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Experimental and Analytical Study on the Flutter and Gust Response Characteristics of a Torsion-Free-Wing Airplane Model

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EXPERIMENTAL AND ANALYTICAL STUDY ON THE FLUTTER AND GUST RESPONSE CHARACTERISTICS OF A TORSION-FREE-WING AIRPLANE MODEL

by

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for

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SYMBOLS

$\bar{A}$	rms gust response
A_A	antisymmetric aerodynamic pressure matrix
A_S	symmetric aerodynamic pressure matrix
b	reference length
E	modulus of elasticity
F	aerodynamic force on one side of the centerline
f	frequency (Hz)
G	modulus of rigidity
g	structural damping coefficient or acceleration of gravity
h	mode shape deflection
H	transfer function
I	area moment of inertia for bending
J	area moment of inertia for torsion
i	$\sqrt{-1}$
k	spring rate or reduced frequency ($\omega b/V$)
L	scale of atmospheric turbulence
M	mass (dm = element of mass)
$\bar{M}$	bending moment
V	velocity
V_E	equivalent airspeed
x,y	coordinates (dx,dy = incremental distance in coordinate system)

SYMBOLS (continued)

α	angle of attack
γ	viscous damping coefficient (zero for this study)
ξ	generalized coordinate
ω	frequency (rad/sec)
Δp	pressure difference between airfoil upper and lower surfaces
ρ	density of medium, air or freon
ν	Poisson's ratio
μ	flutter parameter, mass density ratio

Subscripts:

VERT	vertical direction or for vertical bending stiffness
LAT	lateral direction or for lateral bending stiffness
YAW	yaw direction or for yaw bending stiffness
F&A	fore and aft direction or for fore and aft bending stiffness
r	mode r
s	mode s
S	symmetric
L	left side
R	right side or ratio of model to full scale quantity
A	antisymmetric or airplane
e	excitation
g	gust
V	vane
M	model
o	output
i	input

SYMBOLS (continued)

Superscripts:

R	right side
L	left side
$\overline{R}_1$	average of right side aerodynamic forces produced by applying right side downwash
$\overline{L}_1$	average of left side aerodynamic forces produced by applying right side downwash
$\overline{R}_2$	average of right side aerodynamic forces produced by applying left side downwash
$\overline{L}_2$	average of left side aerodynamic forces produced by applying left side downwash
$\overline{R}$	desired right side aerodynamic force
$\overline{L}$	desired left side aerodynamic force

Abbreviations:

KTS	knots or nautical miles per hour
GVT	ground vibration test
TFW	torsion free wing

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1.0 SUMMARY

This report presents some experimental data and correlative analytical results on the transonic flutter and gust response characteristics of a wind tunnel model of a torsion-free-wing (TFW) airplane. This model was a 1/5.5-size complete airplane version of a conceptual supersonic fighter airplane which had a freely pivoting wing arrangement consisting of wing/boom/canard surfaces. The model was tested with the wing free to pivot in pitch and with the wing locked to the fuselage. (Both right and left side wings were interconnected by a common, stiff pivot shaft through the fuselage.) Flutter and gust-response tests were conducted in the Langley Transonic Dynamics Tunnel with the model mounted on a cable mount system that provided a near free-flying condition. The tests were limited to Mach numbers below 1.0 because of a model lateral instability on the mount system.

In general, the present TFW configuration appears to be a viable concept from a flutter viewpoint but was not effective as a gust alleviation configuration. The experimental-analytical correlation was considered to be fair for the flutter results and for the gust-response results. It was concluded that the present model as tested was not a particularly suitable vehicle for a gust-response study for two reasons. First the major portion of the model response to the applied gusts was in the rigid-body modes which are appreciably affected by the mount system. Hence, the effectiveness of the TFW (wing-free) in alleviating the gust response may have been altered or obscured by the interaction of the mount system with the normal free-flying rigid-body modes of the model. Second, the center of pressure of the present wing/boom/canard configuration is believed to be too close to the wing pivot to obtain appreciable gust alleviation and, perhaps, even to calculate good definitive gust-response data for a TFW vehicle. However, it is believed the above problems could be corrected by a few simple hardware changes on the present model for any future TFW gust studies.

Experimental flutter data were obtained over a Mach number range from about 0.85 to 0.95 for both the wing-free and wing-locked configurations. Tunnel time limitations did not allow a very broad examination of the flutter boundaries. All flutter cases were essentially symmetric. With the wing locked, the flutter mode appeared to be a conventional fundamental bending-torsion type and the flutter dynamic pressure decreased slightly with increasing Mach number. With the wing free, two different flutter modes were encountered. At Mach numbers (M) below about 0.95, the wing-free configuration fluttered in a mode similar to the wing-locked flutter mode but at a somewhat higher dynamic

pressure. At M = 0.95, a lower frequency flutter mode was encountered for the wing-free configuration that appeared to involve a coupling of the rigid wing pitch and wing first bending modes, and the flutter dynamic pressure decreased rapidly with little or no change in Mach number to a level about 20 percent less than that for the wing-locked configuration. The reasons for this unusual phenomenon should be further investigated experimentally. However, since the wing-locked configuration was much like a conventional fixed wing configuration which would necessarily have to be flutter free, the 20 percent reduction in the flutter dynamic pressure obtained with the free wing is not considered large enough to make the present TFW configuration unacceptable as a viable design concept.

Flutter analyses were conducted for direct correlation with the model wind tunnel test results. These analyses were conducted in model, not full scale, quantities and used modal input data either measured during the model ground vibration test (GVT) or calculated using the NASTRAN computer program. Both the wing-free and locked cases were analyzed. The analyses were conducted at several Mach and altitude combinations and actual wind tunnel flutter boundaries plotted.

The degree of correlation between calculated and measured flutter characteristics was considered to be fair and was not significantly better with either type of modal data. Essentially the same flutter frequencies were predicted by analysis as was measured in the wind tunnel, but the correlation of flutter speeds was not very good.

The gust-response characteristics of the wing-free and wing-locked configurations were also measured in the wind tunnel. Fuselage accelerations plus wing and canard root bending moments were measured. A sinusoidal gust excitation was achieved by use of the wind tunnel gust excitation vane mechanism. Gust response data were obtained at Mach 0.65 and 0.90 at dynamic pressures of 60 and 100 psf, respectively. Gust excitation frequencies ranged from .2 to 18 Hz.

Observation of the model in the wind tunnel indicated that the pitch response of the wing to the gust excitation was not very great for the free-wing tests. Also there was no discernable model response in the upper range of gust excitation frequency.

The gust response analyses were conducted at the same Mach numbers as the wind tunnel gust tests. The same aerodynamic program was used to obtain the gust generalized aero forces as was used in the flutter analyses. Analyses were conducted with GVT and NASTRAN modal data for the wings both free and locked. In order to examine the effect of the free-wing on the gust response in a realistic aircraft flight environment, both the wind-tunnel and analytical results were converted to full-scale airplane quantities and the response to a von Karman atmospheric gust spectrum determined. The correlation between the experimental and analytical response of fuselage accelerations to the atmospheric gust spectrum was good for both the wing-free and locked cases. However, the correlation of measured and calculated bending moment response was only fair. Possible reasons for this are presented in the text.

2.0 INTRODUCTION

A Torsion-Free-Wing (TFW) aircraft represents a design that is significantly different from other types of aircraft design. The term Torsion-Free-Wing as defined herein means a wing which is mounted on the fuselage by means of a spanwise oriented pivot shaft and is mechanically unrestrained in rigid body pitch. This is similar to all-movable horizontal tail surfaces except the wings are completely unrestrained in pitch in the TFW concept.

Investigations made by others have utilized the terms free-wing or free floating wing for similar or identical type configurations.

In order to place the wing at the desired angle of attack in the TFW concept, a trim surface, which is attached to the wing, is driven to a required position. The resulting lift force on the trim surface, which can be attached directly to the wing, or placed forward or aft of the wing on a boom, creates a pitching moment about the wing pivot which in turn moves the wing in pitch or angle of attack until the net pitching moment about the wing pivot is made to be zero. Due to the pitch angle change that the wing has experienced, the total wing lift is similarly changed. The wing/boom/trim surface is made stable in pitch by locating the wing pivot ahead of the net aerodynamic center.

There are several potential advantages for the use of a TFW on a fighter airplane. Among these are gust relief, greater maneuverability, shorter takeoff and landing distance, better target tracking and better ground strafing capability. However because of the free rigid body pitching capability of the wing, there are also potential problems of which one of the more important is flutter. A wing unrestrained in torsion such as a TFW could have a flutter speed so low that a TFW airplane would be unacceptable as a viable design concept. The adequacy of present analytical methods to predict the flutter of a TFW has only been partially assessed because of the lack of experimental data. There is also a need for experimental data on the gust response of a TFW.

The purposes of the present study were to conduct an exploratory wind-tunnel investigation of the subsonic and transonic flutter and gust response characteristics of a complete model representative of a TFW fighter airplane and to examine how well present analytical methods will predict these characteristics. Subsonic flutter and divergence tests and analyses of some small trend models of the same wing planform are reported in Reference 2.

The TFW of this model was a wing/boom/canard arrangement (see figures 1 and 2) and was tested both with the wing free and with the wing locked to the fuselage. The present TFW concept, in particular the wing/boom/canard planforms and wing airfoil geometry, was based upon a TFW supersonic fighter airplane design that had been studied at the Fort Worth Division of the General Dynamics Company (GD/FW). A 1/5.5-size model was designed and built by GD/FW in 1975 as part of an in-house Independent Research and Development program. The model was tested in the NASA Langley Transonic Dynamics Tunnel (TDT) in 1976 as a joint NASA-GD/FW venture. The post-test vibration surveys, flutter and gust analyses were made by GD/FW under NASA Contract NAS1-15412.

This report describes the vibration, gust, and flutter tests and accompanying analyses which were conducted upon the model. It is intended that all the information necessary to conduct similar analyses by an independent investigator be included herein.

3.0 MODEL DESCRIPTION

The model was not designed to be dynamically similar to the full scale vehicle upon which the model design was based because of budget limitations. Rather, it was designed so that actual wing flutter could be achieved within the operating range of the NASA LRC 16 Foot Transonic Dynamic Tunnel using freon as a test medium.

It was decided to build a model that was quite large. Major factors which were considered were wind tunnel size, ease of making the mechanisms employed in the model and the adaptability of tail surfaces from other existing large models to this model. A dimensioned 3-view of the model is shown in Figure 1. A photograph of the model is shown in Figure 2.

The wing structural member was made from a solid, flat aluminum plate with large cutouts in it ahead of the 14 percent chord line and aft of the 75 percent chord. A linear spanwise taper was machined into the plate in order to give a reasonably typical distribution of mass and stiffness. The airfoil shape was furnished by end grain balsa bonded to the plate. A soft epoxy finish was applied to the balsa to provide a smooth aerodynamic surface and moisture proofing.

The boom was designed to be very stiff in vertical bending and torsion. No particular bending stiffness design value was used to establish the structure, but rather ease of design and fabrication together with housing the canard drive system and standard material thicknesses were major factors used to establish the boom design keeping the high stiffness goal in mind. The boom is rectangular in cross section and is a hollow shell. It is bolted together (top, bottom and sides as well as having a bolted joint at a section aft of the canard trailing edge station). In the area of the wing pivot, the inboard wall of the boom is machined integrally with the wing pivot shaft. A shelf is also integrally machined with the lower corner of the outboard wall of the boom at this same general location to allow the wing to be bolted to the boom. This shelf is 5.08 cm. (2 in.) in the spanwise direction and about 27.94 cm. (11 in.) chordwise. Two chordwise rows of bolts attach the wing to the .76 cm. (.3 in.) thick shelf.

The canard trim surface was designed and fabricated as a balsa covered aluminum plate also. It was quite stiff to preclude canard flutter. The canard was mounted on an aluminum shelf which was integrally machined with the canard pivot shaft.

FIGURE 1

TORSION FREE WING MODEL
3 - VIEW

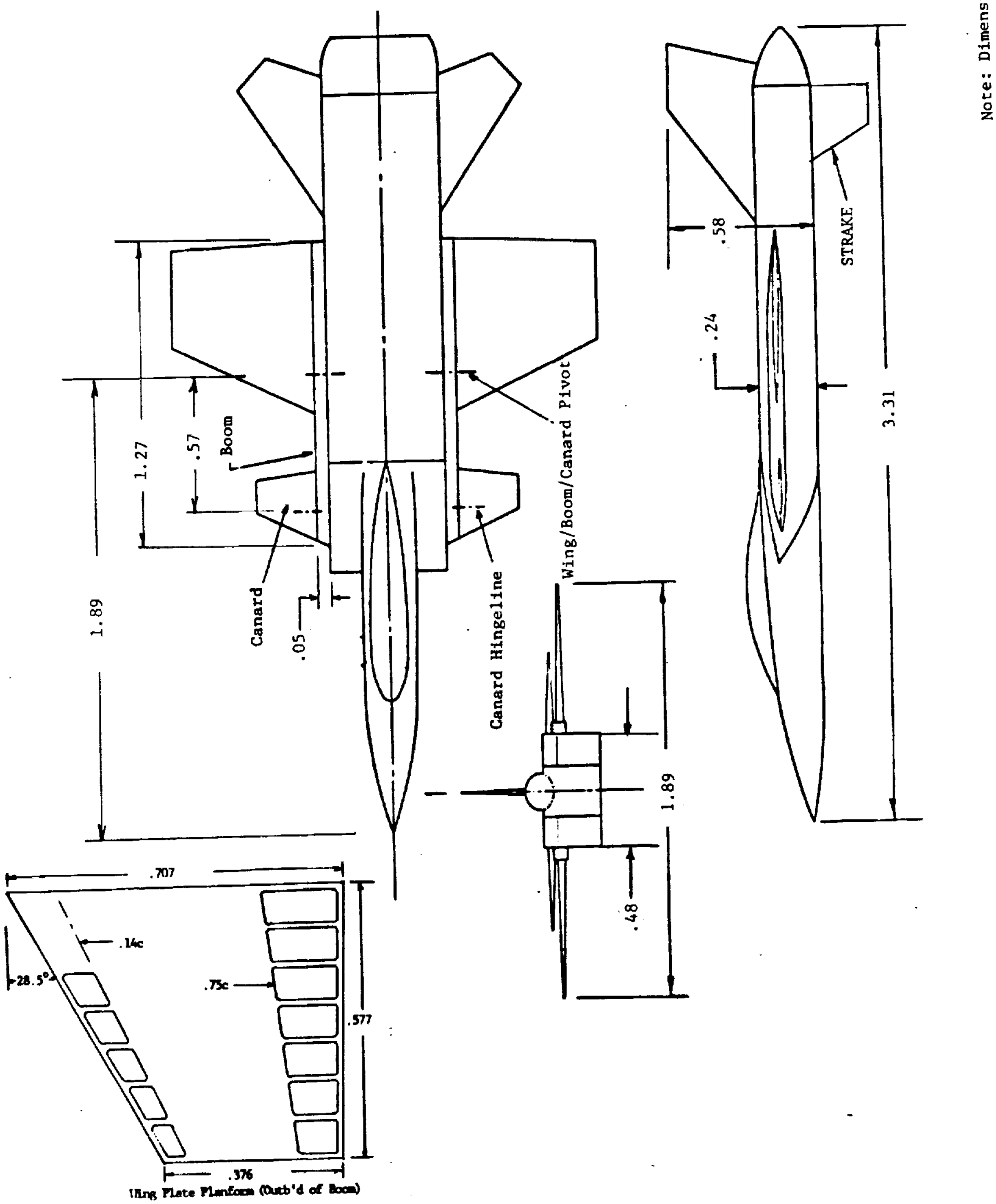


FIGURE 2
MODEL MOUNTED ON STING IN WIND TUNNEL

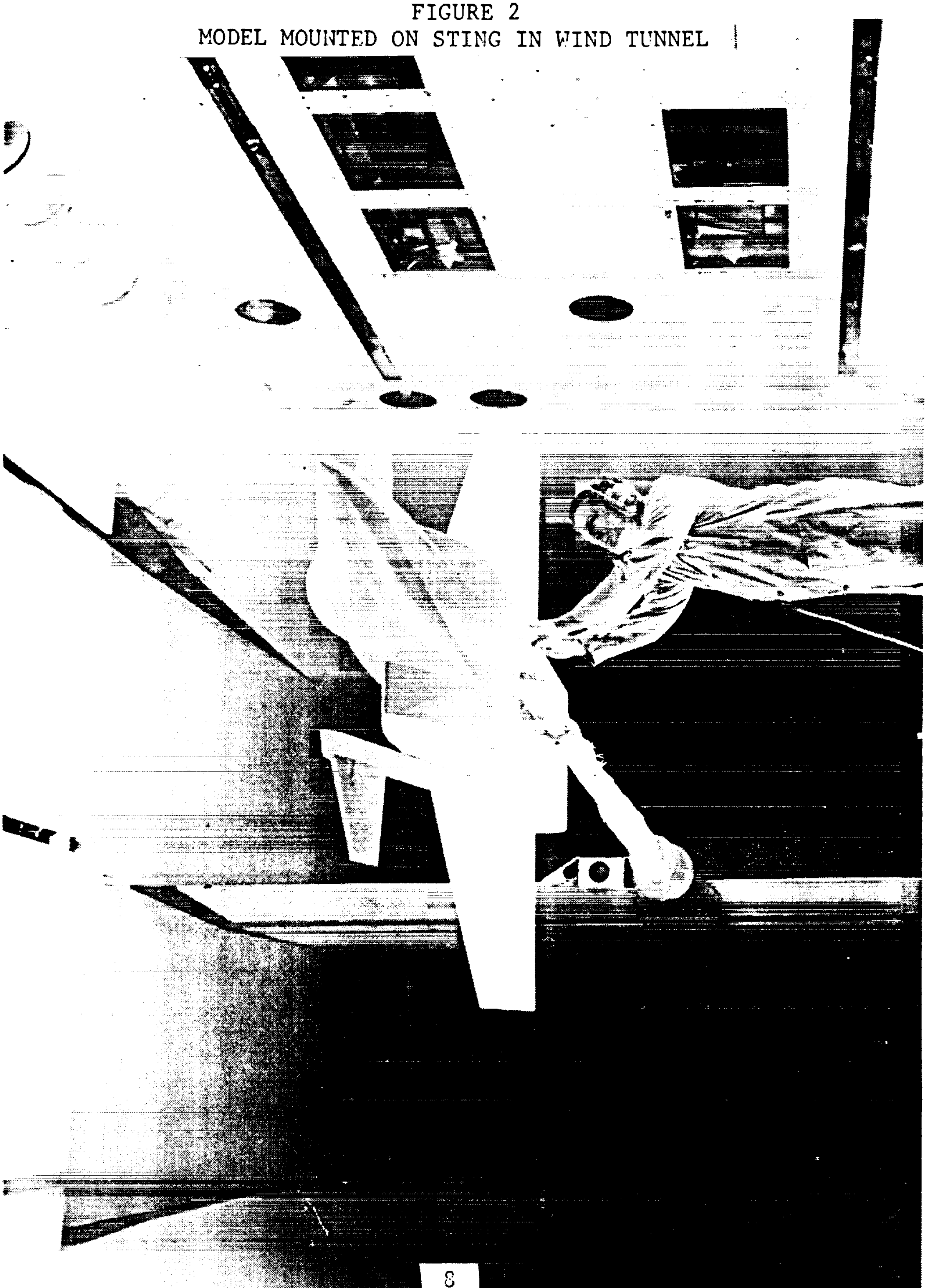
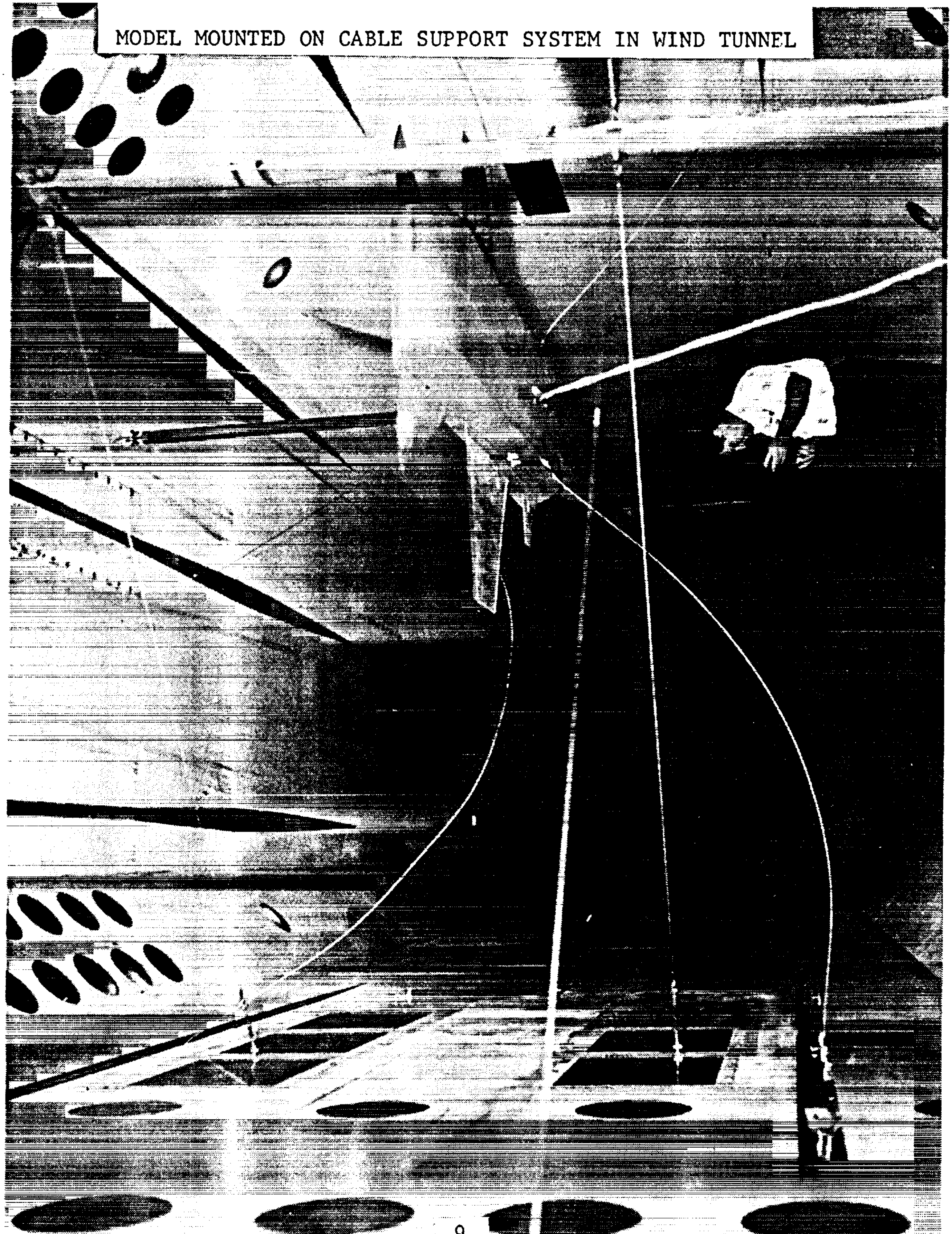


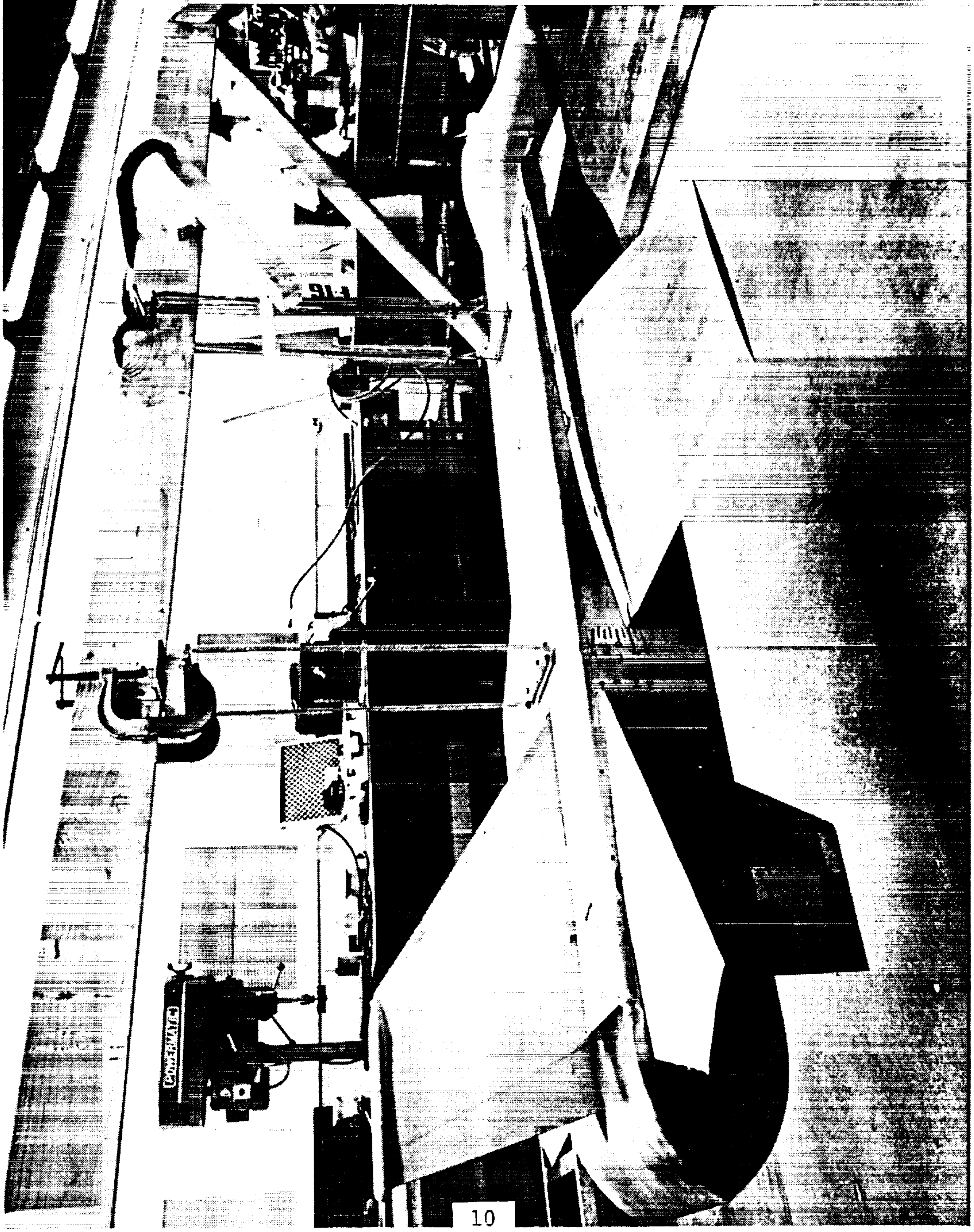
FIGURE 2-(a)



MODEL MOUNTED ON CABLE SUPPORT SYSTEM IN WIND TUNNEL

FIGURE 2-(b)

MODEL MOUNTED FOR GROUND VIBRATION TESTING



Actuation of the canards in pitch was achieved by a motor housed in the wing pivot shaft inside the fuselage. A power train connected the motor output to the canard by means of various gearing and flexible shaft mechanisms mounted in the boom. During the wind tunnel tests, the size of the canard was changed and a smaller flat plate aluminum canard installed in order to improve wing/boom/canard pitch stability. Planforms of each canard are shown in Figure 3.

The fuselage center portion was a rectangular cross section closed shell aluminum structure with longitudinal skin stiffeners added to form a semi-monocoque body. A few stiff aluminum bulkheads were incorporated in this portion of the structure also. The wing/boom pivots shafts were bearing-mounted to one of these bulkheads. A metal sleeve which formed a structural attachment between the individual left and right pivot shafts joined the two shafts together to effectively form a single pivot shaft. Thus the wings were constrained to move symmetrically in their rigid body pitch mode for the wing-free case. The booms could also be bolted to the sides of the fuselage with a single bolt joining the boom/fuselage components at a point about 30.48 cm. (12 in.) forward of the pivot shaft. This produced the wing-locked case.

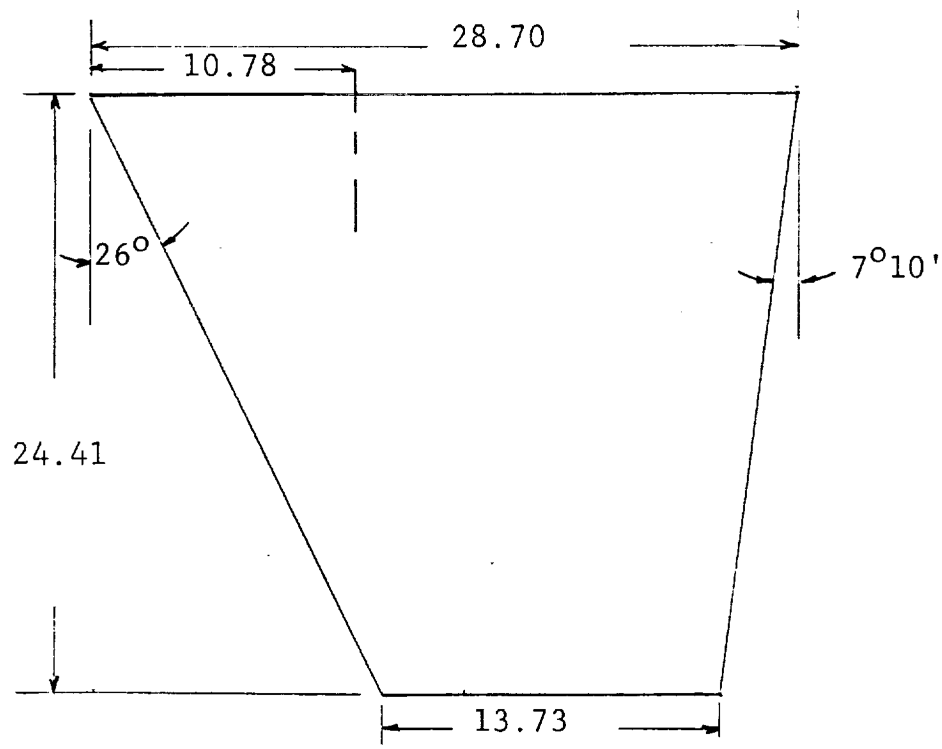
A balsa wood boattail formed the aft end of the fuselage. The forward fuselage was made of balsa wood bonded to three horizontally adjacent longitudinal hollow aluminum tubes. The tubes extended forward from the forward fuselage bulkhead. The balsa wood was faired in to form the closed forward end of the nacelle inlets, the pilot's canopy and the fuselage nose.

The tail surfaces were lightweight, stiff aluminum skinned sandwich structures borrowed from a dynamically similar model of another airplane and adapted to this model. The horizontal tails were all moveable and independently controlled. The rudder was not controlled. In this application the horizontal tails furnished total model roll control and pitch control of the fuselage. A strake extended vertically downward from each of the lower corners of the aft fuselage. These were made of an aluminum plate.

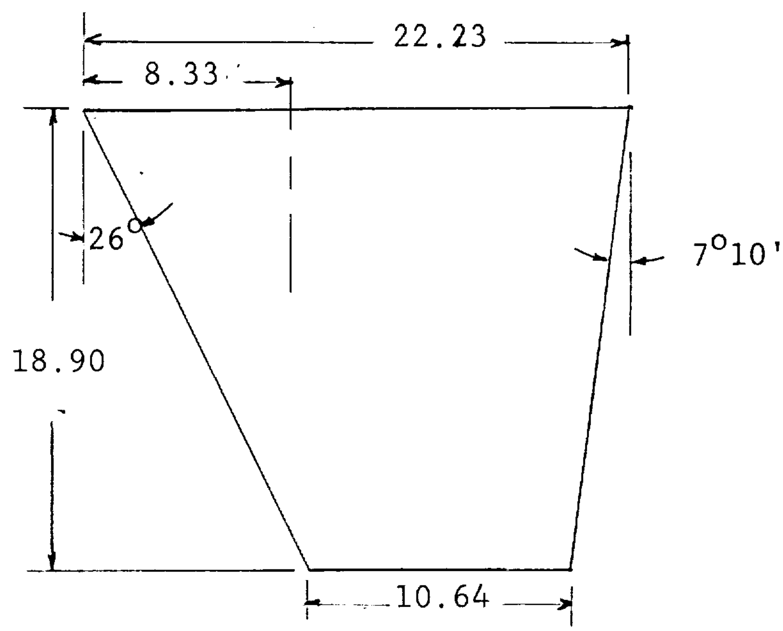
Mounting of the model in the wind tunnel could be achieved in either of two ways. These were sting and cable mounting. Both methods were used in the wind tunnel tests. The sting mount tests were conducted primarily to check model behavior, wing/boom/canard stability and model response to tunnel gust vane excitation. Cable mounting was utilized to obtain all of the meaningful flutter and gust response data.

FIGURE 3

ORIGINAL SIZE CANARD



CANARD AS WIND TUNNEL TESTED



NOTE: DIMENSIONS IN CM.

The cable mount consisted of a forward and an aft cable loop. Inside the tunnel, both loops lay in the vertical plane of the tunnel centerline. The forward cable loop was attached to the model fuselage and then passed forward and upward through a slot at the centerline of the tunnel ceiling, thence around pulleys laterally to the outside of the tunnel wall, downward to the floor level and then around some pulleys, laterally back to the outside of the tunnel floor centerline, around a pulley and then up through the floor and aft to the model fuselage.

The aft cable was essentially the same except that it passed aftward and either upward or downward from the model fuselage through a series of pulleys to form a closed loop. Within the aft cable loop was a spring which could be remotely stretched in such a way as to control the tension in the aft cable for assisting in maintaining model stability. Four safety cables which could be remotely tightened, were attached to the four corners of the fuselage shell near the model c.g. These passed transversely across the tunnel from the model to the corner slots of the tunnel test section and thence to the model safety snubber actuating mechanism.

Model components were weighed and other mass properties experimentally determined after the wind tunnel tests were complete. The distribution of the mass properties for use in dynamic analyses was computed separately. Total distributed values were compared with measured totals for each component and correction factors applied to cause agreement between measured and calculated total values. A summary of model mass properties is shown in Table 1.

The weight difference between left and right wing/boom/canard assemblies of Table 1 is known to be entirely associated with the wings themselves. This was caused by an extra coating of soft epoxy finish on the left wing. This caused some of the modes of vibration to be asymmetric and also necessitated the gust and flutter analyses to be conducted on a complete vehicle, tip-to-tip basis.

TABLE 1

MODEL MASS PROPERTIES

Model Component	Weight		CG Location X **		Inertia			
					Pitch		Yaw	
	(Kg.)	(lbs)	(m.)	(in)	($Kg-m^2$)	($lb-in^2$)	($Kg-m^2$)	($lb-in^2$)
Left Canard*	.268	.59	1.379	53.88				
Right Canard*	.268	.59	1.366	53.78				
Left Boom	3.402	7.5						
Right Boom	3.402	7.5						
Left Wing	4.209	9.28						
Right Wing	3.983	8.78						
Left Pivot Shaft	.050	.11	1.891	74.45				
Right Pivot Shaft	.050	.11	1.891	74.45				
Left H. Tail*	.549	1.21	2.891	113.83				
Right H. Tail*	.549	1.21	2.891	113.83				
Vertical Tail*	.948	2.09	2.891	113.84				
Left Strake*	.363	.80	2.926	115.19				
Right Strake	.363	.80	2.926	115.19				
Fuselage*	65.727	144.9	1.592	62.69				
Total Model*	84.143	185.5	1.692	66.63	62.712	214,293	66.427	226,989
Left Wing/Boom/Canard*	7.929	17.48	1.883	74.15	.8422	2,878		
Right Wing/Boom/Canard	7.702	16.98	1.883	74.15	.8311	2,840		

* Values determined experimentally

** Distance aft of fuselage nose

4.0 FINITE ELEMENT REPRESENTATION OF MODEL

The types of finite elements to represent the separate portions of the model structure were chosen to be compatible with the MSC/NASTRAN vibration analysis program. Figures 4 through 7 present a visual description of the structural representation of each model component along with the grid numbering system.

The finite elements representing the aluminum plate portion of the wing panels are shown in Figures 4 and 5. These elements are either plate elements (QUAD 4 and TRIA3) or beam elements (BAR). The plate elements generally represent the interior portion of the wing, whereas the beam elements represent the portion of the plate remaining where the rectangular cutouts were made along the forward and aft portions of the plate. Both chordwise and spanwise beam elements were used. Wing grid points 56 and 208 were tied to boom grids 71 and 198, respectively, allowing only roll motion as a degree of freedom.

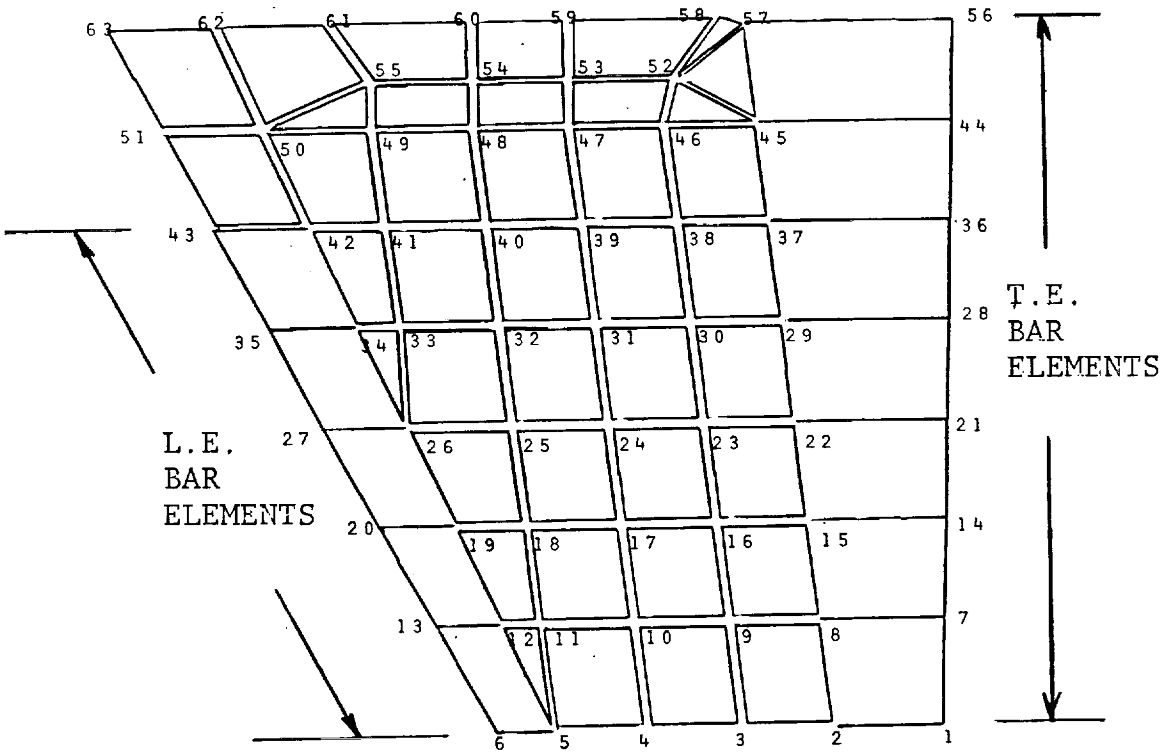
Plate elements (QUAD 4 and TRIA3) were used entirely to represent both left and right canard surfaces. In the area of the root fitting, the arrangement of elements was selected to best make the transition from the plate structure of the canard to the fitting. Figure 6 shows the canard structural arrangement.

The wing plate tapered linearly from a thickness of .422 cm. (.166 in.) 5.08 cm. (2 in.) outboard of the root to .23 cm. (.09 in.) at the tip. This covered a span distance of 52.65 cm. (20.73 in.). The inboard 5.08 cm. (2.0 in.) was a constant thickness of .422 cm. (.166 in.). The values of modulus used for the wing plate structure were $E = 91.4 \times 10^9$ N/M^2 (13.26×10^6 psi) and $G = 34.8 \times 10^9$ N/M^2 (5.04×10^6 psi). For the beam elements, the modulus values used were $E = 72.4 \times 10^9$ N/M^2 (10.5×10^6 psi) and 27.6 N/M^2 (4.0×10^6 psi).

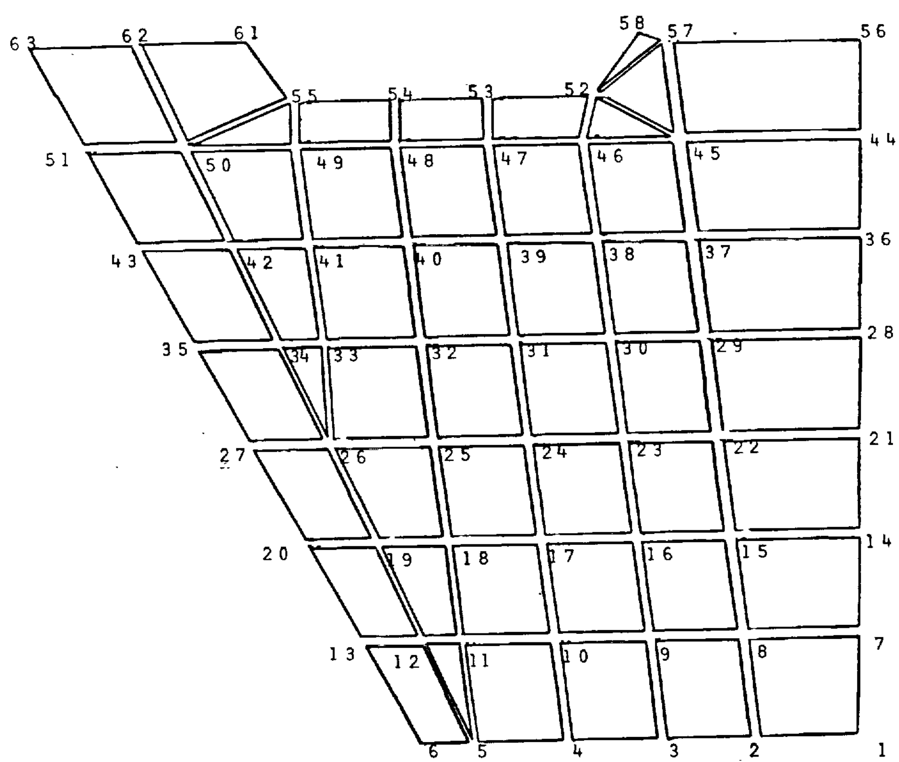
The balsa wood covering of the wing plate structure plus the soft epoxy paint finish was assumed to be a full depth plate element (QUAD 4) for analysis purposes. In this way, there was balsa wood occupying the same space that the aluminum plate occupied, but since this occurred at the mid-plane of the structure, it was assumed that only a very small error occurred. The balsa wood properties used in the analysis are presented in Tables 3 and 4.

FIGURE 4

NASTRAN ELEMENTS FOR LEFT WING
ALUMINUM PLATE AND BALSA COVERING



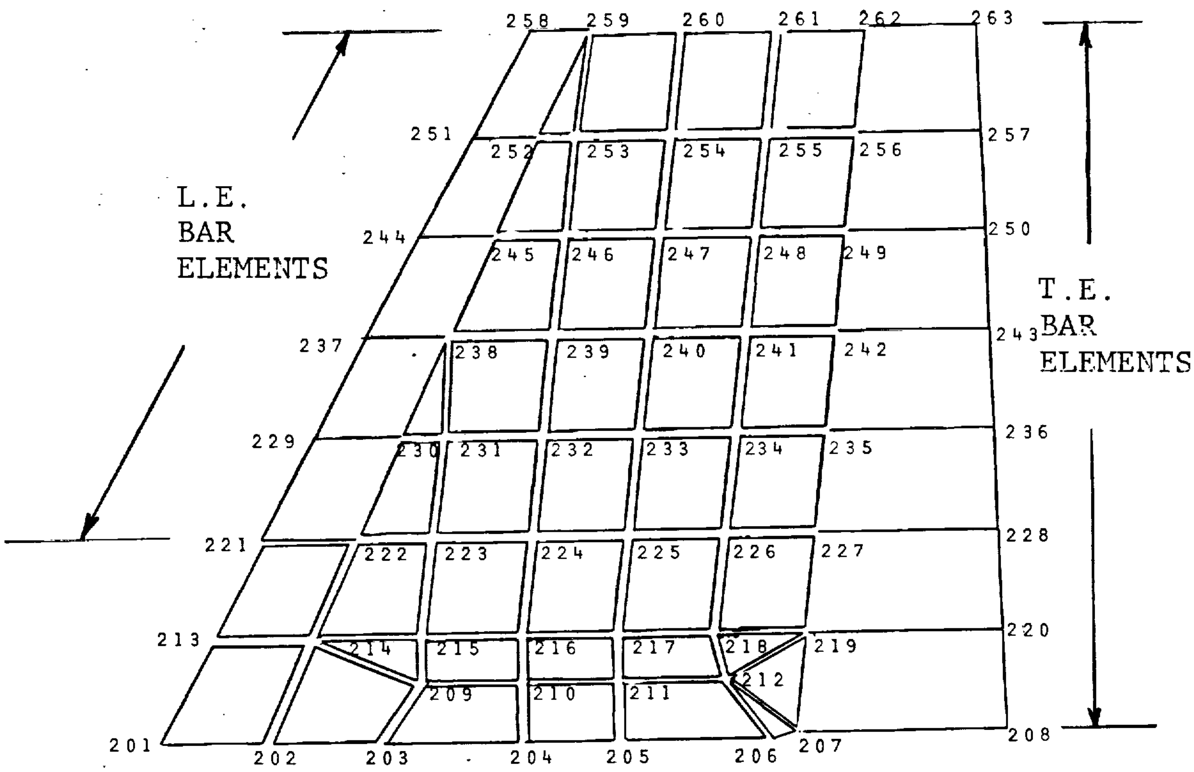
ALUMINUM PLATE ELEMENTS



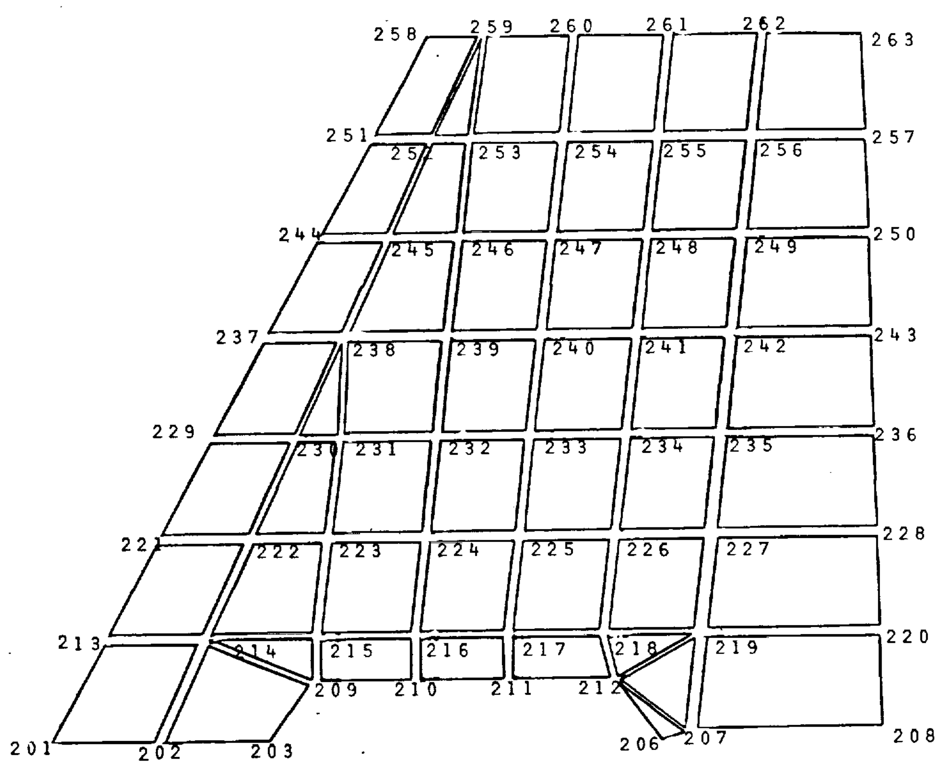
BALSA ELEMENTS

FIGURE 5

NASTRAN ELEMENTS FOR RIGHT WING
ALUMINUM PLATE AND BALSA COVERING



ALUMINUM PLATE ELEMENTS



BALSA ELEMENTS

FIGURE 6

NASTRAN ELEMENTS FOR LEFT AND RIGHT CANARD SURFACES

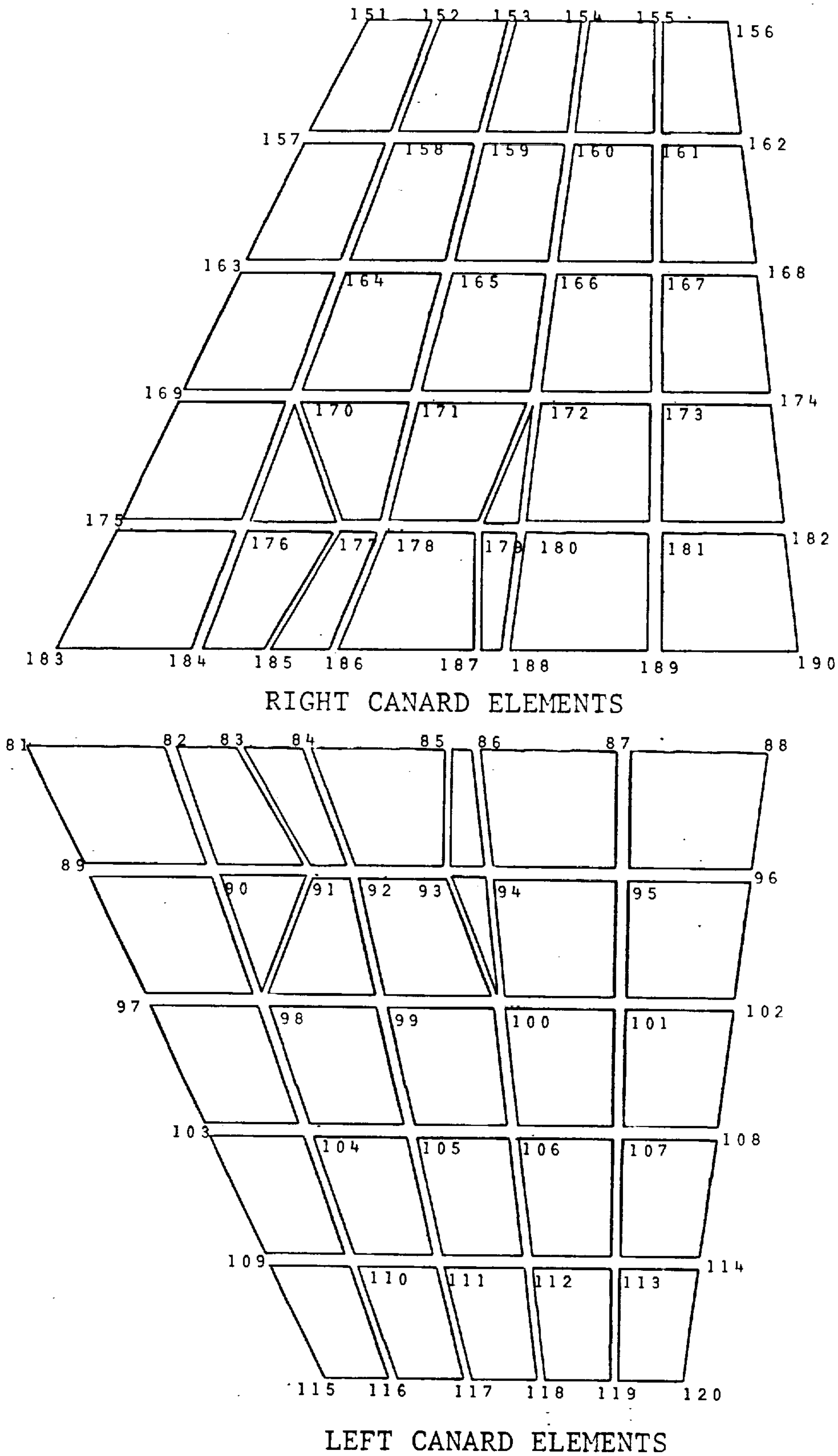
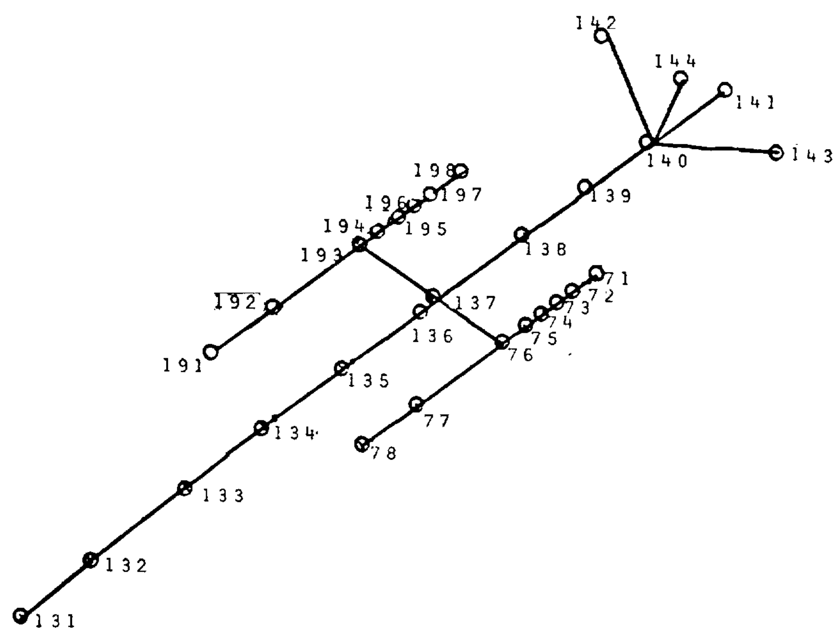


FIGURE 7

NASTRAN REPRESENTATION OF FUSELAGE,
BOOMS, AND TAIL SURFACES



Numbers indicate NASTRAN grid numbers.

A fore and aft oriented beam (BAR element) was used to represent each boom. The stiffness and mass properties of these beams are listed in Table 2. Similarly, a beam was used to tie the canards surfaces to the booms. However, the wings were tied to the booms by four concentrated spring elements (CELAS 2) each. Thus, roll springs provided structural continuity between the root of the wings and booms. Spring stiffness values for each of these springs are listed at the bottom of Table 2. For the other five degrees of freedom (vertical, lateral, and fore and aft translation plus yaw and pitch), the wings were tied rigidly (RBAR elements) to the booms.

Beam elements represented the entire fuselage, horizontal and vertical tails and the structural tie of the left and right booms to the fuselage. This produced a so-called "stick" representation of the fuselage and tail surfaces. At the point where the beam representing the pivot shaft joined the fuselage, no degrees of freedom were allowed except pitch. In this way the analysis properly represented the TFW concept of a mechanically unrestrained rigid body pitch degree of freedom. The stiffnesses of the tail surfaces and the structural members which tie the booms to the fuselage and the canards to the booms are shown at the bottom of Table 5.

For the wing locked condition, a rigid bar element (RBAR) was fixed to the fuselage "stick" structural representation at the appropriate fuselage station. The rigid bar element extended spanwise to the boom. The boom, in turn, was pinned to the rigid bar element.

TABLE 2

BOOM STIFFNESS AND MASS PROPERTIES
USED IN NASTRAN ANALYSIS

Grid No.	Structural Member Stiffness Properties							
	Area		I_{VERT}		I_{LAT}		J	
	(cm^2)	(in^2)	(cm^4)	(in^4)	(cm^4)	(in^4)	(cm^4)	(in^4)
78-77	19.4	3	42.9	1.03	249.7	6.0	334.7	1.34
77-76	19.4	3	42.9	1.03	249.7	6.0	334.7	1.34
76-75	19.4	3	42.9	1.03	249.7	6.0	334.7	1.34
75-74	19.4	3	42.9	1.03	249.7	6.0	334.7	1.34
74-73	19.4	3	10.5	.253	62.4	1.5	20.8	.50
73-72	19.4	3	10.5	.253	62.4	1.5	20.8	.50
72-71	19.4	3	4.0	.096	249.7	6.0	.51	.0123

NOTE: $E = 72.4 \times 10^9\ N/M^2\ (10.5 \times 10^6\ psi)$
$G = 27.6 \times 10^9\ N/M^2\ (4.0 \times 10^6\ psi)$
$\nu = .3125$

Grid No.	Weight (Kg.)	Weight (Lbs)
78	1.00	2.208
77	.88	1.935
76	.98	2.171
72	.22	.4956
71	.19	.4204

Wing-to-Boom Springs

Grid No.	k (N-M /rad.)	k (in.lb./rad.)
61-75	2018	17860
60-73	2018	17860
59-72	2018	17860
58-71	2018	17860

TABLE 3

BALSA WOOD PROPERTIES AT LEFT WING GRID POINTS

Grid Point No.	Weight (gm.)	Weight (lb x 10^{-3})	Grid Point No.	Weight (gm.)	Weight (lb x 10^{-3})
1	10.24	22.570	33	32.77	72.248
2	19.32	42.601	34	12.79	28.191
3	18.51	40.815	35	16.96	37.384
4	18.24	40.204	36	32.66	71.994
5	15.90	35.057	37	51.52	113.58
6	7.09	15.637	38	39.06	86.091
7	21.25	46.843	39	40.30	88.852
8	38.85	85.643	40	40.42	89.115
9	35.96	79.275	41	32.74	72.169
10	35.66	78.619	42	28.63	63.111
11	28.71	63.284	43	16.19	35.691
12	10.15	22.378	44	37.10	81.799
13	12.93	28.513	45	52.85	116.52
14	23.61	52.043	46	40.58	89.468
15	41.02	90.439	47	46.40	102.29
16	35.69	78.673	48	45.58	100.48
17	35.91	79.166	49	42.83	94.432
18	29.39	64.803	50	35.81	78.944
19	24.27	53.514	51	17.04	37.569
20	12.45	27.438	56	20.08	44.263
21	26.71	58.880	57	26.21	57.788
22	44.72	98.582	58	20.77	45.779
23	37.02	81.617	59	25.89	57.071
24	37.56	82.805	60	24.96	55.021
25	35.53	78.325	61	24.63	54.309
26	32.36	71.336	62	19.97	44.024
27	15.38	33.903	63	9.04	19.919
28	29.74	65.569			
29	48.19	106.23			
30	38.01	83.804			
31	38.92	85.794			
32	38.74	85.404			

NOTE: Includes surface soft epoxy

Stiffness properties

$E = 3.41 \times 10^8$ N/M^2 (49140 PSI)

$G = 1.39 \times 10^8$ N/M^2 (20160 PSI)

TABLE 4

BALSA WOOD PROPERTIES AT RIGHT WING GRID POINTS

Grid Point No.	Weight (gm.)	Weight (lb x 10^{-3})	Grid Point No.	Weight (gm.)	Weight (lb x 10^{-3})
263	8.67	19.098	233	34.42	75.880
262	16.54	36.456	232	34.04	75.035
261	16.09	35.470	231	28.83	62.450
260	15.81	34.859	230	10.89	24.018
259	13.56	29.890	229	14.35	31.634
258	5.96	13.143	228	28.14	62.038
257	18.05	39.792	227	44.76	98.674
256	33.33	73.480	226	34.55	76.177
255	31.32	69.051	225	35.81	78.938
254	31.02	68.395	224	35.75	78.821
253	24.63	54.297	223	28.66	63.182
252	8.58	18.924	222	24.36	53.710
251	10.86	23.946	221	13.58	29.941
250	20.15	44.431	220	32.09	70.736
249	35.34	77.909	219	45.99	101.38
248	31.22	68.836	218	36.02	79.402
247	31.45	69.329	217	41.36	91.184
246	25.49	56.198	216	40.54	89.363
245	20.61	45.441	215	37.70	83.108
244	10.46	23.051	214	30.51	67.263
243	22.87	50.427	213	14.16	31.207
242	38.63	85.172	208	17.40	38.364
241	32.52	71.702	207	22.81	50.291
240	33.06	72,890	206	18.45	40.669
239	31.00	68,335	205	23.10	50.926
238	27.67	61,009	204	22.24	49.033
237	12.98	28.608	203	21.72	47.883
236	25.56	56.357	202	17.04	37.572
235	41.76	92.058	201	7.50	16.540
234	33.52	73.890			

NOTE: Includes surface soft epoxy

Stiffness Properties:

$E = 3.41 \times 10^8$ N/M^2 (49140 PSI)

$G = 1.39 \times 10^8$ N/M^2 (20160 PSI)

TABLE 5

FUSELAGE STIFFNESS AND MASS PROPERTIES USED IN NASTRAN ANALYSIS

Grid No.	Structural Member Stiffness Properties							
	Area		I_{VERT}		I_{LAT}		J	
	(cm^2)	(in^2)	(cm^4)	(in^4)	(cm^4)	(in^4)	(cm^4)	(in^4)
131-132	64.5	10	297.6	7.15	890.7	21.4	143.2	3.44
132-133	↓	↓	504.1	12.11	1511	36.3	242.7	5.83
133-134			710.9	17.08	2135	51.3	342.6	8.23
134-135			1632	39.20	4912	118.0	786.7	18.9
135-136			2393	57.5	7201	173.0	2164	52.0
136-138			↓	↓	↓	↓	↓	↓
138-139								
139-140								
140-141								
136-137	64.5	10	41581	999	41581	999	41581	999

NOTE: $E = 72.40 \times 10^9$ N/M^2 (10.5×10^6 psi)
$G = 27.58 \times 10^9$ N/M^2 (4.0×10^6 psi)
$\nu = .3125$

Grid No.	Mass Properties			
	Weight		Rolling Mass Mom. Inertia	
	(Kg.)	(Lbs)	($Kg\text{-}M^2$)	($Lb\text{-}In^2$)
131	7.199	15.87	.01299	44.4
132	3.624	7.99	.00416	14.2
133	11.59	25.56	.06409	219.0
135	17.66	38.94	.1995	681.8
136	8.473	18.68	.09567	326.9
138	1.855	4.09	.02110	72.1
139	6.310	13.91	.05777	197.4
141	9.725	21.44	.08891	303.8

Structural Member	Area		I_{VERT}		I_{YAW}		J		Weight	
	(cm^2)	(in^2)	(cm^4)	(in^4)	(cm^4)	(in^4)	(cm^4)	(in^4)	(Kg.)	(Lb.)
Canard-to-Boom	2.85	.442	4.16	.1	4.16	.1	.0807	.00194	-	-
Boom-to-Fuselage	12.90	2.0	416	10.0	416	10.0	416	10.0	-	-
Horiz Tail	64.5	10	41581	999	41581	999	41581	999	.549	1.21
Vert Tail*	64.5	10	41581	999	41581	999	41581	999	.948	2.09
Strake**									.363	.80

* For the vertical tail I_{VERT} becomes I_{LAT} and I_{YAW} becomes $I_{F\&A}$.
** The weight of the two strakes are included in the fuselage weight at grid point 141.

5.0 MODEL VIBRATION CHARACTERISTICS

The vibration characteristics of the model were determined both experimentally and analytically. This two-pronged approach was taken to determine

1. If the natural modes and frequencies could be accurately and reliably determined for a TFW vehicle by analysis and

2. If there is an abnormal sensitivity in flutter speeds and response due to gust for a TFW vehicle due to differences in measured and calculated modes and frequencies.

For vibration testing, the model was supported by overhead soft springs attached to the fuselage shell structure at the forward and aft bulkheads. A very soft spring (rubber band) was used to maintain the wings in a constant pitch attitude relative to the fuselage. All rigid body frequencies were below 1 Hz and therefore the measured modes are treated as being free-free.

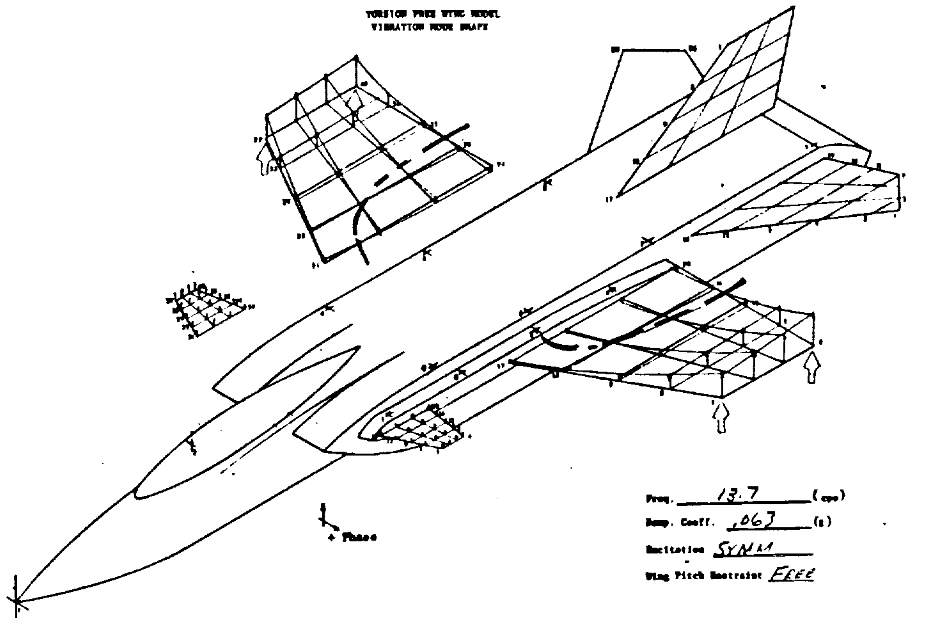
Lightweight electro-magnetic shakers were used to excite the model. Initially, two paired shakers were located at appropriate locations on the model and were phased either symmetrically or antisymmetrically while the excitation frequency was varied from 100 to about 5 Hz. Frequency response curves were automatically plotted from selected transducers (accelerometers). The peaks on these curves were then used to locate the natural frequencies of the model.

Multiple shakers up to four, were then positioned on the model to excite each of the natural modes. In general, the shakers were located at a point of large motion. The modes were then measured by the roving-reference accelerometer method. The weight of the accelerometer plus wire and vacuum pad used to hold the accelerometer to the structure was less than one gram. Modes were measured for the wing free to pitch (unrestrained) and with the wings locked or fixed in pitch.

Figures 8 and 9 show the ground vibration test flexible modes which are believed to be more important in the flutter and gust response characteristics of the model. All of the modes measured during the vibration test are presented in the Appendix.

FIGURE 8

TFW MODEL MODES OF PRIMARY INTEREST -
GVT, WING FREE



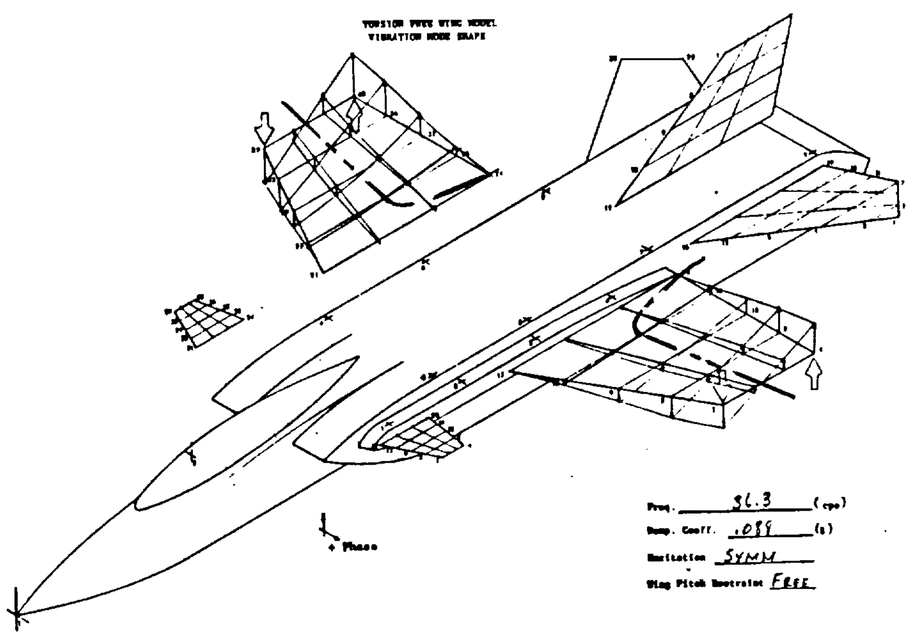
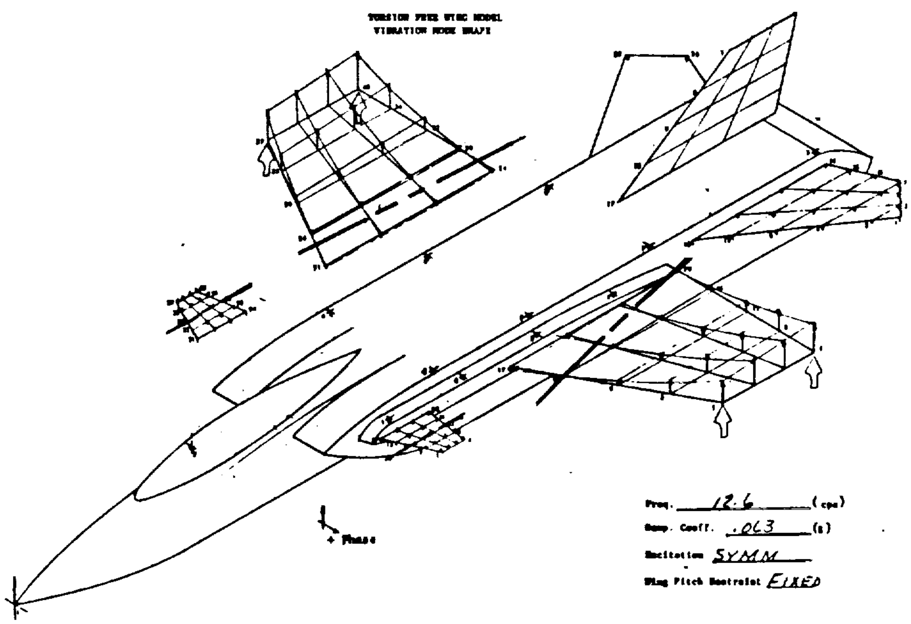
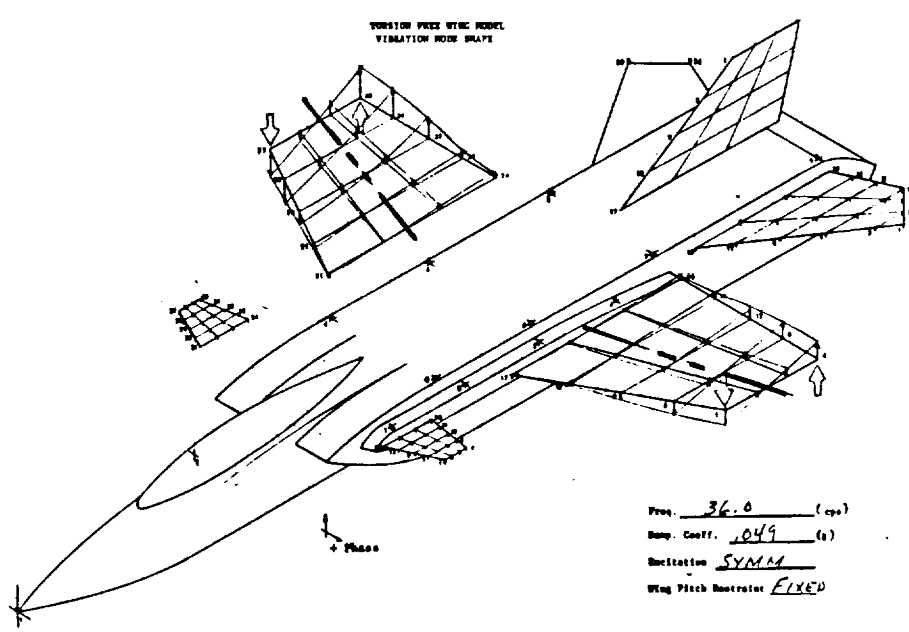


FIGURE 9

TFW MODEL MODES OF PRIMARY INTEREST -
GVT, WING LOCKED





The finite element representation of the TFW model as described in Section 4 was used to calculate the modes and frequencies. Because of the known asymmetry of the wing weight, and also knowing that some of the measured model modes were asymmetric, a complete tip-to-tip vibration modal analysis was conducted.

The model modes and frequencies were computed by the structural analysis computer program MSC/NASTRAN. This program can compute directly the free-free modes and frequencies of an asymmetric TFW vehicle. No artificial supports or centerline boundary conditions are required in this program.

In order to improve the correlation between the analytical modes and the experimental modes, some successive adjustments were made in the wing aluminum plate and the wing balsa wood stiffness values. As discussed in Section 8.1, the plate modulus finally used was adjusted upward from the values for aluminum of 72.4×10^9 N/M^2 (10.5×10^6 psi) and 27.58×10^9 N/M^2 (4.0×10^6 psi) to 91.4×10^9 N/M^2 (13.26×10^6 psi) and 34.8×10^9 N/M^2 (5.04×10^6 psi) respectively. Even with these adjustments, the calculated modes did not agree with the measured modes well. This is especially true in the higher frequency modes.

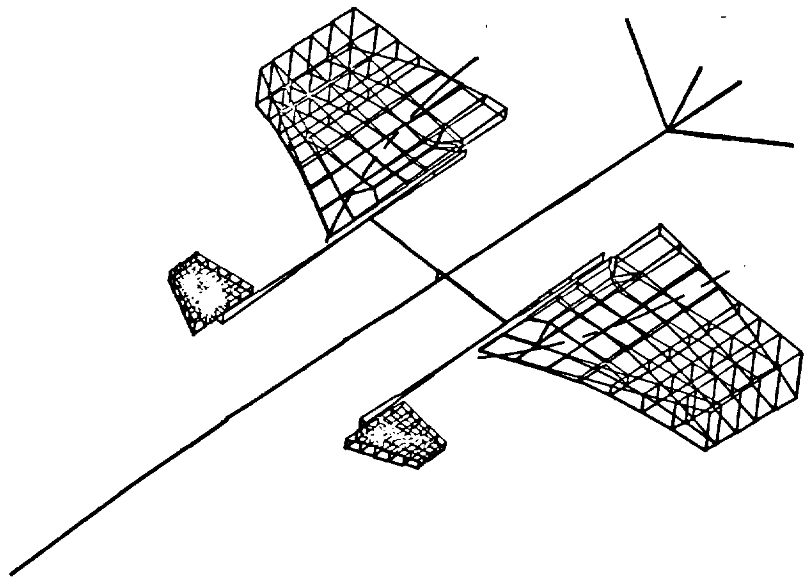
For both the wing free and wing locked cases the lowest frequency (0 Hz) modes calculated were the rigid body modes. For the wing free case an extra rigid body mode describing the wing rigid body pitch motion was calculated.

The analytical modes of primary interest are shown in Figures 10 and 11. The Appendix contains all of the modes which were calculated in the NASTRAN procedure.

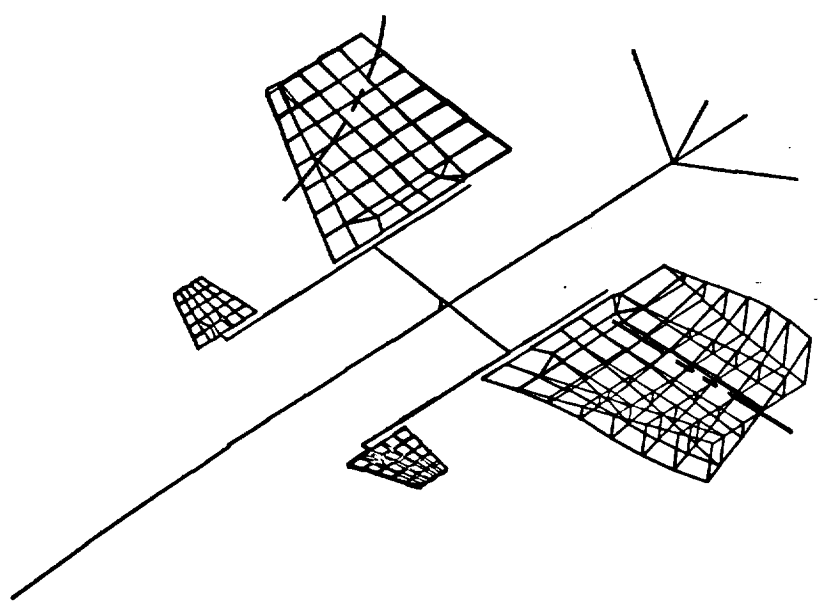
A summary of the measured and calculated frequencies and associated measured damping ratios of the natural vibration modes is shown in Table 5-(a). In the table, each model surface that participated significantly in a vibration mode is identified, and the surface (or surfaces) whose motion predominated is indicated by an underline. Most of the GVT modes exhibited either symmetric or antisymmetric motion although some asymmetry was present in all of these modes. Many calculated modes involved motion primarily on one vehicle side only and are listed as asymmetric modes in the table.

FIGURE 10

TFW MODEL MODES OF PRIMARY INTEREST -
NASTRAN, WING FREE

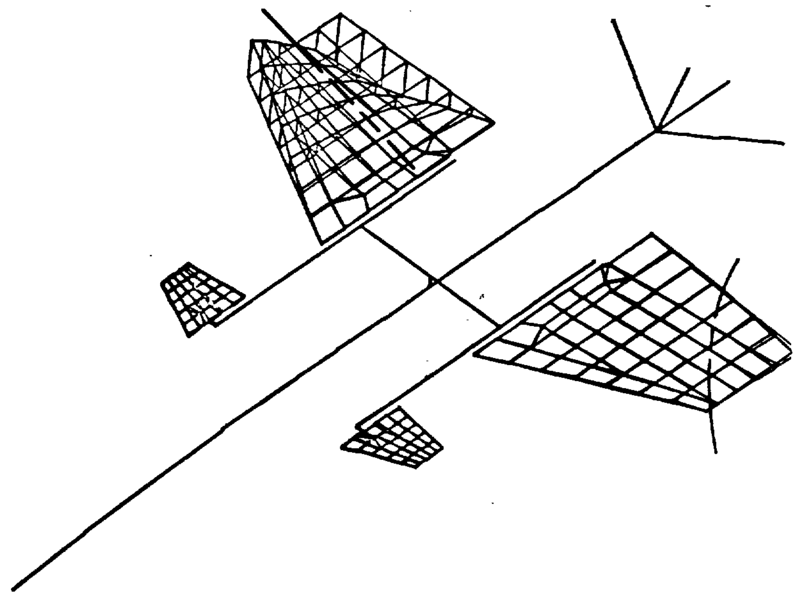


MODE 8 FREQ. 14.25936



MODE 10 FREQ. 33.20002

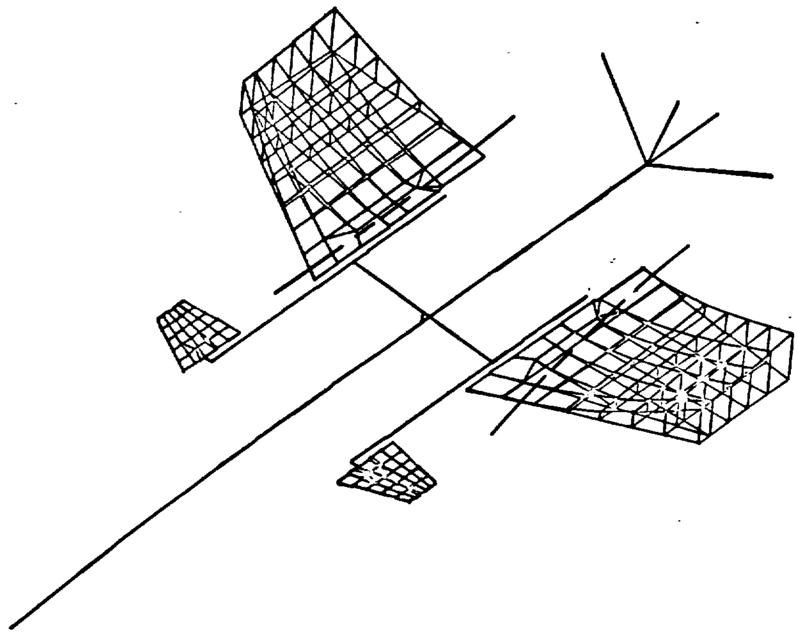
FIGURE 10 (continued)



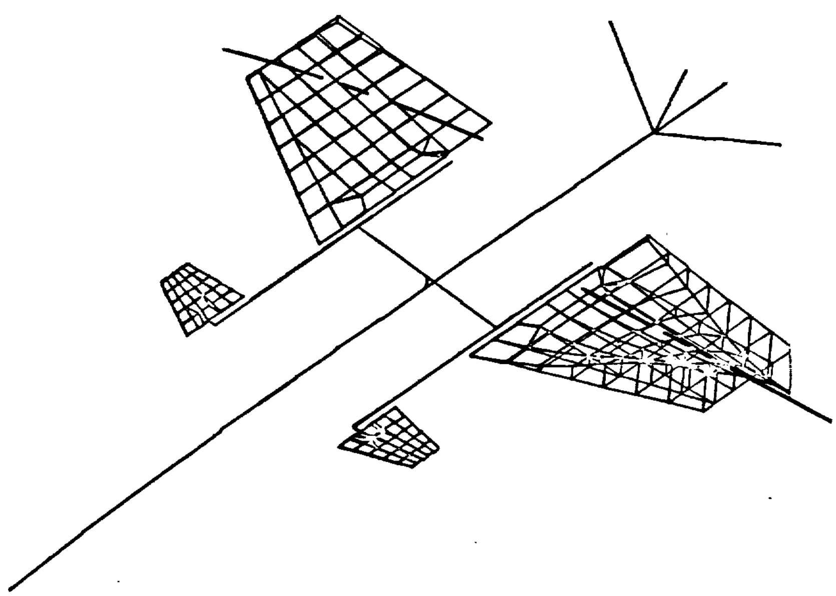
MODE 11 FREQ. 34.75158

FIGURE 11

TFW MODEL MODES OF PRIMARY INTEREST -
NASTRAN, WING LOCKED

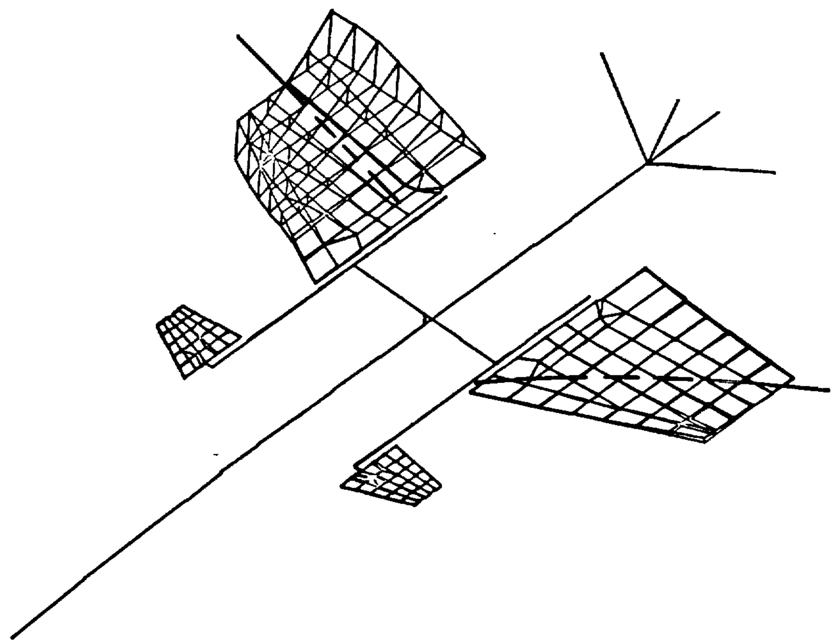


MODE 7 FREQ. 12.66541



MODE 9 FREQ. 32.96274

FIGURE 11 (continued)



MODE 10 FREQ. 34.55498

TABLE 5-(a)

MEASURED AND CALCULATED VIBRATION-MODE CHARACTERISTICS

Mode Code: Example W1B = Wing 1st bending.

W: Wing	S: Horizontal Stabilizer	B: Bending
F: Fuselage	V: Vertical Stabilizer	T: Torsion
C: Canard		

Mode	Measured (GVT)				Calculated (NASTRAN)			
	Symmetric		Antisymmetric		Symmetric	Antisym-metric	Asymmetric	
	f (Hz)	g	f (Hz)	g	f(Hz)	f(Hz)	Left f(Hz)	Right f(Hz)
Rigid-body modes for both model configurations								
Vertical translation	0.92	0.4	-	-	0	-	-	-
Pitch	0.76	.04	-	-	0	-	-	-
Side translation	-	-	1.05	-	-	0	-	-
Roll	-	-	1.95	-	-	0	-	-
Yaw	-	-	0.4	-	-	0	-	-
TFW-free configuration								
Rigid-TFW pitch	0	-	-	-	-	-	-	-
W1B	13.7	.063	17.5	.081	14.26	16.91	-	-
W1T	36.3	.088	36.7	.063	-	-	33.20	34.75
WB, SB, CB, F1B	44.3	.02	-	-	-	-	-	-
W2B	-	-	-	-	-	-	48.23	50.06
W2B, SB, CB	54.3	-	-	-	-	-	-	-
WB, SB, CB, V1B	-	-	58.0	.036	-	-	-	-
C1B	68.3	.037	68.1	.036	-	-	-	-
W2T, CB	-	-	-	-	-	-	67.22	70.15
WB, C1B	-	-	-	-	-	-	75.25	73.63
C1T	-	-	-	-	-	-	78.84	-
W2T - right wing	83.5	.063	83.3	.068	-	-	-	86.82
W2T - left wing	88.1	.088	88.0	.082	-	-	84.11	-
W2T	-	-	-	-	89.13	-	-	-
TFW-locked configuration								
W1B	12.6	.063	15.2	.063	12.67	16.93	-	-
W1T - left wing	36.0	.049	35.8	.063	-	-	32.96	-
W1T - right wing	36.4	.073	36.3	.063	-	-	-	34.55
S1B	44.5	.049	-	-	-	-	-	-
WB, SB, F1B	45.7	.028	-	-	-	-	-	-
W2B, SB, CB	53.8	-	-	-	46.19	50.34	-	-
WB, SB, V1B	-	-	54.8	.040	-	-	-	-
C1B	65.3	.050	65.0	.030	-	-	76.77	72.86
W2T - right wing	83.0	.055	-	-	-	-	-	-
W2T	-	-	87.4	.073	-	-	67.23	70.28
W2T - left wing	87.6	.088	-	-	-	-	-	-
C1B	-	-	-	-	-	-	78.36	-
W2T	-	-	-	-	-	-	83.72	86.62
Wing mode	-	-	-	-	-	-	-	87.88

6.0 MODEL FLUTTER CHARACTERISTICS

Flutter characteristics of the model were determined both experimentally and analytically. The experimental results will be discussed first.

Initially, the model was tunnel mounted on a sting (Figure 2a) which passed forward from the tunnel sting support, under the model fuselage to a point near the wing pivot. At this location, a bolted joint was used to tie the sting to a stiffened section of the fuselage lower surface. The primary reason for the sting tests was to check the aerodynamic characteristics of the model while it was mounted in the most secure manner available.

An important result of the sting tests was the discovery that the wing/boom/canard assembly was apparently aerodynamically statically unstable in pitch. However the instability manifested itself in a peculiar way. This was evidenced by an inability to trim the wing/boom/canard in approximately a ± 6 angle from neutral. Beyond this range of motion the assembly was stable but it seemed not to be much more than neutrally stable. Installation of smaller planform area canards solved this problem. Canards with both 70 and 60 percent of the original planform area canards were stabilizing. The 60 percent canards were used for all the remaining tests.

Tuft motion on the canards and wings indicated the possibility that near the neutral position the canards were unstalled and the flow was attached, whereas the tufts indicated that at about the $\pm 6^{o}$ position the canards were stalled or partially stalled. This could cause them to lose lift, which in turn could move the net center of lift aft thus stabilizing the wing/boom/canard assembly at angles beyond the $\pm 6^{o}$ range. This is hypothesis however.

While the model was sting mounted, the tunnel Mach number was increased to 1.15 with no strange or peculiar effects being noticed. Also the tunnel gust vanes were oscillated while the model was sting mounted. The wings responded visibly in pitch to this excitation at very low frequencies (1-3 Hz) but above this frequency there seemed to be little or no visible wing pitch response.

The model was mounted on the cable system (Figure 2b) described previously for all flutter testing. Initially the model did not possess the degree of stability desired when mounted on the cables. This was improved by adding weight to the forward fuselage and also moving the forward cable attachment point on the model farther forward.

Flutter testing could not be accomplished above Mach 1.01 because of a very low frequency mild lateral instability which occurred about Mach 1.0. Strakes (left and right) were added near the aft end of the fuselage in an effort to improve this condition, but were essentially unsuccessful in improvement. However the strakes were in place for all flutter and gust tests.

Tests were conducted first with the wings locked to the fuselage and then with the wings free. Flutter points were obtained for both cases. The wind tunnel flutter data are summarized in Figures 12 and 13. All instabilities are essentially symmetric.

With the wings locked to the fuselage, flutter was experienced at two different Mach, dynamic pressure combinations at a frequency close to 18 Hz. This appeared to be a coupling of symmetric wing 1st bending and torsion modes. For the wing free case, two separate flutter conditions manifested themselves. One was a low frequency case at about 7 Hz and apparently was a coupling of rigid wing pitch and wing 1st bending. This case was peculiarly associated with .95 Mach as shown in Figure 12. The second flutter condition occurred at a frequency of about 18 Hz and appeared to be a coupling of the wing 1st bending and torsion modes.

It is interesting to note that the 18 Hz flutter instability which was experienced for both the wing locked and wing free cases, occurred at a higher dynamic pressure for the wing free than for the wing locked. This seems unusual, considering the wing pitch degree of freedom involved for the two cases. A review of the ground vibration test modes and frequencies offers no explanation either. These data indicate that the flutter dynamic pressure for the wing free case should be lower because of a smaller frequency separation between wing first bending and wing torsion for symmetric response.

6.1 Flutter Analyses

Flutter analyses were conducted for the wing free and wing locked cases using both ground vibration test and NASTRAN calculated modal input data. Analyses were performed at .65, .86, .90 .95 and .975 Mach. The analyses utilized complete (tip-to-tip) span modal data and complete span aerodynamic pressure matrices and generalized aerodynamic forces. Generalized mass terms were likewise calculated for the tip-to-tip modes and mass distribution. As a check on the complete span generalized aerodynamic terms, a conventional half span analysis modified to correctly produce generalized aerodynamic terms associated with

FIGURE 12

TORSION FREE WING WIND TUNNEL TEST
FLUTTER RESULTS - WING FREE

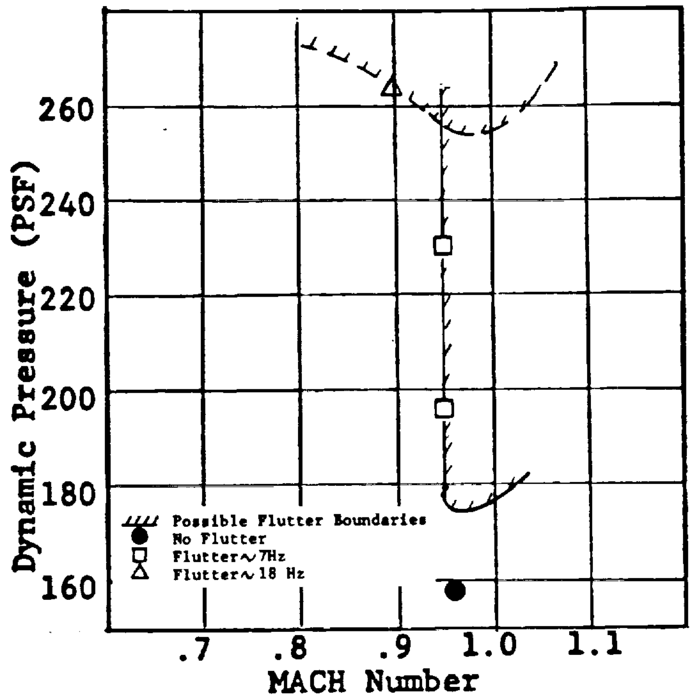
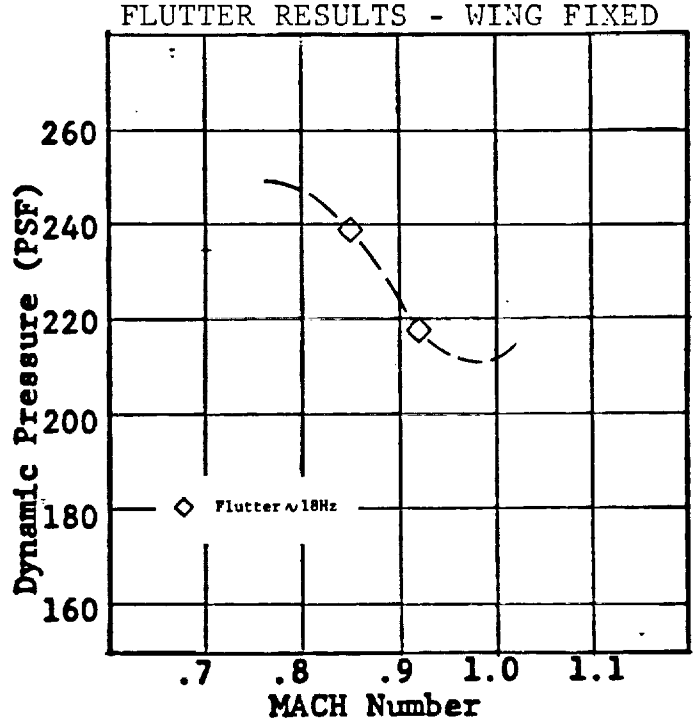


FIGURE 13

TORSION FREE WING WIND TUNNEL TEST
FLUTTER RESULTS - WING FIXED



modal asymmetry was conducted for the wing free case using GVT modal input data. In addition, flutter analyses were conducted on ½ of the model (the side selected was the left side which was more active in the wind tunnel tests). The modes used in this analysis were the GVT modes which were primarily symmetric.

The flutter analyses were conducted at a sufficient number of Mach numbers and altitudes to allow a flutter boundary to be plotted. A flutter boundary is defined to be the flutter instability curve every point on which the Mach number, density and equivalent velocity are compatible. An alternate way of stating this is that this instability curve provides compatibility between Mach and dynamic pressure. This is often referred to as a "matched point" solution. This is a direct way of comparing analyses and wind tunnel results.

The procedure used to calculate the unsteady aerodynamic loads utilized in the flutter analysis was originally developed for NASA by General Dynamics' Fort Worth Division. This aerodynamic program, which utilizes a high speed digital computer, has the capability of computing aerodynamic loads on multiple surface configurations throughout the Mach range including mixed transonic flow. The loads may be either steady or oscillatory for arbitrary deformations of the lifting surfaces. The theory is based on linearized potential flow over thin surfaces, and mixed flow cases with embedded shocks are solved as linear perturbations about a known linear mean flow. This latter capability was not used herein.

The arrangement of the lifting surfaces on the TFW was such that the total airplane configuration could be adequately represented. For this case the fuselage, wings, canards, booms, and horizontal tails were all treated as co-planar surfaces with aerodynamic interference. Past experience has proved this technique to be as accurate as methods which include body thickness effects for predicting subsonic or supersonic aerodynamic loads.

The aerodynamic method utilized solves the fundamental integral equation for the acceleration flow potential representation of lifting surfaces in either steady or unsteady, subsonic or supersonic flow. The solution technique makes use of assumed pressure functions with unknown series coefficients. These coefficients are solved for by formulating an equal number of equations for satisfying the surface normal-wash at unique collocation points. The surface normal-wash is obtained from the input natural mode shapes. Once the coefficients are obtained, the differential pressure distribution over the surface in each of the modes can be determined. This is then integrated with the natural vibration modes to solve for the generalized aerodynamics forces, Q_{rs}, for use in the flutter and gust calculations.

The digital flutter analysis was performed using the existing General Dynamics computing procedures. The approach used in these procedures is that of a Lagrangean system. The final flutter mode is assumed to be a combination of two or more normal vibration modes; the amount of each normal mode present (the generalized coordinates) are then the principal unknowns. The total energy (kinetic and potential) of the oscillating flutter mode is written and then substituted into Lagrange's equation The result, then, is a system of equations, one for each generalized coordinate. Since the aerodynamic forces are proportional to the generalized coordinates, the system is homogenous and must be solved as an Eigenvalue problem. The Eigenvalues will be complex because the aerodynamic terms are complex; the real part will be proportional to the flutter frequency and the imaginary part to the structural damping necessary to maintain neutral stability in the system.

The system of equations solved to yield the flutter speed and frequency, in matrix form is:

$$\begin{bmatrix} A_{11} & A_{12} & \cdots & A_{1n} \\ A_{21} & A_{22} & \cdots & A_{2n} \\ \vdots & \vdots & & \vdots \\ A_{n1} & A_{n2} & \cdots & A_{nn} \end{bmatrix} \begin{Bmatrix} \xi_1 \\ \xi_2 \\ \vdots \\ \xi_n \end{Bmatrix} = 0$$

where $[\ ]$ is a square matrix

$\{\ \}$ is a column matrix

ξ = Generalized coordinates

The terms of the matrix are defined to be:

$$A_{rs} = A_{rr} = \left[1 - \left(\frac{\omega_r}{\omega}\right)^2 (1 + i\, g_r) \right] M_{rr} + Q_{rr} \quad \text{for } r = s$$

$$A_{rs} = M_{rs} + Q_{rs} \quad \text{for } r \neq s$$

ω = flutter frequency

g_r = structural damping of the r^{th} mode where M_{rs} = generalized mass

$$= \frac{1}{4 \rho b^3} \int_{\text{Vehicle}} h_r h_s dm$$

Q_{rs} = generalized aerodynamic force

$$= \frac{1}{4\rho b^3 \omega^2} \iint_{\text{Vehicle}} h_r(x,y) \quad \Delta p_s(x,y) \; dxdy$$

For the analyses involving ground vibration test modes, the off diagonal M_{rs} terms were not zero valued. This is because for the flexible modes, perfectly orthogonal modes were not excited. Also for the rigid body modes, perfect rigid body modes were not assumed. Therefore, mass coupling existed between all generalized coordinates.

It is known, of course, that for pure normal modes there must be no mass coupling. Therefore, for the ground vibration test modes, the mass coupling terms involving purely flexible modes were forced to be zero, whereas for those modes involving the assumed rigid body modes, any existing mass coupling was allowed to remain in the flutter equations.

The population of normal-wash point used to generate the aerodynamic pressures for each of the surfaces is shown in Table 6. As explained in Section 8, the final selection of the normal-wash point distribution over the various surfaces was a result of an effort to show better coorelation between calculated and wind tunnel measured flutter parameters.

Because the flutter analysis of this TFW model was the first direct complete vehicle flutter analysis performed by General Dynamics Fort Worth Division, it was deemed advisable to cross check the results by conventional half span analysis methods. The analytical approach to achieving this was developed previously and is presented here for the benefit of the interested reader.

Considering pure symmetric motion, the total generalized aerodynamic force acting on a complete vehicle is given by

TABLE 6

NORMAL-WASH POINT DISTRIBUTION
OVER EACH AERODYNAMIC SURFACE

Aerodynamic Surface	Normal-Wash Point Distribution Spanwise	Chordwise
Left Canard	2	2
Right Canard	2	2
Left Wing	5	5
Right Wing	5	5
Left Boom	1	5
Right Boom	1	5
Left Inboard Horizontal Tail	3	2
Left Horizontal Tail Tip	1	2
Right Inboard Horizontal Tail	3	2
Right Horizontal Tail Tip	1	2
Vertical Tail	1	1
Left Vertical Fuselage	1	4
Right Vertical Fuselage	1	4
Lateral Fuselage	1	4
Strakes	1	1

$$Q_{rs_S} = 2 \lfloor h_{r_S} \rfloor \left[A_S \right] \left\{ w_{s_S} \right\}$$

where Q_{rs_S} = total generalized aerodynamics force due to pure symmetric motion.

A_S = Symmetric aerodynamic pressure matrix for one half of the vehicle.

w_{s_S} = Aerodynamic downwash (or normal-wash)

$= V(\alpha_s + \frac{i\omega h_s}{V})$

h_{r_S} = Symmetric mode shape

Similarly for pure antisymemtric motion

$$Q_{rs_A} = 2 \lfloor h_{r_A} \rfloor \left[A_A \right] \left\{ w_{s_A} \right\}$$

However, if the vehicle is undergoing asymmetric motion (neither a left-right mirror image, nor inverse image about the center-line), the aerodynamic forces can be described by the following procedure:

Aerodynamic forces produced by right side downwash

Applying the right side downwash symmetrically to both right and left sides, we have for the aerodynamic force on left and right sides

$$\left\{F_1\right\}^R = \left[A_S\right] \left\{w_R\right\} = \left\{F_1\right\}^L$$

Now apply the negative of the right side downwash to the left side and the positive of the right side downwash to the right side. This is an antisymmetric aerodynamic loading. The left and right side aerodynamic forces are:

$$\left\{F_2\right\}^R = \left[A_A\right] \left\{w_R\right\} = -\left\{F_2\right\}^L$$

Now the aerodynamic force on the right side associated with the desired right side downwash acting on the right side and zero downwash on the left is,

$$\left\{F\right\}^{\bar{R}_1} = \frac{1}{2}\left\{F_1\right\}^R + \frac{1}{2}\left\{F_2\right\}^R$$

$$= \frac{1}{2}\left(\left[A_S\right]\left\{w_R\right\} + \left[A_A\right]\left\{w_R\right\}\right)$$

Similarly on the left side we have

$$\left\{F\right\}^{\bar{L}_1} = \frac{1}{2}\left\{F_1\right\}^L - \frac{1}{2}\left\{F_2\right\}^L$$

$$= \frac{1}{2}\left(\left[A_S\right]\left\{w_R\right\} - \left[A_A\right]\left\{w_R\right\}\right)$$

Aerodynamic forces produced by left side downwash

Proceeding as above, except first applying the left side downwash symmetrically to both left and right sides and then applying the negative of the left side downwash to the right side and the positive of the left side downwash to the left side, we would have (as above),

$$\left\{F\right\}^{\bar{L}_2} = \frac{1}{2}\left(\left[A_S\right]\left\{w_L\right\} + \left[A_A\right]\left\{w_L\right\}\right)$$

and for the right side

$$\left\{F\right\}^{\bar{R}_2} = \frac{1}{2}\left(\left[A_S\right]\left\{w_L\right\} - \left[A_A\right]\left\{w_L\right\}\right)$$

Now the total aerodynamic force acting on the right side due to the desired left and right side downwash acting on the left and right sides is

$$\left\{F\right\}^{\bar{R}} = \left\{F\right\}^{\bar{R}_1} + \left\{F\right\}^{\bar{R}_2}$$

Similarly for the left side

$$\left\{F\right\}^{\bar{L}} = \left\{F\right\}^{\bar{L}_1} + \left\{F\right\}^{\bar{L}_2}$$

The total generalized aerodynamic force acting on the complete vehicle can be expressed as

$$Q_{rs} = \lfloor h_R \rfloor \left\{ F \right\}^{\bar{R}} + \lfloor h_L \rfloor \left\{ F \right\}^{\bar{L}}$$

where h_R is the right side mode shape and
h_L is the left side mode shape
or

$$= \frac{1}{2}\left(\lfloor h_R \rfloor \left[\left[A_S \right] \left\{ w_R \right\} + \left[A_A \right] \left\{ w_R \right\} \right] \right)$$
$$+ \frac{1}{2}\left(\lfloor h_R \rfloor \left[\left[A_S \right] \left\{ w_L \right\} - \left[A_A \right] \left\{ w_L \right\} \right] \right)$$
$$+ \frac{1}{2}\left(\lfloor h_L \rfloor \left[\left[A_S \right] \left\{ w_R \right\} - \left[A_A \right] \left\{ w_R \right\} \right] \right)$$
$$+ \frac{1}{2}\left(\lfloor h_L \rfloor \left[\left[A_S \right] \left\{ w_L \right\} + \left[A_A \right] \left\{ w_L \right\} \right] \right)$$

or combing terms

$$Q_{rs} = \frac{1}{2}\left(\lfloor h_R \rfloor \left[A_S \right] \left\{ w_R + w_L \right\} + \lfloor h_L \rfloor \left[A_S \right] \left\{ w_R + w_L \right\} \right)$$
$$+ \frac{1}{2}\left(\lfloor h_R \rfloor \left[A_A \right] \left\{ w_R - w_L \right\} + \lfloor h_L \rfloor \left[A_A \right] \left\{ w_L - w_R \right\} \right)$$
$$= \frac{1}{2}\left(\lfloor h_R + h_L \rfloor \left[A_S \right] \left\{ w_R + w_L \right\} + \lfloor h_R - h_L \rfloor \left[A_A \right] \left\{ w_R - w_L \right\} \right)$$

Therefore it is seen that by this method the total generalized aerodynamic force may be evaluated by summing left and right side mode shapes and combining this with a normal half span symmetric pressure matrix then subtracting left and right side mode shapes combined with a normal half span antisymmetric pressure matrix. These are then summed and averaged. However, it must be remembered that the total vehicle generalized mass must be obtained to use in the flutter equations.

The conventional half span analysis results compared almost exactly with the complete vehicle, tip-to-tip analysis at all Mach numbers and densities. This comparison was made for the wing free case using GVT modal input.

Figures 14 and 15 show the calculated flutter boundaries and the model test flutter points. The results of the flutter analyses are presented in Tables 7 and 8.

For the analyses of the wing-free configuration using ground vibration test modes, the modal input consisted of thirteen measured flexible modes plus six assumed rigid body modes. Because of the way the model was supported in the tunnel on the cable system, rigid body modes describing vertical translation, lateral translation, yaw, pitch and roll all had finite zero airspeed frequencies which were measured. These frequencies were used in the flutter analyses. The sixth rigid body mode, wing pitch, had a zero airspeed frequency of zero. Fore and aft translation was not allowed.

With the wings locked to the fuselage, the ground vibration test modal input to the flutter analysis consisted of fifteen flexible modes and five rigid body modes. Wing pitch, of course, did not exist for this case.

The NASTRAN analysis for the wing free case utilized fourteen flexible modes and the same six rigid body modes as were used in the analysis of the ground vibration test modes. For the wing fixed case, fourteen flexible modes and five rigid body modes were utilized. It should be pointed out that the NASTRAN rigid body modes were calculated in the analysis program and all were for zero frequency. This is because the model modes were assumed to be free-free. The cable support system was not modeled. As a result, some differences exist between the NASTRAN rigid body mode shapes and those assumed for the GVT case. The frequencies measured on the tunnel mount system were used in both modal input cases at zero airspeed however.

The same aerodynamic program was used to generate the generalized aerodynamic forces in the flutter solution of both the NASTRAN and ground vibration test mode cases.

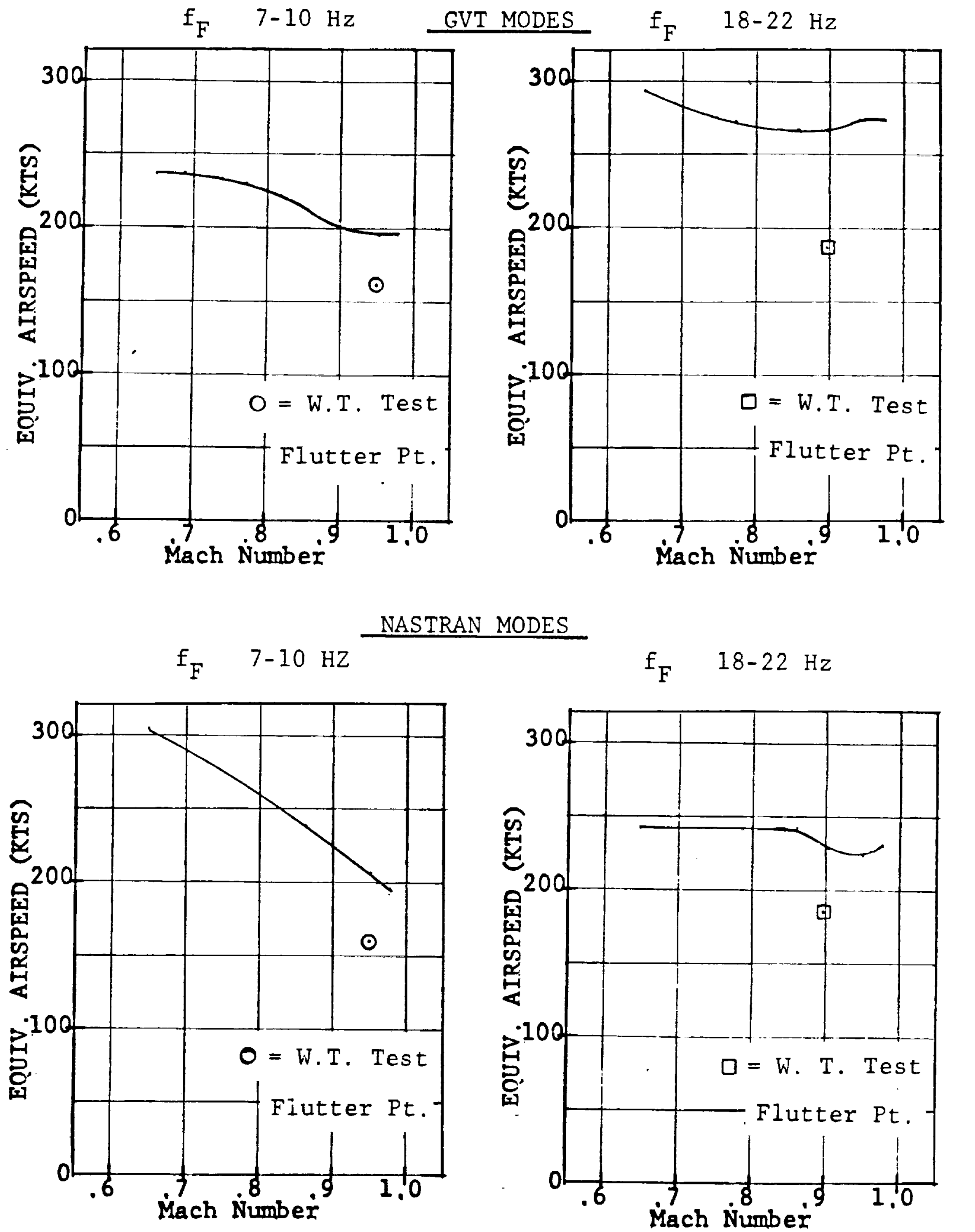
6.2 Stability Analysis

As a sub-case of the flutter analyses, the strange behavior of the wing/boom/canard combination was investigated. This was done by reducing the aerodynamics to the steady flow case (k=0) and placing the wing, the boom and the canard at a unit angle of attack. The resulting lift and center of pressure location combined with the area of each of the surfaces were used to determine the net center of pressure location. This was done for Mach .65.

FIGURE 14

WIND TUNNEL/ANALYTICAL FLUTTER SPEED COMPARISON

(WING FREE)



Note: V_E based upon ρ = 2.732 Kg/M^3 (.0053018 $slug/ft^3$)

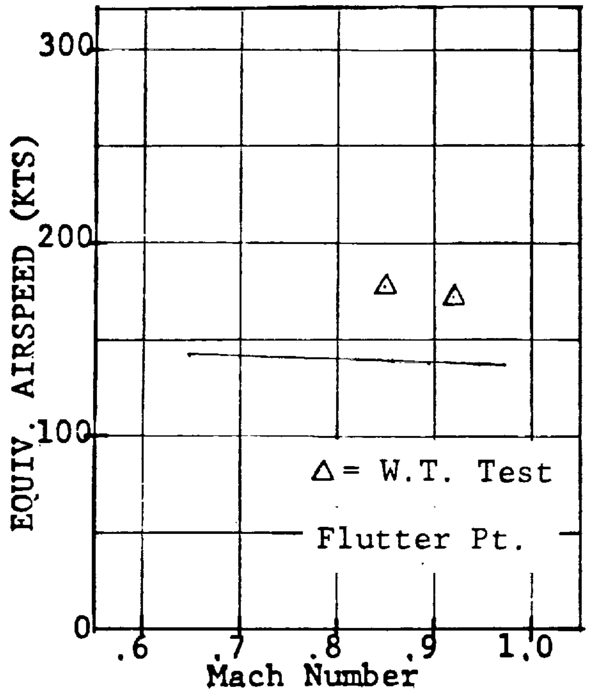
FIGURE 15

WIND TUNNEL/ANALYTICAL FLUTTER SPEED COMPARISON

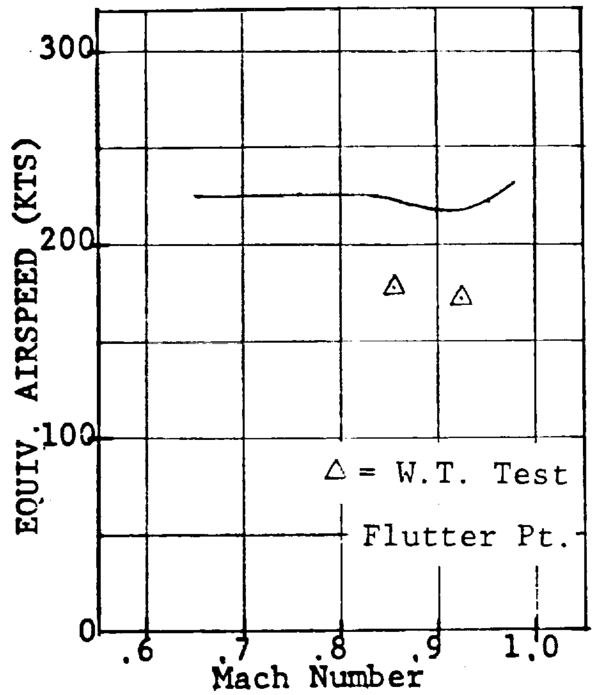
(WING LOCKED)

GVT MODES

f_F 17-22 Hz

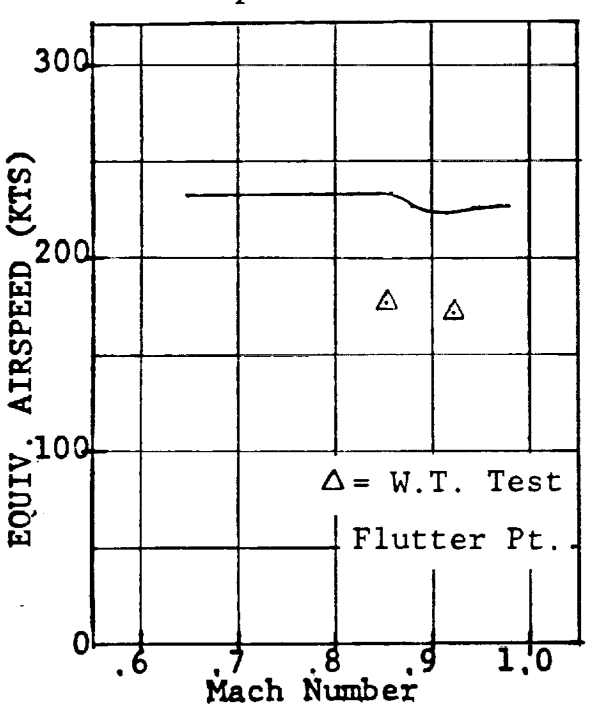


f_F 19-24 Hz

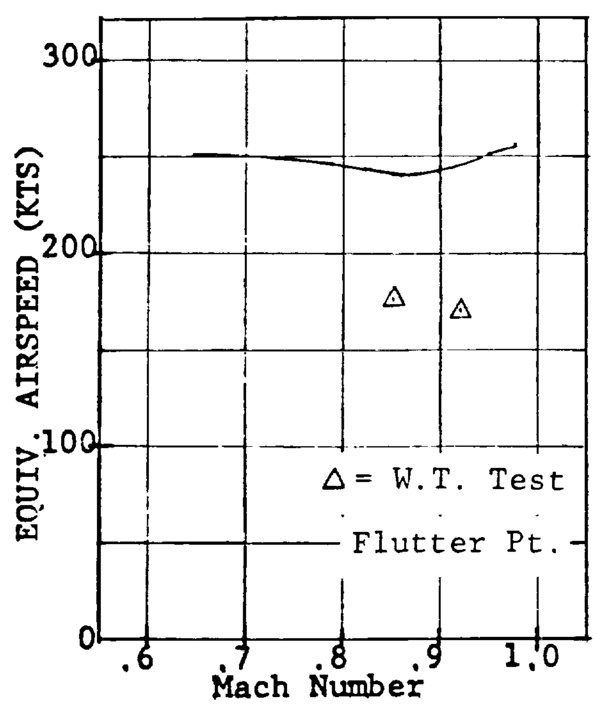


NASTRAN MODES

f_F 17-22 Hz



f_F 19-24 Hz



Note: V_E based upon $\rho = 2.732$ Kg/M^3 (.0053018 slug/ft^3)

TABLE 7

WING FREE FLUTTER ANALYSIS RESULTS

MACH NO	DENSITY	LOW FREQ. FLUTTER INSTABILITY				HIGH FREQ. FLUTTER INSTABILITY			
		* GVT		* NASTRAN		* GVT		* NASTRAN	
		V_E(KTS)	f(cps)	V_E(KTS)	f(cps)	V_E(KTS)	f(cps)	V_E(KTS)	f(cps)
.65	.0053018	225	10.3	280	10.5	245	20.5	225	21.5
	.0039159	220	10.1			240	20.3		
	.0028269	220	10.1			240	20.3		
	.0080534	235	10.0	285	10.5	265	20.5	235	21.0
	.011786			295	10.3			250	21.5
	.018673			315	9.8			270	22.5
.86	.0029205	208	9.9	241	11.0	245	19.3	230	21.0
	.0021570	208	10.0	238	11.0	238	19.3	223	21.5
	.0015572	208	10.0			234	19.5	223	21.5
	.0044362	211	10.1	234	10.5	256	19.8	241	21.0
	.006492			256	10.3			249	20.5
	.01029			271	10.2			260	21.0
.90	.0025975	203	10.1	231	10.3	242	19.3	224	20.5
	.0019185	203	10.0	224	10.2	239	19.0	210	20.2
	.0013850					231	19.0	213	21.0
	.0039456	206	10.0	227	10.2	255	19.3	227	21.0
	.005774			234	10.1			241	21.0
	.009148			248	10.1			252	21.0
.95	.0017374	192	9.9	206	10.0	246	19.3	220	20.5
	.0012832					238	19.3	214	20.2
	.0009264					232	19.3	215	20.5
	.0026391	192	10.0	206	9.9	257	19.5	223	20.0
	.003863	194	9.9	209	9.9	269	20.2	229	20.0
	.006119	360	9.5	220	9.7	272	21.0	240	20.3
.975	.0016831	189	9.5	192	9.7	265	20.8	217	20.3
	.0012431					256	20.8	217	20.2
	.00089743					245	19.8	211	20.2
	.0025566	192	9.5	197	9.7	270	21.0	225	20.0
	.003742	192	9.5	203	9.7	270	22.0	234	20.0
	.005927	203	9.2	217	9.5	274	22.0	245	20.0

* V_E based upon a density of 2.732 Kg/M^3 (.0053018 $slugs/ft^3$)

NOTE: If a blank occurs in the table, either no analysis was conducted at that density, or no crossing of the zero damping axis occurred on the V-g curves.

TABLE 8

WING LOCKED FLUTTER ANALYSIS RESULTS

MACH NO	DENSITY	GVT MODES V_E^*(KTS)	f(cps)	V_E^*(KTS)	f(cps)	NASTRAN MODES V_E^*(KTS)	f(cps)	V_E^*(KTS)	f(cps)
.65	.0048284	153	19.0	224	22.0	224	21.0	234	23.0
	.003566	143	19.0	219	22.0				
	.002574	143	18.8	219	22.0				
	.007334	153	18.8	224	22.5	229	21.0	243	23.0
	.01073					243	22.0	258	23.0
	.01699					267	22.	286	24.0
.86	.0025960	143	17.3	217	20.2	224	21.0	224	21.0
	.001917	140	17.5	210	20.0	220	21.0	220	21.0
	.001384	136	17.5	220	19.8	213	19.5	220	20.5
	.003943	150	17.2	220	20.5	231	20.0	231	21.0
	.005771					234	20.5	248	22.0
	.009143					252	21.0	269	22.5
.90	.0022123	142	17.2	216	19.5	220	20.0	220	20.0
	.001634	139	17.2	210	19.5	216	19.5	219	20.5
	.001180	136	17.0	207	19.5	210	19.0	216	20.5
	.003360	152	17.0	216	19.5	220	20.0	239	21.5
	.003918	155	17.0	226	20.0	233	20.0	249	22.0
	.007792	171	17.0	239	20.5	242	20.5	265	22.0
.95	.0018881	140	16.5	212	19.5	218	20.5	232	21.5
	.001395	140	16.0	209	19.5	215	20.5	230	21.5
	.001007	137	16.5	206	19.0	207	20.5	215	20.5
	.002868	143	16.5	218	19.5	221	20.0	245	21.5
	.004197	152	16.5	227	20.0	227	20.5	251	22.5
	.006650	167	16.5	239	20.5	230	21.0	263	23.0
.975	.0017757	139	17.0	217	20.0	214	20.5	243	23.0
	.001312	136	16.5	214	19.5	208	20.0	243	22.5
	.000947	133	16.5	211	19.5	214	20.0	249	23.0
	.002697	145	17.0	226	20.0	214	20.0	249	23.0
	.003947	153	17.0	231	20.3	226	19.7	252	23.0
	.006254	165	17.0	240	20.5	240	20.0	260	23.0

* V_E based upon a density of 2.732 Kg/M^3 (.0053018 slugs/ft^3)

NOTE: If a blank occurs in the table, either no analysis was conducted at that density or no crossing of the zero damping axis occurred on the V-g curves.

The results of this investigation showed:

1. The center of pressure of the three combined surfaces (wing, plus boom, plus canard) with the original canard installed was 1.27 cm. (.5 in.) ahead of the wing pivot axis.

2. The net center of pressure with the small (60% of original area canard) canard installed was .89 cm. (.35 in.) behind the wing pivot axis.

This analysis assumed that the wing, boom and canard were in the same horizontal plane and that interference effects were present. This shows why the wing/boom/canard assembly was unstable with the large canard installed and stable with the small canard installed.

To approximate the effect of rotating the entire wing/boom/canard assembly through a 5 degree angle, the original canard was translated 5.08 cm. (2 in.) vertically (out of the wing/boom horizontal plane) and the calculations repeated. This moved the net center of pressure aft .33 cm. (.13 in.) but still left it .94 cm. (.37 in.) forward of the wing pivot axis.

The large canard was also translated vertically 12.7 cm. (5 in.) relative to the plane of the wing/boom assembly and the calculations repeated. This moved the net center of pressure slightly forward to a position 1.09 cm. (.43 in.) forward of the wing pivot axis.

The effect of the large canard interference on the wing was also investigated. This was done by placing all three surfaces in the same horizontal plane but disregarding any interference effects. The result of this was about the same as translating the canard surface 5.08 cm. (2 in.) vertically. The center of pressure was calculated to lie .86 cm. (.34 in.) forward of the wing pivot axis.

It is interesting to note that of the total lift force, including interference effects, developed by the wing/boom/canard, and with the small canard installed, 11 percent is produced by the boom, 12 percent by the canard, and 77 percent by the wing. The planform area contributed by each of these components is 14, 7 and 79 percent of the total respectively.

This investigation shows why the wing/boom/canard combination of lifting surfaces was unstable in the original configuration and stable in the final configuration. It also offers some indication why the original (large canard) configuration became stable at angle of attack, since moving it 5.08 cm. (2 in.) out of the wing/boom horizontal plane moved the center of pressure aft.

7.0 GUST RESPONSE CHARACTERISTICS

The model was cable mounted in the wind tunnel for all gust response measurements. Because the wings were constrained to have only symmetric rigid body wing pitch motion, a symmetric gust input was generated in the air stream by symmetrically oscillating the tunnel gust vanes. These vanes are located upstream of the test section. A pair of vanes separated by about three feet vertically, are located on each side of the throat of the tunnel. The vanes were oscillated through an angle of attack range of $\pm 6^{\circ}$ at all frequencies. The frequency range used was from .2 to 18 cycles per second with the frequency being varied slowly over the frequency range in a linear manner. A more detailed description of the flow field generated by the gust vanes and the vane operation is given in Reference 1.

A continuous tape recording was made of several transducers on the model to measure the response of various model parameters to the sinusoidal gust input. The response items measured were:

1. Fuselage vertical accelerations at 5 points along the fuselage length, including pilot station and c.g. location (or near the c.g.) accelerations.

2. Left wing root bending and torsion moments.

3. Left canard root bending moment.

4. Right wing root bending and torsion moments.

5. Right canard root bending moment.

6. Wing pitch angle relative to the fuselage.

Post wind tunnel test processing of five of these data items was accomplished to produce values of response in power spectral density form. The five items were:

1. Pilot station acceleration (accelerometer No. 1)

2. Center of gravity acceleration (accelerometer No. 3)

3. Acceleration of a point on the forward fuselage about midway between the pilot station and the center of gravity (accelerometer No. 2).

4. Left wing bending moment.

5. Left canard bending moment.

A decision was made to process the wind tunnel measured response data and to manipulate it in such a way as to produce response data for an equivalent full scale airplane. In order to do this, scaling ratios had to be established between the model and an equivalent full scale airplane. The length ratio was known to be equal to 1/5.5 because of the full scale vehicle upon which the model wing, fuselage, boom and canard geometry was based. Also the weight of the full scale airplane wing/boom/canard assembly was available. The same model components were weighed, thus establishing a weight ratio. Assuming a μ ratio between model and full scale of unity, and using this in conjunction with the known weight or mass ratio, allowed a test medium density ratio to be established. Proceeding in such a manner as this, and assuming an $\omega b/V$ ratio of unit to exist, provided a method of evaluating the various scaling ratios shown in Table 9 . These were used, along with the von Karman atmospheric gust spectrum to produce equivalent full scale airplane response to gust.

The von Karman atmospheric gust spectrum is given by:

$$\phi_i\left(\omega\right) = \left(\sigma_u\right)^2 \frac{L}{\pi V} \left\{ \frac{1 + 8/3(1.339 \frac{L\omega}{V})^2}{\left[1 + (1.339 \frac{L\omega}{V})^2\right]^{11/6}} \right\}$$

where

σ_u = gust velocity (taken as 1 fps)
L = scale of turbulence (taken as 500 feet)

The wind tunnel gust velocity, as provided by NASA Langley from measurements made in the 16 foot Transonic Dynamics Tunnel, can be obtained from the following equation:

TABLE 9

TORSION FREE WING
1/5.5 MODEL
SCALING RATIOS

1. Mach Ratio = 1.0

2. Reduced Velocity Ratio = $(V/b\omega)_R = (V/b\omega)_M/(V/b\omega)_A = 1.0$

3. Mass Density Ratio = $\mu_R = (M/\rho l^3)_M/(M/\rho l^3)_A = 1.0$

4. Froude Number Ratio = $\overline{F}_R = (V^2/lg)_M/(V^2/lg)_A = 1.25$

5. Length Ratio = $l_R = l_M/l_A = 1/5.5$

6. Air Density Ratio = $\rho_R = \rho_M/\rho_A = 1.925$

7. Velocity Ratio - $V_R = V_M/V_A = 1/2.09$ (V_R = Speed of sound ratio)

8. Frequency Ratio = $f_R = V_R/l_R = 2.63$ ($V/b\omega_R = 1.0$)

9. Mass Ratio = $M_R = \rho_R l_R^3 = 1/86.43$

10. Acceleration Ratio = $a_R = V_R^2/l_R = 1.258$

11. Force Ratio = $F_R = \rho_R V_R^2 l_R^2 = 1/68.64$

12. Bending Moment Ratio = $\overline{M}_R = F_R l_R = 1/377.53$

13. Transfer Function Ratio (accels) = $H_R = \dfrac{a_R}{V_R} = 2.63$

(Bending Moms) = $\dfrac{\overline{M}_R}{V_R} = 1/180.64$

Notes:

1. Using a model test point of q = 263psf at .9 Mach and a tunnel speed of sound of 500 feet/sec., gives a tunnel density of .0025975 slugs/ft^3. Solving for an airplane density using the above density ratio gives .001349. The atmosphere has a standard day density of this value at an altitude of 18200 ft. The speed of sound at this altitude is 1044 fps. This then, in conjunction with a tunnel speed of sound of 500 fps was used to determine the velocity ratio.

$$V_g = V \tan \varepsilon_g$$

and $$\frac{\varepsilon_g}{\alpha_v} = .174 - .213 \left(\frac{\omega_v}{V}\right) + .089 \left(\frac{\omega_v}{V}\right)^3 - .029 \left(\frac{\omega_v}{V}\right)^4$$

where ω_v = gust or vane frequency (rad/sec)

V = tunnel velocity (meters/sec)

ε_g = gust angle (degrees)

α_v = vane angle (zero-to-peak angle-degrees)
= 6^o for our case.

Dividing the model response spectrum (acceleration or bending moment) by the input wind tunnel gust velocity spectrum and converting these quantities (acceleration, bending moment, and gust velocity) to full scale values, provided a transfer function for each quantity.

Having both the transfer function and the atmospheric input spectrum expressed in full scale airplane quantities, the output spectrum in power spectral density form for accelerations or bending moments is obtained from the product of the input spectrum and the square of the absolute value of the transfer function.

The wind tunnel gust response tests were performed at two different Mach/dynamic pressure conditions. These were:

$M = .65$, $q = 60$ psf ($\rho = .5856$ Kg/M^3 (.0011361 slug/ft^3)
$M = .90$, $q = 100$ psf ($\rho = .5090$ Kg/M^3 (.0009876 slug/ft^3)

These model wind tunnel conditions are the equivalent of full scale conditions:

$M = .65$, alt = 39900 ft.
$M = .90$, alt = 42800 ft.

Testing was done with the wings free to pitch and with the wing/boom/canard assembly locked to the fuselage. The same response items were measured for all conditions.

The output spectrum, in full scale airplane terms, of the five response items for the various model and tunnel conditions, is shown in Figures 22 through 24. Included in each figure is the value of $\bar{A}$ and N_o. These terms are defined as

$$\bar{A} = \sqrt{\int_{\omega_1}^{\omega_2} \phi_o(\omega)\,d\omega}$$

and

$$N_o = \sqrt{\frac{\int_{\omega_1}^{\omega_2} \omega^2 \; \phi_o(\omega)\,d\omega}{\int_{\omega_1}^{\omega_2} \phi_o(\omega)\,d\omega}}$$

A tabulation of the experimental and analytical values of $\bar{A}$ and N_o for the all condition is presented in Tables 10 and 11.

An analysis of the response of the five quantities to gust input was also conducted. This was done on the basis of a complete tip-to-tip representation of the geometry, structure and aerodynamics of the model but scaled up to full scale airplane quantities. This was done on the basis of the scaling ratios shown in Table 9. The analysis assumed the same input spectrum (von Karman) as was used in the reduction of the experimental data. A brief description of the analytical procedure used to generate the response quantities follows.

The response (in power spectral density form) of a given point, in terms of acceleration, bending moment, shear, etc., to a random input can be expressed as

$$\phi_o(\omega) = \phi_i(\omega) \left| H(\omega) \right|^2$$

where $\phi_o(\omega)$ = output power spectrum

$\phi_i(\omega)$ = input power spectrum

$H(\omega)$ = transfer function.

For some given response point, L, and excitation frequency, ω, the transfer function is expressed as

$$H_L(\omega) = \sum_{j=1}^{n} \left[(i\omega)^p F_{j_L} + \bar{F}_{j_L}(\omega) \right] \xi_j(\omega) + \bar{F}_{f_L}(\omega) + i(\omega)^p F_{f_L}$$

where n = number of generalized coordinates.

Or for a number of different response points, the transfer function, in matrix form is

$$\begin{Bmatrix} H_1(\omega) \\ \cdot \\ \cdot \\ \cdot \\ H_r(\omega) \end{Bmatrix} = \begin{bmatrix} & & \\ & I(\omega) & \\ & & \end{bmatrix} \begin{Bmatrix} \\ \xi(\omega) \\ \\ \end{Bmatrix} + \begin{Bmatrix} \\ M(\omega) \\ \\ \end{Bmatrix}$$

where $\left[I(\omega)\right] = \left[(i\omega)^2 F_j + \bar{F}_j(\omega) \right]$

$\left\{M(\omega)\right\} = \left\{\bar{F}_f(\omega) + (i\omega)^2 F_f\right\}$

for $p = 2$

These terms are further defined as

$(i\omega)$ = imaginary frequency vector

F_j = mode shape deflections at response point (for accelerations)

= bending moment at response point due to inertia forces outboard of response point

F_f = acceleration or bending moment at response points due to the mass of the exciting force ($F_f = 0$ for our case)

$\bar{F}_j$ = bending moment at response point due to the aerodynamic forces generated by the generalized coordinates ($\bar{F}_j = 0$ for accelerations)

$\bar{F}_f$ = bending moment at response point due to a unit amount of the exciting force (the presence of the gust itself)

$\xi(\omega)$ = the response of the generalized coordinates

or

$$\left\{\xi\right\} = -\left[A'\right]^{-1}\left\{A_f\right\}$$

$$\begin{Bmatrix} \xi_1 \\ \xi_2 \\ \cdot \\ \cdot \\ \xi_n \end{Bmatrix} = -\begin{bmatrix} A'_{11} & A'_{12} & \cdots & A'_{1n} \\ A'_{21} & A'_{22} & & \cdot \\ \cdot & & & \cdot \\ \cdot & \cdot & & \cdot \\ A'_{n1} & \cdots & \cdots & A'_{nn} \end{bmatrix}^{-1} \begin{Bmatrix} A_{1f} \\ A_{2f} \\ \cdot \\ \cdot \\ A_{nf} \end{Bmatrix}$$

$$A'_{rs} = A'_{rr} = \left[1 - \left(\frac{\omega_r}{\omega_e}\right)^2 (1 + ig_r) - 2i\,\gamma_r\left(\frac{\omega_r}{\omega_e}\right)\right] M_{rr} + Q_{rr} \quad \text{for } r = s$$

$$A'_{rs} = M_{rs} + Q_{rs} \quad \text{for } r \neq s$$

$$A_{rf} = M_{rf} + Q_{rf}$$

where M_{rf} = generalized mass of forcing function which is zero for the gust forcing function problem.

Q_{rf} = generalized force of the forcing function.

$$= \frac{1}{4\rho b^3 \omega_e^2} \iint h_r(x,y)\,\Delta p_f(x,y)\,dxdy$$

and ω_e = excitation or gust frequency

Δp_f = pressure differential due to the gust.

TABLE 10

FULL SCALE RESPONSE OF FUSELAGE
TO ATMOSPHERIC GUST SPECTRUM

ACCEL NO.	MACH	WING RESTRAINT	EXPERIMENTAL		GVT MODES		NASTRAN MODES	
			$\bar{A}$ (g)	N_o (Hz)	$\bar{A}$ (g)	N_o (Hz)	$\bar{A}$ (g)	N_o (Hz)
1	.65	FREE*	.0167	1.893	.011	1.65	.016	1.14
		LOCKED	.0154	1.697	.012	1.24	.013	1.14
	.90	FREE	.0195	2.201	.019	2.14	.023	1.77
		LOCKED	.0166	1.800	.027	1.37	.023	1.62
2	.65	FREE*	.0172	1.997	.013	1.54	.018	1.26
		LOCKED	.0178	1.574	.014	1.29	.016	1.23
	.90	FREE	.0217	2.187	.024	2.05	.028	1.89
		LOCKED	.0188	1.919	.032	1.52	.029	1.76
3	.65	FREE*	.0197	2.110	.014	1.56	.019	1.31
		LOCKED	.0208	1.676	.015	1.34	.017	1.30
	.90	FREE	.0254	2.256	.027	2.67	.030	1.94
		LOCKED	.0224	2.052	.035	1.61	.032	1.84

* With the frequency of the rigid body modes made to be zero, the analysis using GVT modes gave the following results:

Accel. No.	$\bar{A}$	N_o
1	.010	1.63
2	.013	1.55
3	.013	1.58

TABLE 11

FULL SCALE RESPONSE OF WING AND CANARD
ROOT BENDING MOMENTS TO ATMOSPHERIC GUST SPECTRUM

BENDING MOMENT	MACH	WING RESTRAINT	EXPERIMENTAL		GVT MODES		NASTRAN MODES	
			$\overline{A}$ (Ft-lb)	N_o (Hz)	$\overline{A}$ (Ft-lb)	N_o (Hz)	$\overline{A}$ (Ft-lb)	N_o (Hz)
WING	.65	FREE	496.0	2.604	520.2	1.61	664.0	1.80
		LOCKED	477.6	2.285	838.0	.59	483.0	1.60
	.90	FREE	699.5	3.019	1385.0	1.34	1804.0	1.78
		LOCKED	642.7	2.826	1150.0	.59	1010.0	2.45
CANARD	.65	FREE	8.85	1.994	16.3	.82	20.8	1.06
		LOCKED	7.96	2.153	27.4	.30	13.4	.54
	.90	FREE	11.61	2.410	40.0	1.21	48.9	1.68
		LOCKED	8.38	1.769	42.3	.32	24.7	1.21

8.0 DISCUSSION AND CORRELATION OF ANALYSES AND EXPERIMENTAL RESULTS

This discussion will concern itself with the degree of correlation, and probable reasons for this degree, between analytical and experimental quantities. These quantities, and the order in which they will be discussed are:

1 - Vibration characteristics
2 - Flutter characteristics and
3 - Gust response characteristics.

8.1 Vibration Characteristics

There is a strong tendency to accept experimental data as the norm against which analytical results are to be measured. Surely this would be true if all experimental data were measured accurately under precisely controlled conditions using perfect equipment which was used or applied in a theoretically perfect manner. Extremely little experimental data reflects the demands of all these stringent conditions because to achieve this degree of perfection would require a large expenditure of time and money. However, it is rather remarkable how many good experimental answers (good because they agree well with known theoretical quantities) can be obtained with something less than optimum or perfect experimental techniques and equipment.

The experimental vibration modes are known not to be perfect normal modes primarily because of the existence of off-diagonal terms in the generalized mass matrix. These are not presented herein, but vary in magnitude, relative to the diagonal terms, from mode to mode. This could be due to a number of things such as joint friction, not using massless exciters and transducers, not calculating the correct distribution of mass over the airframe or not properly exciting the modes (distribution of exciting force magnitude not being correct) etc. However, extreme care was used to measure and excite the modes in as theoretically a perfect manner as could be reasonably done. As such, the experimental modes are taken as the norm against which the theoretical modes are compared and possible shortcomings in the analyses are explained.

It is quite obvious, considering that all cases of flutter discovered in the wind tunnel tests, were symmetric in nature, that agreement between analysis and test in the modes which were primarily symmetric was probably a higher priority than agreement in the primarily antisymmetric modes. Also, all gust testing was done with a symmetric gust being generated by the tunnel gust vanes and impinging on a model whose wings, for the wing free case, were constrained to move symmetrically in rigid body wing pitch.

It can be seen by examining the wing free analytical modes, that there is quite good agreement both in frequency and shape for modes which can be described as symmetric wing 1st bending and 1st torsion. The asymmetry of the left and right wing panels is displayed in the torsion modes, particularly the analytical modes. The effect of the wing asymmetry manifests itself differently between the GVT and analytical modes. For many of the modes above the first two analytical modes, one wing panel may exhibit motion while the other side has very little. In general this is not true for the GVT modes. Here both sides show substantial motion. This difference in behavior from side to side is believed to be attributable to differences in damping between GVT and NASTRAN modes.

The agreement in the 1st bending and torsion modes did not occur initially. It was believed that the wing structure had been reasonably well represented, especially the aluminum plate portion. It was not so easy however to be assured that the balsa portion of the wing structure had been correctly represented, especially the modulus values. However, even though the balsa represented a considerably larger portion of the airfoil cross section of the wing than the aluminum plate, it seemed that large errors did not exist in the representation of this structural component of the wing. The modulus values used are acceptable for end grain balsa.

Some simple calculations showed however, that there could be a sizeable stiffness contribution from the surface epoxy point. This unknown stiffness component was maximized by its location at the aerodynamic surface. Because this material was not separately represented in the analysis, it was decided to increase the modulus values of the aluminum plate until reasonable frequency agreement was realized for the fundamental modes. Therefore, the values of $E = 91.4 \times 10^9$ N/M^2 and $G = 34.8 \times 10^9$ N/M^2 were used. A similar result could have been obtained by increasing the balsa wood modulus instead.

It is apparent also that there is poor agreement between the experimental and analytical fuselage vertical bending mode. No apparent analytical mode appears in the 14 flexible modes presented. However, the experimental modes at 44.3 Hz for the wing free, and at 44.5 and 45.7 Hz for the wing locked might be the fundamental fuselage vertical bending modes or they might be horizontal tail bending modes. Of course, the tail surfaces were represented stiffness-wise in the analysis by rigid beams tied to the fuselage. Therefore, if these model modes are horizontal tail resonances, no agreement should be expected.

The correlation between measured and calculated higher wing torsion modes and canard modes is not very good frequency-wise. These modes occur in the frequency range above 60 Hz. Mode shape correlation is quite good. The poor correlation which exists in the higher wing torsion modes might be due to the surface epoxy finish. It is not easily explained why the canard fundamental modes at 68.1 and 68.3 Hz (GVT) and 73.6, 75.2 and 78.8 Hz (NASTRAN) for the wing free case do not agree better.

Many of the same comments which were made on the correlation of theoretical and experimental modes for the wing free case could also be made for the wing locked case. The frequency and mode shape correlation for the fundamental wing bending and torsion modes is acceptable, but the agreement in the higher wing modes and canard fundamental modes is only fair at best. Here again there is no correlation in the tail modes and fundamental fuselage vertical bending mode.

8.2 Flutter Characteristics

The model fluttered in the wind tunnel in both the wing free and wing locked configurations. As mentioned previously, with the wing free, a low frequency instability close to 7 Hz was encountered at two different values of dynamic pressure at Mach .95. This was definite and easily identified. However, at Mach .9, this low frequency root was not encountered, but a higher one at about 17 Hz was. It was not nearly so easily identified because the onset of flutter was not definite, but instead, wing amplitude of motion built up over a range of dynamic pressure making the onset of flutter difficult to accurately identify.

Flutter analyses of the wing free model using GVT or NASTRAN modes produced flutter frequencies close to the same ones experienced in the wind tunnel. This indicates that the same flutter mechanism was produced in the analyses as was experienced in the tunnel. In general the correlation of flutter speeds, between analysis and model was considered to be reasonably good. However, somewhat disturbing is the analytical prediction of flutter speeds which are higher than those measured in the tunnel. Also the analysis using GVT modes indicates that at all Mach numbers the low frequency instability should be encountered first. This was not true in the tunnel test. The analysis using NASTRAN modes predicts that at .95 Mach the low frequency instability is critical whereas at .8 Mach the high frequency flutter case is critical. This is more nearly consistent with tunnel results. However, the shape of the low frequency root flutter boundary is strange, showing what may be substantial compressibility effects beginning at quite low (.65) Mach numbers. The shape of the flutter boundary in the lower Mach range is strongly affected by the analysis results at .65 and .86 Mach and may not be an essentially straight line as shown.

The analtyical and experimental results for the wing locked case have about the same degree of correlation as for the wing free case. The analyses, using either GVT or NASTRAN modes apparently produces the same unstable root as the wind tunnel tests did because of the flutter frequency. However, the analyses generally predict higher flutter speeds than the wind tunnel tests exhibited. While it makes little difference, based upon pure correlation, whether the analyses differ from experimental by predicting too high or too low speeds, the same cannot be said for the analytical predictions of flutter speeds for a real airplane. In this case, it is desirable to be slightly conservative in the prediction of flutter speeds by analysis. As such it is good for the analysis to predict flutter speeds lower than actual.

Several things were tried in the analyses in attempting to show better correlation. Among these were:

1. Changing the arrangement and number of the normalwash collocation points on the wing.

2. Not including fuselage aerodynamics.

3. Not incorporating interference effects of the canard aerodynamics on the wing.

4. Making all rigid body frequencies equal to zero frequency at zero airspeed.

5. For the GVT modes, hand plotting the model deflections in the chordwise direction and smoothing out any small irregularities to produce more realistic mode shapes on the wings and canards.

None of these items produced any substantial change in predicted flutter speeds and frequencies. It is believed that except for the .95 Mach wing free case, the difficulty in pinpointing the onset of flutter may also affect the degree of correlation.

An abbreviated analytical study was also made of the flutter characteristics using only the GVT modes which were essentially symmetric in character and using only the left half of the model. This would correspond to the usual type of symmetric flutter analysis wherein modal symmetry is assumed and associated half span aerodynamic terms are used. This was for the wing free case. Matched point solutions were obtained at 0.65 and 0.95 Mach.

The results showed that for the high frequency flutter root (18-22 Hz), these results predicted a lower flutter speed (40 KEAS at M=.65 and 15 KEAS at M=.95) than the tip-to-tip analysis. However for the low frequency case, the one side analysis predicted a 50 KEAS higher flutter speed at M = .95 and did not produce a matched point instability at .65M. The V-g curves associated with this root almost went unstable (at the analysis air density nearest a matched point solution, the results indicated a flutter speed near 500 KEAS) but only reached the zero damping level.

This study would seem to indicate that for the high frequency root, the one side analysis which assumes symmetry is conservative, but is unconservative for the low frequency root. Another observation is that the analysis may require the contribution of the primarily antisymmetric modes to more nearly match the wind tunnel test results for this low frequency case.

8.3 Gust Response Characteristics

Before the gust response characteristics are discussed, it should be repeated that in the tunnel, the gust excitation frequency varied from .3 Hz to 18 Hz. This corresponds to a full scale airplane frequency range of .076 to 6.84 Hz. Since the gust response study was conducted in full scale airplane terms, this frequency range covered rigid body mode frequencies and only the fundamental bending mode (symmetric and antisymmetric) for the wing either free or locked. There was extremely little response from any of the other higher flexible modes because the frequency of the next higher flexible mode beyond fundamental bending is about twice the maximum gust excitation frequency. As a consequence of this, for the fuselage acceleration response analysis, with the wing free, only four modes were used in the analysis for both GVT and NASTRAN modal input. These were:

1. Rigid body vertical translation

2. Rigid body pitch

3. Rigid body wing pitch and

4. Wing fundamental bending (symmetric).

For the wing locked case, solving for fuselage acceleration response with both GVT and NASTRAL modal input, the following modes were used in the analysis:

1. Rigid body vertical translation

2. Rigid body pitch

3-6. The four lowest frequency flexible modes.

The bending moment response solution utilized seven modes for the wing free case for both GVT and NASTRAN modal input. These were:

1. Rigid body vertical translation

2. Rigid body pitch

3. Rigid body wing pitch

4-7. The four lowest frequency flexible modes.

With the wing locked, using GVT or NASTRAN modal input, the following modes were used in the analysis:

1. Rigid body vertical translation

2. Rigid body pitch

3-6. The four lowest frequency flexible modes.

This reduction in the number of modes used in the gust response analyses is believed to have affected the results in only the smallest degree because of the aforementioned frequency spread between the maximum excitation frequency and the next highest flexible mode.

A review of the $\bar{A}$ and N_0 values shown in Tables 10 and 11 shows reasonably good agreement between the measured and calculated quantities. Perhaps the overall agreement is better for the fuselage accelerations than for the wing and canard root bending moments. However reasonably good agreement is shown for both.

In every case, the $\bar{A}$ values for fuselage accelerations, using GVT modal data, are lower for the wing free case than for the wing locked, thus indicating some gust relief analytically for the wing free condition. The NASTRAN modal input data did not produce a consistent gust analysis trend regarding wing free fuselage response compared to wing locked. Some cases indicated higher response with the wing free although not by a large amount. The wind tunnel data did not always show consistent results either. The data of Table 10 indicates that generally the fuselage response using NASTRAN modal data input agrees better with the experimental data than does the analysis results based upon GVT modes.

The bending moment response comparison of Table 11 shows that the wing bending moments compare better with analysis than the canard bending moments do. This is probably affected by the small size of the canard relative to the wing and the use of far fewer normal-wash points (4) on the canard than on the wing (25).

For the wing bending moment response, the M = 0.65 analysis results compare better with experiment than do the .9 Mach results. Also there is poor agreement in N_0 values for the wing locked case involving GVT modes. There is no consistent trend between the wing free and wing locked conditions in the analytical results using either GVT or NASTRAN modal data.

A review of the PSD response values in the Appendix shows that virtually all of the response for both fuselage accelerations and bending moments comes from very low frequency modes. These are substantially below wing first bending and are obviously closely associated either with the natural rigid body modes of the airframe or the rigid body modes associated with the cable mounting system. It is indeed unfortunate that these rigid body modes, either the natural airframe modes associated with the mass and inertia properties of the vehicle and the effective aerodynamic spring restraint or the same mass and inertia properties of the airframe interacting with the spring stiffness of the cable mounting system in the wind tunnel, are apparently in the same frequency range. Also, because the vast majority of the total $\bar{A}$ quantities come from the very low frequency range, there may be some question about the accuracy of the oscillatory aerodynamics in this frequency range.

Inspection of the generalized coordinate response produced as part of the computerized analysis results (not included herein) shows that for the analysis using either GVT or NASTRAN modes, the largest contribution to the fuselage accelerations comes from the vertical translation mode. A small amount also comes from the pitch mode with only a minor contribution from the wing pitch mode and the first flexible mode.

A similar observation can also be made about the bending moment response. Here again, most of the response comes from the rigid body modes with the contribution from the vertical translation mode being predominant. Perhaps the reason the bending moment response calculations do not correlate quite as well as the fuselage accelerations is because of the more complicated nature of this type response. Whereas the accelerations are primarily dependent on aerodynamic loading (or shear), the bending moments are primarily dependent on the integrated shear (moment). This additional step required to calculate the moment response could result in degradation of the correlation.

It should be pointed out that the tabulated $\bar{A}$ and N_o values are for the same range of frequencies for all three sources of data. This was achieved in the analysis by calculating new values of $\bar{A}$ and N_o at each frequency increment corresponding to each incremental value of $\omega b/V$. There were 191 of these incremental values used in the analysis.

A major observation made of the tabulated N_o and $\bar{A}$ values is the apparent generally small effect of the TFW concept in reducing fuselage, especially pilot station, response to gust and also the failure to consistently get wing bending moment relief. Perhaps this is not too unexpected from this one test and accompanying analyses for the particular TFW configuration of this program. This is probably because of the close proximity of the aerodynamic center of pressure of the wing/boom/canard assembly to the wing pivot axis. It is likely that the closer the center of pressure is to the wing pivot, the more nearly the free wing will approach a locked wing in its physical behavior. To get a real measure of the gust relief characteristics of a TFW vehicle, the net center of pressure of the wing/boom/canard should be farther removed from the wing pivot. Or stated in terms of the wing-free pitch mode frequency, the gust response would be expected to be reduced if the wing pitch frequency were increased. This could be achieved by either reducing the wing/boom/canard pitching mass moment of inertia about the wing pivot axis or by increasing the aerodynamic spring force. This could be achieved by moving the aerodynamic center of pressure farther aft. However, this may tend to lower the flutter speed for the low frequency case involving the wing pitch mode because it would make the separation of the wing pitch and 1st bending mode frequencies less.

9.0 CONCLUSIONS

There are three major conclusions which can logically be derived from the work represented by this report.

First, a free floating wing configuration will not necessarily have a flutter speed so low as to be restrictive. The selection of this type configuration for a flying vehicle need not alone be cause for flutter concern. If there is a low flutter speed which emerges, other normal factors may be responsible. Further, the flutter characteristics can be reasonably well predicted by analysis. At least the configuration is amenable to existing analytical methods. The peculiarity in the wind tunnel tests, wherein a vertical flutter boundary seemed to be present at .95 Mach, should be investigated further experimentally.

A second major conclusion is that this TFW model was not configured in an optimum manner to investigate the gust relief characteristics attributed to a floating wing vehicle. There should be a larger distance between the wing pivot and the free pitching assembly center of pressure. The model of this investigation is capable of having the wing panels shifted aft relative to the pivot. Testing a configuration with a large degree of aerodynamic stability would be a good investigative step.

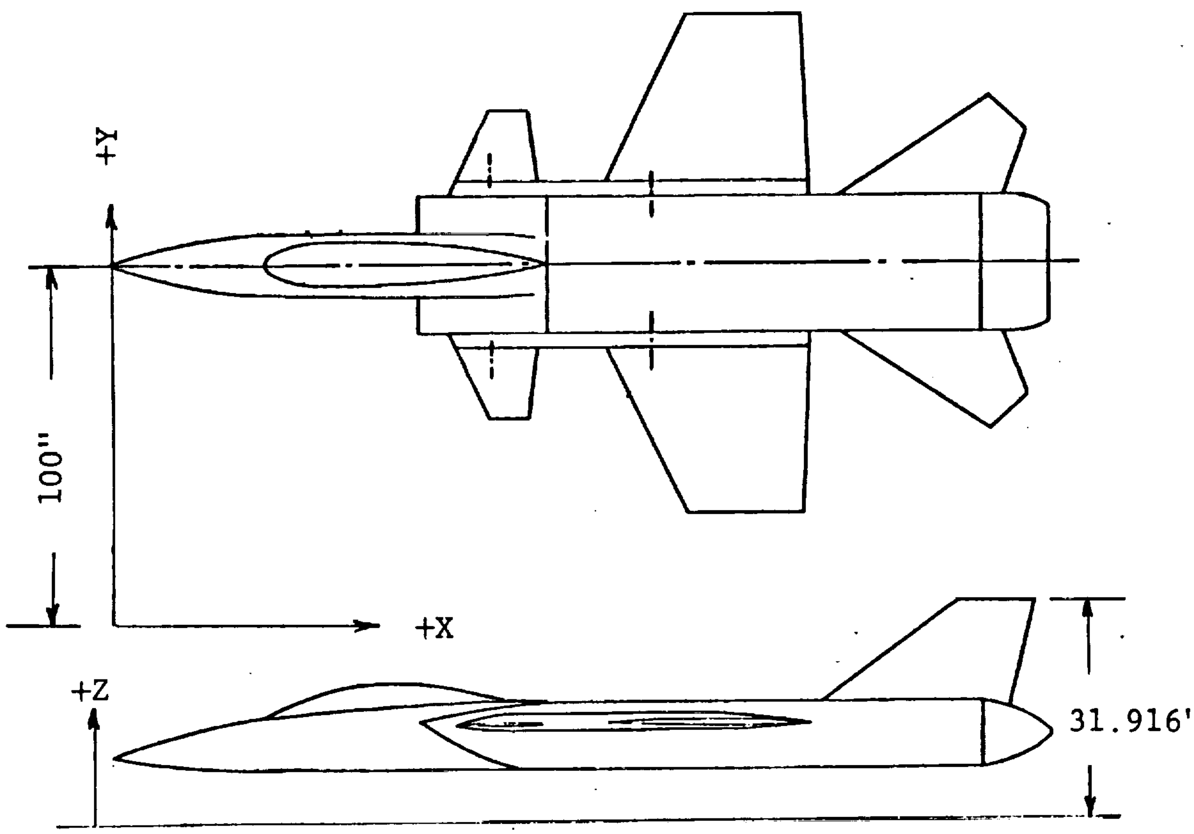
The third conclusion is that because the vast majority of the response to gust comes from the very low frequency range where the model frequencies associated with the tunnel mount system lie in the same frequency range as the natural rigid body modes of the vehicle in the airstream, the response in these natural rigid body modes may be clouded. It would be desirable to either be able to analytically subtract out of the total response that portion which is due to the natural frequencies of the mount system or else eliminate from the test results all of the response due to the presence of mount system natural frequencies.

APPENDIX

(This appendix contains geometry and mass data plus plotted analytical results)

FIGURE 16

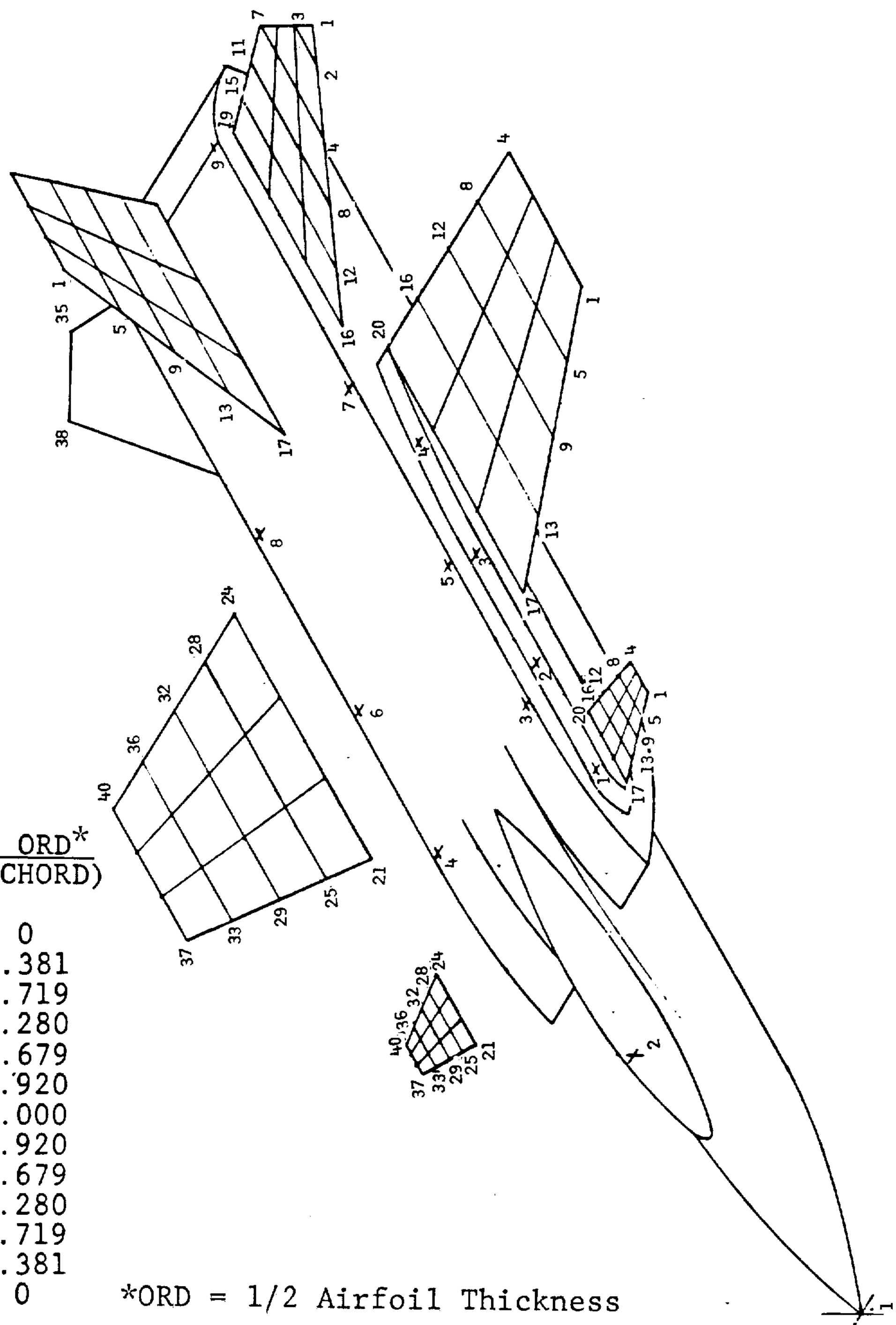
AXIS SYSTEM FOR TFW ANALYSES



Note: Distances shown
are in inches.

FIGURE 17

GVT MODE SHAPE READING POINTS
AND WING AIRFOIL GEOMETRY



DIST AFT L.E. (% CHORD)	ORD* (% CHORD)
0	0
5	.381
10	.719
20	1.280
30	1.679
40	1.920
50	2.000
60	1.920
70	1.679
80	1.280
90	.719
95	.381
100	0

*ORD = 1/2 Airfoil Thickness

TABLE 12

GROUND VIBRATION TEST MODE SHAPE POINT GEOMETRY

GROUND VIBRATION TEST MODE SHAPE POINTS	X	Y	X	Y	X	Y	X	Y
LEFT CANARD								
1-4	+52.545	+81.14	+53.942	+81.14	+55.338	+81.14	+56.735	+81.14
5-8	+51.638	+83.0	+53.415	+83.0	+55.191	+83.0	+56.968	+83.0
9-12	+50.73	+84.86	+52.887	+84.86	+55.043	+84.86	+57.2	+84.86
13-16	+49.823	+86.72	+52.36	+86.72	+54.896	+86.72	+57.433	+86.72
17-20	+48.915	+88.58	+51.832	+88.58	+54.748	+88.58	+57.665	+88.58
RIGHT CANARD								
21-24	+48.915	+111.42	+51.832	+111.42	+54.748	+111.42	+57.665	+111.42
25-28	+49.823	+113.28	+52.36	+113.28	+54.896	+113.28	+57.433	+113.28
29-32	+50.73	+115.14	+52.887	+115.14	+55.043	+115.14	+57.2	+115.14
33-36	+51.638	+117.0	+53.415	+117.0	+55.191	+117.0	+56.968	+117.0
37-40	+52.545	+118.86	+53.942	+118.86	+55.338	+118.86	+56.735	+118.86
LEFT WING								
1-4	+81.289	+65.853	+86.228	+65.853	+91.168	+65.853	+96.107	+65.853
5-8	+78.204	+71.535	+84.227	+71.535	+90.25	+71.535	+96.272	+71.535
9-12	+75.119	+77.217	+82.225	+77.217	+89.331	+77.217	+96.437	+77.217
13-16	+72.034	+82.898	+80.224	+82.898	+88.413	+82.898	+96.602	+82.898
17-20	+68.949	+88.58	+78.222	+88.58	+87.494	+88.58	+96.767	+88.58
RIGHT WING								
21-24	+68.949	+111.42	+78.222	+111.42	+87.494	+111.42	+96.767	+111.42
25-28	+72.034	+117.102	+80.224	+117.102	+88.413	+117.102	+96.602	+117.102
29-32	+75.119	+122.784	+82.2251	+122.784	+89.331	+122.784	+96.437	+122.784
33-36	+78.204	+128.465	+84.227	+128.465	+90.250	+128.465	+96.272	+128.465
37-40	+81.289	+134.147	+86.228	+134.147	+91.168	+134.147	+96.107	+134.147
LEFT H.T.								
1-3a	+122.85	+77.125	+120.364	+78.729	+124.102	+78.729	+125.355	+80.334
4-7	+115.392	+81.958	+120.147	+81.938	+124.017	+81.938	+126.607	+81.938
8-11	+110.859	+84.825	+116.529	+84.825	+121.609	+84.825	+125.836	+84.825
12-15	+106.327	+87.713	+112.912	+87.713	+119.202	+87.713	+125.065	+87.713
16-19	+101.794	+90.6	+109.294	+90.6	+116.794	+90.6	+124.294	+90.6
RIGHT H.T.								
20-23	+101.794	+109.4	+109.294	+109.4	+116.794	+109.4	+124.294	+109.4
24-27	+106.327	+112.287	+112.912	+112.287	+119.202	+112.287	+125.065	+112.287
28-31	+110.859	+115.175	+116.529	+115.175	+121.609	+115.175	+125.836	+115.175
32-35	+115.392	+118.062	+120.147	+118.062	+124.017	+118.062	+126.607	+118.062
36,37,37a,38	+120.364	+121.27	+124.102	+121.270	+125.355	+119.666	+122.85	+122.875
VERTICAL TAIL *								
1-4	+117.307	+31.916	+120.961	+31.916	+124.616	+31.356	+128.27	+31.916
5-8	+112.538	+28.577	+117.503	+28.577	+122.468	+28.577	+127.433	+28.577
9-12	+107.77	+25.238	+114.045	+25.238	+120.32	+25.238	+126.595	+25.238
13-16	+103.001	+21.899	+110.586	+21.899	+118.172	+21.899	+125.758	+21.899
17-20	+98.232	+18.56	+107.128	+18.56	+116.024	+18.56	+124.92	+18.56

TABLE 12 (cont)

GROUND VIBRATION TEST MODE SHAPE POINTS	X	Y	X	Y	X	Y	X	Y
FUSELAGE VERTICAL								
1-4	+0.0	+100.0	+30.32	+100.0	+60.0	+91.0	+60.0	+109.0
5-8	+75.0	+91.0	+75.0	+109.0	+96.0	+91.0	+96.0	+109.0
9-10	+121.0	+91.0	+121.0	+109.0				
FUSELAGE LATERAL *								
1,2,3,5	+0.0	+11.06	+30.32	+20.0	+60.0	+18.56	+75.0	+18.56
7,9	+96.0	+18.56	+121.0	+18.56				
LEFT BOOM								
1-4	+52.0	+89.6	+63.23	+89.6	+74.45	+89.6	+87.25	+89.6
RIGHT BOOM								
5-8	+52.0	+110.4	+63.23	+110.4	+74.45	+110.4	+87.25	+110.4

* Values listed as Y for these surfaces are Z values

TABLE 13

WEIGHT AT GROUND VIBRATION TEST POINTS

POINT NO.	WEIGHT (Lb.)	POINT NO.	WEIGHT (Lb.)	POINT NO.	WEIGHT (Lb.)	POINT NO.	WEIGHT (Lb.)	POINT NO.	WEIGHT (Lb.)
LEFT CANARD		LEFT WING		LEFT H.T.		VERTICAL TAIL		FUSELAGE LATERAL	
1	.008	1	.061	1	.012	1	.030	1	15.87
2	.017	2	.256	2	.027	2	.060	2	33.55
3	.017	3	.216	3	.044	3	.060	3	47.72
4	.008	4	.065	3a	.020	4	.030	5	36.21
5	.020	5	.161	4	.051	5	.069	7	26.15
6	.040	6	.638	5	.072	6	.137	9	25.46
7	.040	7	.542	6	.065	7	.137	LEFT BOOM	
8	.020	8	.128	7	.021	8	.069	1	3.2
9	.025	9	.174	8	.057	9	.087	2	2.0
10	.049	10	.853	9	.108	10	.172	3	1.6
11	.049	11	.712	10	.094	11	.172	4	.816
12	.025	12	.159	11	.043	12	.087	RIGHT BOOM	
13	.029	13	.408	12	.066	13	.104	5	3.2
14	.065	14	1.096	13	.131	14	.209	6	2.0
15	.020	15	.912	14	.123	15	.209	7	1.6
16	.029	16	.185	15	.059	16	.104	8	.816
17	.016	17	.260	16	.037	17	.059		
18	.051	18	1.142	17	.073	18	.118		
19	.040	19	1.184	18	.072	19	.118		
20	.016	20	.128	19	.036	20	.059		
RIGHT CANARD		RIGHT WING		RIGHT H.T.		FUSELAGE VERTICAL			
21	.016	21	.247	20	.037	1	15.87		
22	.051	22	1.115	21	.073	2	33.55		
23	.040	23	1.177	22	.072	3	19.47o		
24	.016	24	.115	23	.036	4	19.47		
25	.029	25	.383	24	.066	5	10.18		
26	.065	26	1.047	25	.131	6	10.18		
27	.020	27	.863	26	.123	7	8.51		
28	.029	28	.160	27	.059	8	8.51		
29	.025	29	.153	28	.057	9	12.22		
30	.049	30	.810	29	.108	10	12.22		
31	.049	31	.669	30	.094				
32	.025	32	.138	31	.043				
33	.020	33	.143	32	.051				
34	.040	34	.602	33	.072				
35	.040	35	.506	34	.065				
36	.020	36	.110	35	.021				
37	.008	37	.053	36	.027				
38	.017	38	.240	37	.044				
39	.017	39	.200	37a	.020				
40	.008	40	.049	38	.012				

TABLE 14

NASTRAN GRID POINT GEOMETRY

GRID POINT NUMBERS	X	Y	X	Y	X	Y	X	Y	X	Y
1-5	+9576700+ 2	+6585000+ 2	+9241700+ 2	+6585000+ 2	+8941700+ 2	+6585000+ 2	+8641700+ 2	+6585000+ 2	+8341700+ 2	+6585000+ 2
6-10	+8166700+ 2	+6585000+ 2	+9586700+ 2	+6928000+ 2	+9202700+ 2	+6928000+ 2	+8903700+ 2	+6928000+ 2	+8603700+ 2	+6928000+ 2
12-16	+8181700+ 2	+6928000+ 2	+7981700+ 2	+6928000+ 2	+9596700+ 2	+7241000+ 2	+9166700+ 2	+7241000+ 2	+8866700+ 2	+7241000+ 2
17-21	+8565700+ 2	+7241000+ 2	+8265700+ 2	+7241000+ 2	+8038700+ 2	+7241000+ 2	+7808700+ 2	+7241000+ 2	+9604700+ 2	+7558000+ 2
22-26	+9130700+ 2	+7558000+ 2	+8830700+ 2	+7558000+ 2	+8528700+ 2	+7558000+ 2	+8226700+ 2	+7558000+ 2	+7892700+ 2	+7558000+ 2
27-31	+7636700+ 2	+7558000+ 2	+9613700+ 2	+7678000+ 2	+9094700+ 2	+7878000+ 2	+8794700+ 2	+7878000+ 2	+8491700+ 2	+7878000+ 2
32,34-37	+8190700+ 2	+7878000+ 2	+7743700+ 2	+7878000+ 2	+7466700+ 2	+7878000+ 2	+9621700+ 2	+8198000+ 2	+9056700+ 2	+8198000+ 2
38-42	+8756700+ 2	+8198000+ 2	+8455700+ 2	+8198000+ 2	+8153700+ 2	+8198000+ 2	+7836700+ 2	+8198000+ 2	+7598700+ 2	+8198000+ 2
43-47	+7291700+ 2	+8198000+ 2	+9630700+ 2	+8515000+ 2	+9018700+ 2	+8515000+ 2	+8718700+ 2	+8515000+ 2	+8416700+ 2	+8515000+ 2
48-51,56	+8116700+ 2	+8515000+ 2	+7798700+ 2	+8515000+ 2	+7451700+ 2	+8515000+ 2	+7121700+ 2	+8515000+ 2	+9638700+ 2	+8833000+ 2
57,59-62	+8981700+ 2	+8833000+ 2	+8416700+ 2	+8858000+ 2	+8116700+ 2	+8958000+ 2	+7661700+ 2	+8858000+ 2	+7296700+ 2	+8858000+ 2
63,71,73,76,77	+6936700+ 2	+8858000+ 2	+8907000+ 2	+8958000+ 2	+8119000+ 2	+8958000+ 2	+7444900+ 2	+8958000+ 2	+6330000+ 2	+8958000+ 2
78,82,84,86,88	+5219500+ 2	+8958000+ 2	+5066500+ 2	+8858000+ 2	+5219500+ 2	+8958000+ 2	+5416500+ 2	+8858000+ 2	+5766500+ 2	+8858000+ 2
90,92,94,96,98	+5121500+ 2	+8708000+ 2	+5278500+ 2	+8708000+ 2	+5434500+ 2	+8708000+ 2	+5747500+ 2	+8708000+ 2	+5176500+ 2	+8556000+ 2
100,102,104,106,108	+5451500+ 2	+8558000+ 2	+5729500+ 2	+8558000+ 2	+5230500+ 2	+8408000+ 2	+5469500+ 2	+8408000+ 2	+5711500+ 2	+8408000+ 2
110,112,114,116,118	+5285500+ 2	+8258000+ 2	+5488500+ 2	+8258000+ 2	+5691500+ 2	+8258000+ 2	+5337500+ 2	+8114000+ 2	+5505500+ 2	+8114000+ 2
120,131-134	+5673500+ 2	+8114000+ 2	+1000000+ 2	+1000000+ 3	+2100000+ 2	+1000000+ 3	+3150000+ 2	+1000000+ 3	+4252000+ 2	+1000000+ 3
135-139	+6019000+ 2	+1000000+ 3	+7444900+ 2	+1000000+ 3	+7444900+ 2	+1553000+* 2	+8600000+ 2	+1000000+ 3	+9750000+ 2	+1000000+ 3
140-144	+1095000+ 3	+1000000+ 3	+1206600+ 3	+1000000+ 3	+1155800+ 3	+1126200+ 3	+1155800+ 3	+8738000+ 2	+1138390+ 3	+2046000+* 2
152,154,156,158,160	+5337500+ 2	+1188600+ 3	+5505500+ 2	+1188600+ 3	+5673500+ 2	+1188600+ 3	+5285500+ 2	+1174200+ 3	+5488500+ 2	+1174200+ 3

GRID NOS:			
Left Wing	1-63	VT	144
Left Boom	71-78	Rt Can	151-190
Left Canard	81-120	Rt Boom	191-198
Fus	131-141	Rt Wing	201-263
RHT	142	TOTAL =	189 Grid Points
LHT	143	EX.:	+9576700 + 2 = +95.767 inches

* = Z value

TABLE 14 (cont)

GRID POINT NUMBERS	X	Y	X	Y	X	Y	X	Y	X	Y
162,164,166,168,170	+5691500+ 2	+1174200+ 3	+5230500+ 2	+1159200+ 3	+5469500+ 2	+1159200+ 3	+5711500+ 2	+1159200+ 3	+5176500+ 2	+1144200+ 3
172,174,176,178,180	+5451500+ 2	+1144200+ 3	+5729500+ 2	+1144200+ 3	+5121500+ 2	+1129200+ 3	+5278500+ 2	+1129200+ 3	+5434500+ 2	+1129200+ 3
182,184,186,188,190	+5747500+ 2	+1129200+ 3	+5066500+ 2	+1114200+ 3	+5219500+ 2	+1114200+ 3	+5416500+ 2	+1114200+ 3	+5766500+ 2	+1114200+ 3
191,192,193,196,198	+5219500+ 2	+1104200+ 3	+6330000+ 2	+1104200+ 3	+7444900+ 2	+1104200+ 3	+8119000+ 2	+1104200+ 3	+8907000+ 2	+1104200+ 3
201-205	+6936700+ 2	+1114200+ 3	+7296700+ 2	+1114200+ 3	+7661700+ 2	+1114200+ 3	+8116700+ 2	+1114200+ 3	+8416700+ 2	+1114200+ 3
207,208,213-215	+8981700+ 2	+1116700+ 3	+9638700+ 2	+1116700+ 3	+7121700+ 2	+1148500+ 3	+7451700+ 2	+1148500+ 3	+7798700+ 2	+1148500+ 3
216-220	+8116700+ 2	+1148500+ 3	+8416700+ 2	+1148500+ 3	+8718700+ 2	+1148500+ 3	+9018700+ 2	+1148500+ 3	+9630700+ 2	+1148500+ 3
221-225	+7291700+ 2	+1180200+ 3	+7598700+ 2	+1180200+ 3	+7836700+ 2	+1180200+ 3	+8153700+ 2	+1180200+ 3	+8455700+ 2	+1180200+ 3
226-228,229,230	+8756700+ 2	+1180200+ 3	+9056700+ 2	+1180200+ 3	+9621700+ 2	+1180200+ 3	+7466700+ 2	+1212200+ 3	+7743700+ 2	+1212200+ 3
232-236	+8190700+ 2	+1212200+ 3	+8491700+ 2	+1212200+ 3	+8794700+ 2	+1212200+ 3	+9094700+ 2	+1212200+ 3	+9613700+ 2	+1212200+ 3
237-241	+7636700+ 2	+1244200+ 3	+7892700+ 2	+1244200+ 3	+8226700+ 2	+1244200+ 3	+8528700+ 2	+1244200+ 3	+8830700+ 2	+1244200+ 3
242,243,244-246	+9130700+ 2	+1244200+ 3	+9604700+ 2	+1244200+ 3	+7808700+ 2	+1275900+ 3	+8038700+ 2	+1275900+ 3	+8265700+ 2	+1275900+ 3
247-250,251	+8965700+ 2	+1275900+ 3	+8866700+ 2	+1275900+ 3	+9166700+ 2	+1275900+ 3	+9596700+ 2	+1275900+ 3	+7981700+ 2	+1307200+ 3
253-257	+8181700+ 2	+1307200+ 3	+8603700+ 2	+1307200+ 3	+8903700+ 2	+1307200+ 3	+9202700+ 2	+1307200+ 3	+9586700+ 2	+1307200+ 3
258-262	+8166700+ 2	+1341500+ 3	+8351700+ 2	+1341500+ 3	+8641700+ 2	+1341500+ 3	+8941700+ 2	+1341500+ 3	+9241700+ 2	+1341500+ 3
263,143,142,131†132*	+9576700+ 2	+1341500+ 3	+1050000+ 3	+8738000+ 2	+1050000+ 3	+1126200+ 3	+1000000+ 2	+1158000+ 2	+2100000+ 2	+1268000+ 2
133*-136†138*	+3150000+ 2	+1326000+ 2	+4252000+ 2	+1378000+ 2	+6019000+ 2	+1392000+ 2	+7444900+ 2	+1392000+ 2	+8600000+ 2	+1392000+ 2
139*-141†144*	+9750000+ 2	+1392000+ 2	+1C95000+ 3	+1392000+ 2	+1206600+ 3	+1392000+ 2	+1038390+ 3	+2C46000+ 2 1	0+ 0	

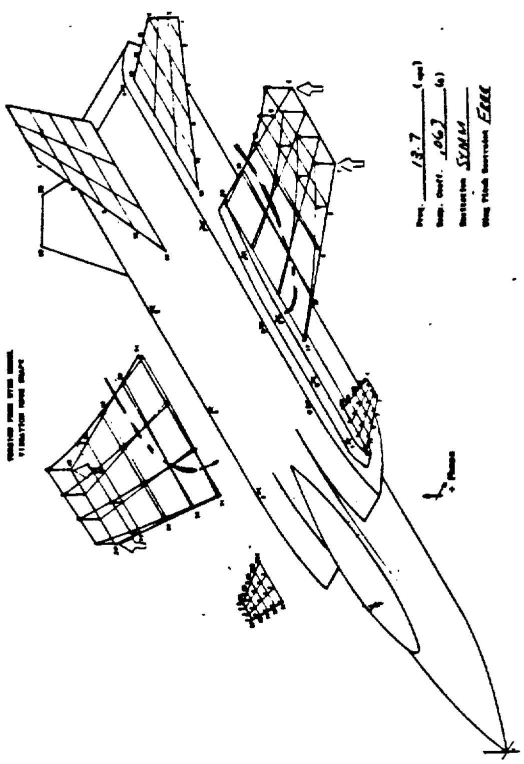
* Distances listed are X and Z

Note: Grid Point Geometry values are in inches.

FIGURE 18

TFW GROUND VIBRATION TEST MODES

(WING FREE)



TORSION FREE WING MODEL
VIBRATION TEST DATA

Model Weight ______
Date 8/1/71
Norm. Accel. Pt. W4
Wing Pitch Restraint FREE
Frequency 13.7 cps
Damp. Coeff. .063 (g)
Excitation SYMM

Wing

Point	Pha.	Ampl.
1	+	.77
2	+	.81
3	+	.92
4	+	1.0
5	+	.43
6	+	.49
7	+	.52
8	+	.57
9	+	.12
10	+	.17
11	+	.15
12	+	.16
13	+	.02
14		0
15	–	.02
16	–	.05
17	+	.02
18	–	.04
19	–	.07
20	–	.14
21	+	.04
22	–	.04
23	–	.11
24	–	.18
25	+	.05
26		0
27	–	.05
28	–	.11
29	+	.15
30	+	.17
31	+	.16
32	+	.11
33	+	.44
34	+	.47
35	+	.45
36	+	.59
37	+	.73
38	+	.83
39	+	.87
40	+	.92

Horiz. Tail

Point	Pha.	Ampl.
1	–	.04
2	–	.04
3	–	.05
3a	–	.05
4	–	.04
5	–	.04
6	–	.04
7	–	.04
8	–	.04
9	–	.04
10	–	.04
11	–	.04
12	–	.03
13	–	.04
14	–	.03
15	–	.04
16	–	.03
17	–	.03
18	–	.04
19	–	.03
20	–	.05
21	–	.03
22	–	.04
23	–	.05
24	–	.03
25	–	.03
26	–	.03
27	–	.04
28	–	.03
29	–	.03
30	–	.03
31	–	.03
32	–	.03
33	–	.03
34	–	.03
35	–	.04
36	–	.03
37	–	.03
37a	–	.03
38	–	.04

Vert. Tail

Point	Pha.	Ampl.
1		0
2		
3		
4	+	.01
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Trim Surf.

Point	Pha.	Ampl.
1	+	.14
2	+	.13
3	+	.12
4	+	.12
5	+	.13
6	+	.12
7	+	.12
8	+	.11
9	+	.13
10	+	.12
11	+	.11
12	+	.10
13	+	.13
14	+	.11
15	+	.10
16	+	.09
17	+	.12
18	+	.12
19	+	.10
20	+	.08
21	+	.23
22	+	.20
23	+	.17
24	+	.15

Fus.

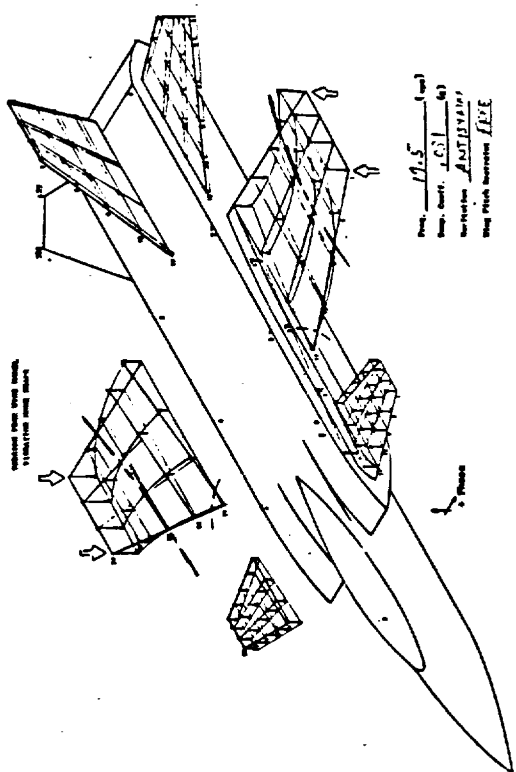
Point	Pha.	Ampl.
1V	–	.017
1L	–	.024
2V	–	.020
2L		0
3V	–	.022
3L	+	.007
4V	–	.015
5V	–	.026
5L	+	.006
6V	–	.012
7V	–	.011
7L	+	.007
8V	–	.025
9V	–	.027
9L	+	.006
10V	–	[illegible]

Boom

Point	Pha.	Ampl.
1	+	.15
2	+	.05
3	–	.02
4	–	.05
5	+	.25
6	+	.15
7	–	.02
8	–	.13

Trim Surf.

Point	Pha.	Ampl.
25	+	.23
26	+	.20
27	+	.19
28	+	.16
29	+	[illegible]
30	+	.22
31	+	.19
32	+	.18
33	+	[illegible]
34	+	.22
35	+	.21
36	+	.20
37	+	.27
38	+	.27
39	+	.21
40	+	.22
41		
42		



TORSION FREE WING MODEL
VIBRATION TEST DATA

Model Weight ______
Date 8/1/71
Norm. Accel. Pt. W4
Wing Pitch Restraint FREE
Frequency [illegible] cps
Damp. Coeff. [illegible] (g)
Excitation [illegible]

Wing

Point	Pha.	Ampl.
1	+	.55
2	+	.57
3	+	.58
4	+	1.00
5	+	.37
6	+	.40
7	+	.42
8	+	.32
9	–	.07
10	–	.09
11	–	.12
12	–	.27
13	–	.67
14	–	.22
15	–	.45
16	–	.61
17	+	.07
18	–	.11
19	–	.62
20	–	.72
21	–	.02
22	+	.13
23	+	.40
24	+	.65
25	+	.07
26	+	.12
27	+	.31
28	+	.02
29		0
30	+	.03
31	+	.01
32	+	.11
33	–	.44
34	–	.41
35	–	.41
36	–	.43
37	–	1.03
38	–	1.06
39	–	1.07
40	–	1.10

Horiz. Tail

Point	Pha.	Ampl.
1	–	.26
2	–	.23
3	–	.24
3a	–	.31
4	–	.31
5	–	.30
6	–	.16
7	–	.20
8	–	.17
9	–	.17
10	–	.16
11	–	.16
12	–	.13
13	–	.13
14	–	.14
15	–	.13
16	–	.10
17	–	.12
18	–	.13
19	–	.10
20	+	.10
21	+	.11
22	+	.11
23	+	.11
24	+	.13
25	+	.14
26	+	.15
27	+	.15
28	+	.17
29	+	.18
30	+	.19
31	+	.19
32	+	.21
33	+	.32
34	+	.31
35	+	.31
36	+	.36
37	+	.39
37a	+	.34
38	+	[illegible]

Vert. Tail

Point	Pha.	Ampl.
1	+	.15
2	+	.17
3	+	.16
4	+	.16
5	+	.11
6	+	.17
7	+	.13
8	+	.13
9	+	.05
10	+	.10
11	+	.05
12	+	.10
13	+	.07
14	+	.05
15	+	.06
16	+	.06
17	+	.03
18	+	.03
19	+	.03
20	+	.04

Trim Surf.

Point	Pha.	Ampl.
1	+	.47
2	+	.41
3	+	.46
4	+	.37
5	+	.46
6	+	.44
7	+	.35
8	+	.34
9	+	.45
10	+	.47
11	+	.57
12	+	.53
13	+	.57
14	+	.47
15	+	.35
16	+	.51
17	+	.54
18	+	.47
19	+	.36
20	+	.38
21	–	.57
22	–	.47
23	–	.35
24	–	.37

Fus.

Point	Pha.	Ampl.
1V		0
1L		0
2V		0
2L	+	.07
3V	–	.09
3L	–	.07
4V	+	.07
5V	–	.09
5L	+	.09
6V	+	.07
7V	–	.07
7L	+	.09
8V	+	.07
9V	–	.09
9L	+	.05
10V	–	.07

Boom

Point	Pha.	Ampl.
1	+	.46
2	+	.16
3	–	.11
4	–	.46
5	–	.49
6	–	.10
7	+	.09
8	+	.41

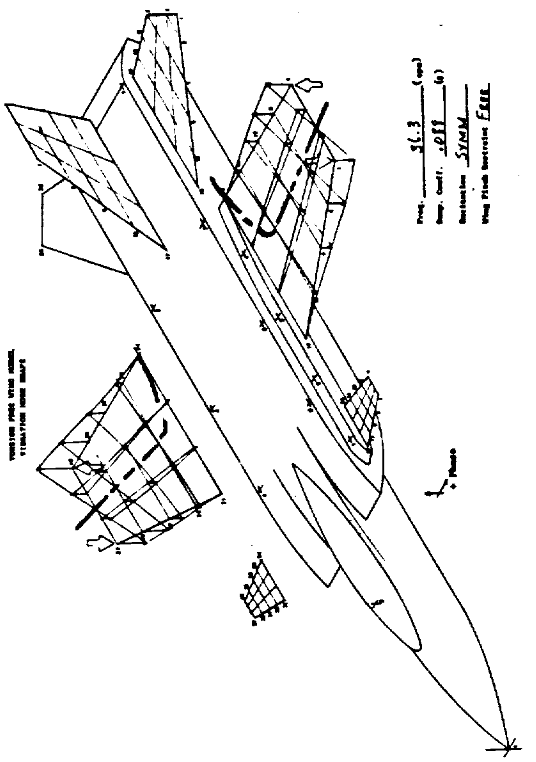
Trim Surf.

Point	Pha.	Ampl.
25	–	.32
26	–	.47
27	–	.38
28	–	.39
29	–	.32
30	–	.40
31	–	.37
32	–	.31
33	–	.33
34	–	.45
35	–	.43
36	–	.31
37	–	.43
38	–	.43
39	–	.47
40	–	.31
41		
42		

FIGURE 18 (continued)

TFW GROUND VIBRATION TEST MODES

(WING FREE)



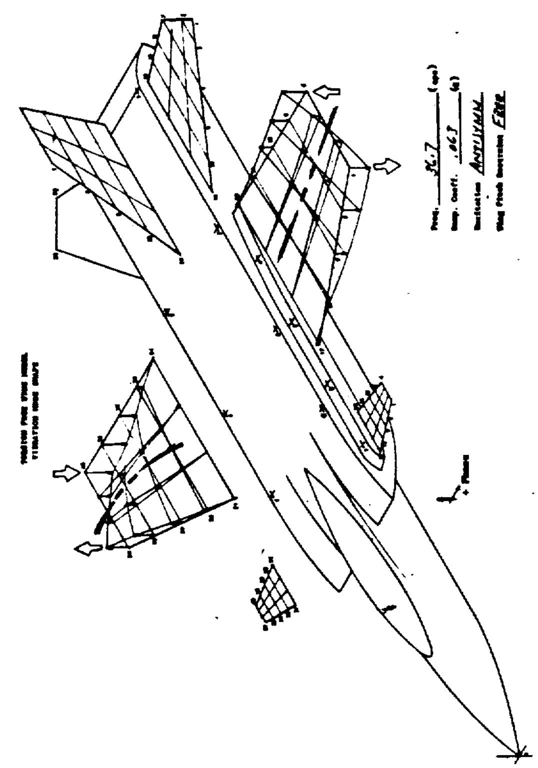
TORSION FREE WING MODEL
VIBRATION TEST DATA

Model Weight ______
Date 8/1/78
Norm. Accel. Pt. W4

Wing Pitch Restraint FREE

Frequency 36.3 cps
Damp. Coeff. .082 (g)
Excitation SYMM

Wing			Horiz. Tail			Vert. Tail			Fus.		
Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.
1	−	.73	1		0	1	+	.01	1V	+	.06
2	−	.21	2		0	2			1L		0
3	+	.35	3		0	3			2V	+	.002
4	+	1.0	3a		0	4	+	.01	2L		0
5	−	.70	4		0	5			3V	−	.002
6	−	.27	5		0	6			3L		0
7	+	.23	6		0	7			4V	+	.002
8	+	.82	7		0	8			5V	−	.003
9	−	.35	8		0	9			5L		0
10	−	.21	9		0	10			6V	+	.002
11	+	.05	10		0	11			7V		0
12	+	.51	11		0	12			7L		0
13	−	.09	12		0	13			8V	+	.004
14	−	.08	13		0	14			9V	+	.005
15	+	.01	14		0	15			9L		0
16	+	.15	15		0	16			10V	+	.002
17		0	16		0	17			Boom		
18	−	.02	17		0	18			1	+	.02
19	−	.02	18		0	19			2	+	.01
20		0	19	+	.005	20			3	−	.01
21		0	20	+	.01	Trim Surf.			4	−	.02
22	−	.02	21	+	.013	1	+	.02	5	+	.04
23	−	.02	22	+	.017	2	+	.02	6	+	.02
24		0	23	+	.02	3	+	.02	7		0
25	−	.13	24	+	.017	4	+	.02	8	−	.02
26	−	.12	25	+	.019	5	+	.02	Trim Surf.		
27	+	.02	26	−	.014	6	+	.02	25	+	.04
28	+	.30	27	+	.02	7	+	.02	26	+	.04
29	−	.56	28	+	.021	8	+	.02	27	+	.03
30	−	.35	29	+	.026	9	+	.02	28	+	.03
31	+	.14	30	+	.018	10	+	.02	29	+	.04
32	+	.75	31	+	.03	11	+	.02	30	+	.03
33	−	1.0	32	+	.03	12	+	.02	31	+	.03
34	−	.45	33	+	.02	13	+	.03	32	+	.03
35	+	.36	34	+	.02	14	+	.03	33	+	.03
36	+	1.15	35	+	.03	15	+	.02	34	+	.03
37	−	1.10	36	+	.019	16	+	.02	35	+	.03
38	−	.37	37	+	.011	17	+	.03	36	+	.03
39	+	.62	37a	+	.031	18	+	.02	37	+	.03
40	+	1.40	38	+	.04	19	+	.02	38	+	.03
						20	+	.02	39	+	.03
						21	+	.04	40	+	.03
						22	+	.04	41		
						23	+	.03	42		
						24	+	.03			



TORSION FREE WING MODEL
VIBRATION TEST DATA

Model Weight ______
Date 8/1/78
Norm. Accel. Pt. W4

Wing Pitch Restraint FREE

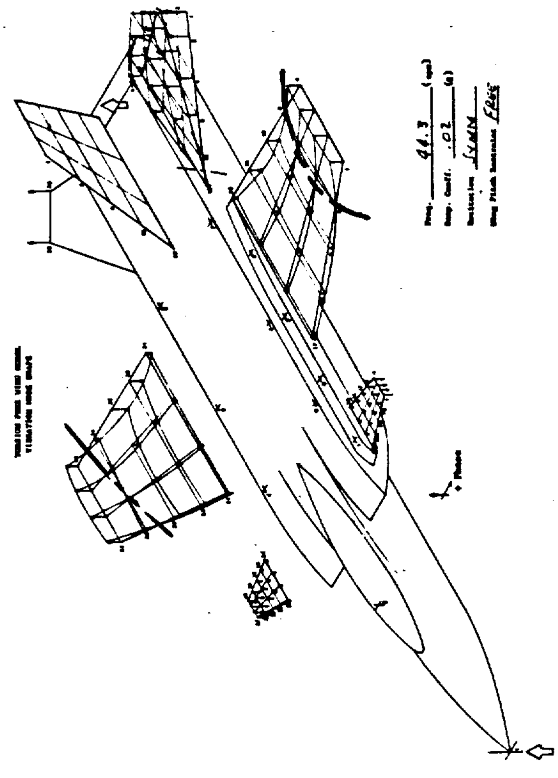
Frequency 36.7 cps
Damp. Coeff. .063 (g)
Excitation ANTISYMM

Wing			Horiz. Tail			Vert. Tail			Fus.		
Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.
1	−	.77	1	+	.07	1	−	.02	1V	−	.008
2	−	.25	2	+	.06	2	−	.02	1L	+	.003
3	+	.32	3	+	.06	3	−	.02	2V		0
4	+	1.0	3a	+	.05	4	−	.02	2L	−	.007
5	−	.73	4	+	.05	5	−	.015	3V	+	.007
6	−	.30	5	+	.05	6	−	.013	3L	−	.004
7	+	.27	6	+	.05	7	−	.015	4V	−	.006
8	+	.72	7	+	.05	8	−	.015	5V	+	.008
9	−	.37	8	+	.04	9	−	.011	5L	−	.003
10	−	.21	9	+	.04	10	−	.01	6V	−	.009
11	+	.10	10	+	.04	11	−	.011	7V	+	.006
12	+	.50	11	+	.04	12	−	.011	7L	−	.003
13	−	.07	12	+	.03	13	−	.007	8V	−	.007
14	−	.07	13	+	.03	14	−	.007	9V	+	.006
15	+	.03	14	−	.03	15	−	.007	9L	−	.004
16	+	.22	15	−	.03	16	−	.007	10V	−	.009
17	+	.01	16	+	.01	17	−	.003	Boom		
18		0	17	−	.02	18	−	.003	1	+	.02
19		0	18	−	.03	19	−	.003	2	+	.03
20	+	.02	19	+	.03	20	−	.002	3	+	.01
21	−	.01	20	−	.01	Trim Surf.			4	−	.005
22		0	21	−	.02	1	+	.06	5	−	.06
23	+	.01	22	−	.03	2	+	.06	6	−	.03
24		0	23	−	.04	3	+	.06	7		0
25	+	.09	24	−	.02	4	+	.06	8	+	.01
26	+	.08	25	−	.02	5	+	.06	Trim Surf.		
27	−	.03	26	−	.04	6	+	.06	25	−	.05
28	−	.34	27	−	.04	7	+	.05	26	−	.05
29	+	.46	28	−	.05	8	+	.05	27	−	.05
30	+	.27	29	−	.05	9	+	.05	28	−	.04
31	−	.14	30	−	.05	10	+	.05	29	−	.05
32	−	.65	31	−	.05	11	+	.05	30	−	.05
33	+	.80	32	−	.06	12	+	.05	31	−	.05
34	+	.37	33	−	.06	13	+	.05	32	−	.04
35	−	.32	34	−	.06	14	+	.05	33	−	.06
36	−	.97	35	−	.06	15	+	.05	34	−	.06
37	+	.84	36	−	.08	16	+	.04	35	−	.05
38	+	.30	37	−	.08	17	+	.03	36	−	.05
39	−	.47	37a	−	.07	18	+	.05	37	−	.06
40	−	1.07	38	−	.09	19	+	.04	38	−	.06
						20	+	.04	39	−	.06
						21	−	.05	40	−	.06
						22	−	.05	41		
						23	−	.04	42		
						24	−	.04			

FIGURE 18 (continued)

TFW GROUND VIBRATION TEST MODES

(WING FREE)



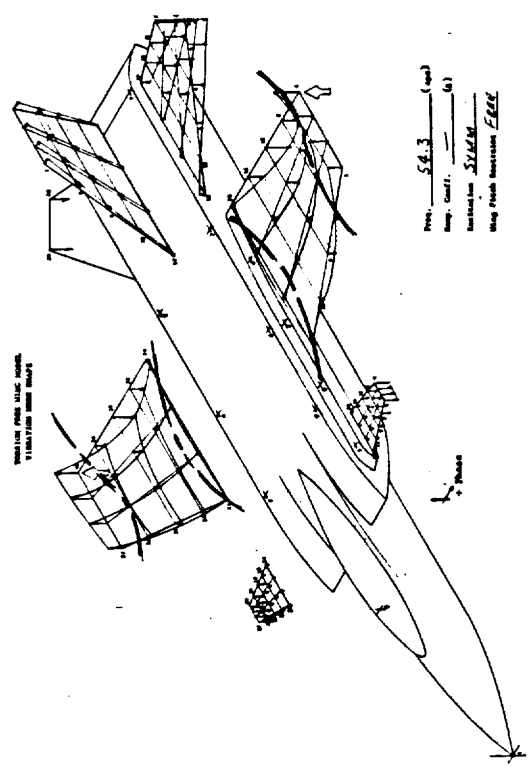
TORSION FREE WING MODEL
VIBRATION TEST DATA

Model Weight ______
Date 8/2/78
Norm. Accel. Pt. T7

Wing Pitch Restraint FREE

Frequency 44.3 cps
Damp. Coeff. .02 (g)
Excitation SYMM

Wing Point	Phs.	Ampl.	Horiz. Tail Point	Phs.	Ampl.	Vert. Tail Point	Phs.	Ampl.	Fus. Point	Phs.	Ampl.
1	+	.50	1	+	.97	1		0	1V	+	.25
2	+	.52	2	+	.87	2			1L	−	.016
3	+	.52	3	+	1.00	3			2V	+	.013
4	+	.47	3a	+	1.00	4	−	.03	2L		0
5		0	4	+	.67	5			3V	−	.11
6	+	.06	5	+	.78	6			3L	+	.062
7	+	.03	6	+	.91	7			4V	−	.11
8	−	.12	7	+	1.0	8			5V	−	.085
9	−	.23	8	+	.41	9			5L	+	.063
10	−	.18	9	+	.57	10			6V	−	.075
11	−	.17	10	+	.73	11			7V	+	.010
12	−	.52	11	+	.87	12			7L	−	.007
13	−	.15	12	+	.17	13			8V	+	.010
14	−	.19	13	+	.35	14			9V	+	.13
15	−	.27	14	+	.55	15			9L	−	.069
16	−	.38	15	+	.71	16			10V	+	.14
17	−	.10	16	−	.06	17			Boom		
18	−	.11	17	+	.19	18			1	−	.13
19	−	.15	18	+	.39	19			2	−	.10
20	−	.23	19	+	.57	20			3	−	.09
21	−	.10	20	−	.01	Trim Surf.			4	−	.13
22	−	.11	21	+	.14	1	−	.35	5	−	.13
23	−	.14	22	+	.29	2	−	.36	6	−	.10
24	−	.20	23	+	.47	3	−	.39	7	−	.09
25	−	.20	24	+	.19	4	−	.39	8	−	.11
26	−	.19	25	+	.73	5	−	.27	Trim Surf.		
27	−	.26	26	+	.48	6	−	.29	25	−	.16
28	−	.51	27	+	.58	7	−	.31	26	−	.18
29	−	.21	28	+	.39	8	−	.33	27	−	.19
30	−	.21	29	+	.51	9	−	.21	28	−	.22
31	−	.31	30	+	.59	10	−	.22	29	−	.23
32	−	.64	31	+	.73	11	−	.23	30	−	.25
33	+	.01	32	+	.55	12	−	.25	31	−	.26
34	+	.07	33	+	.67	13	−	.15	32	−	.25
35	−	.03	34	+	.67	14	−	.17	33	−	.30
36	−	.21	35	+	.11	15	−	.18	34	−	.32
37	+	.57	36	+	.73	16	−	.19	35	−	.34
38	+	.58	37	+	.80	17	−	.12	36	−	.35
39	+	.62	37a	+	.78	18	−	.13	37	−	.37
40	+	.42	38	+	.83	19	−	.12	38	−	.40
						20	−	.14	39	−	.40
						21	−	.12	40	−	.42
						22	−	.13	41		
						23	−	.14	42		
						24	−	.15			



TORSION FREE WING MODEL
VIBRATION TEST DATA

Model Weight ______
Date 8/2/78
Norm. Accel. Pt. W4

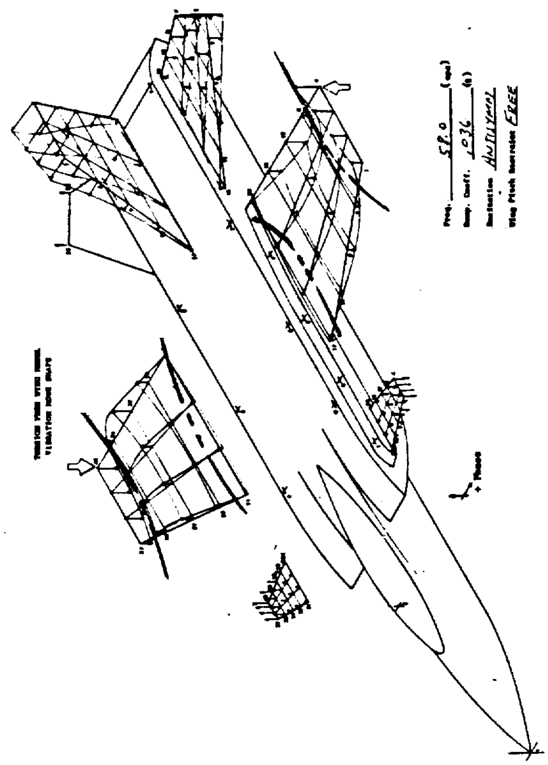
Wing Pitch Restraint FREE

Frequency 54.3 cps
Damp. Coeff. — (g)
Excitation SYMM

Wing Point	Phs.	Ampl.	Horiz. Tail Point	Phs.	Ampl.	Vert. Tail Point	Phs.	Ampl.	Fus. Point	Phs.	Ampl.
1	+	.58	1	−	.73	1	+	.13	1V	−	.092
2	+	.62	2	−	.77	2	+	.25	1L		0
3	+	.71	3	−	.61	3	+	.27	2V	+	.015
4	+	1.0	3a	−	.87	4	+	.30	2L		0
5		0	4	−	.45	5	+	.14	3V	+	.067
6		0	5	−	.42	6	+	.18	3L	−	.009
7	−	.29	6	−	.79	7	+	.21	4V	+	.055
8	−	.20	7	−	.88	8	+	.23	5V	+	.053
9	−	.37	8	−	.22	9	+	.07	5L	+	.004
10	−	.23	9	−	.39	10	+	.10	6V	+	.045
11	−	.41	10	−	.57	11	+	.14	7V	+	.042
12	−	1.02	11	−	.70	12	+	.17	7L	−	.006
13	−	.13	12	+	.02	13	+	.04	8V	+	.035
14	−	.12	13	−	.15	14	+	.04	9V	+	.035
15	−	.21	14	−	.36	15	+	.07	9L	+	.025
16	−	.25	15	−	.56	16	+	.07	10V	+	.047
17		0	16	+	.23	17	+	.01	Boom		
18	+	.05	17	+	.02	18	+	.02	1	−	.05
19	+	.05	18	−	.11	19	+	.02	2	−	.01
20	−	.04	19	−	.40	20	+	.03	3	+	.03
21		0	20	+	.17	Trim Surf.			4	+	.04
22	+	.03	21		0	1	−	.50	5	−	.06
23	+	.03	22	−	.14	2	−	.51	6	−	.02
24	−	.03	23	−	.33	3	−	.53	7	+	.03
25	−	.10	24	−	.04	4	−	.57	8	−	.05
26	−	.12	25	−	.16	5	−	.31	Trim Surf.		
27	−	.19	26	−	.32	6	−	.38	25	−	.11
28	−	.51	27	−	.44	7	−	.41	26	−	.14
29	−	.31	28	−	.25	8	−	.42	27	−	.15
30	−	.21	29	−	.37	9	−	.21	28	−	.17
31	−	.39	30	−	.50	10	−	.24	29	−	.21
32	−	.90	31	−	.63	11	−	.26	30	−	.22
33	−	.24	32	−	.51	12	−	.29	31	−	.25
34		0	33	−	.60	13	−	.14	32	−	.25
35	−	.15	34	−	.72	14	−	.15	33	−	.30
36	−	.43	35	−	.76	15	−	.15	34	−	.32
37	+	.53	36	−	.77	16	−	.18	35	−	.37
38	+	.63	37	−	.73	17	−	.09	36	−	.41
39	+	.73	37a	−	.71	18	−	.10	37	−	.40
40	+	.83	38	−	.77	19	−	.10	38	−	.45
						20	−	.09	39	−	.47
						21	−	.07	40	−	.51
						22	−	.09	41		
						23	−	.09	42		
						24	−	.10			

FIGURE 18 (continued)

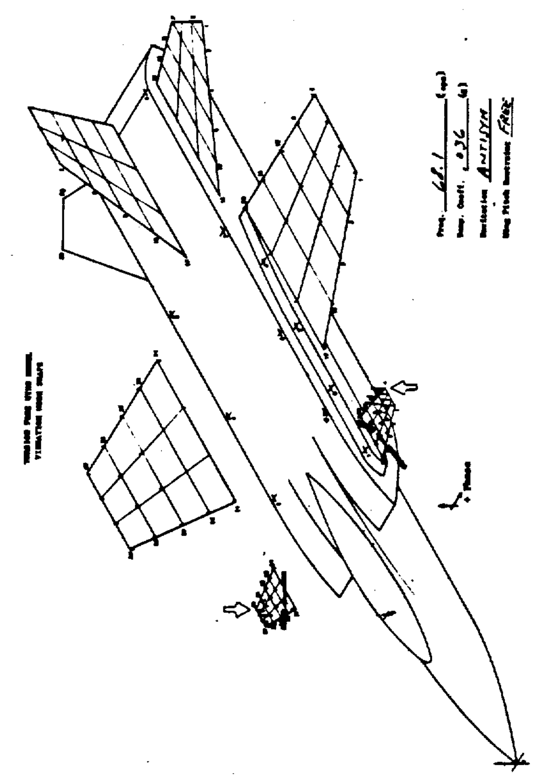
TFW GROUND VIBRATION TEST MODES
(WING FREE)



TORSION FREE WING MODEL
VIBRATION TEST DATA

Model Weight ______
Date 8/2/78
Norm. Accel. Pt. W4
Wing Pitch Restraint FREE
Frequency 58.0 cps
Damp. Coeff. .036 (g)
Excitation Antisym.

Wing			Horiz. Tail			Vert. Tail			Fus.		
Point	Phs.	Ampl.	Point	Phs.	Ampl.	Point	Phs.	Ampl.	Point	Phs.	Ampl.
1	+	.45	1	−	.70	1	−	1.02	1V		0
2	+	.64	2	−	.58	2	−	1.05	1L	−	.043
3	+	.80	3	−	.66	3	−	1.25	2V	+	.007
4	+	1.0	3a	−	.63	4	−	1.35	2L	−	.008
5	−	.27	4	−	.34	5	−	.65	3V	+	.063
6	−	.05	5	−	.46	6	−	.84	3L	−	.017
7	−	.11	6	−	.54	7	−	1.05	4V	−	.075
8	−	.33	7	−	.58	8	−	1.20	5V	+	.057
9	−	.33	8	−	.15	9	−	.30	5L	−	.010
10	−	.26	9	−	.27	10	−	.45	6V	−	.062
11	−	.40	10	−	.40	11	−	.67	7V	+	.063
12	−	.90	11	−	.50	12	−	.88	7L	−	.014
13	−	.07	12		0	13	−	.13	8V	−	.050
14	−	.10	13	−	.09	14	−	.18	9V	+	.058
15	−	.20	14	−	.24	15	−	.30	9L	−	.022
16	−	.57	15	−	.38	16	−	.47	10V	−	.037
17	+	.02	16	+	.20	17	−	.03	Boom		
18	+	.04	17		0	18	−	.06	1	−	.10
19	+	.03	18	−	.10	19	−	.10	2	−	.01
20	−	.03	19	−	.24	20	−	.12	3	+	.65
21	−	.01	20	−	.08	Trim Surf.			4	+	.55
22	−	.03	21	−	.02	1	−	.52	5	+	.07
23	−	.03	22	+	.06	2	−	.54	6	+	.01
24		0	23	+	.15	3	−	.58	7	−	.04
25	+	.14	24		0	4	−	.61	8	−	.66
26	+	.13	25	+	.07	5	−	.37	Trim Surf.		
27	+	.18	26	+	.13	6	−	.40	25	+	.12
28	+	.45	27	+	.20	7	−	.44	26	+	.15
29	+	.46	28	+	.11	8	−	.48	27	+	.17
30	+	.33	29	+	.18	9	−	.23	28	+	.20
31	+	.38	30	+	.24	10	−	.21	29	+	.23
32	+	.77	31	+	.30	11	−	.29	30	+	.26
33	+	.40	32	+	.23	12	−	.33	31	+	.29
34	+	.07	33	+	.30	13	−	.13	32	+	.33
35	+	.10	34	+	.32	14	−	.15	33	+	.37
36	+	.25	35	+	.36	15	−	.17	34	+	.40
37	−	.45	36	+	.39	16	−	.20	35	+	.44
38	−	.75	37	+	.43	17	−	.08	36	+	.47
39	−	.85	37a	+	.35	18	−	.10	37	+	.50
40	−	.83	38	+	.39	19	−	.09	38	+	.54
						20	−	.11	39	+	.58
						21	+	.06	40	+	.62
						22	+	.09	41		
						23	+	.09	42		
						24	+	.11			



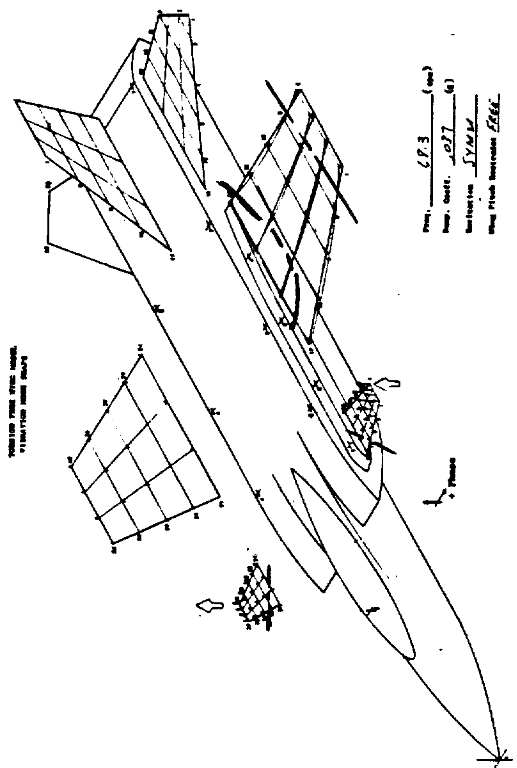
TORSION FREE WING MODEL
VIBRATION TEST DATA

Model Weight ______
Date 8/2/78
Norm. Accel. Pt. T4
Wing Pitch Restraint FREE
Frequency 68.1 cps
Damp. Coeff. .036 (g)
Excitation Antisym.

Wing			Horiz. Tail			Vert. Tail			Fus.		
Point	Phs.	Ampl.	Point	Phs.	Ampl.	Point	Phs.	Ampl.	Point	Phs.	Ampl.
1	+	.09	1	+	.01	1	−	.05	1V	−	.004
2	+	.13	2			2	−	.066	1L	+	.011
3	+	.15	3			3	−	.062	2V		0
4	+	.16	3a			4	−	.07	2L	−	.002
5	−	.05	4	+	.01	5	−	.03	3V		0
6	−	.01	5			6	−	.04	3L	−	.004
7	−	.02	6			7	−	.05	4V	+	.002
8	−	.08	7		0	8	−	.055	5V		0
9	−	.06	8			9	−	.01	5L	−	.003
10	−	.04	9			10	−	.02	6V	+	.003
11	−	.06	10			11	−	.03	7V		0
12	−	.18	11			12	−	.04	7L		0
13	−	.02	12			13	−	.005	8V	+	.002
14		0	13			14	−	.01	9V	−	.002
15	−	.01	14			15	−	.015	9L	+	.004
16	−	.05	15			16	−	.02	10V		0
17	−	.01	16		0	17		0	Boom		
18	+	.02	17			18		0	1	−	.66
19	+	.03	18			19		0	2	−	.13
20	+	.05	19		0	20		0	3		0
21	+	.01	20		0	Trim Surf.			4	+	.04
22		0	21			1	+	.92	5	+	.04
23	−	.02	22			2	+	.93	6	+	.02
24	−	.03	23		0	3	+	.94	7		0
25	+	.01	24			4	+	1.0	8	−	.02
26		0	25			5	+	.56	Trim Surf.		
27		0	26			6	+	.64	25	+	.05
28	+	.03	27			7	+	.71	26	−	.03
29	+	.03	28			8	+	.15	27	−	.09
30	+	.03	29			9	+	.22	28	−	.19
31	+	.04	30			10	+	.34	29	−	.08
32	+	.11	31			11	+	.45	30	−	.15
33	+	.04	32		0	12	+	.53	31	−	.27
34	+	.02	33			13		0	32	−	.32
35	+	.02	34			14	+	.10	33	−	.27
36	+	.05	35		0	15	+	.16	34	−	.37
37	−	.05	36			16	+	.25	35	−	[illegible]
38	−	.07	37			17	−	.15	36	−	.42
39	−	.08	37a			18	−	.04	37	−	.56
40	−	.70	38	−	.01	19	−	.01	38	−	.53
						20	+	.05	39	−	.60
						21	+	.11	40	−	.71
						22	+	.08	41		
						23	−	.02	42		
						24	−	.09			

FIGURE 18 (continued)

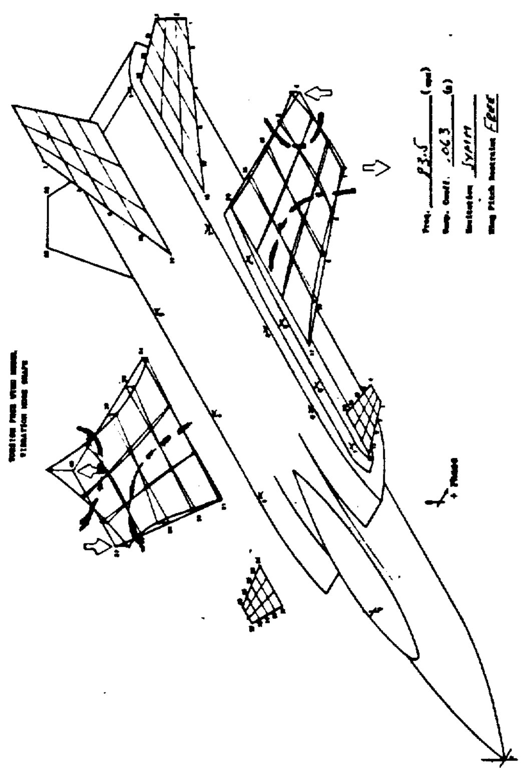
TFW GROUND VIBRATION TEST MODES
(WING FREE)



TORSION FREE WING MODEL
VIBRATION TEST DATA

Model Weight ______
Date 8/2/71
Norm. Accel. Pt. T4
Wing Pitch Restraint FREE
Frequency 67.3 cps
Damp. Coeff. .027 (g)
Excitation SYMM

Wing			Horiz. Tail			Vert. Tail			Fus.		
Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.
1	+	.08	1	+	.01	1	−	.05	1V	−	.004
2	+	.12	2			2	−	.06	1L	+	.010
3	+	.14	3			3	−	.09	2V		0
4	+	.16	3a			4	−	.08	2L	−	.001
5	−	.05	4	+	.01	5	−	.03	3V	+	.004
6	−	.01	5			6	−	.04	3L	−	.002
7	−	.02	6			7	−	.05	4V	+	.002
8	−	.07	7		0	8	−	.06	5V	+	.003
9	−	.05	8			9	−	.01	5L	−	.002
10	−	.04	9			10	−	.02	6V		0
11	−	.06	10			11	−	.03	7V		0
12	−	.17	11			12	−	.04	7L	+	.002
13	−	.01	12			13	−	.005	8V		0
14		0	13			14	−	.01	9V		0
15	−	.01	14			15	−	.015	9L	+	.004
16	−	.06	15			16	−	.02	10V		0
17	−	.01	16		0	17		0	Boom		
18	+	.01	17			18		0	1	−	.02
19	+	.03	18			19		0	2	−	.02
20	+	.05	19		0	20		0	3		0
21		0	20		0	Trim Surf.			4	+	.04
22	+	.01	21			1	+	.80	5	−	.03
23	+	.03	22			2	+	.86	6	−	.02
24	+	.03	23		0	3	+	.92	7		0
25		0	24			4	+	1.0	8	+	.02
26		0	25			5	+	.53	Trim Surf.		
27		0	26			6	+	.61	25	−	.03
28	−	.02	27			7	+	.69	26	+	.03
29	−	.03	28			8	+	.74	27	+	.10
30	−	.02	29			9	+	.20	28	+	.16
31	−	.03	30			10	+	.27	29	+	.09
32	−	.10	31		0	11	+	.37	30	+	.16
33	−	.03	32			12	+	.52	31	+	.22
34	−	.01	33			13		0	32	+	[illegible]
35	−	.02	34			14	+	.07	33	+	[illegible]
36	−	.05	35		0	15	+	.15	34	+	[illegible]
37	+	.05	36			16	+	.23	35	+	.42
38	+	.07	37			17	−	.12	36	+	.48
39	+	.08	37a			18	−	.04	37	+	.47
40	+	.10	38		0	19		0	38	+	.50
						20	+	.05	39	+	.57
						21	−	.10	40	+	.62
						22	−	.03	41		
						23	+	.03	42		
						24	+	.08			



TORSION FREE WING MODEL
VIBRATION TEST DATA

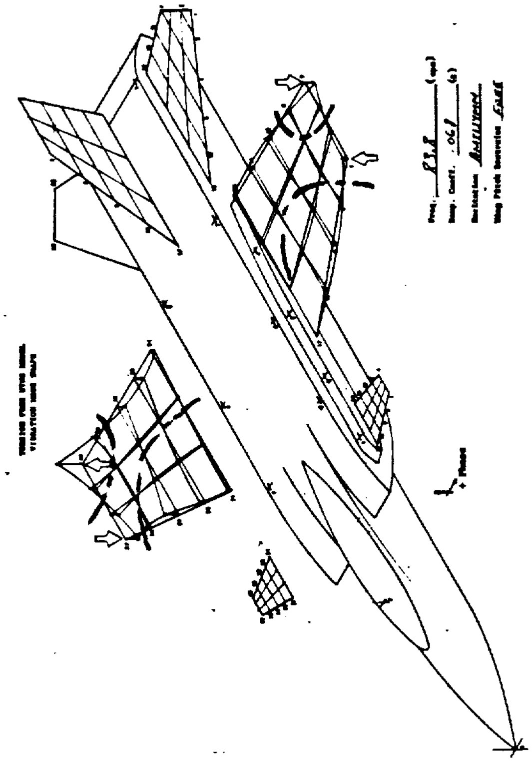
Model Weight ______
Date 8/2/71
Norm. Accel. Pt. W40
Wing Pitch Restraint FREE
Frequency 83.5 cps
Damp. Coeff. .063 (g)
Excitation SYMM

Wing			Horiz. Tail			Vert. Tail			Fus.		
Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.
1	−	.16	1		0	1		0	1V	+	.002
2	−	.08	2		0	2			1L	+	.001
3	+	.05	3	−	.005	3			2V	−	.001
4	+	.52	3a	−	.01	4	+	.01	2L	−	.001
5	+	.05	4		0	5			3V	+	.002
6	−	.03	5		0	6			3L	−	.002
7		0	6	−	.005	7			4V	−	.004
8	+	.05	7	−	.01	8			5V	+	.001
9	+	.15	8	−	.005	9			5L	−	.002
10	+	.04	9		0	10			6V	−	.004
11	−	.03	10	−	.005	11			7V	+	.001
12	−	.11	11	−	.01	12			7L	−	.002
13	+	.05	12	−	.005	13			8V	−	.002
14	+	.03	13		0	14			9V	+	.002
15	−	.02	14	−	.005	15			9L	−	.001
16	−	.11	15	−	.01	16			10V	−	.003
17		0	16	+	.01	17			Boom		
18		0	17	+	.005	18			1		0
19		0	18	−	.005	19			2		0
20	−	.02	19	−	.01	20			3		0
21	+	.02	20	−	.01	Trim Surf.			4		0
22	+	.01	21	−	.066	1	−	.01	5	−	.02
23	−	.01	22	−	.033	2	−	.013	6		0
24	−	.06	23		0	3	−	.017	7		0
25	+	.22	24	−	.066	4	−	.02	8	−	.02
26	+	.10	25	−	.033	5	−	.005	Trim Surf.		
27	−	.04	26		0	6	−	.007	25	−	.01
28	−	.24	27	+	.033	7	−	.01	26	−	.015
29	+	.48	28	−	.033	8	−	.15	27	−	.02
30	+	.14	29		0	9		0	28	−	.025
31	−	.09	30	+	.033	10	−	.003	29	−	.01
32	−	.37	31	+	.066	11	−	.001	30	−	.02
33	+	.15	32		0	12	−	.01	31	−	.025
34	−	.07	33	+	.033	13		0	32	−	.03
35	−	.02	34	+	.066	14	−	.001	33	−	.02
36	+	.22	35	+	.01	15	−	.003	34	−	.025
37	−	.51	36	+	.066	16	−	.005	35	−	.03
38	−	.27	37	+	.01	17		0	36	−	.035
39	+	.60	37a	+	.01	18		0	37	−	.07
40	+	1.0	38	+	.01	19		0	38	−	.033
						20		0	39	−	.037
						21	−	.01	40	−	.04
						22	−	.013	41		
						23	−	.017	42		
						24	−	.02			

FIGURE 18 (continued)

TFW GROUND VIBRATION TEST MODES

(WING FREE)

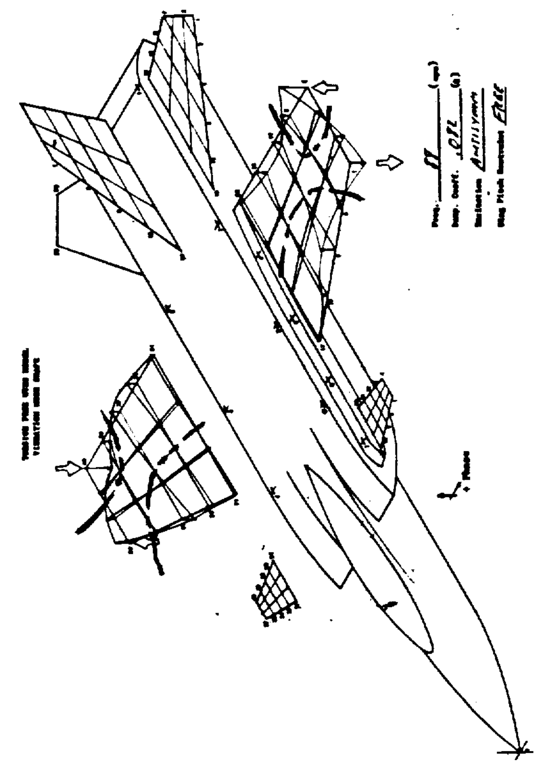


TORSION FREE WING MODEL
VIBRATION TEST DATA

Model Weight ______
Date ______
Norm. Accel. Pt. W40 Wing Pitch Restraint FREE

Frequency 83.8 cps
Damp. Coeff. .068 (g)
Excitation ANTISYMM

Wing			Horiz. Tail			Vert. Tail			Fus.		
Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.
1	+	.21	1	−	.01	1	+	.01	1V	+	.002
2	+	.11	2	−	.005	2	+	.013	1L	+	.002
3	−	.04	3	−	.013	3	+	.011	2V		0
4	−	.37	3a	−	.017	4	+	.02	2L		0
5	−	.07	4		0	5	+	.007	3V	+	.003
6	+	.03	5	−	.007	6	+	.009	3L	−	.003
7		0	6	−	.013	7	+	.012	4V	−	.005
8	−	.09	7	−	.02	8	+	.015	5V	+	.003
9	−	.19	8	+	.007	9	+	.003	5L	−	.007
10	−	.06	9		0	10	+	.005	6V	−	.004
11	+	.03	10	−	.009	11	+	.008	7V	+	.004
12	+	.11	11	−	.017	12	−	.01	7L	−	.003
13	−	.06	12	+	.013	13		0	8V	−	.004
14	−	.04	13	+	.005	14	+	.001	9V	+	.005
15	+	.02	14	−	.005	15	+	.003	9L	−	.002
16	+	.13	15	−	.013	16	+	.005	10V	−	.004
17		0	16	+	.02	17	−	.003	Boom		
18		0	17	+	.01	18	−	.003	1	+	.01
19	+	.01	18		0	19	−	.002	2		0
20	+	.04	19	−	.01	20	−	.002	3		0
21	+	.02	20	−	.02	Trim Surf.			4	+	.01
22	+	.01	21	−	.01	1	−	.01	5	−	.02
23	−	.01	22		0	2	−	.01	6		0
24	−	.06	23	+	.01	3	−	.01	7		0
25	+	.21	24	−	.013	4	−	.01	8	−	.02
26	+	.11	25	−	.005	5	−	.005	Trim Surf.		
27	−	.04	26	+	.005	6	−	.005	25	−	.01
28	−	.39	27	+	.013	7	−	.005	26	−	.013
29	+	.54	28	−	.007	8	−	.005	27	−	.016
30	+	.15	29		0	9		0	28	−	.02
31	−	.10	30	+	.01	10		0	29	−	.015
32	−	.39	31	+	.016	11		0	30	−	.018
33	+	.17	32		0	12		0	31	−	.022
34	−	.07	33	+	.01	13		0	32	−	.025
35	−	.02	34	+	.015	14		0	33	−	.02
36	+	.27	35	+	.02	15		0	34	−	.023
37	−	.54	36	+	.01	16		0	35	−	.024
38	−	.30	37	+	.02	17	+	.01	36	−	.03
39	+	.23	37a	+	.02	18	+	.005	37	−	.02
40	+	1.20	38	+	.02	19		0	38	−	.023
						20		0	39	−	.024
						21	−	.01	40	−	.03
						22	−	.013	41		
						23	−	.016	42		
						24	−	.02			



TORSION FREE WING MODEL
VIBRATION TEST DATA

Model Weight ______
Date 8/2/78
Norm. Accel. Pt. W4 Wing Pitch Restraint FREE

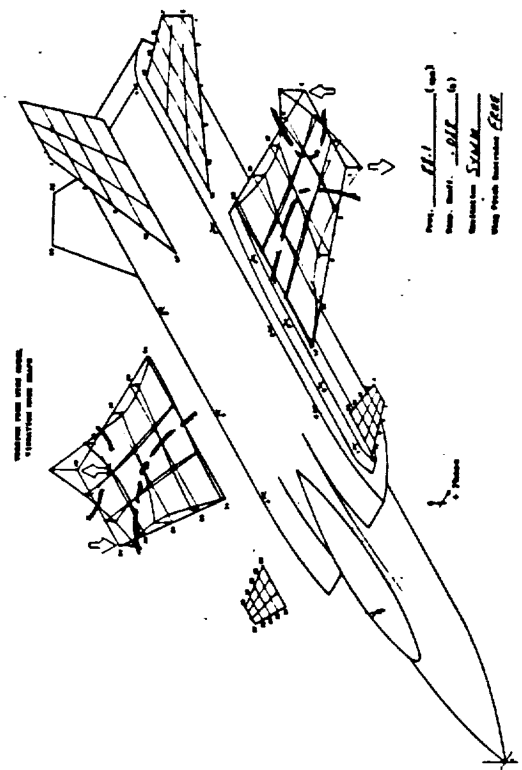
Frequency 87.0 cps
Damp. Coeff. .012 (g)
Excitation ANTISYMM

Wing			Horiz. Tail			Vert. Tail			Fus.		
Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.
1	−	.62	1	+	.01	1	−	.01	1V		0
2	−	.31	2	+	.005	2	−	.013	1L	−	.006
3	+	.19	3	+	.013	3	−	.012	2V		0
4	+	1.0	3a	+	.017	4	−	.02	2L	+	.002
5	+	.16	4		0	5	−	.007	3V	−	.004
6	−	.09	5	+	.007	6	−	.009	3L	+	.005
7	+	.03	6	+	.013	7	−	.012	4V	+	.005
8	+	.35	7	+	.02	8	−	.015	5V	−	.004
9	+	.57	8	−	.01	9	−	.003	5L	+	.004
10	+	.15	9		0	10	−	.005	6V	+	.005
11	−	.08	10	+	.01	11	−	.008	7V	−	.004
12	−	.36	11	+	.02	12	−	.01	7L	+	.003
13	+	.22	12	−	.02	13		0	8V	+	.005
14	+	.11	13	−	.01	14	−	.001	9V	−	.005
15	−	.06	14	+	.01	15	−	.007	9L	+	.003
16	−	.47	15	+	.02	16	−	.005	10V	+	.003
17	+	.01	16	−	.03	17	+	.005	Boom		
18	+	.01	17	−	.02	18	+	.005	1	−	.03
19	−	.03	18	+	.01	19	+	.005	2	−	.01
20	−	.13	19	+	.02	20	+	.005	3		0
21	−	.02	20	+	.02	Trim Surf.			4	−	.03
22	−	.01	21	+	.01	1		0	5	+	.02
23	+	.01	22	−	.01	2		0	6		0
24	+	.07	23	−	.02	3		0	7		0
25	−	.26	24	+	.03	4		0	8	+	.02
26	−	.12	25	+	.007	5		0	Trim Surf.		
27	+	.05	26	−	.013	6		0	25	+	.01
28	+	.40	27	−	.022	7		0	26	+	.01
29	−	.55	28	+	.007	8		0	27	−	.01
30	−	.13	29		0	9	−	.01	28	+	.01
31	+	.10	30	−	.017	10	−	.01	29	+	.01
32	+	.37	31	−	.027	11	−	.01	30	+	.01
33	−	.12	32		0	12	−	.01	31	+	.01
34	+	.09	33	−	.02	13	−	.02	32	+	.01
35		0	34	−	.023	14	−	.02	33		0
36	−	.37	35	−	.03	15	−	.02	34		0
37	+	.55	36	−	.02	16	−	.02	35		0
38	+	.32	37	−	.02	17	−	.03	36		0
39	−	.33	37a	−	.03	18	−	.02	37		0
40	−	.59	38	−	.03	19	−	.02	38		0
						20	−	.02	39		0
						21	+	.02	40		0
						22	+	.02	41		
						23	+	.02	42		
						24	+	.02			

FIGURE 18 (concluded)

TFW GROUND VIBRATION TEST MODES

(WING FREE)



TORSION FREE WING MODEL
VIBRATION TEST DATA

Model Weight ______ Date 8/2/71 Norm. Accel. Pt. W4

Wing Pitch Restraint FREE

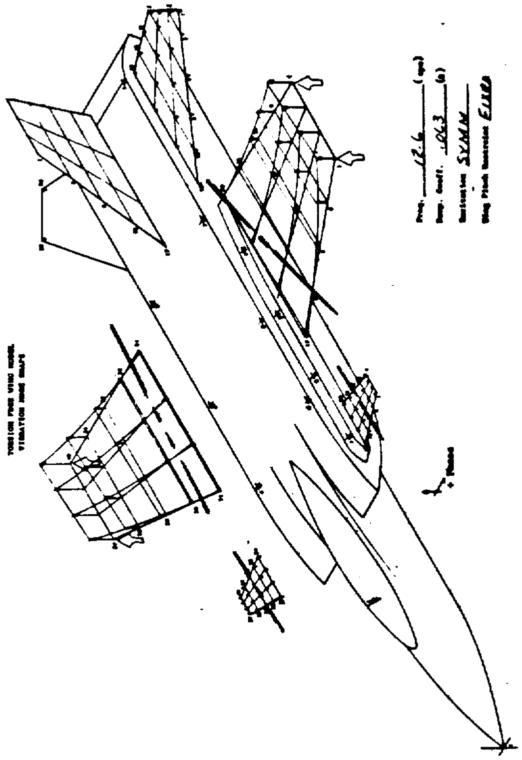
Frequency 82.1 cps Damp. Coeff. .022 (g) Excitation SYMM

Wing			Horiz. Tail			Vert. Tail			Fus.		
Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.
1	-	.64	1		0	1		0	1F	+	.057
2	-	.35	2		0	2			1L		0
3	+	.20	3		0	3			2F		0
4	+	1.5	3a			4		0	2L		0
5	+	.15	4			5			3F		0
6	-	.10	5			6			3L	+	.062
7	+	.08	6			7			4F	-	.007
8	+	.31	7		0	8			5F	-	.002
9	+	.12	8			9			5L		0
10	+	.16	9			10			6F		0
11	-	.07	10			11			7F	+	.002
12	-	.39	11			12			7L	+	.004
13	+	.72	12			13			8F	-	.005
14	+	.16	13			14			9F		0
15	-	.06	14			15			9L		0
16	-	.47	15			16			10F		0
17	+	.01	16	-	.02	17			Boom		
18	+	.01	17			18			1	-	.02
19	-	.02	18			19			2	-	.01
20	-	.13	19		0	20			3		0
21	+	.02	20		0	Trim Surf.			4	-	.03
22	-	.01	21			1	-	.02	5	-	.02
23	-	.01	22			2	-	.04	6		0
24	-	.06	23		0	3	-	.04	7		0
25	+	.31	24			4	-	.05	8	-	.02
26	+	.14	25			5	-	.015	Trim Surf.		
27	-	.09	26			6	-	.03	25	-	.0[illegible]
28	-	.37	27			7	-	.015	26	-	.02
29	+	.66	28			8	-	.03	27	-	.03
30	+	.17	29			9	-	.02	28	-	.04
31	-	.11	30			10	-	.021	29	-	.02
32	-	.31	31			11	-	.027	30	-	.03
33	+	.14	32			12	-	.03	31	-	.04
34	-	.15	33			13	-	.035	32	-	.0[illegible]
35	-	.03	34			14	-	.035	33	-	.05
36	+	.44	35		0	15	-	.035	34	-	.03
37	-	.12	36			16	-	.035	35	-	.057
38	-	.47	37			17	-	.03	36	-	.07
39	+	.22	37a			18	-	.027	37	-	.07
40	+	1.01	38		0	19	-	.023	38	-	.09
						20	-	.02	39	-	.03
						21	-	.01	40	-	.09
						22	-	.017	41		
						23	-	.026	42		
						24	-	.03			

FIGURE 19

TFW GROUND VIBRATION TEST MODES

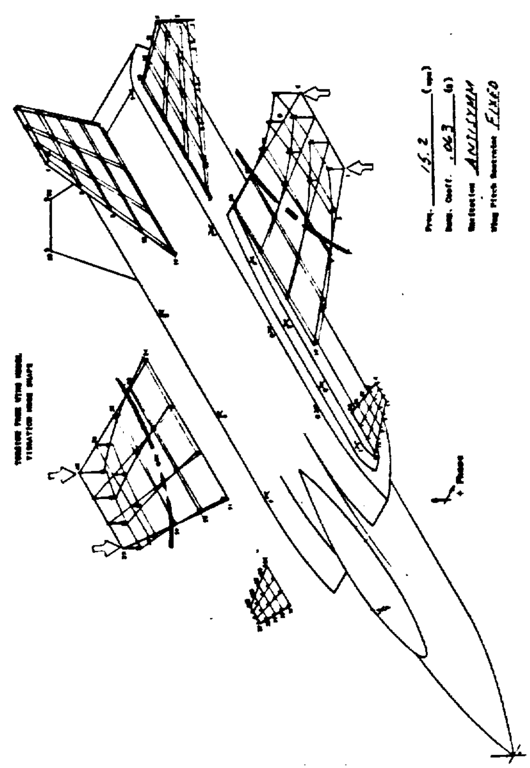
(WING LOCKED)



TORSION FREE WING MODEL
VIBRATION TEST DATA

Model Weight ______
Date 7/28/78
Norm. Accel. Pt. W4
Wing Pitch Restraint FIXED
Frequency 12.6 cps
Damp. Coeff. .063 (g)
Excitation SYMM

Wing			Horiz. Tail			Vert. Tail			Fus.		
Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.
1	+	.72	1	−	.04	1		0	1V		0
2	−	.96	2	−	.04	2			1L		0
3	+	.93	3	−	.04	3			2V	−	.008
4	+	1.00	3a	−	.04	4		0	2L		0
5	+	.42	4	−	.04	5			3V	−	.015
6	+	.53	5	−	.04	6			3L		0
7	+	.61	6	−	.04	7			4V	−	.020
8	+	.67	7	−	.04	8			5V	−	.022
9	+	.12	8	−	.03	9			5L		0
10	+	.21	9	−	.04	10			6V	−	.025
11	+	.28	10	−	.03	11			7V	−	.033
12	+	.31	11	−	.04	12			7L		0
13		0	12	−	.03	13			8V	−	.030
14	+	.03	13	−	.03	14			9V	−	.043
15	+	.07	14	−	.03	15			9L		0
16	+	.08	15	−	.03	16			10V	−	.045
17	−	.01	16	−	.02	17			Boom		
18	−	.01	17	−	.03	18			1	−	.01
19	−	.01	18	−	.04	19			2	−	.01
20		0	19	−	.04	20			3	−	.02
21	−	.01	20	−	.03	Trim Surf.			4	−	.01
22	−	.01	21	−	.03	1	+	.01	5	−	.01
23	−	.01	22	−	.03	2	+	.01	6	−	.01
24	−	.005	23	−	.04	3	+	.01	7	−	.01
25	+	.01	24	−	.03	4	+	.01	8	−	.015
26	+	.04	25	−	.03	5	+	.005	Trim Surf.		
27	+	.08	26	−	.04	6	+	.005	25	−	.005
28	+	.10	27	−	.04	7	+	.005	26	−	.005
29	+	.13	28	−	.03	8	+	.005	27	−	.005
30	+	.25	29	−	.04	9		0	28	−	.005
31	+	.34	30	−	.04	10		0	29		0
32	+	.39	31	−	.04	11		0	30		0
33	+	.48	32	−	.04	12		0	31		0
34	+	.62	33	−	.04	13	−	.005	32		0
35	+	.74	34	−	.05	14	−	.005	33	+	.005
36	+	.81	35	−	.05	15	−	.005	34	+	.005
37	+	.93	36	−	.04	16	−	.005	35	+	.005
38	+	1.01	37	−	.05	17	−	.01	36	+	.005
39	+	1.04	37a	−	.05	18	−	.01	37	+	.010
40	+	1.10	38	−	.05	19	−	.01	38	+	.01
						20	−	.01	39	+	.01
						21	−	.01	40	+	.01
						22	−	.01	41		
						23	−	.01	42		
						24	−	.015			



TORSION FREE WING MODEL
VIBRATION TEST DATA

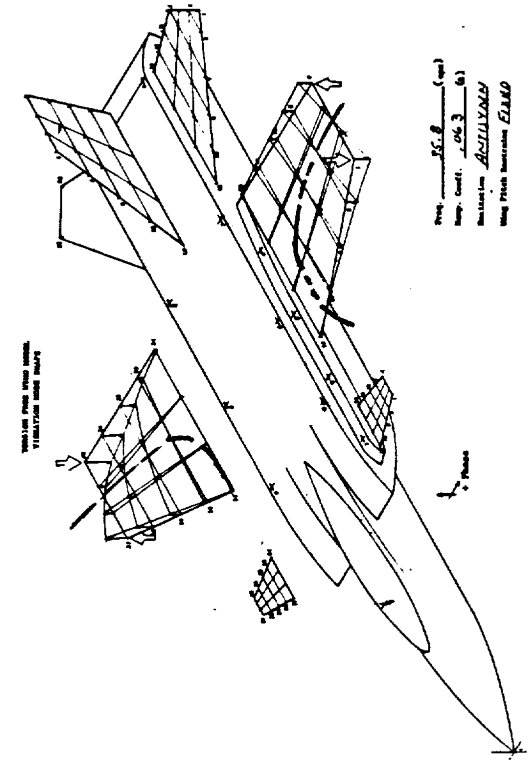
Model Weight ______
Date 7/28/78
Norm. Accel. Pt. ______
Wing Pitch Restraint FIXED
Frequency 15.2 cps
Damp. Coeff. .063 (g)
Excitation ANTISYM

Wing			Horiz. Tail			Vert. Tail			Fus.		
Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.
1	+	.67	1	−	.21	1	+	.11	1V		0
2	+	.71	2	−	.15	2	+	.11	1L	−	.01
3	+	.79	3	−	.19	3	+	.11	2V	−	.003
4	+	1.0	3a	−	.18	4	+	.10	2L	+	.004
5	+	.25	4	−	.15	5	+	.09	3V	−	.06
6	+	.39	5	−	.15	6	+	.09	3L	+	.025
7	+	.51	6	−	.16	7	+	.09	4V	+	.070
8	+	.61	7	−	.16	8	+	.09	5V	−	.075
9	−	.01	8	−	.12	9	+	.06	5L	+	.025
10	+	.09	9	−	.12	10	+	.06	6V	+	.070
11	+	.18	10	−	.13	11	+	.06	7V	−	.075
12	+	.23	11	−	.13	12	+	.06	7L	+	.020
13	−	.09	12	−	.10	13	+	.04	8V	+	.060
14	−	.05	13	−	.10	14	+	.04	9V	−	.065
15	−	.01	14	−	.10	15	+	.04	9L	+	.020
16	−	.005	15	−	.10	16	+	.05	10V	+	.070
17	−	.07	16	−	.07	17	+	.03	Boom		
18	−	.07	17	−	.07	18	+	.02	1	−	.07
19	−	.06	18	−	.07	19	+	.02	2	−	.06
20	−	.05	19	−	.07	20	+	.02	3	−	.06
21	+	.07	20	+	.07	Trim Surf.			4	−	.06
22	+	.07	21	+	.07	1	−	.11	5	+	.07
23	+	.06	22	+	.07	2	−	.12	6	+	.07
24	+	.05	23	+	.07	3	−	.12	7	+	.07
25	+	.01	24	+	.09	4	−	.12	8	+	.06
26	+	.05	25	+	.09	5	−	.11	Trim Surf.		
27	+	.02	26	+	.09	6	−	.11	25	+	.08
28	+	.01	27	+	.10	7	−	.11	26	+	.08
29	+	.02	28	+	.12	8	−	.11	27	+	.08
30	−	.08	29	+	.12	9	−	.09	28	+	.08
31	−	.17	30	+	.12	10	−	.09	29	+	.09
32	−	.23	31	+	.14	11	−	.09	30	+	.09
33	−	.25	32	+	.14	12	−	.10	31	+	.09
34	−	.38	33	+	.14	13	−	.09	32	+	.09
35	−	.51	34	+	.14	14	−	.08	33	+	.10
36	−	.61	35	+	.14	15	−	.08	34	+	.10
37	−	.67	36	+	.17	16	−	.08	35	+	.10
38	−	.79	37	+	.18	17	−	.07	36	+	.10
39	−	.92	37a	+	.16	18	−	.07	37	+	.11
40	−	1.01	38	+	.15	19	−	.07	38	+	.11
						20	−	.07	39	+	.11
						21	+	.08	40	+	.11
						22	+	.08	41		
						23	+	.07	42		
						24	+	.08			

FIGURE 19 (continued)

TFW GROUND VIBRATION TEST MODES

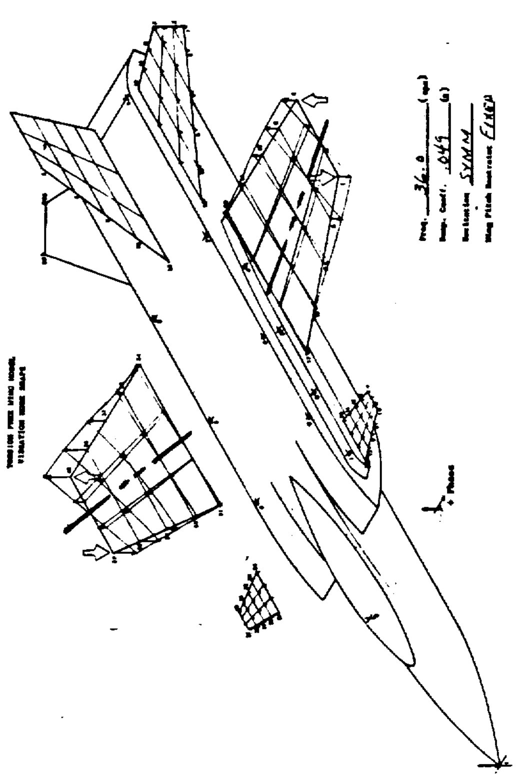
(WING LOCKED)



TORSION FREE WING MODEL
VIBRATION TEST DATA

Model Weight ______
Date 7/28/78
Norm. Accel. Pt. W40
Wing Pitch Restraint FIXED
Frequency 35.8 cps
Damp. Coeff. .063 (g)
Excitation ANTISYMM

Wing			Horiz. Tail			Vert. Tail			Fus.		
Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.
1	–	.50	1	+	.05	1	–	.01	1V	–	.002
2	–	.18	2	+	.04	2	–	.01	1L	+	.002
3	+	.14	3	+	.05	3	–	.01	2V		0
4	+	.57	3a	+	.04	4	–	.01	2L		0
5	–	.40	4	+	.03	5	–	.007	3V	+	.005
6	–	.17	5	+	.03	6	–	.007	3L	–	.003
7	+	.11	6	+	.04	7	–	.007	4V	–	.005
8	+	.41	7	+	.04	8	–	.007	5V	+	.005
9	–	.19	8	+	.02	9	–	.005	5L	–	.004
10	–	.10	9	+	.03	10	–	.005	6V	–	.005
11	+	.08	10	+	.03	11	–	.005	7V	+	.004
12	+	.33	11	+	.03	12	–	.005	7L	–	.002
13	–	.08	12	+	.02	13	–	.003	8V	–	.005
14	–	.02	13	+	.02	14	–	.003	9V	+	.004
15	+	.03	14	+	.02	15	–	.003	9L	–	.002
16	+	.17	15	+	.02	16	–	.003	10V	–	.008
17	+	.005	16	+	.01	17		0	Boom		
18	+	.01	17	+	.01	18		0	1	+	.005
19	+	.02	18	+	.02	19		0	2	+	.005
20	+	.03	19	+	.02	20		0	3	+	.005
21		0	20	–	.01	Trim Surf.			4	+	.017
22		0	21	–	.015	1	+	.005	5	–	.005
23	–	.01	22	–	.020	2	+	.005	6	–	.005
24	–	.04	23	–	.030	3	+	.005	7	–	.005
25	+	.07	24	–	.010	4	+	.005	8	–	.02
26	+	.05	25	–	.02	5	+	.005	Trim Surf.		
27	–	.05	26	–	.02	6	+	.005	25		0
28	–	.26	27	–	.03	7	+	.005	26		0
29	+	.35	28	–	.03	8	+	.005	27		0
30	+	.20	29	–	.03	9	+	.005	28		0
31	–	.13	30	–	.03	10	+	.005	29		0
32	–	.41	31	–	.03	11	+	.005	30		0
33	+	.71	32	–	.03	12	+	.005	31		0
34	+	.30	33	–	.04	13	+	.005	32	+	.005
35	–	.25	34	–	.04	14	+	.005	33	+	.005
36	–	.86	35	–	.04	15	+	.005	34	+	.005
37	+	.83	36	–	.04	16	+	.005	35	+	.007
38	+	.30	37	–	.05	17	+	.005	36	+	.007
39	–	.31	37a	–	.05	18	+	.015	37	+	.008
40	–	1.0	38	–	.05	19	+	.005	38	+	.009
						20	+	.005	39	+	.005
						21	–	.005	40	+	.010
						22		0	41		
						23	–	.005	42		
						24	–	.005			



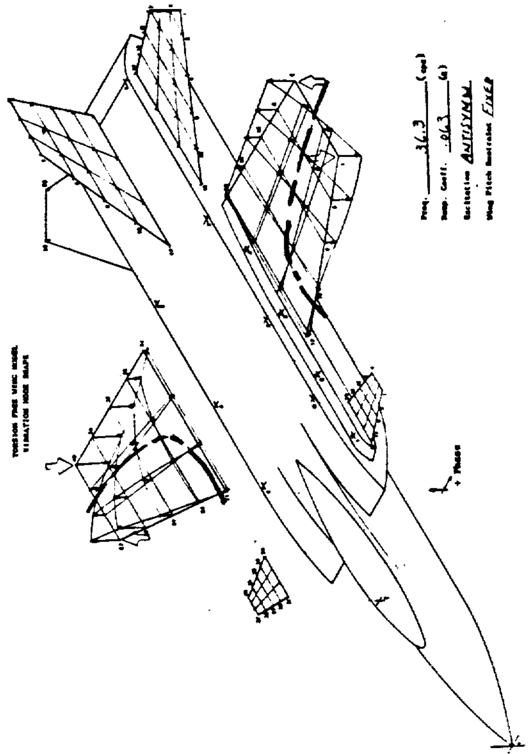
TORSION FREE WING MODEL
VIBRATION TEST DATA

Model Weight ______
Date 7/28/78
Norm. Accel. Pt. W40
Wing Pitch Restraint FIXED
Frequency 36.0 cps
Damp. Coeff. .049 (g)
Excitation SYMM

Wing			Horiz. Tail			Vert. Tail			Fus.		
Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.
1	–	.48	1	–	.01	1		0	1V	+	.008
2	–	.16	2	–	.01	2			1L		0
3	+	.20	3	–	.01	3			2V	+	.002
4	+	.59	3a	–	.01	4		0	2L	+	.002
5	–	.40	4	–	.01	5			3V	–	.003
6	–	.17	5	–	.01	6			3L	+	.001
7	+	.14	6	–	.01	7			4V	+	.001
8	+	.50	7	–	.01	8			5V	–	.003
9	–	.32	8	–	.01	9			5L	+	.001
10	–	.13	9	–	.005	10			6V	+	.002
11	+	.07	10	–	.005	11			7V	–	.001
12	+	.36	11	–	.005	12			7L		0
13	–	.05	12	–	.005	13			8V	+	.002
14	–	.04	13	–	.005	14			9V	+	.002
15	+	.02	14	–	.005	15			9L		0
16	+	.14	15	–	.005	16			10V	–	.002
17	–	.01	16	–	.002	17			Boom		
18	–	.05	17	–	.002	18			1	–	.005
19	+	.02	18	–	.002	19			2	–	.005
20	+	.03	19		0	20			3	–	.004
21	–	.01	20	+	.005	Trim Surf.			4	+	.01
22		0	21	+	.005	1	–	.02	5	–	.002
23	+	.01	22	+	.01	2	–	.02	6	–	.002
24	+	.04	23	+	.015	3	–	.02	7		0
25	–	.10	24	+	.01	4	–	.02	8	+	.01
26	–	.07	25	+	.01	5	–	.02	Trim Surf.		
27	+	.04	26	+	.015	6	–	.02	25	–	.01
28	+	.27	27	+	.02	7	–	.02	26	–	.01
29	–	.40	28	+	.015	8	–	.02	27	–	.01
30	–	.23	29	+	.02	9	–	.015	28	–	.01
31	+	.13	30	+	.02	10	–	.015	29	–	.015
32	+	.64	31	+	.02	11	–	.015	30	–	.015
33	–	.79	32	+	.025	12	–	.015	31	–	.015
34	–	.35	33	+	.025	13	–	.01	32	–	.02
35	+	.25	34	+	.025	14	–	.01	33	–	.02
36	+	.93	35	+	.025	15	–	.01	34	–	.02
37	–	.88	36	+	.03	16	–	.01	35	–	.02
38	–	.28	37	+	.03	17	–	.005	36	–	.02
39	+	.37	37a	+	.03	18	–	.005	37	–	.02
40	+	1.00	38	+	.03	19	–	.005	38	–	.025
						20	–	.005	39	–	.03
						21	–	.005	40	–	.03
						22	–	.005	41		
						23	–	.005	42		
						24	–	.005			

FIGURE 19 (continued)

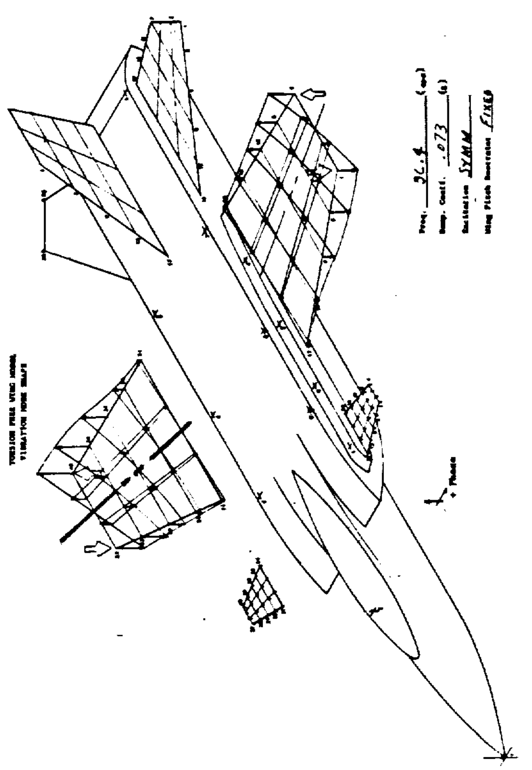
TFW GROUND VIBRATION TEST MODES
(WING LOCKED)



TORSION FREE WING MODEL
VIBRATION TEST DATA

Model Weight ______
Date 7/28/78
Norm. Accel. Pt. W4
Wing Pitch Restraint FIXED
Frequency 36.3 cps
Damp. Coeff. .063 (g)
Excitation ANTISYMM

Wing			Horiz. Tail			Vert. Tail			Fus.		
Point	Phs.	Ampl.	Point	Phs.	Ampl.	Point	Phs.	Ampl.	Point	Phs.	Ampl.
1	-	.91	1	+	.09	1	-	.02	1V	-	.004
2	-	.74	2	+	.07	2	-	.02	1L	+	.002
3	+	.29	3	+	.08	3	-	.02	2V		0
4	+	1.0	3a	+	.07	4	-	.02	2L	-	.003
5	-	.77	4	+	.05	5	-	.015	3V	+	.009
6	-	.31	5	+	.06	6	-	.015	3L	-	.004
7	+	.23	6	+	.06	7	-	.015	4V	-	.007
8	+	.86	7	+	.06	8	-	.015	5V	+	.008
9	-	.59	8	+	.04	9	-	.01	5L	-	.004
10	-	.20	9	+	.04	10	-	.01	6V	-	.010
11	+	.16	10	+	.05	11	-	.015	7V	+	.009
12	+	.61	11	+	.05	12	-	.02	7L	-	.005
13	-	.06	12	+	.03	13	-	.01	8V	-	.008
14	-	.05	13	+	.03	14	-	.01	9V	+	.010
15	+	.07	14	+	.03	15	-	.01	9L	-	.003
16	+	.32	15	+	.04	16	-	.01	10V	-	.010
17	+	.005	16	+	.01	17	-	.005	Boom		
18	+	.01	17	+	.02	18	-	.005	1	+	.01
19	+	.03	18	+	.02	19	-	.005	2	+	.01
20	+	.07	19	+	.03	20	-	.005	3	+	.01
21	-	.003	20	-	.015	Trim Surf.			4	+	.02
22	-	.007	21	-	.02	1	+	.01	5	-	.005
23	-	.03	22	-	.03	2	+	.01	6	-	.005
24	-	.08	23	-	.05	3	+	.01	7	-	.005
25	+	.12	24	-	.03	4	+	.01	8	-	.03
26	+	.09	25	-	.03	5	+	.01	Trim Surf.		
27	-	.07	26	-	.04	6	+	.01	25	-	.005
28	-	.45	27	-	.05	7	+	.01	26	-	.005
29	+	.57	28	-	.05	8	+	.01	27	-	.005
30	+	.33	29	-	.05	9	+	.01	28	-	.005
31	-	.21	30	-	.06	10	+	.01	29	-	.005
32	-	.95	31	-	.06	11	+	.01	30		0
33	+	1.02	32	-	.06	12	+	.01	31		0
34	+	.50	33	-	.06	13	+	.01	32		0
35	-	.36	34	-	.07	14	+	.01	33		0
36	-	1.15	35	-	.07	15	+	.01	34		0
37	+	1.10	36	-	.08	16	+	.01	35		0
38	+	.45	37	-	.08	17	+	.01	36		0
39	-	.47	37a	-	.08	18	+	.01	37	+	.005
40	-	1.26	38	-	.09	19	+	.01	38		0
						20	+	.01	39		0
						21	-	.005	40		0
						22	-	.005	41		
						23	-	.005	42		
						24	-	.005			



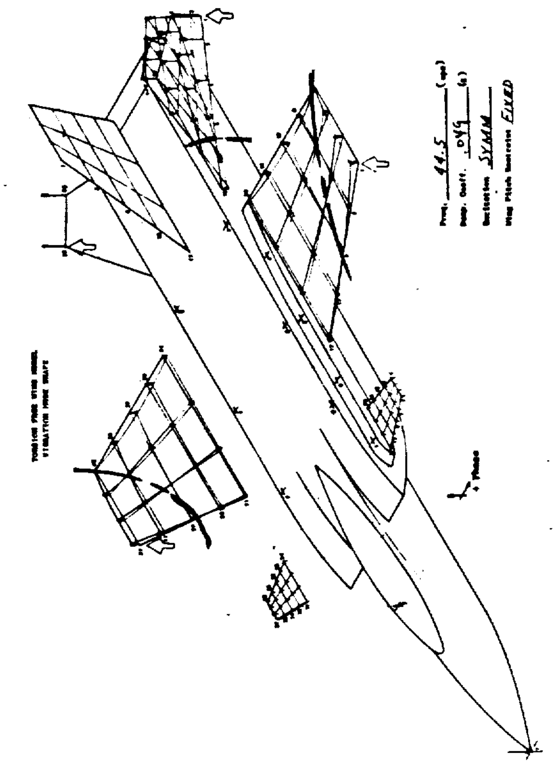
TORSION FREE WING MODEL
VIBRATION TEST DATA

Model Weight ______
Date 7/28/78
Norm. Accel. Pt. W4
Wing Pitch Restraint FIXED
Frequency 36.4 cps
Damp. Coeff. .073 (g)
Excitation SYMM

Wing			Horiz. Tail			Vert. Tail			Fus.		
Point	Phs.	Ampl.	Point	Phs.	Ampl.	Point	Phs.	Ampl.	Point	Phs.	Ampl.
1	-	.80	1		0	1	+	.005	1V	+	.015
2	-	.26	2		0	2	+	.005	1L		0
3	+	.35	3		0	3	+	.005	2V	+	.004
4	+	1.0	3a		0	4	+	.005	2L	+	.003
5	-	.75	4		0	5	+	.002	3V	-	.005
6	-	.30	5		0	6	+	.002	3L	+	.002
7	+	.24	6		0	7	+	.002	4V		0
8	+	.85	7		0	8	+	.002	5V	-	.003
9	-	.40	8		0	9	+	.002	5L		0
10	-	.21	9		0	10	+	.002	6V		0
11	+	.13	10		0	11	+	.002	7V		0
12	+	.60	11		0	12	+	.002	7L		0
13	-	.05	12		0	13	+	.001	8V	+	.02
14	-	.07	13		0	14	+	.001	9V	+	[illegible]
15	+	.04	14		0	15	+	.001	9L		
16	+	.28	15		0	16	+	.001	10V	-	.006
17	-	.01	16		0	17		0	Boom		
18	-	.01	17		0	18			1	-	.01
19	+	.01	18		0	19		0	2	-	.01
20	+	.05	19		0	20		0	3	-	.005
21	-	.01	20	+	.005	Trim Surf.			4	+	.01
22	-	.005	21	+	.005	1	-	.03	5		0
23	+	.02	22	+	.01	2	-	.03	6	-	.03
24	+	.07	23	+	.02	3	-	.03	7	-	.005
25	-	.15	24	+	.015	4	-	.03	8	+	.02
26	-	.11	25	+	.02	5	-	.03	Trim Surf.		
27	+	.06	26	+	.02	6	-	.03	25	-	.03
28	+	.43	27	+	.02	7	-	.03	26	-	.05
29	-	.65	28	+	.02	8	-	.03	27	-	.05
30	-	.36	29	+	.02	9	-	.02	28	-	.02
31	+	.23	30	+	.02	10	-	.02	29	-	.02
32	+	.99	31	+	.03	11	-	.02	30	-	.02
33	-	1.02	32	+	.03	12	-	.02	31	-	.02
34	-	.50	33	+	.03	13	-	.015	32	-	.025
35	+	.37	34	+	.03	14	-	.015	33	-	.03
36	+	1.25	35	+	.03	15	-	.015	34	-	.03
37	-	1.10	36	+	.04	16	-	.020	35	-	.03
38	-	.47	37	+	.04	17	-	.01	36	-	.03
39	+	.59	37a	+	.04	18	-	.01	37	-	.03
40	+	1.35	38	+	.04	19	-	.01	38	-	.04
						20	-	.01	39	-	.04
						21	-	.005	40	-	.04
						22	-	0	41		
						23	-	0	42		
						24	-	.01			

FIGURE 19 (continued)

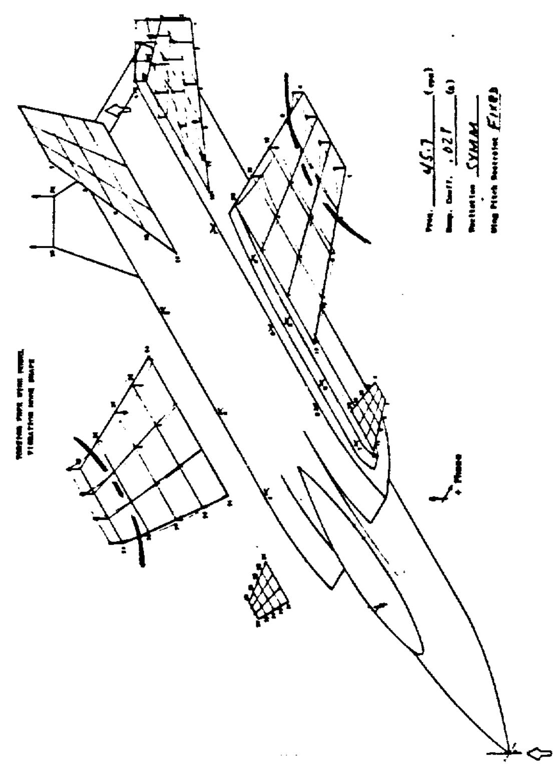
TFW GROUND VIBRATION TEST MODES
(WING LOCKED)



TORSION FREE WING MODEL
VIBRATION TEST DATA

Model Weight ______ Frequency 44.5 cps
Date 12/31/78 Damp. Coeff. .049 (g)
Norm. Accel. Pt. H1 Wing Pitch Restraint FIXED Excitation SYMM

Wing			Horiz. Tail			Vert. Tail			Fus.		
Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.
1	+	.21	1	+	1.0	1	−	.01	1V	+	.11
2	+	.25	2	+	.55	2	−	.013	1L	−	.007
3	+	.19	3	+	.88	3	−	.017	2V	+	.006
4		0	3a	+	.98	4	−	.02	2L		0
5	+	.16	4	+	.57	5	−	.007	3V	−	.046
6	+	.09	5	+	.70	6	−	.01	3L	+	.005
7	−	.03	6	+	.76	7	−	.013	4V	−	.042
8	−	.17	7	+	.55	8	−	.012	5V	−	.036
9		0	8	+	.23	9	−	.005	5L	+	.003
10		0	9	+	.46	10	−	.007	6V	−	.031
11	−	.11	10	+	.65	11	−	.01	7V	−	.006
12	−	.18	11	+	.80	12	−	.013	7L		0
13	−	.06	12	−	.46	13	−	.003	8V	−	.004
14	−	.06	13	+	.21	14	−	.005	9V	+	.042
15	−	.10	14	+	.46	15	−	.002	9L	−	.005
16	−	.23	15	+	.70	16	−	.01	10V	+	.04
17	−	.04	16	−	.25	17		0	Boom		
18	−	.04	17	−	.03	18	−	.001	1	−	.05
19	−	.06	18	+	.38	19	−	.003	2	−	.04
20	−	.05	19	+	.56	20	−	.005	3	−	.03
21	−	.04	20	−	.31	Trim Surf.			4	−	.05
22	−	.04	21	−	.06	1	−	.15	5	−	.04
23	−	.05	22	+	.25	2	−	.15	6	−	.04
24	−	.08	23	+	.50	3	−	.16	7	−	.03
25	−	.07	24	−	.10	4	−	.17	8	−	.04
26	−	.07	25	+	.17	5	−	.12	Trim Surf.		
27	−	.10	26	+	.41	6	−	.12	25	−	.06
28	−	.23	27	+	.63	7	−	.13	26	−	.06
29		0	28	+	.20	8	−	.14	27	−	.07
30		0	29	+	.40	9	−	.08	28	−	.08
31	−	.12	30	+	.58	10	−	.05	29	−	.08
32	−	.32	31	+	.75	11	−	.05	30	−	.05
33	+	.23	32	+	.46	12	−	.10	31	−	.05
34	+	.11	33	+	.62	13	−	.06	32	−	.10
35	−	.03	34	+	.80	14	−	.07	33	−	.12
36	−	.23	35	+	.85	15	−	.07	34	−	.12
37	+	.32	36	+	.75	16	−	.08	35	−	.13
38	+	.27	37	+	.84	17	−	.05	36	−	.14
39	+	.23	37a	+	.85	18	−	.05	37	−	.15
40		0	38	+	.84	19	−	.03	38	−	.16
						20	−	.06	39	−	.17
						21	−	.04	40	−	.17
						22	−	.05	41		
						23	−	[illegible]	42		
						24	−	.06			



TORSION FREE WING MODEL
VIBRATION TEST DATA

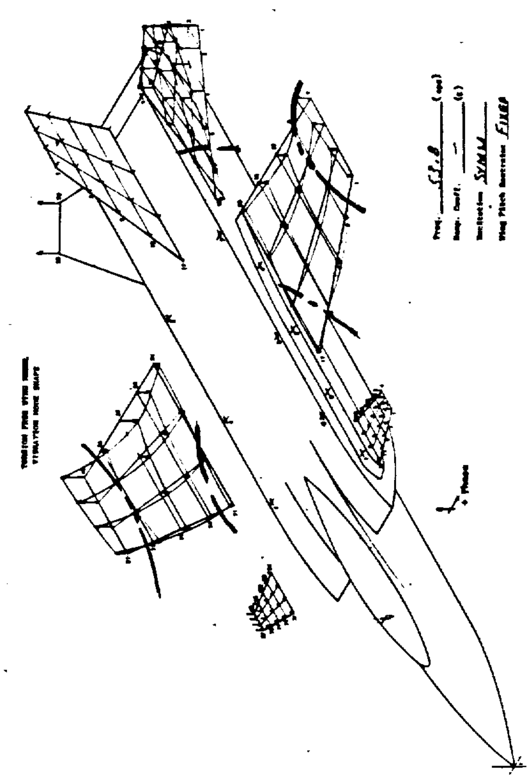
Model Weight ______ Frequency 45.7 cps
Date 8/1/78 Damp. Coeff. .027 (g)
Norm. Accel. Pt. H7 Wing Pitch Restraint FIXED Excitation SYMM

Wing			Horiz. Tail			Vert. Tail			Fus.		
Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.
1	+	.41	1	+	1.01	1	−	.02	1V	+	.20
2	+	.41	2	+	.87	2	−	.022	1L	−	.025
3	+	.41	3	+	.96	3	−	.027	2V	+	.013
4	+	.41	3a	+	.95	4	−	.03	2L	+	.003
5		0	4	+	.57	5	−	.015	3V	−	.087
6	+	.05	5	+	.75	6	−	.018	3L	+	.016
7	+	.03	6	+	.84	7	−	.022	4V	−	.08
8	−	.05	7	+	1.0	8	−	.025	5V	−	.065
9	−	.20	8	+	.34	9	−	.01	5L	+	.007
10	−	.15	9	+	.52	10	−	.013	6V	−	.055
11	−	.22	10	+	.65	11	−	.017	7V		0
12	−	.44	11	+	.78	12	−	.02	7L		0
13	−	.14	12	+	.10	13	−	.005	8V	−	.065
14	−	.15	13	+	.29	14	−	.008	9V	+	.10
15	−	.21	14	+	.48	15	−	.012	9L	−	.012
16	−	.41	15	+	.69	16	−	.015	10V	+	.11
17	−	.08	16	−	.12	17		0	Boom		
18	−	.08	17	+	.05	18	−	.003	1	−	.11
19	−	.11	18	+	.36	19	−	.007	2	−	.09
20	−	.21	19	+	.52	20	−	.01	3	−	.07
21	−	.07	20	−	.05	Trim Surf.			4	−	.10
22	−	.07	21	+	.11	1	−	.34	5	−	.10
23	−	.11	22	+	.27	2	−	.34	6	−	.07
24	−	.17	23	+	.45	3	−	.35	7	−	.06
25	−	.16	24	+	.13	4	−	.35	8	−	.05
26	−	.16	25	+	.27	5	−	.25	Trim Surf.		
27	−	.23	26	+	.41	6	−	.26	25	−	.13
28	−	.45	27	+	.55	7	−	.28	26	−	.14
29	−	.23	28	+	.73	8	−	.29	27	−	.16
30	−	.18	29	+	.45	9	−	.19	28	−	.18
31	−	.28	30	+	.57	10	−	.21	29	−	.19
32	−	.55	31	+	.69	11	−	.22	30	−	.20
33		0	32	+	.83	12	−	.23	31	−	.22
34	+	.04	33	+	.64	13	−	.14	32	−	.24
35		0	34	+	.73	14	−	.15	33	−	.25
36	−	.17	35	+	.75	15	−	.16	34	−	.27
37	+	.48	36	+	.75	16	−	.17	35	−	.29
38	+	.53	37	+	.73	17	−	.11	36	−	.31
39	+	.51	37a	+	.84	18	−	.12	37	−	.33
40	+	.45	38	+	.83	19	−	.11	38	−	.35
						20	−	.12	39	−	.36
						21	−	.10	40	−	.37
						22	−	.11	41		
						23	−	.12	42		
						24	−	.13			

FIGURE 19 (continued)

TFW GROUND VIBRATION TEST MODES

(WING LOCKED)



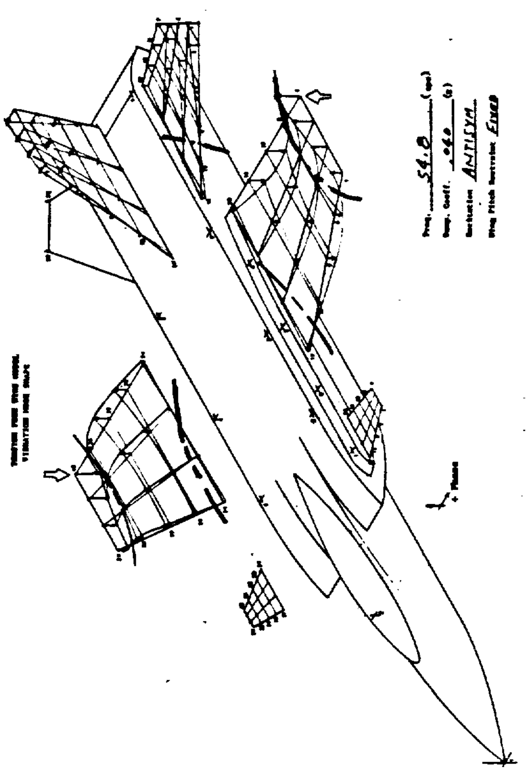
TORSION FREE WING MODEL
VIBRATION TEST DATA

Model Weight ______
Date 12/31/78
Norm. Accel. Pt. H1

Wing Pitch Restraint FIXED

Frequency 53.8 cps
Damp. Coeff. — (g)
Excitation SYMM

Wing			Horiz. Tail			Vert. Tail			Fus.		
Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.
1	+	.16	1	+	1.0	1	+	.18	1V	−	.16
2	+	.27	2	+	.87	2	+	.17	1L	+	.012
3	+	.41	3	+	1.0	3	+	.20	2V	+	.004
4	+	.60	3a	+	.98	4	+	.24	2L		0
5	−	.15	4	+	.50	5	+	.10	3V	+	.082
6	−	.04	5	+	.70	6	+	.12	3L		0
7	+	.07	6	+	.87	7	+	.14	4V	+	.19
8		0	7	+	.94	8	+	.15	5V	+	.042
9	−	.15	8	+	.20	9	+	.06	5L		0
10	−	.13	9	+	.42	10	+	.07	6V	+	.066
11	−	.19	10	+	.62	11	+	.10	7V	−	.008
12	−	.44	11	+	.80	12	+	.13	7L	+	.007
13		0	12	−	.07	13	+	.03	8V	+	.023
14	−	.05	13	+	.16	14	+	.04	9V	−	.095
15	−	.12	14	+	.40	15	+	.06	9L	+	.015
16	−	.35	15	+	.63	16	+	.07	10V	−	.097
17	+	.06	16	−	.24	17	+	.02	Boom		
18	+	.03	17	−	.06	18	+	.02	1	+	.10
19	−	.03	18	+	.21	19	+	.03	2	+	.07
20	−	.10	19	+	.50	20	+	.03	3	+	.14
21	+	.06	20	−	.24	Trim Surf.			4	−	.02
22	+	.03	21	−	.07	1	+	.28	5	+	.12
23	−	.05	22	+	.19	2	+	.29	6	+	.08
24	−	.10	23	+	.42	3	+	.31	7	+	.05
25	−	.05	24	−	.06	4	+	.33	8	−	.03
26	−	.13	25	+	.17	5	+	.22	Trim Surf.		
27	−	.23	26	+	.35	6	+	.23	25	+	.13
28	−	.57	27	+	.63	7	+	.25	26	+	.14
29	−	.38	28	+	.23	8	+	.27	27	+	.15
30	−	.30	29	+	.39	9	+	.15	28	+	.17
31	−	.37	30	+	.55	10	+	.17	29	+	.16
32	−	.74	31	+	.69	11	+	.19	30	+	.18
33	−	.35	32	+	.47	12	+	.21	31	+	.20
34	−	.07	33	+	.62	13	+	.12	32	+	.22
35		0	34	+	.75	14	+	.13	33	+	.21
36	−	.20	35	+	.93	15	+	.14	34	+	.24
37	+	.38	36	+	.75	16	+	.15	35	+	.26
38	+	.65	37	+	.87	17	+	.09	36	+	.28
39	+	.76	37a	+	.86	18	+	.10	37	+	.30
40	+	.88	38	+	.88	19	+	.10	38	+	.33
						20	+	.11	39	+	.32
						21	+	.10	40	+	.34
						22	+	.12	41		
						23	+	.12	42		
						24	+	.15			



TORSION FREE WING MODEL
VIBRATION TEST DATA

Model Weight ______
Date 12/31/78
Norm. Accel. Pt. W4

Wing Pitch Restraint FIXED

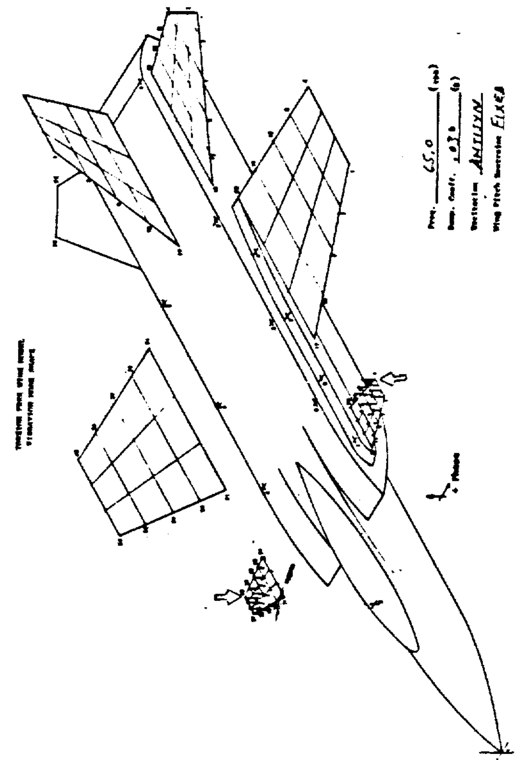
Frequency 54.8 cps
Damp. Coeff. .040 (g)
Excitation ANTISYM

Wing			Horiz. Tail			Vert. Tail			Fus.		
Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.
1	+	.35	1	−	.49	1	−	.40	1V		0
2	+	.60	2	−	.41	2	−	.43	1L	−	.010
3	+	.82	3	−	.49	3	−	.51	2V	+	.003
4	+	1.0	3a	−	.47	4	−	.58	2L	−	.012
5	−	.27	4	−	.23	5	−	.23	3V	+	.050
6	−	.06	5	−	.33	6	−	.30	3L	−	.018
7		0	6	−	.40	7	−	.37	4V	−	.053
8	−	.12	7	−	.44	8	−	.41	5V	+	.048
9	−	.31	8	−	.05	9	−	.11	5L	−	.012
10	−	.28	9	−	.15	10	−	.16	6V	−	.045
11	−	.35	10	−	.25	11	−	.22	7V	+	.053
12	−	.79	11	−	.37	12	−	.29	7L	−	.012
13	−	.05	12	+	.03	13	−	.05	8V	−	.040
14	−	.12	13	−	.06	14	−	.06	9V	+	.06
15	−	.26	14	−	.17	15	−	.10	9L	−	.007
16	−	.65	15	−	.23	16	−	.15	10V	−	.233
17	+	.04	16	+	.15	17	−	.01	Boom		
18	+	.02	17	+	.03	18	−	.02	1	+	.05
19	−	.06	18	−	.09	19	−	.03	2	+	.04
20	−	.18	19	−	.21	20	−	.03	3	+	.08
21	−	.03	20	−	.02	Trim Surf.			4	−	.03
22	−	.01	21	+	.01	1	+	.10	5	−	.05
23	+	.04	22	+	.03	2	+	.11	6	−	.04
24	+	.12	23	+	.05	3	+	.11	7	−	.03
25	+	.08	24	+	.02	4	+	.12	8	+	.02
26	+	.11	25	+	.03	5	+	.08	Trim Surf.		
27	+	.21	26	+	.05	6	+	.09	25	−	.05
28	+	.52	27	+	.07	7	+	.09	26	−	.05
29	+	.35	28	+	.04	8	+	.10	27	−	.07
30	+	.28	29	+	.06	9	+	.06	28	−	.08
31	+	.85	30	+	.08	10	+	.06	29	−	.07
32	+	.66	31	+	.10	11	+	.07	30	−	.07
33	+	.92	32	+	.08	12	+	.08	31	−	.09
34	+	.07	33	+	.10	13	+	.05	32	−	.10
35	+	.09	34	+	.12	14	+	.05	33	−	.10
36	+	.19	35	+	.13	15	+	.05	34	−	.10
37	−	.32	36	+	.13	16	+	.07	35	−	.11
38	−	.57	37	+	.14	17	+	.04	36	−	.12
39	−	.75	37a	+	.13	18	+	.05	37	−	.13
40	−	.90	38	+	.15	19	+	.05	38	−	.14
						20	+	.05	39	−	.15
						21	−	.04	40	−	.16
						22	−	.05	41		
						23	−	.05	42		
						24	−	.06			

FIGURE 19 (continued)

TFW GROUND VIBRATION TEST MODES

(WING LOCKED)



TORSION FREE WING MODEL
VIBRATION TEST DATA

Model Weight ______
Date 8/1/78
Norm. Accel. Pt. ______
Wing Pitch Restraint FIXED
Frequency 65.0 cps
Damp. Coeff. .030 (g)
Excitation ANTI SYM

Wing

Point	Phs.	Ampl.
1	−	.03
2	−	.03
3	−	.03
4	−	.03
5	−	.026
6	−	.026
7	−	.026
8	−	.026
9	−	.022
10	−	.022
11	−	.022
12	−	.022
13	−	.018
14	−	.018
15	−	.018
16	−	.016
17	−	.016
18	−	.014
19	−	.014
20	−	.014
21	+	.014
22	+	.016
23	+	.014
24	+	.019
25	+	.018
26	+	.018
27	+	.018
28	+	.018
29	+	.022
30	+	.022
31	−	.022
32	−	.022
33	+	.026
34	+	.026
35	−	.026
36	+	.026
37	+	.03
38	+	.03
39	+	.02
40	+	.02

Horiz. Tail

Point	Phs.	Ampl.
1	+	.06
2	+	.05
3	+	.07
3a	+	.075
4	+	.03
5	+	.05
6	+	.07
7	+	.07
8	+	.01
9	+	.03
10	+	.05
11	+	.07
12	−	.02
13	+	.01
14	+	.04
15	+	.01
16	−	.04
17	−	.01
18	+	.03
19	+	.05
20	+	.03
21	+	.01
22	−	.01
23	−	.03
24	+	.01
25	−	.01
26	−	.03
27	−	.077
28	−	.01
29	−	.02
30	−	.02
31	−	.043
32	−	.02
33	−	.03
34	−	.04
35	−	.05
36	−	.03
37	−	.042
37a	−	.047
38	−	.04

Vert. Tail

Point	Phs.	Ampl.
1		0
2	−	.013
3	−	.024
4	−	.04
5	−	.001
6	−	.01
7	−	.02
8	−	.01
9	−	.003
10	−	.006
11	−	.013
12	−	.02
13	+	.005
14		0
15	−	.007
16	−	.01
17	+	.007
18	+	.003
19		0
20	−	.007

Trim Surf.

Point	Phs.	Ampl.
1	+	.85
2	+	.96
3	+	.99
4	+	1.0
5	+	.61
6	+	.70
7	+	.75
8	+	.82
9	+	.35
10	+	.35
11	+	.47
12	+	.53
13	+	.13
14	+	.17
15	+	.20
16	+	.27
17		0
18	+	.02
19	+	.05
20	+	.09
21	+	.10
22	−	.05
23	−	.16
24	−	.32

Fus.

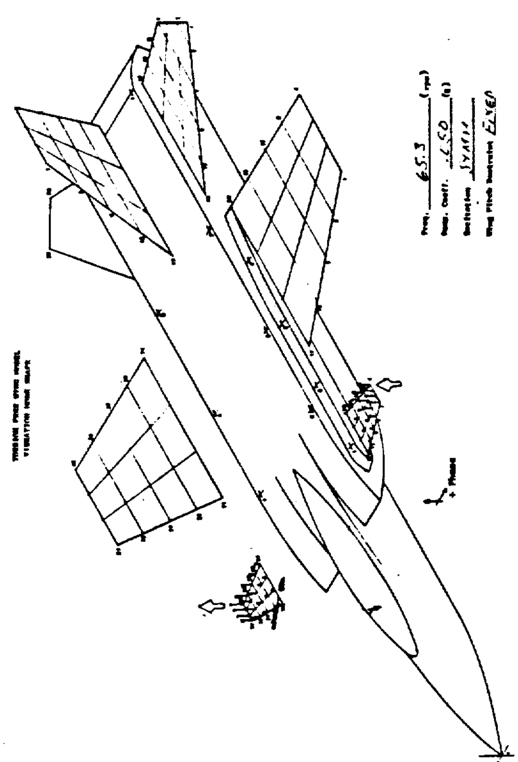
Point	Phs.	Ampl.
1V		0
1L	−	.02
2V		0
2L	+	.004
3V	−	.011
3L	+	.013
4V	+	.013
5V	−	.012
5L	+	.013
6V	+	.016
7V	−	.014
7L	+	.007
8V	+	.014
9V	−	.016
9L	−	.007
10V	+	.006

Boom

Point	Phs.	Ampl.
1	+	.025
2	−	.025
3	−	.012
4	−	.014
5		0
6	+	.01
7	+	.01
8	+	.02

Trim Surf.

Point	Phs.	Ampl.
25		0
26	−	.17
27	−	.23
28	−	.45
29	−	.56
30	−	.42
31	−	.59
32	−	.71
33	−	.60
34	−	.71
35	−	.8
36	−	.9
37	−	.84
38	−	.9
39	−	1.05
40	−	1.16
41		
42		



TORSION FREE WING MODEL
VIBRATION TEST DATA

Model Weight ______
Date 8/1/78
Norm. Accel. Pt. T4
Wing Pitch Restraint FIXED
Frequency 65.3 cps
Damp. Coeff. .050 (g)
Excitation SYMM

Wing

Point	Phs.	Ampl.
1	−	.01
2		0
3	+	.02
4	+	.04
5		0
6		0
7		0
8	+	.02
9	+	.01
10		0
11		0
12		0
13	+	.01
14		0
15		0
16	−	.02
17		0
18		0
19	−	.01
20	−	.02
21		0
22		0
23	−	.01
24	−	.02
25	+	.01
26		0
27		0
28	−	.02
29	+	.01
30		0
31		0
32		0
33		0
34		0
35		0
36	+	.02
37	−	.01
38		0
39	+	.02
40	+	.04

Horiz. Tail

Point	Phs.	Ampl.
1	−	.10
2	−	.08
3	−	.09
3a	−	.09
4	−	.04
5	−	.06
6	−	.08
7	−	.09
8	−	.02
9	−	.03
10	−	.05
11	−	.07
12	+	.02
13		0
14	−	.03
15	−	.05
16	+	.04
17	+	.02
18	−	.01
19	−	.03
20	+	.03
21	+	.02
22	−	.01
23	−	.03
24		0
25	−	.01
26	−	.02
27	−	.04
28	−	.02
29	−	.03
30	−	.04
31	−	.07
32	−	.04
33	−	.05
34	−	.07
35	−	.07
36	−	.07
37	−	.08
37a	−	.08
38	−	.09

Vert. Tail

Point	Phs.	Ampl.
1	+	.05
2	+	.023
3	+	.027
4	+	.04
5	+	.03
6	+	.02
7	+	.03
8	+	.03
9	+	.02
10	+	.02
11	+	.02
12	+	.02
13	+	.01
14	+	.01
15	+	.01
16	+	.01
17		0
18		0
19		0
20		0

Trim Surf.

Point	Phs.	Ampl.
1	+	.85
2	+	.95
3	+	.99
4	+	1.0
5	+	.60
6	+	.66
7	+	.77
8	+	.13
9	+	.30
10	+	.35
11	+	.44
12	+	.51
13	+	.11
14	+	.17
15	+	.17
16	+	.27
17	−	.04
18	+	.04
19	+	.05
20	+	.10
21	−	.10
22	+	.05
23	+	.15
24	+	.27

Fus.

Point	Phs.	Ampl.
1V	+	.027
1L	−	.004
2V	−	.005
2L	+	.002
3V	−	.015
3L		0
4V	−	.02
5V	−	.011
5L	+	.008
6V	−	.013
7V		0
7L		0
8V	−	.003
9V	+	.021
9L	−	.003
10V	+	.018

Boom

Point	Phs.	Ampl.
1		0
2		0
3	−	.008
4	−	.010
5		0
6	−	.008
7	−	.010
8	−	.018

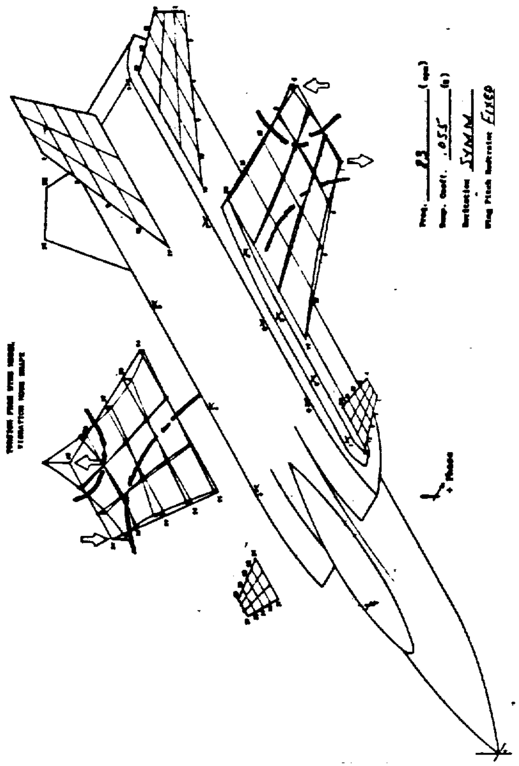
Trim Surf.

Point	Phs.	Ampl.
25		0
26	+	.17
27	+	.31
28	+	.47
29	+	.27
30	+	.40
31	+	.54
32	+	.70
33	+	.57
34	+	.64
35	+	.82
36	+	.92
37	+	.85
38	+	.94
39	+	1.01
40	+	1.05
41		
42		

FIGURE 19 (continued)

TFW GROUND VIBRATION TEST MODES

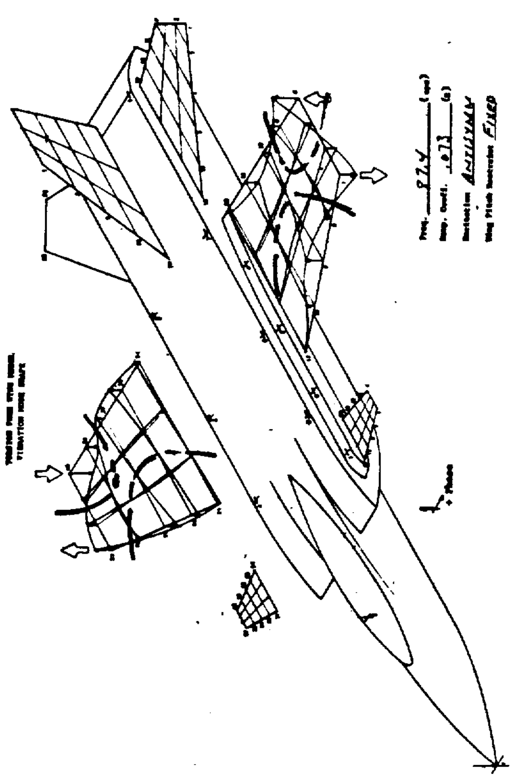
(WING LOCKED)



TORSION FREE WING MODEL
VIBRATION TEST DATA

Model Weight ______
Date 7/31/78
Norm. Accel. Pt. W40
Wing Pitch Restraint FIXED
Frequency 83.0 cps
Damp. Coeff. .055 (g)
Excitation SYMM

Wing			Horiz. Tail			Vert. Tail			Fus.		
Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.
1	−	.15	1	−	.01	1		0	1V		0
2	−	.07	2	−	.01	2		0	1L		0
3	+	.04	3	−	.013	3		0	2V		0
4	+	.27	3a	−	.017	4		0	2L		0
5	+	.05	4	−	.005	5		0	3V	+	.002
6	−	.02	5	−	.01	6		0	3L		0
7		0	6	−	.015	7		0	4V	−	.002
8	+	.05	7	−	.02	8		0	5V	+	.002
9	+	.14	8	+	.005	9		0	5L		0
10	+	.04	9		0	10		0	6V	−	.002
11	−	.02	10	−	.01	11		0	7V	+	.002
12	−	.09	11	−	.017	12		0	7L	−	.001
13	+	.05	12	+	.01	13		0	8V	−	.002
14	+	.03	13	+	.006	14		0	9V	+	.002
15	−	.02	14		0	15		0	9L		0
16	−	.10	15	−	.013	16		0	10V	−	.002
17		0	16	+	.02	17		0	Boom		
18		0	17	−	.01	18		0	1		0
19		0	18		0	19		0	2		0
20	−	.03	19	−	.01	20		0	3		0
21	+	.03	20	−	.01	Trim Surf.			4		0
22	+	.01	21	−	.005	1	−	.02	5		0
23	−	.03	22		0	2	−	.023	6		0
24	−	.08	23	+	.005	3	−	.027	7		0
25	+	.22	24	−	.007	4	−	.03	8		0
26	+	.10	25	−	.004	5	−	.015	Trim Surf.		
27	−	.05	26	+	.006	6	−	.018	25		0
28	−	.34	27	+	.007	7	−	.012	26		0
29	+	.50	28	−	.005	8	−	.025	27	−	.02
30	+	.15	29		0	9	−	.01	28	−	.03
31	−	.08	30	+	.005	10	−	.01	29	−	.01
32	−	.33	31	+	.009	11	−	.01	30	−	.02
33	+	.18	32	−	.003	12	−	.01	31	−	.03
34	−	.06	33		0	13	−	.005	32	−	.04
35		0	34	+	.009	14	−	.005	33	−	.03
36	+	.75	35	+	.01	15	−	.005	34	−	.04
37	−	.50	36	−	.001	16	−	.005	35	−	.05
38	−	.29	37	+	.003	17		0	36	−	.06
39	+	.14	37a	+	.007	18		0	37	−	.05
40	+	1.0	38		0	19		0	38	−	.06
						20		0	39	−	.07
						21	+	.01	40	−	.08
						22		0	41		
						23	−	.01	42		
						24	−	.02			



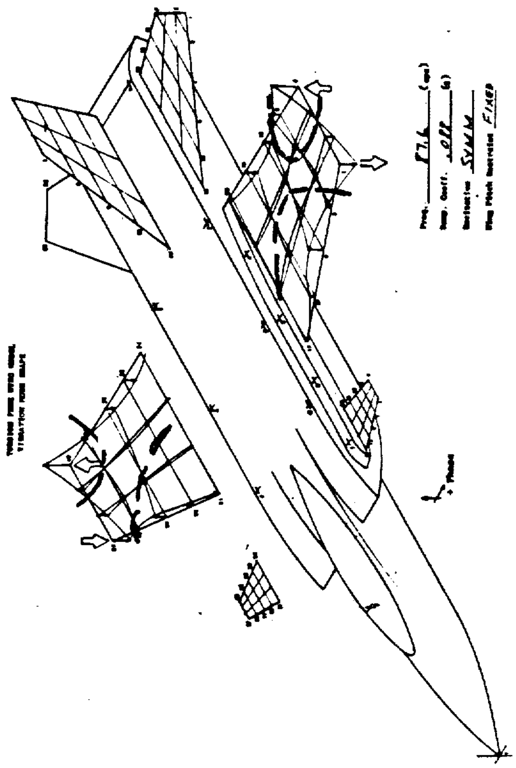
TORSION FREE WING MODEL
VIBRATION TEST DATA

Model Weight ______
Date 7/31/78
Norm. Accel. Pt. W4
Wing Pitch Restraint FIXED
Frequency 87.4 cps
Damp. Coeff. .073 (g)
Excitation ANTISYMM

Wing			Horiz. Tail			Vert. Tail			Fus.		
Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.	Point	Pha.	Ampl.
1	−	.41	1	+	.03	1	−	.01	1V		0
2	−	.35	2	+	.03	2	−	.013	1L	−	.003
3	+	.16	3	+	.02	3	−	.017	2V		0
4	+	1.0	3a	+	.02	4	−	.02	2L		0
5	+	.21	4	+	.02	5	−	.007	3V	−	.005
6	−	.08	5	+	.03	6	−	.01	3L		0
7	+	.03	6	+	.03	7	−	.013	4V	+	.006
8	+	.35	7	+	.03	8	−	.012	5V	−	.005
9	+	.63	8		0	9	−	.003	5L	+	.002
10	+	.17	9	+	.02	10	−	.007	6V	+	.006
11	−	.07	10	+	.02	11	−	.01	7V	−	.005
12	−	.33	11	+	.02	12	−	.013	7L	+	.002
13	+	.25	12	−	.02	13		0	8V	+	.004
14	+	.12	13		0	14	−	.001	9V	−	.006
15	−	.08	14	+	.03	15	−	.003	9L	+	.003
16	−	.50	15	+	.03	16	−	.01	10V	+	.006
17	+	.01	16	−	.05	17	+	.002	Boom		
18		0	17	−	.03	18	+	.002	1	−	.005
19	−	.05	18	+	.02	19	+	.003	2		0
20	−	.19	19	+	.03	20	+	.003	3		0
21	−	.05	20	+	.03	Trim Surf.			4	−	.05
22		0	21	+	.02	1	−	.05	5		0
23	+	.34	22		0	2	−	.06	6		0
24	+	.15	23	−	.02	3	−	.07	7		0
25	−	.28	24	+	.02	4	−	.07	8	+	.04
26	−	.12	25		0	5	−	.05	Trim Surf.		
27	+	.07	26	−	.02	6	−	.04	25		0
28	+	.48	27	−	.02	7	−	.05	26		0
29	−	.60	28		0	8	−	.06	27	+	.02
30	−	.17	29	−	.03	9	−	.01	28	+	.03
31	+	.09	30	−	.03	10	−	.02	29		0
32	+	.35	31	−	.03	11	−	.03	30	+	.02
33	−	.17	32	−	.02	12	−	.04	31	+	.03
34	+	.10	33	−	.03	13		0	32	+	.04
35	−	.04	34	−	.03	14		0	33	+	.05
36	−	.48	35	−	.03	15	−	.01	34	+	.04
37	+	.60	36	−	.03	16	−	.02	35	+	.05
38	+	.37	37	−	.03	17	+	.01	36	+	.06
39	−	.28	37a	−	.03	18		0	37	+	.05
40	−	.38	38	−	.03	19		0	38	+	.06
						20	−	.01	39	+	.07
						21		0	40	+	.08
						22		0	41		
						23		0	42		
						24	+	.02			

FIGURE 19 (concluded)

TFW GROUND VIBRATION TEST MODES
(WING LOCKED)



TORSION FREE WING MODEL
VIBRATION TEST DATA

Model Weight ______
Date 7/31/78
Norm. Accel. Pt. ____

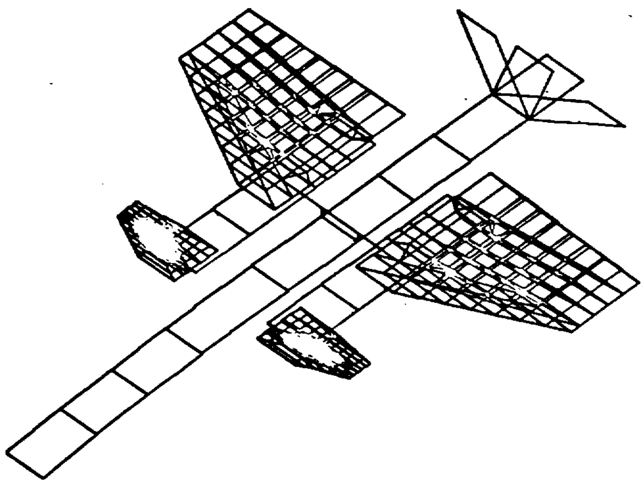
Wing Pitch Restraint FIXED

Frequency 87.6 cps
Damp. Coeff. .011 (g)
Excitation SYMM

Wing			Horiz. Tail			Vert. Tail			Fus.		
Point	Phs.	Ampl.	Point	Phs.	Ampl.	Point	Phs.	Ampl.	Point	Phs.	Ampl.
1	–	.64	1	–	.02	1		0	1T	+	.054
2	–	.37	2	–	.02	2	–	.007	1L		0
3	+	.18	3	–	.01	3	–	.013	2T		0
4	+	1.0	3a	-	0	4	–	.02	2L		0
5	+	.15	4	–	.02	5		0	3T	–	.004
6	–	.08	5	–	.015	6	–	.005	3L		0
7	+	.04	6	–	.01	7	–	.01	4T	–	.004
8	+	.36	7		0	8	–	.015	5T	–	.005
9	+	.60	8	–	.025	9		0	5L		0
10	+	.13	9	–	.02	10		0	6T	–	.005
11	–	.07	10	–	.01	11	–	.005	7T		0
12	–	.32	11		0	12	–	.01	7L		0
13	+	.22	12	–	.027	13		0	8T		0
14	+	.11	13	–	.02	14		0	9T		+.005
15	–	.07	14	–	.01	15		0	9L		0
16	–	.48	15		0	16	–	.005	10T	+	.005
17	+	.02	16	–	.03	17		0	Boom		
18		0	17	–	.02	18		0	1		0
19	–	.05	18	–	.01	19		0	2		0
20	–	.17	19		0	20			3		0
21	+	.03	20	+	.02	Trim Surf.			4	–	.04
22	+	.01	21	+	.01	1	–	.06	5		0
23	–	.05	22		0	2	–	.07	6		0
24	–	.17	23	–	.01	3	–	.08	7		0
25	+	.27	24	+	.01	4	–	.09	8	–	.05
26	+	.12	25		0	5	–	.03	Trim Surf.		
27	–	.08	26	–	.01	6	–	.04	25	+	.01
28	–	.10	27	–	.013	7	–	.05	26		0
29	+	.60	28		0	8	–	.07	27	–	.02
30	+	.17	29	–	.01	9	–	.02	28	–	.04
31	–	.10	30	–	.015	10	–	.03	29	–	.01
32	–	.38	31	–	.017	11	–	.04	30	–	.03
33	+	.15	32	–	.01	12	–	.05	31	–	.04
34	–	.11	33	–	.015	13		0	32	–	.06
35		0	34	–	.02	14		0	33	–	.04
36	+	.25	35	–	.02	15	–	.02	34	–	.05
37	–	.45	36	–	.015	16	–	.03	35	–	.07
38	–	.43	37	–	.02	17	+	.01	36	–	.07
39	+	.23	37a	–	.02	18		0	37	–	.07
40	+	1.03	38	–	.02	19		0	38	–	.07
						20	–	.01	39	–	.09
						21	+	.01	40	–	.10
						22		0	41		
						23		0	42		
						24	–	.02			

FIGURE 20

TFW NASTRAN MODES
(WING FREE)



Freq = 0

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-3320121-12	-2986651-12	-2986651-12	-2986651-12	-2986651-12
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+1401195-12	+1401125-12	+1255586-12	+1255547-12	+1255508-12
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+1012743-12	+1012464-12	+1012185-12	+1011896-12	+1011186-12
+1105479-12	+1108215-12	+1109235-12	+1108873-12	+1108496-12
+1131787-12	+1131379-12	+1434369-12	+1435712-12	+1436240-12
+1436592-12	+1436947-12	+1437109-12	+1437179-12	+1437131-12
+1738300-12	+1738855-12	+1739137-12	+1739881-12	+1740660-12
+1741181-12	+1741575-12	+1742163-12	+2044637-12	+2045187-12
+2046505-12	+2047475-12	+2048291-12	+2049029-12	+2050170-12
+2351207-12	+2352164-12	+2353401-12	+2354508-12	+2355546-12
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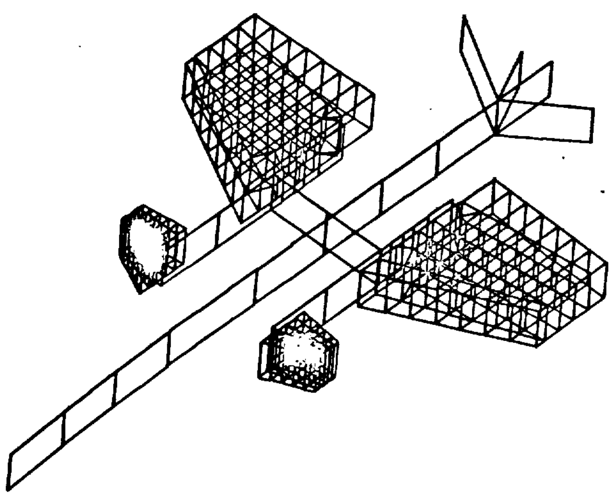

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+1275905-11	+1275905-11	+1275905-11	+1275905-11	+1127406-11
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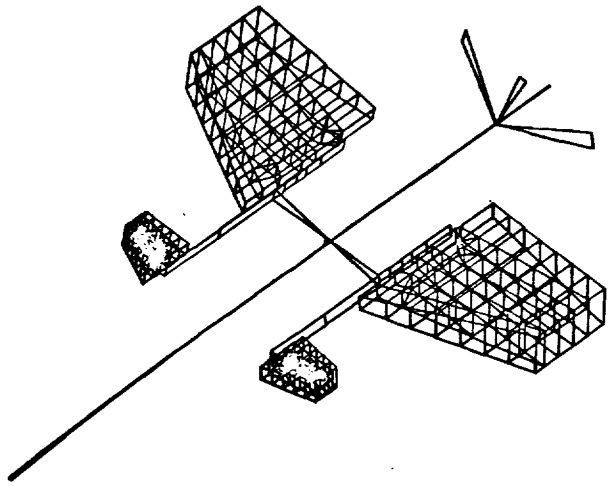
FIGURE 20 (continued)

TFW NASTRAN MODES
(WING FREE)



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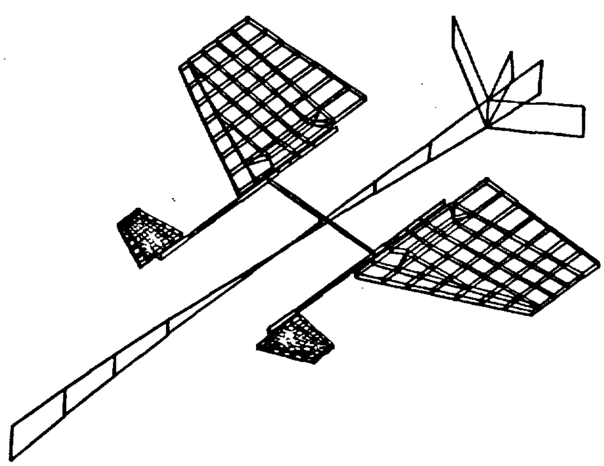
-3046739+ 1 -3046739+ 1 -3046739+ 1 -3299448+ 1 -3299448+ 1
-3299448+ 1 +1033436- 1 +1033436- 1 +1033436- 1 +1033436- 1
+1033436- 1 +1033436- 1 -2704484+ 0 +1033436- 1 +1033436- 1
+1033436- 1 +1033436- 1 +2225045+ 1 -2204377+ 1 -1135625+ 1
+3320117+ 1 +3320117+ 1 +3320117+ 1 +3067408+ 1 +3067408+ 1
+3067408+ 1 +2804170+ 1 +2804170+ 1 +2804170+ 1 +2540931+ 1
+2540931+ 1 +2540931+ 1 +2277693+ 1 +2277693+ 1 +2277693+ 1
+2277693+ 1 +2014455+ 1 +2014455+ 1 +2014455+ 1 +2014455+ 1
+1838963+ 1 +1838963+ 1 +1838963+ 1 +1838963+ 1 +1838963+ 1
+2014455+ 1 +2014455+ 1 +2014455+ 1 +2014455+ 1 +2014455+ 1
+2058328+ 1 +2058328+ 1 +2616393+ 1 +2616393+ 1 +2616393+ 1
+2616393+ 1 +2616393+ 1 +2616393+ 1 +2616393+ 1 +2616393+ 1
+3172703+ 1 +3172703+ 1 +3172703+ 1 +3172703+ 1 +3172703+ 1
+3172703+ 1 +3172703+ 1 +3172703+ 1 +3734278+ 1 +3734278+ 1
+3734278+ 1 +3734278+ 1 +3734278+ 1 +3734278+ 1 +3734278+ 1
+4295853+ 1 +4295853+ 1 +4295853+ 1 +4295853+ 1 +4295853+ 1
+4295853+ 1 +4295853+ 1 +4852163+ 1 +4852163+ 1 +4852163+ 1
+4852163+ 1 +4852163+ 1 +4852163+ 1 +4852163+ 1 +5401454+ 1
+5401454+ 1 +5401454+ 1 +5401454+ 1 +5401454+ 1 +5401454+ 1
+6003392+ 1 +6003392+ 1 +6003392+ 1 +6003392+ 1 +6003392+ 1
+6003392+ 1 -2204377+ 1 +2225045+ 1 +4227456+ 0 +2297043+ 0
+1244090+ 0 +3666289- 1 +1209398- 1 +1209398- 1 +1209398- 1
+1209398- 1 +1209399- 1 +1209399- 1 -1135625+ 1) 0+ 0

Freq = 0

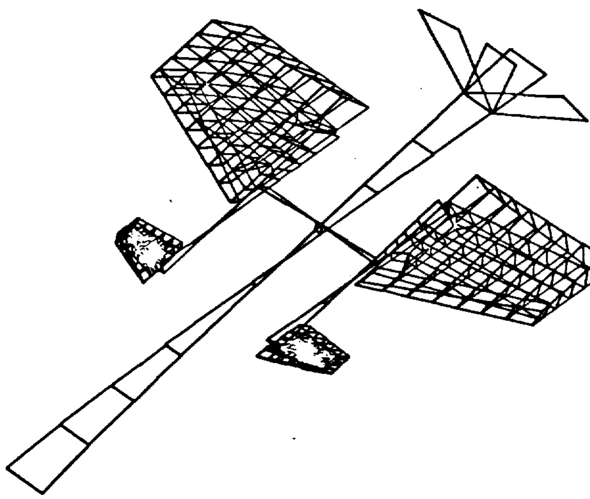


-3679726+ 0 -3679726+ 0 -3679726+ 0 -3679726+ 0 -3679726+ 0
-3679726+ 0 -3691008+ 0 -3691008+ 0 -3691008+ 0 -3691008+ 0
-3691008+ 0 -3691008+ 0 -3701304+ 0 -3701304+ 0 -3701304+ 0
-3701304+ 0 -3701304+ 0 -3701304+ 0 -3701304+ 0 -3711731+ 0
-3711731+ 0 -3711731+ 0 -3711731+ 0 -3711731+ 0 -3711731+ 0
-3711731+ 0 -3722256+ 0 -3722256+ 0 -3722256+ 0 -3722256+ 0
-3722256+ 0 -3722256+ 0 -3722256+ 0 -3732782+ 0 -3732782+ 0
-3732782+ 0 -3732782+ 0 -3732782+ 0 -3732782+ 0 -3732782+ 0
-3732782+ 0 -3743209+ 0 -3743209+ 0 -3743209+ 0 -3743209+ 0
-3743209+ 0 -3743209+ 0 -3743209+ 0 -3743209+ 0 -3753668+ 0
-3753668+ 0 -3754491+ 0 -3754491+ 0 -3754491+ 0 -3754491+ 0
-3754491+ 0 -3757780+ 0 -3757780+ 0 -3757780+ 0 -3757780+ 0
-3757780+ 0 -3754491+ 0 -3754491+ 0 -3754491+ 0 -3754491+ 0
-3749557+ 0 -3749557+ 0 -3749557+ 0 -3749557+ 0 -3744623+ 0
-3744623+ 0 -3744623+ 0 -3739689+ 0 -3739689+ 0 -3739689+ 0
-3734755+ 0 -3734755+ 0 -3734755+ 0 -3730019+ 0 -3730019+ 0
-3730019+ 0 +2511621+ 1 +2018222+ 1 +1547250+ 1 +1052953+ 1
+2603746+ 0 -3792054+ 0 +5069017- 3 -8973195+ 0 -1413146+ 1
-1951400+ 1 -2451976+ 1 -2228266+ 1 -2219964+ 1 +2128503- 2
-3854089+ 0 -3854089+ 0 -3854089+ 0 -3849353+ 0 -3849353+ 0
-3849353+ 0 -3844419+ 0 -3844419+ 0 -3844419+ 0 -3839485+ 0
-3839485+ 0 -3839485+ 0 -3834551+ 0 -3834551+ 0 -3834551+ 0
-3834551+ 0 -3829617+ 0 -3829617+ 0 -3829617+ 0 -3829617+ 0
-3826328+ 0 -3826328+ 0 -3826328+ 0 -3826328+ 0 -3826328+ 0
-3829617+ 0 -3829617+ 0 -3829617+ 0 -3829617+ 0 -3829617+ 0
-3830440+ 0 -3830440+ 0 -3840899+ 0 -3840899+ 0 -3840899+ 0
-3840899+ 0 -3840899+ 0 -3840899+ 0 -3840899+ 0 -3840899+ 0
-3851326+ 0 -3851326+ 0 -3851326+ 0 -3851326+ 0 -3851326+ 0
-3851326+ 0 -3851326+ 0 -3851326+ 0 -3861852+ 0 -3861852+ 0
-3861852+ 0 -3861852+ 0 -3861852+ 0 -3861852+ 0 -3861852+ 0
-3872378+ 0 -3872378+ 0 -3872378+ 0 -3872378+ 0 -3872378+ 0
-3872378+ 0 -3872378+ 0 -3882804+ 0 -3882804+ 0 -3882804+ 0
-3882804+ 0 -3882804+ 0 -3882804+ 0 -3882804+ 0 -3893100+ 0
-3893100+ 0 -3893100+ 0 -3893100+ 0 -3893100+ 0 -3893100+ 0
-3904382+ 0 -3904382+ 0 -3904382+ 0 -3904382+ 0 -3904382+ 0
-3904382+ 0 -1745404+ 1 -1753706+ 1 -7923526- 3 -4305349- 3
-2331798- 3 -6871729- 4 -2266777- 4 -2266777- 4 -2266777- 4
-2266777- 4 -2266777- 4 -2266777- 4 +2128503- 2) 0+ 0

Freq = 0

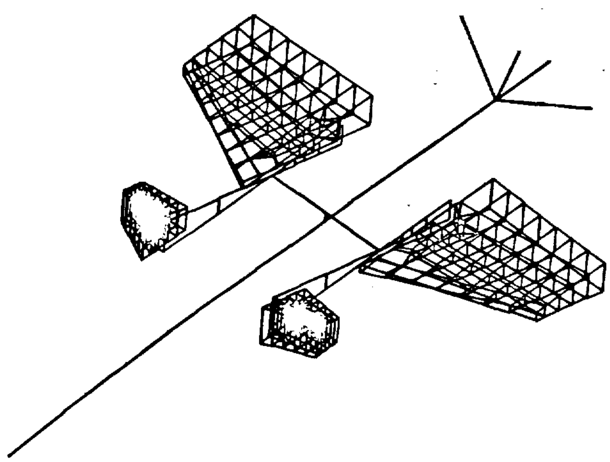
FIGURE 20 (continued)

TFW NASTRAN MODES
(WING FREE)



Freq = 0

-5458073+ 0	-5458073+ C	-5458073+ 0	-5458073+ C	-5458073+ 0
-5458073+ 0	-4908624+ 0	-4908824+ 0	-4908824+ 0	-4908824+ 0
-4908824+ 0	-4908624+ 0	-4407615+ 0	-4407615+ 0	-4407615+ 0
-4407615+ 0	-4407615+ 0	-4407615+ 0	-4407615+ 0	-3900000+ 0
-3900000+ 0	-3900000+ 0	-3900000+ 0	-3900000+ 0	-3900000+ 0
-3900000+ 0	-3387581+ C	-3387581+ 0	-3387561+ 0	-3387581+ 0
-3387581+ 0	-3387581+ 0	-3387581+ 0	-2875162+ 0	-2875162+ 0
-2875162+ 0	-2875162+ 0	-2675162+ 0	-2875162+ 0	-2875162+ 0
-2875162+ 0	-2367547+ 0	-2367547+ 0	-2367547+ 0	-2367547+ 0
-2367547+ 0	-2367547+ 0	-2367547+ 0	-2367547+ 0	-1858330+ 0
-1858330+ 0	-1818298+ 0	-1818298+ 0	-1818298+ 0	-1818298+ 0
-1818298+ 0	-1658167+ 0	-1658167+ 0	-1658167+ 0	-1658167+ 0
-1658167+ 0	-1818298+ 0	-1818298+ 0	-1618298+ 0	-1818298+ 0
-2058494+ 0	-2058494+ 0	-2058494+ 0	-2058494+ 0	-2298690+ 0
-2298690+ 0	-2298690+ 0	-2538887+ 0	-2538887+ 0	-2538887+ 0
-2779083+ 0	-2779083+ 0	-2779083+ 0	-3009672+ 0	-3009672+ 0
-3009672+ 0	+3020454- 3	+4279532- 3	+5481380- 3	+6742748- 3
+8765285- 3	+1039739- 2	+3336598+ 0	+1171954- 2	+1303585- 2
+1440939- 2	+1568678- 2	+2035958+ 0	-2005747+ 0	+1957413+ 1
+3030467+ 0	+3030467+ 0	+3030467+ 0	+2799878+ 0	+2799878+ 0
+2799878+ 0	+2559682+ 0	+2559682+ 0	+2559682+ 0	+2319485+ 0
+2319485+ 0	+2319485+ 0	+2079289+ 0	+2079289+ 0	+2079289+ 0
+2079289+ 0	+1839092+ 0	+1839092+ 0	+1839092+ 0	+1839092+ 0
+1678962+ 0	+1678962+ C	+1678962+ 0	+1678962+ 0	+1678962+ 0
+1839092+ 0	+1839092+ 0	+1839092+ 0	+1839092+ 0	+1839092+ 0
+1879125+ 0	+1879125+ 0	+2388342+ 0	+2388342+ 0	+2388342+ 0
+2388342+ 0	+2388342+ 0	+2388342+ 0	+2388342+ 0	+2388342+ 0
+2895957+ 0	+2895957+ 0	+2895957+ 0	+2895957+ 0	+2895957+ 0
+2895957+ 0	+2895957+ 0	+2895957+ 0	+3408375+ 0	+3408375+ 0
+3408375+ 0	+3408375+ 0	+3408375+ 0	+3408375+ 0	+3408375+ 0
+3920794+ 0	+3920794+ 0	+3920794+ 0	+3920794+ 0	+3920794+ 0
+3920794+ 0	+3920794+ 0	+4428409+ 0	+4428409+ C	+4428409+ 0
+4428409+ 0	+4428409+ 0	+4428409+ 0	+4428409+ 0	+4929619+ 0
+4929619+ 0	+4929619+ 0	+4929619+ 0	+4929619+ 0	+4929619+ 0
+5478868+ 0	+5478868+ 0	+5478868+ 0	+5478868+ 0	+5478868+ 0
+5478868+ 0	-2006958+ 0	+2034747+ 0	-2389003+ 1	-1931124+ 1
-1486852+ 1	-1018501+ 1	-2569280+ 0	+3594408+ 0	+8587519+ 0
+1355858+ 1	+1874578+ 1	+2356988+ 1	+1525147+ 1	) - 0+ 0

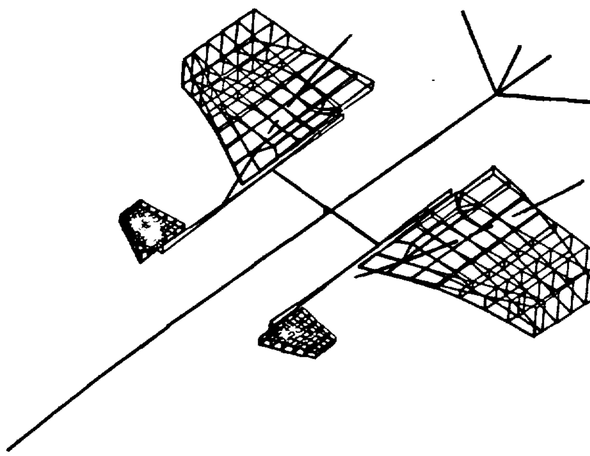


Freq = 0

-5298858+ 1	-4445603+ 1	-3681494+ 1	-2917385+ 1	-2153276+ 1
-1707546+ 1	-5333009+ 1	-4354949+ 1	-3593388+ 1	-2829279+ 1
-1754432+ 1	-1245026+ 1	-5366400+ 1	-4271178+ 1	-3507069+ 1
-2740413+ 1	-1976304+ 1	-1398128+ 1	-8123114+ 0	-5394799+ 1
-4187507+ 1	-3423398+ 1	-2654195+ 1	-1884992+ 1	-1034284+ 1
-3822448+ 0	-5425821+ 1	-4103912+ 1	-3339803+ 1	-2568053+ 1
-1801398+ 1	-6628753+ 0	+4265186- 1	-5454295+ 1	-4015224+ 1
-3251115+ 1	-2484459+ 1	-1715256+ 1	-9078475+ 0	-3016544+ 0
+4802836+ 0	-5485241+ 1	-3926459+ 1	-3162350+ 1	-2393147+ 1
-1629038+ 1	-8190828+ 0	+6473645- 1	+9052562+ 0	-5513665+ 1
-3840267+ 1	-2401826+ 1	-1637719+ 1	-4786202+ 0	+4508456+ 0
+1367776+ 1	-3653167+ 1	-1646108+ 1	+7084505- 1	+2910528+ 1
+5739005+ 1	+6131231+ 1	+5741535+ 1	+5239771+ 1	+4348310+ 1
+5994940+ 1	+5595057+ 1	+5197720+ 1	+4400500+ 1	+5658650+ 1
+5158217+ 1	+4450143+ 1	+5724906+ 1	+5116166+ 1	+4499785+ 1
+5588616+ 1	+5071569+ 1	+4554522+ 1	+5459815+ 1	+5031914+ 1
+4604013+ 1	+2265752- 1	+2638122- 1	+2993566- 1	+3366614- 1
+3964776- 1	+4447469- 1	+3432696- 2	+4838492- 1	+5227788- 1
+5634018- 1	+6011796- 1	+2646029- 1	+9033629- 1	+1368835- 1
+5364355+ 1	+4936454+ 1	+4508553+ 1	+5500445+ 1	+4983398+ 1
+4466351+ 1	+5644327+ 1	+5035587+ 1	+4419206+ 1	+5785663+ 1
+5085230+ 1	+4377156+ 1	+5929546+ 1	+5529662+ 1	+5132326+ 1
+4335105+ 1	+6073429+ 1	+5683733+ 1	+5181968+ 1	+4290508+ 1
+5686264+ 1	+2857788+ 1	+1810433- 1	-1698848+ 1	-3705908+ 1
+1309974+ 1	+3930434+ C	-5366224+ 0	-1695521+ 1	-2459630+ 1
-3899334+ 1	-5572733+ 1	+8300931+ 0	-1042668- 1	-8942459+ 0
-1704201+ 1	-2468310+ 1	-3237513+ 1	-4001622+ 1	-5560404+ 1
+3890756+ 0	-3928625+ 0	-9990555+ 0	-1606464+ 1	-2575667+ 1
-3342323+ 1	-4106432+ 1	-5545503+ 1	-6475296- 1	-7702801+ 0
-1905802+ 1	-2675458+ 1	-3447208+ 1	-4211317+ 1	-5533225+ 1
-5058464+ 0	-1157886+ 1	-2008594+ 1	-2777797+ 1	-3547000+ 1
-4311109+ 1	-5518401+ 1	-9519579+ 0	-1537775+ 1	-2115950+ 1
-2880059+ 1	-3646715+ 1	-4410824+ 1	-5506047+ 1	-1400515+ 1
-1909921+ 1	-2984768+ 1	-3748876+ 1	-4510438+ 1	-5488498+ 1
-1880396+ 1	-2351597+ 1	-3090235+ 1	-3854344+ 1	-4618453+ 1
-5471708+ 1	+8675477- 1	+2287876- 1	-2929930- 2	-7663219- 3
+1601054- 3	+8041391- 3	+1621588- 3	-6418039- 3	-1293082- 2
-1941485- 2	-2618078- 2	-3247311- 2	+1425218- 1	) 0+ 0

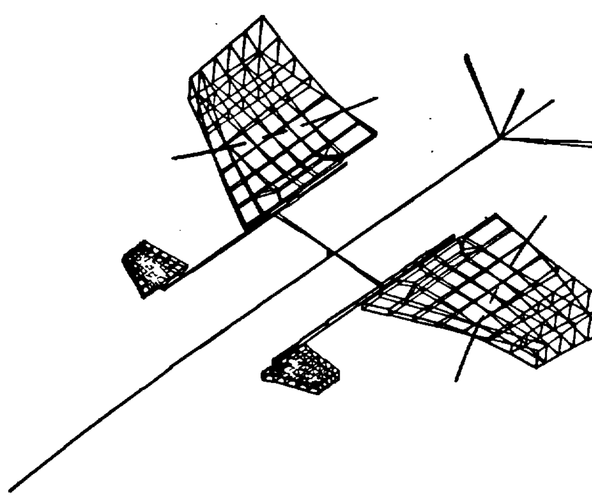
FIGURE 20 (continued)

TFW NASTRAN MODES
(WING FREE)



Freq = 14.26

-1373097+ 2	-1305511+ 2	-1264451+ 2	-1226367+ 2	-1187806+ 2
-1166616+ 2	-1000698+ 2	-9445539+ 1	-9150610+ 1	-8848960+ 1
-8346135+ 1	-8104C93+ 1	-6611793+ 1	-6288905+ 1	-6136188+ 1
-5943380+ 1	-5693150+ 1	-5445140+ 1	-5187636+ 1	-3402984+ 1
-3420014+ 1	-3430944+ 1	-3378031+ 1	-3263654+ 1	-3046435+ 1
-2840935+ 1	-6884103+ 0	-1028196+ 1	-1190465+ 1	-1284386+ 1
-1329960+ 1	-1293775+ 1	-1250595+ 1	+1281607+ 1	+7476118+ 0
+4767629+ 0	+2527027+ 0	+4407007- 1	-1567209+ 0	-2939251+ 0
-5054072+ 0	+2498845+ 1	+1864557+ 1	+1530804+ 1	+1205329+ 1
+8752768+ 0	+5204783+ C	+1472870+ 0	-1781408+ 0	+3276247+ 1
+2400784+ 1	+1742168+ 1	+1360504+ 1	+7750664+ C	+3935916+ 0
+8672597- 1	+2391645+ 1	+1363461+ 1	+4798877+ 0	-1014465+ 1
-2523624+ 1	-2710574+ 1	-2511574+ 1	-2254200+ 1	-1804345+ 1
-2624982+ 1	-2421457+ 1	-2221928+ 1	-1825097+ 1	-2546792+ 1
-2197008+ 1	-1846528+ 1	-2478090+ 1	-2176402+ 1	-1871043+ 1
-2412225+ 1	-2156691+ 1	-1900451+ 1	-2351519+ 1	-2140086+ 1
-1928056+ 1	+1949661+ 0	+2163729+ 0	+2376507+ 0	+2615885+ 0
+3042270+ 0	+3426241+ 0	+1869066- 1	+3767227+ 0	+4129240+ 0
+4522064+ 0	+4893839+ 0	+2981410+ 0	+6465799+ 0	+7471250- 1
-2900199+ 1	-2694848+ 1	-2488900+ 1	-2915801+ 1	-2667351+ 1
-2419340+ 1	-2935144+ 1	-2641149+ 1	-2344246+ 1	-2958359+ 1
-2616124+ 1	-2275212+ 1	-2992631+ 1	-2792116+ 1	-2596326+ 1
-2209672+ 1	-3035642+ 1	-2899047+ 1	-2584880+ 1	-2145110+ 1
-2823510+ 1	-1306872+ 1	+1928712+ 0	+1080017+ 1	+2114447+ 1
-2740464+ C	+6266653- 1	+4618293+ C	+1051175+ 1	+1436308+ 1
+2103561+ 1	+2982411+ 1	-5657971+ 0	-2183639+ 0	+1772558+ 0
+5375913+ 0	+6802792+ C	+1218483+ 1	+1563734+ 1	+2231299+ 1
-9079305+ 0	-6638411+ C	-4975825+ 0	-2607974+ 0	-2042238- 1
+2328820+ 0	+5257756+ C	+1094542+ 1	-1618541+ 1	-1593798+ 1
-1528332+ 1	-1423791+ 1	-1277668+ 1	-1074213+ 1	-6776036+ 0
-3054042+ 1	-3165885+ 1	-3273234+ 1	-3300051+ 1	-3274115+ 1
-3193529+ 1	-3057692+ 1	-5120383+ 1	-5281359+ 1	-5435517+ 1
-5572954+ 1	-5660042+ 1	-5710864+ 1	-5849874+ 1	-7662594+ 1
-7814992+ 1	-8129246+ 1	-8303021+ 1	-8468870+ 1	-8820990+ 1
-1075772+ 2	-1089166+ 2	-1112423+ 2	-1135988+ 2	-1162062+ 2
-1210025+ 2	+6115104+ C	+2630716+ 0	-1611597- 1	-4225701- 2
+8934461- 3	+4439025- 2	+9213454- 3	-3531745- 2	-7121701- 2
-1063685- 1	-1426517- 1	-1762252- 1	+7772517- 1	) 0+ 0

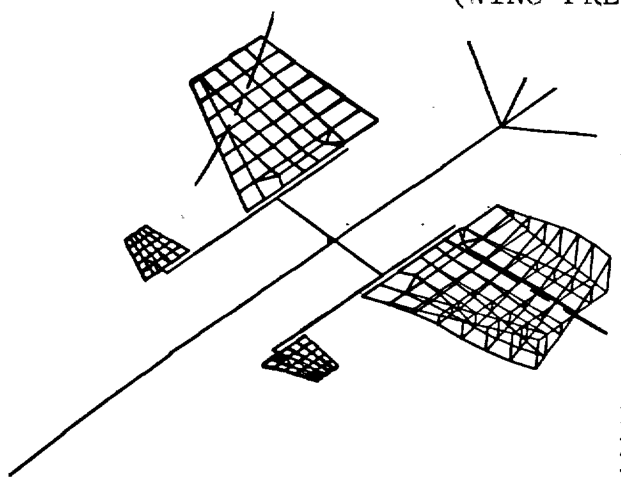


Freq = 16.91

-1331557+ 2	-1166081+ 2	-1050771+ 2	-9420432+ 1	-8346180+ 1
-7743376+ 1	-9922149+ 1	-6291600+ 1	-7295136+ 1	-6314098+ 1
-4865723+ 1	-4167507+ 1	-6782673+ 1	-5370328+ 1	-4561927+ 1
-3727566+ 1	-2845476+ 1	-2117879+ 1	-1356191+ 1	-3797992+ 1
-2790650+ 1	-2192525+ 1	-1546665+ 1	-8477512+ 0	+6956368- 2
+7185419+ 0	-1353597+ 1	-7159840+ 0	-3361429+ C	+1046640+ 0
+5936192+ 0	+1391250+ 1	+1908711+ 1	+2668333+ 0	+6883543+ 0
+9149508+ 0	+1181371+ 1	+1456245+ 1	+1757001+ 1	+1954893+ 1
+2266836+ 1	+1080641+ 1	+1413566+ 1	+1543182+ 1	+1673540+ 1
+1792408+ 1	+1918153+ 1	+2078928+ 1	+2281677+ 1	+1440923+ 1
+1531399+ 1	+1662051+ 1	+1717242+ 1	+1790507+ 1	+1960235+ 1
+2224306+ 1	+1442757+ 1	+1567163+ 1	+1659538+ 1	+1814373+ 1
+1991114+ 1	+2155201+ 1	+2153609+ 1	+2148953+ 1	+2160720+ 1
+2404806+ 1	+2405478+ 1	+2411363+ 1	+2434404+ 1	+2669132+ 1
+2686257+ 1	+2712222+ 1	+2950819+ 1	+2572911+ 1	+2996368+ 1
+3242649+ 1	+3264410+ 1	+3284900+ 1	+3526991+ 1	+3545888+ 1
+3563453+ 1	-1474798- 1	-1755714- 1	-1963952- 1	-2124739- 1
-2387184- 1	-2668430- 1	+2209950+ 0	-2950930- 1	-3257156- 1
-3593234- 1	-3912827- 1	-2092655+ 1	+2017330+ 1	+8798617+ 0
-3136945+ 1	-3186150+ 1	-3234504+ 1	-2852481+ 1	-2910789+ 1
-2968555+ 1	-2559696+ 1	-2624903+ 1	-2692908+ 1	-2275570+ 1
-2342836+ 1	-2420150+ 1	-2005604+ 1	-2035623+ 1	-2070319+ 1
-2152292+ 1	-1747838+ 1	-1774650+ 1	-1807702+ 1	-1887845+ 1
-1612516+ 1	-1652424+ 1	-1711824+ 1	-1746474+ 1	-1772541+ 1
-2198709+ 1	-1992184+ 1	-1882994+ 1	-1893762+ 1	-1893834+ 1
-1857632+ 1	-1896746+ 1	-2197624+ 1	-2051693+ 1	-1950570+ 1
-1875081+ 1	-1803598+ 1	-1720269+ 1	-1640336+ 1	-1405121+ 1
-2111610+ 1	-1872981+ 1	-1654430+ 1	-1381022+ 1	-1134641+ 1
-8999277+ 0	-7138959+ 0	-3720985+ 0	-1594792+ 1	-1071838+ 1
-2621545+ 0	+2179449+ 0	+6532502+ 0	+1009750+ 1	+1584297+ 1
-9310064- 1	+6423101+ 0	+1531682+ 1	+2249730+ 1	+2903356+ 1
+3484229+ 1	+4439243+ 1	+2404038+ 1	+3192954+ 1	+3956036+ 1
+4875707+ 1	+5736047+ 1	+6553732+ 1	+7889031+ 1	+5692725+ 1
+6421677+ 1	+7945506+ 1	+8967740+ 1	+9988071+ 1	+1156372+ 2
+9813225+ 1	+1049827+ 2	+1160324+ 2	+1274563+ 2	+1393657+ 2
+1559057+ 2	+2020338+ 1	-2089642+ 1	-1911680+ 0	-5012807- 1
+1069524- 1	+5290565- 1	+1197232- 1	-4018914- 1	-8271207- 1
-1250107+ 0	-1691315+ 0	-2101747+ 0	+9166297+ 0	) 0+ 0

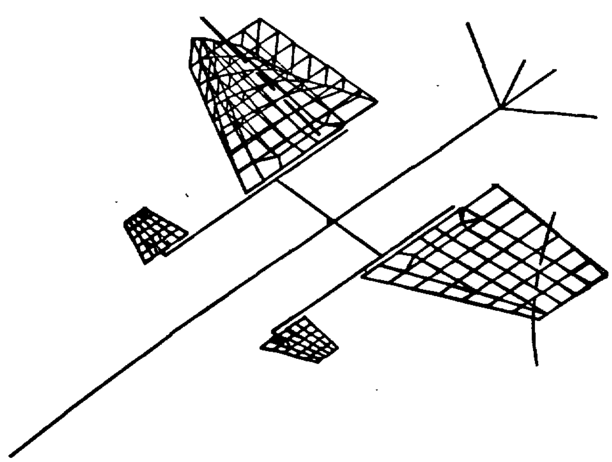
FIGURE 20 (continued)

TFW NASTRAN MODES
(WING FREE)



Freq = 33.20

+2383560+	2	+1039085+	2	+9942639+	0	-7546599+	1	-1551060+	2
-2017523+	2	+2397976+	2	+9607084+	1	+1373645+	1	-5996557+	1
-1504079+	2	-1924914+	2	+2225649+	2	+8293137+	1	+1426458+	1
-4546827+	1	-9639254+	1	-1298690+	2	-1635219+	2	+1867366+	2
+6501720+	1	+1284749+	1	-3132555+	1	-6729677+	1	-9707560+	1
-1168219+	2	+1402128+	2	+4510968+	1	+9691308+	0	-1899593+	1
-4063916+	1	-5847540+	1	-6359502+	1	+9133611+	1	+2567446+	1
+5393682+	0	-9399913+	0	-1939211+	1	-2557454+	1	-2762893+	1
-2769009+	1	+4673009+	1	+1050868+	1	+1739084+	0	-2711601+	0
-5384001+	0	-6937979+	0	-9154299+	0	-1033461+	1	+4776236+	0
+2845181+	0	+1301567+	0	+1276971+	0	+2094815+	0	+3506579+	0
+4914897+	0	+2192947+	0	+1156673+	0	+2448815+	0	+5760665+	0
+9481216+	0	+9906556+	0	+9714526+	0	+9426155+	0	+9183074+	0
+1029441+	1	+1012679+	1	+1003926+	1	+1000809+	1	+1090879+	1
+1084473+	1	+1089549+	1	+1178718+	1	+1182896+	1	+1168069+	1
+1281243+	1	+1288603+	1	+1293771+	1	+1385669+	1	+1392725+	1
+1397701+	1	+1415112-	1	+1229425-	1	+1117192-	1	+1092021-	1
+1209915-	1	+1417460-	1	+3133750-	1	+1665351-	1	+1978402-	1
+2349451-	1	+2713532-	1	-2647969+	0	+3156938+	0	+1238600+	0
+3959648+	0	+3495914+	0	+3024610+	0	+4190438+	0	+3632190+	0
+3063278+	0	+4447306+	0	+3786790+	0	+3111191+	0	+4740639+	0
+3962622+	0	+3191099+	0	+5119153+	0	+4643157+	0	+4194186+	0
+3304325+	0	+5572627+	0	+5106816+	0	+4491370+	0	+3435676+	0
+5327515+	0	+1446365+	0	-2221043+	0	-4413729+	0	-7400376+	0
-1416016+	0	-2181169+	0	-3131068+	0	-4636776+	0	-5721256+	0
-8085427+	0	-1075073+	1	-2063141+	0	-2927802+	0	-4023241+	0
-5165436+	0	-6400335+	0	-7870897+	0	-9891377+	0	-1729253+	1
-2408288+	0	-3077744+	0	-3725607+	0	-4916663+	0	-6468940+	0
-8580638+	0	-1148335+	1	-2174091+	1	-1341479+	0	-1742060+	0
-3284879+	0	-5234670+	0	-8008340+	0	-1173142+	1	-2305192+	1
+2464415+	0	+1776559+	0	+2355569-	1	-2120977+	0	-5405705+	0
-9694563+	0	-2070670+	1	+8522980+	0	+7258519+	0	+5816114+	0
+3089904+	0	-5655014-	1	-5132989+	0	-1482308+	1	+1618080+	1
+1433337+	1	+1011361+	1	+6167052+	0	+1577769+	0	-6052502+	0
+2524658+	1	+2279466+	1	+1912113+	1	+1493620+	1	+1044105+	1
+5231484+	0	+3122929+	0	-2681955+	0	-2821123-	1	-7460938-	2
+1649874-	2	+7964953-	2	+2378415-	2	-5136544-	2	-1139730-	1
-1764719-	1	-2416452-	1	-3028116-	1	+1293151+	0	) 0+	0

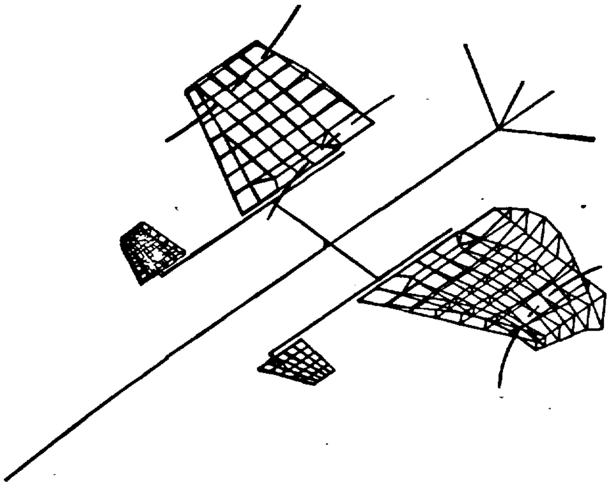


Freq = 34.75

-3790419+	1	-2498468+	1	-1707151+	1	-1002689+	1	-3341294+	0
+4700312-	1	-2543068+	1	-1390192+	1	-7771706+	0	-2112289+	0
+5616908+	0	+9410441+	0	-1290890+	1	-4666130+	0	-4878713-	1
+3534958+	0	+7462777+	0	+1048716+	1	+1381767+	1	-1006125+	0
+2539696+	0	+4702522+	0	+6990419+	0	+9275266+	0	+1169498+	1
+1378414+	1	+7712639+	0	+6920773+	0	+7456191+	0	+8237193+	0
+9051220+	0	+9887646+	0	+1028304+	1	+1187230+	1	+8590273+	0
+8087125+	0	+7797601+	0	+7533845+	0	+7192194+	0	+6869647+	0
+6309482+	0	+1183992+	1	+8326611+	0	+7361654+	0	+6474873+	0
+5632306+	0	+4764635+	0	+4085486+	0	+3517954+	0	+9344241+	0
+7088973+	0	+5006950+	0	+4002960+	0	+2526459+	0	+1519041+	0
+7163127-	1	+6454262+	0	+3805083+	0	+1658921+	0	-2069514+	0
-6077725+	0	-6339513+	0	-5905938+	0	-5329688+	0	-4396531+	0
-5984013+	0	-5546971+	0	-5149398+	0	-4392315+	0	-5733057+	0
-5058148+	0	-4413793+	0	-5600669+	0	-5044442+	0	-4479810+	0
-5523628+	0	-5059995+	0	-4584940+	0	-5472684+	0	-5089009+	0
-4696198+	0	-2064757-	1	-1917957-	1	-1792957-	1	-1714306-	1
-1794073-	1	-2079030-	1	+2454091-	1	-2471482-	1	-2972756-	1
-3569679-	1	-4156392-	1	-2667327+	0	+1890445+	0	+9733538-	1
-1314165+	1	-1323872+	1	-1331598+	1	-1215042+	1	-1225501+	1
-1233985+	1	-1118136+	1	-1125701+	1	-1134846+	1	-1036176+	1
-1033126+	1	-1042848+	1	-9811252+	0	-9656220+	0	-9586059+	0
-9606591+	0	-9492488+	0	-9309546+	0	-9035882+	0	-8847429+	0
-9125352+	0	-5346002+	0	-2001832+	0	-7220498-	1	-1872189+	0
-4057869+	0	-2897689+	0	-1595149+	0	-7855931-	1	-8381959-	1
-2471007+	0	-4536157+	0	+1216505+	1	+1066984+	1	+8172224+	0
+6474603+	0	+3627262+	0	-1062823+	0	-1022280+	1	-4757534+	1
+3057634+	1	+3028650+	1	+2798444+	1	+2135019+	1	+1077131+	1
-4776315+	0	-2596128+	1	-9374506+	1	+6835330+	1	+6270778+	1
+4360920+	1	+2072837+	1	-9426339+	0	-4646617+	1	-1449406+	2
+1238644+	2	+1027916+	2	+7113236+	1	+3313653+	1	-1331642+	1
-6794745+	1	-1944257+	2	+1717091+	2	+1360747+	2	+1006269+	2
+4688334+	1	-1554837+	1	-6795285+	1	-2336017+	2	+2000714+	2
+1557497+	2	+6040797+	1	-1710722+	1	-1035559+	2	-2540566+	2
+2071928+	2	+1553258+	2	+7431699+	1	-1547399+	1	-1142594+	2
-2557798+	2	+1945197+	0	-2612556+	0	-2223673-	1	-5916124-	2
+1289400-	2	+6267124-	2	+1865475-	2	-4089062-	2	-9025392-	2
-1389102-	1	-1693879-	1	-2362870-	1	+1015361+	0	) 0+	0

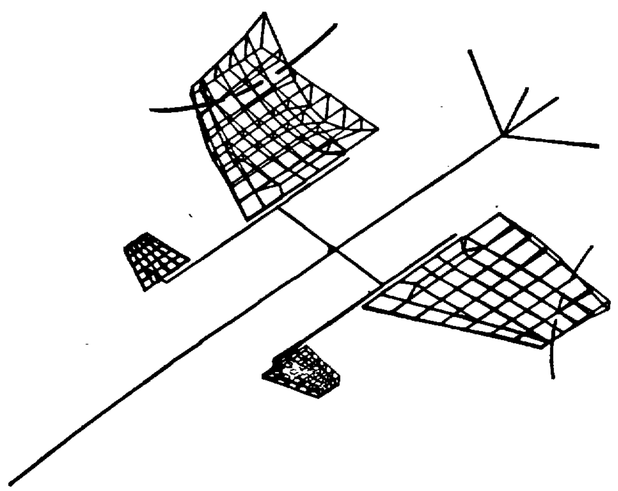
FIGURE 20 (continued)

TFW NASTRAN MODES
(FREE WING)



Freq = 48.23

-2580939+	2	-1801495+	2	-1439238+	2	-1123903+	2	-7990991+	1
-6102025+	1	-8039269+	1	-6000138+	1	-4541194+	1	-2724592+	1
+8105652+	C	+2869242+	1	+7389072+	1	+2727317+	1	+2275778+	1
+2786374+	1	+4079148+	1	+5537841+	1	+7469496+	1	+1784677+	2
+7639681+	1	+5859357+	1	+5338199+	1	+5678926+	1	+6715175+	1
+8020829+	1	+2063619+	2	+8319301+	1	+6144879+	1	+5155725+	1
+4940717+	1	+5253587+	1	+5694945+	1	+1675980+	2	+5915253+	1
+4131218+	1	+3256076+	1	+2931303+	1	+2870489+	1	+2902175+	1
+2961232+	1	+9153208+	1	+2456502+	1	+1437334+	1	+1000210+	1
+8175264+	0	+7651122+	0	+9259231+	0	+1056484+	1	-8402950-	1
-3046748+	0	-6238587+	C	-8622225+	0	-7777236+	C	-7748797+	0
-8587393+	0	-7324203+	C	-8667730+	0	-6486314+	0	-2712345-	1
+6554300+	0	+7013600+	0	+6107065+	0	+4911505+	0	+2745773+	0
+6121238+	0	+5176433+	0	+4278188+	0	+2414102+	0	+5360894+	0
+3756608+	0	+2111989+	C	+4736223+	0	+3326536+	0	+1867881+	0
+4147004+	0	+2928679+	C	+1686387+	0	+3591339+	0	+2566902+	0
+1529683+	0	-3481733+	0	-2494637+	0	-1734104+	0	-1227786+	0
-1038529+	0	-1407381+	C	-7390703-	1	-2065739+	0	-2982410+	0
-4113707+	0	-5240593+	0	+2111001+	0	-1154300+	1	-2900460+	0
+5549051+	1	+5909490+	1	+6254037+	1	+4798368+	1	+5220052+	1
+5627075+	1	+4069436+	1	+4521474+	1	+4994335+	1	+3465470+	1
+3882252+	1	+4412946+	1	+3072600+	1	+3197782+	1	+3386735+	1
+3908244+	1	+2859255+	1	+2952677+	1	+3042448+	1	+3454479+	1
+2884591+	1	+1517300+	1	+4242443+	0	-6936584-	1	-5945652+	0
+1083230+	1	+6637409+	0	+3196563+	0	-4211808-	2	-2050180+	0
-4966134+	0	-9216897+	0	+1426549+	1	+1034295+	1	+6882527+	0
+4634401+	0	+2898409+	0	+1719375+	0	+1844755+	0	+1013643+	1
+1733455+	1	+1368301+	1	+1122632+	1	+8775310+	0	+7526626+	0
+7818722+	0	+1024554+	1	+2890046+	1	+2019838+	1	+1563490+	1
+1124650+	1	+1051967+	1	+1220047+	1	+1690562+	1	+4292421+	1
+1782661+	1	+1291354+	1	+9433768+	0	+9033210+	0	+1160791+	1
+1773029+	1	+4497478+	1	+7163282+	0	+3635128+	0	+1439231+	0
+1177929+	0	+4051224+	0	+1029601+	1	+3235030+	1	-1091032+	1
-1232187+	1	-1310673+	1	-1027757+	1	-4961853+	0	+8759221+	0
-3538414+	1	-3474291+	1	-3377420+	1	-3116559+	1	-2726913+	1
-2228473+	1	-1049502+	1	+3158877+	0	+7100163-	1	+1930695-	1
-4213727-	2	-2037376-	1	-7788461-	2	+1071570-	1	+2638802-	1
+4168323-	1	+5745586-	1	+7208907-	1	-3037513+	0	) 0+	0

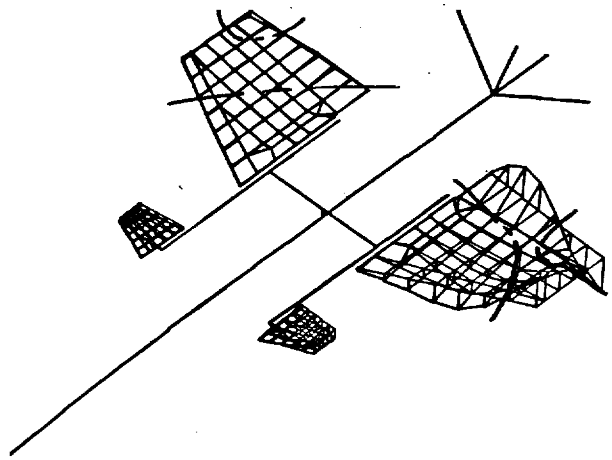


Freq = 50.06

-6811901+	1	-3823171+	1	-2161368+	1	-7225025+	0	+6289058+	0
+1463410+	1	-3500578+	1	-1700448+	1	-6904350+	0	+2335592+	0
+1394382+	1	+1955884+	1	-2203199+	0	-1582098-	1	+3734141+	0
+7888466+	0	+1168347+	1	+1411147+	1	+1642282+	1	+2413858+	1
+1101584+	1	+9760214+	0	+9675563+	0	+9769772+	0	+9126230+	0
+7875213+	0	+3710549+	1	+1490170+	1	+1074748+	1	+8074302+	0
+5903987+	0	+1736640+	0	-1997192+	0	+3655798+	1	+1286571+	1
+8016163+	0	+4545761+	0	+1650634+	0	-1498467+	0	-4258651+	0
-8385451+	0	+2619505+	1	+8316152+	0	+4221553+	0	+1112594+	0
-1560148+	0	-4281643+	0	-7782232+	0	-1219024+	1	+1022967+	1
+4692179+	0	-5415809-	1	-2858237+	0	-5981721+	0	-1007565+	1
-1581946+	1	+4018239+	0	-2229480+	0	-6630800+	0	-1601327+	1
-2830664+	1	-2754674+	1	-2917708+	1	-3087510+	1	-3676217+	1
-3035240+	1	-3236298+	1	-3509976+	1	-4221627+	1	-3529205+	1
-4113890+	1	-4829243+	1	-4275885+	1	-4891843+	1	-5529984+	1
-5174579+	1	-5743365+	1	-6292545+	1	-6099442+	1	-6564202+	1
-7048616+	1	+2520633+	C	+1816033+	0	+1244554+	0	+8279485-	1
+6187025-	1	+8690785-	1	-1018694+	0	+1362212+	0	+2054230+	0
+2910765+	0	+3764841+	0	+1271707+	1	-5982834+	0	-3965980+	0
+1833995+	1	+2095727+	1	+2352581+	1	+1472036+	1	+1760306+	1
+2085704+	1	+1115826+	1	+1457302+	1	+1814052+	1	+8076693+	0
+1154993+	1	+1556677+	1	+5728778+	0	+7263413+	0	+9022470+	0
+1324604+	1	+3989593+	0	+5344733+	0	+7002520+	0	+1110307+	1
+4650351+	C	+6035922+	C	+7956081+	0	+8133939+	0	+4245027+	0
+1199893+	1	+5948567+	0	+8796389+	0	+8244918+	0	+6899647+	0
-2351269-	1	-4562823+	0	-7886390+	0	-7673562+	0	-7195056+	0
-8796466+	0	-1163987+	1	-1707955+	1	-2834911+	1	-9683122+	1
-2777160+	1	-2834398+	1	-2892832+	1	-3069444+	1	-3501347+	1
-4481764+	1	-6368230+	1	-1730667+	2	-5659993+	1	-5331059+	1
-5174669+	1	-5480183+	1	-6552668+	1	-8801016+	1	-2108754+	2
-8203225+	1	-6947689+	1	-5969889+	1	-5672838+	1	-6226025+	1
-8016395+	1	-1790471+	2	-7768022+	1	-5801595+	1	-4319491+	1
-2997225+	1	-2448213+	1	-2828239+	1	-6908854+	1	-3041616+	1
-8944558+	0	+2799060+	1	+4719176+	1	+6307407+	1	+8862634+	1
+6412043+	1	+8490777+	1	+1177611+	2	+1507176+	2	+1883335+	2
+2680772+	2	-6776756+	0	+1192297+	1	+9858862-	1	+2679420-	1
-6000498-	2	-2857365-	1	-1179952-	1	+1333778-	1	+3506253-	1
+5682440-	1	+7965432-	1	+1010134+	0	-4156785+	0	) 0+	0

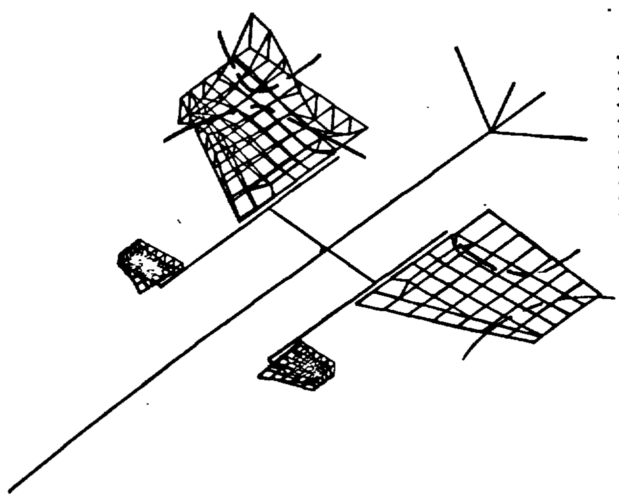
FIGURE 20 (continued)

TFW NASTRAN MODES
(FREE WING)



Freq = 67.22

-2605852+	2	-1955307+	1	+7967396+	1	+1418843+	2	+1791298+	2
+2005936+	2	-2368572+	2	-3316429+	1	+2834847+	1	+5993709+	1
+5327863+	1	+4612217+	1	-1178872+	2	-2495637+	1	-1958586+	0
+1958351+	0	-1355095+	1	-3943065+	1	-8C59078+	1	+6033660+	1
-5210780+	0	-1549800+	1	-3C19186+	1	-5369080+	1	-9348093+	1
-1444167+	2	+1980434+	2	+1089761+	1	-1666745+	1	-3750588+	1
-5883858+	1	-9555514+	1	-1284585+	2	+2271323+	2	+1453581+	1
-1227298+	1	-2824187+	1	-4085000+	1	-5436656+	1	-6555264+	1
-7996407+	1	+1499582+	2	+9062684+	0	-6429306+	0	-1303848+	1
-1753648+	1	-2195952+	1	-3415991+	1	-4976620+	1	+1039180+	1
+3995694+	0	+7670928-	1	+3293643-	2	+3297138-	1	-5966766+	0
-1968045+	1	+4527948+	0	+2842679-	1	+6361537-	1	+4459283+	0
+1062315+	1	+6405352+	0	+1092839+	1	+1607635+	1	+2980776+	1
+9705950+	0	+1492416+	1	+2116435+	1	+3640350+	1	+1619648+	1
+2901732+	1	+4397938+	1	+2657357+	1	+3957736+	1	+5299075+	1
+3944958+	1	+5132975+	1	+6290048+	1	+5286345+	1	+6298394+	1
+7276805+	1	+2448771+	0	+1212005+	0	+2654485-	1	-3784651-	1
-7527818-	1	-5481364-	1	+2012785-	1	-6635942-	2	+6279230-	1
+1495994+	0	+2364742+	0	+1573305-	1	+3762120+	0	+7538301-	1
-3270561+	1	-3919216+	1	-4546661+	1	-2419563+	1	-3181431+	1
-3923643+	1	-1601660+	1	-2437142+	1	-3297695+	1	-9397900+	0
-1767549+	1	-2727424+	1	-5191899+	0	-8616507+	0	-1266517+	1
-2246540+	1	-2960951+	0	-5950802+	0	-9371447+	0	-1826824+	1
-5678454+	0	-3109842+	0	-2C11306+	0	-1934326+	0	-1395651+	0
-6217521+	0	-3502032+	0	-2157494+	0	-2086187+	0	-1941107+	0
-1417546+	0	-7578167-	1	-7679228+	0	-5335502+	0	-3760829+	0
-3180425+	0	-2633128+	0	-1865184+	0	-3148636-	1	+1127605+	1
-9101855+	0	-7033742+	0	-5658164+	0	-4172811+	0	-2839714+	0
-1129206+	0	+1627804+	0	+2057033+	1	-1092943+	1	-7756865+	0
-4224711+	0	-2229930+	0	-6113404-	2	+3084541+	0	+2311749+	1
-9109875+	0	-5372380+	0	-2375268+	0	-6036502-	1	+6027541-	1
+2560772+	0	+1459365+	1	-1760635+	0	+3504341-	1	+1600092+	0
+1950663+	0	+1135880+	0	-4972543-	1	-3262350+	0	+8416217+	0
+7667790+	0	+5027495+	0	+9222705-	1	-5190826+	0	-2192207+	1
+1784962+	1	+1402407+	1	+8291908+	0	+5179895-	1	-1045654+	1
-3563663+	1	+2955243+	0	-6494780-	1	-2205122-	1	-6498010-	2
+1053863-	2	+6307418-	2	+3727725-	2	-1286437-	2	-5996502-	2
-1087552-	1	-1610692-	1	-2106152-	1	+7978975-	1	) 0+	0

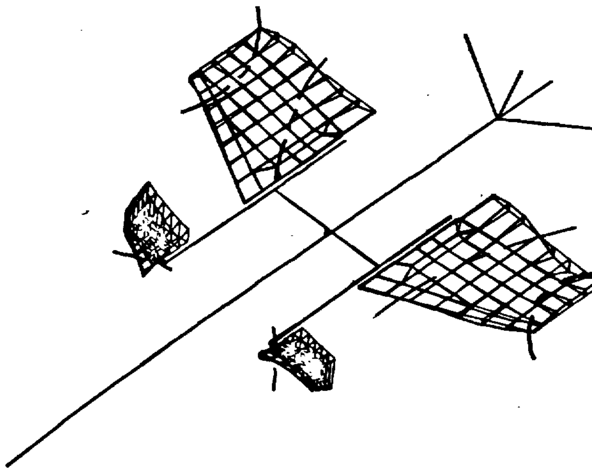


Freq = 70.15

-8659312+	0	+106661C+	C	+4175963+	0	+5562821+	0	+5856022+	0
+5908748+	C	-8859120+	0	-2983624-	1	+1561834+	0	+2065830+	0
+1088099+	0	+1778371-	1	-5836295+	0	-6741474-	1	-4434309-	2
-2771003-	1	-1159540+	C	-2219472+	0	-3657715+	0	+9143399-	1
-3515031-	1	-832747C-	1	-1515892+	0	-2387439+	C	-3555823+	0
-4744637+	C	+7594482+	0	+8606876-	2	-9751539-	1	-1696814+	0
-2279934+	0	-2885576+	0	-3169619+	0	+9219022+	0	+1496938-	1
-7721707-	1	-1175220+	0	-1349609+	0	-1369081+	C	-1236788+	0
-7822943-	1	+5557062+	0	-6724069-	2	-4324916-	1	-4031597-	1
-2866093-	1	-9816610-	2	+2474618-	1	+9456336-	1	-5910330-	1
-2000200-	1	+2301957-	1	+4526947-	1	+7853270-	1	+1525872+	0
+2762060+	C	-8148516-	2	+4574230-	1	+9239393-	1	+4009935+	0
+9657877+	0	+3109193+	0	+9956510+	0	+1775455+	1	+3796152+	1
+7709651+	0	+1554727+	1	+2478476+	1	+4711632+	1	+1682331+	1
+3576247+	1	+5768436+	1	+3148181+	1	+5062629+	1	+7031654+	1
+4975211+	1	+6722758+	1	+6423367+	1	+6882411+	1	+8371249+	1
+9810C68+	1	-2918969+	0	-1372814+	0	-1859583-	1	+6270543-	1
+1112767+	0	+8730599-	1	-1858598-	2	+2910623-	1	-5454025-	1
-1590141+	0	-2635295+	0	-2015499+	0	-2280684+	0	-5660264-	2
-8894095+	1	-1083938+	2	-1272378+	2	-6455013+	1	-8736799+	1
-1096481+	2	-4119347+	1	-6616745+	1	-9198036+	1	-2247137+	1
-4714623+	1	-7591526+	1	-1085648+	1	-2102577+	1	-3306336+	1
-6245611+	1	-5041593+	0	-1386640+	1	-2401360+	1	-5078522+	1
-1352466+	1	-4461995+	0	+1066186+	0	+1747894+	0	-2172693+	0
+2378423+	1	+8579408+	0	+1607602+	0	+2104080+	0	+1479637+	0
-1678784+	0	-7781983+	0	+5322311+	1	+3653916+	1	+2378781+	1
+1926470+	1	+1469542+	1	+7926912+	0	-7922362+	0	-1499469+	2
+8254071+	1	+6711664+	1	+5540987+	1	+4149400+	1	+2855561+	1
+1203517+	1	-1570956+	1	-2322841+	2	+1283211+	2	+9490819+	1
+5758002+	1	+3598107+	1	+1447505+	1	-1456279+	1	-2104154+	2
+1393482+	2	+8940044+	1	+5026717+	1	+2729094+	1	+1250823+	1
+8189341-	1	-7713010+	1	+7163087+	1	+3297700+	1	+8857182+	0
-4565476+	0	+7604193-	1	+2365443+	1	+1054091+	2	-5524968+	1
-6389334+	1	-5968562+	1	-2449546+	1	+3947451+	1	+2415225+	2
-2057796+	2	-1781876+	2	-1357224+	2	-6733871+	1	+3795334+	1
+2873611+	2	-1309891+	0	-1044743+	0	+2447183-	2	+6411389-	3
-2269486-	3	-7995560-	3	-9349690-	3	-9573323-	3	-7337644-	3
-1035169-	3	+8348241-	3	+1842840-	2	-6524016-	2	) 0+	0

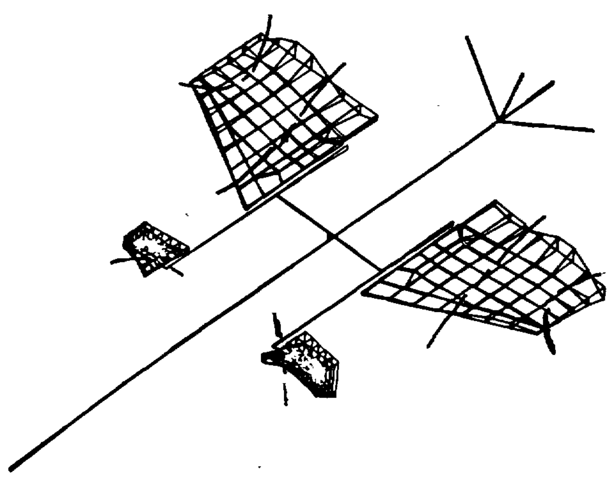
FIGURE 20 (continued)

TFW NASTRAN MODES
(FREE WING)



+6608012+	1	+6435296+	1	+5728833+	1	+4265732+	1	+1943280+	1
+2530879+	0	-6192128+	1	+1085297+	1	+1660482+	1	+8742007+	0
-1867758+	1	-3853069+	1	-1217526+	2	-1503660+	1	-4432299+	0
-8044532+	0	-2018090+	1	-3293136+	1	-5105874+	1	-9251177+	1
-1505760+	1	-7938992+	0	-1022782+	1	-1776255+	1	-2840990+	1
-3947343+	1	-6170140+	0	+4002182-	1	+5379154-	2	-2902955+	0
-7492211+	0	-1289868+	1	-1497632+	1	+6364070+	1	+1572622+	1
+1042467+	1	+6964876+	0	+3941681+	0	+1732553+	0	+1523140+	0
+3653858+	0	+7130020+	1	+2253071+	1	+1703940+	1	+1401783+	1
+1163664+	1	+9848749+	0	+9735254+	0	+1293942+	1	+2900078+	1
+2192733+	1	+1687290+	1	+1474527+	1	+1221982+	1	+1479381+	1
+2179839+	1	+2077805+	1	+1403130+	1	+1032307+	1	-1462801+	0
-2008140+	1	+1712762+	0	-2013505+	1	-4512873+	1	-1102145+	2
-1135139+	1	-3643605+	1	-6592956+	1	-1375637+	2	-3652376+	1
-9906973+	1	-1693292+	2	-8308866+	1	-1443643+	2	-2075271+	2
-1390902+	2	-1950916+	2	-2496839+	2	-1977360+	2	-2454940+	2
-2917015+	2	-3524988+	0	-1615989+	0	-1171012-	1	+9520724-	1
+1642449+	0	+1367549+	0	+1379208+	0	+6377846-	1	-4074987-	1
-1711353+	0	-3015098+	0	-1456441+	1	+9749511+	0	+5085746+	0
+2301808+	2	+2858182+	2	+3395895+	2	+1612513+	2	+2265137+	2
+2900304+	2	+9541206+	1	+1668629+	2	+2403224+	2	+4297278+	1
+1136502+	2	+1953092+	2	+1089041+	1	+4029314+	1	+7473191+	1
+1578853+	2	-4708772+	0	+2100254+	1	+5029372+	1	+1256681+	2
+2078740+	1	+2991085+	0	-7476179+	0	-1002938+	1	-1522172+	1
-6669193+	0	-7890989+	0	-8977499+	0	-1066881+	1	-1220443+	1
-1585003+	1	-2156200+	1	+2778023+	0	-3903515-	3	-3159024+	0
-5097782+	0	-7268627+	0	-1009373+	1	-1570254+	1	-6604508+	1
+1298415+	1	+1076014+	1	+8496480+	0	+5013405+	C	+1420479+	0
-2898876+	0	-1007700+	1	-7328999+	1	+3248118+	1	+2573878+	1
+1689440+	1	+1123762+	1	+6679388+	0	+2281451+	0	-3002042+	1
+5091014+	1	+3579800+	1	+2326082+	1	+1576636+	1	+1287601+	1
+1562336+	1	+3881749+	1	+4597050+	1	+2795613+	1	+1642150+	1
+7900900+	0	+7845310+	0	+1843468+	1	+8283992+	1	+1024965+	1
-2510069+	0	-1629047+	1	-1309367+	1	+2202366+	0	+7097180+	1
-5258225+	1	-5512159+	1	-5769646+	1	-5153535+	1	-3519968+	1
+7666714+	0	+1096040+	1	-1335304+	1	-1590854+	0	-4673569-	1
+9092647-	2	+4707735-	1	+2997904-	1	-5994281-	2	-3959870-	1
-7324938-	1	-1085830+	0	-1417431+	0	+5381400+	0	) 0+	0

Freq = 73.63

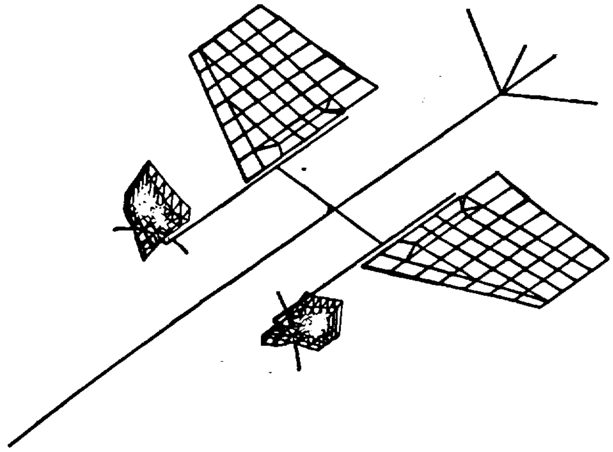


-8471934+	1	-4904183+	1	-3364243+	1	-1857172+	1	-6198763-	1
+1117862+	1	+2302265+	1	-8191650+	0	-7587442+	0	-1939636-	1
+1862767+	1	+3245903+	1	+8800338+	1	+1117653+	1	+3910877+	0
+6062605+	0	+1322708+	1	+2029773+	1	+3068009+	1	+8432926+	1
+9756369+	0	+2638549+	0	+2933080+	0	+6681397+	0	+1147708+	1
+1529418+	1	+2503987+	1	-3587352+	0	-5409401+	0	-4260235+	0
-1834861+	0	+3145085-	1	-1615209-	1	-3217250+	1	-1579934+	1
-1290160+	1	-1045371+	1	-8124556+	0	-6516689+	0	-6596013+	0
-8765820+	0	-4703522+	1	-2057673+	1	-1635926+	1	-1344419+	1
-1098262+	1	-9027090+	0	-9422324+	0	-1311877+	1	-2655122+	1
-1979211+	1	-1424367+	1	-1182203+	1	-8720034+	0	-1088753+	1
-1772783+	1	-1898794+	1	-1196071+	1	-7524836+	0	-3224429+	0
-1389413+	0	+1795679+	1	-1928447+	0	-2482117+	1	-8164311+	1
+6059691+	0	-1647711+	1	-4239690+	1	-1041441+	2	-1707335+	1
-6983585+	1	-1302591+	2	-5421863+	1	-1071960+	2	-1616082+	2
-1007724+	2	-1490655+	2	-1961368+	2	-1495172+	2	-1906846+	2
-2305348+	2	+2243068+	1	+9231746+	0	-7139401-	1	-7313003+	0
-1110710+	1	-9199554+	0	+3234623-	1	-4739960+	0	+1597212+	0
+9479205+	0	+1735252+	1	+1102710+	1	+1634105+	1	+1059602+	0
-7479163+	1	-9523764+	1	-1149618+	2	-4969538+	1	-7372990+	1
-9703178+	1	-2566665+	1	-5212428+	1	-7905873+	1	-6374386+	0
-3288126+	1	-6277074+	1	+5845907+	0	-5655745+	0	-1870611+	1
-4919715+	1	+1241114+	1	+2118279+	0	-9596787+	0	-3749025+	1
+2655263+	0	-3963145+	0	-1121637+	1	-1650822+	1	-2538107+	1
-1834995+	1	-1386297+	1	-1296886+	1	-1661173+	1	-1954292+	1
-2613696+	1	-3501195+	1	-9183018+	0	-8067416+	0	-9751753+	0
-1253412+	1	-1571286+	1	-1936344+	1	-2482147+	1	-6665025+	1
+1650918-	1	+2920032-	1	-1209601+	0	-4657135+	0	-8316103+	0
-1174871+	1	-1583213+	1	-4727265+	1	+1902558+	1	+1414770+	1
+6804230+	0	+1950145+	0	-4362605-	1	+9206667-	1	+2373252+	1
+4200632+	1	+2853459+	1	+1703613+	1	+9744917+	0	+8233016+	0
+1598514+	1	+9054983+	1	+5039093+	1	+3154988+	1	+1898358+	1
+7804796+	0	+5268433+	0	+1522687+	1	+9968839+	1	+3401097+	1
+1524619+	1	-9157835+	0	-1471000+	1	-8421346+	0	+4605766+	1
-1190998+	1	-2581788+	1	-4333042+	1	-5314908+	1	-5474766+	1
-4364559+	1	+9024915+	0	+3711151+	0	-3414890-	1	-1007311-	1
+1702638-	2	+1079853-	1	+8918255-	2	+2577714-	2	-5153288-	2
-1515565-	1	-2717731-	1	-3911527-	1	+1164381+	0	) 0+	0

Freq = 75.25

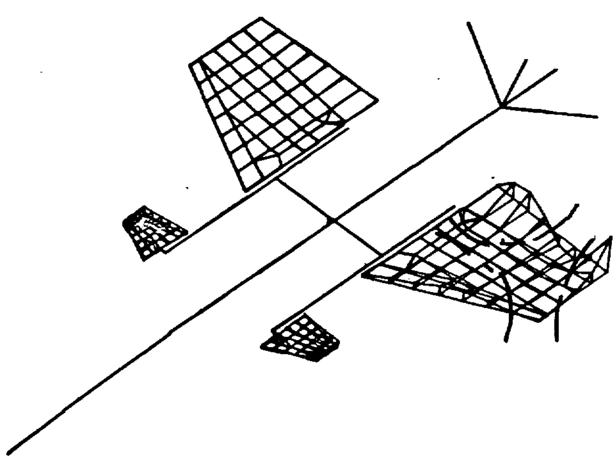
FIGURE 20 (continued)

TFW NASTRAN MODES
(WING FREE)



Freq = 78.84

+1070582+	1	-5967915+	0	-1028481+	1	-1154142+	1	-1102023+	1
-1038203+	1	+1115589+	1	-8354185-	5	-2219520+	0	-2624708+	0
-1274502+	0	-1538055-	1	+4321039+	0	+3219939+	0	+2924621+	0
+3090655+	0	+3300337+	0	+3466577+	0	+3307892+	0	-9576662+	0
+4182290+	0	+5533858+	0	+5845737+	0	+5177894+	0	+3411746+	0
+1049662+	0	-2469644+	1	+3973630+	0	+6041936+	0	+5966500+	0
+4415267+	0	-4283069-	1	-5423483+	0	-2868146+	1	+4036152+	0
+5320460+	0	+4382262+	0	+2238875+	0	-1276295+	0	-5256531+	0
-1272978+	1	-1534460+	1	+4562286+	0	+4080526+	0	+2176882+	0
-4302248-	2	-2894704+	0	-9105388+	0	-1912673+	1	+9529749+	0
+4934107+	0	+7261243-	1	-1377964+	0	-4358894+	0	-1237620+	1
-2641955+	1	+4127467+	0	-1427103+	0	-5720431+	0	-1195492+	1
-1801539+	1	-5338494+	1	-1686008+	1	+2587897+	1	+1329416+	2
-3246140+	1	+9173152+	0	+5668588+	1	+1713308+	2	+7446432+	0
+1042407+	2	+2157919+	2	+7124553+	1	+1684551+	2	+2689637+	2
+1514690+	2	+2402264+	2	+3272218+	2	+2356552+	2	+3114500+	2
+3851160+	2	+1218370+	1	+4620999+	0	-1049669+	0	-4780427+	0
-6908378+	0	-5848129+	0	+1666699-	2	-3407397+	0	+2404091-	2
+4274730+	0	+8514566+	0	+6422219+	0	+6657732+	0	+3485641-	2
+2309257+	2	+3072620+	2	+3815737+	2	+1479576+	2	+2373152+	2
+3250894+	2	+6892357+	1	+1667665+	2	+2682045+	2	+6099311+	0
+1035525+	2	+2161889+	2	-3325540+	1	+8722363+	0	+5661370+	1
+1726366+	2	-5397123+	1	-1722980+	1	+2605349+	1	+1350034+	2
-1837370+	1	-1197301+	1	-5618091+	0	-1496602+	0	+3430985+	0
-1708023+	1	-9255152+	0	-4271727+	0	-1442673+	0	+4623332-	1
+4069879+	0	+8024177+	0	-1139455+	1	-5837390+	0	-2118295+	0
+4236937-	2	+1793120+	0	+3208338+	0	+3146695+	0	-1687510+	1
-6048188+	0	-1783257+	0	+4814334-	1	+2515272+	0	+3726340+	0
+3919239+	0	+1941837+	0	-3145916+	1	+1725551+	0	+3185829+	0
+4928010+	0	+5160270+	0	+4392876+	0	+1671057+	0	-2870082+	1
+8055797+	0	+6456933+	0	+5675433+	0	+5022052+	0	+4126635+	0
+2647420+	0	-1084869+	1	+7205172+	0	+4747045+	0	+3211943+	0
+2166467+	0	+2103881+	0	+3336171+	0	+9683903+	0	-9877869-	1
-2580413+	0	-3953639+	0	-2454713+	0	+1665518+	0	+1957010+	1
-1561963+	1	-1477660+	1	-1350795+	1	-1011694+	1	-3662575+	0
+1393536+	1	+2716372+	0	+2480967+	0	-3947154-	2	-2308548-	2
-1319688-	2	-4697701-	4	+1530261-	2	+2525116-	2	+2335956-	2
+8429439-	3	-1611927-	2	-4324499-	2	+5791880-	2	) 0+	0



Freq = 84.11

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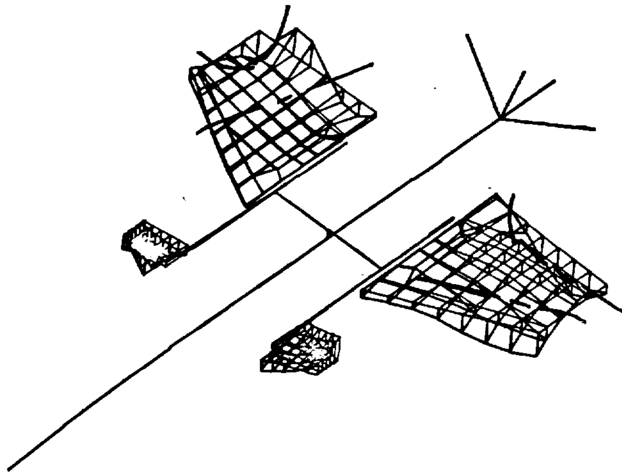
-3210917+	1	+7269441+	1	-4603313+	0	-2712712+	1	-3333250+	1
-1086401+	1	+1210466+	1	-1661373+	2	-7562591+	1	-5707448+	1
-3752043+	1	-5612091+	0	+2824491+	1	+7926889+	1	-1329848+	2
-7361859+	1	-5040428+	1	-2473127+	1	+1094552+	1	+6341353+	1
+1283269+	2	+8761713+	1	-3039587+	1	-2487684+	1	-7470918+	0
+1981010+	1	+7165227+	1	+1184582+	2	+2468884+	2	+6293532+	0
-3237972+	0	+2927706+	0	+1653019+	1	+3578341+	1	+5309386+	1
+7660442+	1	+2050520+	2	+1463341+	1	+3929319+	0	+3330144+	0
+5934689+	0	+1135171+	1	+2911032+	1	+5391733+	1	+9592224+	0
+1942012+	0	-4204877+	0	-5585715+	0	-6431501+	0	+5652971+	0
+3061796+	1	-2733099-	1	-5621760+	0	-6279436+	0	-6546872+	0
-7669439+	0	-1619250+	1	-7698095+	0	+2285794+	0	+2743994+	1
-1191241+	1	-2195369+	0	+8850541+	0	+3566447+	1	-3372906+	0
+1918303+	1	+4525617+	1	+1057490+	1	+3327064+	1	+5679864+	1
+2830568+	1	+4906530+	1	+6945497+	1	+4699705+	1	+6474983+	1
+8202721+	1	+5551682+	0	+1822205+	0	-9318012-	1	-2691413+	0
-3644065+	0	-3124978+	0	-5790044-	1	-2011159+	0	-4805089-	1
+1398870+	0	+3267426+	0	+7271711+	0	-2475570+	0	-2032180+	0
-6865256+	1	-9399650+	1	-1185275+	2	-4066469+	1	-7034692+	1
-9927261+	1	-1409306+	1	-4661867+	1	-7994212+	1	+6847312+	0
-2559171+	1	-6241660+	1	+1971962+	1	+5577741+	0	-1030642+	1
-4793106+	1	+2627558+	1	+1372379+	1	-7284671-	1	-3556025+	1
+1374732+	1	+6039129+	0	+3987559-	1	-2286355+	0	-6549313+	0
+6736854+	0	+2656763+	0	-7027511-	2	-2001540+	0	-3527945+	0
-7033649+	0	-1093151+	1	+5212688+	0	+1895687+	0	-7230899-	1
-2572194+	0	-4307069+	0	-6040162+	0	-7457030+	0	-6971391+	0
+3851565+	0	+9679315-	1	-1080665+	0	-3555927+	0	-5528541+	0
-6783681+	0	-6747549+	0	+7806632+	0	+3538750+	0	+3798767-	1
-3742360+	0	-5890569+	0	-6612380+	0	-4726861+	0	+2722642+	1
+5328301+	0	+1482629+	0	-2178127+	0	-4794062+	0	-5537152+	0
-3011096+	0	+3232079+	1	+9224114+	0	+4566269+	0	+1311611+	0
-2364922+	0	-4176614+	0	-3120933+	0	+1873907+	1	+1415324+	1
+8472136+	0	+6358640-	1	-3056677+	0	-4606646+	0	+2067938+	0
+1718497+	1	+1093280+	1	+3496065+	0	-2404467+	0	-6434738+	0
-7409189+	0	-4213938+	0	+5533035+	0	+8160024-	1	+2717100-	1
-2114876-	2	-2170527-	1	-1783780-	1	-2650067-	2	+1219955-	1
+2740604-	1	+4348085-	1	+5865047-	1	-2167092+	0	) 0+	0

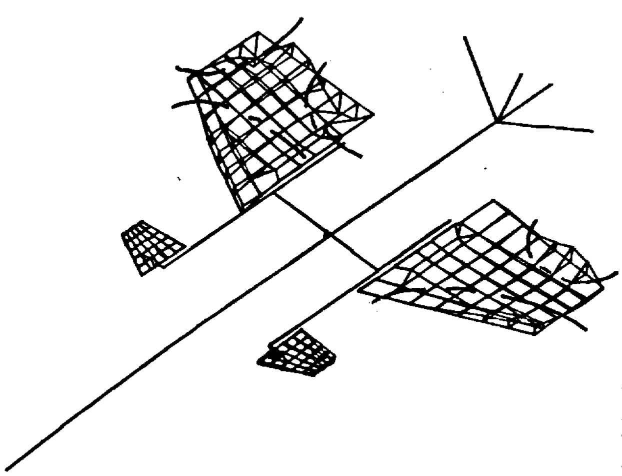
FIGURE 20 (concluded)

TFW NASTRAN MODES
(FREE WING)



```
-4979642+ 1 +2989497+ 1 +2544960+ 1 -1291779+ 1 -8023424+ 1
-1334511+ 2 -1500449+ 2 +3777843+ 1 +4209666+ 1 +1011227+ 1
-7738683+ 1 -1429235+ 2 -1975053+ 2 +5302149+ 1 +6001864+ 1
+3278457+ 1 -1715537+ 1 -6275371+ 1 -1292344+ 2 -1872107+ 2
+6660380+ 1 +7074657+ 1 +4755954+ 1 +7446602+ 0 -4373820+ 1
-9823188+ 1 -1307564+ 2 +6655416+ 1 +6721408+ 1 +4801594+ 1
+1897030+ 1 -2585356+ 1 -5731157+ 1 -5827056+ 1 +5560599+ 1
+4969748+ 1 +3556181+ 1 +1779436+ 1 -1664766+ 0 -1633291+ 1
-3418604+ 1 -4157188+ 0 +3454578+ 1 +2695181+ 1 +1825064+ 1
+9924957+ 0 +1221062+ 0 -1439135+ 1 -3579433+ 1 +2779503+ 1
+1733878+ 1 +5350504+ 0 +1474503+ 0 -2140311+ 0 -1558265+ 1
-4123381+ 1 +1247144+ 1 +1335356+ 0 -2939640+ 0 -1026126+ 1
-2166340+ 1 -3760258+ 1 -2150084+ 1 -2298486+ 0 +4511771+ 1
-2979224+ 1 -1143748+ 1 +9085294+ 0 +5875716+ 1 -1506955+ 1
+2661587+ 1 +7464716+ 1 +8579303+ 0 +5031796+ 1 +9370389+ 1
+3869571+ 1 +7684963+ 1 +1144713+ 2 +7050931+ 1 +1031646+ 2
+1350477+ 2 +7831191- 1 +2691418- 1 -1253493- 1 -3962531- 1
-5634527- 1 -4944007- 1 -4361658- 1 -3269264- 1 -9769826- 2
+1831172- 1 +4620427- 1 +3828560+ 0 -3163935+ 0 -1459259+ 0
-9894193+ 1 -1421502+ 2 -1841642+ 2 -5464561+ 1 -1051628+ 2
-1546983+ 2 -1268572+ 1 -6797536+ 1 -1250205+ 2 +2029879+ 1
-3490442+ 1 -9792216+ 1 +4080299+ 1 +1648591+ 1 -1061397+ 1
-7540215+ 1 +5165844+ 1 +3017687+ 1 +4971495+ 0 -5610829+ 1
+3047804+ 1 +1330352+ 1 +2002080+ 0 -2965993+ 0 -1348958+ 1
-9380372+ 0 -1668468+ 0 +8300895- 1 -2962043+ 0 -6463120+ 0
-1630759+ 1 -2709682+ 1 -1560885+ 1 -9542507+ 0 -7215905+ 0
-9310401+ 0 -1264738+ 1 -1741475+ 1 -2562777+ 1 -8840037+ 1
-2103058+ 1 -1616059+ 1 -1423232+ 1 -1431673+ 1 -1624508+ 1
-1959896+ 1 -2571218+ 1 -7595460+ 1 -2416997+ 1 -1734663+ 1
-1343914+ 1 -1344301+ 1 -1331165+ 1 -1047254+ 1 +2464978+ 1
-1168568+ 1 -6148273+ 0 -4064516+ 0 -4178366+ 0 -1597833+ 0
+1099878+ 1 +1372038+ 2 +1659313+ 1 +1397968+ 1 +1107761+ 1
+6139482+ 0 +4772847+ 0 +1591851+ 1 +1466121+ 2 +4529064+ 1
+3212505+ 1 +9829647+ 0 -4230037+ 0 -1213853+ 1 +1975151+ 1
+5658225+ 1 +3337967+ 1 +1996337+ 0 -3135916+ 1 -7415013+ 1
-1876860+ 2 -3423447+ 0 +3568900+ 0 +5036148- 1 +1597298- 1
-2209011- 2 -1569762- 1 -1325079- 1 -2445928- 2 +8672305- 2
+1966455- 1 +3110956- 1 +4180562- 1 -1554749+ 0 )        0+ 0
```

Freq = 86.82



```
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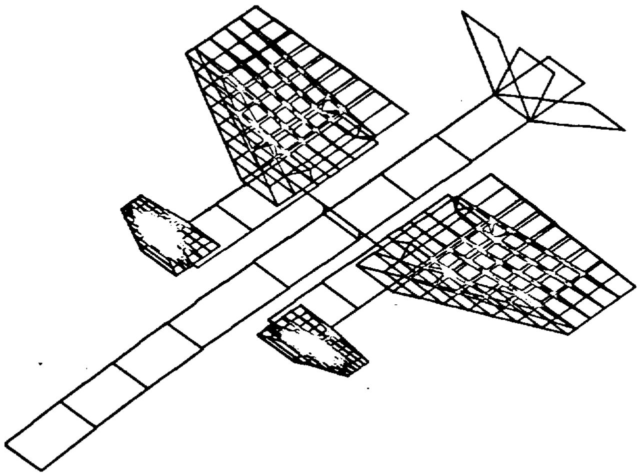
+9867473+ 1 +1291212+ 2 -2568222+ 1 -2728933+ 1 -3897226+ 0
+4956114+ 1 +8387354+ 1 +1614535+ 2 -2773169+ 1 -3299349+ 1
-1622839+ 1 +1136266+ 1 +3443976+ 1 +6462819+ 1 +7977358+ 1
-3679307+ 1 -3677569+ 1 -2375740+ 1 -3829145+ 0 +1856109+ 1
+3993342+ 1 +1002411+ 1 -3699406+ 1 -3281708+ 1 -2311580+ 1
-1044344+ 1 +4421768+ 0 +1028886+ 1 +1416012+ 1 -2436122+ 1
-2089232+ 1 -1920060+ 1 -9005890+ 0 -3692786+ 0 -1385399+ 0
-3675779- 1 +2629945+ 1 -8048572+ 0 -6592685+ 0 -4704575+ 0
-3117687+ 0 -1825321+ 0 -2408037- 2 +3080516+ 0 +4220522+ 0
+2917321+ 0 +3952405+ 0 +3674626+ 0 +2742012+ 0 +4722723+ 0
+1025014+ 1 +5080101+ 0 +4039294+ 0 +2294279+ 0 -4082929+ 0
-1329666+ 1 -2212264+ 1 -1328028+ 1 -2431249+ 0 +2447742+ 1
-1834410+ 1 -8209908+ 0 +3019897+ 0 +3049334+ 1 -1144019+ 1
+1121260+ 1 +3750824+ 1 -4330233- 1 +2216402+ 1 +4588981+ 1
+1369080+ 1 +3435527+ 1 +5491543+ 1 +2867945+ 1 +4639528+ 1
+6381003+ 1 -5596176+ 0 -1758405+ 0 +1134036+ 0 +3056560+ 0
+4180629+ 0 +3659763+ 0 -2416824- 1 +2482576+ 0 +8921263- 1
-1048337+ 0 -2973332+ 0 -3234007- 1 -8833262+ 0 -6458314- 1
+7656975+ 0 +5080380- 1 -7041516+ 0 +6826746+ 0 -1388085+ 0
-1040265+ 1 +5912402+ 0 -2966771+ 0 -1356618+ 1 +5048747+ 0
-3894098+ 0 -1596260+ 1 +4721779+ 0 +6820999- 1 -3970774+ 0
-1771900+ 1 +4834211+ 0 +1750444+ 0 -3299954+ 0 -1907419+ 1
+1679770+ 0 +2757096+ 0 +4436808+ 0 +5377117+ 0 +3776140+ 0
-7787776+ 1 -2256053+ 1 +4747420+ 0 +5135501+ 0 +4983599+ 0
+2038277+ 0 -1792716+ 0 -9241459+ 1 -4563977+ 1 -1953860+ 1
-6727110+ 0 -2126020+ 0 -9683186- 1 -9949497+ 0 -1869891+ 2
-1073151+ 2 -6688814+ 1 -4090073+ 1 -1529597+ 1 +8056255- 1
+7525438+ 0 -2270937+ 0 -2361864+ 2 -1399962+ 2 -7691230+ 1
-1400787+ 1 +1448486+ 1 +2966889+ 1 +3121292+ 1 -1032901+ 2
-1286401+ 2 -5470571+ 1 +1583955- 1 +3350017+ 1 +5408590+ 1
+6999659+ 1 +9578616+ 1 -9706357+ 1 -1166230+ 1 +1774912+ 1
+4305516+ 1 +5617767+ 1 +6910803+ 1 +1451510+ 2 +6656896+ 0
+1923006+ 1 +2781302+ 1 +1777148+ 1 -1190212+ 0 -4111666+ 1
+1651301+ 1 +5043571+ 0 -1993490+ 1 -6338855+ 1 -1404404+ 2
-3775556+ 2 -2041053+ 0 +1468616+ 0 +4434320- 1 +2480966- 1
+1148188- 1 -1671100- 2 -9093488- 2 -5971637- 2 +1411755- 2
+1083721- 1 +2210078- 1 +3326734- 1 -7438636- 1 )        0+ 0
```

Freq = 89.13

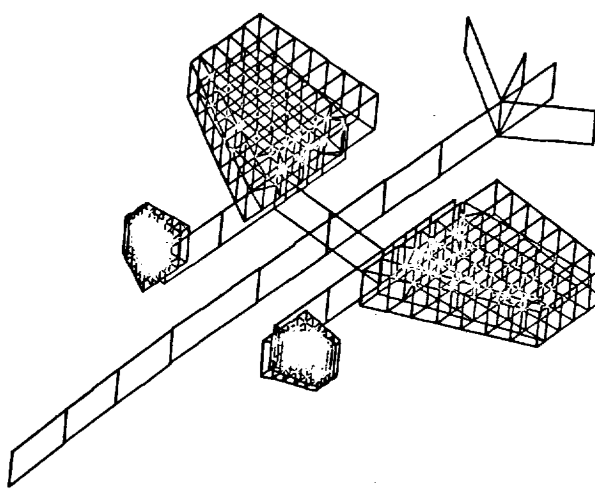
FIGURE 21

TFW NASTRAN MODES
(WING LOCKED)



Freq = 0

-1560078-11	-1591200-11	-1350415-11	-1109629-11	-8688431-12
-7283848-12	-1852019-11	-1543813-11	-1303830-11	-1063044-11
-7243391-12	-5638153-12	-1645367-11	-1500241-11	-1259455-11
-1017867-11	-7770810-12	-5948865-12	-4102841-12	-1836922-11
-1456481-11	-1215695-11	-9733041-12	-7309132-12	-4628384-12
-2573680-12	-1829139-11	-1412560-11	-1171794-11	-9266009-12
-6870125-12	-3282418-12	-1059164-12	-1820554-11	-1367074-11
-1126289-11	-8847002-12	-6423093-12	-3878790-12	-1968557-12
+4954833-13	-1812912-11	-1321709-11	-1080923-11	-8385324-12
-5977467-12	-3425138-12	-6400503-13	+2008592-12	-1804420-11
-1277100-11	-8224474-12	-5816617-12	-2164701-12	+7648588-13
+3654287-12	-1211282-11	-5788182-12	-3777277-13	+5922609-12
+1087927-11	+1151529-11	+1083238-11	+9953079-12	+8390870-12
+1119946-11	+1049869-11	+9802394-12	+8405333-12	+1068362-11
+9656173-12	+8415333-12	+1057225-11	+9505489-12	+8425333-12
+1025642-11	+9350341-12	+8444260-12	+9956794-12	+9206933-12
+8457073-12	+1557287-10	+1258441-10	+9731782-11	+6737885-11
+1937328-11	+ 0+ 0	+1445934+ 1	-5397097-12	-1889531-11
-3742145-11	-5542810-11	+6467082-10	-7412172-10	+1445934+ 1
+3156943-11	+2897867-11	+2638790-11	+3230745-11	+2917694-11
+2604644-11	+3308907-11	+2940340-11	+2567146-11	+3385527-11
+2961443-11	+2532733-11	+3463689-11	+3221575-11	+2981004-11
+2498320-11	+3541850-11	+3305906-11	+3002108-11	+2462365-11
+3301469-11	+1592554-11	+3591627-13	-7434925-12	-1653030-11
+6272147-12	+2116399-12	-2103510-12	-7362222-12	-1082587-11
-1732764-11	-2490718-11	+4285560-12	+4778427-13	-3524004-12
-7188873-12	-1064350-11	-1412065-11	-1757291-11	-2461059-11
+2462581-12	-1076817-12	-3816960-12	-7462616-12	-1093411-11
-1439380-11	-1784090-11	-2433036-11	+5823257-13	-2603428-12
-7738334-12	-1119515-11	-1467430-11	-1811822-11	-2407923-11
-1229416-12	-4168146-12	-8001555-12	-1146755-11	-1493336-11
-1837655-11	-2381917-11	-3056251-12	-5694808-12	-8298880-12
-1174053-11	-1519394-11	-1863617-11	-2357190-11	-4892774-12
-7186685-12	-1202685-11	-1546810-11	-1689846-11	-2330526-11
-6851264-12	-8972892-12	-1229861-11	-1573931-11	-1918068-11
-2302439-11	-7239761-10	+6637264-10	+1445934+ 1	+1445934+ 1
+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1
+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1	) 0+ 0



Freq = 0

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+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1
+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1
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+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1
+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1
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+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1
+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1
+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1
+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1
+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1
+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1
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+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1
+1445934+ 1	+1445934+ 1	-2297506-11	+1445934+ 1	+1445934+ 1
+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1	-1156314-10
+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1
+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1
+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1
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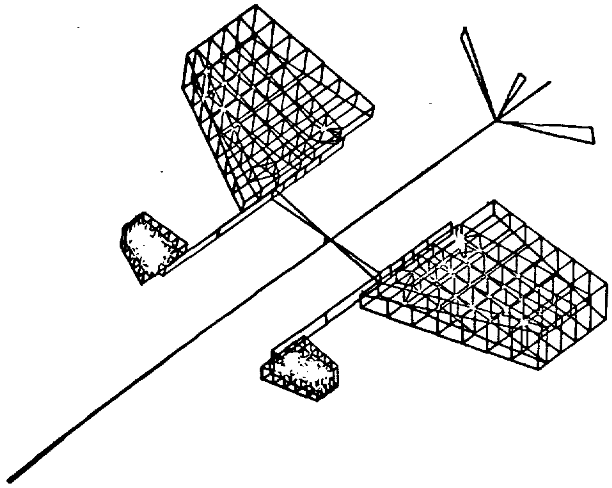
+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1
+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1	+1445934+ 1
+1445934+ 1	+1445934+ 1	+1445934+ 1	-3259059-11	-2668245-11
-2387842-11	-2175288-11	-2251437-11	-2297603-11	-2446102-11
-2795559-11	-3223571-11	-3603683-11	-1121597-10	) 0+ 0

FIGURE 21 (continued)

TFW NASTRAN MODES
(WING LOCKED)




```
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-3299448+ 1 +1033436- 1 +1033436- 1 +1033436- 1 +1033436- 1
+1033436- 1 +1033436- 1 -2704484+ 0 +1033436- 1 +1033436- 1
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+2277693+ 1 +2014455+ 1 +2014455+ 1 +2014455+ 1 +2014455+ 1
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+2058328+ 1 +2058328+ 1 +2616393+ 1 +2616393+ 1 +2616393+ 1
+2616393+ 1 +2616393+ 1 +2616393+ 1 +2616393+ 1 +2616393+ 1
+3172703+ 1 +3172703+ 1 +3172703+ 1 +3172703+ 1 +3172703+ 1
+3172703+ 1 +3172703+ 1 +3172703+ 1 +3734278+ 1 +3734278+ 1
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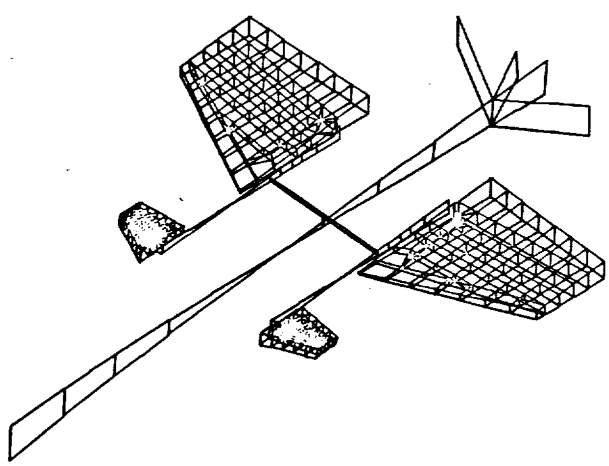
+4295853+ 1 +4295853+ 1 +4852163+ 1 +4852163+ 1 +4852163+ 1
+4852163+ 1 +4852163+ 1 +4852163+ 1 +4852163+ 1 +5401454+ 1
+5401454+ 1 +5401454+ 1 +5401454+ 1 +5401454+ 1 +5401454+ 1
+6003392+ 1 +6003392+ 1 +6003392+ 1 +6003392+ 1 +6003392+ 1
+6003392+ 1 -2204377+ 1 +2225045+ 1 +4227456+ 0 +2297043+ 0
+1244090+ 0 +3666289- 1 +1209398- 1 +1209398- 1 +1209398- 1
+1209398- 1 +1209399- 1 +1209399- 1 -1135625+ 1 )       0+ 0
```


Freq = 0

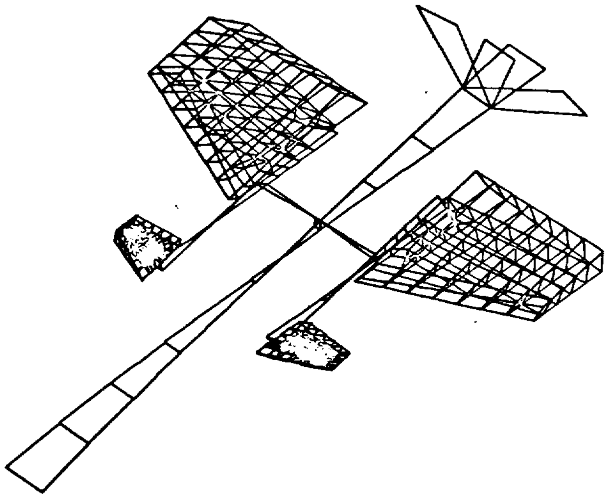



```
-1280364+ 1 -1132570+ 1 -1000216+ 1 -8678626+ 0 -7355091+ 0
-6583028+ 0 -1287378+ 1 -1117966+ 1 -9860536+ 0 -8537001+ 0
-6675228+ 0 -5792872+ C -1294165+ 1 -1104458+ 1 -9721047+ 0
-8393100+ 0 -7069565+ 0 -6068090+ 0 -5053380+ 0 -1300099+ 1
-1090981+ 1 -9586274+ 0 -8253915+ 0 -6921556+ 0 -5448020+ 0
-4318604+ 0 -1306498+ 1 -1077526+ 1 -9451728+ 0 -8114957+ 0
-6787010+ 0 -4814943+ 0 -3592679+ 0 -1312455+ 1 -1063189+ 1
-9308358+ 0 -7980411+ 0 -6648052+ 0 -5249517+ 0 -4199512+ 0
-2845095+ 0 -1318831+ 1 -1048830+ 1 -9164761+ 0 -7832402+ 0
-6508867+ 0 -5105920+ 0 -3575031+ 0 -2119142+ 0 -1324773+ 1
-1034919+ 1 -7858425+ 0 -6534890+ 0 -4527529+ C -2917227+ 0
-1328985+ 0 -1002911+ 1 -6552624+ 0 -3578641+ 0 +1340057+ 0
+6239343+ 0 +6921933+ 0 +6246930+ 0 +5377808+ 0 +3833684+ 0
+6690665+ 0 +5998015+ 0 +5309777+ 0 +3928888+ 0 +6459397+ 0
+5246157+ 0 +4019681+ 0 +6232541+ 0 +5178125+ 0 +4110473+ 0
+6001274+ 0 +5105682+ 0 +4210090+ 0 +5782786+ 0 +5041606+ 0
+4300427+ 0 +2477581+ 1 +1992285+ 1 +1529047+ 1 +1042869+ 1
+2633066+ 0 -3657697+ 0 +1169211- 2 -8753748+ 0 -1362730+ 1
-1912144+ 1 -2404499+ 1 -2169955+ 1 -2170806+ 1 +4909568- 2
+5496607+ 0 +4755427+ C +4014248+ 0 +5736945+ 0 +4841353+ 0
+3945761+ 0 +5990974+ 0 +4936557+ 0 +3868906+ 0 +6240590+ 0
+5027350+ 0 +3800874+ 0 +6494619+ 0 +5801969+ 0 +5113730+ 0
+3732842+ 0 +6748647+ 0 +6073644+ 0 +5204523+ C +3660399+ 0
+6081231+ 0 +1181945+ 0 -3736752+ 0 -6710736+ 0 -1018722+ 1
-1502271+ 0 -3090513+ C -4700814+ 0 -6708176+ 0 -8031711+ 0
-1052627+ 1 -1342481+ 1 -2344474+ 0 -3800363+ 0 -5331252+ 0
-6734199+ 0 -8057734+ 0 -9390093+ 0 -1071363+ 1 -1341364+ 1
-3118528+ 0 -4472945+ 0 -5522950+ 0 -6921485+ 0 -8253844+ 0
-9581791+ 0 -1090533+ 1 -1339798+ 1 -3914868+ 0 -5136932+ 0
-7109000+ 0 -8436947+ 0 -9773717+ 0 -1109725+ 1 -1338697+ 1
-4689150+ 0 -5818566+ 0 -7292102+ 0 -8624461+ 0 -9956819+ 0
-1125035+ 1 -1337154+ 1 -5472027+ 0 -6486737+ 0 -7488212+ 0
-8811747+ 0 -1013969+ 1 -1146323+ 1 -1336030+ 1 -6259013+ 0
-7141369+ 0 -9003142+ 0 -1032668+ 1 -1164580+ 1 -1333993+ 1
-7101216+ 0 -7917396+ 0 -9196813+ 0 -1052035+ 1 -1184388+ 1
-1332183+ 1 -1704039+ 1 -1723188+ 1 -1827627- 2 -9930645- 3
-5378487- 3 -1585021- 3 -5228509- 4 -5228509- 4 -5228509- 4
-5228509- 4 -5228509- 4 -5228509- 4 +4909568- 2 )       0+ 0
```


Freq = 0

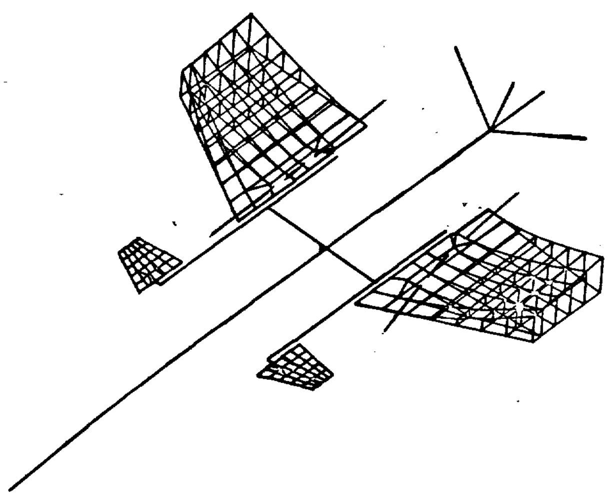
FIGURE 21 (continued)

TFW NASTRAN MODES
(WING LOCKED)



Freq = 0

-5452902+	0	-5453608+	0	-5454239+	0	-5454871+	0	-5455503+	0
-5455871+	0	-4903623+	0	-4904431+	0	-4905061+	0	-4905692+	0
-4906581+	0	-4907002+	0	-4402383+	0	-4403288+	0	-4403920+	0
-4404554+	0	-4405186+	0	-4405663+	0	-4406148+	0	-3894742+	0
-3895740+	0	-3896372+	0	-3897008+	0	-3897644+	0	-3898347+	0
-3898886+	0	-3382295+	0	-3383388+	0	-3384020+	0	-3384658+	0
-3385292+	0	-3386233+	0	-3386816+	0	-2869851+	0	-2871040+	0
-2871672+	0	-2872306+	0	-2872942+	0	-2873609+	0	-2874110+	0
-2874757+	0	-2362208+	0	-2363497+	0	-2364128+	0	-2364764+	0
-2365396+	0	-2366065+	0	-2366796+	0	-2367491+	0	-1852966+	0
-1854349+	0	-1815505+	0	-1816137+	0	-1817095+	0	-1817864+	0
-1818622+	0	-1654339+	0	-1655999+	0	-1657418+	0	-1659765+	0
-1662104+	0	-1822559+	0	-1822237+	0	-1821823+	0	-1821086+	0
-2062644+	0	-2062314+	0	-2061985+	0	-2061326+	0	-2302729+	0
-2302150+	0	-2301565+	0	-2542816+	0	-2542313+	0	-2541803+	0
-2782901+	0	-2782473+	0	-2782046+	0	-3013384+	0	-3013030+	0
-3012676+	0	-2394733-	3	-7861768-	5	+2132220-	3	+4452546-	3
+8173070-	3	+1117539-	2	+3336594+	0	+1360752-	2	+1602891-	2
+1855558-	2	+2090539-	2	+2040723+	0	-2001052+	0	+1957412+	1
+3026860+	0	+3027214+	0	+3027567+	0	+2796158+	0	+2796585+	0
+2797013+	0	+2555842+	0	+2556345+	0	+2556854+	0	+2315527+	0
+2316106+	0	+2316692+	0	+2075211+	0	+2075541+	0	+2075870+	0
+2076529+	0	+1834895+	0	+1835217+	0	+1835631+	0	+1836368+	0
+1675083+	0	+1677421+	0	+1679769+	0	+1681168+	0	+1682847+	0
+1838832+	0	+1839590+	0	+1840359+	0	+1641317+	0	+1841949+	0
+1883172+	0	+1884555+	0	+2388481+	0	+2389175+	0	+2389906+	0
+2390576+	0	+2391207+	0	+2391843+	0	+2392475+	0	+2393763+	0
+2896462+	0	+2897109+	0	+2897610+	0	+2898277+	0	+2898913+	0
+2899547+	0	+2900179+	0	+2901368+	0	+3409259+	0	+3409842+	0
+3410783+	0	+3411417+	0	+3412055+	0	+3412687+	0	+3413779+	0
+3922045+	0	+3922584+	0	+3923287+	0	+3923923+	0	+3924559+	0
+3925190+	0	+3926188+	0	+4430031+	0	+4430515+	0	+4430993+	0
+4431624+	0	+4432258+	0	+4432890+	0	+4433795+	0	+4931613+	0
+4932034+	0	+4932923+	0	+4933555+	0	+4934184+	0	+4934993+	0
+5481261+	0	+5481651+	0	+5482262+	0	+5482893+	0	+5483525+	0
+5484230+	0	-2003279+	0	+2038496+	0	-2389003+	1	-1931124+	1
-1486852+	1	-1018501+	1	-2569280+	0	+3594409+	0	+8587520+	0
+1355859+	1	+1874578+	1	+2356988+	1	+1525145+	1	) 0+	0

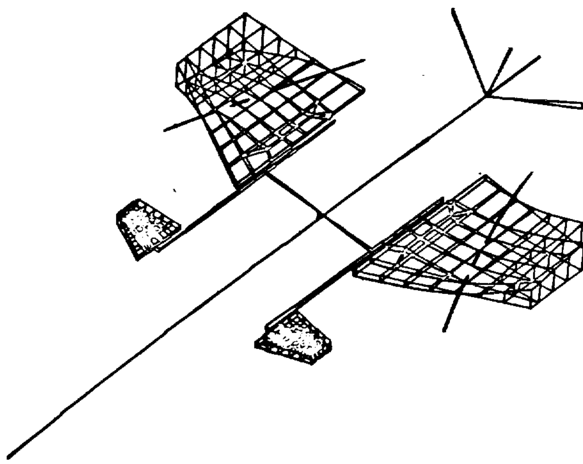


Freq = 12.67

+1430420+	2	+1327156+	2	+1251231+	2	+1178177+	2	+1105190+	2
+1063616+	2	+1121490+	2	+1019695+	2	+9536532+	1	+8876856+	1
+7899173+	1	+7434230+	1	+8380768+	1	+7487529+	1	+6948058+	1
+6384903+	1	+5786557+	1	+5292114+	1	+4788966+	1	+5671418+	1
+4991767+	1	+4597038+	1	+4159757+	1	+3683603+	1	+3094592+	1
+2617199+	1	+3345906+	1	+2868074+	1	+2613521+	1	+2312479+	1
+1985665+	1	+1431409+	1	+1077941+	1	+1600880+	1	+1241199+	1
+1096459+	1	+9253583+	0	+7504652+	0	+5585884+	0	+4064489+	0
+2434971+	0	+4388979+	0	+1715517+	0	+1003094+	0	+3172175-	1
-2543306-	1	-8355260-	1	-1467991+	0	-2362016+	0	-3955100+	0
-3832986+	0	-4583721+	0	-4656452+	0	-4672012+	0	-5441148+	0
-6806767+	0	-4689352+	0	-4685048+	0	-4552359+	0	-3955116+	0
-3269617+	0	-3244411+	0	-3356422+	0	-3499560+	0	-3772106+	0
-3419725+	0	-3536604+	0	-3657199+	0	-3909309+	0	-3605805+	0
-3822749+	0	-4049933+	0	-3803371+	0	-3996954+	0	-4194690+	0
-4008374+	0	-4174782+	0	-4340818+	0	-4207178+	0	-4345412+	0
-4483048+	0	+2388845-	1	-4147706-	1	-1037310+	0	-1690243+	0
-2742295+	0	-3601052+	0	-1335996-	1	-4323478+	0	-5066325+	0
-5857261+	0	-6599588+	0	-5015506+	0	-7505757+	0	-5334731-	1
-3904762-	1	-4978747-	1	-6045649-	1	-5027058-	1	-6327378-	1
-7616298-	1	-6198677-	1	-7731422-	1	-9267721-	1	-7397751-	1
-9159086-	1	-1092303+	0	-6631311-	1	-9630375-	1	-1062673+	0
-1259870+	0	-9899781-	1	-1087850+	0	-1212153+	0	-1429366+	0
-1197435+	0	-1901521+	0	-2508557+	0	-2653697+	0	-2680694+	0
-4325329+	0	-3115430+	0	-2437264+	0	-2437977+	0	-2380205+	0
-1657472+	0	-1787551+	0	+4356457-	1	+1214229+	0	+1760261+	0
+2275326+	0	+2784049+	0	+3398218+	0	+4036424+	0	+6443598+	0
+5472333+	0	+6929099+	0	+8294413+	0	+1001556+	1	+1158255+	1
+1311447+	1	+1440761+	1	+1764720+	1	+1379131+	1	+1696599+	1
+2194638+	1	+2487029+	1	+2755624+	1	+2981972+	1	+3409276+	1
+2851843+	1	+3278909+	1	+3806135+	1	+4230935+	1	+4619603+	1
+4968917+	1	+5567251+	1	+4890460+	1	+5339407+	1	+5780394+	1
+6312807+	1	+6811774+	1	+7287221+	1	+8064629+	1	+7348487+	1
+7762525+	1	+8631579+	1	+9214858+	1	+9795576+	1	+1068001+	2
+1031182+	2	+1070206+	2	+1132815+	2	+1197322+	2	+1264020+	2
+1354121+	2	-6803851+	0	-4313602+	0	+1155157-	1	+3031680-	2
-6297541-	3	-3168286-	2	-6763526-	3	+2461383-	2	+5010240-	2
+7554861-	2	+1021534-	1	+1269300-	1	-5556616-	1	) 0+	0

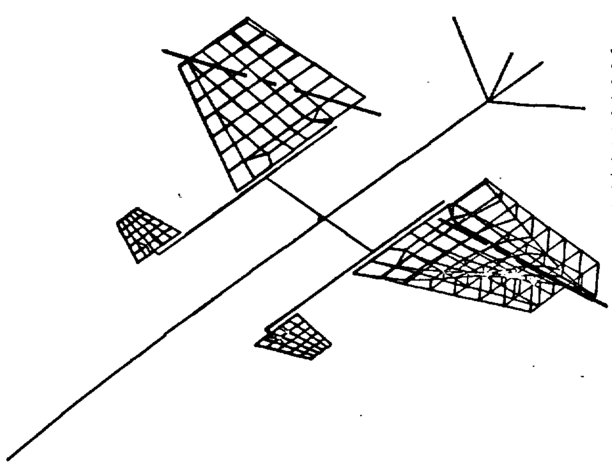
FIGURE 21 (continued)

TFW NASTRAN MODES
(WING LOCKED)



Freq = 16.93

+1365654+ 2	+1205585+ 2	+1090438+ 2	+9804869+ 1	+8710496+ 1
+8087264+ 1	+1012966+ 2	+8555311+ 1	+7565963+ 1	+6584685+ 1
+5135668+ 1	+4438279+ 1	+6841674+ 1	+5509179+ 1	+4716566+ 1
+3892974+ 1	+3021336+ 1	+2303704+ 1	+1562757+ 1	+3752337+ 1
+2798835+ 1	+2234481+ 1	+1608988+ 1	+9292873+ 0	+9515940- 1
-5942511+ 0	+1242179+ 1	+6372444+ 0	+2854334+ 0	-1342767+ 0
-5922445+ 0	-1357951+ 1	-1856847+ 1	-4519919+ 0	-8397140+ 0
-1031391+ 1	-1264911+ 1	-1508752+ 1	-1779324+ 1	-1996619+ 1
-2242570+ 1	-1325906+ 1	-1597702+ 1	-1690352+ 1	-1765691+ 1
-1870960+ 1	-1962519+ 1	-2087562+ 1	-2258918+ 1	-1710812+ 1
-1721767+ 1	-1786223+ 1	-1807312+ 1	-1830754+ 1	-1965563+ 1
-2199660+ 1	-1624801+ 1	-1657060+ 1	-1675886+ 1	-1693501+ 1
-1724785+ 1	-1863447+ 1	-1887614+ 1	-1921636+ 1	-2023868+ 1
-2118057+ 1	-2147905+ 1	-2184285+ 1	-2282692+ 1	-2381712+ 1
-2452701+ 1	-2542926+ 1	-2655370+ 1	-2725979+ 1	-2804837+ 1
-2935521+ 1	-2999894+ 1	-3066718+ 1	-3207147+ 1	-3262225+ 1
-3318112+ 1	+2576925- 2	+3164577- 2	+4831326- 2	+7814250- 2
+1341770- 1	+1768712- 1	-2223282+ 0	+2102419- 1	+2454824- 1
+2836021- 1	+3196293- 1	+2094343+ 1	-2033715+ 1	-8835399+ 0
+3254714+ 1	+3303380+ 1	+3352067+ 1	+2976430+ 1	+3033587+ 1
+3091773+ 1	+2689718+ 1	+2752693+ 1	+2821316+ 1	+2410622+ 1
+2473990+ 1	+2552380+ 1	+2143963+ 1	+2170342+ 1	+2202634+ 1
+2286900+ 1	+1886321+ 1	+1910269+ 1	+1939369+ 1	+2023649+ 1
+1747484+ 1	+1722298+ 1	+1710346+ 1	+1692891+ 1	+1661622+ 1
+2228415+ 1	+1999622+ 1	+1865269+ 1	+1841489+ 1	+1819704+ 1
+1746281+ 1	+1737823+ 1	+2232017+ 1	+2064145+ 1	+1938981+ 1
+1841866+ 1	+1750734+ 1	+1648330+ 1	+1548056+ 1	+1220157+ 1
+2151805+ 1	+1894706+ 1	+1662917+ 1	+1372502+ 1	+1110513+ 1
+8598627+ 0	+6540829+ 0	+2068970+ 0	+1651644+ 1	+1116073+ 1
+2901972+ 0	-2015034+ 0	-6504441+ 0	-1024878+ 1	-1670007+ 1
+1869455+ 0	-5560209+ 0	-1452844+ 1	-2180127+ 1	-2846118+ 1
-3443256+ 1	-4429982+ 1	-2249157+ 1	-3042772+ 1	-3808932+ 1
-4736321+ 1	-5608403+ 1	-6442251+ 1	-7802954+ 1	-5450068+ 1
-6184939+ 1	-7716600+ 1	-8749925+ 1	-9786170+ 1	-1139142+ 2
-9456252+ 1	-1014610+ 2	-1125734+ 2	-1240966+ 2	-1361489+ 2
-1529454+ 2	-2037113+ 1	+2090942+ 1	+1938859+ 0	+5063368- 1
-1093554- 1	-5366237- 1	-1223187- 1	+4021394- 1	+8281441- 1
+1254006+ 0	+1699614+ 0	+2114702+ 0	-9207121+ 0	) 0+ 0

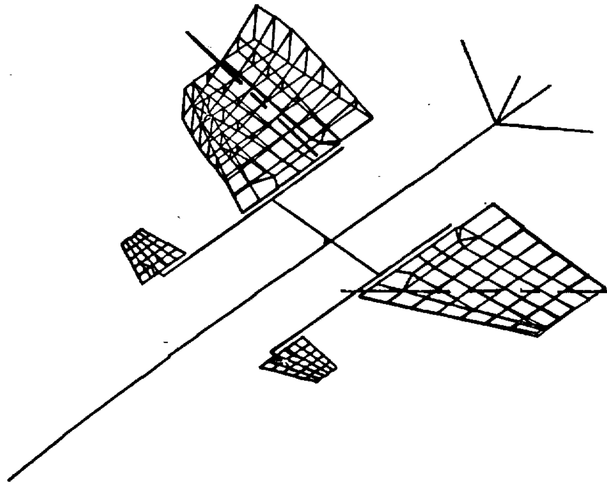


Freq = 32.96

-2294946+ 2	-9674380+ 1	-3697030+ 0	+8089850+ 1	+1597400+ 2
+2058778+ 2	-2357127+ 2	-9297252+ 1	-1104129+ 1	+6228836+ 1
+1521983+ 2	+1940085+ 2	-2232074+ 2	-8325764+ 1	-1442502+ 1
+4541537+ 1	+9640634+ 1	+1299032+ 2	+1635882+ 2	-1915388+ 2
-6806478+ 1	-1518857+ 1	+2954930+ 1	+6600204+ 1	+9626448+ 1
+1163659+ 2	-1476278+ 2	-4983197+ 1	-1333585+ 1	+1625264+ 1
+3868691+ 1	+5763502+ 1	+6345653+ 1	-1001821+ 2	-3100353+ 1
-9492150+ 0	+6357965+ 0	+1731604+ 1	+2447266+ 1	+2725330+ 1
+2828234+ 1	-5524450+ 1	-1569561+ 1	-5728831+ 0	-2024378- 1
+3481185+ 0	+6071146+ 0	+9390029+ 0	+1163683+ 1	-1183641+ 1
-7613896+ 0	-4071823+ 0	-3047324+ 0	-2407582+ 0	-2639093+ 0
-2847974+ 0	-6664896+ 0	-2957328+ 0	-2115434+ 0	-2160352+ 0
-2552153+ 0	-2639311+ 0	-2741700+ 0	-2882679+ 0	-3344372+ 0
-2975918+ 0	-3106429+ 0	-3272458+ 0	-3733099+ 0	-3371737+ 0
-3704270+ 0	-4133555+ 0	-3834814+ 0	-4173219+ 0	-4549842+ 0
-4340393+ 0	-4651547+ 0	-4971794+ 0	-4643425+ 0	-5110248+ 0
-5378808+ 0	-8319335- 1	-6562183- 1	-5022751- 1	-3667950- 1
-2183017- 1	-1573119- 1	-2621201- 1	-1176450- 1	-7854569- 2
-3800940- 2	-4232552- 4	+2404784+ 0	-2439814+ 0	-1033900+ 0
+3913526+ 0	+4172520+ 0	+4431040+ 0	+3421988+ 0	+3726933+ 0
+4035831+ 0	+2925389+ 0	+3263778+ 0	+3627617+ 0	+2465598+ 0
+2811990+ 0	+3226458+ 0	+2063747+ 0	+2216612+ 0	+2395344+ 0
+2841483+ 0	+1712477+ 0	+1844331+ 0	+2016494+ 0	+2468404+ 0
+1652215+ 0	+1760039+ 0	+1806988+ 0	+1680193+ 0	+1400557+ 0
+2464701+ 0	+2138145+ 0	+1963794+ 0	+1879911+ 0	+1794518+ 0
+1611945+ 0	+1324373+ 0	+4426708+ 0	+3941668+ 0	+3460437+ 0
+3177392+ 0	+2849762+ 0	+2420146+ 0	+1740062+ 0	-6026910- 1
+6472871+ 0	+6069433+ 0	+5609183+ 0	+4792402+ 0	+3767811+ 0
+2468538+ 0	+9023233- 1	-3362703+ 0	+9877511+ 0	+8796642+ 0
+6511244+ 0	+4365360+ 0	+1629945+ 0	-1009804+ 0	-7602653+ 0
+1373951+ 1	+1122932+ 1	+7893615+ 0	+4366981+ 0	+3930426- 1
-3974752+ 0	-1316073+ 1	+1568436+ 1	+1205223+ 1	+8551740+ 0
+3605034+ 0	-1843389+ 0	-7814073+ 0	-1924945+ 1	+1495930+ 1
+1082091+ 1	+2083420+ 0	-4676207+ 0	-1203809+ 1	-2461232+ 1
+1156616+ 1	+7012213+ 0	-1644005- 1	-8004585+ 0	-1657877+ 1
-2904389+ 1	-2475469+ 0	+2369112+ 0	+2362994- 1	+6242749- 2
-1429199- 2	-6660729- 2	-1932378- 2	+4307739- 2	+9451929- 2
+1465641- 1	+2014608- 1	+2528385- 1	-1079830+ 0	) 0+ 0

FIGURE 21 (continued)

TFW NASTRAN MODES
(WING LOCKED)



Freq = 34.55


```
-7660516+ 0 +1247240+ 0 +7727188+ 0 +1357403+ 1 +1888651+ 1
+2202995+ 1 -1378512+ 1 -3307157+ 0 +2669004+ 0 +7832139+ 0
+1363022+ 1 +1620540+ 1 -1786985+ 1 -6356035+ 0 -1025696+ 0
+3317653+ C +6672550+ 0 +8591475+ 0 +1C38439+ 1 -1929293+ 1
-7861444+ 0 -3463862+ 0 -6099198- 2 +2388405+ 0 +3977417+ 0
+4700593+ 0 -1782799+ 1 -7743391+ 0 -4475359+ 0 -2092820+ 0
-5346884- 1 +2830160- 1 +1146500- 1 -1412367+ 1 -6326275+ 0
-4256835+ 0 -2899825+ 0 -2101853+ 0 -1740595+ 0 -1757332+ 0
-2034925+ 0 -9073455+ 0 -4390289+ 0 -3369223+ 0 -2862258+ 0
-2571026+ 0 -2425667+ 0 -2407286+ 0 -2606560+ 0 -3172019+ 0
-2749133+ 0 -2310715+ 0 -2221693+ 0 -2197989+ 0 -2459716+ 0
-2927464+ 0 -2358771+ 0 -2014535+ 0 -2005714+ 0 -1974280+ 0
-1935885+ 0 -1973001+ 0 -2147180+ 0 -2386753+ 0 -3055083+ 0
-2361383+ 0 -2569837+ 0 -2815280+ 0 -3456355+ 0 -2803085+ 0
-3278705+ 0 -3866643+ 0 -3304985+ 0 -3772571+ 0 -4288208+ 0
-3847655+ 0 -4271841+ 0 -4709542+ 0 -4385678+ 0 -4747941+ 0
-5114243+ 0 +7273346- 1 +5545009- 1 +4130881- 1 +3008743- 1
+1925966- 1 +1572970- 1 -2892517- 1 +1369950- 1 +1193817- 1
+1027394- 1 +8800476- 2 +2759223+ 0 -2570030+ 0 -1136861+ 0
+5446197+ 0 +5748584+ 0 +6049330+ 0 +4832542+ 0 +5186642+ 0
+5545039+ 0 +4217481+ 0 +4604378+ 0 +5025431+ 0 +3659329+ 0
+4040866+ 0 +4519768+ 0 +3193751+ 0 +3343948+ 0 +3533932+ 0
+4041101+ 0 +2808754+ 0 +2930507+ 0 +3088580+ 0 +3581460+ 0
+2721190+ 0 +2336046+ C +2309798+ 0 +3189644+ 0 +7090375+ 0
+2898020+ 0 +2805470+ 0 +2623250+ 0 +3292932+ 0 +4370463+ 0
+8100561+ 0 +1254196+ 1 -1229256+ 1 -9635285+ 0 -6290101+ 0
-3551868+ 0 +3321383- 1 +6148560+ 0 +1661076+ 1 +5781103+ 1
-2975711+ 1 -2859872+ 1 -2563059+ 1 -1806096+ 1 -6506142+ 0
+1016837+ 1 +3274186+ 1 +1C48165+ 2 -6661441+ 1 -6045631+ 1
-4042868+ 1 -1678706+ 1 +1433232+ 1 +5262652+ 1 +1547989+ 2
-1219468+ 2 -1008240+ 2 -6691755+ 1 -3052688+ 1 +1651640+ 1
+7199514+ 1 +2007849+ 2 -1710734+ 2 -1357284+ 2 -1004637+ 2
-4678562+ 1 +1613270+ 1 +8836045+ 1 +2344188+ 2 -2023875+ 2
-1584923+ 2 -6387932+ 1 +1322081+ 1 +9920932+ 1 +2482904+ 2
-2141963+ 2 -1627494+ 2 -8249206+ 1 +6452253+ 0 +1041137+ 2
+2428538+ 2 -2555650+ C +2773386+ 0 +2621961- 1 +6944350- 2
-1591127- 2 -7403585- 2 -2217437- 2 +4672315- 2 +1035851- 1
+1611690- 1 +2219427- 1 +2788304- 1 -1187716+ 0 )       0+ 0
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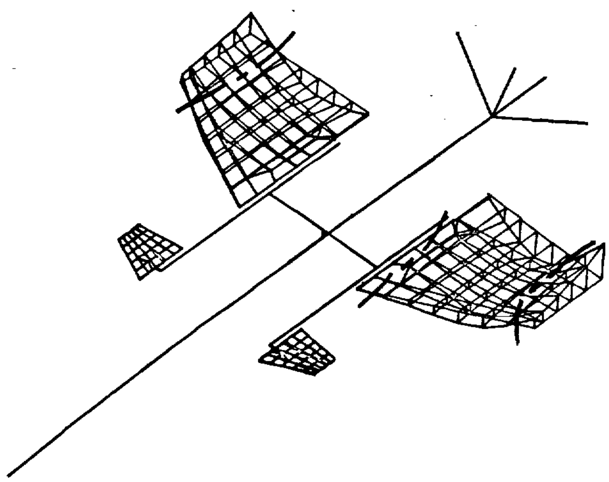
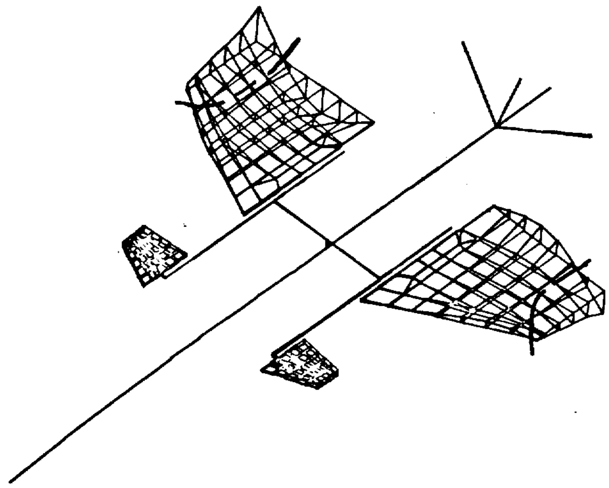


Freq = 46.19

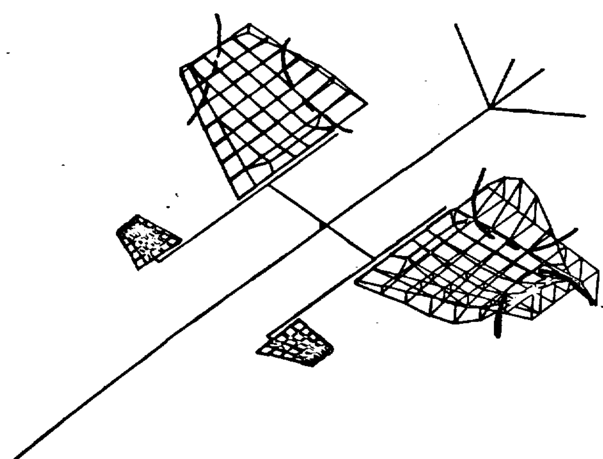

```
+2296955+ 2 +1612169+ 2 +1292393+ 2 +1017695+ 2 +7397606+ 1
+5814100+ 1 +8110644+ 1 +5656079+ 1 +4228360+ 1 +2580942+ 1
-4969755+ 0 -2252333+ 1 -4939577+ 1 -2070870+ 1 -1891482+ 1
-2429666+ 1 -3580834+ 1 -4852248+ 1 -6527044+ 1 -1427101+ 2
-6639702+ 1 -5274985+ 1 -4892557+ 1 -5195219+ 1 -6070252+ 1
-7186984+ 1 -1754508+ 2 -7635874+ 1 -5825475+ 1 -4969113+ 1
-4736234+ 1 -4892853+ 1 -5192482+ 1 -1513486+ 2 -5932251+ 1
-4342983+ 1 -3502551+ 1 -3107862+ 1 -2919379+ 1 -2840698+ 1
-2748182+ 1 -9162151+ 1 -3182046+ 1 -2169239+ 1 -1637251+ 1
-1316396+ 1 -1095064+ 1 -1050893+ 1 -1006949+ 1 -1470661+ 1
-8686017+ 0 -8231011- 1 +1336458+ 0 +3379046+ 0 +5246171+ 0
+7506914+ 0 -4454736+ C +1589842+ 0 +3818345+ 0 +4046147+ 0
+3609450+ 0 +3221491+ 0 +3790996+ 0 +4534405+ C +6491489+ 0
+3761244+ 0 +4422551+ 0 +5193529+ 0 +7123882+ 0 +4515300+ 0
+6012996+ 0 +7806811+ 0 +5516826+ 0 +6982059+ 0 +8558333+ 0
+6678098+ 0 +7999845+ 0 +9339112+ 0 +7857765+ 0 +8981060+ 0
+1010237+ 1 +1251522+ 0 +1139735+ 0 +1C72728+ 0 +1084125+ 0
+1336766+ 0 +1784311+ 0 +3411185- 1 +2470497+ 0 +3417483+ 0
+4582113+ C +5740715+ 0 +2076244+ 0 +8326898+ 0 +1325030+ 0
-6975003+ 0 -7632867+ 0 -8287917+ 0 -5867441+ 0 -6634170+ 0
-7412745+ 0 -4769529+ 0 -5600268+ 0 -6511248+ 0 -3798899+ 0
-4605911+ 0 -5637243+ 0 -3028356+ 0 -3336860+ 0 -3731888+ 0
-4919638+ 0 -2429143+ 0 -2671906+ 0 -2989092+ 0 -4042107+ 0
-2364695+ C -1227618+ 0 -1071058+ 0 -2690624+ 0 -6890032+ 0
-6873090- 1 -1098618+ 0 -1807485+ 0 -3243635+ 0 -4731134+ 0
-1005690+ 1 -1423054+ 1 -1252440+ 1 -1207559+ 1 -1199775+ 1
-1338578+ 1 -1548968+ 1 -1896863+ 1 -2550440+ 1 -6196303+ 1
-2400177+ 1 -2383317+ 1 -2390839+ 1 -2484734+ 1 -2733799+ 1
-3277116+ 1 -4295136+ 1 -9869607+ 1 -3875477+ 1 -3581046+ 1
-3399638+ 1 -3547363+ 1 -4113184+ 1 -5285944+ 1 -1131182+ 2
-4779013+ 1 -4005707+ 1 -3416832+ 1 -3253396+ 1 -3558270+ 1
-4496960+ 1 -9243257+ 1 -3795831+ 1 -2760101+ 1 -1982532+ 1
-1342372+ 1 -1139661+ 1 -1422941+ 1 -3466220+ 1 -4736730+ 0
+5260555+ 0 +2237837+ 1 +3038038+ 1 +3641271+ 1 +4603019+ 1
+5245634+ 1 +6102733+ 1 +7508488+ 1 +6885748+ 1 +1045169+ 2
+1389354+ 2 +7249074+ 0 +9984663- 1 -3448995- 1 -9233390- 2
+2223313- 2 +9936354- 2 +3751156- 2 -4708634- 2 -1173477- 1
-1895645- 1 -2665292- 1 -3389909- 1 +1389667+ 0 )       0+ 0
```

TFW NASTRAN MODES
(WING LOCKED)



Freq = 50.34

-1653132+	2	-1035847+	2	-7446218+	1	-5C02197+	1	-2626654+	1
-1244715+	1	-6027752+	1	-3603346+	1	-2202013+	1	-7362253+	0
+1651609+	1	+2966350+	1	+3205051+	1	+1304196+	1	+1369282+	1
+1881454+	1	+2719755+	1	+3541900+	1	+4613106+	1	+9755882+	1
+4036931+	1	+3132755+	1	+2888949+	1	+3046842+	1	+3452245+	1
+3943549+	1	+1184698+	2	+4365528+	1	+3099500+	1	+2485851+	1
+2252445+	1	+2079523+	1	+1964095+	1	+9770882+	1	+2985123+	1
+1882425+	1	+1290343+	1	+9796134+	0	+7529850+	0	+5691565+	0
+2790498+	0	+5354352+	1	+1090876+	1	+4113207+	0	+5836016-	1
-1574315+	0	-3270244+	0	-4909987+	0	-7716101+	0	+1736589-	1
-3210884+	0	-7867958+	0	-9094117+	0	-1016900+	1	-1302767+	1
-1797832+	1	-5077618+	0	-8455629+	0	-9510395+	0	-1045983+	1
-1238159+	1	-1112297+	1	-1338689+	1	-1636224+	1	-2482776+	1
-1371142+	1	-1642626+	1	-1967316+	1	-2812249+	1	-1731377+	1
-2374730+	1	-3165342+	1	-2210400+	1	-2852772+	1	-3550495+	1
-2767801+	1	-3353575+	1	-3948871+	1	-3335983+	1	-3836592+	1
-4336506+	1	+5529097-	1	+3225712-	1	+1863353-	1	+1497729-	1
+2249500-	1	+3518137-	1	-1386579+	0	+5322725-	1	+7890466-	1
+1108549+	0	+1427744+	0	+1383577+	1	-1127774+	1	-5312489+	0
+3477960+	1	+3939309+	1	+4395306+	1	+2673829+	1	+3415438+	1
+3958118+	1	+2281075+	1	+2876777+	1	+3512290+	1	+1773195+	1
+2370055+	1	+3088949+	1	+1398531+	1	+1648826+	1	+1948706+	1
+2707644+	1	+1137070+	1	+1349784+	1	+1617505+	1	+2356007+	1
+1251878+	1	+1095513+	1	+1000355+	1	+8043795+	0	+2272941+	0
+1692741+	1	+1303426+	1	+1037780+	1	+8473083+	0	+6383379+	0
-1446493+	0	-7196904+	0	-4142079-	1	-2013514+	0	-3094057+	0
-5540676+	0	-8917632+	0	-1449370+	1	-2516150+	1	-9049591+	1
-1800865+	1	-2027475+	1	-2195183+	1	-2465884+	1	-2919299+	1
-3829218+	1	-5530064+	1	-1564537+	2	-4445493+	1	-4356816+	1
-4402605+	1	-4714640+	1	-5656459+	1	-7607190+	1	-1851018+	2
-7049420+	1	-6083917+	1	-5301206+	1	-5027656+	1	-5440829+	1
-6894342+	1	-1524361+	2	-7170624+	1	-5452160+	1	-4125062+	1
-2864037+	1	-2210924+	1	-2313462+	1	-5301262+	1	-3459151+	1
-1467343+	1	+2063219+	1	+4037357+	1	+5786803+	1	+8789226+	1
+4560763+	1	+6604943+	1	+9832980+	1	+1313614+	2	+1693381+	2
+2482128+	2	-1157423+	1	+1353908+	1	+1452720+	0	+3933417-	1
-9458620-	2	-4219252-	1	-1749776-	1	+1717383-	1	+4603810-	1
+7588710-	1	+1078169+	0	+1379284+	0	-5580967+	0	) 0+	0

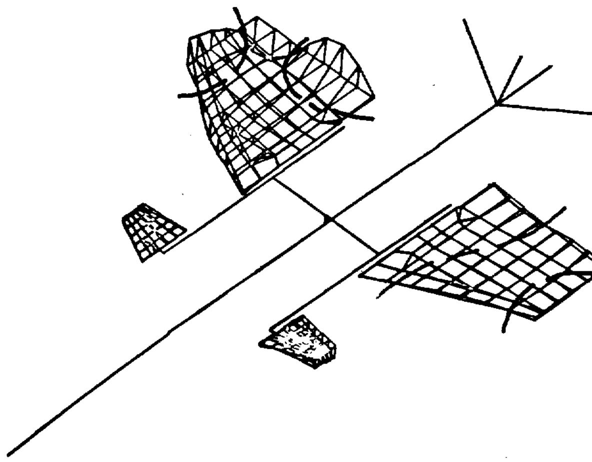


Freq = 67.23

-2476784+	2	-1209040+	1	+8484764+	1	+1450555+	2	+1801462+	2
+2003386+	2	-2386133+	2	-3159142+	1	+2948943+	1	+6008725+	1
+5606294+	1	+4235706+	1	-1272789+	2	-2682092+	1	-2915088+	0
+8226845-	1	-1563731+	1	-4262564+	1	-8552295+	1	+4631858+	1
-7725099+	0	-1657268+	1	-3104342+	1	-5508307+	1	-9597797+	1
-1484009+	2	+1873791+	2	+1011319+	1	-1641805+	1	-3712972+	1
-5889194+	1	-9661585+	1	-1303932+	2	+2249306+	2	+1627648+	1
-1034223+	1	-2655187+	1	-3968906+	1	-5388499+	1	-6555889+	1
-8051147+	1	+1539972+	2	+1259963+	1	-3356488+	0	-1056631+	1
-1571531+	1	-2083001+	1	-3376031+	1	-4991319+	1	+1626657+	1
+8143868+	0	+3550630+	0	+2119179+	0	+1425087+	0	-5423947+	0
-1947620+	1	+8479976+	C	+23C2106+	0	+1192645+	C	+1356937+	0
+2273889+	0	+6536161-	1	+2512778+	0	+4852338+	0	+1122793+	1
+1913416+	0	+4105942+	0	+6673620+	0	+1319333+	1	+4040911+	0
+9200425+	0	+1539625+	1	+7227954+	0	+1240546+	1	+1792906+	1
+1114129+	1	+1587568+	1	+2062337+	1	+1521460+	1	+1926611+	1
+2327C51+	1	+3993124+	0	+2045791+	0	+5236290-	1	-5498417-	1
-1208845+	0	-9037979-	1	+3436432-	1	-1916488-	1	+8179696-	1
+2072600+	0	+3325453+	0	-1760418-	1	+5659567+	C	+1212239+	0
-3218929+	1	-3961189+	1	-4686889+	1	-2362022+	1	-3232741+	1
-4092822+	1	-1537662+	1	-2493403+	1	-3493453+	1	-8676239+	0
-1821150+	1	-2941116+	1	-4317519+	0	-8350088+	0	-13C7415+	1
-2470243+	1	-1880633+	0	-5372729+	0	-9563440+	0	-2056134+	1
-5021010+	0	-3786075+	0	-3252519+	0	-2819667+	0	-1675311+	0
-9971514+	C	-5620042+	0	-3377164+	0	-3069432+	0	-2731284+	0
-1771098+	0	-4690957-	1	-1289036+	1	-8981533+	0	-6249927+	0
-5184931+	0	-4218919+	0	-2930611+	0	-3323914-	1	+2123505+	1
-1565295+	1	-1209634+	1	-9692866+	0	-7119551+	0	-4908388+	0
-2174614+	0	+2288019+	0	+3583958+	1	-1924477+	1	-1350805+	1
-7372686+	0	-4091376+	0	-6952194-	1	+4172524+	0	+3675988+	1
-1619644+	1	-9445671+	0	-4235306+	0	-1292630+	0	+8293265-	1
+3249973+	0	+2030791+	1	-3405884+	0	+3521082-	1	+2592499+	0
+3272147+	0	+1832954+	0	-1218228+	0	-8197837+	0	+1369896+	1
+1274207+	1	+8729639+	0	+2074334+	0	-8C31135+	0	-3631283+	1
+2929225+	1	+2344595+	1	+1446033+	1	+2C29790+	0	-1569848+	1
-5646740+	1	+4495271+	0	-1340298+	0	-4132751-	1	-1167398-	1
+2802976-	2	+1239144-	1	+6946071-	2	-1985524-	2	-9665653-	2
-1783699-	1	-2672391-	1	-3515977-	1	+1287339+	0	) 0+	0

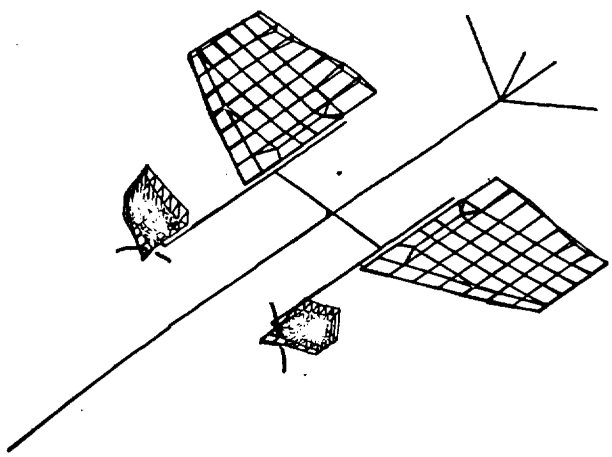
FIGURE 21 (continued)

TFW NASTRAN MODES
(WING LOCKED)



Freq = 70.28

+1326076+ 1	-1192512+ 1	-2214828+ 1	-2715690+ 1	-2780257+ 1
-2786919+ 1	+3734319+ 1	+2003108+ 0	-6230882+ 0	-8568389+ 0
-3063832+ 0	+2321149+ 0	+3508970+ 1	+7028581+ 0	+2485976+ 0
+2765812+ 0	+7026897+ 0	+1278285+ 1	+2177940+ 1	+9018885+ 0
+4818410+ 0	+4857189+ 0	+7081598+ 0	+1128706+ 1	+1792959+ 1
+2588038+ 1	-2155425+ 1	-4671602- 1	+2850057+ 0	+5811740+ 0
+9018565+ 0	+1355477+ 1	+1671906+ 1	-3610887+ 1	-4424887+ 0
-4626865- 1	+1888480+ 0	+3649631+ 0	+5098194+ 0	+5774711+ 0
+5841985+ 0	-2872641+ 1	-5576089+ 0	-3002770+ 0	-1934502+ 0
-1274665+ 0	-8646939- 1	-3379403- 1	-5541644- 1	-6621226+ 0
-5126677+ 0	-4346674+ 0	-4169165+ 0	-4230571+ 0	-5161962+ 0
-6845703+ 0	-5026904+ 0	-4017312+ 0	-4101905+ 0	-4936579+ 0
-7155192+ 0	-1776463- 1	-7649165+ 0	-1643121+ 1	-3907720+ 1
-5109074+ 0	-1367297+ 1	-2366070+ 1	-4795842+ 1	-1432413+ 1
-3458224+ 1	-5814851+ 1	-2879579+ 1	-4912853+ 1	-7023039+ 1
-4673470+ 1	-6525875+ 1	-8344127+ 1	-6543000+ 1	-8121359+ 1
-9657211+ 1	+6018022+ 0	+2797427+ 0	+3445115- 1	-1309646+ 0
-2258227+ 0	-1767780+ 0	-3529667- 1	-6902499- 1	+8299341- 1
+2715530+ 0	+4597196+ 0	+6922156+ 0	+5193087- 1	-1334678+ 0
+1685304+ 1	+2081373+ 1	+2466599+ 1	+1197613+ 1	+1662021+ 1
+2117719+ 1	+7286965+ 0	+1237690+ 1	+1765896+ 1	+3474465+ 0
+8534000+ 0	+1442413+ 1	+9826582- 1	+3114957+ 0	+5602423+ 0
+1166545+ 1	-4366633- 1	+1419214+ 0	+3597874+ 0	+9236493+ 0
+1165543+ 0	+4225176- 1	+3708208- 1	+1596845+ 0	+8157022+ 0
-2428951+ 1	-7569683+ 0	+6294807- 1	+1421238+ 0	+2974338+ 0
+7962071+ 0	+1647601+ 1	-5405952+ 1	-3592211+ 1	-2184177+ 1
-1637566+ 1	-1093246+ 1	-3340590+ 0	+1319468+ 1	+1562293+ 2
-8391763+ 1	-6738781+ 1	-5491884+ 1	-4006252+ 1	-2639865+ 1
-9508554+ 0	+1812030+ 1	+2311485+ 2	-1315164+ 2	-9715609+ 1
-5845613+ 1	-3621239+ 1	-1480545+ 1	+1294991+ 1	+1977286+ 2
-1458005+ 2	-9423114+ 1	-5343124+ 1	-2946542+ 1	-1488945+ 1
-5297882+ 0	+5613998+ 1	-8039816+ 1	-3508269+ 1	-1296511+ 1
+2365475+ 0	-2450887+ 0	-2703067+ 1	-1238302+ 2	+4761295+ 1
+5965721+ 1	+6054561+ 1	+2730599+ 1	-3656632+ 1	-2458477+ 2
+2045934+ 2	+1807962+ 2	+1432170+ 2	+7867084+ 1	-2379004+ 1
-2702264+ 2	-1229558+ 0	+5173120+ 0	+4457754- 1	+1241446- 1
-3294435- 2	-1349004- 1	-7717999- 2	+1714598- 2	+9969493- 2
+1892325- 1	+2879151- 1	+3826526- 1	-1418570+ 0)	0+ 0

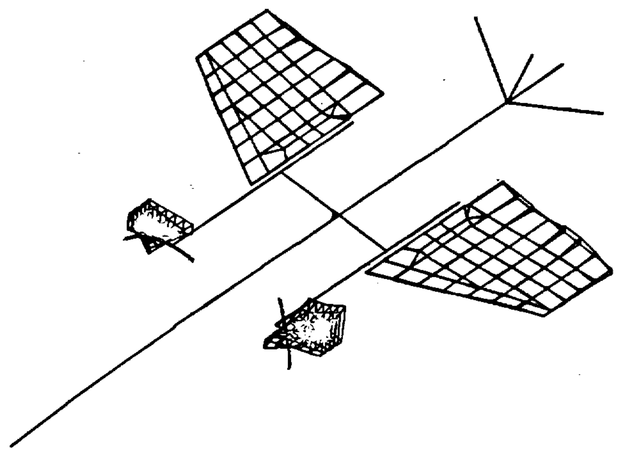


Freq = 72.86

+2099195+ 1	+1989575+ 1	+2147735+ 1	+2130436+ 1	+1821027+ 1
+1603707+ 1	-2497077+ 1	-2402942- 1	+4468897+ 0	+4504593+ 0
-2622800+ 0	-8911641+ 0	-4143002+ 1	-8368979+ 0	-3908144+ 0
-4350950+ 0	-8173833+ 0	-1290355+ 1	-2023964+ 1	-2227066+ 1
-6008000+ 0	-4624263+ 0	-5967431+ 0	-8973630+ 0	-1314381+ 1
-1695893+ 1	+9913653+ 0	+1179576+ 0	-6995496- 1	-2762790+ 0
-4894420+ 0	-6627878+ 0	-6233696+ 0	+2726971+ 1	+6969116+ 0
+3827010+ 0	+1844433+ 0	+5230173- 1	-8771057- 4	+4700954- 1
+2336244+ 0	+2499792+ 1	+9091451+ 0	+6621079+ 0	+5364628+ 0
+4600748+ 0	+4331086+ 0	+5157070+ 0	+7634063+ 0	+1116403+ 1
+8832237+ 0	+7188443+ 0	+6704463+ 0	+6469580+ 0	+8565244+ 0
+1284086+ 1	+8649859+ 0	+6754926+ 0	+6498055+ 0	+7946405+ 0
+1268817+ 1	-7895086+ 0	+1347028+ 1	+3792404+ 1	+9948365+ 1
+5712417+ 0	+2996598+ 1	+5812799+ 1	+1255421+ 2	+3226485+ 1
+8970985+ 1	+1557017+ 2	+7480216+ 1	+1325446+ 2	+1918347+ 2
+1278615+ 2	+1804577+ 2	+2316605+ 2	+1832717+ 2	+2280533+ 2
+2713615+ 2	-1938283+ 1	-8640512+ 0	-4328990- 1	+5138228+ 0
+8394065+ 0	+6812413+ 0	-6004004- 2	+3313821+ 0	-1575824+ 0
-7619059+ 0	-1364188+ 1	-1098361+ 1	-1069166+ 1	+8901865- 2
+2040640+ 2	+2572799+ 2	+3089992+ 2	+1420912+ 2	+2045067+ 2
+2656782+ 2	+8280007+ 1	+1512489+ 2	+2221270+ 2	+3530746+ 1
+1034336+ 2	+1824159+ 2	+5534019+ 0	+3440123+ 1	+6790471+ 1
+1491372+ 2	-9896024+ 0	+1533483+ 1	+4484214+ 1	+1203119+ 2
+1440834+ 1	+8862096+ 0	+7100970+ 0	+7258014+ 0	+9265131+ 0
+1069141+ 1	+8323760+ 0	+7074632+ 0	+7198923+ 0	+7647681+ 0
+9242174+ 0	+1192733+ 1	+6291734- 1	+4665829- 1	+1477428+ 0
+2352139+ 0	+3621183+ 0	+5552590+ 0	+9851637+ 0	+4603833+ 1
-9658355+ 0	-9342624+ 0	-8035686+ 0	-5399108+ 0	-2299907+ 0
+1714186+ 0	+8159766+ 0	+5576900+ 1	-2772151+ 1	-2171457+ 1
-1386086+ 1	-6445317+ 0	-3477362+ 0	+1926340+ 0	+3232993+ 1
-4232238+ 1	-2851439+ 1	-1749631+ 1	-1066653+ 1	-7038950+ 0
-6749382+ 0	-1200814+ 1	-3464818+ 1	-1975549+ 1	-1058228+ 1
-4132287+ 0	-4098081+ 0	-1126160+ 1	-5007855+ 1	-1306847+ 0
+6700850+ 0	+1381737+ 1	+6615156+ 0	-5369668+ 0	-5798518+ 1
+5095650+ 1	+4771357+ 1	+4340405+ 1	+3239777+ 1	+1338029+ 1
-3010134+ 1	-5091800+ 0	-5383439+ 0	+8653906- 2	+3146109- 2
-6507879- 4	-2577054- 2	-2230814- 2	-8039952- 3	+8458425- 4
+7416283- 3	+1217984- 2	+1441178- 2	+8600672- 2)	0+ 0

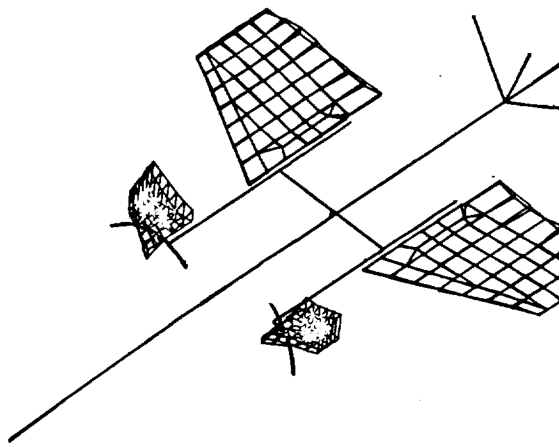
FIGURE 21 (continued)

TFW NASTRAN MODES
(WING LOCKED)



Freq = 76.77

-5926393+	1	-4190666+	1	-3332416+	1	-2298500+	1	-9069029+	0
+3090256-	1	+3213133+	1	-5350280+	0	-7302080+	0	-2234889+	0
+1311830+	1	+2395056+	1	+7381970+	1	+1161130+	1	+5311614+	0
+6959875+	0	+1288091+	1	+1902327+	1	+2830014+	1	+5426084+	1
+1038313+	1	+5932856+	0	+6476074+	0	+9293099+	0	+1264970+	1
+1561625+	1	-2633935+	0	-8336402-	1	-4273967-	1	+6660720-	1
+1935164+	0	+8830938-	1	-2342716+	0	-4722293+	1	-1051916+	1
-6896124+	0	-5275439+	C	-4614707+	0	-5280038+	0	-7318043+	0
-1213302+	1	-4823818+	1	-1314702+	1	-9661493+	0	-8282953+	0
-7591703+	0	-7663164+	0	-1042303+	1	-1638195+	1	-1368634+	1
-1049241+	1	-8102702+	0	-7421686+	0	-6958147+	0	-1129137+	1
-2021887+	1	-9457060+	0	-6886135+	0	-6312766+	0	-5473232+	0
-2202803+	0	-3977993+	1	-1395711+	0	+4250287+	1	+1520278+	2
-1688698+	1	+2666599+	1	+7679465+	1	+1966257+	2	+2839036+	1
+1309485+	2	+2484473+	2	+1016162+	2	+2048471+	2	+3107520+	2
+1935947+	2	+2877867+	2	+3794664+	2	+2899778+	2	+3702929+	2
+4479433+	2	+1276044+	0	+4214052-	1	-1773292-	1	-5178890-	1
-6530798-	1	-5257928-	1	-8494618-	1	-2614060-	1	+1297819-	1
+6235236-	1	+1119289+	0	+8433603+	0	-6657956+	0	-3147696+	0
-2336460+	2	-2989180+	2	-3620594+	2	-1559778+	2	-2325160+	2
-3070697+	2	-8168152+	1	-1657526+	2	-2518819+	2	-2293525+	1
-1062567+	2	-2018297+	2	+1346392+	1	-2192716+	1	-6266219+	1
-1602071+	2	+3180869+	1	+6487622-	1	-3506856+	1	-1243979+	2
+1203688+	0	+4186173+	0	+5182870+	0	+5683308+	0	+7669992+	0
+9475845+	0	+6999194+	0	+5803494+	0	+6163435+	0	+6678902+	0
+8321277+	0	+1074636+	1	+5195418+	0	+4178580+	0	+4233043+	0
+4685869+	0	+5486978+	0	+6737466+	0	+9481329+	0	+3226425+	1
+4608810-	1	-4182344-	1	-3955870-	1	+4642253-	1	+1837328+	0
+3793849+	0	+7218368+	0	+3488172+	1	-9421864+	0	-8251016+	0
-5757719+	0	-3490555+	C	-1527873+	0	+2313596-	1	+1135445+	1
-2147402+	1	-1586305+	1	-1080136+	1	-7410038+	0	-6143207+	0
-8123654+	0	-2639833+	1	-2452203+	1	-1607802+	1	-1033683+	1
-5515716+	0	-4780735+	0	-1006467+	1	-4919842+	1	-1252478+	1
-4658554+	0	+5497763+	0	+6437460+	0	+7710377-	1	-3500624+	1
+1566106+	1	+2069134+	1	+2694244+	1	+2890944+	1	+2614955+	1
+1455014+	1	-7117815+	0	+7973613+	0	+8827328-	1	+2530926-	1
-6404253-	2	-2683542-	1	-1655372-	1	+3888910-	2	+2306174-	1
+4416560-	1	+6760267-	1	+9014520-	1	-3347316+	0	) 0+	0

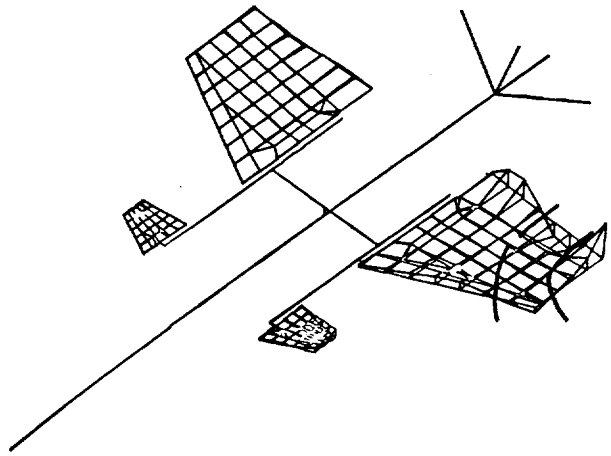


Freq = 78.36

-6696469+	1	-3673767+	1	-2635016+	1	-1756756+	1	-7500326+	0
-1231406+	0	+1471293+	1	-2290023+	0	-2672947+	0	+8771922-	1
+1096303+	1	+1858575+	1	+6079485+	1	+1327938+	1	+7835708+	0
+8042152+	0	+1073461+	1	+1347286+	1	+1765619+	1	+4591064+	1
+1063572+	1	+6570557+	0	+5977910+	0	+6278827+	0	+5582030+	0
+2925860+	0	-6173910+	0	-1330582+	0	-8120366-	1	-3935034-	1
-7455076-	1	-4775601+	0	-1095733+	1	-4213576+	1	-1081798+	1
-7290895+	0	-5894205+	0	-5845378+	0	-7467277+	0	-1022966+	1
-1562209+	1	-4087820+	1	-1305154+	1	-9631784+	0	-8195474+	0
-7616028+	[illegible]	-7960961+	0	-1132913+	1	-1748010+	1	-1376002+	1
-1051250+	1	-7831012+	0	-7144901+	0	-6848099+	0	-1080395+	1
-1878334+	1	-9797923+	0	-7199965+	0	-7000018+	C	-8322592+	0
-9557318+	0	-3290850+	1	-8719809+	0	+2003283+	1	+9335136+	1
-1928178+	1	+8499526+	0	+4030414+	1	+1179437+	2	+6488250+	0
+7115844+	1	+1463353+	2	+4751683+	1	+1124949+	2	+1801384+	2
+9910708+	1	+1584943+	2	+2169985+	2	+1532680+	2	+2040325+	2
+2535519+	2	+1731735+	1	+6816274+	0	-1145129+	0	-6487838+	0
-9622394+	0	-8170321+	0	+2005021-	1	-4555744+	0	+6456885-	1
+7145465+	0	+1364897+	1	+9902781+	0	+1133160+	1	+2498832-	1
+2274710+	2	+2930142+	2	+3563176+	2	+1486142+	2	+2254442+	2
+3001250+	2	+7341779+	1	+1575737+	2	+2437197+	2	+1359470+	1
+9717222+	1	+1925611+	2	-2351343+	1	+1211463+	1	+5289783+	1
+1499871+	2	-4253914+	1	-1106766+	1	+2478775+	1	+1133332+	2
-1201762+	1	-1097055+	1	-9539055+	0	-9493484+	0	-1161115+	1
-2582537+	1	-1500003+	1	-9547673+	0	-9603858+	0	-1007799+	1
-1211378+	1	-1501248+	1	-1887828+	1	-1157339+	1	-8118884+	0
-7860985+	0	-8555460+	0	-1004112+	1	-1372568+	1	-4686010+	1
-1136353+	1	-5501855+	0	-3210362+	0	-2765222+	0	-4002059+	0
-6386753+	0	-1071911+	1	-4500094+	1	+3502141+	0	+5934197+	0
+5437895+	0	+2973375+	C	+5170562-	1	-1242474+	0	-3954587+	0
+2487138+	1	+1873428+	1	+1299640+	1	+8664845+	0	+6835551+	0
+9643296+	0	+4410234+	1	+3392875+	1	+2151461+	1	+1383789+	1
+7299987+	0	+5864092+	0	+1171380+	1	+5830741+	1	+1863632+	1
+7694238+	0	-5523566+	0	-7052921+	0	-1680658+	0	+3029592+	1
-2026509+	1	-2469276+	1	-3114143+	1	-3312286+	1	-3106122+	1
-2495886+	1	+5291416+	0	+3862115+	0	-2589346-	1	-7060882-	2
+2416325-	2	+8421413-	2	+5292563-	2	-2326341-	3	-4281005-	2
-7776607-	2	-1097548-	1	-1355199-	1	+2747002-	1	) C+	0

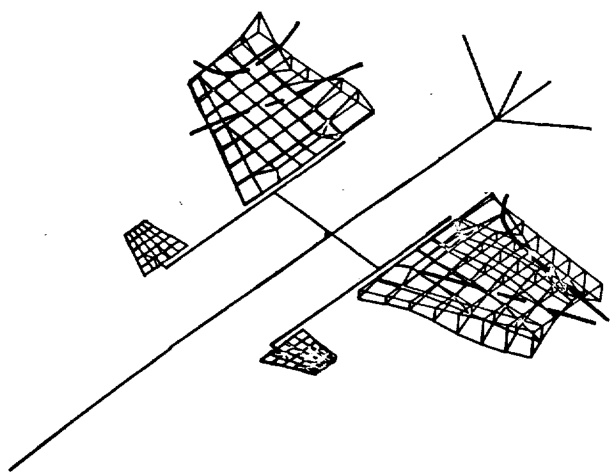
FIGURE 21 (continued)

TFW NASTRAN MODES
(WING LOCKED)



Freq = 83.72

```
+4605729+ 2 +1536007+ 2 +5333059+ 1 -6213805+ 0 -4688319+ 1
-6978228+ 1 +4069673+ 1 +7784011+ 0 -1536520+ 1 -3139717+ 1
-3267544+ 1 -2722845+ 1 -2179682+ 2 -6477166+ 1 -4443850+ 1
-3148469+ 1 -1126659+ 1 +1246550+ 1 +4934586+ 1 -1898294+ 2
-6237206+ 1 -3657123+ 1 -1514884+ 1 +1244066+ 1 +5485301+ 1
+1095734+ 2 +5147489+ 1 -1802233+ 1 -1127951+ 1 +3072442+ 0
+2494301+ 1 +6806596+ 1 +1083571+ 2 +2405342+ 2 +1820163+ 1
+7964666+ 0 +1171952+ 1 +2190500+ 1 +3704513+ 1 +5109789+ 1
+7024442+ 1 +2142197+ 2 +2402349+ 1 +1162798+ 1 +9146513+ 0
+9797232+ 0 +1298826+ 1 +2685578+ 1 +4639787+ 1 +1922805+ 1
+8557155+ 0 -6416281- 1 -3303997+ 0 -5815378+ 0 +2581555+ 0
+2120500+ 1 +5375584+ 0 -3426656+ 0 -6402340+ 0 -7994598+ 0
-9573503+ 0 -1899562+ 1 -9503437+ 0 +1159481+ 0 +2697632+ 1
-1365467+ 1 -2956724+ 0 +9154112+ 0 +3774311+ 1 -2920305+ 0
+2206221+ 1 +5033732+ 1 +1469089+ 1 +3991287+ 1 +6558067+ 1
+3704400+ 1 +6011458+ 1 +8244686+ 1 +6058755+ 1 +8029376+ 1
+9926559+ 1 +6682575+ C +2263027+ 0 -1006374+ 0 -3093631+ 0
-4175997+ 0 -3518507+ C -5429287- 1 -2321271+ C -7593647- 1
+1118086+ 0 +2970094+ 0 +7272282+ 0 -3051151+ 0 -2111994+ 0
-8737325+ 0 -1220782+ 1 -1558759+ 1 -5411311+ 0 -9481910+ 0
-1348103+ 1 -2278189+ 0 -6746316+ 0 -1138132+ 1 +1147904- 1
-4346035+ 0 -9511031+ 0 +1416255+ 0 -5016715- 1 -2700320+ 0
-8032942+ 0 +1842798+ 0 +1615733- 1 -1816906+ 0 -6827245+ 0
-1457726- 1 -3178553- 1 +1610925- 1 +1500120+ 0 +4165812+ 0
-1045209+ 0 +6515445- 2 +8980878- 1 +1674046+ 0 +2741349+ 0
+5062477+ 0 +7820750+ 0 +1971638+ 0 +2432578+ 0 +2764293+ 0
+3303530+ 0 +4033973+ 0 +5079481+ 0 +7004199+ 0 +2369653+ 1
+4307604+ 0 +4074403+ 0 +3789660+ 0 +3674249+ 0 +3867490+ 0
+4402080+ 0 +5819769+ 0 +2246666+ 1 +6029791+ 0 +3676223+ 0
+2182810+ 0 +1784250+ 0 +1354790+ 0 +5083160- 1 -1901860+ 0
+1912781+ 0 -3867617- 1 -1175241+ 0 -1345586+ 0 -2307883+ 0
-5801904+ 0 -3354038+ 1 -6933828+ 0 -6129671+ 0 -4977794+ 0
-3261957+ 0 -2865912+ 0 -6289988+ 0 -4100890+ 1 -1454300+ 1
-9597429+ 0 -1472219+ 0 +2781629+ 0 +3669791+ 0 -1155761+ 1
-1449270+ 1 -5417182+ 0 +5734755+ 0 +1571653+ 1 +2519549+ 1
+4211139+ 1 -4777756+ 0 +5545179+ 0 +7494325- 1 +2070588- 1
-6354151- 2 -2334811- 1 -1518639- 1 +2246776- 3 +1479860- 1
+3111993- 1 +4946010- 1 +6728789- 1 -2269053+ 0 )       0+ 0
```

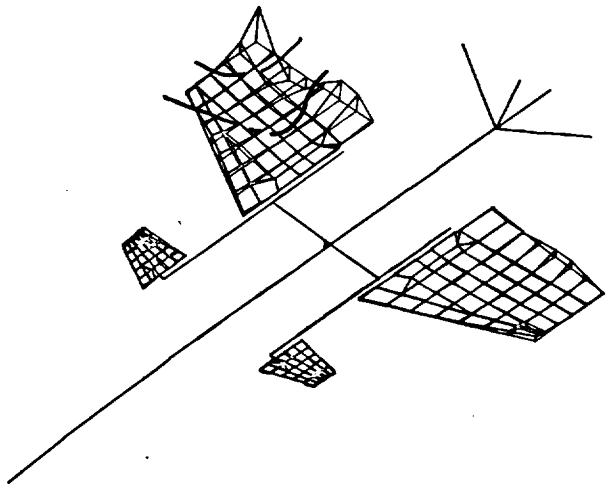


Freq = 86.62

```
-1122325+ 2 +2962648+ 1 +3100898+ 1 -1629097+ 1 -1014286+ 2
-1698170+ 2 -1827430+ 2 +5075213+ 1 +5564065+ 1 +1529669+ 1
-9271414+ 1 -1715328+ 2 -2246950+ 2 +7089024+ 1 +7731404+ 1
+4290687+ 1 -1892048+ 1 -7501736+ 1 -1545899+ 2 -2207096+ 2
+8248695+ 1 +8696158+ 1 +5840870+ 1 +8712550+ 0 -5593498+ 1
-1263926+ 2 -1638116+ 2 +7977830+ 1 +7939103+ 1 +5665485+ 1
+2064728+ 1 -3778749+ 1 -8222895+ 1 -8069938+ 1 +6247827+ 1
+5721191+ 1 +4103878+ 1 +1937777+ 1 -6003168+ 0 -2582259+ 1
-5146660+ 1 -1308837+ 1 +3645400+ 1 +3080773+ 1 +2109899+ 1
+1133728+ 1 +4976950- 1 -2100843+ 1 -5104702+ 1 +3118351+ 1
+1998473+ 1 +7065489+ 0 +2842606+ 0 -1114498+ 0 -1931703+ 1
-5455715+ 1 +1454285+ 1 +2472979+ 0 -2239725+ 0 -3506493+ 0
-3815383+ 0 -5642799+ 0 -3722121+ 0 -1994191+ 0 +1233082+ 0
-4196873+ 0 -2135937+ 0 +1062925- 1 +4745626+ 0 -1189187+ 0
+3783557+ 0 +8891735+ 0 +3901702+ 0 +9096497+ 0 +1397325+ 1
+1046292+ 1 +1529021+ 1 +1968559+ 1 +1743634+ 1 +2158695+ 1
+2539897+ 1 +4075442+ 0 +1216359+ 0 -8324106- 1 -2050155+ 0
-2546582+ 0 -2053948+ 0 -1076262- 1 -1458488+ 0 -8095760- 1
-9445194- 2 +5869753- 1 +1096213+ 0 -5477362- 1 -3152808- 1
+2622847+ 0 +2764296+ 0 +2867246+ 0 +1606766+ 0 +1808914+ 0
+1946582+ 0 +5885743- 1 +8535035- 1 +1040402+ 0 -2927335- 1
-3446016- 4 +2374519- 1 -9100219- 1 -7664516- 1 -6474941- 1
-4446088- 1 -1306382+ 0 -1156361+ 0 -1091345+ 0 -1053476+ 0
-1300938+ 0 -1505836+ 0 -8856994- 1 +1483571+ C +7124138+ 0
+1050045+ 1 +3020791+ 0 -9898035- 2 +1737106+ 0 +3523595+ 0
+8863403+ 0 +1505943+ 1 +1739897+ 1 +1040517+ 1 +6263094+ 0
+6729813+ 0 +7264955+ 0 +9423600+ 0 +1472071+ 1 +7556806+ 1
+2314083+ 1 +1636611+ 1 +1233634+ 1 +9223407+ 0 +8070943+ 0
+8619927+ 0 +1265670+ 1 +7404834+ 1 +2899862+ 1 +1727927+ 1
+7865897+ 0 +4444730+ 0 +2094311+ 0 -3658169- 1 -3695044+ 0
+1744196+ 1 +7406155+ 0 +9727548- 1 -2440439+ 0 -6491616+ 0
-1594482+ 1 -9091644+ 1 -7584186+ 0 -8054755+ 0 -8527685+ 0
-7968138+ C -8877639+ 0 -1668789+ 1 -9201419+ 1 -2734905+ 1
-1923888+ 1 -6806831+ C +1418113+ 0 +7247674+ 0 +1346765+ 0
-2985001+ 1 -1545552+ 1 +4152887+ 0 +2558900+ 1 +5403953+ 1
+1308239+ 2 -1169313+ 0 +4547041- 1 +2006495- 1 +3339940- 2
-3778355- 2 -7224555- 2 -3263930- 2 +1199496- 2 +4564323- 2
+7451675- 2 +1014111- 1 +1247536- 1 -3367180- 1 )       0+ 0
```

FIGURE 21 (concluded)

TFW NASTRAN MODES
(WING LOCKED)



Freq = 87.88


```
-2344532+ 1 -2378346+ 1 -1025653+ 1 +1250792+ 1 +4432018+ 1
+6907998+ 1 +4931882+ 1 -1691881+ 1 -1493163+ 1 -2536513- 1
+3250613+ 1 +5554858+ 1 +9866431+ 1 -1686943+ 1 -2126065+ 1
-1209649+ 1 +4287494+ 0 +1803640+ 1 +3644254+ 1 +9401575+ 1
-2153576+ 1 -2589499+ 1 -1934685+ 1 -7157345+ 0 +7547885+ 0
+2157122+ 1 +4338092+ 1 -2496072+ 1 -2520354+ 1 -1942134+ 1
-1048102+ 1 +3354729+ 0 +1292060+ 1 -4609829+ 0 -2169080+ 1
-1840502+ 1 -1347829+ 1 -7653982+ 0 -1098427+ 0 +4056645+ 0
+1112034+ 1 -1956645+ 1 -1295188+ 1 -6940359+ 0 -5558677+ 0
-2594272+ 0 +4618856- 1 +6228703+ 0 +1484075+ 1 -8925621+ 0
-4647241+ 0 +2528962- 1 +1687486+ 0 +2857605+ 0 +8580474+ 0
+1972813+ 1 -2763351+ 0 +1489727+ 0 +2720277+ 0 +3308531+ 0
+4312035+ 0 +7798591+ 0 +4553589+ 0 +1467320+ 0 -4805053+ 0
+5866780+ 0 +2410694+ 0 -1466527+ 0 -9681972+ 0 +1342957+ 0
-6880270+ 0 -1551388+ 1 -6479236+ 0 -1482292+ 1 -2277653+ 1
-1646185+ 1 -2405136+ 1 -3103317+ 1 -2696514+ 1 -3339487+ 1
-3935649+ 1 +2467604+ 0 +7550581- 1 -5050127- 1 -1300632+ 0
-1702442+ 0 -1443383+ 0 +7132950- 1 -9839951- 1 -3925035- 1
+3144275- 1 +1010257+ 0 -5379304+ 0 +6754391+ 0 +2425740+ 0
+3499285+ 1 +4982916+ 1 +6422867+ 1 +1959145+ 1 +3691695+ 1
+5387830+ 1 +5052003+ 0 +2396410+ 1 +4346427+ 1 -6266772+ 0
+1249610+ 1 +3399787+ 1 -1308885+ 1 -4944930+ 0 +4193587+ 0
+2618887+ 1 -1643428+ 1 -9279879+ 0 -9658063- 1 +1954259+ 1
-9140993+ 0 -6694342+ 0 -5237520+ 0 -3179004+ 0 +4302791+ 0
+4198864+ 1 +1007481+ 1 -5009022+ 0 -3177304+ 0 -1041860+ 0
+6894303+ 0 +1654952+ 1 +6196578+ 1 +3290529+ 1 +1361319+ 1
+8720035+ C +6975302+ 0 +8595140+ 0 +2070974+ 1 +2191630+ 2
+8169744+ 1 +5561794+ 1 +3777275+ 1 +1917201+ 1 +6625608+ 0
+1968909+ 0 +1268977+ 1 +2552350+ 2 +1175456+ 2 +7102159+ 1
+2108582+ 1 -3986269+ 0 -1973617+ 1 -2521086+ 1 +7547529+ 1
+1182791+ 2 +5749745+ 1 +9380614+ 0 -2228383+ 1 -4560635+ 1
-7009580+ 1 -1654690+ 2 +6001326+ 1 +1737018+ 1 -1076086+ 1
-3598795+ 1 -5171451+ 1 -7169427+ 1 -2030563+ 2 -1130740+ 1
-2339076+ 1 -3126646+ 1 -1906181+ 1 +3479942+ 0 +4923943+ 1
-5006225+ 1 -3228261+ 1 -3719634- 1 +5435438+ 1 +1541634+ 2
+4754246+ 2 +6104968+ 0 -6028283+ 0 -1057838+ 0 -3106719- 1
+7722166- 2 +3279548- 1 +2404904- 1 +3910274- 2 -1552640- 1
-3759763- 1 -6253816- 1 -8673759- 1 +2639388+ 0 |       0+ 0
```

FIGURE 22

FULL SCALE RESPONSE OF FUSELAGE TO
ATMOSPHERIC GUST SPECTRUM

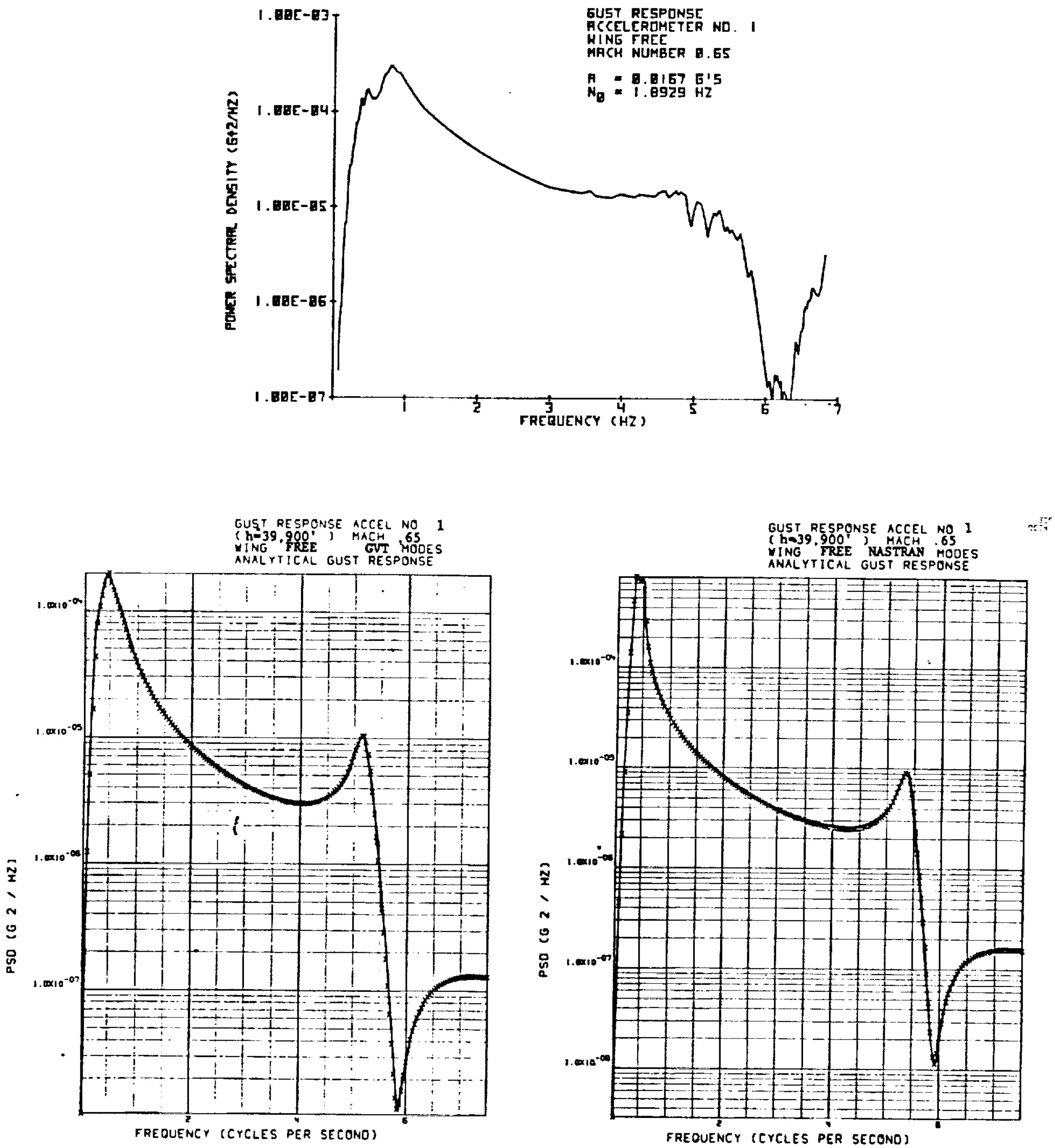
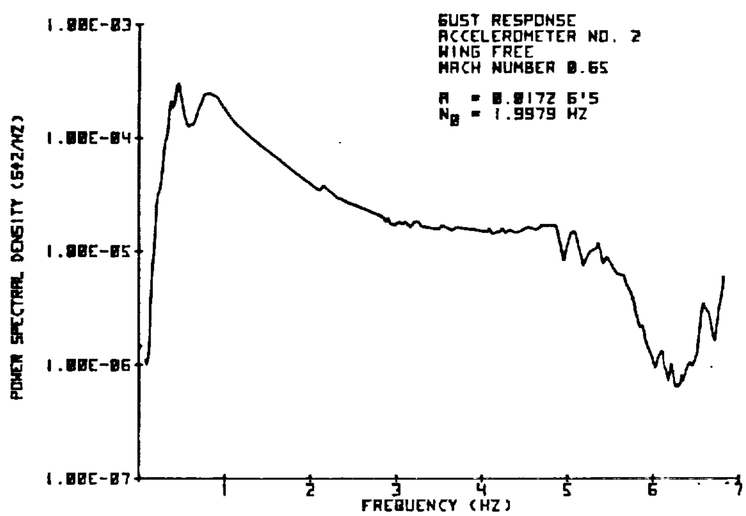
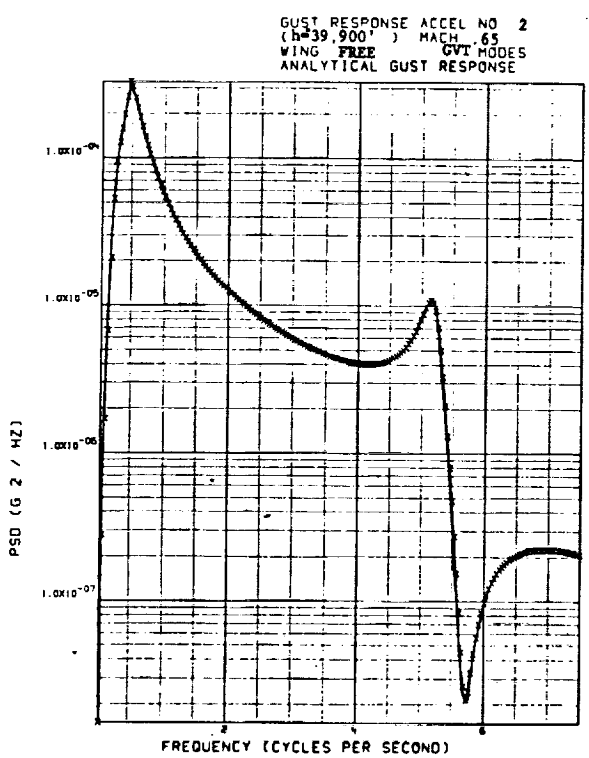


FIGURE 22 (continued)

FULL SCALE RESPONSE OF FUSELAGE TO

ATMOSPHERIC GUST SPECTRUM





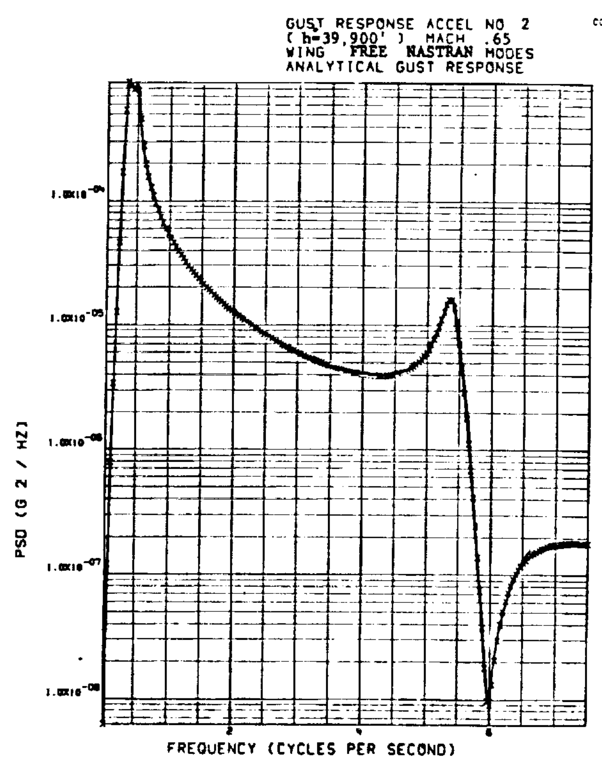
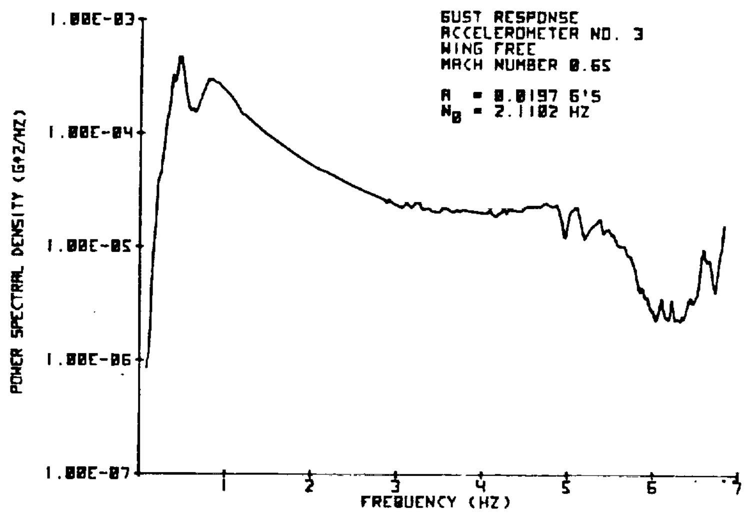
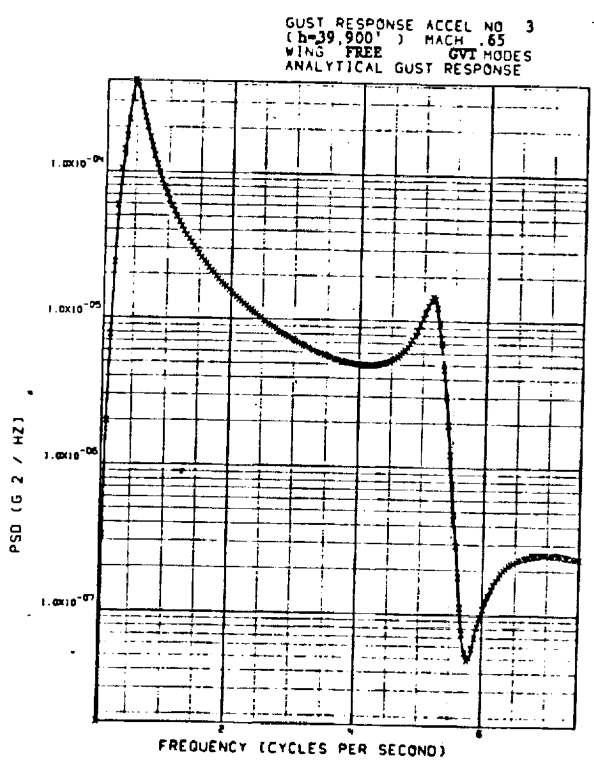


FIGURE 22 (continued)

FULL SCALE RESPONSE OF FUSELAGE TO ATMOSPHERIC GUST SPECTRUM





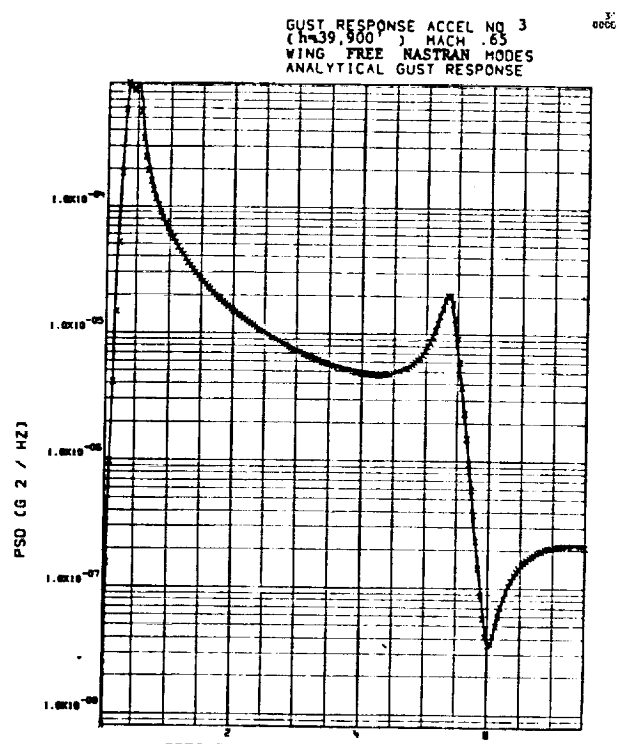


FIGURE 22 (continued)

FULL SCALE RESPONSE OF FUSELAGE TO ATMOSPHERIC GUST SPECTRUM

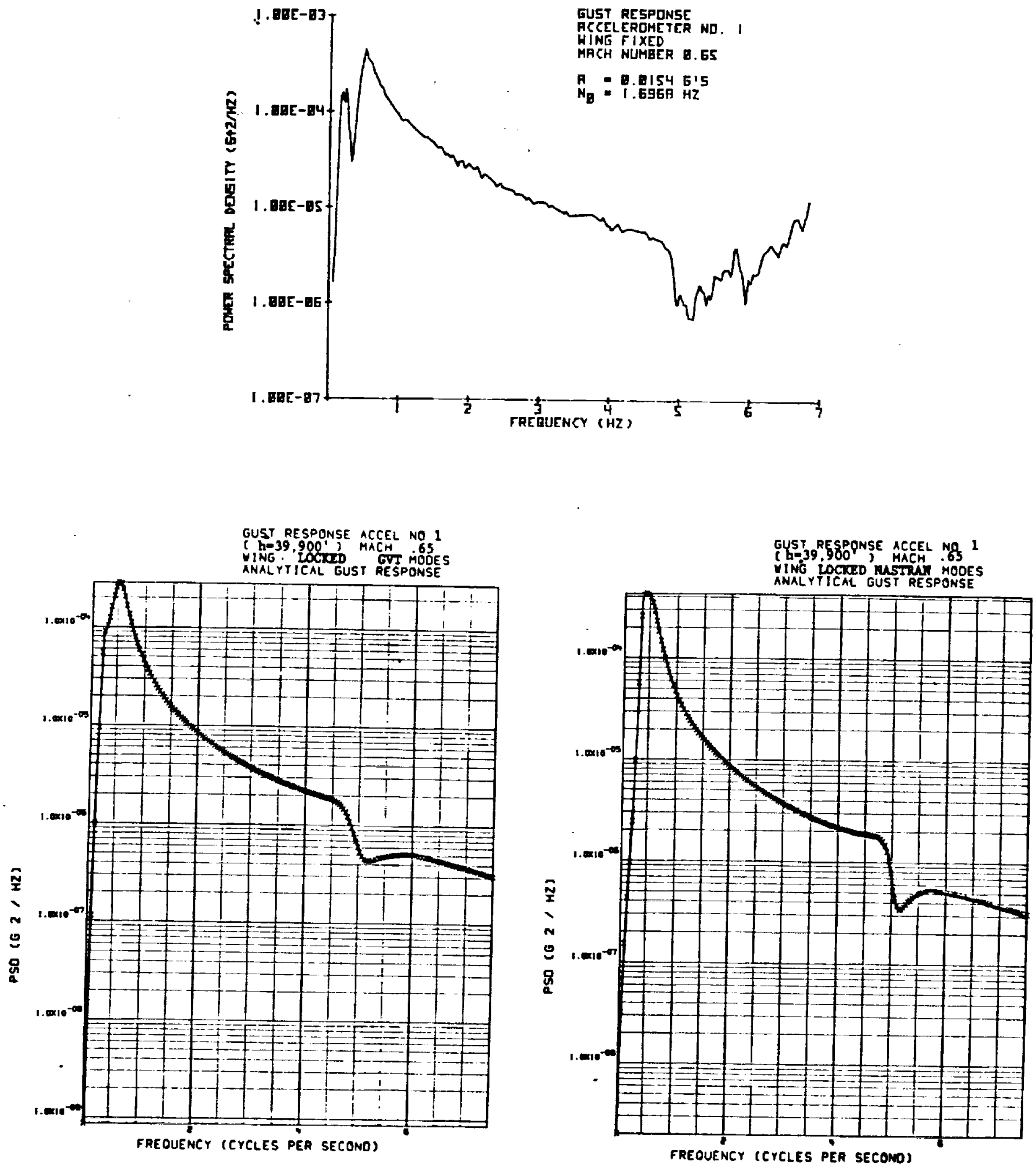
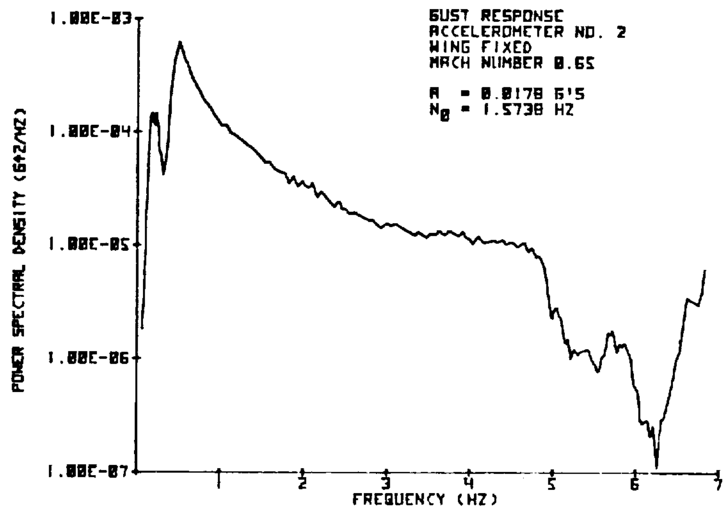
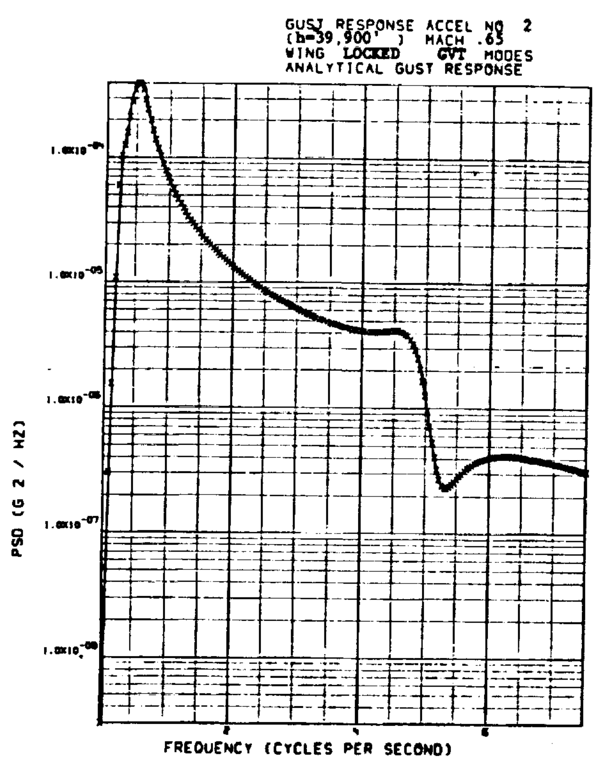


FIGURE 22 (continued)

FULL SCALE RESPONSE OF FUSELAGE TO ATMOSPHERIC GUST SPECTRUM





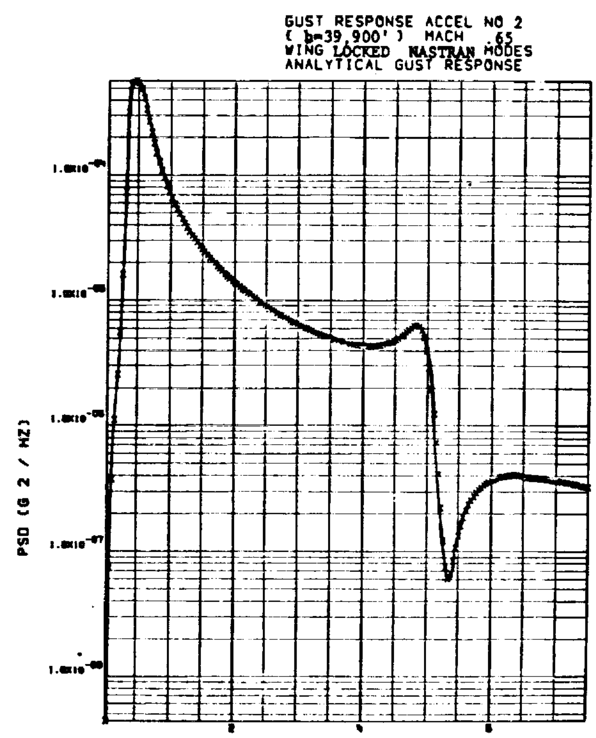
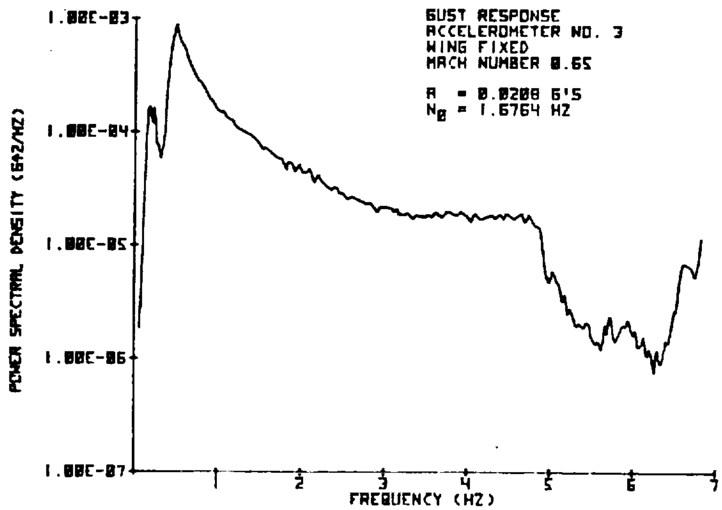
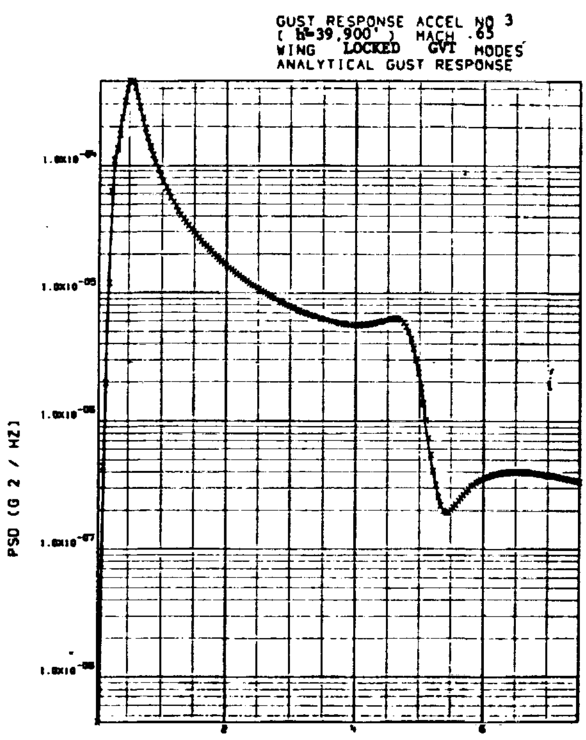


FIGURE 22 (continued)

FULL SCALE RESPONSE OF FUSELAGE TO

ATMOSPHERIC GUST SPECTRUM





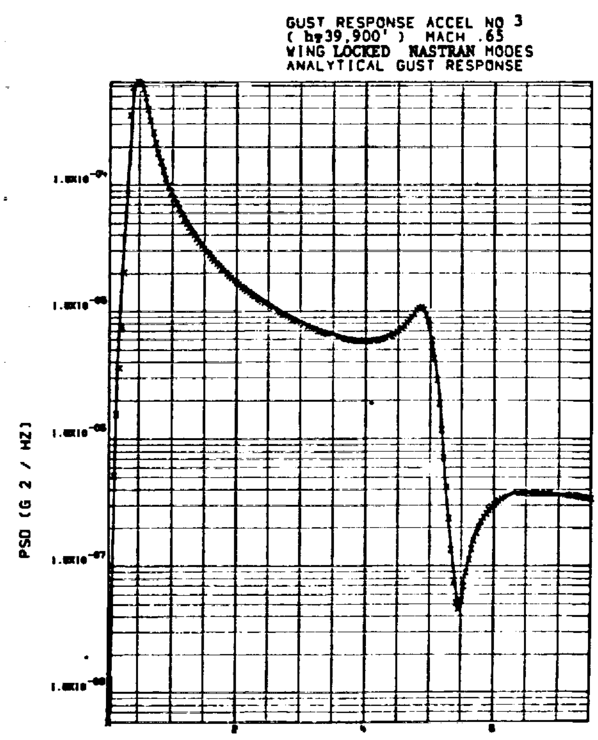
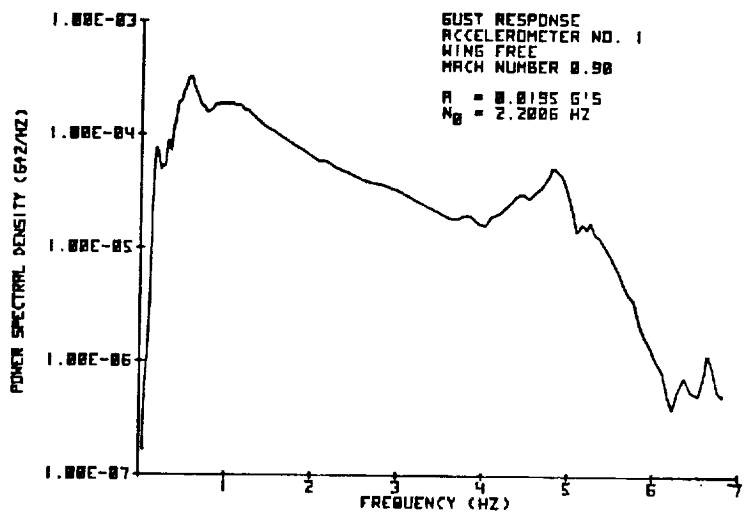
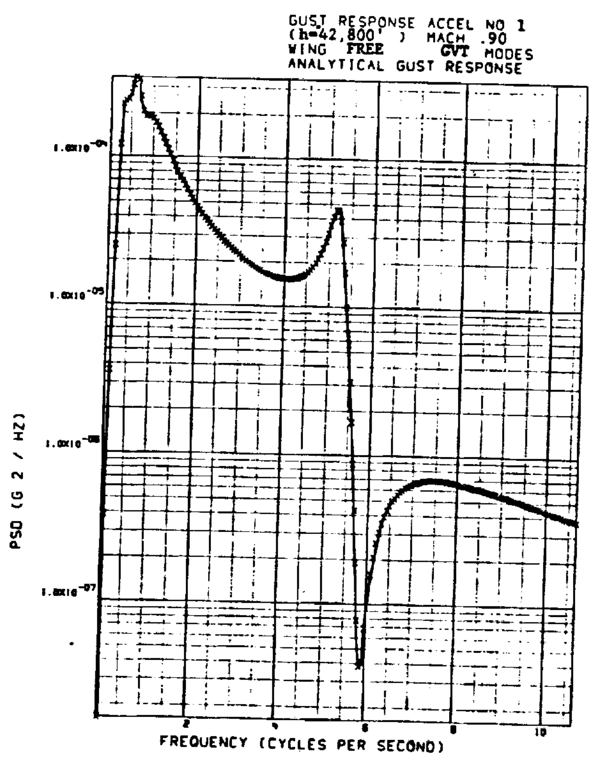


FIGURE 22 (continued)

FULL SCALE RESPONSE OF FUSELAGE TO ATMOSPHERIC GUST SPECTRUM





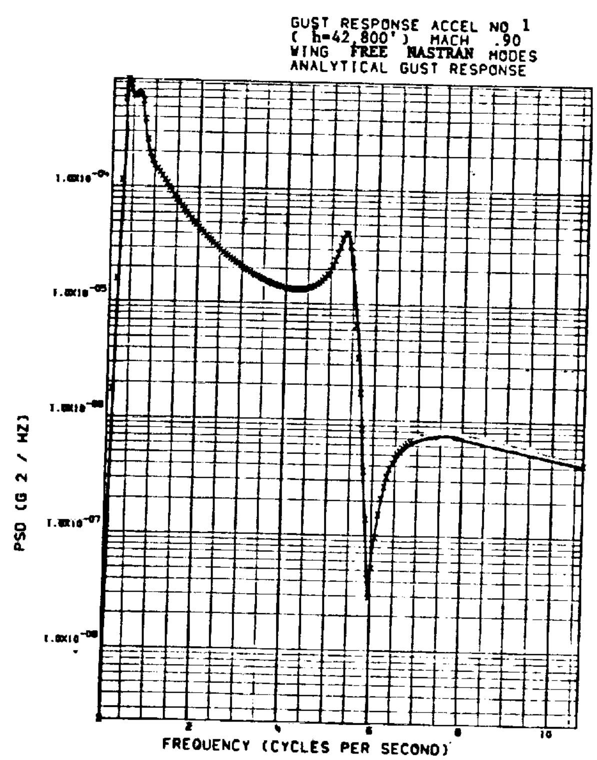
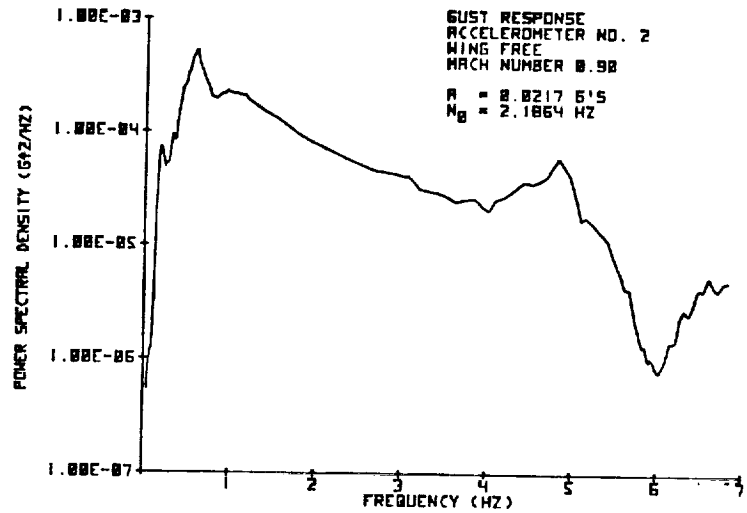
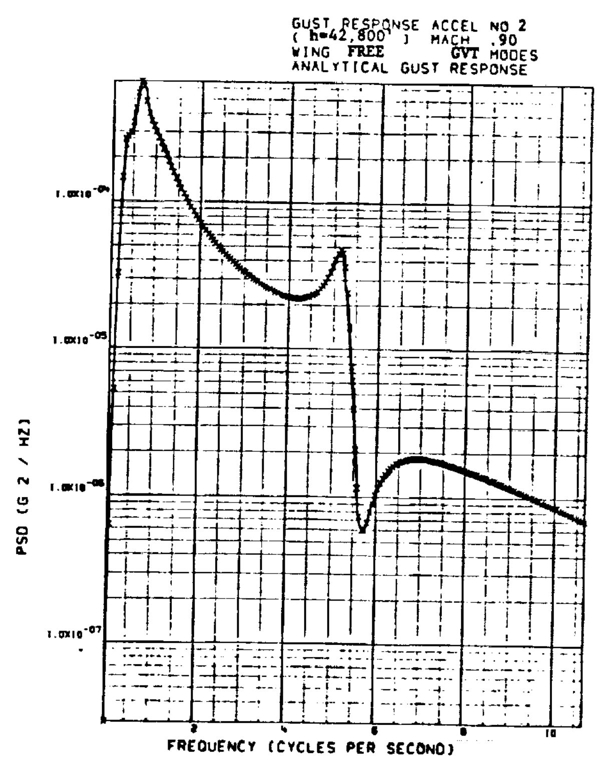


FIGURE 22 (continued)

FULL SCALE RESPONSE OF FUSELAGE TO ATMOSPHERIC GUST SPECTRUM





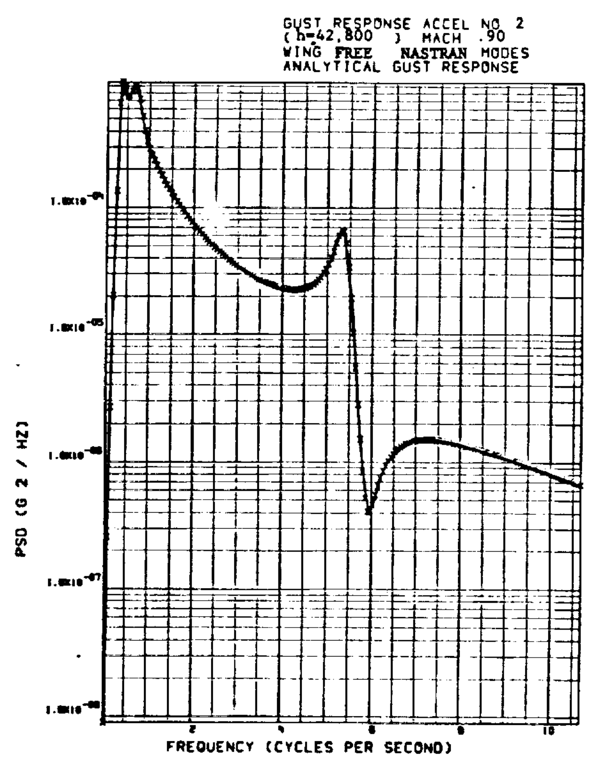
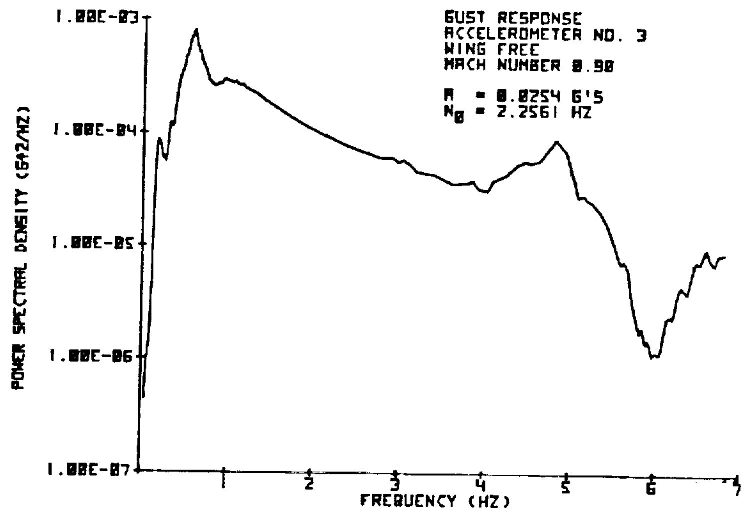
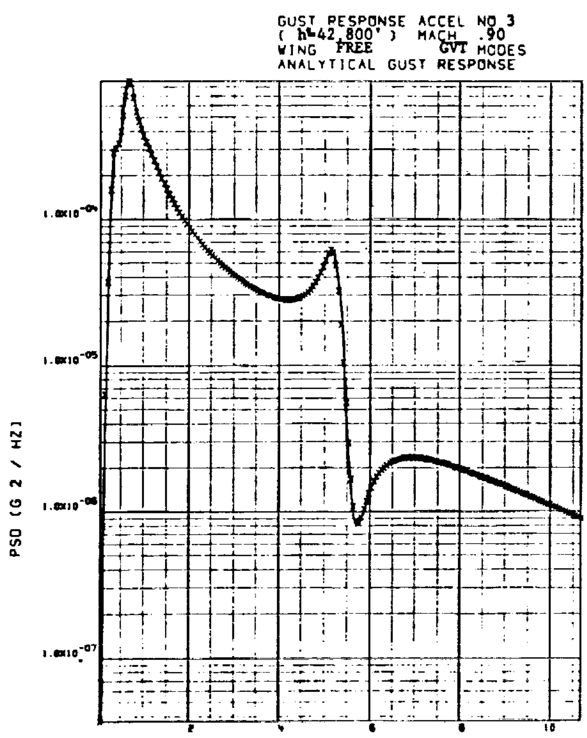


FIGURE 22 (continued)

FULL SCALE RESPONSE OF FUSELAGE TO ATMOSPHERIC GUST SPECTRUM





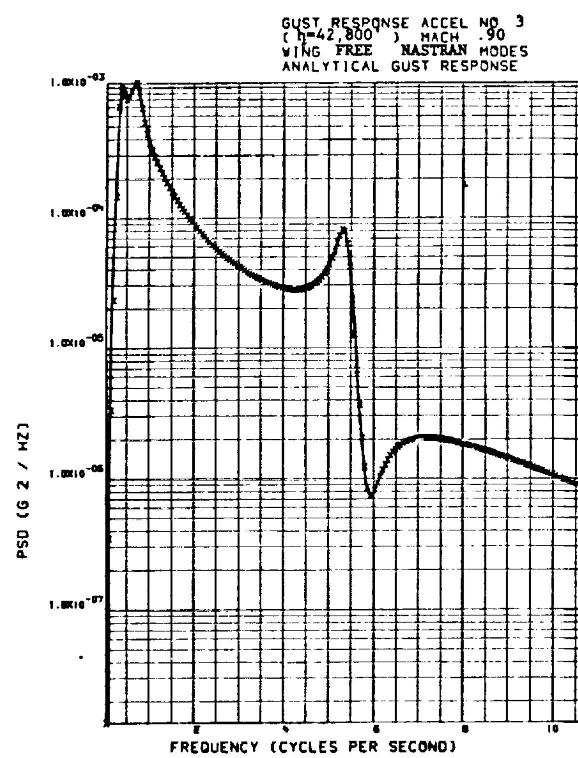
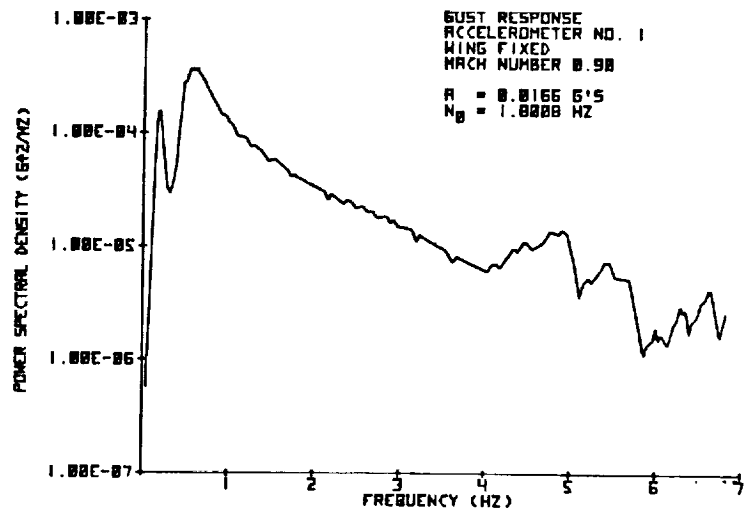
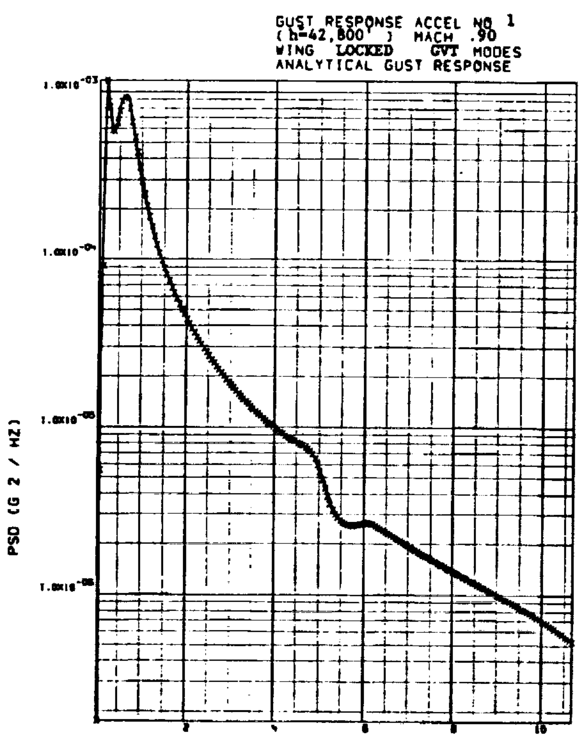


FIGURE 22 (continued)
FULL SCALE RESPONSE OF FUSELAGE TO
ATMOSPHERIC GUST SPECTRUM





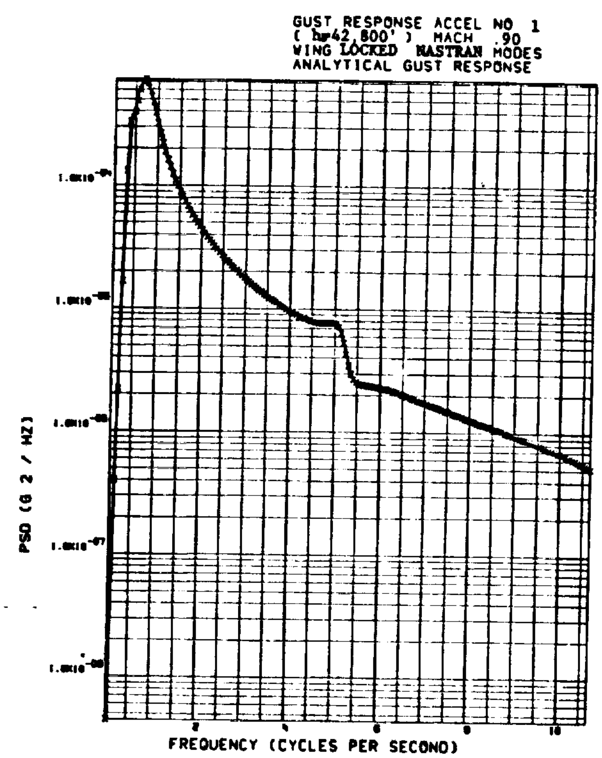
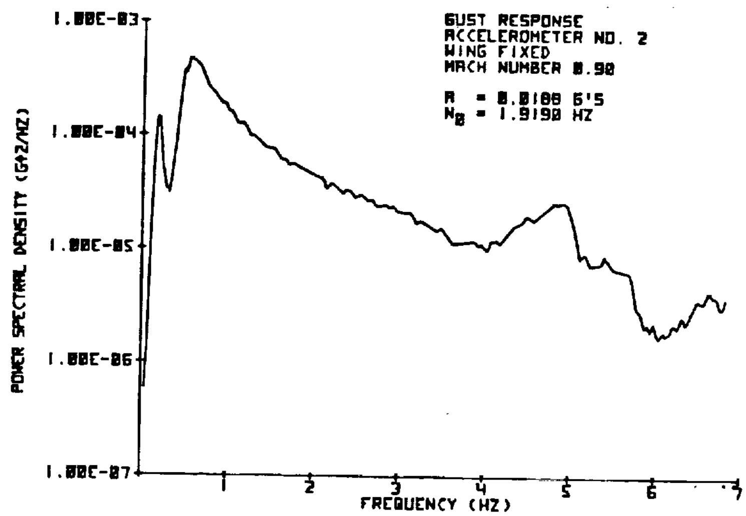
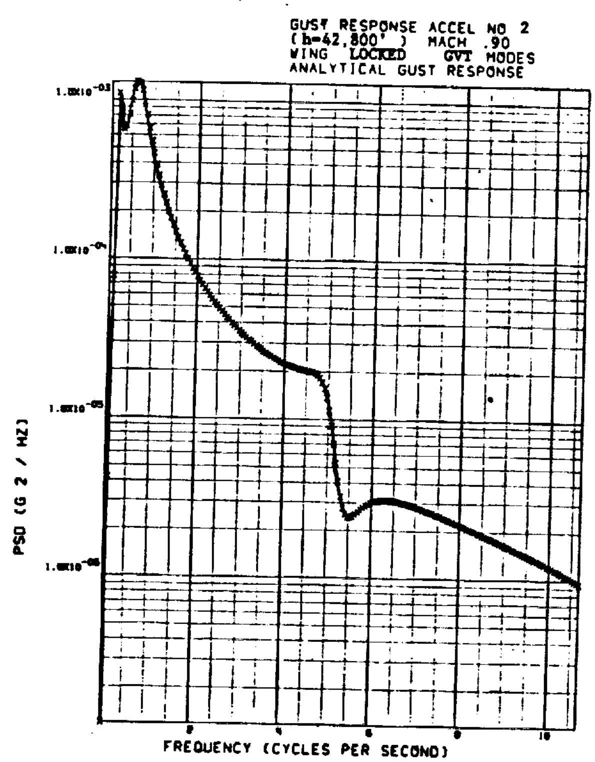


FIGURE 22 (continued)

FULL SCALE RESPONSE OF FUSELAGE TO

ATMOSPHERIC GUST SPECTRUM





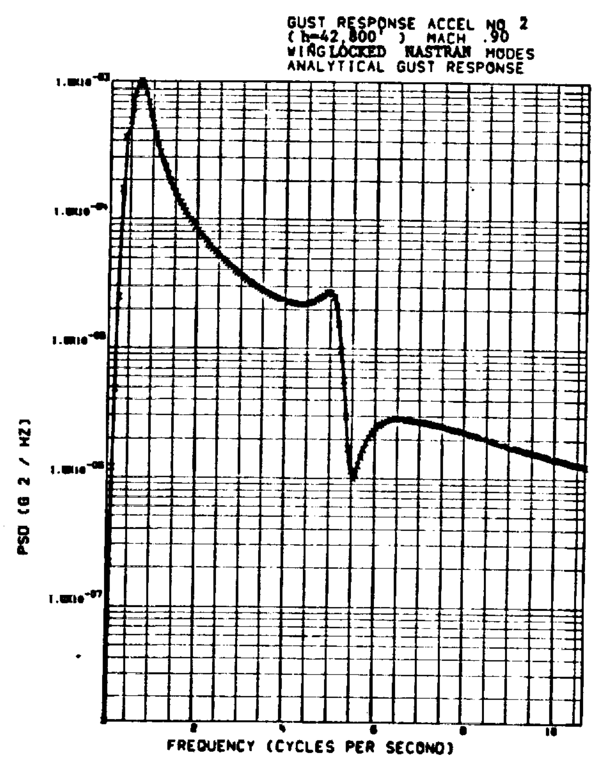
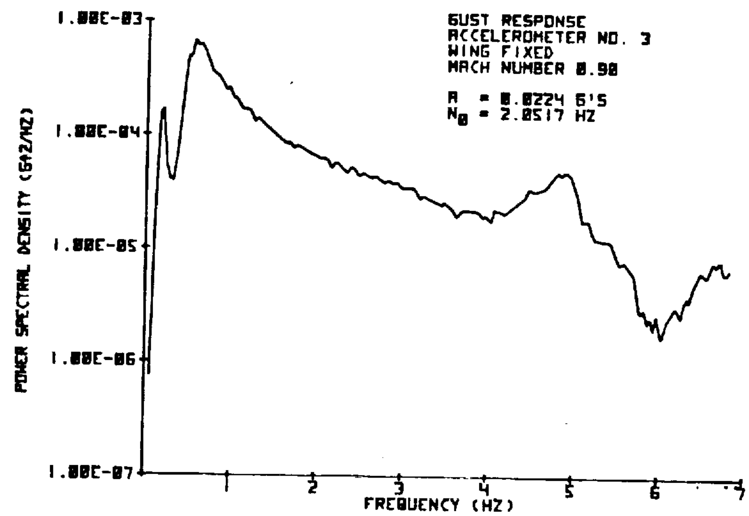
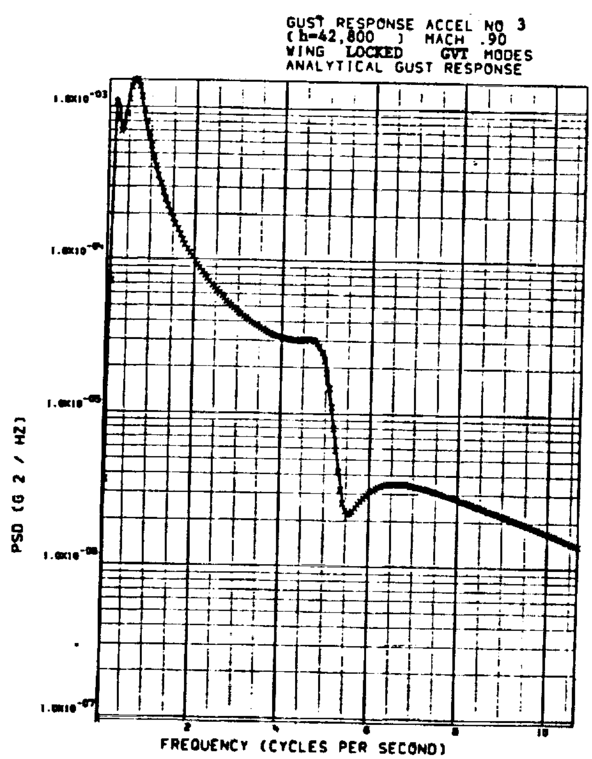


FIGURE 22 (concluded)

FULL SCALE RESPONSE OF FUSELAGE TO

ATMOSPHERIC GUST SPECTRUM





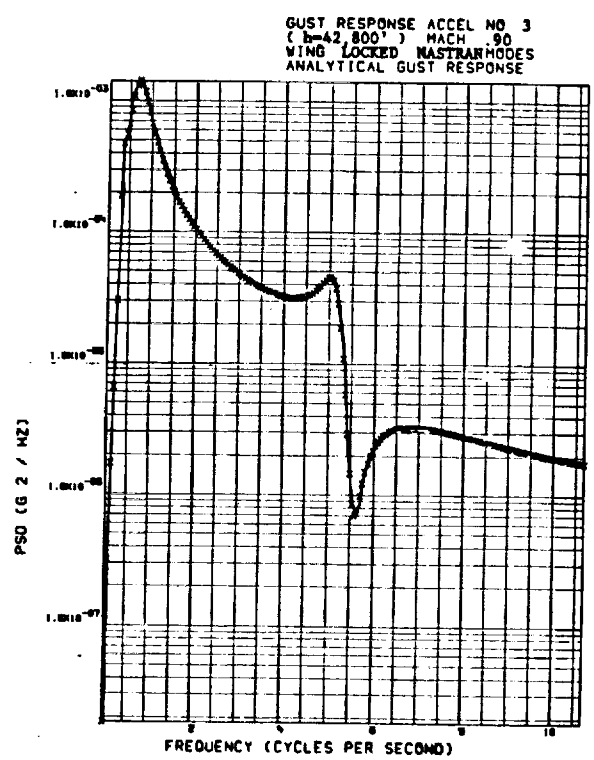
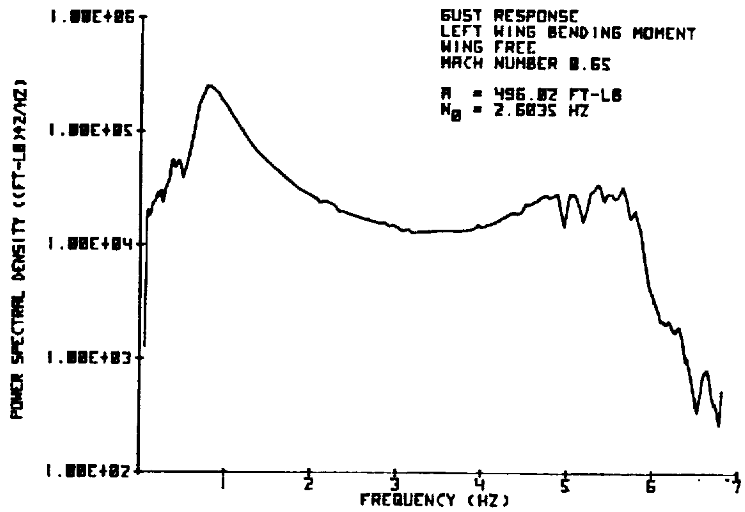
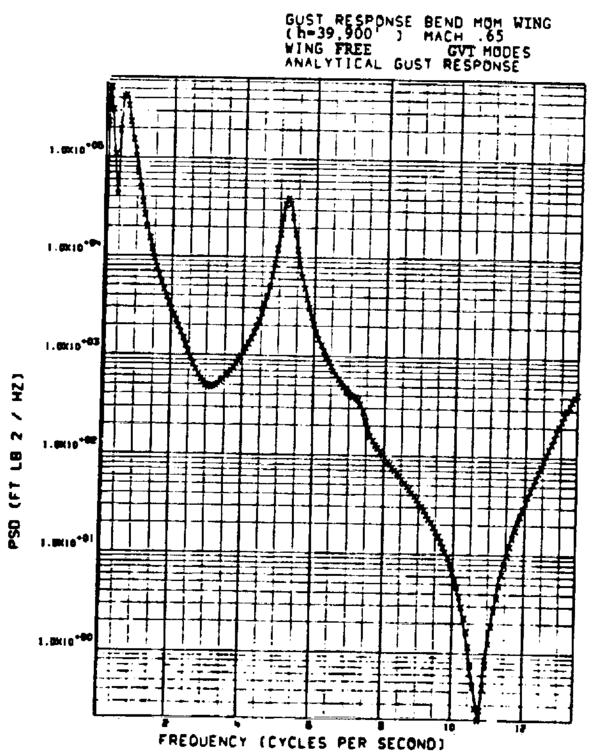


FIGURE 23

FULL SCALE RESPONSE OF LEFT WING ROOT BENDING MOMENT TO ATMOSPHERIC GUST SPECTRUM





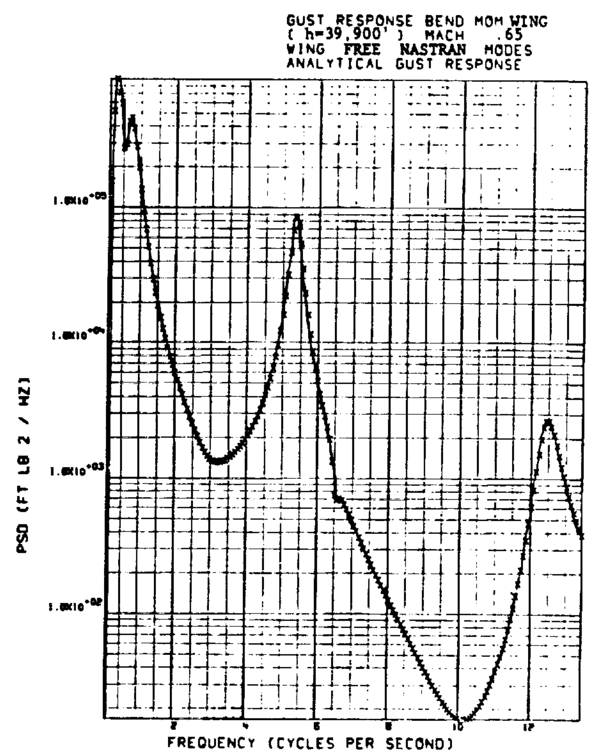
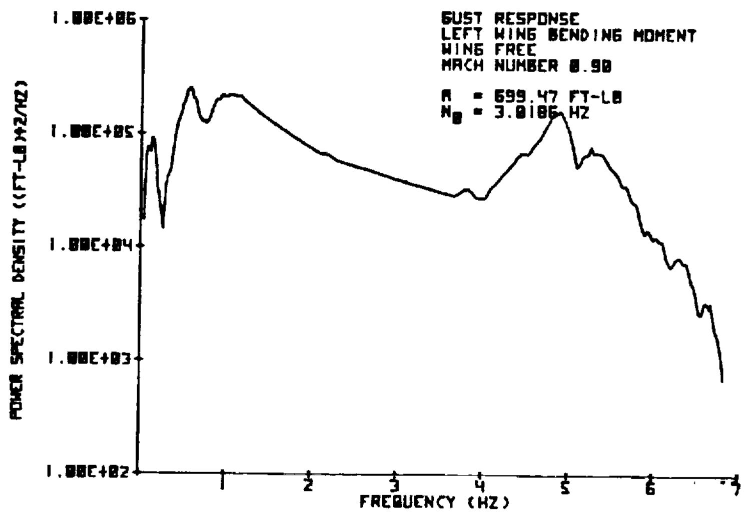
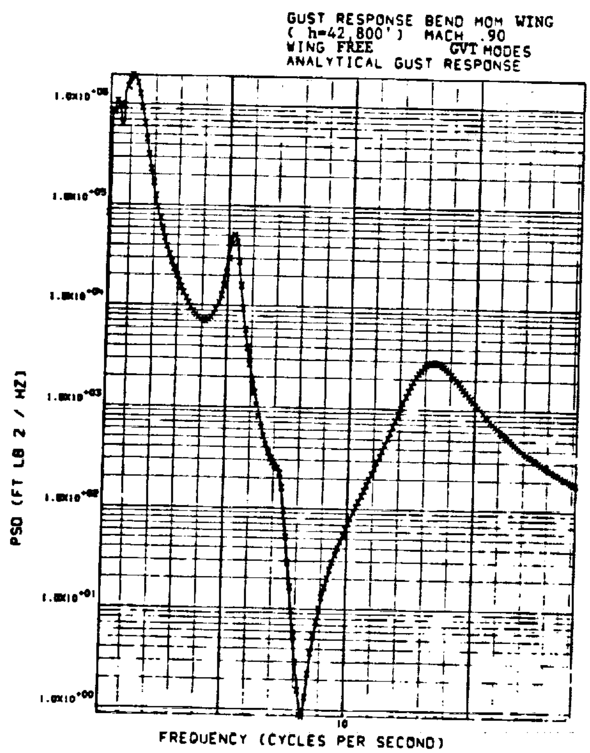


FIGURE 23 (continued)

FULL SCALE RESPONSE OF LEFT WING ROOT BENDING MOMENT TO ATMOSPHERIC GUST SPECTRUM





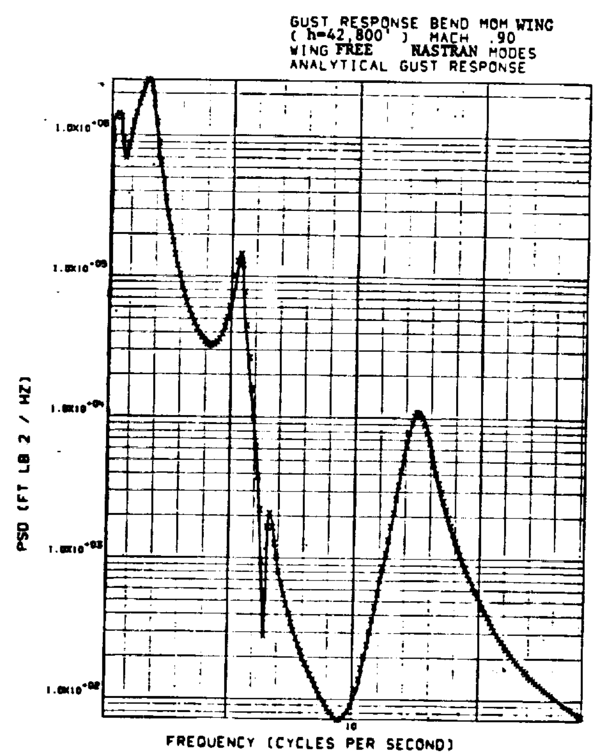
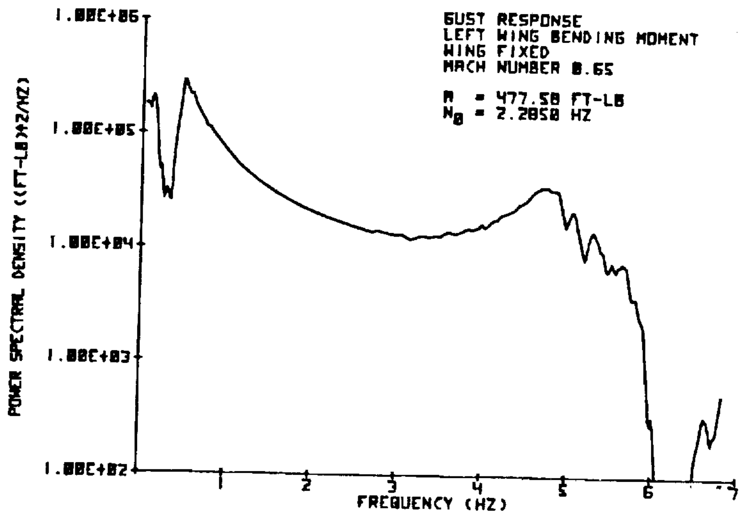
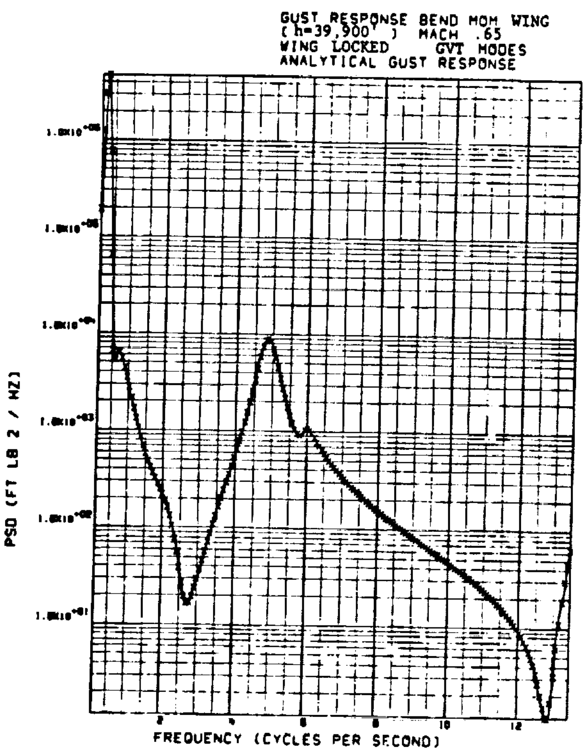


FIGURE 23 (continued)

FULL SCALE RESPONSE OF LEFT WING ROOT BENDING MOMENT TO ATMOSPHERIC GUST SPECTRUM





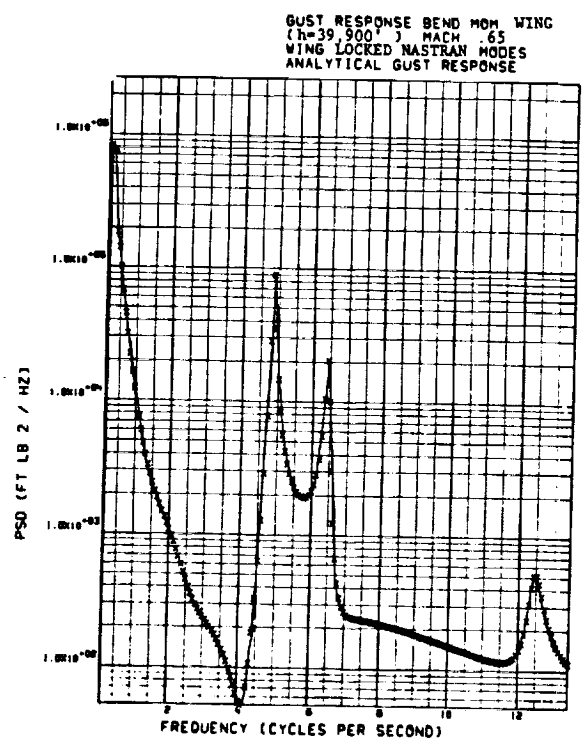
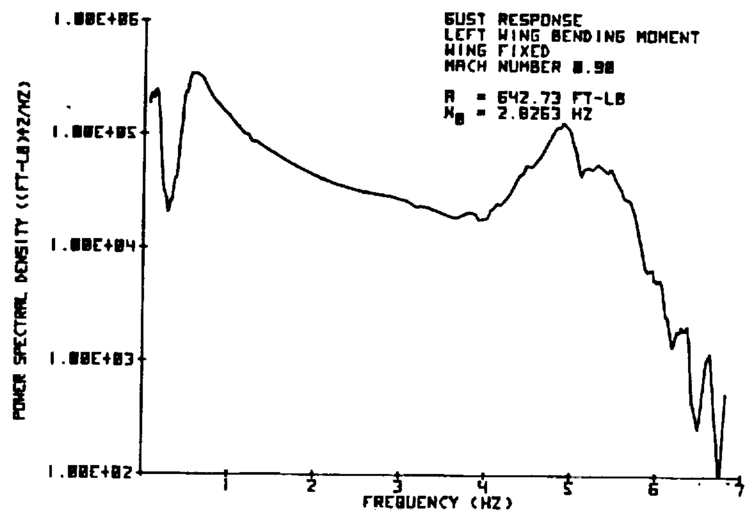
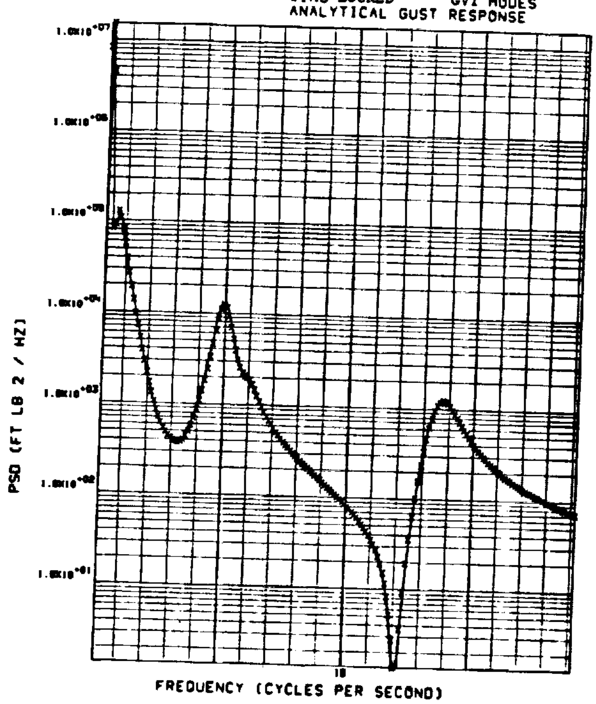


FIGURE 23 (concluded)

FULL SCALE RESPONSE OF LEFT WING ROOT BENDING MOMENT TO ATMOSPHERIC GUST SPECTRUM





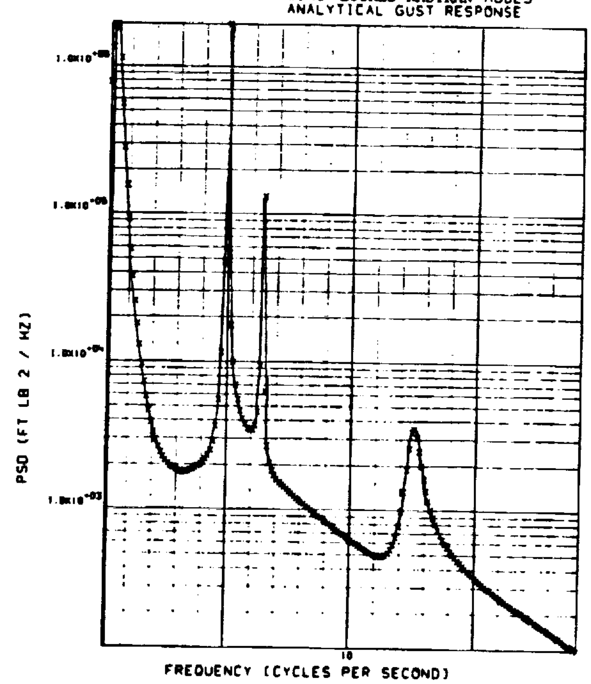


FIGURE 24

FULL SCALE RESPONSE OF LEFT CANARD ROOT BENDING MOMENT TO ATMOSPHERIC GUST SPECTRUM

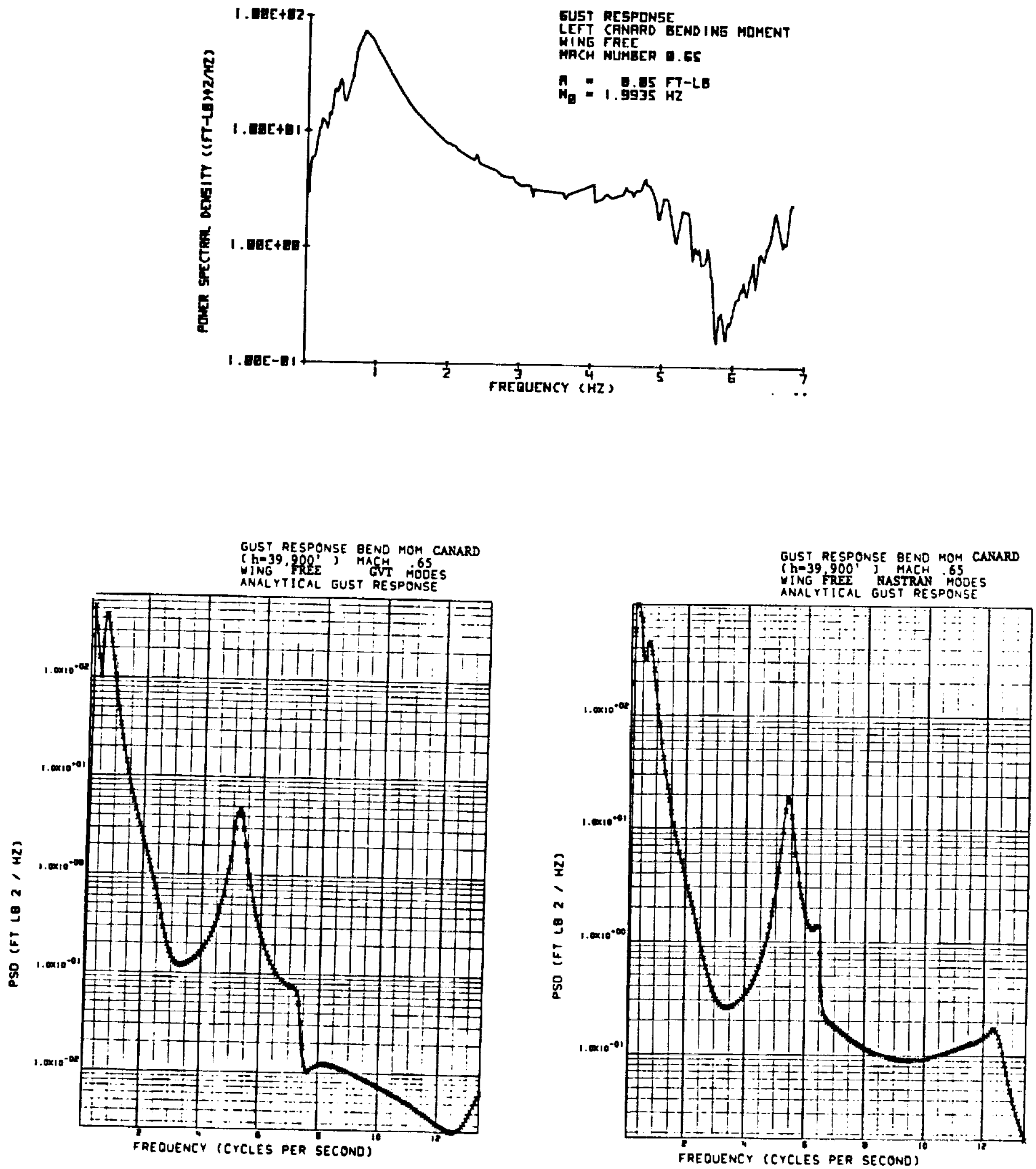
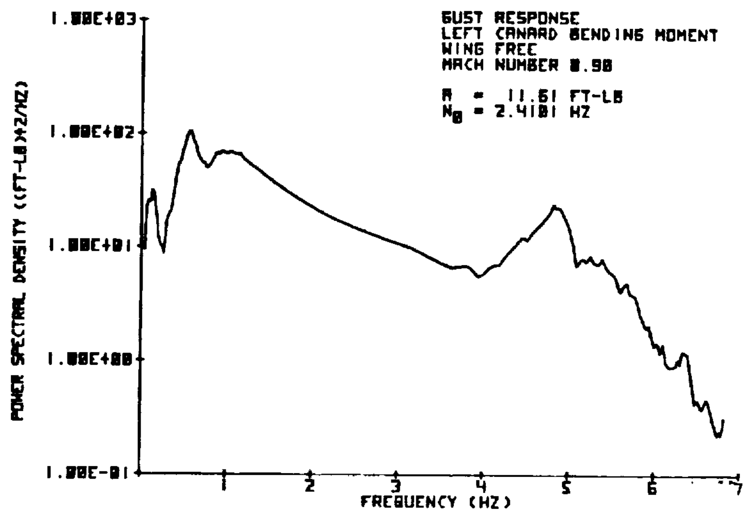
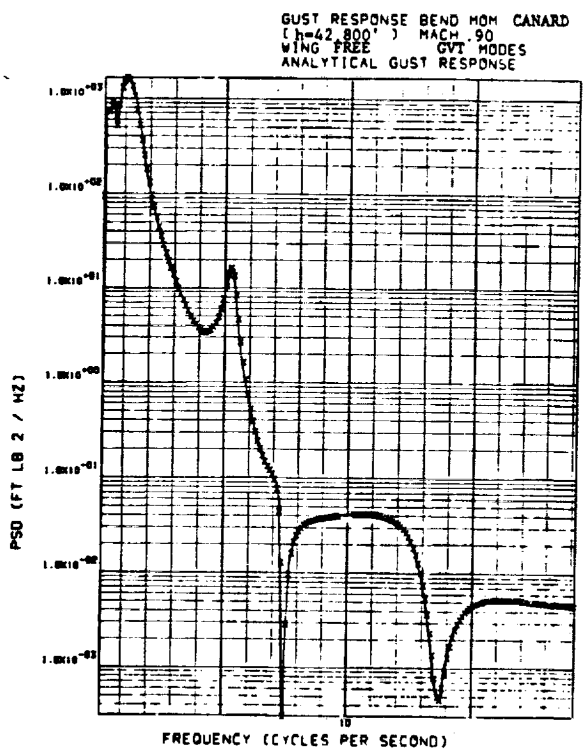


FIGURE 24 (continued)

FULL SCALE RESPONSE OF LEFT CANARD ROOT BENDING MOMENT TO ATMOSPHERIC GUST SPECTRUM





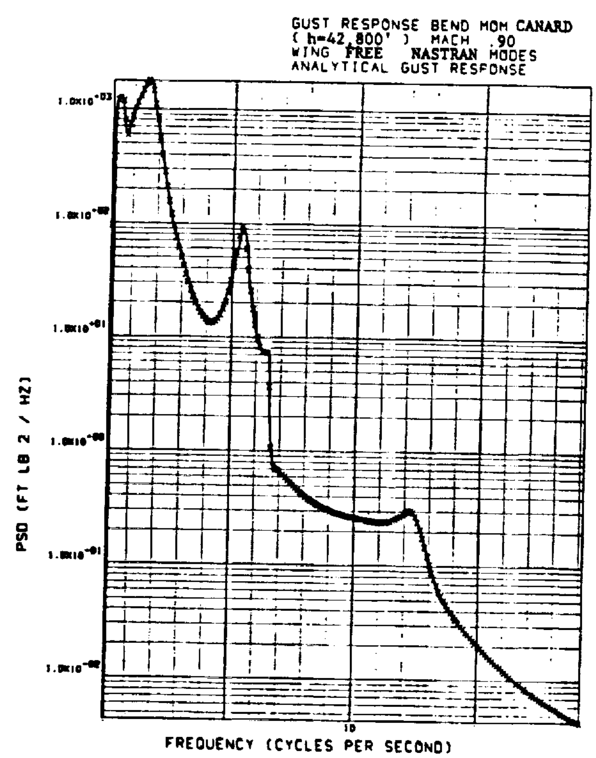
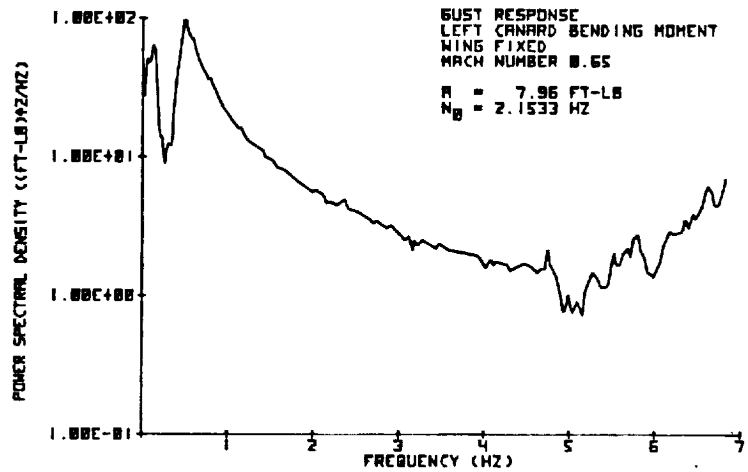
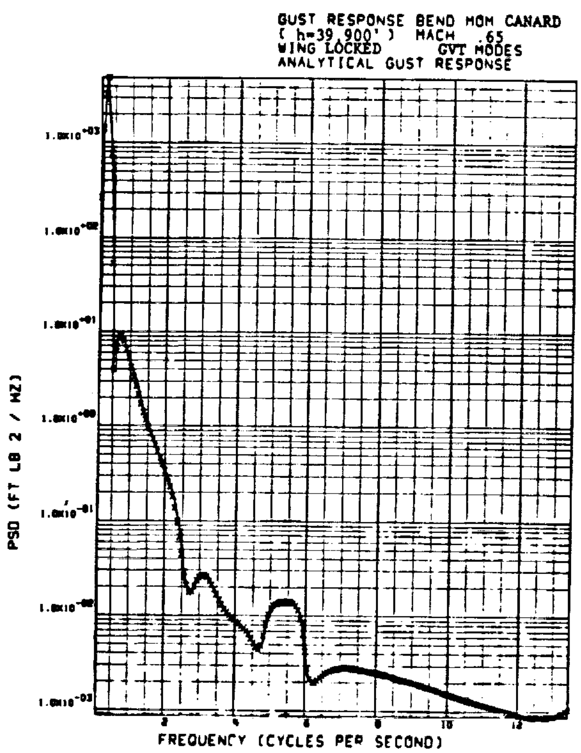


FIGURE 24 (continued)

FULL SCALE RESPONSE OF LEFT CANARD ROOT BENDING MOMENT TO ATMOSPHERIC GUST SPECTRUM





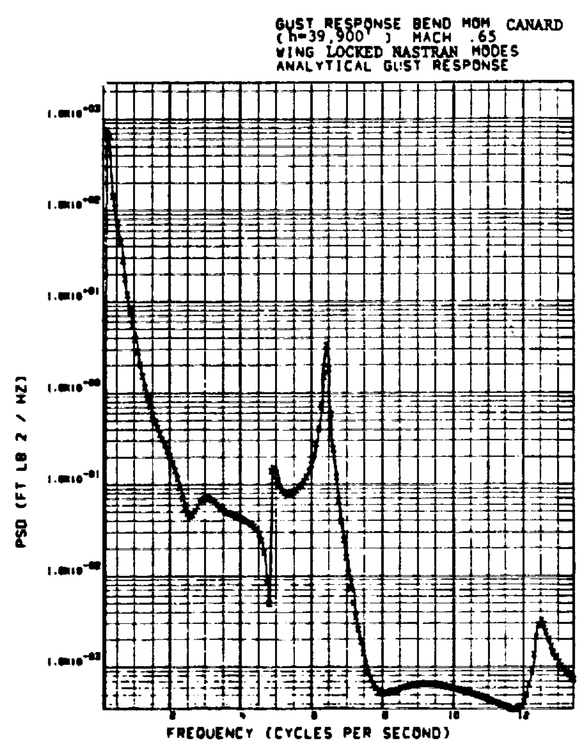
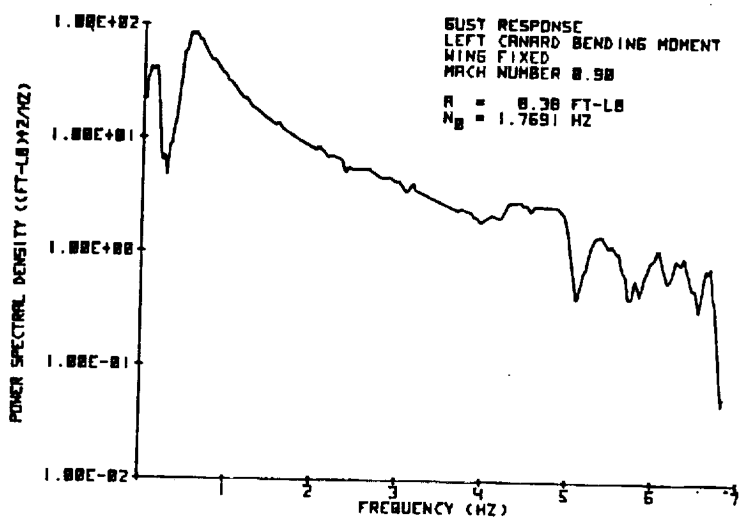
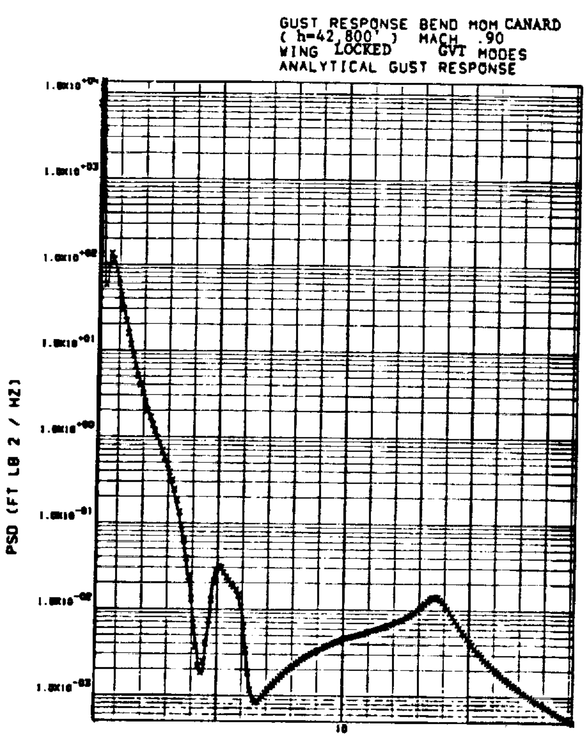
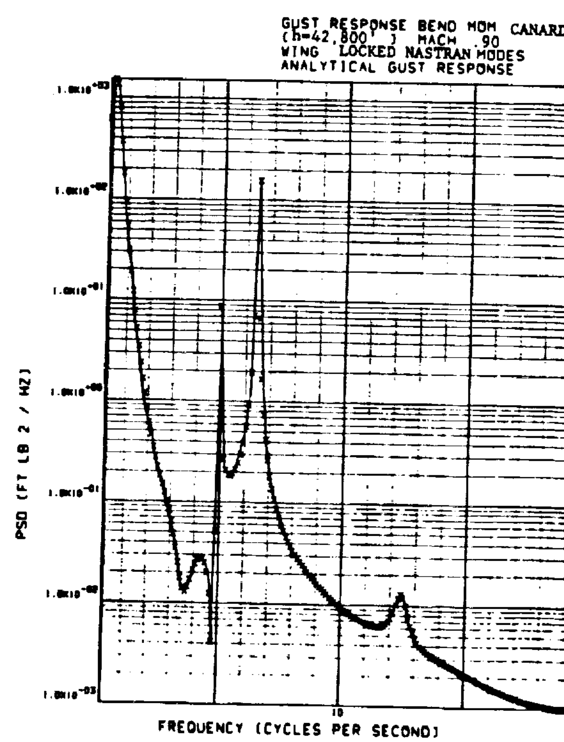


FIGURE 24 (concluded)

FULL SCALE RESPONSE OF LEFT CANARD ROOT BENDING MOMENT TO ATMOSPHERIC GUST SPECTRUM







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7. Author(s) Arthur C. Murphy		8. Performing Organization Report No.
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15. Supplementary Notes

Langley Technical Monitor: Charles L. Ruhlin, Aeroelasticity Branch, SDD

16. Abstract

This report presents some experimental data and correlative analytical results on the flutter and gust response characteristics of a Torsion-Free-Wing (TFW) fighter airplane model. This TFW consisted of a combined wing/boom/canard surface and was tested with the TFW free to pivot in pitch and with the TFW locked to the fuselage. Flutter and gust response characteristics were measured in the Langley Transonic Dynamics Tunnel with the complete airplane model mounted on a cable mount system that provided a near free-flying condition. Experimental flutter data were obtained at Mach numbers (M) from about 0.85 to 0.95, and the gust responses to a sinusoidal gust of slowly sweeping frequency were measured at M = 0.65 and 0.90. Although the lowest flutter dynamic pressure was measured for the wing-free configuration (at M = 0.95), it was only about 20 percent less than that for the wing-locked configuration. However, no appreciable alleviation of the gust response was measured by freeing the wing. The experimental-analytical correlation was reasonably good for the flutter results but was rather poor for the gust-response results.

17. Key Words (Suggested by Author(s)) Torsion-Free-Wing Airplane Flutter Gust Response Transonic Wing-Tunnel Tests	18. Distribution Statement Unclassified - Unlimited Subject Category 05

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