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Numerical Simulation of Flutter Tests

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EXECUTIVE SUMMARY

The study examines novel flutter prediction methodologies that support and enhance the safety of flutter flight tests. The project, done in collaboration with Dr. Matthew McCrink in the Aerospace Research Center of Ohio State University, includes the design and flutter testing of a dedicated UAS configuration. The testbed vehicle is designed to be a research and technology demonstrator, pushing the flutter envelope. Hence, some crashes in flight tests are expected. Taking advantage of 3D printing technology, the vehicle is designed for rapid manufacturing and assembly, in a low cost. The vehicle will be instrumented with inertial measurement units (IMUs) that measure three-axes rates and accelerations and with strain gauges. Data collected in flight will be used for the two proposed flutter prediction methods, which are briefly presented in the Introduction section of this report. The report summarizes the structural and aeroelastic analyses performed for aircraft design.

The focus of the vehicle design are the flexible wings, which are assembled of eight 3Dprinted Nylon-12 segments connected by two 6061-T6 aluminum spars. The wings attach to a plywood fuselage with a Polyurethane foam empennage belonging to an existing UAS platform. The flight computer and control surface servo systems are off-the-shelf components. The vehicle's structure was designed to experience flutter within the flight envelope. A unique wing-tip pod with a shaker mechanism was developed for flutter prediction by the Parametric Flutter Margin (PFM) method. The shaker device's inertial properties and installation location were designed to significantly increase the vehicle's flutter speed (relative to that of the baseline configuration, without the shaker) and allow for safe flight at the baseline configuration's flutter speed. The shaker device collects force and acceleration data at a range of airspeeds, including the baseline configuration's flutter speed, from which the flutter speed of the baseline configuration is positively identified.

The report presents the workflow from a conceptual design and detailed Computer-Aided Design (CAD) model to create an accurate finite-element analysis (FEA) model, aeroelastic model, flutter solutions, and numerical flutter test simulations. The proposed vehicle configuration, albeit with stiffer wings, was built and assembled by Dr. McCrink's team at OSU and is currently at its preliminary flight test stage.

The vehicle's structure was modeled using the Nastran finite-element software. Freevibration analysis provided the dynamical properties of the vehicle. An aerodynamic linear panel model was created in the ZAERO aeroelastic software, also used for flutter analysis. The modal and aerodynamic models were imported to the Dynresp software, used for numerical flutter simulations and the PFM analyses. The Dynresp-based PFM analysis was expanded to include a sensitivity study of the variation of the flutter characteristics with the mass and location of the wingtip shaker pod. It was shown that the 26 m/s flutter onset speed of the baseline configuration could be pushed to about 34 m/s by moving the added mass location inside the wing tip pod towards the leading edge. Both velocities are inside the flight envelope, thus offering an excellent experimental test case for the safe flutter test methodology.

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1. INTRODUCTION

The purpose of the numerical simulations presented in this work, using the demonstrated tools, is to present an accurate yet agile method for building FEA models for numerical simulation of flutter test that are based on the Parametric Flutter Margin (PFM) method. [1] [2] [3]The first phase of the work is centered in using Solidworks for building an accurate assembly of the UAV with all the parts, from the wings and fuselage to servos, flight computers, and wheels. With that comes the need to define accurately the materials and properties used in the UAV parts. It is important to mention that using such models enables stress-strain analysis, in addition to the dynamic models used in the flutter test simulations.

Based on the CAD model and using FEMAP (NASTRAN Pre & Post Processor), it is possible to import the CAD assembly to FEMAP as geometry objects. Upon them I was able to accurately build and mimic the geometry of the CAD model using manually created FE elements. Deciding on each geometry how could I best represent it using FE, the geometry of every component, including wings, wheels, ailerons, and servos push rods, was transformed to that of the FEM. FEMAP was then used to set up the NASTRAN model, run it for normal modes analysis, and plot the resulted modes.

The f06 file generated using NASTRAN is then used in aeroelastic flutter analysis using ZAERO based on the g-method. [4] The ZAERO input requires the design of aerodynamic panel models for the various aerodynamic component. 3D body models are built for the fuselage and wing tip pods, and flat surfaces models for the wings and tail. Each surface is defined in the same coordinates system as the NASTRAN model and coupled with the respective grid points in the FEA FEMAP model using a proper spline. Then ZAERO can provide the numerical flutter result.

The ZAERO model is used to export the generalized unsteady aerodynamic matrices for subsequent flutter test simulations. Dynresp can then be executed with the NASTRAN's output (f06) file and the aero matrices from ZAERO as input files. Dynresp conducts numerical response simulations from which flutter characteristics are extracted using the PFM method which is explained later.

In its initial version, the PFM method is based on adding a single stabilizing parameter, such as a certain modal damping coefficient or a discrete mass, which increases the flutter stability margins. This version facilitated very efficient massive sensitivity studies with respect to selected stabilizing parameters [2]. Furthermore, it facilitated safer flutter tests where flutter

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or nonlinear limit-cycle oscillation (LCO) boundaries of a certain configuration are positively identified while testing a more stable configuration.

2. PFM METHOD REVIEW

2.1 Generalized parametric flutter margin (PFM) method

Linear ASE dynamic stability analysis techniques are aimed at finding the flight conditions that define the flutter boundary, at which there is a nontrivial solution to the homogeneous aeroelastic frequency-domain (FD) equation of motion,

$$[A(i\omega)]\{x_L(i\omega)\} = \{0\}$$
⁽¹⁾

where $\{x_L(i\omega)\}$ is the FD vector of modal displacements, linear control-system states, and actuator states, $[A(i\omega)]$ is the closed-loop linear system matrix that includes the structural inertial, viscous and stiffness effects, the aerodynamic effects, and the control-system ones. While common flutter solutions, such as that of ZAERO are based on finding the conditions at which $|A(i\omega)| = (0., 0.)$, the Parametric Flutter Margin (PFM) method is based on FRFs with a stabilizing flutter parameter, p_f , added to the ASE system. Flutter margins are defined by the factored values of p_f that would cause flutter if removed from the modified system. At the flutter boundary of the original system, this factor would be 1.0.

The PFM method was first presented in [1] in its single-input-single-output (SISO) version, in which the selected p_f must be such that its effects can be removed by a SISO control feedback. The p_f parameter that will be used in the proposed flight tests is a concentrated mass at the forward zone of the wing-tip pod. It is assumed that only the vertical (Z) motion of this mass affects the flutter mechanism, such that the SISO PFM version can be used.

2.2 Linear SISO-PFM method

When the flutter parameter is limited to those that can be expresses by SISO feedback loops, a flutter solution that is based on SISO dynamic response functions without resorting to eigenvalue analysis is used. Another important application of the SISO-PFM scheme is in performing safe flutter tests, as discussed in the following chapters.

The input and output vectors in Eq. (2) become scalars in the SISO-PFM formulation,

$$\begin{bmatrix} \overline{A}_{v}(i\omega) + B_{f}P_{f}C_{f}(i\omega) \end{bmatrix} \{x_{v}(i\omega)\} = \{B_{f}\}u_{f}(i\omega)$$

$$y_{f}(i\omega) = \lfloor C_{f}(i\omega) \rfloor \{x_{v}(i\omega)\}$$
(2)

Where $\left[\bar{A}_{\nu}(i\omega)\right]$ is the original system matrix with all its actual control loops closed, when applicable. It is easy to see that if the open control loop in Eq. (7) is closed by the SISO gain P_{f} , such that

$$u_f(i\omega) = P_f y_f(i\omega) \tag{3}$$

we get the homogeneous equation

$$\left[\overline{A}_{v}(i\omega)\right]\left\{x_{v}(i\omega)\right\} = \left\{0\right\}$$
(4)

that yields a non-trivial solution at the flutter boundary when $|\overline{A}_{\nu}(i\omega)| = 0$. This implies that the interpolated velocity-frequency pair, for which Eq. (4) is satisfied, forms the flutter velocity V_f and the flutter frequency ω_f .

The selected P_f , and the associated single output and single input parameters of Eq. (3), yield frequency response functions to sinusoidal inputs of amplitude $u_f(i\omega) = 1.0$. The FRFs may presented as Bode plots by their gain and phase variations with frequency

$$G(\omega) = 20\log |P_f y_f(i\omega)| [dB]; \quad \Phi(\omega) = \angle (P_f y_f(i\omega)) [deg]$$
(5)

The original PFM method [1] used these gain and phase expressions as a basis for calculating flutter gain margins. The Bode plots are generated for selected points along a line in the flight envelop. The points can be of various air velocities at constant altitude, and various altitudes along a constant Mach line. In a search for non-match flutter conditions at constant altitude and Mach number, the phase function at each flight velocity is used for finding the associated phase-crossover frequencies ω_{co} at which $\Phi(\omega_{co}) = \pm 360^{\circ} n$. The gains at these frequencies form the parametric flutter margins $PFM = -G(\omega_{pco})$. The velocity and phase-crossover frequencies ω_{f} and ω_{f} . The associated solution of Eq. (2) is the flutter mode $\{x_{f}(i\omega)\}$.

The Dynresp framework provides for using a selected ASE response parameter, y_f , which can be defined as a frequency-dependent linear combination of the system states and control inputs, as a "sensor". When the selected P_f is an actual control gain, the stability analysis in Dynresp provides the standard Nyquist SISO control gain and phase margins [8], with aeroelastic effects of course.

An alternative flutter margin, which may be more useful in flutter tests, is defined as the incremental flutter parameter ΔP_f that, if added to the nominal system, would bring it to the verge of flutter. This definition implies

$$\left(P_f - \Delta P_f\right) y_f(\omega_{co}) / u_f(\omega_{co}) = 1 \quad \Rightarrow \quad \Delta P_f = P_f - u_f(\omega_{co}) / y_f(\omega_{co}) \tag{6}$$

where $u_f(\omega_{co})$ is not necessarily (1., 0.), to accommodate arbitrary input amplitude and phase in the test.

An example of added flutter parameter P_f that can be practically used in the planned flutter flight tests is a concentrated mass located at a "good" place that increases the flutter velocity. It is assumed here that the mass effect of flutter is significant only in one direction, i.e., normal to the lifting surface. An excitation u_f force is applied at this location and a co-located acceleration measurement y_f is taken, both in the effective direction. The PFM method is applied with these parameters, at selected flight velocities, to find ω_{co} and calculate the increment ΔP_f of Eq. (6). This increment is now the added mass Δm that would cause flutter at the selected flight velocity. At flight conditions where $\Delta m < P_f$, the tested configuration is stable. However, the removal of $P_f - \Delta m$ would make it unstable. In this way, by testing a stable configuration, we can positively map the unstable regions of other configurations.

3. FLUTTER PREDICTION BY SYSTEM IDENTIFICATION AND A FLUTTER STABILITY CRITERION

The most straightforward and commonly used approach to flutter prediction is to characterize the dynamic aeroelastic system based on measured structural responses at subcritical conditions and track the system's damping [5]. The drawbacks of this so called Modal Damping Extrapolation (MDE) approach are that the damping values are difficult to predict accurately, and that the significant decrease of damping might only occur very close to flutter onset. This could risk the platform in cases of hard flutter with abrupt switching from positive to negative damping. As a result, several flutter prediction methods were developed that rely on a stability parameter (other than the damping value) that varies as a known, smooth function of the dynamic pressure. The stability parameter can be estimated based on the structural response at lower, safe, dynamic pressures and tracked (extrapolated) to predict the flutter onset conditions.

The process of flutter prediction based on tracking a stability parameter can be divided in two: Learning the aeroelastic system's dynamics from structural responses at pre-flutter conditions, and computing and extrapolating the stability parameter to predict the flutter onset conditions.

Zimmerman and Weissenburger [6] proposed the Flutter Margin (FM) stability parameter that is computed from the identified frequencies and damping values of a two degrees of freedom (DOF) aeroelastic system. For a certain dynamic pressure value, the FM predicts how much stability is left in the system based on the measured system's frequencies and damping at that dynamic pressure. The FM reduces monotonically with the dynamic pressure, thus it is a better indicator of flutter closeness than the damping values. Zimmerman and Weissenburger show that when the terms of the characteristic equation of the system (from which the frequencies and damping values are computed) are expressed as analytical functions of the configuration parameters and the product $C_{L\alpha}q$ (lift coefficient times the dynamic pressure), the FM is a quadratic function of $C_{L\alpha}q$. For cases of fixed $C_{L\alpha}$, the expression for the FM, which Zimmerman and Weissenburger term 'the flutter prediction equation' is a quadratic function of the dynamic pressure itself. When this is the case, the quadratic flutter prediction equation can then be extrapolated to find the dynamic pressure for which FM=0, which is the estimated flutter onset speed. Thus, Zimmerman and Weissenburger's FM concept offers two valuable pieces of information: 1) the margin from flutter onset at a given dynamic pressure value, and 2) flutter dynamic pressure onset prediction by extrapolation of the FM function to zero. Zimmerman and Weissenburger's FM was derived under several restricting assumptions. Namely, it applies to aeroelastic systems that behave as analytical two DOF systems of fixed lift coefficient, fixed center of pressure, and with no structural damping. The derivation also neglects the oscillatory terms in the aerodynamic forces (to which Zimmerman and Weissenburger offer a correction, and note that the effect is small).

For discrete time description of the aeroelastic system, which suits measured responses in a wind-tunnel or flight tests, Matsuzaki and co-authors [7] proposed a flutter stability parameter that is a function of the Jury stability criterion. The aeroelastic system's dynamics is presented as an autoregressive moving-average (ARMA) process, with coefficients that are identified from time-history data of the system's dynamic response. The advantage of the ARMA modeling for flutter testing is that it is based on responses to initial conditions and therefore does not require a dedicated excitation system (this is in comparison to Zimmerman and Weissenburger, for example, where the system's dynamics were extracted from resonance responses). The ARMA model also accounts for excitation noise, e.g., atmospheric turbulence disturbances. The stability criterion is then computed from the AR coefficients. Matsuzaki and Ando also presented a modified stability parameter, the Fz, that is shown to behave similar to the FM parameter (for a two DOF system and small sampling times [8]). They demonstrate how extrapolation of a least-square straight-line fitting to the stability criterion at pre-flutter dynamic pressure values accurately points to the flutter onset. Because the stability criteria are derived for a two DOF system, the ARMA modeling was restricted to this model order (i.e., ARMA model of four). Several studies demonstrated the use of ARMA modeling together with the Jury stability criterion for flutter prediction based on computational or experimental data. [9] [10]

In experimental cases, the structural responses used for system identification are typically accelerations or strains, measured by several accelerometers or strain gauges attached to the structure. In the ARMA modeling approach, the ARMA model coefficients, and hence the system dynamic properties, are evaluated from a single response time history. When several

responses are available, they have to be somehow accounted for simultaneously, to provide the best single representation of the system dynamics. Nahom-Jidovetski et al. [11] proposed a root-classification procedure that averages the ARMA model coefficients from data that yield roots that are stacked together closely. This approach was tested in a dedicated windtunnel experiment, in which accelerations and strains were recorded at several wing locations in response to turbulence excitation in the tunnel. The root classification technique, together with two DOF ARMA modeling, and the Fz and FM stability criteria, yielded accurate flutter predictions. This approach was also examined in an experimental study, conducted by the Israel Air Force [12], that assessed several advanced flutter flight-test techniques, including the ARMA modeling, with various stability parameters. Iovnovich et al. also examined an Operational Modal Analysis (OMA) approach, in which the aeroelastic dynamic parameters were estimated based on multiple response data and then used in the FM for flutter onset prediction. The study concluded that the ARMA approach was easier to implement and straightforward to use in real time. In this study too, the ARMA model was of order four, corresponding to two DOF modeling of the aeroelastic system, to fit the assumptions for which the stability criteria were derived.

Argaman and Raveh [10] suggested to use Multi-Output Autoregressive (MOAR) system identification. In this approach, several response data are used simultaneously to achieve the best single AR model of the system dynamics (this is, instead of averaging the dynamics from several ARMA models, as done in Refs. [11] and [12]). Argaman and Raveh demonstrated the method on three computational test cases. The Fz stability parameter was assessed based on the frequencies and damping values of the two modes that participate in flutter.

In the current study, we propose to use the ARMA system identification method with multiple channels experimental data for Multi-Output ARMA (MOARMA) identification of the aeroelastic system at pre-flutter speeds. We treat the system identification and flutter prediction parts separately. For the system identification, a best model-order is fitted, which physically accurately accounts for participation of several structural modes as well as for aerodynamic lag terms. The modes participating in flutter are tracked and their properties are used for flutter prediction using the FM. The detailed mathematical model is provided in

Ref. [10]. The method takes advantage of the large data that is nowadays available from fiber optic sensors (FOS) that could hold many sensors on a single fiber. Since the FOS interrogation system is highly expensive, the current study will be based on data from multiple strain gauges and IMUs.

4. CONCEPTUAL DESIGN AND FLUTTER ANALYSIS OF OSU VEHICLE

3.1 Conceptual design

The design concepts were discussed in a preliminary meeting held with Prof. Jim Gregory and Dr. Matt McCreenk of Ohio State University (OSU) at Technion, December 2018, at the SciTech conference in January 2020 and in Zoom meetings since. OSU has a UAV with single electric engine to which they are going to replace the wing with a 3.3*m*-span flexible one. It is planned to be a straight wing with two uniform spars on which 3D-printed segments, wrapped by a transparent skin, will be installed following the structural design concept of the wings of Technion's A3TB UAV. [13] A detailed SolidWorks CAD model was created by Dr. Matt McCrink and his team. Based on their CAD model I manually created highly detailed FEA model in FEMAP for further numerical analysis using NASTRAN.

A general view of the planned test vehicle is given in Figure 6. Each wing will be constructed with 8 segments. There will be two types of segments shown in Figure 7. Six of the segments will be without ailerons and 2 (No. 6 and 7 from the root) with ailerons. The two aileron segments will be interconnected and driven by a single actuator. The tip pods are designed to carry the shaker system with the needed batteries and controllers. As shown in the flutter analysis below, the shakers are placed in a forward point of each tip pod to move the flutter velocity up and provide the excitation needed for identifying the nominal flutter velocity using the PFM method. There is sufficient room in the tip pods to place the shaker components in a favorable symmetric or a-symmetric manner, as discussed later.



Figure 6: General view of the test vehicle CAD model



Figures 7-8: Two types of wing segments: without (right) and with (left) aileron.

3.2 Detailed finite element model

FEMAP was first used for manually constructing a detailed model that follows the CAD drawings while representing the actual structural parts by NASTRAN's finite elements. A general view of the detailed model is shown in Fig 9 and the vehicle general properties are listed in Table 1. Table 2 is the matching model weight table of the entire vehicle generated by NASTRAN in FEMAP. It is based on 9,162 grid points that yield more than 50,000 degrees of freedom (DOF). The tip pod is represented by a circular tube beam along its centerline. Seven different material properties are used: ULTEM 9085 for the Wing 3D-printed structure, OraCover Light for the wing cover, 6061-T6 (Aluminum Alloy) for the two wing spars and landing gear, Plywood for the fuselage, T300 carbon fiber for the wing flaps, E-Glass-Fiber for the wing tip pod case and Polyurethane Foam Rigid for the tail. The element material properties for the various parts are given in Table 3,4,5.

Specifications:	Value
Weight	12.5 Kg.

Wingspan	3500 mm
Aspect Ratio	10.51
Chord length	333 mm

Table 1: OSU-ASSURE specifications



Figure 9: Detailed NASTRAN finite-element model in FEMAP

	Mass	Х	Y	Z		
Structural	12.48715	0.399023	-2.4486E-5	0.0682939		
NonStructural	0.	0.213077	-0.704341	-1.108221		
Total	12.48715	0.399023	-2.4486E-5	0.0682939		
Inertias	Ixx	Iyy	Izz	Ixy	Iyz	Izx
About CSys	10.62637	3.31405	13.58358	0.00066646	-4.7877E-6	0.349063
About CG	10.56813	1.267612	11.59538	7.88466E-4	1.60939E-5	0.0087774
Total_Length	(Line_Elements_or	nly) = 145.	.5229			
Total_Area	(Area_Elements_o	nly) = 2.9	92616			
Total_Volume	(All_Elements)	= 0.012	29546			

Table 2: Model's mass table generated by FEMAP

<u>ULTEM 9085 (Nylon 12)</u>: For the wing 3D-printed skeleton

ID 1 Title UL	Color	55 Palette	Layer 1 Type
General Function Referen Stiffness Youngs Modulus, E Shear Modulus, G	2.15E+9 814393939.	ailure Creep Electr Limit Stress Tension Compression	0.
Poisson's Ratio, nu Thermal Expansion Coeff, a Conductivity, k Specific Heat, Cp Heat Generation Factor	0.32	Shear Mass Density Damping, 2C/Co Reference Temp	0. 1340. 0. 0.

<u>OraCover Light</u>: For the wing skin

ID 3	Title 🧿	raCove	er Light	Color	55	Palet	te	Layer 1	L	Type
General Stiffner Young Shear	Function Refere ss s Modulus, E Modulus, G	ailure Li	Creep mit Stress Tension Compres	Electri s	ical/Optical 0. 0.	Phase				
Poisso	Poisson's Ratio, nu 0.3				Shear 0.					
Therma	al									
Expan Condu Specifi	sion Coeff, a ictivity, k ic Heat, Cp	0.			Ma Da Re	ass Densi amping, 2 eference	ty C/Co Temp	0. 0. 0.		
neat 0	seneration Facto		0.							

6061-T6: for the wing spars and landing gear.

ID 7 Tit Colo	le <u>6061-T6</u> or 55		Layer 1			Material Type
General Function Refer	ences Nonlinear	Ply/Bond Failure	Creep	Electric	al/Optical	Phase
Youngs Modulus, E Shear Modulus, G	6.9E+10 310000000.		Tension Compres	sion	0.	
Poisson's Ratio, nu	0.33		Shear		0.	
Thermal						
Expansion Coeff, a	Expansion Coeff, a 0.				2700.	
Specific Heat, Cp	0.	Da	Damping, 2C/Co		0.	
Heat Generation Facto	or 0.	Re	eference 1	Temp [v .	

Table 3: Material properties, wing

• <u>T300 ISO</u>: For the wing Flaps

ID	8 Titl Colo	e 17300 ISO r 55		Layer 1		Materi	al Type	
Ge	neral Function Refere	ences Nonlinear	Ply/Bond Failu	ure Creep	Electrical/Op	otical Phase	2	
	Stiffness			Limit Stress				
	Youngs Modulus, E	6.475E+10		Tension	0.			
	Shear Modulus, G	2.0111E+9		Compres	sion 0.			
	Poisson's Ratio, nu	0.04		Shear	0.			
	Thermal							
	Expansion Coeff, a	0.		Mass Densil	147	1.5		
	Conductivity, k	0.		Passing D				
Specific Heat, Cp 0.		0.		Damping, 2		0.		
	Heat Generation Facto	r 0.		Reference 1	Temp 0.			

• <u>*E-Glass-Fibre*</u>: For the wing tip pod case

ID 9	Title	e 🖪	Glass-Fiber						Material Trees	
	Colo	r 55				Layer 1			Material Type	
General	Function Refere	nces	Nonlinear	Ply/Bond Fa	ailure	Creep	Electri	cal/Optical	Phase	
Stiffne	SS				7 F U	imit Stress	S			
Young	js Modulus, E	7.8E	E+10			Tension	[0.		
Shear	Shear Modulus, G 3.3E+1			Com			sion	0.		
Poisso	on's Ratio, nu	0.22	2		Shear			0.		
Therm	al									
Expan	nsion Coeff, a	0.						2770		
Condu	Conductivity, k 0. Specific Heat, Cp 0.		M	Mass Density Damping, 2C/Co		0				
Specif			Di			0.				
Heat	Generation Factor	r	0.		R	eference	Temp	υ.		

• <u>Polyurethane Foam Rigid</u>: for the Tail.

ID 10	Title	Pol	yurethane F	oam Rigid						Material Trees
	Colo	r 55				Layer 1				Material Type
General	Function Refere	nces	Nonlinear	Ply/Bond Fa	ilure	Creep	Electri	cal/Opt	ical	Phase
Stiffne	ss				i – Li	mit Stress	3			
Young	s Modulus, E	3000	0000.			Tension		0.		
Shear	Modulus, G	1920	0000.			Compres	sion	0.		
Poisso	n's Ratio, nu	0.35				Shear		0.		
Therma	al									
Expan	sion Coeff, a	0.						180		
Condu	ictivity, k	0.			Ma	iss Densi	cy c / c	0		
Specifi	ic Heat, Cp	0.			Da	mping, 2	C/Co	0.		
Heat G	Generation Factor		0.		Re	ference	Temp	υ.		

 Table 4: Material properties, flaps, pod, and tail

• <u>*Plywood*</u>: For the fuselage

ID 4	Title	e Plywood					Material Trees
	Colo	r 55		Layer 1			Material Type
General	Function Refere	ences Nonlinear	Ply/Bond Fail	lure Creep	Electric	cal/Optical	Phase
Stiffne	SS			Limit Stres	s		
Young	s Modulus, E	8.E+9		Tension	[31000000.	
Shear	Modulus, G	175000000.		Compre	ssion	36000000.	
Poisso	n's Ratio, nu	0.3		Shear	[0.	
Therma	al						
Expan	sion Coeff, a	0.				500	
Condu	ictivity, k	0.		Mass Dens	ity	0	
Specif	ìc Heat, Cp	0.		Damping, 2	2C/Co	0.	
Heat (Generation Factor	r 0.		Reference	Temp	υ.	

Table 5: Material properties, fuselage

3.2 Finite element model properties

The FEMAP model contains several main parts.

The Wings:

The wings are made from ULTEM 9085 3D-printed sections and 2 main 6061-T6 SS spars. In addition, carbon fibre flaps are attached to the wing last 4 sections. Thus, each wing is assembled from a total of 8 3D-Printed sections where the first 4 are without flaps TE cutout and the last 4 sections are with a proper cutout for the carbon fibre flaps. The model contains the actuators, hinges etc. the wing tip is made from E-Glass-Fibre and contains the masses of the internal components including the shaker. Figure 10 shows the complete FE NASTRAN model of the wings span, Including all the components. Table 6 is the matching model weight table of the entire wings span generated by NASTRAN in FEMAP.



Figure 10: General view of the Wing finite-element model

		Cen	ter of Gravity	7		
	Mass	Х	Y	Z		
Structural	6.969876	0.359399	-3.0348E-5	0.124985		
Nonstructural	0.	0.213077	-0.704341	-1.108221		
Total	6.969876	0.359399	-3.0348E-5	0.124985		
Inertias	Ixx	Iyy	Izz	Ixy	Iyz	Izx
About CSys	9.381027	1.084555	10.24142	7.24196E-4	-2.847E-5	0.313798
About CG 4	9.272149	0.0753938	9.341138	8.00217E-4	-2.0333E-6	7.15621E-
Total_Length	(Line_Elements_onl	y) = 128.	9138 5364			
iocai_Aiea	Tota	al_Volume (All	l_Elements)	= 0.00351	104	

Table 6: Wings span model mass table generated by FEMAP

The Fuselage:

The Fuselage is made from Plywood, includes the front engine, landing gear with wheels, and the flight computer & servos mass. Figure 11 shows the complete FE NASTRAN model of the fuselage, Including all the components. Table 7 is the matching model weight table of the entire fuselage generated by NASTRAN in FEMAP.



Figure 11: General view of the Fuselage finite-element model

			Center of Grav	ity		
	Mass	Х	Y	Z		
Structural	3.681499	0.361012	2.92288E-5	-0.0450853		
NonStructural	0.	0.213077	-0.704341	-1.108221		
Total	3.681499	0.361012	2.92288E-5	-0.0450853		
Inertias	Ixx	Iyy	Izz	Ixy	Iyz	Izx
About CSys	0.11062	1.035012	1.050031	2.32401E-4	5.39214E-5	-0.0231975
About CG	0.103137	0.547719	0.570222	1.93554E-4	5.87728E-5	0.0367239
Total_Length Total_Area Total_Volume	(Line_Elements_only) (Area_Elements_only) (All_Elements)	= 16. = 0. = 0.005	19379 70319 12123			

Table 7: Fuselage model mass table generated by FEMAP

Wing-Tip pod Mass Configuration:

There are 3 suggested position configurations of the shaker and the batteries inside the wing tip pod, as presented in Figure 12. They will be referred to as cases 1-3. Marking reference are:

- 1 Shaker = 133 gr
- 2 Shaker Housing (including control board) = 80 gr
- 3 Batteries = 150 gr



Figure 12: Mass configurations of the wing tip pod

3.3 Natural frequencies and normal modes

Normal modes were calculated for three mass configurations (Cases 1-3), the nominal one described above, and two modified ones with moved shaker/batteries mass at the forward point of the wing-tip pod section. The pod masses in these cases are placed symmetrically, such that the entire UAV is symmetric with respect to the center plane. As a result, all the natural modes are either symmetric (sym) or antisymmetric (Anti). The various configurations will be used later in the project to optimize the mass placement positions inside the pod. The resulting fundamental frequencies and mode descriptions are given in Table 8.

Мо				
de	Case	Case	Case	
Nu	1	2	3	Description
mb	[Hz]	[Hz]	[Hz]	
er				
1-6	0.00	0.00	0.00	Rigid body
7	5.12 9	5.167	5.376	1 st bending - Sym
8	6.13 5	6.177	6.569	1 st torsion – Anti
9	6.46 4	6.717	6.846	1 st torsion – Sym
10	14.1 0	14.21	14.19	1 st bending – Anti
11	15.8 6	16.06	16.01	1 st Tail bending - Anti
12	16.9 9	17.00	17.00	1 st Tail bending - Sym

 Table 8: OSU ASSURE Model fundamental natural frequencies

The eigenvalue table of NASTRAN's normal modes analysis of the nominal configuration (Case 1), with the natural frequencies, generalized masses and stiffness properties, are given in Table 9. The first 6 rigid-body frequencies are practically zero. The mode shapes associated with the first 6 non-zero frequencies are shown in Figure 13.

MODE	EXTRACTION	ETGENIVALUE			GENERAL TZED	GENERAL TZED
NO.	ORDER	LIGENVALOE	RADIANS	CICLES	MASS	STIFFNESS
1	1	-7.993767F-06	2.827325E-03	4,499828F-04	1,000000F+00	-7,993767F-06
2	2	-2.072447F-06	1.439600F-03	2.291194F-04	1,000000F+00	-2.072447F-06
3	3	-9.395243E-07	9.692906E-04	1.542674E-04	1.000000E+00	-9.395243E-07
4	4	2.126359E-08	1.458204E-04	2.320804E-05	1.000000E+00	2.126359E-08
5	5	1.080220E-06	1.039336E-03	1.654155E-04	1.000000E+00	1.080220E-06
6	6	3.938488E-06	1.984562E-03	3.158529E-04	1.000000E+00	3.938488E-06
7	7	1.038882E+03	3.223169E+01	5.129832E+00	1.000000E+00	1.038882E+03
8	8	1.485936E+03	3.854784E+01	6.135080E+00	1.000000E+00	1.485936E+03
9	9	1.649962E+03	4.061972E+01	6.464830E+00	1.000000E+00	1.649962E+03
10	10	7.849723E+03	8.859866E+01	1.410091E+01	1.000000E+00	7.849723E+03
11	11	9.939616E+03	9.969763E+01	1.586737E+01	1.000000E+00	9.939616E+03
12	12	1.140404E+04	1.067897E+02	1.699611E+01	1.000000E+00	1.140404E+04
13	13	1.451592E+04	1.204820E+02	1.917531E+01	1.000000E+00	1.451592E+04
14	14	1.708518E+04	1.307103E+02	2.080319E+01	1.000000E+00	1.708518E+04
15	15	1.782722E+04	1.335186E+02	2.125015E+01	1.000000E+00	1.782722E+04
16	16	2.539453E+04	1.593566E+02	2.536239E+01	1.000000E+00	2.539453E+04
17	17	2.625681E+04	1.620395E+02	2.578939E+01	1.000000E+00	2.625681E+04
18	18	2.987933E+04	1.728564E+02	2.751095E+01	1.000000E+00	2.987933E+04
19	19	3.099014E+04	1.760402E+02	2.801766E+01	1.000000E+00	3.099014E+04
20	20	3.215843E+04	1.793277E+02	2.854089E+01	1.000000E+00	3.215843E+04
21	21	4.803369E+04	2.191659E+02	3.488134E+01	1.000000E+00	4.803369E+04
22	22	4.883419E+04	2.209846E+02	3.517079E+01	1.000000E+00	4.883419E+04
23	23	5.199020E+04	2.280136E+02	3.628949E+01	1.000000E+00	5.199020E+04
24	24	5.366305E+04	2.316529E+02	3.686870E+01	1.000000E+00	5.366305E+04
25	25	5.500435E+04	2.345301E+02	3.732662E+01	1.000000E+00	5.500435E+04
FREQ	UENCY MODES			SEPTEMBER	12, 2021 SIMCENTE	R NASTRAN 3/12/2
0511	ASSURE					

Table 9: Natural frequencies from normal-mode analysis

- 1. 1st Sym wing bending 5.129832 Hz

Ηz

3. 1st Sym wing torsion – 6.46483 Hz

2. 1st Anti-Sym wing torsion – 6.13508



4. 1st Anti-Sym wing bending – 14.10091



Hz



5. 2^{nd} Anti-Sym wing bending – 15.86737 Hz

6. 1st Tail mode – 16.99611 Hz



Figure 13: Mode shapes, 7-12, in the structural grid, Configuration 1

Case 2 is the mass position configuration of the shaker and the batteries where the shaker was moved further to the front section of the wing tip pod. The eigenvalue table of NASTRAN's normal modes analysis of the nominal configuration (Case 2), with the natural frequencies, generalized masses and stiffness properties, are given in Table 10. The first 6 rigid-body frequencies are practically zero. The mode shapes associated with the first 6 non-zero frequencies are shown in

			REAL EIGE	NVALUES		
MODE	EXTRACTION	EIGENVALUE	RADIANS	CYCLES	GENERALIZED	GENERALIZED
NO.	ORDER				MASS	STIFFNESS
1	1	-1.327245E-05	3.643137E-03	5.798233E-04	1.000000E+00	-1.327245E-05
2	2	-2.369365E-06	1.539274E-03	2.449831E-04	1.000000E+00	-2.369365E-06
3	3	-1.236953E-06	1.112184E-03	1.770096E-04	1.000000E+00	-1.236953E-06
4	4	-1.118509E-06	1.057596E-03	1.683216E-04	1.000000E+00	-1.118509E-06
5	5	3.962374E-07	6.294739E-04	1.001839E-04	1.000000E+00	3.962374E-07
6	6	1.429962E-06	1.195810E-03	1.903191E-04	1.000000E+00	1.429962E-06
7	7	1.054156E+03	3.246777E+01	5.167406E+00	1.000000E+00	1.054156E+03
8	8	1.506363E+03	3.881190E+01	6.177105E+00	1.000000E+00	1.506363E+03
9	9	1.781411E+03	4.220676E+01	6.717415E+00	1.000000E+00	1.781411E+03
10	10	7.977360E+03	8.931607E+01	1.421509E+01	1.000000E+00	7.977360E+03
11	11	1.018439E+04	1.009178E+02	1.606156E+01	1.000000E+00	1.018439E+04
12	12	1.141247E+04	1.068292E+02	1.700239E+01	1.000000E+00	1.141247E+04
13	13	1.461828E+04	1.209061E+02	1.924280E+01	1.000000E+00	1.461828E+04
14	14	1.714101E+04	1.309237E+02	2.083715E+01	1.000000E+00	1.714101E+04
15	15	1.819090E+04	1.348737E+02	2.146581E+01	1.000000E+00	1.819090E+04
16	16	2.551724E+04	1.597412E+02	2.542360E+01	1.000000E+00	2.551724E+04
17	17	2.789606E+04	1.670211E+02	2.658224E+01	1.000000E+00	2.789606E+04
18	18	3.040975E+04	1.743839E+02	2.775406E+01	1.000000E+00	3.040975E+04
19	19	3.114208E+04	1.764712E+02	2.808626E+01	1.000000E+00	3.114208E+04
20	20	3.313556E+04	1.820318E+02	2.897126E+01	1.000000E+00	3.313556E+04
21	21	4.802759E+04	2.191520E+02	3.487912E+01	1.000000E+00	4.802759E+04
22	22	4.879177E+04	2.208886E+02	3.515551E+01	1.000000E+00	4.879177E+04
23	23	5.201593E+04	2.280700E+02	3.629847E+01	1.000000E+00	5.201593E+04
24	24	5.366409E+04	2.316551E+02	3.686906E+01	1.000000E+00	5.366409E+04
25	25	5.508455E+04	2.347010E+02	3.735382E+01	1.000000E+00	5.508455E+04
FREQ	UENCY MODES -	CASE 2		OCTOBER	25, 2021 SIMCENTE	R NASTRAN 3/12/2
0SU	ASSURE					

Figure 14.

Table 10: Natural frequencies from normal-mode analysis

- 1. 1st Sym wing bending 5.167406 Hz
- 2. 1st Anti-Sym wing torsion 6.177105



Hz

3. 1st Sym wing torsion – 6.717415 Hz



4. 1st Anti-Sym wing bending – 14.21509



Appendix Market State St

5. 2nd Anti-Sym wing bending – 16.06156 Hz

6. 1st Tail mode – 17.00239 Hz



Figure 14: Mode shapes, 7-12, in the structural grid, Configuration 2

Case 3 is the mass position configuration of the shaker and the batteries where the shaker and the batteries were moved further to the front section of the wing tip pod. The eigenvalue table of NASTRAN's normal modes analysis of the nominal configuration (Case 3), with the natural frequencies, generalized masses and stiffness properties, are given in Table 11. The first 6 rigid-body frequencies are practically zero. The mode shapes associated with the first 6 non-zero

			REAL EIGE	NVALUES		
MODE	EXTRACTION	EIGENVALUE	RADIANS	CYCLES	GENERALIZED	GENERALIZED
NO.	ORDER				MASS	STIFFNESS
1	1	-3.596406E-06	1.896419E-03	3.018245E-04	1.000000E+00	-3.596406E-06
2	2	-1.866675E-06	1.366263E-03	2.174475E-04	1.000000E+00	-1.866675E-06
3	3	-1.224559E-06	1.106598E-03	1.761206E-04	1.000000E+00	-1.224559E-06
4	4	-7.962245E-07	8.923141E-04	1.420162E-04	1.000000E+00	-7.962245E-07
5	5	3.456648E-08	1.859206E-04	2.959019E-05	1.000000E+00	3.456648E-08
6	6	1.089448E-06	1.043766E-03	1.661206E-04	1.000000E+00	1.089448E-06
7	7	1.141134E+03	3.378068E+01	5.376362E+00	1.000000E+00	1.141134E+03
8	8	1.703680E+03	4.127565E+01	6.569225E+00	1.000000E+00	1.703680E+03
9	9	1.850429E+03	4.301661E+01	6.846307E+00	1.000000E+00	1.850429E+03
10	10	7.953869E+03	8.918446E+01	1.419415E+01	1.000000E+00	7.953869E+03
11	11	1.012279E+04	1.006121E+02	1.601291E+01	1.000000E+00	1.012279E+04
12	12	1.141823E+04	1.068561E+02	1.700668E+01	1.000000E+00	1.141823E+04
13	13	1.461812E+04	1.209054E+02	1.924269E+01	1.000000E+00	1.461812E+04
14	14	1.712050E+04	1.308453E+02	2.082468E+01	1.000000E+00	1.712050E+04
15	15	1.810394E+04	1.345509E+02	2.141444E+01	1.000000E+00	1.810394E+04
16	16	2.551285E+04	1.597274E+02	2.542141E+01	1.000000E+00	2.551285E+04
17	17	2.787763E+04	1.669660E+02	2.657346E+01	1.000000E+00	2.787763E+04
18	18	3.097864E+04	1.760075E+02	2.801246E+01	1.000000E+00	3.097864E+04
19	19	3.168190E+04	1.779941E+02	2.832864E+01	1.000000E+00	3.168190E+04
20	20	3.280298E+04	1.811159E+02	2.882550E+01	1.000000E+00	3.280298E+04
21	21	4.809686E+04	2.193100E+02	3.490427E+01	1.000000E+00	4.809686E+04
22	22	4.905914E+04	2.214930E+02	3.525170E+01	1.000000E+00	4.905914E+04
23	23	5.202750E+04	2.280954E+02	3.630251E+01	1.000000E+00	5.202750E+04
24	24	5.366471E+04	2.316564E+02	3.686927E+01	1.000000E+00	5.366471E+04
25	25	5.508573E+04	2.347035E+02	3.735422E+01	1.000000E+00	5.508573E+04
FREQU	JENCY MODES -	CASE 3		OCTOBER	25, 2021 SIMCENTE	R NASTRAN 3/12/2
0SU	ASSURE					

frequencies are shown in Figure 15.

Table 11: Natural frequencies from normal-mode analysis

1. 1st Sym wing bending – 5.376362 Hz



Ηz

3. 1st Sym wing torsion – 6.846307 Hz





4. 1st Anti-Sym wing bending – 14.19415



5. 2nd Anti-Sym wing bending – 16.01291 Hz



6. 1st Tail mode – 17.00668 Hz



Figure 15: Mode shapes, 7-12, in the structural grid, Configuration 3

3.4 Conventional flutter analysis - ZAERO

The ZAERO aeroelastic code was used for constructing the panel model for the wing shown in Figure 12. The modal deflections of the previous section are projected to the aerodynamic model using the Infinite-Plate Spline (IPS) technique, based on the upper surface structural displacements.



Figure 16: ZAERO aerodynamic model

The ZAERO aerodynamic model includes all main plane parts. The fuselage, the wings, the wingtip pod, the flaps, the ailerons, and the tail unit are included. The analysis is an Open-loop flutter analysis that was performed using the g-method option of the ZAERO software package, assuming 2% structural damping with the 12 modes of Table 8 considered in each case. The damping and the frequency parts of the V-g plots of the nominal case 1 configuration are given in Figures 18 and 19 respectively. So does V-g plots of case 2 and case 3 are given in Figures 23-24 and 28-29 respectively. Snap shots of the obtained symmetric and antisymmetric flutter case 1 modes are shown Figures 20 and 21. So does snap shots of cases 2 and 3 are given in Figures 25-26 and 30-31 respectively. The resulting flutter characteristics are summarized in Table 12. The Flutter analysis results summary from ZAERO for cases 1-3 are presented in Figures 17,22,27 respectively.

Configuration	Mechanism Symmetry	Flutter velocity (m/s)	Flutter frequency (Hz.)	Flutter mechanism	Fi
	Anti	30.89	4.23	Wing torsion-roll	
Case 1	Sym	26.69	5.49	Wing torsion- bending	
	Anti	28.95	4.43	Wing torsion-roll	
Case 2	Sym	26.56	5.71	Wing torsion- bending	
	Anti	34.21	4.43	Wing torsion-roll	
Case 3	Sym	36.32	5.64	Wing torsion- bending	

Table 12: Cases 1-3 Flutter characteristics

It can be observed that the lowest flutter velocity in Cases 1 and 2 is the symmetric one with very small difference between the two (both about 26.6 m/s). The flutter mechanism is of a classic torsion-bending interaction. The anti-symmetric flutter mechanism is of the interaction of wing torsion and rigid-body roll, a mechanism that is often called "body-freedom flutter". The critical flutter velocity increases in Case 3 by about 10%, with the anti-symmetric flutter becoming more critical, at 34.2 m/s. The exact mass locations at flutter tests will be determined after the model is verified by ground vibration test (GVT).

SPEED UNITS= M / SEC 26.6923 27.0810 27.5326 27.9842 28.5112 29.0440 29.6124 30.1927 30.7985
V/VREF UNITS= NONE 26.6923 27.0810 27.5326 27.9842 28.5112 29.0440 29.6124 30.1927 30.7985
FREQ UNITS= HZ 5.5015 5.4951 5.4880 5.4810 5.4708 5.4603 5.4463 5.4314 5.4146
DYN P UNITS=KG /M /S**2 4.363+02 4.491+02 4.643+02 4.796+02 4.978+02 5.166+02 5.370+02 5.583+02 5.809+02
DYNAMIC PRESSURE AT G=0.0, W = 5.5015 HZ, V = 2.6692E+01 : COMPUTED = 4.3609E+02, INTERPOLATED = 4.3639E+02, ERROR = -6.8841E-02%. CORRESPONDING EIGENVECTOR OF 25 MODES = -1.938E-01 1.722E-01, -2.830E-02 1.688E-02, 1.855E-02 -2.100E-02, -1.805E-02 1.382E-02, -4.316E-01 3.564E-01, 4.915E-02 -1.578E-01, 1.000E+00 0.000E+00, 7.964E-02 1.298E-02, 3.493E-01 -8.080E-01, 2.267E-03 2.095E-03, -3.453E-03 -1.381E-03, 6.996E-03 -2.693E-03, -1.270E-03 -5.540E-04, -8.549E-03 9.087E-03, 4.263E-03 -9.252E-05, 4.898E-04 4.898E-04 1.092E-04, -6.048E-03 5.029E-03, 1.637E-02 -1.256E-02, -1.254E-03 4.441E-05, -6.196E-03 1.730E-02, -5.943E-05 2.332E-04, -1.994E-03 3.448E-03, 1.071E-04 2.401E-05, -8.122E-05 1.509E-04, 1.022E-03 -1.123E-03,
FLUTTER MODE TRACKING: 100% = PRIMARY MODE. 0% = NO CONTRIBUTION TO FLUTTER MODE. MODE(1) = 26.7051%, MODE(2) = 17.3389%, MODE(3) = 17.2910%, MODE(4) = 17.3086%, MODE(5) = 8.4053%, MODE(6) = 16.2333%, MODE(7) = 43.0021%, MODE(8) = 17.8424%, MODE(9) = 100.0000%, MODE(10) = 17.3374%, MODE(11) = 17.3347%, MODE(12) = 16.7927%, MODE(13) = 17.3301%, MODE(14) = 17.4348%, MODE(15) = 17.3389%, MODE(16) = 17.3317%, MODE(17) = 17.3163%, MODE(18) = 18.0157%, MODE(19) = 17.3267%, MODE(20) = 17.7902%, MODE(21) = 17.3557%, MODE(22) = 18.3161%, MODE(23) = 17.3313%, MODE(24) = 17.3316%, MODE(25) = 17.5901%,
FLUTTER AT MODE NO.: 9 G= 0.00% G= 0.50% G= 1.00% G= 1.50% G= 2.00% G= 2.50% G= 3.00% G= 3.50% G= 4.00%
FLUTTER AT MODE NO.: 9 G= 0.00% G= 0.50% G= 1.00% G= 1.50% G= 2.00% G= 2.50% G= 3.00% G= 3.50% G= 4.00% SPEED UNITS= M / SEC 30.8948 31.0791 31.2262 31.3734 31.5205 31.6676 31.8147 31.9618 32.0943
FLUTTER AT MODE NO.: 9 G= 0.00% G= 0.50% G= 1.00% G= 1.50% G= 2.00% G= 2.50% G= 3.00% G= 3.50% G= 4.00% SPEED UNITS= M / SEC 30.8948 31.0791 31.2262 31.3734 31.5205 31.6676 31.8147 31.9618 32.0943 V/VREF UNITS= NONE 30.8948 31.0791 31.2262 31.3734 31.5205 31.6676 31.8147 31.9618 32.0943
FLUTTER AT MODE NO.: 9 G= 0.00% G= 0.50% G= 1.00% G= 1.50% G= 2.00% G= 2.50% G= 3.00% G= 3.50% G= 4.00% SPEED UNITS= M / SEC 30.8948 31.0791 31.2262 31.3734 31.5205 31.6676 31.8147 31.9618 32.0943 V/VREF UNITS= NONE 30.8948 31.0791 31.2262 31.3734 31.5205 31.6676 31.8147 31.9618 32.0943 FREQ UNITS= HZ 4.2316 4.2089 4.1893 4.1697 4.1501 4.1305 4.1109 4.0913 4.0736
FLUTTER AT MODE NO.: 9 G= 0.00% G= 1.00% G= 1.50% G= 2.00% G= 3.00% G= 3.50% G= 4.00% G= SPEED UNITS= M SEC 30.8948 31.0791 31.2262 31.3734 31.5205 31.6676 31.8147 31.9618 32.0943 G= V/VREF UNITS= NONE 30.8948 31.0791 31.2262 31.3734 31.5205 31.6676 31.8147 31.9618 32.0943 G= V/VREF UNITS= NONE 30.8948 31.0791 31.2262 31.3734 31.5205 31.6676 31.8147 31.9618 32.0943 G= FREQ UNITS= NONE 30.8948 31.0791 31.2262 31.3734 31.5205 31.6676 31.8147 31.9618 32.0943 G= FREQ UNITS= HZ 4.2316 4.2089 4.1697 4.1501 4.1305 4.1109 4.0913 4.0736 DYN P UNITS=KG /M /S**2 5.846+02 5.972+02 6.028+02
FLUTTER AT MODE NO.: 9 G= 0.00% G= 0.50% G= 1.00% G= 1.50% G= 2.00% G= 2.50% G= 3.00% G= 3.50% G= 4.00% SPEED JUNITS= M / SEC 30.8948 31.0791 31.2262 31.3734 31.5205 31.6676 31.8147 31.9618 32.0943 V/VREF UNITS= NONE 30.8948 31.0791 31.2262 31.3734 31.5205 31.6676 31.8147 31.9618 32.0943 V/VREF UNITS= NONE 30.8948 31.0791 31.2262 31.3734 31.5205 31.6676 31.8147 31.9618 32.0943 FREQ UNITS= NONE 30.8948 31.0791 31.2262 31.3734 31.5205 31.6676 31.8147 31.9618 32.0943 FREQ UNITS= HZ 4.2316 4.2089 4.1893 4.1697 4.1501 4.1305 4.1109 4.0913 4.0736 DYN P UNITS=KG /M /S**2 5.846+02 5.972+02 6.028+02 6.085+02 6.142+02 6.199+02 6.257+02 6.309+02 1.000E <t< td=""></t<>

Figure 17: Case 1 Flutter velocity calculation using ZAERO



Figure 19: Case 1 Frequency Plot



Figure 20: Case 1 Flutter mode 1 – 4.23 Hz



Figure 21: Case 1 Flutter mode 2 – 5.49 Hz

SPEED UNITS= M / SEC 26.5690 26.7406 26.9123 27.1024 27.3119 27.5214 27.7309 27.9404 28.1911
V/VREF UNITS= NONE 26.5690 26.7406 26.9123 27.1024 27.3119 27.5214 27.7309 27.9404 28.1911
FREQ UNITS= HZ 5.7162 5.7110 5.7059 5.7016 5.6982 5.6948 5.6915 5.6881 5.6842
DYN P UNITS=KG /M /S**2 4.323+02 4.379+02 4.436+02 4.499+02 4.568+02 4.639+02 4.710+02 4.781+02 4.867+02
DYNAMIC PRESSURE AT G=0.0, W = 5.7162 HZ, V = 2.6569E+01 : COMPUTED = 4.3205E+02, INTERPOLATED = 4.3237E+02, ERROR = -7.3963E-02%. CORRESPONDING EIGENVECTOR OF 25 MODES = -2.572E-01 -1.131E-01, -1.780E-02 3.955E-03, 2.355E-02 6.139E-03, 2.664E-02 4.918E-03, 5.214E-01 2.285E-01, 3.370E-02 -1.173E-01, -1.889E-01 -5.845E-01, -1.365E-01 -1.016E-01, 1.000E+00 0.000E+00, 1.950E-03 -2.029E-03, 8.957E-06 3.666E-03, 6.070E-03 6.247E-03, 1.506E-04 1.572E-03, 1.083E-02 3.998E-03, 1.834E-03 4.700E-03, -2.808E-04 -6.319E-04, 7.096E-03 4.121E-03, -1.042E-02 -9.805E-03, -2.088E-03 -1.153E-03, -2.325E-02 -5.609E-04, -9.079E-04 -2.383E-04, 5.261E-03 7.713E-04, -1.234E-04 -1.882E-04, 1.912E-04 -3.754E-05, 1.711E-03 4.708E-04,
FLUTTER MODE TRACKING: 100% = PRIMARY MODE. 0% = NO CONTRIBUTION TO FLUTTER MODE. MODE(1) = 17.9265%, MODE(2) = 12.1251%, MODE(3) = 12.1377%, MODE(4) = 12.1334%, MODE(5) = 2.4255%, MODE(6) = 11.6093%, MODE(7) = 28.3007%, MODE(8) = 9.8361%, MODE(9) = 100.0000%, MODE(10) = 12.1558%, MODE(11) = 12.1429%, MODE(12) = 11.8980%, MODE(13) = 12.1422%, MODE(14) = 12.2743%, MODE(15) = 12.1297%, MODE(16) = 12.1434%, MODE(17) = 12.3370%, MODE(18) = 13.8167%, MODE(19) = 12.2380%, MODE(20) = 12.1123%, MODE(21) = 12.2969%, MODE(22) = 14.1114%, MODE(23) = 12.1474%, MODE(24) = 12.1414%, MODE(25) = 12.0534%,
LELUTTER AT MODE NO · 7 G= 0 00% G= 0 50% G= 1 00% G= 1 50% G= 2 00% G= 2 50% G= 3 00% G= 3 50% G= 4 00%
SPEED UNITS= M / SEC 28.9506 29.0883 29.2238 29.3594 29.4949 29.6304 29.7660 29.9015 30.0337
SPEED UNITS= M / SEC 28.9506 29.0883 29.2238 29.3594 29.4949 29.6304 29.7660 29.9015 30.0337 V/VREF UNITS= NONE 28.9506 29.0883 29.2238 29.3594 29.4949 29.6304 29.7660 29.9015 30.0337
SPEED UNITS= M / SEC 28.9506 29.0883 29.2238 29.3594 29.4949 29.6304 29.7660 29.9015 30.0337 V/VREF UNITS= NONE 28.9506 29.0883 29.2238 29.3594 29.4949 29.6304 29.7660 29.9015 30.0337 I FREQ UNITS= NONE 28.9506 29.0883 29.2238 29.3594 29.4949 29.6304 29.7660 29.9015 30.0337 I FREQ UNITS= HZ 4.4084 4.3877 4.3669 4.3462 4.3254 4.3047 4.2840 4.2642
SPEED UNITS= M / SEC 28.9506 29.0883 29.2238 29.3594 29.4949 29.6304 29.7660 29.9015 30.0337 V/VREF UNITS= NONE 28.9506 29.0883 29.2238 29.3594 29.4949 29.6304 29.7660 29.9015 30.0337 FREQ UNITS= HZ 4.4301 4.4084 4.3877 4.3669 4.3462 4.3254 4.3047 4.2840 4.2642 DYN P UNITS=KG /M /S**2 5.133+02 5.182+02 5.230+02 5.279+02 5.328+02 5.377+02 5.426+02 5.476+02 5.524+02
SPEED UNITS= M / SEC 28.9506 29.0883 29.2238 29.3594 29.4949 29.6304 29.7660 29.9015 30.0337 V/VREF UNITS= NONE 28.9506 29.0883 29.2238 29.3594 29.4949 29.6304 29.7660 29.9015 30.0337 V/VREF UNITS= NONE 28.9506 29.0883 29.2238 29.3594 29.4949 29.6304 29.7660 29.9015 30.0337 FREQ UNITS= NONE 28.9506 29.0883 29.2238 29.3594 29.4949 29.6304 29.7660 29.9015 30.0337 FREQ UNITS= NONE 28.9506 29.0883 29.2238 29.3594 29.4949 29.6304 29.7660 29.9015 30.0337 FREQ UNITS= MZ 4.4301 4.3877 4.3669 4.3462 4.3254 4.3047 4.2840 4.2642 DYNAMIC PRESSURE AT G=0.0, W 4.4301 HZ, V = 2.8951E+01 : Image: Compute Distribut Product Distret Distribut Product Distribut Product Distret

Figure 22: Case 2 Flutter velocity calculation using ZAERO



Figure 24: Case 2 Frequency Plot


Figure 25: Case 2 Flutter mode 1 – 4.43 Hz



Figure 26: Case 2 Flutter mode 2 – 5.71 Hz

FLUTTER AT MODE NO.: 7 G= 0.00% G= 0.50% G= 1.00% G= 1.50% G= 2.00% G= 2.50% G= 3.00% G= 3.50% G= 4.00%
SPEED UNITS= M / SEC 34.2173 34.3489 34.4804 34.6120 34.7436 34.8752 35.0068 35.1391 35.2715
V/VREF UNITS= NONE 34.2173 34.3489 34.4804 34.6120 34.7436 34.8752 35.0068 35.1391 35.2715
FREQ UNITS= HZ 4.4311 4.4134 4.3957 4.3780 4.3603 4.3426 4.3250 4.3094 4.2938
DYN P UNITS=KG /M /S**2 7.171+02 7.226+02 7.282+02 7.337+02 7.393+02 7.449+02 7.506+02 7.562+02 7.619+02
DYNAMIC PRESSURE AT G=0.0, W = 4.4311 HZ, V = 3.4217E+01 : COMPUTED = 7.1680E+02, INTERPOLATED = 7.1713E+02, ERROR = -4.5985E-02%. CORRESPONDING EIGENVECTOR OF 25 MODES = -1.265E-03 3.862E-03, -6.439E-02 9.641E-03, 9.279E-02 6.061E-03, 7.166E-02 -8.485E-04, -4.719E-01 -3.685E-03, 1.000E+00 0.000E+00, 1.689E-02 -3.174E-03, -4.294E-01 1.572E-01, 2.992E-03 -1.386E-03, -2.934E-02 -9.910E-04, -4.116E-02 6.426E-03, -4.207E-06 1.021E-06, 1.524E-02 -2.320E-03, 3.770E-03 -3.487E-04, 3.115E-02 -2.682E-03, -5.249E-03 4.764E-04, 5.935E-05 7.159E-06, 2.588E-06 1.428E-05, -1.426E-02 6.670E-03, -3.131E-04 1.173E-04, 5.001E-03 -1.331E-03, -5.082E-06 9.023E-06, -3.037E-04 -1.420E-04, 4.698E-06 7.931E-04, -2.736E-05 1.046E-04,
$ \begin{array}{llllllllllllllllllllllllllllllllllll$
FLUTTER AT MODE NO.: 9 G= 0.00% G= 0.50% G= 1.00% G= 1.50% G= 2.00% G= 2.50% G= 3.00% G= 3.50% G= 4.00%
SPEED UNITS= M / SEC 36.3293 37.0984 38.1105 40.0472 43.1838
SPEED UNITS= M / SEC 36.3293 37.0984 38.1105 40.0472 43.1838 V/VREF UNITS= NONE 36.3293 37.0984 38.1105 40.0472 43.1838
SPEED UNITS= M / SEC 36.3293 37.0984 38.1105 40.0472 43.1838 V/VREF UNITS= NONE 36.3293 37.0984 38.1105 40.0472 43.1838 FREQ UNITS= HZ 5.6399 5.6254 5.6096 5.5905 5.5622
SPEED UNITS= M / SEC 36.3293 37.0984 38.1105 40.0472 43.1838 V/VREF UNITS= NONE 36.3293 37.0984 38.1105 40.0472 43.1838 V/VREF UNITS= NONE 36.3293 37.0984 38.1105 40.0472 43.1838 FREQ UNITS= HZ 5.6399 5.6254 5.6096 5.5905 5.5622 DYN P UNITS=KG /M /S**2 8.083+02 8.429+02 8.896+02 9.823+02 1.142+03
SPEED JUNITS= M / SEC 36.3293 37.0984 38.1105 40.0472 43.1838 I I I V/VREF UNITS= NONE 36.3293 37.0984 38.1105 40.0472 43.1838 I I I V/VREF UNITS= NONE 36.3293 37.0984 38.1105 40.0472 43.1838 I I I FREQ UNITS= HZ 5.6399 5.6254 5.6096 5.5905 5.5622 I I I DYN P UNITS=KG /M /S**2 8.083+02 8.429+02 8.896+02 9.823+02 1.142+03 I I I DYN P UNITS=KG /M /S**2 8.083+02 8.429+02 8.896+02 9.823+02 1.142+03 I I I DYNAMIC PRESSURE AT G=0.0, W = 5.6399 HZ, V = 3.6329E+01 : Image: COMPUTED = 8.0815E+02, INTERPOLATED = 8.0839E+02, ERROR = -2.9408E-02%. CORRESPONDING EIGENVECTOR OF 25 MODES = 8.021E-02 -9.201E-02, -1.123E-02 9.321E-03, -1.016E-02, 2.447E-02 -2.322E-02, 2.922E-01, -2.419E-01, 1.065E-01 -1.039E-01, 1.000E+00, 0.000E+00, 1.033E-02 -5.77

Figure 27: Case 3 Flutter velocity calculation using ZAERO



Figure 29: Case 3 Frequency Plot



Figure 30: Case 3 Flutter mode 1 – 4.43 Hz



Figure 31: Case 3 Flutter mode 2 – 5.63 Hz

3.5 Dynresp Flutter analysis

ZAERO Vs Dynresp results comparison

The PFM method for flutter analysis [1] is applied using the Dynresp code such that it forms the basis to the planned flutter flight tests. The flutter parameter, P_f , is selected to be a mass term of 0.7Kg in the Z (vertical) direction, located at the right-wing, tip-section, leading-edge shaker mass grid point (1547). The added mass is applied in Dynresp by a SISO zero-order control system that reads the selected acceleration, y, multiplies it by P_f , and closed the loop by $u=P_f y$ to create the system matrix in Eq. (2). These input and output are also kept open for calculating the PFM response of Eq. (2). PFM plots and flutter characteristics are given in following section. ZAERO-Dynresp flutter results summery and comparison in given in Table 13. The Flutter analysis results



summary from Dynresp out files for cases 1-3 are presented in Figures 33,35,37 respectively.

			ZAERO	Dy	nresp (SISO)
Cas	Symmetr y	Flutter velocit y (m/s)	Flutter frequenc y (Hz.)	Flutter velocit y (m/s)	Flutter frequenc y (Hz.)
Cas	Anti	30.89	4.23	30.91	4.20
e 1	Sym	26.69	5.49	26.28	5.52
Cas	Anti	28.95	4.43	27.80	4.33
e 2	Sym	26.56	5.71	24.74	5.71
Cas	Anti	34.21	4.43	34.12	4.41
e 3	Sym	36.32	5.64	34.41	5.66

Figure 32: GRID 1547 location in the wing-tip pod section

FLUTTER SUMMARY IDGAIN = 33
THERE ARE 2 FLUTTER POINTS
1 FLUTTER POINT VELOCITY 26.28991 DENSITY 1.225 FREQUENCY 5.528622 THE FLUTTER MODE IS :
<pre><1><-REAL-><-IMAG-><-REAL-><-IMAG-><-REAL-><-IMAG-><-REAL-><-IMAG-><-REAL-><-IMAG-><-10></pre>
2 FLUTTER POINT VELOCITY 30.89482 DENSITY 1.225 FREQUENCY 4.206216 THE FLUTTER MODE IS :
<pre><1><-REAL-><-IMAG-><-REAL-><-IMAG-><-REAL-><-IMAG-><-REAL-><-IMAG-><-REAL-><-IMAG-><-REAL-><-IMAG-><-10></pre>
+ 3.6784-5-9.008-5 ************************************

Figure 33: Case 1 Flutter velocity calculation using Dynresp

The FRFs $y_f(V;i\omega)$ were calculated in Dynresp for selected air velocities between 18 and 55 m/s. Cross-over frequencies, ω_{co} , at which $\Phi = \angle (y_f(i\omega)) = \pm 360^\circ n$, and the corresponding gains $y_f(\omega_{co})$, which are positive real numbers, were used for calculating ΔP_f of Eq. (6), were calculated for each velocity. In our case, ΔP_f is the mass increment Δm needed to cause the current velocity to become a flutter-boundary point V_f . Every velocity may yield several cross-over frequencies that correspond to different Δm values associated with different flutter mechanisms.

The variations of $\Delta m = \Delta P_f$ and $f = \omega_{co}$ with air velocity, corresponding to all the velocity point at which one or more phase-cross-over frequency points exist, are shown in Figure 34. Since the baseline NASTRAN model in this case is with the added moving mass of the shaker, control board and batteries, the corresponding flutter velocities are those at which a Δm branch crosses the zero line. These velocities, and the corresponding flutter frequencies are compared to the ZAERO results, demonstrating practically identical results.





The plots in Figures 34 also reveal the flutter sensitivity to variations in Δm . As with 0 to 350 grams addition the flutter velocity is increased up to 37 m/s (as the red markings indicate). The flutter velocities and frequencies expected, for example, for the nominal structure are those at which a Δm branch crosses the -0 line (as the purple markings indicate). The resulting flutter characteristics are V_f =26.29 m/s, ω_f =5.52 Hz for symmetric flutter mode and V_f =30.89 m/s, ω_f =4.20 Hz for the antisymmetric flutter mode. It is important to note that the used SISO-PFM method allows the removal of mass in one direction only (obviously, we removed the mass in the Z direction).

IDGAIN = 33
THERE ARE 2 FLUTTER POINTS
1 FINTED DOTNT
$\frac{1}{1} = \frac{1}{1} = \frac{1}$
DENSITY 1 225
ERECUENCY 5, 71814
THE FLUTTER MODE TS :
<1><-REAL-><-IMAG-><-REAL-><-IMAG-><-REAL-><-IMAG-><-REAL-><-IMAG-><-REAL-><-IMAG-><10>
21497089723023191-4.987-3027307-9.506-3.01010392.0585-3+
+4450616515 .0808608.0786693188125128301809303921 +
+ 10 7.7918-4-4.992-4-4.905-5-1.035-34.8853-35.0619-3+
+ 7.6951-54.4649-48.8593-33.4417-31.2762-31.7897-3-1.519-4-2.229-4+
+ -5.649-3-3.347-3-6.594-3-7.945-3-2.042-4-2.123-402021 -1.103-3+
+ -3.538-4-1.988-43.8149-32.9891-4-4.698-5-7.75-5 -1.114-4-1.044-5+
+ 1.4578-34.1634-4
2 FLUTTER POINT
VELOCITY 27.80094
DENSITY 1.225
FREQUENCY 4.335121
THE FLUTTER MODE IS :
<i><-KEAL-><-IMAG-><-KEAL-><-IMAG-><-KEAL-><-IMAG-><-KEAL-><-IMAG-><-IMAG-><iø></iø></i>
+ $.10403 - 8.491 - 31.$ $.0$ $.0340318 - 0.982 - 3 - 04813 .183402 + $
+ $-0.5/8 - 55.1521 - 501/58/ - 2.501 - 5028/555.2444 - 5 - 1.00 - 4 - 5.525 - 5 +$
+ $0112/32-1.435-5-2.700-51.7803-4.0252300-1.025-5-5.005-5-4.552-0+$ 06506550055-1.73601-2013000-00000000000000000000000000000
$\begin{array}{cccccccccccccccccccccccccccccccccccc$
$\begin{array}{cccccccccccccccccccccccccccccccccccc$

Figure 35: Case 2 Flutter velocity calculation using Dynresp

The Δm and frequency plots of case 2 are given in Figures 36. The location of the shaker and control board further towards the pod tip decreases the flutter velocity from 26.28 m/s and 30.91 m/s to 24.27 m/s and 27.80 m/s with the flutter frequency remaining the same. With 0 to 350 grams the flutter velocity is increased up to 32.5 m/s (as the red markings indicate).



Figure 36: Dynresp flutter V-Delta and V-f plots starting with case 2 mass configuration.

2 FLUTTER POINT
VELOCITY 34.12957
DENSITY 1.225
FREQUENCY 4.411695
THE FLUTTER MODE IS :
<1><-REAL-><-IMAG-><-REAL-><-IMAG-><-REAL-><-IMAG-><-REAL-><-IMAG-><-10>
-1.885 - 33.3696 - 30650868.9941 - 3.09239655.6619 - 3.0716905 - 7.87 - 4 +
+47187 -3.134-310 .0147747-1.774-342767 .140414 +
+ 2.0667-3-1.48-3028846-8.687-40408925.8123-3-3.155-71.2944-5+
+ .0151924-2.125-33.7211-3-3.15-4 .0308881-2.431-3-5.203-34.3063-4+
+ 4.2748-52.1028-64.1157-52.5372-50143955.9639-3-3.049-49.7667-5+
+ 4.9775-3-1.191-37.3106-68.9209-6-2.947-4-1.267-4-4.331-57.1419-4+
+ -3.426-59.7844-5
3 FLUTTER POINT
VELOCITY 34.41823
DENSITY 1.225
FREQUENCY 5.660467
THE FLUTTER MODE IS :
<1><-REAL-><-IMAG-><-REAL-><-IMAG-><-REAL-><-IMAG-><-REAL-><-IMAG-><-REAL-><-IMAG-><10>
.083231108253701157 9.8007-3.0109802010286.0255959022694+
+ .30124722523 .11474710935 10 .0119993-5.461-4+
+ .15496628846 5.329-4 3.7139-49.1071-41.6084-4-3.799-32.7491-3+
+ -3.106-4-8.98-5 6.4465-3-6.238-3-1.447-34.6832-41.797-4 -1.461-5+
+ 5.0009-3-4.446-3011449.01050341.1614-41.6139-4-2.606-37.3183-3+
+ -5.501-5-2.551-5-1.084-31.9009-31.307-5 9.2205-64.6388-5-5.695-5+
+ -5.762-46.7271-4

Figure 37: Case 3 Flutter velocity calculation using Dynresp

The Δm and frequency plots for case 3 are given in Figures 38. The displacement of the **batteries**, the shaker, and the control board further towards the pod tip increases the flutter velocity from 26.28 m/s and 30.91 m/s to 34.12 m/s and 34.41m/s with the flutter frequency remaining the same. With 0 to 350 grams the flutter velocity is increased to 38 m/s (as the red markings indicate).



Figure 38: Dynresp flutter V-Delta and V-f plots starting with case 3 mass configuration.

5. PRELIMINARY SHAKER SELECTION

The preliminary voice-coil shaker of Figure 39, which may be adequate for the frequency range of 5-15Hz with resulting force of ~2,5N, was selected by OSU based on our preliminary specifications. The overall height is ~2.75", and 1" in diameter: http://www.moticont.com/HVCM-025-038-003-02.htm. The moving mass is 98g, and the coil is 35g, for an all-up weight of 133g. The design currently has 1 accelerometer on the moving mass, and one on the boom attached to the wing.



Figure 39: Voice-coil shaker

A driver and closed-loop controller to provide excitation, resulting in the theoretical response curves for the moving mass at 12 Hz shown in Figure 40, was designed. By changing the position and frequency commands, a constant resultant force which is independent of excitation frequency (constant power spectra) can be designed. The housing was designed to support the shaker and allow us to reposition it along the chord of the wing. The assembly in the tip pod is depicted in Figure 41.



Figure 40: Acceleration and position response to 12 Hz excitation



Figure 41: Shaker location in the tip pod

6. CONCLUSIONS

- 1. An agile method for conceptual design and flutter analysis is presented and discussed. This method enables rapid design changes to be taken into consideration with ease.
- 2. The PFM method formulation was adapted to consider an experimental application using moving mass and voice-coils for online flutter reduction. The method results were also compared to the traditional ZAERO commercial software analysis.
- 3. Moving the batteries, the shaker, and the control board forward increases the symmetric and antisymmetric flutter velocities from 26.28 m/s and 30.91 m/s to 34.12 m/s and 34.41m/s with the flutter frequencies remain 4.4 and 5.7 Hz. respectively.

7. BIBLIOGRAPHY

- [1] F. Roizner and M. Karpel, "Parametric Flutter Margin Method for Aeroservoelastic Stability Analysis," *AIAA Journal*, vol. 56, no. 3, pp. 1011-1022, 2018.
- [2] F. Roizner and M. Karpel, "Sensitivity of Aeroservoelastic Stability Characteristics Using Parametric Flutter MArgins," *Journal of Aircraft*, vol. 56, no. 4, pp. 1387-1397, 2019.
- [3] F. Roizner, D. E. Raveh and M. Karpel, "Safe Flutter Tests Using Parametric Flutter Marhins," *Journal of Aircraft*, vol. 56, no. 1, 2019.
- [4] P. C. Chen, "Damping perturbation method for flutter solution : The g-method," *AIAA Journal*, vol. 38, no. 9, pp. 1519-1524, 2000.
- [5] M. W. Kehoe, "A Historical Overview of Flight Flutter Testing," NASA, 1995.
- [6] N. H. Zimmerman and J. T. Weissenburger, "Prediction of Flutter Onset Speed Based on Flight Testing at Subcritical Speeds," *Journal of Aircraft*, vol. 1, no. 4, pp. 190-202, 1964.
- [7] Y. Matsuzaki and Y. Ando, "Estimation of Flutter Boundary from Random Re-sponses due to Turbulence at Subcritical Speeds," *Journal of Aircraft*, vol. 19, no. 10, p. 862–868, 1981.
- [8] H. Torii and Y. Matsuzaki, "Flutter Margin Evaluation for Discrete-Time System," *Journal of Aircraft*, vol. 38, no. 1, pp. 42-47, 2001.
- [9] G. Dimitriadis and J. E. Cooper, "Flutter Prediction from Flight Flutter Test Data," *Journal of Aircraft*, vol. 38, no. 2, p. 55–367, 2001.
- [10] M. Argaman and D. E. Raveh, "Multioutput Autoregressive Aeroelastic System Identification and Flutter Prediction," *Journal of Aircraft*, vol. 56, no. 1, pp. 30-42, 2019.
- [11] T. Nahom Jidovetski, D. E. Raveh and M. Iovnovich, "Wind-Tunnel Study of the Autoregressive Moving-Average Flutter Prediction Method," *Journal of Aircraft*, vol. 56, no. 4, 2019.
- [12] M. Iovnovich, T. Nahom, M. Presman, T. Avsaid and D. E. Raveh, "As- sessment of Advanced Flutter Flight-Test Techniques and Flutter Boundary Prediction Methods," *Journal of Aircraft*, vol. 55, no. 5, p. 1877–1889, 2018.
- [13] T. Joels, A. Mayer, L. Edry-Azulay and D. E. Raveh, "Design, Analysis, and Testing of the Active Aeroelastic Aircraft Testbed (A3TB) Platform," in *AIAA SciTech Forum*, 2021.
- [14] P. C. Chen, "Damping Perturbation Method for Flutter Solution: The g-method," AIAA Journal, vol. 38, no. 9, pp. 1519-1524, 2000.

8. APPENDIX

File repository

The file repository for the project can be found and <u>downloaded</u> on the following link:

https://1drv.ms/u/s!AgC19zrr4eAqpMsnOaya1PsXHcHZQA?e=Kbdi3Y

Repository structure

- 1. Dynresp Files for the Dynresp Flutter analysis
- a. Case 1
- i. MATR Aerodynamic matrices from ZAERO needed for the Dynresp analysis
- ii. aerocards.dat Aerodynamic matrices location redirect file
- iii. Assure_FullSpan_Gen2_Dynresp_case1_v2.inp Dynresp analysis input file
- iv. Assure_FullSpan_Gen2_Dynresp_case1_v2.out analysis out file and result summery
- v. Assure_FullSpan_Gen2_Dynresp_case1_v2.f58 Frequency-domain structural, aerodynamic and control outputs $\{y_v(i\omega)\}$ of the main linear block, including nonlinear effects when applicable.
- vi. Assure_FullSpan_Gen2_Dynresp_case1_v2.f118 Output associated with stability analysis
- vii. pro-assureguy_fullplane2_v35-005.f06 NASTRAN structural f06 file needed for the analysis
- viii. struct.dat Aerodynamic matrices location redirect file
 - b. Case 2
 - i. MATR Aerodynamic matrices from ZAERO needed for the Dynresp analysis
 - ii. aerocards.dat Aerodynamic matrices location redirect file
- iii. Assure_FullSpan_Gen2_Dynresp_case2_v2.inp Dynresp analysis input file
- iv. Assure_FullSpan_Gen2_Dynresp_case2_v2.out analysis out file and result summery
- v. Assure_FullSpan_Gen2_Dynresp_case2_v2.f58 Frequency-domain structural, aerodynamic and control outputs $\{y_v(i\omega)\}$ of the main linear block, including nonlinear effects when applicable.
- vi. Assure_FullSpan_Gen2_Dynresp_case2_v2.f118 Output associated with stability analysis
- vii. pro-assureguy_fullplane2_v37-003.f06 NASTRAN resulted structural modes f06 file needed for the analysis
- viii. struct.dat Aerodynamic matrices location redirect file
 - c. Case 3
 - i. MATR Aerodynamic matrices from ZAERO needed for the Dynresp analysis
 - ii. aerocards.dat Aerodynamic matrices location redirect file
- iii. Assure_FullSpan_Gen2_Dynresp_case3_v2.inp Dynresp analysis input file
- iv. Assure_FullSpan_Gen2_Dynresp_case3_v2.out analysis out file and result summery

- v. Assure_FullSpan_Gen2_Dynresp_case3_v2.f58 Frequency-domain structural, aerodynamic and control outputs $\{y_v(i\omega)\}$ of the main linear block, including nonlinear effects when applicable.
- vi. Assure_FullSpan_Gen2_Dynresp_case3_v2.f118 Output associated with stability analysis
- vii. pro-assureguy_fullplane2_v37-002.f06 NASTRAN structural f06 file needed for the analysis
- viii. struct.dat Aerodynamic matrices location redirect file
 - 2. Matlab Files for the Dynresp results analysis in Matlab
 - a. Assure_FullSpan_Gen2_Dynresp_case1_v2.out out file from Dynresp case 1 run
 - b. Assure_FullSpan_Gen2_Dynresp_case1_v2_1.f58 F58 file from Dynresp case 1 run
 - c. Assure_FullSpan_Gen2_Dynresp_case2_v2_1.f58 F58 file from Dynresp case 2 run
 - d. Assure_FullSpan_Gen2_Dynresp_case3_v2_1.f58 F58 file from Dynresp case 3 run
 - e. Documentation.docx Matlab code documentation.
 - f. dynresp_f58analysis_main.m Main file for the Matlab analysis
 - g. dynresp_output_read.m Matlab secondary function
 - h. dynresp_output_read_f58.m Matlab secondary function
 - i. plot_comparison.m Matlab secondary function
 - j. plot_f58_results.m Matlab secondary function
 - 3. NASTRAN FEMAP Files for the normal modes analysis in NASTRAN using FEMAP
 - a. Case 1
 - i. PRO-AssureGuy_FullPlane2_V35-005.dat NASTRAN normal modes analysis input file
 - ii. pro-assureguy_fullplane2_v35-005.f04 NATRAN module execution log
 - iii. pro-assureguy_fullplane2_v35-005.f06 NASTRAN resulted structural modes f06
 - iv. pro-assureguy_fullplane2_v35-005.log NASTRAN log
 - v. pro-assureguy_fullplane2_v35-005.mon1 NASTRAN temp
- vi. pro-assureguy_fullplane2_v35-005.mon2 NASTRAN temp
- vii. pro-assureguy_fullplane2_v35-005.op2 NASTRAN temp
- b. Case 2
- i. PRO-AssureGuy_FullPlane2_V37-003.dat NASTRAN normal modes analysis input file
- ii. pro-assureguy_fullplane2_v37-003.f04 NATRAN module execution log
- iii. pro-assureguy_fullplane2_v37-003.f06 NASTRAN resulted structural modes f06
- iv. pro-assureguy_fullplane2_v37-003.log NASTRAN log
- v. pro-assureguy_fullplane2_v37-003.mon1 NASTRAN temp
- vi. pro-assureguy_fullplane2_v37-003.mon2 NASTRAN temp
- vii. pro-assureguy_fullplane2_v37-003.op2 NASTRAN temp
- c. Case 3
- i. PRO-AssureGuy_FullPlane2_V37-002.dat NASTRAN normal modes analysis input file
- ii. pro-assureguy_fullplane2_v37-002.f04 NATRAN module execution log
- iii. pro-assureguy_fullplane2_v37-002.f06 NASTRAN resulted structural modes f06
- iv. pro-assureguy_fullplane2_v37-002.log NASTRAN log
- v. pro-assureguy_fullplane2_v37-002.mon1 NASTRAN temp
- vi. pro-assureguy_fullplane2_v37-002.mon2 NASTRAN temp
- vii. pro-assureguy_fullplane2_v37-002.op2 NASTRAN temp
- d. PRO-AssureGuy_FullPlane2_V37.modfem The latest version of the FEA model in FEMAP
- 4. ZAERO Files for the ZAERO Flutter analysis
- a. Case 1
- i. MATR Aerodynamic matrices output needed for the Dynresp analysis later
- ii. Assure_FullSpan_Gen2_SurfNpod_V5.inp ZAERO flutter analysis input file

- iii. Assure_FullSpan_Gen2_SurfNpod_V5.log ZAERO flutter analysis log file
- iv. Assure_FullSpan_Gen2_SurfNpod_V5.out ZAERO flutter analysis output file
- v. FLUT1MOFT.NEU Flutter mode number 1 plot file for FEMAP
- vi. FLUT2MOFT.NEU Flutter mode number 2 plot file for FEMAP
- vii. FLUT3MOFT.NEU Flutter mode number 3 plot file for FEMAP
- viii. FLUT4MOFT.NEU Flutter mode number 4 plot file for FEMAP
- ix. FLUT5MOFT.NEU Flutter mode number 5 plot file for FEMAP
- x. FLUT6MOFT.NEU Flutter mode number 6 plot file for FEMAP
- xi. FLUT7MOFT.NEU Flutter mode number 7 plot file for FEMAP
- xii. FLUT8MOFT.NEU Flutter mode number 8 plot file for FEMAP
- xiii. FLUT9MOFT.NEU Flutter mode number 9 plot file for FEMAP
- xiv. FLUT10MOFT.NEU Flutter mode number 10 plot file for FEMAP
- xv. FLUT11MOFT.NEU Flutter mode number 11 plot file for FEMAP
- xvi. FLUT12MOFT.NEU Flutter mode number 12 plot file for FEMAP
- xvii. pro-assureguy_fullplane2_v35-005.f06 NASTRAN structural f06 file needed for the analysis
- xviii. VG_CLMP.PLT V-g plot data for VGPlot.exe
 - b. Case 2
 - i. MATR Aerodynamic matrices output needed for the Dynresp analysis later
 - ii. Assure_FullSpan_Gen2_SurfNpod_V5_case2.inp ZAERO flutter analysis input file
 - iii. Assure_FullSpan_Gen2_SurfNpod_V5_case2.log ZAERO flutter analysis log file
 - iv. Assure_FullSpan_Gen2_SurfNpod_V5_case2.out ZAERO flutter analysis output file
 - v. FLUT1MOFT.NEU Flutter mode number 1 plot file for FEMAP
 - vi. FLUT2MOFT.NEU Flutter mode number 2 plot file for FEMAP
 - vii. FLUT3MOFT.NEU Flutter mode number 3 plot file for FEMAP
 - viii. FLUT4MOFT.NEU Flutter mode number 4 plot file for FEMAP
 - ix. FLUT5MOFT.NEU Flutter mode number 5 plot file for FEMAP
 - x. FLUT6MOFT.NEU Flutter mode number 6 plot file for FEMAP
 - xi. FLUT7MOFT.NEU Flutter mode number 7 plot file for FEMAP
 - xii. FLUT8MOFT.NEU Flutter mode number 8 plot file for FEMAP
 - xiii. FLUT9MOFT.NEU Flutter mode number 9 plot file for FEMAP
 - xiv. pro-assureguy_fullplane2_v37-003.f06 NASTRAN structural f06 file needed for the analysis
 - xv. VG_CLMP.PLT V-g plot data for VGPlot.exe
 - c. Case 3
 - i. MATR Aerodynamic matrices output needed for the Dynresp analysis later
 - ii. Assure_FullSpan_Gen2_SurfNpod_V5_case3.inp ZAERO flutter analysis input file
 - iii. Assure_FullSpan_Gen2_SurfNpod_V5_case3.log ZAERO flutter analysis log file
 - iv. Assure_FullSpan_Gen2_SurfNpod_V5_case3.out ZAERO flutter analysis output file
 - v. FLUT1MOFT.NEU Flutter mode number 1 plot file for FEMAP
 - vi. FLUT2MOFT.NEU Flutter mode number 2 plot file for FEMAP
 - vii. FLUT3MOFT.NEU Flutter mode number 3 plot file for FEMAP
 - viii. FLUT4MOFT.NEU Flutter mode number 4 plot file for FEMAP
 - ix. FLUT5MOFT.NEU Flutter mode number 5 plot file for FEMAP
 - x. FLUT6MOFT.NEU Flutter mode number 6 plot file for FEMAP
 - xi. FLUT7MOFT.NEU Flutter mode number 7 plot file for FEMAP
 - xii. FLUT8MOFT.NEU Flutter mode number 8 plot file for FEMAP
 - xiii. FLUT9MOFT.NEU Flutter mode number 9 plot file for FEMAP
 - xiv. FLUT10MOFT.NEU Flutter mode number 10 plot file for FEMAP

- xv. pro-assureguy_fullplane2_v37-002.f06 NASTRAN structural f06 file needed for the analysis
- xvi. VG_CLMP.PLT V-g plot data for VGPlot.exe
- d. VGPlot.exe ZAERO freeware for V-g plotting

Case 1 – ZAERO Code

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MEMORY 8192MB
CPU 16
ASSIGN FEM=pro-assureguy fullplane2 v35-005.f06,BOUNDARY=ASYM,FORM=MSC, PRINT=0
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        PRINT
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        SAVE
        AERCLP.0
        +MK1

        +MK1
        0.00
        0.02
        0.03
        0.04
        0.05
        0.06
        0.07
        0.1
        +MK2

        +MK2
        0.12
        0.125
        0.13
        0.14
        0.15
        0.2
        0.25
        0.28
        +MK3

        +MK3
        0.3
        0.4
        0.5
        0.6
        0.7
        0.8
        0.9
        1.0
        +MK4

        +MK4
        1.5
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        +W1L1
        -7.091-30.7043411.1909290.333908

        +W1L2
        -7.078-3-.3876191.2264910.333908

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CAERO7 557 LWING2 10
+W2L1 -7.078-3-.3876191.2264910.261137
+W2L2 -7.078-3-.9986391.2478280.261137
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+W1R2 -7.078-31.7963021.226491 .333908
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CAERO7 1557 RWING2 10 12 +W2R1
+W2R1 -7.078-31.7963021.2264910.261137 +W2R2
+W2R2 -7.078-32.4073161.2478280.261137
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CAERO7 1757 FLAP1 10 8 +W3R1
+W3R1 0.254015 1.796261.2310120.072771
+W3R2 0.254022.4072741.2523490.072771
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+F1L2 1.0078110.3109591.11267 0.137705
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CAERO7 2501 LTAIL F 5 10 +F2L1
+F2L1 1.1310250.697809 1.112670.054803 +F2L2
+F2L2 1.1455160.3109591.1126490.040094
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+	6	5128		6136		6152		6168	3	618	4	6200)	6216	5			
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SET1		6		2869		3209)	3226	5	322	7	3228	3	3229)	3230+		
+		3231		3234		3394		3444	1	345	3	3458	3	4329	,			
\$ Femap	Aero	Spl	ine	8 :	VTai	1_F												
\$ ¢					·													
2 6			sel	TOL	une .	ғтар	S											
\$1>		>	<3	(>	< 4	>	<5		>< 6		><	.7`	><8		><9	><	10	>
ý⊥ SFlap 1	. 2)								~	/ /				~	10	
SET1	600		1955	j	1980		2197		2195		217	5	2177		2157	+		
+	2155		2136	j	2134		2116	;	2114		209	96	2094		2011	+		
+	2009		1988	;	1986		1967		1963		193	35	1931		1861			
\$																		
\$ Flap 2	:																	
SET1	700		1536	į	1441		1442		1537		153	88	1465		1479	+		
+	1539		1540) I	1502		1541		1503		154	12	1513		1543	+		
+	1514		1544		1212		1545		1516		154	6	151/		1109			
\$																		\$
\$																		\$
\$					AS	ECON	IT De	fini	ltion									Ş
\$																		\$
\$				·														\$
CORD2R	401				0.61	86	0.39	4	0.0		1.0	816	1.52	4	0.0		+CR1	1
+CR11	1.081	L6	1.52	.4	0.5													
Ċ																		ć
\$ ¢						 ~f~~												\$
ч \$					5u:	тт ц 	ue1	. ± 119										ς 2
S-ACTU->)>	< A	0>	<	1>	<a< td=""><td>2></td><td>></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Ŷ</td></a<>	2>	>									Ŷ
ACTU	601		2.15	1E+6	4.77	- 2E+4	586	.8										
ACTU	602		2.15	1E+6	4.77	2E+4	586	.8										
ACTU	603		2.15	1E+6	4.77	2E+4	586	.8										
ACTU	604		2.15	1E+6	4.77	2E+4	586	.8										
ACTU	605		2.15	1E+6	4.77	2E+4	586	.8										
Ş										- -		0						
SAESURFZ		≤ц-> 	<'I'YP	'ビーー> ″	<-CI	∪> 1	-SE	:TK−>	><-SE	TG-	><-₽	ACTID-	->					
ALOUKFZ	VIATI	∟_Ľ`	лэĭМ	1	-40	1	55	1 L	ю		6	υUT						

 AESURFZ
 RTAIL
 F
 ASYM
 -401
 351
 7
 602

 AESURFZ
 LTAIL
 F
 ASYM
 -401
 451
 8
 603

 AESURFZ
 FLAP1
 ASYM
 -401
 103
 600
 604

 AESURFZ
 FLAP2
 ASYM
 -401
 203
 700
 605
 SURFSET 350 VTAIL F RTAIL F LTAIL F FLAP1 FLAP2 \$_____\$ Ś * BODY Elements * Ś \$_____\$ Ś \$ FUSELAGE SPLINE (BEAM SPLINE) $\$\dots1\dots|\dots2\dots|\dots3\dots|\dots4\dots|\dots5\dots|\dots6\dots|\dots7\dots|\dots8\dots|\dots9\dots|\dots10\dots|$ SPLINE2 101010SET1102688343714709 704 699 694 2494 PANLST2 10 10001 10001 THRU 10030 \$ Right AIM9-P MISSILE (BEAM SPLINE) \$...1.|..2...|..3...|..4...|...5...|...6...|...7...|...8...|...9...|...10..|
 SPLINE2
 70
 50

 SET1
 50
 858
 1166
 1173
 1179
 1187
 1196
 1226
 1341

 PANLST2
 70
 40001
 40001
 THRU
 40088
 Ś \$ Left AIM9-P MISSILE (BEAM SPLINE) \$...1..|..2...|..3...|..4...|..5...|..6...|..7...|..8...|..9...|..10..|
 SPLINE2
 71
 51

 SET1
 51
 1343
 1547
 1602
 1669
 1723
 1751
 2354
 2465

 PANLST2
 71
 41001
 41001
 THRU
 41088
 2465
 \$ \$ FUSELAGE \$...1..|...2...|...3...|...4...|...5...|...6...|...7...|...8...|...9...|...10..| BODY7 10001FUSELAGE 10 1 10001 $\$\dots1\dots|\dots2\dots|\dots3\dots|\dots4\dots|\dots5\dots|\dots6\dots|\dots7\dots|\dots8\dots|\dots9\dots|\dots10\dots|$ SEGMESH 10001 7 6 +SEG10 $\begin{array}{c} 3-0.17190\\ 3-0.14592\\ 30.0\\ 30.343016\\ 30.570651\\ 30.955669\\ 31.328021 \end{array}$ 99 +SEG10 98 +SEG11 +SEG11 101 102 +SEG12 +SEG12 103 105 103 104 +SEG13 +SEG14 +SEG13 106 107108109110111112 +SEG14 +SEG15 +SEG15 +SEG16 +SEG16 +SEG17 +SEG18 Ś
 \$+SEG17
 30.954842

 \$+SEG18
 31.074291

 \$+SEG19
 31.301778
 114 113 115 116 117 118 +SEG19 117

 \$...1.|...2...|...3...|...4...|...5...|...6...|...7...|...8...|...9...|...10..|

 AEFACT
 98
 0.0
 0.0
 0.0
 0.0

 AEFACT
 98
 0.0
 0.0
 0.0
 0.0

 AEFACT
 990.0203320.0203320.0203320.0203320.0203320.0203320
 0.0
 0.0

 990.0203320.0203320.0203320.0203320.0203320.02033

 1010.0
 0.05
 0.069
 -0.07
 -0.054
 0.0

 102-0.07
 -0.053
 0.06
 0.06
 -0.073
 -0.07

 1030.0
 0.0762
 0.0762
 -0.0762
 -0.0762
 0.0

 104-0.061
 -0.061
 0.0762
 0.0762
 -0.061
 -0.061

 1050.0
 0.069
 0.072
 -0.072
 -0.069
 0.0

 106-0.054
 -0.054
 0.109
 0.109
 -0.054
 -0.054

 107-0.0
 0.069
 0.069
 -0.068
 -0.069
 -0.0

 108-0.054
 -0.054
 0.076
 0.076
 -0.054
 -0.054

 1090.0
 0.038
 0.038
 -0.037
 0.0
 110-0.043
 -0.043
 0.065
 0.065
 -0.043

 110.013
 0.013
 0.013
 0.013
 0.013
 0.013
 1.003

 1120.003
 0.003
 0.003
 0.003
 0.003
 0.003
 0.003
 AEFACT \$ Tip Shaker Pod R \$...1.|...2...|...3...|...4...|...5...|...6...|...7...|...8...|...9...|...10..| ACOORD 40 -0.210742.4399491.261518 0.0 0.0 0.0 \$...1..|..2...|..3...|..4...|..5...|..6...|..7...|..8...|..9...|..10..| BODY7 40001TipPodR 13 40 1 40001 \$...1.|...2...|...3...|...4...|...5...|...6...|...7...|...8...|...9...|...10..| PBODY7 13 1 -0.2 \$...1..|...2...|...3...|...4...|...5...|...6...|...7...|...8...|...9...|...10..|

 SEGMESH
 40001
 12
 9

 +SEG11
 1
 0.00232
 0.0
 0.0

 +SEG12
 1
 0.05206
 0.0
 0.01550

 +SEG13
 1
 0.10041
 0.0
 0.03175

 +SEG14
 1
 0.24756
 0.0
 0.03175

 +SEG11 +SEG12+SEG13+SEG14 +SEG15 +SEG15 1 0.25214 0.0 0.03175 +SEG16

+SEG16 +SEG17 +SEG18 +SEG19 +SEG20 +SEG21 +SEG22 \$ Tip SP	naker Po	1 0.3211 1 0.3946 1 0.4682 1 0.5173 1 0.5663 1 0.6398 1 0.7135 d L	2 0. 9 0. 7 0. 1 0. 6 0. 6 0. 1 0.	0 0.0317 0 0.0317 0 0.0317 0 0.0317 0 0.0317 0 0.0155 0 0.	5 5 5 5 5 5 0 0				+SEG17 +SEG18 +SEG19 +SEG20 +SEG21 +SEG22
ACOORD	41	-0.2115	-1.0316	41.26151	8 0.	0 0.	0 0.	0	10
\$1 BODY7	4100	3 1TipPodL	1 4	5 4 4	6 1	7 1 4100	8 1	9	10
\$1 PBODY7	1 2	3 4	1 -0.	5 2	6	7	8	9	10
\$1 SEGMESH +SEG11 +SEG12 +SEG13 +SEG14 +SEG15 +SEG16 +SEG17 +SEG18 +SEG19 +SEG20 +SEG21 +SEG22	124100	13 11 10.00156 10.05066 10.12414 10.17319 10.27126 10.32026 10.39386 10.46746 10.59006 10.63906 10.71266	1 2 8 0. 8 0. 8 0. 8 0. 8 0. 8 0. 8 0. 8 0. 8 0. 8 0. 8 0. 8 0. 8 0. 8 0. 8 0. 8 0. 8 0. 8 0. 8 0. 8 0. 8 0. 8 0. 8 0.	9 0 0. 0 0.0155 0 0.0317 0 0.0317 0 0.0317 0 0.0317 0 0.0317 0 0.0317 0 0.0317 0 0.0317 0 0.0317	6 0 5 5 5 5 5 5 5 5 5 5 5 5 5 0 0	7	8	9	10 +SEG11 +SEG12 +SEG13 +SEG14 +SEG15 +SEG16 +SEG17 +SEG19 +SEG20 +SEG21 +SEG22
\$ \$			 דנוד *	TER ANAL	 YSTS *				\$ \$
\$									\$
ې \$	SETID	SYM	FIX	NMODE	TABDMP	MLIST	CONMLST	NKSTEP	₽
FLUTTER \$	100	ASYM	100	25	20			30	
\$ TABDMP1	2.0								+
+	0.00	0.00	0.99	0.00	1.00	0.02	100.0	0.02	< 10 >
FIXMDEN	100	100	1.225	KG	M	1.0	0	1	+
+ +	5.0 13.0	6.0 14.0	15.0	8.0 16.0	9.0 17.0	10.0 18.0	11.0 19.0	12.0 20.0	+ +
+	21.0	21.5	22.0	22.5	23.0	23.5	24.0	24.5	+
+ +	25.0	26.5 34 0	27.0 35.0	28.0 36.0	29.0 37 0	30.0 38 0	31.0 39.0	32.0	+
+	41.0	42.0	43.0	44.0	45.0	46.0	47.0	48.0	+
+	49.0	50.0	52.0	54.0	56.0	58.0	60.0	64.0	+
+ \$	00.0	12.0	/0.0	00.0					
\$ PLTVG \$	TO PLOT	FREQUEN	CY & DAM	PING V.S	. VELOCI	ТҮ			\$ \$
\$1>	><2	><3	><4	><5	><6	><7	><8	><9>	¢
9 PLTVG	11	100	25	V	r onth	VG_CLMP	.PLT		Ŷ
PLTFLUT PLTFLUT DI TEI IIT	10 20 30	100 100	1 2 3	10 10 10	20.0	- FEMAP FEMAP	FLUT1M FLUT2M FLUT3M	OFT.NEU OFT.NEU	
PLTFLUT	40	100	4	10	20.0	FEMAP	FLUT4M	OFT.NEU	
PLTFLUT	50	100	5	10	20.0	FEMAP	FLUT5M	OFT.NEU	
PLTFLUT	60 70	100	6 7	10	20.0	FEMAP FEMAP	FLUT6M FLUT7M	OFT.NEU	
PLTFLUT	80	100	8	10	20.0	FEMAP	FLUT8M	OFT.NEU	
PLTFLUT	90	100	9	10	20.0	FEMAP	FLUT9M	OFT.NEU	
PLIFLUI PLTFLUT	110	100	11	10	20.0	FEMAP	FLUT11	MOFI.NEU MOFT.NEU	
PLTFLUT	120	100	12	10	20.0	FEMAP	FLUT12	MOFT.NEU	
<pre>> OUTPUT4 OUTPUT4</pre>	SMHH SKHH QHHS010 QHHS010 QHHS010 QHHS010 QHHS010 QHHS010 OHHS010	MATR/SM MATR/SK 1MATR/QH 2MATR/QH 3MATR/QH 5MATR/QH 6MATR/QH 8MATR/QH 8MATR/QH	HH.DAT HH.DAT H01.DAT H02.DAT H03.DAT H04.DAT H05.DAT H05.DAT H07.DAT						
OUTPUT4	QHHS010	9MATR/QH	H09.DAT						

OUTPUT4 QHHS0110MATR/QHH10.DAT OUTPUT4 QHHS0111MATR/QHH11.DAT OUTPUT4 QHHS0112MATR/QHH12.DAT OUTPUT4 QHHSO112MATR/QHH13.DAT OUTPUT4 QHHSO113MATR/QHH13.DAT OUTPUT4 QHHSO114MATR/QHH14.DAT OUTPUT4 QHHSO115MATR/QHH15.DAT OUTPUT4 QHHSO116MATR/QHH16.DAT OUTPUT4 QHHS0117MATR/QHH17.DAT OUTPUT4 QHHS0118MATR/QHH18.DAT OUTPUT4 QHHS0119MATR/QHH19.DAT OUTPUT4 QHHS0120MATR/QHH20.DAT OUTPUT4 QHHS0121MATR/QHH21.DAT OUTPUT4 QHHS0122MATR/QHH22.DAT OUTPUT4 QHHS0123MATR/QHH23.DAT OUTPUT4 QHHS0124MATR/QHH24.DAT OUTPUT4 QHHS0125MATR/QHH25.DAT OUTPUT4 QHHS0126MATR/QHH26.DAT OUTPUT4 QHHS0127MATR/QHH27.DAT OUTPUT4 QHHS0128MATR/QHH28.DAT OUTPUT4 QHHS0129MATR/QHH29.DAT OUTPUT4 QHHS0130MATR/QHH30.DAT \$ Ś

ENDDATA

```
Case 2 – ZAERO Code
MEMORY 8192MB
CPU 16
ASSIGN FEM=pro-assureguy_fullplane2 v37-000.f06,BOUNDARY=ASYM,FORM=MSC, PRINT=0
CEND
Ś
TITLE = OSU ASSURE
ECHO = SORT
SUBCASE = 1
           SUBTITLE= FLUTTER ANALYSIS, M=0.0, SEA LEVEL
           FLUTTER=100
BEGIN BULK
Ś
$_____$
$
                                                                                                    Ś
$
                         * AERO PARAMETERS / FEM MODEL UNITS *
                                                                                                    $
Ś
                                                                                                    Ś
$_____$
                                                                                                    Ś
$--1---><--2---><--3---><--4---><--5---><--6---><--7---><--8---><--9---><--10-->
         ACSID XZSYM FLIP FMMUNIT FMLUNIT REFC REFB REFS $
NO NO KG M 0.333 3.33 1.07 +AE1
$
AEROZ NO NO
+AE1 0.444 0.0 0.076
AEROZ
Ś
                                                                                                    Ś
Ś
                          AERODYNAMIC AIC MATRIX GENERATION
                                                                                                    Ś
Ś
                                                                                                   Ś
                                   * * * MACH = 0.0 * * *
Ś
                                                                                                   Ś
$
                                                                                                   Ś

        $
        IDMK
        MACH
        METHOD
        IDFLT
        SAVE
        <--FILENAME-->
        PRINT
        $

        $
        IDMK
        0.00
        0
        0
        SAVE
        AERCLP.0
        +N

        +MK1
        0.00
        0.02
        0.03
        0.04
        0.05
        0.06
        0.07
        0.1
        +N

        +MK2
        0.12
        0.125
        0.13
        0.14
        0.15
        0.2
        0.25
        0.28
        +N

        +MK3
        0.3
        0.4
        0.5
        0.6
        0.7
        0.8
        0.9
        1.0
        +N

        +MK4
        1.5
        2.5
        3.0
        4.0
        5.0
        10.0
        10.0

                                                                                                  +MK1
+MK2
+MK3
                                                                                                  +MK4
Ś
Ś
$--1---><--2---><--3---><--4---><--5---><--6---><--7---><--8---><--9---><--10-->
CAERO7 1
                   LWING1
                                           25
                                                      2.0
                                                                                                   +W1T.1

        +W1L1
        -7.091-30.7043411.1909290.333908

        +W1L2
        -7.078-3-.3876191.2264910.333908

                                                                                                   +W1L2
$--1--><--2---><--3---><--4---><--5---><--6---><--7---><--8---><--9---><--10-->
CAERO7 757 FLAP2
                                     10
                                                       8
                                                                                                   +W3L1
+W3L1 0.254015-0.387571.2310120.072771
+W3L2 0.25402-0.998581.2523490.072771
                                                                                                    +W31.2
$--1--><--2--><--3---><--5---><--6---><--7--><--8---><--9---><--10-->
CAERO7 1001 RWING1 25
                                                     20
                                                                                                   +W1R1
+W1R1 -7.091-3 .7043411.190929 .333908
+W1R2 -7.078-31.7963021.226491 .333908
                                                                                                    +W1R2
$--1---><--2---><--3---><--5---><--6---><--7---><--8---><--9---><--10-->
CAERO7 1557 RWING2 10 12 +W2R1
+W2R1 -7.078-31.7963021.2264910.261137 +W2R2
+W2R2 -7.078-32.4073161.2478280.261137
$--1---><--2---><--3---><--5---><--6---><--7---><--8---><--9---><--10-->
CAERO7 1757 FLAP1 10 8 +W3R1
+W3R1 0.254015 1.796261.2310120.072771
+W3R2 0.254022.4072741.2523490.072771
                                                                                                    +W3R2
$--1---><--2---><--3---><--4---><--5---><--6---><--7---><--8---><--9---><--10-->
CAERO7 2001 LTAIL
                                          10
                                                      10
                                                                                                    +F11.1
+F1L1 0.9421670.6809521.11267 0.189609
+F1L2 1.0078110.3109591.11267 0.137705
                                                                                                    +F11.2
$--1--><--2--><--3--><--4--><--5--><--6--><--7--><--8---><--9--><--10-->
CAERO7 2501 LTAIL F 5 10 +F2L1
+F2L1 1.1310250.697809 1.112670.054803 +F2L2
+F2L2 1.1455160.3109591.1126490.040094
$--1--><--2--><--3---><--5---><--6---><--7--><--8---><--9---><--10-->
CAERO7 3001 RTAIL 10 10
+F1R1 0.9421670.7273921.11267 0.189609
                                                                                                   +F1R1
                                                                                                    +F1R2
+F1R2 1.0078111.0973861.11267 0.137705
$--1--><--2--><--3---><--5---><--6---><--7--><--8---><--9---><--10-->
```

	3501 1.131025	RTAIL_ 50.7105	F 361.11	267	5 0.0548(10)3						+F2R +F2R
+F2R2	1.145516	51.0973	861.11	269	0.04009	94						
\$1	><2>	><3	-><4	>	><5	-><6	ő>	<7-	><-	8>	<9>	<1
CAERO /	4001	verial	101 10	C 0 F F	1U 70 2000/	10						+ F Z U.
+₽2112	1 <u>Ngapar</u>	20./U51 20.7021	191.12 231 /0	6321	0.30882 10 07570	<u>:</u> / 18						τr'ZU2
\$1	><2>	><3	-><40	>	><5	-><(ñ>	<7-	><-	8>	·<9>·	<1(
CAERO7	4501	VerTai	12		5	10				- ·		+F3U1
+F3U1	1.189841	10.7021	591.12	6957	0.05185	52						+F3U2
+F3U2	1.165003	30.7023	971.40	6357	70.05185	52						
\$ \$		SPLIN	E & PA	 NLST		2 + WI	ING					
\$ \$	 EID	MODEL	CP		SETK	 SET(3	 DZ				
\$ Femap	Aero Spl	line 2	: LWin	g								
SPLINE1	11	LWing1			201	2		0.0				
PANLST1	201	1	1		456							
SPLINE1	111	LWing2			202	2		0.0				
PANLST1	202	557	557		655							
SPLINE1	1111	FLAP2			203	./00		0.0				
\$	203	/5/	/5/		819							
\$ Femap	Aero Spl	Line 1	: Rwin	g	101	1		0 0				
DANI OT	⊥∠ 101	r.w⊥ng⊥ 1001	1001		1456	T		0.0				
SPLINE1	122	Rwina?	TOOT		102	1		0.0				
PANLST1	102	1557	1557		1655	-						
SPLINE1	1222	FLAP1	100/		103	600		0.0				
PANLST1	103	1757	1757		1819							
\$												
\$ Femap	Aero Spl	Line 3	: RTai	1								
SPLINE1	13	RTail			301	4		0.0				
PANLSTI	301	3001	3001		3081 251	~		0 0				
DANI CTT	14 251	81a11_ 3501	1 2501		3536	/		0.0				
Ś	201	3301	2001		5550							
; \$ Femap	Aero Spl	line 4	: LTai	1								
SPLINE1	15	LTail			401	5		0.0				
PANLST1	401	2001	2001		2081							
SPLINE1	16	LTail_	F		451	8		0.0				
PANLST1	451	2501	2501		2536							
s Feman	Aero Spl	line 5	• VTai	1								
SPLINE1	17	VTail	• • • • • • •	-	501	3		0.0				
PANLST1	501	4001	4001		4081	-						
ODT T1	18	VTail	F		551	6		0.0				
SPLINE1		4501	4501		4536							
SPLINE1 PANLST1	551											
SPLINE1 PANLST1 \$ \$	551											
SPLINE1 PANLST1 \$ \$ \$	551				F		- 、	~ 7		0 \	< 0 >	~ 1.
SPLINE1 PANLST1 \$ \$ \$ \$1 \$	551 ><2>	><3	-><4	>	×<5	-><6	5> 	<7-	><-	8>	·<9>·	<1
SPLINE1 PANLST1 \$ \$ \$1 \$ \$	551 ><2>	><3 Set fo	-><4 r the 3	> Body	<5 7 & Wing	-><(5> 	<7- 	><-	8>	.<9>· 	<10
SPLINE1 PANLST1 \$ \$ \$ \$ \$ \$ SET1	551 ><2> 	><3 Set fo	-><4 r the 1 58	> Body 	<5 7 & Wing 2 95	-><() 3 39	5> 960	<7-	><- 979	8> 980	988	<1(+
SPLINE1 PANLST1 \$ \$ \$1 \$ \$ \$ \$ SET1 +	551 ><2> 	><3 Set fo L 8 5 9	-><4 r the 1 58 96	> Body 952 999	<pre>><5 7 & Wing 2 95 3 100 3 120</pre>	-><(3 59)0	5> 960 1170	<7- 	979 .177	8> 980 1183	<9> 988 1188	<1(+ +
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++	6429 6449	- 9 9	6432 6450	6434 6558	64 65	437 561	6441 6562		6443 6563	6	446 568	6447+ 6578+	
+	6617	7	8371	8388	84	448	8560		8594	8	701	8732+	
+ +	8782 8903	2 3	8785 8926	8793 8940	89	794 976	8845 9005		8859 9040	8 9	880 054	8894+ 9059+	
+	9102	2	9117										
S Femap SET1	Aero Spl	Line 5	3 : RT3 6074	all 6083	60	086	6089		6092	6	093	6096+	
+	6098	3	6101	6104	61	106	6108		6113	6	117	6120+	
+ +	6123	5 7	6126 6188	6131 6190	61	142 196	6145		6206	6	218	6161+	
+	6222	2	6787	6790	67	797	6809		6829	6	862	6882+	
+	6896 7146	5	0909	0900	03	908	6978		/059	/	064	/115+	
\$ Femap	Aero Spl	Line	4 : LTa	ail	21	114	21 5 2		2170	2	200	2201	
+	3209	3	2652 3217	2869 3220	31	114 225	3153 3227		31/8	3	200 396	3201+ 3418+	
+	3435	5	3452	3462	38	861	3884		4200	4	204	4212+	
+ +	4272 4722	2	4328 4778	4329 4863	4 : 4 8	394 888	4485 4919		4593	4	613 963	4680+ 5003+	
+	5105	5											
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SET1	C 4 4 5	7	6407	6439	64	440	6441		6442	6	443	6444+	
+ +	6445 6603	3	6446 8862	6447 8966	64 9(448 018	6449 9096		6450	6	451	6571+	
\$ Femap	Aero Spl	Line	6 : RTa	ail_F	<i>c</i> -					_		C A A A	
+	6120	3	6083 6121	6084 6122	61 61	115 123	6116 6124		6117	6 6	118	6119+ 6127+	
+	6128	3	6136	6152	61	168	6184		6200	6	216		
S Femap SET1	Aero Spl	Line 5	7 : LTa 2869	ail_F' 3209	32	226	3227		3228	3	229	3230+	
+	3231	L	3234	3394	34	444	3453		3458	4	329		
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\$ \$> \$ Flap 1 SET1 + \$ \$ Flap 2 SET1 + + \$ \$ Flap 2 SET1 + + \$ \$ Flap 2 SET1 + + \$ \$ Flap 2 SET1 + + \$ \$ Flap 1 \$ \$ Flap 2 \$ \$ Flap 2 \$ \$ SET1 + + \$ \$ SET1 + + \$ \$ SET1 + + \$ \$ SET1 + + \$ \$ SET1 + + \$ \$ SET1 + + \$ \$ SET1 + \$ \$ SET1 + \$ \$ SET1 \$ \$ SET1 \$ \$ SET1 \$ \$ SET1 \$ \$ SET1 \$ \$ SET1 \$ \$ SET1 \$ \$ SET1 \$ \$ SET1 \$ \$ SET1 \$ SE	<pre>><2> 600 2155 2009 2: 700 1539 1514 401 1.0816</pre>	Set 	for the >< 19% 211 19% 144 15% 15% 4 0.%	<pre>> Flap -4> 30 34 36 41 02 15 ASECON 6186 5 6187 5</pre>	s <5 2197 2116 1967 1442 1541 1545 T Defi 0.394 0.394	><- 21 21 19 15 15 15 15 	-6> 95 14 63 37 03 16 on 0	<7 2175 2096 1935 1538 1542 1546 1.08 1.08	> 16	< 2177 2094 1931 1465 1513 1517 1.524 	21 20 18 14 15 11 0.	9>< 57 + 11 + 861 179 + 643 + 69 0	
\$ \$> \$ Flap 1 SET1 + + \$ Flap 2 SET1 + + \$ \$ Flap 2 SET1 + + \$ \$ Flap 2 SET1 + + \$ \$ Flap 2 SET1 + \$ \$ Flap 3 \$ \$ Flap 4 \$ \$ Flap 4 \$ \$ Set 4 \$ S	<pre>><2> 600 2155 2009 2: 700 1539 1514 401 1.0816 ><id></id></pre>	Set 1955 2136 1988 1536 1540 1544 1.52 	for the >< 199 211 190 144 155 155 0.0 4 0.5 	<pre>e Flap -4> 30 34 36 41 02 15 6186 5 6186 5 6187 m</pre>	s <5 2197 2116 1967 1442 1541 1545 T Defi 0.394 0.394	><- 21 21 19 15 15 15 15 	-6> 95 14 63 37 03 16 0 0	7 2175 2096 1935 1538 1542 1546 1.08	> 16	<	><- 21 20 18 14 15 11 0.	9>< .57 + 111 + 361 .79 + .43 + .69 	\$ \$ \$ \$ \$ +CR11 \$ \$ \$
\$ \$ \$ Flap 1 SET1 + + \$ Flap 2 SET1 + + \$	401 1.0816 401 0.0516	Set 1955 2136 1988 1536 1540 1544 1.52 1.52 2.15 2.15	for the >< 199 211 199 144 156 155 4 0.5 0.0 4 0.5 1E+64.7 1E+64.7	<pre>e Flap -4> 30 34 36 41 02 15 6186 5 6186 5 6187 m ASECON 6186 5 6187 722+4 7722+4</pre>	s <5 2197 2116 1967 1442 1541 1545 0.394 0.394 	><- 21 21 19 15 15 15 0. 0. 0.	-6> 95 14 63 37 03 16 0 0	 <7 2175 2096 1935 1538 1542 1546 1.08	> 16 	<8- 2177 2094 1931 1465 1513 1517 1.524 	21 20 18 14 15 11 0.	9>< 57 + 11 + 861 479 + 69 .0	
\$ \$1> \$ Flap 1 SET1 + + \$ Flap 2 SET1 + + \$ \$ Set1 - \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$	<pre> <2> 600 2155 2009 2: 700 1539 1514</pre>	Set 2136 1955 2136 1540 1544 1.52 1.52 2.15 2.15 2.15	for the >< 199 211 199 144 156 157 4 0.9 4 0.9 15+64.7 15+64.7	<pre>e Flap -4> 80 34 86 41 02 15 ASECON 6186 5 6186 5 6187 7 7 2 2 4 7 7 2 2 4 7 7 2 2 4 7 7 2 2 4 7 7 2 2 4 7 7 2 2 4 7 7 2 2 4 7 7 2 2 4 7 7 2 2 4 7 7 2 2 4 7 7 2 2 4 7 7 2 2 4 7 7 2 2 4 7 7 2 7 2</pre>	s <5 21197 2116 1967 1442 1541 1545 T Defi 0.394 0.394 0.394 	 21 21 19 15 15 15 15 0. 0. 0.	-6> 95 14 63 37 03 16 on 0	7 2175 2096 1935 1538 1542 1546 1.08	> 16	< 2177 2094 1931 1465 1513 1517 1.524 	21 20 18 14 15 11 0.	9>< 57 + 11 + 361 479 + 543 + 69 .0	
\$ \$> \$ Flap 1 SET1 + \$ Flap 2 SET1 + \$ Set1 \$ Set1 \$ Set	<pre></pre>	Set 1955 2136 1988 1536 1540 1544 1.52 1.52 2.15 2.15 2.15 2.15	for the 	<pre>e Flap -4> 30 34 36 41 02 15 6186 5 6186 5 6186 5 6187 m 772E+4 772E+4 772E+4 772E+4 772E+4 772E+4</pre>	s <5 2197 2116 1967 1442 1541 1545 T Defi 0.394 0.394 0.394 586.8 586.8 586.8	 21 21 19 15 15 15 15 0. 0. 0.	-6> 95 14 63 37 03 16 0	7 2175 2096 1935 1538 1542 1546 1.08	> 16	< 2177 2094 1931 1465 1513 1517 1.524 	><- 21 20 18 14 15 11 0.	9>< 57 + 11 + 361 179 + 543 + 69 0	
\$ \$> \$ Flap 1 SET1 + + \$ Flap 2 SET1 + + \$ Flap 2 SET1 + + \$	<pre>><2> 1 : 600 2155 2009 2 : 700 1539 1514 401 1.0816> 601 602 603 604 605</pre>	Set 1955 2136 1988 1536 1540 1544 1.52 1.52 2.155 2.155 2.155 2.155	for the >< 199 211 199 144 150 151 4 0.0 4 0.1 4 0.1 2 5 2 4 0.1 4 5 2 4 0.1 4 15 15 	<pre>e Flap -4> 30 34 36 41 02 15 ASECON 6186 5 6186 5 6187 m AI> 772E+4 772E+4 772E+4</pre>	s <5 2197 2116 1967 1442 1541 1545 T Defi 0.394 0.394 0.394 586.8 586.8 586.8	><- 21 21 19 15 15 15 0. 0. 0. 0.	-6> 95 14 63 37 03 16 0	 <7 2175 2096 1935 1538 1542 1546 1.08	> > 16	 2177 2094 1931 1465 1513 1517 1.524 	21 20 18 14 15 11 	9>< .57 + 11 + 361 .79 + .69 	\$ \$ \$ \$ \$ +CR11 \$ \$ \$
\$ \$> \$ Flap 1 SET1 + \$ Flap 2 \$ Flap 2 \$ Flap 2 \$ Flap 2 \$ Flap 2 \$ CORD2R + CORD2R	<pre>><2> 1: 600 2155 2009 2: 700 1539 1514</pre>	Set 2136 1955 2136 1540 1544 1.52 1.52 2.15 2.15 2.15 2.15 2.15 2.15 2.15 2.15	for the >< 199 211 199 144 155 157 4 0. 4 0. 4 0. 4 0. 5 2 4 0. 12+64.1 12+64.2 12+64.1 12+64.2 12+64.	<pre>e Flap -4> 80 34 86 41 02 15 ASECON 6186 5 6186 5 772E+4 772E+4 772E+4 772E+4 772E+4 772E+4 21D> 401</pre>	s <5 21197 2116 1967 1442 1541 1545 T Defi 0.394 0.394 0.394 586.8 586.8 586.8 586.8 586.8 586.8 586.8 586.8	 21 21 19 15 15 15 0. 0. 0. 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	> 95 14 63 37 03 16 0 0 0 SETG-> 6	<pre> <<7 21755 2096 19355 1538 1542 1546 1.08 1.08 <<-AC 60</pre>	> 16 11	< 2177 2094 1931 1465 1513 1517 1.524 	21 20 18 14 15 11	9>< 57 + 11 + 361 479 + 543 + .69 .0	
\$ \$> \$ Flap 1 SET1 + + \$ Flap 2 SET1 + + \$ \$ Flap 2 SET1 + + \$	<pre>><2>> .: .: .: .: .: .: .: .: .: .: .: .: .:</pre>	Set 1955 2136 1988 1536 1540 1544 1.52 1.52 2.15 2.15 2.15 2.15 2.15 2.15 2.15 2.15	for the >< 199 211 199 144 155 155 4 0.4 0.4 0.3 12+64.7 12+64.1 12+64.1 12+64.7 12+64.7 12+64.7 	<pre>e Flap -4> 30 34 36 41 02 15 ASECON 6186 5 6186 5 6186 5 6186 5 6124 772E+4 772E+4 772E+4 772E+4 772E+4 772E+4 772E+4 772E+4 772E+4 772E+4 772E+4 772E+4 772E+4 772E+4</pre>	s <5 2197 2116 1967 1442 1541 1545 T Defi 0.394 0.394 0.394 0.394 586.8 586.8 586.8 586.8 586.8 586.8 586.8 586.8 586.8 586.8	 21 21 19 15 15 15 0. 0. 0. 0. 8 8 8 8 8 8 8 8 8 8 8 8 8 8	> 95 14 63 37 03 16 0 0 0 setg-> 6 7	<pre> <<7 2175 2096 1935 1538 1542 1546 1.08 1.08 <<-AC 60 60</pre>	> > 16 TID- 1 2	< 2177 2094 1931 1465 1513 1517 1.524 	><- 21 20 18 14 15 11 0.	9>< .57 + 11 + 861 .79 + .69 	
\$ \$> \$ Flap 1 SET1 + + \$ Flap 2 SET1 + + \$ Flap 2 SET1 + + \$	<pre>><2>> 1: 600 2155 2009 2: 700 1539 1514 401 1.0816</pre>	Set 1955 2136 1988 1536 1540 1544 1.52 1.52 2.15 2.5 2.5 2.5 2.5 2.5 2.5 2.5 2.	for the >< 199 211 199 144 155 155 0.0 4 0.0 4 0.1 4 0.1 5 4 0.1 4 0.1 5 	<pre>e Flap -4> 30 34 36 41 02 15 ASECON 6186 5 6186 5 6186 5 6186 5 6186 5 6186 5 8 0 401 772E+4</pre>	s <	 21 21 19 15 15 15 15 0. 0. 0. 0. 8 8 8 8 8 8 8 8 8 8 8 8 8 8	> 95 14 63 37 03 16 0 0 0 0 	 <7 2175 2096 1935 1538 1542 1546 1.08 1.08 <-AC 60 60 60 60 60 60	> > 16 TID- 1 2 3 4	< 2177 2094 1931 1465 1513 1517 1.524 	><- 21 20 18 14 15 11 0.	9>< .57 + 11 + 361 .79 + .69 	\$ \$ \$ \$ \$ +CR11 \$ \$ \$

SURFSET 350 VTAIL F RTAIL F LTAIL F FLAP1 FLAP2 \$_____\$ * BODY Elements * Ś-Ś Ś \$ FUSELAGE SPLINE (BEAM SPLINE) $\$\dots 1 \dots | \dots 2 \dots | \dots 3 \dots | \dots 4 \dots | \dots 5 \dots | \dots 6 \dots | \dots 7 \dots | \dots 8 \dots | \dots 9 \dots | \dots 10 \dots |$
 SPLINE2
 10
 10

 SET1
 10
 2688
 343
 714
 709
 704
 699
 694

 PANLST2
 10
 10001
 10001
 THRU
 10030
 10030
 2494 \$ \$ Right AIM9-P MISSILE (BEAM SPLINE) $\$\dots1\dots|\dots2\dots|\dots3\dots|\dots4\dots|\dots5\dots|\dots6\dots|\dots7\dots|\dots8\dots|\dots9\dots|\dots10\dots|$
 SPLINE2
 70
 50

 SET1
 50
 858
 1166
 1173

 PANLST2
 70
 40001
 40001
 THRU
 1179 1187 1196 1226 1341 40088 Ś Ś \$ Left AIM9-P MISSILE (BEAM SPLINE) \$...1..|...2...|...3...|...4...|...5...|...6...|...7...|...8...|...9...|...10..|
 SPLINE2
 71
 51

 SET1
 51
 1343
 1547
 1602
 1669

 PANLST2
 71
 41001
 41001
 THRU
 41088
 1723 1751 2354 2465 \$ \$ FUSELAGE \$...1..|..2...|..3...|..4...|..5...|..6...|..7...|...8...|..9...|..10..|
 ACOORD
 10-0.358980.7041721.096798
 0.0
 0.0
 0.0

 \$ACOORD
 10-0.384970.7041721.128554
 0.0
 0.0
 0.0

 \$...1..|..2...|..3...|..4...|..5...|.6...|..7...|..8...|..9...|..10..|
 0.0
 0.0
 0.0
 BODY7 10001FUSELAGE 10 1 10001 $\$\dots1\dots|\dots2\dots|\dots3\dots|\dots4\dots|\dots5\dots|\dots6\dots|\dots7\dots|\dots8\dots|\dots9\dots|\dots10\dots|$ SEGMESH 10001 7 6 +SEG10 3-0.17190 3-0.14592 +SEG10 98 99 +SEG11 101 102 +SEG11 +SEG1230.0 30.343016 30.570651 30.955669 31.328021 +SEG12 103 104 +SEG13 +SEG14 +SEG15 +SEG13 106 105 105106107108109110111112 +SEG14 +SEG15 +SEG16 +SEG16 +SEG17 +SEG18 +SEG19 Ś 113 114 115 116 117 118 \$+SEG1730.954842\$+SEG1831.074291\$+SEG1931.301778 $\$\dots1\dots|\dots2\dots|\dots3\dots|\dots4\dots|\dots5\dots|\dots6\dots|\dots7\dots|\dots8\dots|\dots9\dots|\dots10\dots|$
 AEFACT
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 0.0
 0.0
 0.0

 AEFACT
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 900.0203320.0203320.0203320.0203320
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 <t AEFACT Ś \$ Tip Shaker Pod R \$...1.|...2...|...3...|...4...|...5...|...6...|...7...|...8...|...9...|...10..| ACOORD 40 -0.210742.4399491.261518 0.0 0.0 0.0 \$...1..|..2...|..3...|...4...|...5...|...6...|...7...|...8...|...9...|...10..| BODY7 40001TipPodR 13 40 1 40001 $\$\dots1\dots|\dots2\dots|\dots3\dots|\dots4\dots|\dots5\dots|\dots6\dots|\dots7\dots|\dots8\dots|\dots9\dots|\dots10\dots|$ PBODY7 13 1 -0.2
 SEGMESH
 40001
 12
 9

 +SEG11
 1
 0.00232
 0.0
 0.0

 +SEG12
 1
 0.05206
 0.0
 0.01550

 +SEG13
 1
 0.10041
 0.0
 0.03175

 +SEG14
 1
 0.24756
 0.0
 0.03175
 +SEG11 +SEG12+SEG13 +SEG14 1 0.24756 1 0.25214 0.0 0.03175 0.0 0.03175 +SEG14 +SEG15+SEG15+SEG16
 1
 0.22112
 0.0
 0.03175

 1
 0.39469
 0.0
 0.03175

 1
 0.46827
 0.0
 0.03175

 1
 0.51731
 0.0
 0.03175
 +SEG17 +SEG16 +SEG17 +SEG18 +SEG18 +SEG19 +SEG19 +SEG20

+SEG20 +SEG21 +SEG22		1 0.5663 1 0.6398 1 0.7135	6 0.0 6 0.0 1 0.0	0.0317 0.0155 0.0.	5 0 0				+SEG +SEG	21 22
\$ Tip Sh \$1	naker Po	d L 3	4		6		18	9	10.	.
ACOORD	41	-0.2115	-1.03164	11.26151	8 0.	0 0.	0 0.0)		• •
\$1 BODY7	4100	3 1TipPodL	14	1 5 1 4	6 1	17 1.4100	8 1	9	10.	•
\$1 PBODY7	2 1	43	4 1 -0.2	5 2	6	7	8	9	10.	•
\$1 SEGMESH +SEG11	4100	3 1 12 10 00156	4 2 9	5 9 1 0	6 n	7	8	9	+SEG	• 11
+SEG12		10.05066	8 0.0	0.0155	0				+SEG	13
+SEG13		10.12414	8 0.0	0.0317	5				+SEG	14
+SEG14 +SEG15		10.1/3198	8 0.0 8 0.0	0.0317 0.0317	5 5				+SEG +SEG	15 16
+SEG16		10.32026	8 0.0	0.0317	5				+SEG	17
+SEG17		10.39386	8 0.0	0.0317	5				+SEG	18
+SEG18		10.46746	8 0.0		5				+SEG	19
+SEG19 +SEG20		10.516468	8 0.0	0.0317	5 5				+SEG +SEG	20
+SEG21		10.63906	8 0.0	0.0155	0				+SEG	22
+SEG22		10.71266	8 0.0	0.	0					
\$ \$			* FLUT	FER ANAL	YSIS *				-\$ \$	
\$									\$	
\$		<i>.</i>							\$	
Ş FIITTT	SETID 100	SYM Asym	F'LX 100	NMODE 25	TABDMP	MLIST	CONMLST	NKSTEP		
\$	100	ADIM	100	2.5	20			50		
\$										
TABDMP1	20	0 00	0 00	0 00	1 00	0 0 0	100 0	0 0 0	+	
+ \$1:	0.00 ><2	0.00 ><3:	0.99 ><4:	0.00 ><5	⊥.00 ><6`	0.02 ><7	 ><8;	0.02 ><9>	<10-	->
FIXMDEN	100	100	1.225	KG	M	1.0	0	1	+	ĺ
+	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	+	
+	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	+	
+	21.0	21.5	22.0	22.5	23.0	23.5	24.0	24.5	+	
+	33.0	34.0	35.0	36.0	37.0	38.0	39.0	40.0	+	
+	41.0	42.0	43.0	44.0	45.0	46.0	47.0	48.0	+	
+	49.0	50.0	52.0	54.0	56.0	58.0	60.0	64.0	+	
+ ¢	68.0	72.0	76.0	80.0						
\$ PLTVG \$	TO PLOT	FREQUEN	CY & DAMI	PING V.S	. VELOCI	TY			\$ \$	
\$1>	><2	><3:	><4>	><5	><6	><7	><8:	><9>	> ~	
₽ PLTVG	SETID 11	100	NMODE 25	V	FORM	VG CLMP	.PLT		Ş	
PLTFLUT	10	100	1	10	20.0	FEMAP	FLUT1M	OFT.NEU		
PLTFLUT	20	100	2	10	20.0	FEMAP	FLUT2M FLUT3M	OFT.NEU OFT.NEU		
PLTFLUT	40	100	4	10	20.0	FEMAP	FLUT4M	OFT.NEU		
PLTFLUT	50	100	5	10	20.0	FEMAP	FLUT5M	OFT.NEU		
PLTFLUT	60 70	100	6	10	20.0	FEMAP	FLUT6M	OFT.NEU		
PLTFLUT	70 80	100	8	10	20.0	FEMAP	FLUT /MO	JET.NEU Set neu		
PLTFLUT	90	100	9	10	20.0	FEMAP	FLUT9M	OFT.NEU		
PLTFLUT	100	100	10	10	20.0	FEMAP	FLUT10	MOFT.NEU		
PLTFLUT	110	100	11	10	20.0	FEMAP	FLUT11	MOFT.NEU		
SPLIFLOI.	120	100	12	10	20.0	FEMAP	F'LU'I'121	MOF'I'.NEU		
OUTPUT4	SMHH	MATR/SM	HH.DAT							
OUTPUT4	SKHH	MATR/SKI	HH.DAT							
OUTPUT4 OUTPUT4	QHHS010 QHHS010	1MATR/QHI 2MATR/QHI	H01.DAT H02.DAT							
OUTPUT4	QHHS010	3MATR/QH	H03.DAT							
OUTPUT4	QHHS010	4MATR/QHI	HU4.DAT							
	QHHS010	6MATR/QH	H06.DAT							
OUTPUT4	QHHS010	7MATR/QH	H07.DAT							
OUTPUT4	QHHS010	8MATR/QHI	H08.DAT							
OUTPUT4	QHHS010	9MATR/QH	H09.DAT							
	QHHS011 OHHS011	umatk/QHI 1matr /∩⊔i	H1U.DA'I' דעת H11							
OUTPUT4	QHHS011	2MATR/OH	H12.DAT							
OUTPUT4	OHHS011	3MATR/OH	H13.DAT							

OUTPUT4 QHHS0114MATR/QHH14.DAT OUTPUT4 QHHS0115MATR/QHH15.DAT OUTPUT4 QHHS0116MATR/QHH16.DAT OUTPUT4 QHHS0116MATR/QHH17.DAT OUTPUT4 QHHS0119MATR/QHH18.DAT OUTPUT4 QHHS0120MATR/QHH20.DAT OUTPUT4 QHHS0121MATR/QHH21.DAT OUTPUT4 QHHS0122MATR/QHH22.DAT OUTPUT4 QHHS0122MATR/QHH23.DAT OUTPUT4 QHHS0125MATR/QHH23.DAT OUTPUT4 QHHS0125MATR/QHH24.DAT OUTPUT4 QHHS0126MATR/QHH25.DAT OUTPUT4 QHHS0126MATR/QHH25.DAT OUTPUT4 QHHS0126MATR/QHH25.DAT OUTPUT4 QHHS0127MATR/QHH26.DAT OUTPUT4 QHHS0127MATR/QHH27.DAT OUTPUT4 QHHS0128MATR/QHH28.DAT OUTPUT4 QHHS0129MATR/QHH28.DAT OUTPUT4 QHHS0120MATR/QHH28.DAT OUTPUT4 QHHS0130MATR/QHH30.DAT \$

ENDDATA

Case 3 – ZAERO Code MEMORY 8192MB CPU 16 ASSIGN FEM=pro-assurequy fullplane2 v37-001.f06,BOUNDARY=ASYM,FORM=MSC, PRINT=0 CEND Ś TITLE = OSU ASSURE ECHO = SORT SUBCASE = 1SUBTITLE= FLUTTER ANALYSIS, M=0.0, SEA LEVEL FLUTTER=100 BEGIN BULK Ś \$_____\$ Ś Ś * AERO PARAMETERS / FEM MODEL UNITS * \$ \$ \$_____\$ Ś Ś -1---><--2---><--3---><--4---><--5---><--6---><--7---><--8---><--9---><--10--> Ś-ACSID XZSYM FLIP FMMUNIT FMLUNIT REFC REFB REFS \$ NO NO KG M 0.333 3.33 1.07 +7 Ś AEROZ +AE1 0.444 0.0 0.076 +AE1 \$ Ś AERODYNAMIC AIC MATRIX GENERATION \$ \$ \$ Ś * * * MACH = 0.0 * * * Ś Ś Ś Ś IDMK MACH METHOD IDFLT SAVE <--FILENAME--> PRINT \$ Ś
 WACH
 MACH
 <th +MK1 +MK2 +MK 3 +MK 4 \$ Ś \$--1--><--2--><--3---><--5---><--6---><--7--><--8---><--9---><--10--> CAERO7 1 LWING1 25 2 +W1L1 -7.091-30.7043411.1909290.333908 +W1L2 -7.078-3-.3876191.2264910.333908 2.0 +W1 T.1 +W1L2 \$--1---><--2---><--3---><--5---><--6---><--7---><--8---><--9---><--10--> CAERO7 557 LWING2 10 12 +W2L1 CAERO7 557 LWING2 +W2L1 -7.078-3-.3876191.2264910.261137 +W2L2 -7.078-3-.9086301.2479290.261137 $+W2T_{1}2$ -7.078-3-.9986391.2478280.261137 +W2L2 \$--1--><--2--><--3---><--5---><--6---><--7--><--8---><--9---><--10--> CAERO7 757 FLAP2 10 8 +W3L1 +W3L1 0.254015-0.387571.2310120.072771 +W3L2 +W3L2 0.25402-0.998581.2523490.072771 \$--1--><--2--><--3---><--5---><--6---><--7--><--8---><--9---><--10--> CAERO7 1001 RWING1 25 20 +W1R1 -7.091-3 .7043411.190929 .333908 25 20 +W1R1 +W1R2 +W1R2 -7.078-31.7963021.226491 .333908 \$--1--><--2--><--3--><--4--><--5---><--6--><--7--><--8---><--9--><--10--> CAERO7 1557 RWING2 10 12 +W2R1 +W2R1 -7.078-31.7963021.2264910.261137 +W2R2 -7.078-32.4073161.2478280.261137 +W2R2 \$--1---><--2---><--3---><--4---><--5---><--6---><--7---><--8---><--9---><--10--> CAERO7 1757 FLAP1 10 +W3R1 8 +W3R1 0.254015 1.796261.2310120.072771 +W3R2 +W3R2 0.254022.4072741.2523490.072771 \$--1--><--2--><--3---><--5---><--6---><--7--><--8---><--9---><--10--> CAERO7 2001 LTAIL 10 10 +F1L1 +F1L1 0.9421670.6809521.11267 0.189609 +F1L2+F1L2 1.0078110.3109591.11267 0.137705 \$--1--><--2--><--3---><--4---><--5---><--6---><--7---><--8---><--9---><--10--> CAERO7 2501 LTAIL F 5 10 +F21.1 +F2L1 1.1310250.697809 1.112670.054803 +F2L2 1.1455160.3109591.1126490.040094 +F2L2 \$--1--><--2--><--3---><--4---><--5---><--6---><--7---><--8---><--9---><--10--> CAERO7 3001 RTAIL 10 10 +F1R1 +F1R10.9421670.7273921.112670.189609+F1R21.0078111.0973861.112670.137705 +F1R2 \$--1--><--2---><--3--><--4--><--5---><--6---><--7---><--8---><--9---><--10--> CAERO7 3501 RTAIL F 5 10 +F2R1

	1.1310250	.09738	61.11267 61.11269	0.05480) 3) 4				+F2R2
\$1,	><>	· ? `	><	><	><		7~	_8	9><10
, CAERO7 +F2U1	4001 V 0.8810280	/erTail .70511	91.12695	10 70.30882	10 127		//	-0/-	+F2U1 +F2U2
\$1;	><2><	(3)	><4>	><5	·><6-	><	7><-	-8><-	9><10
CAERO7	4501 V	/erTail	2	5	10				+F3U1
+F3U1	1.1898410	.70215	91.126957	70.05185	2				+F3U2
+F3U2	1.1650030	.70239	71.406357	70.05185	2				
\$									
? \$ 		SPLINE	& PANLSI	г — ворт	+ WIN	NG 			
\$	EID M	IODEL	CP	SETK	SETG	DZ			
\$ Femap	Aero Spli	ne 2 :	LWing	2.0.1	2	0 0			
DANT.ST1	201 1	WINGI	1	201 456	2	0.0			
SPLINE1	111 I	Wina2	1	202	2	0 0			
PANLST1	202 5	57	557	655	2	0.0			
SPLINE1	1111 F	LAP2		203	700	0.0			
PANLST1	203 7	57	757	819					
Femap	Aero Spli	ne 1 :	Rwing						
SPLINE1	12 F	wing1		101	1	0.0			
PANLST1	101 1	001	1001	1456		-			
SPLINE1	122 F	wing2	1667	102	1	0.0			
PANLS'I'I	102 l	ככ./ 1 מאדי	TDD /	103 103	600	0 0			
PANLST1	103 I	.757	1757	1819	000	0.0			
S Fomar	Aero Coli	ne ? •	RTail						
SPLINE1	13 F	Tail .		301	4	0.	0		
PANLST1	301 3	001	3001	3081					
SPLINE1	14 F	atail F		351	7	Ο.	0		
PANLST1	351 3	501 _	3501	3536					
\$ Femap	Aero Spli	ne 4 :	LTail						
SPLINE1	15 I	Tail		401	5	0.	0		
PANLST1	401 2	2001	2001	2081					
PANLST1	16 I 451 2	501	2501	451 2536	8	0.	0		
S		.ne 5 :	VTail						
\$ Femap	Aero Spli			501	3	Ο.	0		
, \$ Femap SPLINE1	Aero Spli 17 V	Tail		001					
, \$ Femap SPLINE1 PANLST1	Aero Spli 17 V 501 4	Tail 001	4001	4081					
\$ Femap SPLINE1 PANLST1 SPLINE1	Aero Spli 17 V 501 4 18 V	Tail 001 Tail_F	4001	4081 551	6	0.	0		
\$ Femap SPLINE1 PANLST1 SPLINE1 PANLST1	Aero Spli 17 V 501 4 18 V 551 4	Tail 001 Tail_F 501	4001 4501	4081 551 4536	6	0.	0		
Femap SPLINE1 PANLST1 SPLINE1 PANLST1	Aero Spli 17 V 501 4 18 V 551 4	Tail 001 Tail_F 501	4001 4501	4081 551 4536	6	0.	0		
Femap SPLINE1 PANLST1 SPLINE1 PANLST1 S S S S S S S S S S S S S S S S S S	Aero Spli 17 V 501 4 18 V 551 4	/Tail 001 /Tail_F 501	4001 4501 ><4>	4081 551 4536	6 ·><6-	0.	0 7><-	-8><-	-9><10
Femap SPLINE1 PANLST1 SPLINE1 PANLST1 S1	Aero Spli 17 V 501 4 18 V 551 4 ><2><	7Tail 1001 7Tail_F 1501	4001 4501 ><4> the Body	4081 551 4536 ><5 7 & Wing	6 -><6- 	0.	0 7><- 	-8><-	9><10
Femap SPLINE1 PANLST1 PANLST1 PANLST1 S1> S SET1	Aero Spli 17 V 501 4 18 V 551 4 ><2>< S 1	/Tail /Tail_F /501 /Tail_F /501	4001 4501 ><4> the Body 8 952	4081 551 4536	6 6- 1 59	0.	0 7><- 979	-8><- 980	9><1C
Femap SPLINE1 PANLST1 PANLST1 PANLST1 S S SET1	Aero Spli 17 V 501 4 18 V 551 4 ><2> S 1 995	7Tail 7001 7Tail_F 501 6et for 858 990	4001 4501 ><4> the Body 3 952 6 999	4081 551 4536	6 -><6- 59 00 1	0. >< 960 1170	0 7><- 979 1177	-8><- 980 1183	9><10 988+ 1188+
Femap SPLINE1 PANLST1 PANLST1 PANLST1 S	Aero Spli 17 V 501 4 18 V 551 4 ><2> 1 995 1196	Tail (001 (Tail_F 501 Set for 858 999 123	4001 4501 *<4> the Body 3 952 6 999 4 1272	4081 551 4536	6 >><6- 59 00 1 11 1	0. 960 170	0 7><- 979 1177 1801	-8><- 980 1183 1806	9><10 988+ 1188+ 1807+
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Femap SPLINE1 PANLST1 SPLINE1 PANLST1 S	Aero Spli 17 V 501 4 18 V 551 4 ><2>< S 1 995 1196 1810 2386	Tail (001 (Tail_F 501 (501) (5	4001 4501 the Body 3 952 6 999 4 1272 5 1990 9 2447	4081 551 4536	6 -><6- 	0. 960 1170 2070 2495	0 7><- 979 1177 1801 2241 2500 2840	-8><- 980 1183 1806 2260 2564	9><10
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S Femap SPLINE1 PANLST1 SPLINE1 PANLST1 S S S S S S S S S S S S S	Aero Spli 17 V 501 4 18 V 551 4 ><2>< 1 995 196 1810 2386 2666 2906 3122 3299 3522 3749 3868 3984 Aero Spli 2 1547 2437 2647 4010 4243 4469 4694	Tail 001 Tail_F 501 501 501 501 501 501 501 501	4001 4501 +	4081 551 4536 ×5 7 & Wing 2 95 9 100 2 134 0 202 7 245 3 301 4 318 1 335 1 392 4 17 2 175 5 252 4 281 3 406 1 429 5 452 4 281 3 406 1 429 5 452 4 75 5 252 4 281 3 406 1 429 5 452 1 475 5 452 1 475 1 4	6 -><6- 	0. 960 170 2495 2837 3017 3236 3407 3640 3807 3977 304 2122 2533 2836 4117 1345 1630 1756	0 7><- 979 1177 1801 2241 2500 2842 3020 3248 3413 3643 3815 3978 532 2262 2544 2923 4124 4353 4639 4860	-8><- 980 1183 1806 2260 2564 2846 3070 3293 3416 3644 3863 3980 837 2368 2546 2972 4127 4403 4688 4866	9><10

+	5257	,	5260	5372) =	5374		5378		5485		549		5601+	
+	5656	5	5770	5777	,	5574		5570		5405		5555		5001 I	
\$ Femap	Aero Spl	ine	2 : LWi	Lna											
SET1	4	1	6398	6399) 6	5400		6402		6404	6	5407		6425+	
+	6429)	6432	6434	1 6	6437		6441		6443	6	5446		6447+	
+	6449)	6450	6558	3 6	6561		6562		6563	6	5568		6578+	
+	6617	7	8371	8388	8 8	3448		8560		8594	8	3701		8732+	
+	8782	2	8785	8793	8 8	3794		8845		8859	8	3880		8894+	
+	8903	3	8926	8940) 8	3976		9005		9040	9	9054		9059+	
+	9102	2	9117												
\$ Femap	Aero Spl	ine	3 : RTa	ail											
SET1	5)	6074	6083	36	5086		6089		6092	6	5093		6096+	
+	6098	5	6101 6126	6104	1 6	5106 5140		6145		6113		011/ 0150		6161	
+	6123) 7	6120	6100		514Z		6201		6206		5138 5210		62201	
+	6222	, >	6797	6790		5190 5707		6000		6200		210		60021	
+	6896		6959	6965	5 6	5968		6978		7050	-	7067		7115+	
+	7146	5	0,0,0,0	0500		5500		0570		1055		1001		/1101	
S Feman	Aero Sol	ine	4 • T.T.a	a i 1											
SET1	3	3	2652	2869) 3	3114		3153		3178	3	3200		3201+	
+	3209)	3217	3220) 3	3225		3227		3229		3396		3418+	
+	3435	5	3452	3462	2 3	3861		3884		4200	4	1204		4212+	
+	4272	2	4328	4329) 4	1394		4485		4593	4	1613		4680+	
+	4722	2	4778	4863	3 4	1888		4919		4960	4	1963		5003+	
+	5105	5													
\$ Femap \$	Aero Spl	ine	5 : VTa	ail											
SET1	7	7	6407	6439) 6	5440		6441		6442	6	5443		6444+	
+	6445	5	6446	6447	7 6	5448		6449		6450	6	5451		6571+	
+	6603	3	8862	8966	5 9	9018		9096							
\$ Femap	Aero Spl	ine	6 : RTa	ail F											
SET1	- 8	3	6083	6084	1 6	6115		6116		6117	6	5118		6119+	
+	6120)	6121	6122	2 6	5123		6124		6125	6	5126		6127+	
+	6128	3	6136	6152	26	5168		6184		6200	6	5216			
\$ Femap	Aero Spl	ine	7 : LTa	ail_F											
SET1	6	5	2869	3209) 3	3226		3227		3228		3229		3230+	
+	3231	-	3234	3394	1 3	3444		3453		3458	4	1329			
\$ Femap	Aero Spl	lne	8 : V1a	ail_F											
\$ ¢															
ې د		Sot	for the	- Flar											
\$			TOT CIIC	- TTUP	00										
· 1 、															
ST>	><2>	3	 }><	-4>	 ><5-	>	 <6	>	 <7	>	<8-	>‹	 <9		>
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 ...1.
 ...1.
 BODY7 40001TipPodR 13 40 1 40001 $\$\dots1\dots|\dots2\dots|\dots3\dots|\dots4\dots|\dots5\dots|\dots6\dots|\dots7\dots|\dots8\dots|\dots9\dots|\dots10\dots|$ PBODY7 13 1 -0.2

 SEGMESH
 40001
 12
 9

 +SEG11
 1
 0.00232
 0.0
 0.0

 +SEG12
 1
 0.05206
 0.0
 0.01550

 +SEG13
 1
 0.10041
 0.0
 0.03175

 +SEG14
 1
 0.25214
 0.0
 0.03175

 +SEG11 +SEG12+SEG13 +SEG14 +SEG15+SEG16
 1
 0.22112
 0.0
 0.03175

 1
 0.39469
 0.0
 0.03175

 1
 0.46827
 0.0
 0.03175

 1
 0.51731
 0.0
 0.03175
 +SEG17 +SEG16 +SEG17 +SEG18 +SEG18 +SEG19 +SEG19 +SEG20

+SEG20 +SEG21 +SEG22		1 0.5663 1 0.6398 1 0.7135	6 0. 6 0. 1 0.	0 0.0317 0 0.0155 0 0.	75 50 . 0					+SEG21 +SEG22	
\$ Tip Sh	haker Po	d L				. 7	. 0			10 1	
ACOORD	41	-0.2115	-1.0316	41.26151	8 0.	0 0.	0 0.0)))			
BODY7	4100	1TipPodL	14	4 4	6 1	1 4100	18	9	• ·		
\$1 PBODY7	12	3 4	4 1 -0.	5 2	6	7	8	9	.	10	
\$1 SEGMESH +SEG11	4100	3 1 1 10.00156	4 2 8 0.	5 9 0 0.		7	8	9	.	10 +SEG11 +SEG12	
+SEG12		10.05066	80.	0 0.0155	50					+SEG13	
+SEG13		10.12414	80.	0 0.0317	75					+SEG14	
+SEG14 +SEG15		10.17319	80. 80.	0 0.0317	75					+SEG15	
+SEG16		10.32026	8 0.	0 0.0317	75					+SEG17	
+SEG17		10.39386	8 0.	0 0.0317	75					+SEG18	
+SEG18		10.46746	8 0.	0 0.0317	75					+SEG19	
+SEG19		10.51646	80.	0 0.0317	75					+SEG20	
+SEG20 +SEG21		10.59006 10 63906	8 U. 8 O	0 0.0317	5					+SEG21 +SEG22	
+SEG21		10.03500	80.	0 0.0130	.0					100622	
\$									-\$		
\$			* FLUI	TER ANAI	YSIS *				\$		
\$									-\$		
с	SETTO	SVM	FTY	NMODE		MT.TST	CONMIST	NKSTEP	Ş		
FLUTTER	100	ASYM	100	25	20	1111101	COMPIDI	30			
\$											
\$											
TABDMP1	20	0 0 0	0 0 0	0 00	1 0 0	0 00	100 0	0 00	+		
+ ¢1`	0.00	0.00	0.99	0.00	1.00	0.02	100.0 ·0	0.02	~	10>	
FTXMDEN	100	100	1.225	KG	M	1.0	0	1	+	10>	
+	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	+		
+	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	+		
+	21.0	21.5	22.0	22.5	23.0	23.5	24.0	24.5	+		
+	25.0	26.5	27.0	28.0	29.0	30.0	31.0	32.0	+		
+	33.0	34.0	35.0	36.0	37.0	38.0	39.0	40.0	+		
+	41.0	42.0	43.0	44.0	45.0	46.0	47.0	48.0	+		
+	49.0 68.0	72.0	J∠.0 76.0	80.0	30.0	30.0	00.0	04.0	Ŧ		
\$	00.0	, 2.0		00.0							
\$ PLTVG \$	TO PLOT	FREQUEN	CY & DAM	IPING V.S	S. VELOCI	ТΥ			\$ \$		
\$1>	><2	><3	><4	><5	-><6	><7		><9	>		
\$	SETID	IDFLUT	NMODE	XAXIS	FORM	FII	ENM		\$		
PLTVG	11	100	25	V		VG_CLME	P.PLT				
PLTFLUT	10	100	1	10	20.0	FEMAP	FT.UT1M	OFT.NEU			
PLTFLUT	20	100	2	10	20.0	FEMAP	FLUT2M	OFT.NEU			
PLTFLUT	30	100	3	10	20.0	FEMAP	FLUT3M	OFT.NEU			
PLTFLUT	40	100	4	10	20.0	FEMAP	FLUT4M	OFT.NEU			
PLTFLUT	50	100	5	10	20.0	FEMAP	FLUT5M	OFT.NEU			
PLTFLUT	60 70	100	6 7	10	20.0	FEMAP	FLUT6M ETTTT7M	JET.NEU			
PLTFLUT	80	100	8	10	20.0	FEMAP	FLUT 8M	OFT.NEU			
PLTFLUT	90	100	9	10	20.0	FEMAP	FLUT9M	OFT.NEU			
PLTFLUT	100	100	10	10	20.0	FEMAP	FLUT10	MOFT.NEU			
PLTFLUT	110	100	11	10	20.0	FEMAP	FLUT111	MOFT.NEU			
PLTFLUT	120	100	12	10	20.0	FEMAP	FLUT12	MOFT.NEU			
Ş Olimdim (OMITT	MARD / CM									
OUTPUT4	SMAA	MAIR/SM MATR/SK	HH.DAT								
OUTPUT4	QHHS0101MATR/QHH01.DAT										
OUTPUT4	QHHS010	2MATR/QH	H02.DAT								
OUTPUT4	QHHS0103MATR/QHH03.DAT										
OUTPUT4	QHHS0104MATR/QHH04.DAT										
OUTPUT4	ł QHHSU105MATR/QHH05.DAT 4 obus0106matr/obu06 dat										
	4 QHHSUIU0MATK/QHHU0.DAT 1 OHHSU107MaTR/OHHU7 DAT										
OUTPUT4	4 OHHS0108MATR/OHH08.DAT										
OUTPUT4	QHHS010	9MATR/QH	H09.DAT								
OUTPUT4	QHHS011	0MATR/QH	H10.DAT								
OUTPUT4	QHHS011	1MATR/QH	H11.DAT								
OUTPUT4	QHHS011	2MATR/QH	H12.DAT								
00112014	VHHRATT	JMATK/OH	пıз.DA'l'								

OUTPUT4 QHHS0114MATR/QHH14.DAT OUTPUT4 QHHS0115MATR/QHH15.DAT OUTPUT4 QHHS0116MATR/QHH16.DAT OUTPUT4 QHHS0116MATR/QHH17.DAT OUTPUT4 QHHS0119MATR/QHH18.DAT OUTPUT4 QHHS0120MATR/QHH20.DAT OUTPUT4 QHHS0121MATR/QHH21.DAT OUTPUT4 QHHS0122MATR/QHH22.DAT OUTPUT4 QHHS0122MATR/QHH23.DAT OUTPUT4 QHHS0125MATR/QHH23.DAT OUTPUT4 QHHS0125MATR/QHH24.DAT OUTPUT4 QHHS0126MATR/QHH25.DAT OUTPUT4 QHHS0126MATR/QHH25.DAT OUTPUT4 QHHS0126MATR/QHH26.DAT OUTPUT4 QHHS0127MATR/QHH26.DAT OUTPUT4 QHHS0127MATR/QHH27.DAT OUTPUT4 QHHS0128MATR/QHH28.DAT OUTPUT4 QHHS0129MATR/QHH28.DAT OUTPUT4 QHHS0120MATR/QHH28.DAT OUTPUT4 QHHS0130MATR/QHH30.DAT \$

ENDDATA
Case 1 – Dynresp

\$--1--><--2--><--3---><--5---><--6---><--7--><--8---><--9---><--10--> SOURCE ZAERO AERDATA aerocards.dat STRMOD struct.dat CSDATA pro-assureguy_fullplane2_v35-005.f06 ENDINMAT TITLE OSU ASSURE FullSpan \$--1---><--2---><--3---><--4---><--6---><--7---><--8---><--9---><--10--> SUBCASE 1 TIMESET 1 STABLE 1 DAMPING 20 AEROSET 1 FCS 1 OUTRES FORMAT +FORM +FORM FORMAT BEGIN BULK \$ For smaller steps: MARGIN 1 FLUTTER 100 ALT 80 + 18 19 20 21 21.5 22 22.5 23 + 23.5 24 24.2 24.4 24.6 24.8 25 25.2 + 25.4 25.6 25.8 26 26.2 26.4 26.6 26.8 + 27 27.2 27.4 27.6 27.8 28 28.2 28.4 + 28.6 28.8 29 29.2 29.4 29.6 29.8 30. + 30.2 30.4 30.6 30.8 31 31.2 31.4 31.6 + 31.8 32 32.2 32.4 32.6 32.8 33 33.2 + 33.4 33.6 33.8 34 34.2 34.4 34.6 34.8 + 35 35.5 36 36.5 37 38 39 40 + 41 42 43 45 48 50 51 55 \$--1--><--2--><--3--><--6--><--7--><--8--><--9--</pre> \$ For smaller steps: + + + + + +

 +
 -1

 \$--1---><--2---><--3---><--4---><--5---><--0</td>

 AERO
 1
 30.
 1.225
 L
 1000

 MKAEROZ
 1000
 0.15
 0.3

 +MK1
 0.00
 0.02
 0.03
 0.04
 0.05
 0.06
 0.07
 0.1

 +MK2
 0.12
 0.125
 0.13
 0.14
 0.15
 0.2
 0.25
 0.3

 --- 0.4
 0.5
 0.6
 0.7
 0.8
 0.9
 1.0
 1.5

 \$--1--><--2--><--3---><--5---><--6---><--7--><--8---><--9---><--10--> +MK1 +MK2 +MK3 \$ 2.5 3.0 4.0 5.0 10.0 200 з. TTMEF1 1 .05 \$--1---><--2---><--3---><--4---><--6---><--7---><--8---><--9---><--10--> TABDMP 20 + 0.00 0.00 0.99 0.00 1.00 0.02 50.0 0.02 \$+ 0.00 0.00 0.99 0.00 1.00 0.00 50.0 0.00 \$--1--><--2--><--3---><--5---><--6---><--7--><--8---><--9---><--10--> 180 ASECONT 1 910 SENSET 180 102 \$ Acceleration at added mass point ASESNSR 102 2 1547 GAINSET 910 31 3 \$ Zero gain to define the Pf connections ASEGAIN 31 102 1 301 1 0.0 $\$ selected gain that reflect added m of 0.7Kg GAINSET 100 33 ASEGAIN 33 102 ASEGAIN 33 1 301 1 0.7 \$ Unit excitation force CFORCE 301 1547 3 1.0 \$--1---><--2---><--3---><--4---><--5---><--6---><--7---><--8---><--9---><--10-->

ENDDATA

Case 2– Dynresp

\$--1---><--2---><--3---><--4---><--5---><--6---><--7---><--8---><--9---><--10-->
SOURCE ZAERO
AERDATA aerocards.dat
STRMOD struct.dat
CSDATA pro-assureguy_fullplane2_v37-003.f06
ENDINMAT
TITLE OSU_ASSURE_FullSpan
\$--1--><--2--><--3--><--4--><--5---><--6--><--7--><--8---><--9--><--10-->

SUBCASE 1 TIMESET 1 STABLE 1 DAMPING 20 AEROSET 1 FCS 1 OUTRES FORMAT +FORM +FORM FORMAT BEGIN BULK

 \$ For smaller steps:

 MARGIN
 1
 FLUTTER
 100
 ALT
 80

 +
 18
 19
 20
 21
 21.5
 22

 +
 23.5
 24
 24.2
 24.4
 24.6
 24.8

 +
 25.4
 25.6
 25.8
 26
 26.2
 26.4

 +
 27
 27.2
 27.4
 27.6
 27.8
 28

 +
 28.6
 28.8
 29
 29.2
 29.4
 29.6

 +
 30.2
 30.4
 30.6
 30.8
 31
 31.2

 +
 31.8
 32
 32.2
 32.4
 32.6
 32.8

 +
 33.4
 33.6
 33.8
 34
 34.2
 34.4

 +
 35
 35.5
 36
 36.5
 37
 38

 +
 41
 42
 43
 45
 48
 50

 \$ For smaller steps:
 22
 22.5
 23

 24.8
 25
 25.2

 26.4
 26.6
 26.8

 28
 28.2
 28.4

 29.6
 29.8
 30.

 31.2
 31.4
 31.6

 32.8
 33
 33.2
 + + + 31.231.432.833 + 31. 32.8 34.4 34. 28 39 51 33.2 + 34.6 34.8 40 39 55 \$--1--><--2--><--3---><--5---><--6---><--7--><--8---><--9---><--10-->

 AERO
 1
 30.
 1.225
 L
 1000

 MKAEROZ
 1000
 0.15
 0.3

 +MK1
 0.00
 0.02
 0.03
 0.04
 0.05
 0.06
 0.07
 0.1

 +MK2
 0.12
 0.125
 0.13
 0.14
 0.15
 0.2
 0.25
 0.3

 +MK1 +MK2 +MK3 +MK3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.5 3. TIMEF1 1 200 .05 \$--1---><--2---><--3---><--4---><--6---><--7---><--8---><--9---><--10--> TABDMP 20 0.00 0.00 0.99 0.00 1.00 0.02 50.0 0.02 \$--1---><--2---><--3---><--4---><--6---><--7---><--8---><--9---><--10--> 180 910 ASECONT 1 SENSET 180 102 \$ Acceleration at added mass point ASESNSR 102 2 31 1547 3 GAINSET 910 \$ Zero gain to define the Pf connections ASEGAIN 31 102 1 301 1 0.0 \$ selected gain that reflect added m of 0.7Kg GAINSET 100 33 102 1 1 301 ASEGAIN 33 0.7 \$ Unit excitation force 1547 3 CFORCE 301 1.0 ENDDATA

Case 3 – Dynresp

\$--1--><--2--><--3---><--5---><--6---><--7--><--8---><--9---><--10--> SOURCE ZAERO AERDATA aerocards.dat STRMOD struct.dat CSDATA pro-assureguy_fullplane2_v37-002.f06 ENDINMAT TITLE OSU ASSURE FullSpan \$--1---><--2---><--3---><--5---><--6---><--7---><--8---><--9---><--10--> SUBCASE 1 TIMESET 1 STABLE 1 DAMPING 20 AEROSET 1 FCS 1 OUTRES FORMAT +FORM +FORM FORMAT BEGIN BULK

 \$ For smaller steps:

 MARGIN
 1
 FLUTTER
 100
 ALT
 80

 +
 18
 19
 20
 21
 21.5

 +
 23.5
 24
 24.2
 24.4
 24.6

 +
 25.4
 25.6
 25.8
 26
 26.2

 +
 27
 27.2
 27.4
 27.6
 27.8

 +
 28.6
 28.8
 29
 29.2
 29.4

 +
 30.2
 30.4
 30.6
 30.8
 31

 +
 31.8
 32
 32.2
 32.4
 32.6

 '
 23.4
 33.6
 33.8
 34
 34.2

 \$ For smaller steps:
 22
 22.5
 23

 24.8
 25
 25.2

 26.4
 26.6
 26.6

 28
 28.2
 28.4
 + 25.2 + 26.8 28.4 29.8 29.6 30. + 31.4 31.2 31.6 + 32.8 33 33.2 + 34.4 34.2 33.433.633.8343535.53636.541424345 + 34.6 34.8 34.∠ 37 35 38 40 39 + 50 42 + 41 48 51 55 \$--1--><--2--><--3---><--5---><--6---><--7--><--8---><--9---><--10-->

 AERO
 1
 30.
 1.225
 L
 1000

 MKAEROZ
 1000
 0.15
 0.3

 +MK1
 0.00
 0.02
 0.03
 0.04
 0.05
 0.06
 0.07
 0.1

 +MK2
 0.12
 0.125
 0.13
 0.14
 0.15
 0.2
 0.25
 0.3

 +MK1 +MK2 +MK3 0.4 0.5 0.6 0.7 1 200 3. .05 +MK3 0.8 0.9 1.0 1.5 TIMEF1 1 \$--1---><--2---><--3---><--4---><--6---><--7---><--8---><--9---><--10--> TABDMP 20 + 0.00 0.00 0.99 0.00 1.00 0.02 50.0 0.02 \$--1---><--2---><--3---><--4---><--6---><--7---><--8---><--9---><--10--> ASECONT 1 180 910 SENSET 180 102 \$ Acceleration at added mass point ASESNSR 102 2 GAINSET 910 31 1547 \$ Zero gain to define the Pf connections ASEGAIN 31 102 1 301 1 0.0 \$ selected gain that reflect added m of 0.7Kg GAINSET 100 33 ASEGAIN 33 102 1 301 0.7 1 \$ Unit excitation force CFORCE 301 1547 3 1.0 \$--1---><--2---><--3---><--4---><--6---><--7---><--8---><--9---><--10-->

ENDDATA

F58 Plotter Code - Matlab

```
clear variables
clc
set(groot,'defaulttextinterpreter','latex');
set(groot, 'defaultAxesTickLabelInterpreter','latex');
```

parameters

```
path = '.\'; % path of the .out file
n_cases = 1; % please limit number of cases to run together to 1 right now
if_compare = 0; % if you also want to compare .f58 results with .out results
if_add_f58 = 1; % if you also want to add gust and stability output responses
max_freq = 300; % max number of frequecnies that can be expected in any .f58 file
max_vel = 40; % max number of velocities that the user will provide in the inout file
n_maxbranches = 200; % max number of branches, I don't expect more cross-overs even for
significant fluctuations
```

loop over multiple cases

```
for case id = 1:n cases % this option cannot be used right now
case_id = 1; % this is fixed unitl further update is made
% if(if_add_f58 == 1)
% analysis_type = ["STABLE";"GUST"];
% filenames = [strcat(path,"flutterv4_sym_Pfp3_1.f58");
% strcat(path,"flutterv4_sym_gust_1.f58")];
              if(if_add_f58 == 1)
    analysis_type = "STABLE";
    filenames = strcat(path,"Assure_FullSpan_Gen2_Dynresp_case1_v3_1.f58");
              elseif(if_compare == 1)
    analysis_type = "STABLE"; % add the analysis types of the matrix
    filenames = strcat(path, "Assure_FullSpan_Gen2_Dynresp_case1_v3_1.f58");
               else
                             analysis_type = ["STABLE"; "STABLE"]; % add the analysis types of the matrix
 filenames =
[strcat(path,"flutqterv4_sym_Pfp3_1.f58");strcat(path,"fluttaerv4_sym_case1_1.f58")];
               end
              if(if_compare == 1)
    filenameout = strcat(path,"Assure_FullSpan_Gen2_Dynresp_case1_v3.out");
    % calling function to read dynresp .out file
    Filenameout = strcat(path, "Assure_FullSpan_Gen2_Dynresp_case1_v3.out");
    % calling function to read dynresp .out file
    Filenameout = dynresp_output_read
    Filenameout = strcat(path, "Assure_FullSpan_Gen2_Dynresp_case1_v3.out");
    % calling function to read dynresp .out file
    Filenameout = strcat(path, "Assure_FullSpan_Gen2_Dynresp_case1_v3.out");
    % calling function to read dynresp .out file
    filenameout = strcat(path, "Assure_FullSpan_Gen2_Dynresp_case1_v3.out");
    % calling function to read dynresp .out file
    filenameout = strcat(path, "Assure_FullSpan_Gen2_Dynresp_case1_v3.out");
    % calling function to read dynresp .out file
    filenameout = strcat(path, "Assure_FullSpan_Gen2_Dynresp_case1_v3.out");
    % calling function to read dynresp .out file
    filenameout = strcat(path, "Assure_FullSpan_Gen2_Dynresp_case1_v3.out");
    % calling function to read dynresp .out file
    filenameout = strcat(path, "Assure_FullSpan_Gen2_Dynresp_case1_v3.out");
    % calling function to read dynresp .out file
    % calling fun
                             [DELTAm,PCOf,VEL,PF,n_subcases,pos_subcase_change] = dynresp_output_read(filenameout);
               else
                             n_subcases = length(filenames);
if(if_add_f58 == 1)
                                          PF = 0.7*ones(n_subcases,1); % or provide actual PF vector
                             else
                                          PF = [0.7; 0.7];
                            end
              end
              V58 = zeros(max_vel,n_subcases);
Freq = zeros(max_freq,n_subcases);
Y = zeros(max_freq,max_vel,n_subcases);
              for isc = 1:n_subcases
    if(analysis_type(isc) == "STABLE")
        f58_plot_ind = [1;1;1;1]; % non-zero entry means plot is desired
                             else
                                          f58_plot_ind = [0;0;1;1];
                             end
                              filenamef58 = filenames(isc);
                            tilenamet58 = filenames(isc);
[Vtemp,Ftemp,Ytemp] = dynresp_output_read_f58(filenamef58,analysis_type(isc));
V58(1:length(Vtemp),isc) = Vtemp;
Freq(1:length(Ftemp),isc) = Ftemp;
Y(1:size(Ytemp,1),1:size(Ytemp,2),isc) = Ytemp;
G = abs(Ytemp);
Phi = atan(imag(Ytemp)./real(Ytemp))*180/pi;
PcOf58 = -999*ones(length(Vtemp),n_maxbranches);
DeltaPF58 = 999*ones(length(Vtemp),n_maxbranches);
vnco = zeros(length(Vtemp), n_maxbranches);
                            end
                                                         else
                                                                       if (imag(Ytemp(i,j))/G(i,j)<0)
    Phi(i,j) = Phi(i,j) - 180;</pre>
                                                                      end
                                                         end
                                          end
                             end
                             for j=1:length(Vtemp)
```

```
count = 0;
                for i=1:length(Ftemp)-1
    if( (sign(Phi(i,j))~=sign(Phi(i+1,j))) )
end
                end
           end
          plotting .f58 figures
if(if_compare == 1)
                      plot_comparison(VEL(pos_subcase_change(isc):pos_subcase_change(isc+1)-1),...
                           DELTAm(pos_subcase_change(isc):pos_subcase_change(isc+1)-1,:),...
PCOf(pos_subcase_change(isc):pos_subcase_change(isc+1)-1,:),...
Vtemp,DeltaPF58,PCOf58,PF(isc),fig_id) % plotting comparison
                end
           else % this part is used for the n-th subcase if n_subcases>1, or if n_subcases=1
plot_f58_results(Vtemp,DeltaPF58,PCOf58,G,Phi,Ftemp,PF(isc),fig_id,f58_plot_ind) %
plotting figures
                if(if_compare == 1)
    plot_comparison(VEL(pos_subcase_change(isc):end),...
    DELTAm(pos_subcase_change(isc):end,:),...
    PCOf(pos_subcase_change(isc):end,:),Vtemp,DeltaPF58,PCOf58,PF(isc),fig_id) %
plotting comparison
                end
           end
      end
```

Analyzing the modified solution

```
if(if_add_f58 == 1)
     V_add = 30; % in case of adding gust responses to unit sinsuidoal response, what velocity
 you want to use
fstart =
you want to use
    fstart = 3.0; % starting frequency
    fend = 12.8; % ending frequency
    DF = 0.05; % frequency step size
    norm_fact = 0.1; % normalization factor for any gust response
    Vind = find(V58(:,1) == V_add);
    fstartind = find(Freq(:,1) == fstart);
    fendind = find(Freq(:,1) == fend);
    Fmod = Freq(fstartind:fendind,1);
    Ymod = Y(fstartind:fendind,Vind,1) + norm_fact*Y((fstart-(Freq(1,2)))/DF+1:(fend-
(Freq(1,2)))/DF+1,1,2);
    G = abs(Ymod);
    Phi = atan(imag(Ymod)./real(Ymod))*180/pi;
    Pcof58 = -999*ones(1,n_maxbranches);
    DeltaPF58 = 999*ones(1,n_maxbranches);
    ypco = zeros(1,n_maxbranches);
    ypco = zeros(1,n_maxbranche
                                            ypco = zeros(1,n_maxbranches);
                                          end
                                                                 else
                                                                                     if (imag(Ymod(i,j))/G(i,j)<0)
    Phi(i,j) = Phi(i,j) - 180;</pre>
                                                                                     end
                                                               end
                                            end
                                             count = 0;
end
                                             end
                                          ypco = ypco(:,1:count);
DeltaPF58 = DeltaPF58(:,1:count);
PCOf58 = PCOf58(:,1:count);
f58_plot_ind = [0;0;1;1];
```

```
fig_id = 20000;
plot_f58_results(v_add,DeltaPF58,PCOf58,G,Phi,Fmod,PF(1),fig_id,f58_plot_ind)
end
```

```
% end
```

```
function [V,Freq,Y] = dynresp_output_read_f58(filename,analysis_type)
fid = fopen(filename,'r');
A=fscanf(fid,'%c');
fclose(fid);
```

parameters

```
if(analysis_type=="STABLE")
    str1 = 'NDF0_VRQ1P,5E16.9';
else
    str1 = '4NP_DF 1P,5E16.9';
end
str2 = 'SENSORW 1P,5E16.9';
```

extracting the required data

```
id_str1_strt = strfind(A,str1);
id_str2_strt = strfind(A,str2);
NF = str2double(A(id_str1_strt(1) + length(str1) + 3*8 + 4:id_str1_strt(1) + length(str1) + 3*8 +
1000
19));
        str2double(A(id_str1_strt(1) + length(str1) + 3*8 + 20:id_str1_strt(1) + length(str1) + 3*8
DF
+ 35));
V = zeros(size(id_str1_strt,1),1)
Y = zeros(NF,size(id_str1_strt,1));
Freq = zeros(NF,1);
if(analysis_type=="STABLE")
       freg1 =
str2double(A(id_str1_strt(1) + length(str1) + 2*(3*8 + 2) + 34 + 2:id_str1_strt(1) +
length(str1) + 2*(3*8 + 2) + 34 + 17));
else
       freq1 = 0.0;
end
for i=1:length(id_str1_strt)
       1=1: length(10_str1_str1)
if(analysis_type=="STABLE")
V(i) = str2double(A(id_str1_strt(i) + length(str1) + 3*(3*8 + 2) + 34*2 + 2:...
id_str1_strt(i) + length(str1) + 3*(3*8 + 2) + 34*2 + 17));
       end
       for j=1:NF
    Y(j,i) = str2double(A(id_str2_strt(i) + length(str2) + j*(3*8 + 2) + (j-1)*34 + 2:...
    id_str2_strt(i) + length(str2) + j*(3*8 + 2) + (j-1)*34 + 17)) + ...
    li*str2double(A(id_str2_strt(i) + length(str2) + j*(3*8 + 2) + (j-1)*34 + 18:...
    id_str2_strt(i) + length(str2) + j*(3*8 + 2) + (j-1)*34 + 33));

end
for j=1:NF
       Freq(j) = freq1 + (j-1)*DF;
end
end
```

```
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```

```
function [DELTAm,PCOf,VEL,PF,n_subcases,pos_subcase_change] = dynresp_output_read(filename)
fid = fopen(filename,'r');
A=fscanf(fid,'%c');
fclose(fid);
```

Not enough input arguments.

Error in dynresp_output_read (line 3)
fid = fopen(filename,'r');

parameters

target_string1	=	'WPCO_HZ	٠;
target_string2	=	'DELTA	١,
target_string3	=	'VEL	';
tarāet strinā4	=	'PF	1

target_string5 = 'SUBCASE '; tab_size = 8;

gathering ID and no. of branches information

```
id_WPCO_HZ = strfind(A,target_string1)';
id_DELTA = strfind(A,target_string2)';
id_VEL = strfind(A,target_string3)';
id_PF = strfind(A,target_string4)';
id_SUBCASE = strfind(A,target_string5)';
n_subcases = length(id_SUBCASE);
n_branches = round((id_DELTA - id_WPCO_HZ)/2/tab_size - 1);
```

storing PCOf, DELTAm, relevant VEL values, etc.

```
PCOf = -999*ones(length(id_WPCO_HZ),max(n_branches));
DELTAm = 999*ones(length(id_WPCO_HZ),max(n_branches));
VEL = zeros(length(id_WPCO_HZ),1);
PF = zeros(n_subcases,1);
pos_subcase_change = zeros(n_subcases,1);
          i=1:length(id_wPCO_HZ)
 for
for i=1:length(id_WPC0_HZ)
    for j=1:n_branches(i)
    PCOF(i,j) = str2double(A(id_WPC0_HZ(i)+tab_size+(j-
1)*tab_size:id_WPC0_HZ(i)+tab_size+j*tab_size-1));
    temp = A(id_DELTA(i)+tab_size+(j-1)*tab_size:id_DELTA(i)+tab_size+j*tab_size-1);
    if(contains(temp(2:end),'-'))
        pos = strfind(temp(2:end),'-');
    DELTAm(i,j) = str2double(strcat(temp(1:pos),'e',temp(pos+1:end)));
    elseif(contains(temp(2:end),'+');
        DELTAm(i,j) = str2double(strcat(temp(1:pos),'e',temp(pos+1:end)));
    else
                    else
                            DELTAm(i,j) = str2double(temp);
                    end
          end
temp = A(id_VEL(i+length(id_VEL)-length(id_WPCO_HZ))+tab_size:id_VEL(i+length(id_VEL)-
length(id_WPCO_HZ))+2*tab_size-1);
pos = strfind(temp,' ');
if(isempty(pos))
                   VEL(i) = str2double(temp);
          else
                   VEL(i) = str2double(temp(1:pos(1)-1));
          end
 end
end
diff = id_WPCO_HZ(1) - id_SUBCASE(1);
for subcase_i = 1:n_subcases
    temp = A(id_PF(length(id_PF)/n_subcases*(subcase_i - 1) + 1)+tab_size:...
        id_PF(length(id_PF)/n_subcases*(subcase_i - 1) + 1)+2*tab_size-1);
    pos = strfind(temp, ' ');
    if(isompty(nos))
          if(isempty(pos))
                   PF(subcase_i) = str2double(temp);
          else
                   PF(subcase_i) = str2double(temp(1:pos(1)-1));
          end
          pos_subcase_change(subcase_i) = find(id_WPCO_HZ-id_SUBCASE(subcase_i)==diff);
 end
 end
```

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```
function plot_comparison(V,DELTAm,PCOf,V58,DeltaPF58,PCof58,PF,fig_id)
figure(fig_id+8)
hold on
grid on
xlabel('$V$(m/s)','FontName','Arial','FontSize',20)
ylabel('$\Delta m$ (Kg_)','FontName','Arial','FontSize',20)
plot1 = plot(V,DELTAm,'A','Linewidth',1);
for i=1:size(PCOf,2)
    set(plot1(i),'DisplayName',strcat('Branch',num2str(i)));
end
plot(V58,DeltaPF58(:,1:size(DELTAm,2)),'o','Linewidth',1);
yticks(PF*floor(min(min(DELTAm))/PF):PF/2:3*PF)
ylim([PF*floor(min(min(DELTAm))/PF) 3*PF])
hleg1 = legend('show','Location','northwest');
set(hleg1,'FontName','Arial','FontSize',8,'Interpreter','latex')
ax = gca;
ax.FontSize = 16;
hold off
figure(fig_id+9)
hold on
xlabel('$V$(m/s)','FontName','Arial','FontSize',20)
```

```
ylabel('f(Hz.)','FontName','Arial','FontSize',20)
plot1 = plot(V,PCOf,'^','LineWidth',1);
for i=1:size(PCOf,2)
    set(plot1(i),'DisplayName',strcat('Branch',num2str(i)));
end
yticks(floor(min(min(abs(PCOf)))):round((ceil(1.5*max(max(PCOf))) -
floor(min(min(abs(PCOf))))/6):ceil(1.5*max(max(PCOf))))
ylim([floor(min(min(abs(PCOf))) ceil(1.5*max(max(PCOf)))])
plot(V58,PCOf58(:,1:size(PCOf,2)),'o','LineWidth',1);
hleg1 = legend('show');
set(hleg1,'FontName','Arial','FontSize',8,'Interpreter','latex','Location','northwest')
ax = gca;
ax.FontSize = 16;
hold off
end
```

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```
function plot_f58_results(V58,DeltaPF58,PC0f58,G,Phi,Freq,PF,fig_id,f58_plot_ind)
 if(f58_plot_ind(1)~=0)
figure(fig_id+3)
hold on
grid on
slabel('$v$(m/s)','FontName','Arial','FontSize',20)
ylabel('$\Delta m$ (Kg.)','FontName','Arial','FontSize',20)
plot1 = plot(v58,DeltaPF58,'o','LineWidth',1);
for i=1:size(DeltaPF58,2)
         set(plot1(i), 'DisplayName', strcat('Branch', num2str(i)));
 end
vticks(PF*floor(min(min(DeltaPF58))/PF):PF/2:2*PF)
ylim([PF*floor(min(min(DeltaPF58))/PF) 2*PF])
hleg1 = legend('show','Location','northwest');
set(hleg1,'FontName','Arial','FontSize',8,'Interpreter','latex')
ax = qca
 ax.FontSize = 16;
 hold off
 end
if(f58_plot_ind(2)~=0)
figure(fig_id+4)
hold on
grid on
grid on
xlabel('$v$(m/s)', 'FontName', 'Arial', 'FontSize', 20)
ylabel('f(Hz.)', 'FontName', 'Arial', 'FontSize', 20)
yticks(floor(min(min(abs(PCof58)))):round((ceil(1.2*max(max(PCof58))) -
floor(min(min(abs(PCof58))))/6):ceil(1.2*max(max(PCof58))))
ylim([floor(min(min(abs(PCof58)))) ceil(1.2*max(max(PCof58)))]
ylot1 = plot(v58, PCof58, 'o', 'Linewidth', 1);
for i=1:size(DeltaPE58, 2)
plot1 = plot(V58, PCOf58, '
for i=1:size(DeltaPF58, 2)
         set(plot1(i), 'DisplayName', strcat('Branch', num2str(i)));
 end
hleg1 = legend('show');
set(hleg1,'FontName','Arial','FontSize',8,'Interpreter','latex','Location','northwest')
ax = aca
 ax.FontSize = 16;
 hold off
 end
if(f58_plot_ind(3)~=0)
figure(fig_id+5)
hold on
grid on
grid on
xlabel('Freq. (Hz.)', 'FontName', 'Arial', 'FontSize', 20)
ylabel('$|G| (m/s^2)$', 'FontName', 'Arial', 'FontSize', 20)
% yticks(floor(min(min(abs(PCOf)))):round((cei](1.2*max(max(PCOf))) -
floor(min(min(abs(PCOf))))/6):cei](1.2*max(max(PCOf))))
% ylim([floor(min(min(abs(PCOf)))) cei](1.2*max(max(PCOf)))]
plot(Freq,G, 'o', 'Linewidth',1, 'MarkerSize',4);
hleg1 = legend('Gust');
set(hleg1, 'FontName', 'Arial', 'FontSize',8, 'Interpreter', 'latex', 'Location', 'northwest')
ax = gca:
ax = gca;
ax.FontSize = 16;
hold off
end
 if(f58_plot_ind(4)~=0)
 figure(fig_id+6)
hold on
grid on
gind on
xlabel('Freq. (Hz.)','FontName','Arial','FontSize',20)
ylabel('$\Phi$ (degrees)','FontName','Arial','FontSize',20)
% yticks(floor(min(min(abs(PCOf)))):round((ceil(1.2*max(max(PCOf))) -
floor(min(min(abs(PCOf)))))/6):ceil(1.2*max(max(PCOf))))
ylim([-180 180])
plot(Ereq. Pbi 'o' 'linowidth' 1 'waskersize' 4);
 plot(Freq, Phi, 'o', 'Linewidth', 1, 'MarkerSize', 4);
```

```
% hleg1 = legend('show');
hleg1 = legend('Gust');
set(hleg1, 'FontName', 'Arial', 'FontSize', 8, 'Interpreter', 'latex', 'Location', 'northwest')
ax = gca;
ax.FontSize = 16;
hold off
end
end
```

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