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Wrinkling and Buckling of a New Swept Baffled Inflatable Wing Structure

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ABSTRACT

Due to its flexibility and foldable ability, the inflatable wing is widely employed to loitering munitions and aerostats [1-3]. Meanwhile, as a typical flexible thin-walled structure, the wrinkling and buckling behaviors of the inflatable wing induced in flight will limit its load-bearing capacity [4,5]. Therefore, a wrinkling-resistant structural configuration is the key to improving performance of the inflatable wing. Among various schemes, the swept baffled structure is considered to have the potential to retard wrinkling because of the designable axis of twist [6,7]. However, owing to the flexible large deformation of inflatable wing under aerodynamic loads, the wrinkling-resistant performance and mechanization of the swept baffled configuration is still unrevealed. In this paper, the wrinkling behavior of inflatable wings with various sweep angle of baffles including 0 °, ±25 ° and ±50 ° are comparatively analyzed based on fluid-structure interaction (FSI) method. The concept of wrinkled factor is adopted for identifying wrinkled zone in computational structural mechanics (CSM) solver, and a universal criterion is adopted for determining the occurrence of buckling. Result shows that a smaller wrinkled area can be achieved by designing a larger sweep angle of baffles, and the inflatable wing with forward-swept baffles shows superiority in distribution of wrinkled zone and torsional displacement. Works in this study can be a reference for the design of inflatable wing.

KEYWORDS

Inflatable wing; wrinkling; buckling; load-bearing capacity; fluid-structure interaction

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References

1. Aris, A., Song, Y. Y., Nam, T., Sible, S., Dong, S., Gali, D. et al. (2022). Design, Analysis, Test and Fabrication of Baffled Inflatable Wing for Airborne Wind Energy. *Proceedings of AIAA SCITECH Forum 2022,* pp. 1-16. California, USA.
2. Pulliam, W., Norris, R. (2009). Historical perspective on inflatable wing structures. *Proceedings of the 50th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference,* pp. 1-10. California, USA.

3. Sudduth, C., Jacob, J. (2013). Flight testing of a hybrid rocket/inflatable wing UAV. *Proceedings of the 51st AIAA Aerospace Sciences Meeting including the New Horizons Forum and Aerospace Exposition,* pp. 1-18. Texas, USA.
4. Li, B., Dong, N. N., Feng, Z. Z., Niu, W. C. (2016). Wrinkling and failure behavior research of inflated wing. *Acta Aeronautica et Astronautica Sinica, 37(10),* 3044-3053. (in Chinese)
5. Simpson, A., Rowe, J., Smith, S., Jacob, J. (2007). Aeroelastic Deformation and Buckling of Inflatable Wings Under Dynamic Loads. *Proceedings of the 48th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference,* pp. 1-22. Waikiki, Hawaii.
6. Ma, N., Liu, L., Meng, F. M., Meng, J. H. (2023). Structural design and modal behaviors analysis of a new swept baffled inflatable wing. *Defence Technology, 24,* 382-398.
7. Meng, F. M., Ma, N., Ma, W. C., Meng, J. H., Li, W. G. (2023). Wet modal analysis and tests for inflatable wing with swept air-beams. *Acta Aeronautica et Astronautica Sinica, 44(02),* 228-242. (in Chinese)