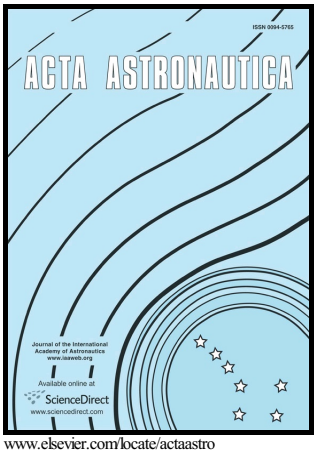

www.elsevier.com/locate/actaastro

The influence of the elastic vibration of the carrier to the aerodynamics of the external store in air-launch-to-orbit process

Yang Lei, Ye Zheng-yin, Wu jie

PII: S0094-5765(16)30549-5
DOI: http://dx.doi.org/10.1016/j.actaastro.2016.07.029
Reference: AA5932

To appear in: *Acta Astronautica*

Received date: 7 June 2016
Accepted date: 22 July 2016

Cite this article as: Yang Lei, Ye Zheng-yin and Wu jie, The influence of the elastic vibration of the carrier to the aerodynamics of the external store in air launch-to-orbit process, *Acta Astronautica* http://dx.doi.org/10.1016/j.actaastro.2016.07.029

The influence of the elastic vibration of the carrier to the aerodynamics of the external store in air-launch-to-orbit process

Yang Lei*, Ye Zheng-yin, Wu jie

National Key Laboratory on Aerodynamic Design and Research, School of Aeronautics, Northwestern Polytechnical University, Xi'an 710072, P.R.China

*Corresponding author: Yang Lei, email address: yangyichuan0768@163.com

Abstract

The separation between the carrier and store is one of the most important and difficult phases in Air-launch-to-orbit technology. Based on the previous researches, the interference aerodynamic forces of the store caused by the carrier are obvious in the earlier time during the separation. And the interference aerodynamics will be more complex when considering the elastic deformation of the carrier. Focusing on the conditions that in the earlier time during the separation, the steady and unsteady interference aerodynamic forces of the store are calculated at different angle of attacks and relative distances between the carrier and store. During the calculation, the elastic vibrations of the carrier are considered. According to the cause of formations of the interference aerodynamics, the interference aerodynamic forces of the store are divided into several components. The relative magnitude, change rule, sphere of influence and mechanism of interference aerodynamic forces components of the store are analyzed quantitatively. When the relative distance between the carrier and store is small, the interference aerodynamic forces caused by the elastic vibration of the carrier is about half of the total aerodynamic forces of the store. And as the relative distance increases, the value of interference aerodynamic forces decrease. When the relative distance is larger than twice the mean aerodynamic chord of the carrier, the values of interference aerodynamic forces of the store can be ignored. Besides, under the influence of the steady interference aerodynamic forces, the lift characteristics of the store are worse and the static stability margin is poorer.

Keywords: Air-launch-to-orbit; interference aerodynamics; elastic vibration; dynamic response

I. Introduction

Air-launch-to-orbit is the method of launching rockets at altitude from a conventional horizontal takeoff aircraft, to carry payload to the earth orbit [1]. With this method, the space activities will become less reliant on the launch site support and launch window, and the launch costs will decrease [2-3]. In future, air-launch-to-orbit will be a rapid, flexible and economical way for space launching.

The separation between the carrier and store is one of the most important and difficult phases in air-launch-to-orbit technology. In order to ensure that the separation process could run smoothly, many separation methods are designed by the researchers. The common methods are captive on