MFC於薄板翼翅的顫振模態控制

林勝義、羅正忠

E-mail: 363561@mail.dyu.edu.tw

摘 要

本論文是研究翼翅平板結構在面對外力振動或發生顫振時，如何有效運用MFC致動器保護平板結構，在任何振動模態下不會造成破壞，方法是當平板結構發生彎曲與扭曲模態時，加入阻尼或是運用外接分流電路消耗平板內能的方式來達到抑振的目標。 上述外加阻尼的方法稱之為主動式控制法，係運用雷射位移計、低通濾波器、電壓放大器以及MFC致動器，構成一套具速度回饋的系統以抑制振動。而外接分流電路的方法稱為被動式控制法，是運用MFC與R-shunt、RL-shunt的數學模型，將主動式實驗所得數據代入模型中，以探討被動式方法的可行性與效果。 最後為主、被動式混合控制；結合兩控制方式的優點透過數學模型進行模擬後，再與主動式、被動式控制結果比較，以了解減振效益。

關鍵詞 : 翼翅平板、MFC致動器、壓電分流器、顫振抑制、混合式控制

目錄

參考文獻

[1]Baz, A. and Ro, J.“ The Concept and Performance of Active Constrained Layer Damping Treatments, ” Sound and Vibration Magazine, 18-21, 1994.

[2]Baz, A. and Ro, J.“ Performance Characteristics of Active Constrained Layer Damping, ” Shock and Vibration Magazine, 33-42, 1995.

[3]Ro, J. and Elsaadawy, Ehab“ Flutter Suppression and Vibration Control of Plate-Wing Using Self-sensing Active Constrained Layer Damping, ” Proceedings of 6th International Forum on Aeroelasticity and Structural Dynamics on June 22-25, Williamsburg, VA, pp.543-552, (1999).

[4]Nam, C., Kim, Y. and Weisshaar, T. A.“ Optimal Sizing and Placement of Piezo-Actuators for Active Flutter Suppression, ” Smart Materials and Structures, 5, pp.216-224 , (1996) [5]Nam C., Oh, S. and Kim, W.“ Active Flutter Suppression of Composite Plate with Piezoelectric Actuators, ” AIAA, pp.94-1745, (1994).

[6]Nam, C. and Y. Kim“ Optimum Design of Adaptive Composite Lifting Surface for Flutter Suppression, ” AIAA Journal, 33, pp.1897-1904, (1995).

[7]Suleman, A., Costa, A. P., Moniz, P. A.,“ Experimental Flutter and Buffeting Suppression Using Piezoelectric Actuators and Sensors, ” SPIE Proceedings, Vol. 3674, pp.72-83, (1999).

[8]Heeg, Jennifer“ An Analytical and Experimental Investigation of Flutter Suppression via Piezoelectric Actuators, ” AIAA, pp.92-2106, (1992).

[9]Heeg, Jennifer“ Analytical and Experimental Investigation of Flutter Suppression by Piezoelectric Actuation, ” NASA Technical Paper 3241, (1993).

[10]Nam, C., Chen, P. C., Liu, Danny D., Chattopadhyay, A., and Kim, J.“ Neural Net-based Controller for Flutter Suppression Using ASTROs

with Smart Structures, ” SPIE Proceedings, 3985, pp.98-109, (2000).
[11]Hagood and Von Flotow, A., “ Damping of Structural Vibrations with Piezoelectric Materials and Passive Electrical Network ”, Journal of Sound and Vibration, 249(2), pp. 227-250, 2002.
[12]Clark, W.W., “ Vibration Control with State-Switched Piezoelectric Materials, ” Journal of Intelligent Material Systems and Structures, Vol. 11, pp. 263-271, 2000.
[13]Onoda, Junjiro; Makihara, Kanjuro And Minesugi, Kenji, 2003, ‵Energy-Recycling Semi-Active Method for Vibration Suppression with Piezoelectric Transducer′ , AIAA Paper, 2003-1869.
[14]Xu, S. X. and Koko T. S., “ Finite element analysis and design of actively controlled piezoelectric smart structures ”, Finite Elements in Analysis and Design, 40, pp.241-262 , 2004.
[15]Ahmadian, M. and Deguilio, A. P., “ Recent Advances in the Use of Piezoceramics for Vibration Suppression, ” The Shock and Vibration Digest, 33(1), pp. 15-22, 2001.
[16]Forward, R. L., “ Electronic Damping of Vibration in Optical Structures ”, Journal of Applied Optics, 18(5), pp. 690-697, 1979.
[17]Saravanos, D. A., “ Damped Vibration of Composite Plates With Passive Piezoelectric-Resistor Elements, ” Journal of Sound and Vibration, 221(5), pp. 867-885, 1999.
[18]Davis, L. C. and George, A. L., “ an Actively Tuned Solid-state Vibration Absorber Using Capacitive Shunting of Piezoelectric Stiffness, ” Journal of Sound and Vibration, 232(3), pp. 601-617, 2000.
[19]Behrens, S., Fleming, A. J., and Moheimani, S. O. R, “ A broadband Controller for Shunt Piezoelectric Damping of Structural Vibration, ” Smart Materials and Structures, 12(1), pp. 18-28, 2003.
[20]Kim, J., Ryu, Y-H. and Choi, S-B., “ New Shunting Parameter Tuning Method for Piezoelectric Damping Based on Measured Electrical Impedance, ” Smart Materials and Structures, 9(6), pp. 868-877, 2000.
[21]Azzouz, M. S., Mei, C., Bevan, J. S. and Ro, J. “ Finite Element Modeling of MFC/AFC Actuators and Performance of MFC, ” Journal of Intelligent Materials Systems and Structures, 12(9), pp.601-612, (2001).
[22]Kim, Seung Jo, Hwanh, Joon Seok and Paik, Seung Hoon “ Direct Numerical Simulation of Active Fiber Composite, ” Proceedings of SPIE 5053, pp.568-575, (2003).
[23]Williams, R. B., Inman, D. J. and Wilkie, W. K., “ Temperature-Dependent Coefficients of Thermal Expansion for Macro Fiber Composite Actuators, ” Proceedings, 5th International Congress on Thermal Stresses, Blacksburg, VA, June 8-11, (2003).
[24]Williams, R. B., Inman, D. J. and Wilkie, W. K., “ Nonlinear Mechanical Behavior of Macro Fiber Composite Actuators, ” Proceedings of the Sixth International Conference on Sandwich Structures, March 31-April 2, (2003).
[25]Williams, R. B., Schultz, M. R., Hyer, M. W., Inman, D. J. and Wilkie, W. K., “ Nonlinear Tensile and shear behavior of Macro Fiber Composite Actuators, ” J. Composite Materials, 38, pp.855-69, (2004).
[26]O Thomas,J Ducarne and J-F Deu ?, “ Performance of piezoelectric shunt for vibration reduction ”, Smart Materials and Structures, 21, 015008(16pp), (2012) [27]J. Ducarne, O. Thomas and J-F Deu ?, “ Placement and dimension optimization of shunted piezoelectric patches for vibration reduction ”, Journal of Sound and Vibration, 331, pp.3286-3303, (2012) [28]Quan Wang and Nan Wu, “ A review on structural enhancement and repair using piezoelectric materials and shape memory alloys ”, Smart Materials and Structures, 21, 013001(23pp), (2012) [29]周卓民, “ 壓電力學 ”, 全華科技圖書股份有限公司, 台北（1992/11）。
[30]“ 陶瓷技術手冊 ”, 經濟部技術處發行, 中華民國產業科技發展協進會與中華民國粉末冶金協會出版（1994/07）。
[31]楊育彰, “ 壓電噴射氣流器設計參數效能評估 ”, 大葉大學碩士論文, 2004。
[32]www.mc2.chalmers.se [33]www.nanowerk.com.
[34]周逸翔, “ 翼翅平板結構的主被動式顫振控制 ”, 大葉大學碩士論文, 2011。
[35]周忠誠, “ 壓電元件與複合壓電結構之動態特性分析與實驗量測 ”, 台灣大學機械工程研究所博士論文, 台北(1998/06)。
[36]D. A. Berlincourt, D. R. Curran and F. Patat, “ Piezoelectric and piezomagnetic materials and their function as transducers ” in Physical Acoustic, W. P. Mason Ed., 1A, Academic Press, New York, 1964.
[37]W. P. Mason, Piezoelectric crystal and their application to ultrasonics, Van Nostrand, New York,（1950） [38]A. F. Ulitko, “ On the theory of electromechanical conversion of energy in nonuniformly deformed pizeoceramic bodies, ” Prik. Mekh., Vol.13(1997).
[39]周卓民, “ 層狀壓電薄殼之研究:設計、製程與實驗 ”, 台灣大學應用力學研究所博士論文, 台北(1997/06)。
[40]T. Ikeda, Fundamentals of Piezoelectricity, Oxford University Press, 1996. pp.11-21.
[41]J. Zelenka, Piezoelectric Resonators and their Application, Elsevier Science Publisher, 1986, pp. 22-34.
[42]池田拓郎 著、陳世春 譯著, “ 基本壓電材料學 ”, 復興出版社出版(1997/12) [43]Nellya N. Rogacheva, “ The theory of piezoelectric shells and plates ”, Institute for Problems in Mechanics Russian Academy of Sciences, Moscow,Russia(1994).
[44]C. K. Lee , “ Pizeoelectric laminates for torsional and bending modal control:theory and experiment ”,A PhD. Thesie presented to the faculty of the graduate school of Cornell University(1978).
[45]錢偉長, “ 彈性力學 ”, 亞東書局, 台北(1991)。
[46]www.smart-material.com.

[47]W.-K. Chen, Passive and Active Filter : Theory and Implementations, John Wiley & Sons, 1986, pp. 324-332