NUMERICAL RESEARCH ON FLUID-STRUCTURE INTERACTION OF LARGE-SCALE INFLATABLE MEMBRANE STRUCTURES FOR STRATOSPHERIC AIRSHIPS

Zhenyu MA, Xiaolong DENG, Xixiang YANG and Zhongxi HOU

College of Aerospace Science and Engineering, National University of Defense Technology, ChangSha 410073, China

Tel: 0086-0731- 87007138, Fax: 0086-0731-87007138,

Email: mazhenyu@nudt.edu.cn

Abstract

With the advantage of long endurance, station keeping and low cost-effectiveness, stratospheric airships have the potential to be the platforms suitable for applications and missions such as earth observation, surveillance, navigation, communication relay and broadcasting. As a large-scale flexible inflatable structure by a huge inner lifting gas volume of several hundred thousand cubic meters, the sensitive characteristic of inner gas and complex wind field of atmospheric environment play important roles in its structural performance. In addition to the applied loads of outside wind field, the day-night variations of the combined thermal conditions lead to the fluctuations of the flow field inside the airship, which will remarkably affect the structural safety of the stratospheric airship.

According to the fluid-structure coupling mechanism mentioned above, a numerical procedure of fluid-structure interaction analysis of inflatable membrane for stratospheric airships is developed. The CFD model of inside and outside flow field and the finite element model of membrane structures are integrated. Based on the validation of the computation models, the distributions of the deformations and stresses of the membrane of the stratospheric airship are calculated. The effects of flight conditions and structural configurations on the inflatable membrane structural performance of stratospheric airships are evaluated. The numerical results can be referenced for the structural design of the large-scale inflatable membrane Structures for stratospheric airships.