = \lambda$		.71177	.0021300	.71217	.0050435	.71607	.012577	.74773	.029323	.79727	.057853								
(56)	λ^2		.50661	.0030321	.50716	.0071837	.51260	.018012	.55824	.043851	.63229	.092249								
(57)	$\lambda^2 - (54)$		.04843	.0007535	.04935	.0016143	.05294	.003568	.07596	.009962	.14091	.024221								
(58)	$\sqrt{(57)}$		.22007	.0017120	.22245	.0036334	.23022	.0077536	.27620	.018073	.37677	.032262								
(59)	$\lambda + (58) = \lambda_1 + i\lambda_1$		.93184	.000418	.93462	.0014101	.94629	.0048234	1.02393	.01125	1.17404	.025591								
(60)	$373(\frac{1}{K} \sqrt{K_1})^{1/4} / K_1$		.4830	.0004486	.9646	.001509	1.917	.005097	3.686	.01099	5.739	.02180								
(61)	$\lambda - (58) = \lambda_2 + i\lambda_2$		.19170	.003842	.48972	.0086769	.48585	.020331	.47153	.047396	.4205	.090115								
(62)	$373(\frac{1}{K} \sqrt{K_2})^{1/4} / K_2$		.6649	.007814	1.333	.01772	2.676	.04185	5.432	.1005	9.589	.2143								

$$\frac{V}{\omega_n} = \frac{b_r}{14} \frac{1}{\sqrt{K}}$$

$$b_r = 5.21$$

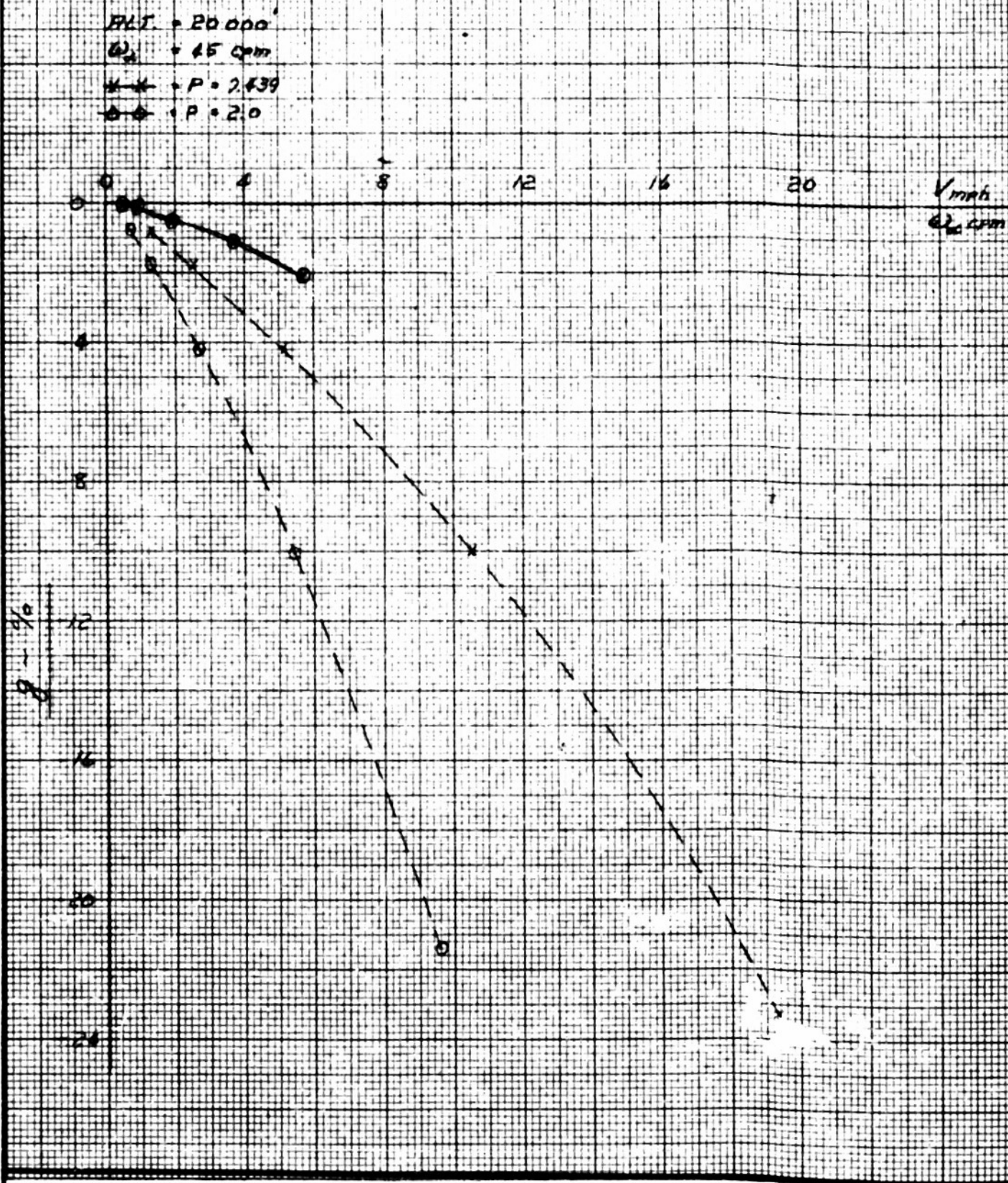
$$P = \left(\frac{\omega_n}{\omega_n} \right)^2$$

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FIGURE N
ANTI-SYMMETRIC BENDING - TORSION - ROLL - FLAPPING FLUTTER



AD-A800 195

ATI 93 783

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(REPORT NO. E-SAF-MX-1016-1)

VIBRATION AND FLUTTER ANALYSIS OF THE B-29 - F-84
TIP-TO-TIP CONFIGURATION

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STRUCTURES (7)

AEROELASTICITY (8)

AIRPLANES - FLUTTER

AIRPLANES - WING-TIP COUPLING

PROJECT MX-1016

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