International Journal of Multidisciplinary Research and Publications
ISSN (Online): 2581-6187

Review on Flutter Control of Wings and Panels

Ehab Magdy[1], Mohamed Elsayed[2]
[1,2]Basic Engineering sciences, Benha University, Benha, Egypt
Email address: engehabmagdy@gmail.com[1], melsayed@bhit.bu.edu.eg[2]

***Abstract*— *The flutter is a self-excited vibration under the interaction of inertial force, aerodynamic force, and elastic force of the structure. After flutter occurs, the plane structures will exhibit limited cycle oscillation, which will lead to catastrophic accidents or damage to structures. Therefore, it is a great theoretical and practical the importance of studying the properties of aerodynamic flexibility and flutter control to improve them aerodynamic stability of aircraft structures. This paper reviews recent developments in aerodynamic analysis and flutter control in wings and panel structures. The aerodynamic flap mechanism of the wings and flaps is shown. Search pneumatic flap methods for various structures that have been developed in recent years are briefly. Various control strategies including linear and nonlinear control algorithms as well as the results of active flutter control of wings and flaps foot. Finally, the paper ends with conclusions that highlight challenges development in elastic air analysis and flutter control, providing a brief overview in future investigations. This study aims to provide a comprehensive understanding of the analysis of aerodynamic elasticity and flutter control. It can also provide guidance on new wing design and plate structures to improve its aerodynamic stability.*

***Keywords*— *Panel Flutter, Aerodynamic Loading, limit cycle oscillation, wings.*

I. Introduction

The field of aeroelasticity investigates how the aerodynamic forces operating on an aircraft's surface structures interact with those forces. One of the most prevalent aeroelastic issues is flutter. The vibration amplitude of the aircraft structure gradually decreases after being disturbed when the flight speed of the aircraft is low. The vibration amplitude stays constant when the flight speed approaches a critical value, and the aircraft structure experiences a limit state.

cyclic oscillation (LCO), a sign that flutter is present. Catastrophic accidents or fatigue damage to the wing or panel structures will result from flutter. At least 70 German V-2 rockets structurally failed during World War II as a result of flutter on the top panel structure during launch. From a historical perspective, this was the first instance of structural failure brought on by flutter.[1] The aeroelastic flutter of the F117A stealth fighter in the 1990s caused the structure to be destroyed, which led to the crash of the aircraft. [2] Flight performance and aircraft structures may be at risk due to flutter instability. Investigating the aeroelastic flutter characteristics of aircraft structures is so crucial.

Beginning in the 1950s, theoretical research on structural flutter was conducted before experimental research to support the phenomenon was done. The selection of the aerodynamic model is crucial for structural flutter studies. The linear potential flow theory and quasi-steady potential flow theory are the main foundations of early explorations into aerodynamic theory. [3] For the supersonic and hypersonic aeroelastic flutter calculations, [4] presented the piston theory, an unstable aerodynamic model, in the 1950s. In 1970, [5] classified the structural flutter models into four groups after conducting a thorough analysis of the aeroelastic stability of plates and shells from theoretical and experimental perspectives. In 1993, [6] expanded the hypersonic flutter analysis model to the fifth category using the finite element method (FEM).

[7] further summarized the Euler and Navier Stokes equations applicable to the subsonic, transonic, supersonic, and hypersonic flows as the sixth category of structural flutter model with the ongoing advancement of aerodynamic theory. Table 1 shows the six distinct categories [8] of linear and nonlinear structural flutter. The flutter problem of aircraft structures has persisted from the beginning of the aviation industry's development until the present, and aviation engineers' investigations into the issue have never ended. Scientists were first drawn to the flutter issues with isotropic panels, shells, and wing structures [9-15]. [16] investigated the limit cycle flutter of cantilever panels using the von Kármán massive deformation and supersonic piston theories. The aspect ratio of the panels has a significant impact on the flutter characteristics, according to numerical results.

TABLE I. Aerodynamic theories of structural flutter. Reproduced with permission.8 Copyright 2012, Springer Nature.

Type	Structure theory	Aerodynamic theory	Range of Mach No.
1	Linear	Linear piston	$2 < M\infty < 5$
2	Linear	Linearized potential flow	$1 < M\infty < 5$
3	Nonlinear	Linear piston	$2 < M\infty < 5$
4	Nonlinear	Linearized potential flow	$1 < M\infty < 5$
5	Nonlinear	Nonlinear piston	$M\infty > 5$
6	Nonlinear	Euler/Navier–Stokes equation	Subsonic/transonic /supersonic

[17, 18] used theoretical analysis and numerical computation to examine the aeroelastic stability of two-dimensional (2D) panels under oblique shock waves and to analyze the impact of shock wave position on the panels' aeroelastic stability. The findings showed that, when the oblique shock wave was taken into account, the aeroelastic stability was obviously lowered, and that the aeroelastic instability will occur when the aerodynamic pressure is low. With an emphasis on the nonlinear aeroelastic issues of the binary air foil, wing, and entire aircraft,[19] evaluated nonlinear aeroelasticity and control of aircraft and provided new research prospects. Numerous new materials have been applied continually to the aircraft industry as a result of the

advancements in materials science. When designing the fiber laying angle, composite structures, a type of laminated structure with high rigidity and light weight, can have their mechanical properties changed. As a result, it has been extensively utilized in the construction of aircraft structures and has greatly piqued scientists' attention. [20-23] For instance, [24] used nonlinear FEM to evaluate the flutter behaviour of laminated plates with non-smooth friction boundary. Aeroelastic analysis of composite pinched panels was performed by [25]., and the impact of pinched points at the edges on the critical dynamic pressure was examined. Reduced-order models were utilized by [26] to investigate the nonlinear flutter characteristics of composite laminated plates with curvilinear fibers. On the LCO amplitudes, the effects of boundary conditions, laminate thickness, and geometric imperfection were discussed.

[27] investigated the aeroelastic flutter characteristics of composite laminated structures using the Carrera universal formulation (CUF). When the CUF model's results were compared to those of the FEM program NASTRAN, it became clear that the CUF model could produce precise results at a cheap computing cost. [28] investigated the flutter and buckling stability properties of composite laminated plates with curved fibers in supersonic airflow based on the Rayleigh-Ritz approach. Functionally graded materials (FGM) are materials that combine ceramic materials' heat resistance with the superior mechanical qualities of metal materials. Therefore, many academics have become interested in the aero thermoelastic characteristics of FGM constructions. [29-31] Lattice sandwich constructions have also been shown to offer high energy absorption, heat insulation, and noise reduction qualities as a new type of lightweight structure.

[32, 33] Lattice sandwich structures can therefore be used in a variety of aerospace applications. An effective hybrid FEM was presented by [34] to forecast the flutter bound of functionally graded cylindrical shells.[35] investigated the aeroelastic properties of carbon nanotube-reinforced functionally graded composite plates based on the high-order shear deformation theory using the state-space Levy approach. Using Donnell's nonlinear cylindrical shell theory, [36] examined the aero-thermoelastic stability of viscoelastic sandwich cylindrical shells. Using the assumed mode approach and Hamilton's principle,[37] investigated the aeroelastic characteristics of the sandwich pyramidal lattice beam. In the presence of aerodynamic pressure, the structure's LCO responses, bifurcation, and chaotic motion were computed.

They then looked at the sandwich panels with a triangle in the middle and a pyramidal lattice. [38] As the calculation results were contrasted with composite laminated structures, the effects of various structural parameters on aeroelastic stability were explored. Lattice sandwich constructions were discovered to offer superior aero thermoelastic properties to composite laminated structures. It is well known that there are primarily two techniques, passive control and active control, for reducing the flutter of aircraft structures. By altering the arrangement of the structures, passive flutter control primarily increases structural stiffness while decreasing structural deformations. However, the aerospace industry does not always find it appropriate to change the configurations of structures. The idea of aircraft design has changed from being passive to being active as a result of the advancement of active control technologies. Active flutter control may actively alter the aeroelastic stability of aircraft structures by adjusting the voltage applied to smart materials such as piezoelectric materials, shape memory alloys, [39-41], and magnetorheological fluids [42] through various control algorithms. It is anticipated that this active design idea will enable the aircraft to be lighter while also improving the aeroelastic performance of the aircraft structure.

The United States, for instance, conducted the active aeroelastic wing program,[43] which employed active control technology to drive the control surface to change the form and surface airflow distribution of the wing and enhance the wing's ability to manage the airflow energy. Results from wind tunnel and flight tests suggested that the technology can lighten the weight of aero plane structures and increase flutter speed.[44] developed a new method for reducing the LCO of aircraft wings, which was brought on by the aerodynamic nonlinearities, based on the nonlinear phenomena of saturation.

A comprehensive summary of the research and advancements in the area of active flutter control for aero planes was provided by [45]. Piezo composite actuators were employed by [46] to decrease the flutter of aircraft wings utilizing velocity feedback control. [47] used piezoelectric materials to perform active control of honeycomb sandwich panel under impact load in supersonic airflow based on proportional feedback control and linear quadratic

regulator (LQR) control, and used a nondominated sequencing genetic algorithm to find the best laying positions of piezoelectric patches.[48] suppressed the LCO, aero-thermal post buckling, and chaotic motion of composite laminated plates using piezoelectric ceramics and piezoelectric fiber composite materials. The adaptive active vibration control and energy harvesting assessments of highly flexible multifunctional wings were performed by [49]. Modern aircraft designs frequently incorporate new kinds of lightweight structures to increase their aeroelastic stability.

The design of aircraft structures has also undergone significant change as a result of the introduction of active flutter control, moving from a passive design that increased structural stiffness to an active design with the intention of regulating configured aircraft. In order to do so, this study discusses recent developments in the analysis of aircraft structures' aeroelastic behaviour, including those involving composite laminated structures, FGM, and lattice sandwich structures, among others. In order to offer some advice for future designs in aircraft structures, the development of active flutter control systems, including linear and nonlinear control, is thoroughly summarized, examined, and compared. In addition, a number of prospective paths for future research are discussed, and several difficulties in the field of aeroelastic flutter control are emphasized.

II. Modelling the Panel Flutter Problem – The Plate Model

For a plate subject to external forces and thermal loading, the equation of motion is developed taking considerable deflection into account. The distribution of temperatures used to account for the thermal burden is constant. The rectangular 4-node Bogner- Fox-Schmidt (BFS) C1 conforming element is the element utilized in this investigation (for the bending DOF's). The continuity of all first derivatives between components is preserved by elements of the C1 type. [50].

A. The linear model

The dynamic equation for a uniformly isotropic plate under thermal loading is as follows:

$\boldsymbol{\rho} h\omega + D\nabla^2\omega + \ddot{N_T}\nabla\omega = f(x,y,t)(1)$

While the aerodynamic pressure may be written as:

$$P_a = 2\frac{q}{\beta}\left[\left(\frac{M_\infty - 2}{M_\infty - 1}\right)\frac{1}{V}\frac{\partial w}{\partial t} + \frac{\partial w}{\partial x}\right] = -\left(\frac{g_a}{w_0}\frac{D_{11}}{a^4}\frac{\partial w}{\partial t} + \lambda\frac{D_{11}}{a^3}\frac{\partial w}{\partial x}\right)(2)$$

where Pa is the aerodynamic loading, V the velocity of air-flow, M_∞ Mach number, q dynamic pressure = $\rho V^2 / 2$,ρ_a air density, $\beta = \sqrt{{M_\infty}^2 - 1}$,

g_a non-dimensional aerodynamic damping given by:

$$g_a = \frac{\rho_a V({M_\infty}^2 - 2)}{\rho h w_0 \beta^3}$$

λ non-dimensional aerodynamic pressure given by:

$$\lambda = \frac{2qa^3}{\beta D_{11}}$$

ω_0 is the fundamental frequency of vibration of the plate given by:

$$\omega_0 = \left(\frac{D_{11}}{\rho h a^4}\right)^{\frac{1}{2}}$$

$$D_{11} = \frac{Eh^3}{12(1 - v^2)}$$

And a is the panel length.

From that, we may write the work done by external (aerodynamic) force to be:

$$\delta W_{Aero} == \int_{Area} \delta w P_a dA = -\int_{Area} \delta w \left(\frac{g_a}{w_0}\frac{D_{11}}{a^4}\frac{\partial w}{\partial t} + \lambda\frac{D_{11}}{a^3}\frac{\partial w}{\partial x}\right) dA$$

Adding that to the external work terms:

$$\delta w_{ex} = \int_{Area} \delta w \left(\frac{g_a}{w_0}\frac{D_{11}}{a^4}\frac{\partial w}{\partial t} + \lambda\frac{D_{11}}{a^3}\frac{\partial w}{\partial x}\right) dA + \int_{Boundary} \delta w N_T Grad(w).ds - \int_{Area} \delta w N_T \nabla w dA + \int_{Area} f(x,y,t)$$

Which ads two extra terms to the equation of motion to become:

$$\rho h w + \ddot{D_{11}}\nabla^2 w + N_T \nabla \mathrm{w} + \frac{g_a}{w_0}\frac{D_{11}}{a^4}\dot{w}\,\lambda\frac{D_{11}}{a^3}w_x = f(x,y,t)$$

Which adds two terms to the finite element equation to become:

$$[M]\{\ddot{w}\} + \frac{g_a}{w_0}\frac{D_{11}}{a^4}[M]\{\dot{w}\} + \left([K] - [K_T]\lambda\frac{D_{11}}{a^3}[K_A]\right)\{w\} = \{q\}$$

Where:

$[G]$ is the aerodynamic damping matrix given by:

$$[G] = \int_{Area} \{N\}\lfloor N \rfloor\, dA = \lfloor M \rfloor / \rho h$$

and $[K_A]$ is the aerodynamic stiffness given by:

$$[K_A] = \int_{Area} \{N\}\lfloor N_x \rfloor\, dA$$

For all the cases we do not consider the velocity or acceleration of the panel, the equations of motion reduce to:

$$\left([K] - [K_T]\lambda\frac{D_{11}}{a^3}[K_A]\right)\{w\} = \{q\}$$

For that case, without any excitation force, the panel should stay flat unless the temperature
exceeds the critical buckling temperature, which is an Eigenvalue problem given by:

$$\left([K] + \lambda\frac{D_{11}}{a^3}[K_A]\right) - T[K_T] = 0$$

Where $[K_T]$ is the thermal stiffness matrix without including the temperature in it.

In which the Eigenvalues are the critical buckling temperatures in which we are interested in the lowest value. We may evaluate the buckling temperature for different values of the non-dimensional dynamic pressure. That will give us a curve presenting the change in the buckling temperature for different values of the dynamic pressure.

On the other hand, if we seek finding the flutter dynamic pressure, we will need to follow a different procedure. If we assume that the panel will be vibrating at a frequency Ω with a mode shape ϕ, we may write the deflection equation as:

$$\{w\} = C_0\{\phi\}e^{(\Omega t)}$$

Substituting into the equation of motion, we get:

$$\left(\Omega^2[M] + \Omega g_a\frac{D_{11}}{a^4}[M] + \left([K] - T[K_T] + \lambda\frac{D_{11}}{a^3}[K_A]\right)\right)C_0\{\phi\}e^{(\Omega t)} = 0$$

Which may be rewritten as:

$$\left(-K[M] + \left([K] - T[K_T] + \lambda\frac{D_{11}}{a^3}[K_A]\right)\right)C_0\{\phi\}e^{(\Omega t)} = 0$$

Where

$$K = \Omega^2 + \Omega g_a\frac{D_{11}}{a^4}$$

It can be shown that the values of the eigenvalues κ will be always real for all values of λ less than the critical flutter value. Thus, the solution procedure follows by increasing the value of λ until κ shows a complex value at which we claim that the flutter has occurred.

The aerodynamic damping and stiffness matrices are made to serve as the aerodynamic pressure by adding a dimensionless aerodynamic pressure that is proportional to airflow velocity. The real part of the eigenvalue will change from being negative to positive or the damping ratio will change from being positive to negative with an increase in aerodynamic pressure. The critical flutter aerodynamic pressure at which the flutter occurs.[20, 21]

The flutter analysis of the composite lattice sandwich panel on elastic basis in [51] is used as an example to better understand the aeroelastic flutter mechanism. The real portion

Ehab Magdy and Mohamed Elsayed, "Review on Flutter Control of Wings and Panels," *International Journal of Multidisciplinary Research and Publications (IJMRAP)*, Volume 5, Issue 8, pp. 33-38, 2023.

of the structure's eigenvalue, real part d, shifts from negative to positive when aerodynamic pressure increases, with 108 being the critical flutter aerodynamic pressure. The vibration response of the panel is convergent for = 105, which is lower than the critical flutter aerodynamic pressure, c_R = 108, and shows that the flutter does not happen.

The wing serves as the primary lift surface of the aero plane when it is flying rapidly. The interaction of elastic force, inertial force, and aerodynamic force results in flutter because structural non linearity and aerodynamic non linearity exist. [52-54] Flutter is a serious problem that puts the aircraft's safety in jeopardy because it might quickly ruin the aircraft's structure or possibly cause it to collapse. Under different conditions, the wing may produce different unstable phenomena such as LCO, Hopf bifurcation,[55] and chaotic motion.

B. Non-linear Strain Displacement Relation

The von Karman large deflection strain-displacement relation for the deflections u, v, and w can be written as follows:

$$\begin{Bmatrix} \varepsilon_x \\ \varepsilon_y \\ \tau_{xy} \end{Bmatrix} = \begin{Bmatrix} u_x \\ v_y \\ u_y + v_x \end{Bmatrix} + \frac{1}{2}\begin{Bmatrix} {w_x}^2 \\ {w_y}^2 \\ 2w_x w_y \end{Bmatrix} - z\begin{Bmatrix} w_{xx} \\ w_{yy} \\ 2w_{xy} \end{Bmatrix}$$

Which may be written in compact for mas:

$$\{\varepsilon\} = \{\varepsilon_m\} + \{\varepsilon_\theta\} + z\{k\}$$

where $\{\varepsilon_m\}$ is the membrain (in-plane) strain, $\{\varepsilon_\theta\}$ is the strain due to non-linear deflections, and $\{\kappa\ \}$ is the lateral curvature. To relate the strain to the nodal displacements (degrees of freedom), we may write:

$$\{k\} = -\begin{Bmatrix} w_{xx} \\ w_{yy} \\ 2w_{xy} \end{Bmatrix} = -\begin{Bmatrix} N_{xx} \\ N_{yy} \\ 2N_{xy} \end{Bmatrix}\{w_b\} = [C_b]\{w_b\}$$

As described before. Also, from the in-plane model of the plates, we may write:

$$\{\varepsilon_m\} = \begin{Bmatrix} u_x \\ v_y \\ u_y + v_x \end{Bmatrix} = [C_m]\{w_m\}$$

While for the non-liner strain, we may write:

$$\{\varepsilon_\theta\} = \frac{1}{2}\begin{Bmatrix} {w_x}^2 \\ {w_y}^2 \\ 2w_x w_y \end{Bmatrix} = \frac{1}{2}\begin{bmatrix} w_x & 0 \\ 0 & w_y \\ w_y & w_x \end{bmatrix}\begin{Bmatrix} w_x \\ w_y \end{Bmatrix} = \frac{1}{2}[\theta][G]$$

In the above step, all what we did is rewriting the non-linear terms into the product of linear terms. That is needed because we will include one of the linear terms in the non-linear matrices, while the other will directly relate to the degrees of freedom. Thus, we may write:

$$\{\varepsilon_\theta\} = \frac{1}{2}[\theta][G] = \frac{1}{2}[\theta]\begin{bmatrix} N_x \\ N_y \end{bmatrix}\{w_b\} = \frac{1}{2}[\theta][C_\theta]\{w_b\}$$

Finally, we may write the total strain:

$$\begin{aligned}\{\varepsilon\} &= \{\varepsilon_m\} + \{\varepsilon_\theta\} + z\{k\} \\ &= [C_m]\{w_m\} + \frac{1}{2}[\theta][C_\theta]\{w_b\} + z[C_b]\{w_b\}\end{aligned}$$

[56] investigated the bifurcation of wing nonlinear flutter and used the equivalent linear method to get the equivalent stiffness of cubic nonlinear stiffness. The corresponding linearization method, which is rather straightforward, is frequently employed to address the flutter issue with supersonic wings. The analogous linearization method is more suited for resolving the flutter issue of the wing under steady airflow, according to [57] study of the limit cycle flutter of a binary wing under steady and unsteady airflows in 1978. The equivalent linearization method was used by[58] to examine the nonlinear flutter stability of wings with large aspect ratios. This method can only be used to solve flutter systems with odd-order nonlinear terms because the first-order averaging method fails for even-order nonlinear terms. In order to study the flutter issues with even-order nonlinear factors using the equivalent linear approach, [59] obtained the quadratic equivalent stiffness of nonlinear stiffness. They also used the method to study the multi degree-of-freedom nonlinear flutter problem,[59] linearized the cubic nonlinear terms of the two degrees of freedom of heave and pitch.

The nonlinear aeroelastic problem of transonic wings has been successfully solved using the aeroelastic analysis approach based on CFD, and it is now possible to estimate the transonic flow field with greater accuracy. The transonic small perturbation equation, the Euler equation, or the N-S equation can all be used to calculate the aerodynamic force in the CFD-based aeroelastic analysis method. The structural model can be expressed using either the structural motion equation or the structural finite element model. Aeroelastic analysis techniques based on CFD have been very popular in recent years for analyzing transonic flutter characteristics. The aeroelastic analysis approach is used to solve the transonic flutter problem of a binary wing subjected to nonlinear aerodynamic forces. based on CFD can be used immediately. The CFD method was used by [60] to analyses the LCO problem of a wing, and the LCO frequencies were in good agreement with the findings of the experimental work done in a wind tunnel. The ternary wing transonic flutter can also be studied using CFD-based aeroelastic analysis techniques. The transonic LCO was computationally simulated by [61], who used the Goland wing model as their research subject and Euler's equation as the flow control equation to determine the LCO for various airflow speeds. In order to evaluate the LCO brought on by the external suspension of the Goland wing model in transonic airflow, [62] also employed a CFD-based aeroelastic analysis approach. According to [63]analysis .'s of the results of CFD time-domain simulations, the Goland wing will display LCO in the tiny Mach number range (from 0.88 to 0.91). [64]used the CFD-based aeroelastic analysis approach to determine the stable pressure distribution of the three-dimensional (3D) wing.

C. Methods of Analysis

Using the variable separation method, the established flutter differential equation may be instantly translated into the frequency domain when linear structural and aerodynamic theories are employed to investigate the panel flutter. The established flutter equation is a nonlinear partial differential equation system that contains both the time and space variables when the structural or aerodynamic theory is nonlinear. Except in the situation of exceedingly simple form, it is impossible to find exact solutions to nonlinear partial differential equations. Therefore, the partial differential equations can only be discretized into finite dimensions ordinary differential equations for the solution using proper spatial discretization techniques. The Galerkin method, the Rayleigh-Ritz method, and FEM are currently the most widely used discrete methods.

REFERENCES

[1] Akhavan, H. and P. Ribeiro "Reduced-order models for nonlinear flutter of composite laminates with curvilinear fibers." AIAA Journal 57(7): 3026-3039.(2019).

[2] Amabili, M. and M. P. Paı¨ doussis "Review of studies on geometrically nonlinear vibrations and dynamics of circular cylindrical shells and panels, with and without fluid-structure interaction." Appl. Mech. Rev. 56(4): 349-381.(2003).

[3] Amabili, M., F. Pellicano and M. Paı¨ doussis "Nonlinear stability of circular cylindrical shells in annular and unbounded axial flow." J. Appl. Mech. 68(6): 827-834.(2001).

[4] Arunkumar, M., J. Pitchaimani, K. Gangadharan and M. Leninbabu "Vibro-acoustic response and sound transmission loss characteristics of truss core sandwich panel filled with foam." Aerospace Science and Technology 78: 1-11.(2018).

[5] Barzegari, M. M., M. Dardel, A. Fathi and M. Ghadimi "Aeroelastic characteristics of cantilever wing with embedded shape memory alloys." Acta Astronautica 79: 189-202.(2012).

[6] Bendiksen, O. O. "Review of unsteady transonic aerodynamics: Theory and applications." Progress in Aerospace Sciences 47(2): 135-167.(2011).

[7] Beran, P. S., N. S. Khot, F. E. Eastep, R. D. Snyder and J. V. Zweber "Numerical analysis of store-induced limit-cycle oscillation." Journal of Aircraft 41(6): 1315-1326.(2004).

[8] Bharati, R. B., M. Filippi, P. K. Mahato and E. Carrera "Flutter analysis of laminated composite structures using Carrera Unified Formulation." Composite Structures 253: 112759.(2020).

[9] Castro, B., J. Ekaterinaris and M. Platzer (2000). Transonic flutter computations for the NLR 7301 airfoil inside a wind tunnel. 38th Aerospace Sciences Meeting and Exhibit.

[10] Chai, Y.-Y., F.-M. Li and Z.-G. Song "Analysis on the Aeroelastic Stability of Open Cylindrical Shells in Subsonic Airflow Using the Theoretical and Two-way CFD/CSD Coupled Methods." International Journal of Acoustics & Vibration 24(3).(2019).

[11] Chai, Y., F. Li and Z. Song "Nonlinear vibrations, bifurcations and chaos of lattice sandwich composite panels on Winkler–Pasternak elastic foundations with thermal effects in supersonic airflow." Meccanica 54(7): 919-944.(2019).

[12] Chen, Y. and J. Liu "On the limit cycles of aeroelastic systems with quadratic nonlinearities." Structural engineering and mechanics: An international journal 30(1): 67-76.(2008).

[13] Cheng, G. and C. Mei "Finite element modal formulation for hypersonic panel flutter analysis with thermal effects." AIAA journal 42(4): 687-695.(2004).

[14] Dowell, E. H. "Panel flutter-A review of the aeroelastic stability of plates and shells." AIAA journal 8(3): 385-399.(1970).

[15] Filippi, M. and E. Carrera "Flutter analysis of fixed and rotary wings through a one-dimensional unified formulation." Composite Structures 133: 381-389.(2015).

[16] Filippi, M. and E. Carrera "Aerodynamic and mechanical hierarchical aeroelastic analysis of composite wings." Mechanics of Advanced Materials and Structures 23(9): 997-1004.(2016).

[17] Gao, C., X. Liu and W. Zhang "On the dispersion mechanism of the flutter boundary of the AGARD 445.6 wing." AIAA Journal 59(7): 2657-2669.(2021).

[18] Garrick, I. and W. H. Reed III "Historical development of aircraft flutter." Journal of Aircraft 18(11): 897-912.(1981).

[19] Gray Jr, C. E. and C. Mei "Large-amplitude finite element flutter analysis of composite panels in hypersonic flow." AIAA journal 31(6): 1090-1099.(1993).

[20] Guimarães, T. A., S. G. Castro, C. E. Cesnik and D. A. Rade "Supersonic flutter and buckling optimization of tow-steered composite plates." AIAA Journal 57(1): 397-407.(2019).

[21] Hall, B. D., D. T. Mook, A. H. Nayfeh and S. Preidikman "Novel strategy for suppressing the flutter oscillations of aircraft wings." AIAA journal 39(10): 1843-1850.(2001).

[22] Hoseini, H. S. and D. H. Hodges "Nonlinear flutter and limit-cycle oscillations of damaged highly flexible composite wings." Nonlinear Dynamics 97(1): 247-268.(2019).

[23] Hussein, O. S. and S. B. Mulani "Nonlinear aeroelastic stability analysis of in-plane functionally graded metal nanocomposite thin panels in supersonic flow." Thin-Walled Structures 139: 398-411.(2019).

[24] Khorshidi, K., M. Karimi and M. Amabili "Aeroelastic analysis of rectangular plates coupled to sloshing fluid." Acta Mechanica 231(8): 3183-3198.(2020).

[25] Koo, K.-N. and W.-S. Hwang "Effects of hysteretic and aerodynamic damping on supersonic panel flutter of composite plates." Journal of Sound and Vibration 273(3): 569-583.(2004).

[26] Li, F.-M. and Z.-G. Song "Flutter and thermal buckling control for composite laminated panels in supersonic flow." Journal of Sound and Vibration 332(22): 5678-5695.(2013).

[27] Li, Q., C. Mei and J.-K. Huang "Suppression of thermal postbuckling and nonlinear panel flutter motions using piezoelectric actuators." AIAA journal 45(8): 1861-1873.(2007).

[28] Lighthill, M. J. "Oscillating airfoils at high Mach number." Journal of the Aeronautical Sciences 20(6): 402-406.(1953).

[29] Liu, J.-K. and L.-C. Zhao "Bifurcation analysis of airfoils in incompressible flow." Journal of Sound and Vibration 154(1): 117-124.(1992).

[30] Liuqing, Y., Y. Zhengyin and W. Xiaochen "Aeroelastic stability analysis of heated flexible panel subjected to an oblique shock." Chinese Journal of Aeronautics 31(8): 1650-1666.(2018).

[31] Livne, E. "Aircraft active flutter suppression: State of the art and technology maturation needs." Journal of Aircraft 55(1): 410-452.(2018).

[32] Mahmoudkhani, S., M. Sadeghmanesh and H. Haddadpour "Aero-thermo-elastic stability analysis of sandwich viscoelastic cylindrical shells in supersonic airflow." Composite Structures 147: 185-196.(2016).

[33] McNamara, J. J. and P. P. Friedmann "Aeroelastic and aerothermoelastic analysis in hypersonic flow: past, present, and future." AIAA journal 49(6): 1089-1122.(2011).

[34] Nezami, M. and B. Gholami "Optimal locations of piezoelectric patches for supersonic flutter control of honeycomb sandwich panels, using the NSGA-II method." Smart Materials and Structures 25(3): 035043.(2016).

[35] Nezami, M. and B. Gholami "Optimal locations of magnetorheological fluid pockets embedded in an elastically supported honeycomb sandwich beams for supersonic flutter suppression." European Journal of Mechanics-A/Solids 74: 81-95.(2019).

[36] Parker, G. H., R. C. Maple and P. S. Beran "Computational aeroelastic analysis of store-induced limit-cycle oscillation." Journal of aircraft 44(1): 48-59.(2007).

[37] Pendleton, E., P. Flick, D. Paul, D. Voracek, E. Reichenbach and K. Griffin (2007). The X-53 A summary of the active aeroelastic wing flight research program. 48th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference.

[38] Sabri, F. and A. A. Lakis "Efficient hybrid finite element method for flutter prediction of functionally graded cylindrical shells." Journal of Vibration and Acoustics 136(1).(2014).

[39] Samadpour, M., H. Asadi and Q. Wang "Nonlinear aero-thermal flutter postponement of supersonic laminated composite beams with shape memory alloys." European Journal of Mechanics-A/Solids 57: 18-28.(2016).

[40] Shahrzad, P. and M. Mahzoon "Limit cycle flutter of airfoils in steady and unsteady flows." Journal of Sound and Vibration 256(2): 213-225.(2002).

[41] Shahverdi, H. and V. Khalafi "Bifurcation analysis of FG curved panels under simultaneous aerodynamic and thermal loads in hypersonic flow." Composite Structures 146: 84-94.(2016).

[42] Shao, C., D. Cao, Y. Xu and H. Zhao "Flutter and thermal buckling analysis for composite laminated panel embedded with shape memory alloy wires in supersonic flow." International Journal of Aerospace Engineering 2016.(2016).

[43] Shubov, M. A. "Flutter phenomenon in aeroelasticity and its mathematical analysis." Journal of Aerospace Engineering 19(1): 1-12.(2006).

[44] Song, Z.-G. and F.-M. Li "Aeroelastic analysis and active flutter control of nonlinear lattice sandwich beams." Nonlinear Dynamics 76(1): 57-68.(2014).

[45] Song, Z.-G. and F.-M. Li "Aerothermoelastic analysis of lattice sandwich composite panels in supersonic airflow." Meccanica 51(4): 877-891.(2016).

[46] Song, Z., L. Zhang and K. Liew "Aeroelastic analysis of CNT reinforced functionally graded composite panels in supersonic airflow using a higher-order shear deformation theory." Composite Structures 141: 79-90.(2016).

[47] Sun, Y., Z. Song, W. Ma and F. Li "Influence mechanism of lumped masses on the flutter behavior of structures." Aerospace Science and Technology 111: 106524.(2021).

[48] Tawfik, M., J.-J. Ro and C. Mei "Thermal post-buckling and aeroelastic behaviour of shape memory alloy reinforced plates." Smart Materials and Structures 11(2): 297.(2002).

[49] Tian, W., T. Zhao and Z. Yang "Nonlinear electro-thermo-mechanical dynamic behaviors of a supersonic functionally graded piezoelectric plate with general boundary conditions." Composite Structures 261: 113326.(2021).

[50] Tsushima, N. and W. Su "A study on adaptive vibration control and energy conversion of highly flexible multifunctional wings." Aerospace Science and Technology 79: 297-309.(2018).

[51] Udrescu, R. (2001). Effects of oscillating shock waves on the dynamics of fluttering panels. 19th AIAA Applied Aerodynamics Conference.

[52] Vio, G. A., G. Dimitriadis, J. E. Cooper, K. J. Badcock, M. A. Woodgate and A. M. Rampurawala "Aeroelastic system identification using transonic CFD data for a wing/store configuration." Aerospace Science and Technology 11(2-3): 146-154.(2007).

[53] Wang, D.-W. and L. Ma "Sound transmission through composite sandwich plate with pyramidal truss cores." Composite Structures 164: 104-117.(2017).

[54] Wang, X., P. Xia and P. Masarati "Active aeroelastic control of aircraft wings with piezo-composite." Journal of Sound and Vibration 455: 1-19.(2019).

[55] Weiliang, Y. and E. Dowell "Limit cycle oscillation of a fluttering cantilever plate." AIAA journal 29(11): 1929-1936.(1991).

[56] Xiang, J., Y. Yan and D. Li "Recent advance in nonlinear aeroelastic analysis and control of the aircraft." Chinese journal of aeronautics 27(1): 12-22.(2014).

[57] Xie, C. and C. Yang "Linearization method of nonlinear aeroelastic stability for complete aircraft with high-aspect-ratio wings." Science China Technological Sciences 54(2): 403-411.(2011).

[58] Xie, F., Y. Qu, Q. Guo, W. Zhang and Z. Peng "Nonlinear flutter of composite laminated panels with local non-smooth friction boundaries." Composite Structures 223: 110934.(2019).

[59] Xie, F., Y. Qu, W. Zhang, Z. Peng and G. Meng "Nonlinear aerothermoelastic analysis of composite laminated panels using a general higher-order shear deformation zig-zag theory." International Journal of Mechanical Sciences 150: 226-237.(2019).

[60] Yang, C., G. Li and Z. Wan "Aerothermal-aeroelastic two-way coupling method for hypersonic curved panel flutter." Science China Technological Sciences 55(3): 831-840.(2012).

[61] Yang, Z., R. Huang, Y. Zhao and H. Hu "Transonic flutter suppression for a three-dimensional elastic wing via active disturbance rejection control." Journal of Sound and Vibration 445: 168-187.(2019).

[62] Ye, L.-Q. and Z.-Y. Ye "Effects of shock location on aeroelastic stability of flexible panel." AIAA Journal 56(9): 3732-3744.(2018).

[63] Zappino, E., E. Carrera and M. Cinefra "Aeroelastic analysis of composite pinched panels using higher-order shell elements." Journal of Spacecraft and Rockets 52(3): 999-1003.(2015).

[64] Zhang, Q., K. Ye, Z.-y. Ye and W.-w. Zhang "Aerodynamic optimization for hypersonic wing design based on local piston theory." Journal of Aircraft 53(4): 1065-1072.(2016).