Aerodynamic characteristics identification of missile control surfaces

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1 Introduction

The paper presents the results of load cell measurements and flow visualization research of two different types of missile aerodynamic control surfaces for Mach 2 conditions. The first one was taken from canard-controlled short range surface-to-air missile (SAM), the second one was a wrap-around fin (WAF) from a unguided spin-stabilized, tube-launched rocket. The aim of the work was to identify the basic aerodynamic characteristics of the objects and validate numerical model of canard control surface.

2 CFD simulation of standalone canard control surface

Due to the application, comparable experimental and numerical data from literature were very limited [1]. To facilitate this drawback, the numerical model of canard control surface was built for free-stream and wind tunnel configuration conditions for direct comparison with experimental data. It was used, inter alia, to assess the interference of external bodies, like nose cone, flat wall on the forces and moments measured solely on the surface. Numerical simulation shows also pressure distribution on the surface which cannot be measured at the moment.

3 Wind tunnel experiments of aerodynamic surfaces

All experiments were carried out using IAAM supersonic wind tunnel. It is an open circuit, intermittent (steady flow maintained usually for 1.5 s), in-draft (suction) type of wind tunnel with Mach 2 de Laval nozzle. The test section has 100 mm width and 350 mm height. However, it is mainly utilized for approximately 2-D flow examination, in this study 3-D geometries were tested with success. The models were mounted to the customized circular disc - aluminum for a load cell and PMMA for flow visualization and put inside the test section through the cavity in the side wall. In this arrangement the change of angle of attack is realized only by disc rotation.

The 6-component external load cell was used for forces & moments data acquisition.

The full time history for each test was stored to examine the flow behavior in the non-stationary phases (opening, closing) of wind tunnel operation as well as blockage possibility determination.

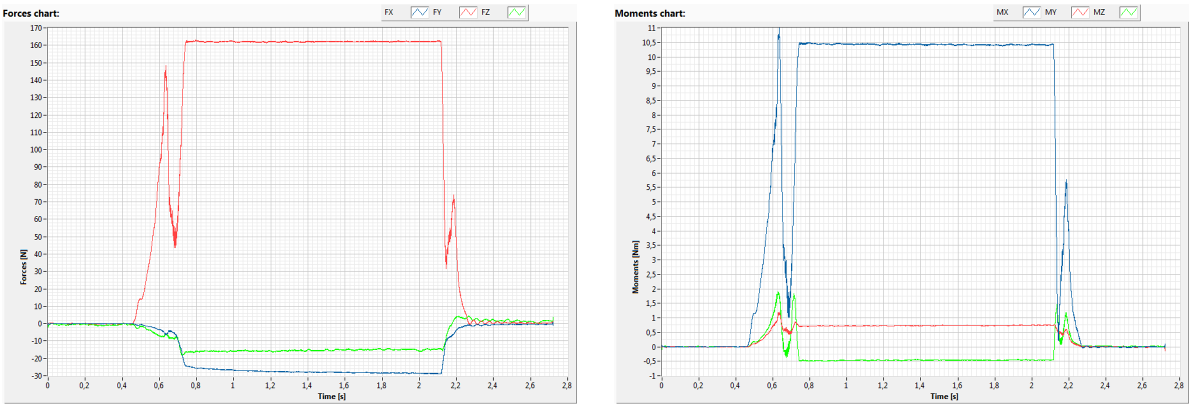

Figure 1: Time history of forces and moments for a single load cell measurement of canard control surface

The flow visualization was prepared by using a Schlieren photograph optical system with 270 mm diameter mirrors. The continuous light source paired with high-speed camera proved to be sufficient to capture major flow phenomenon like shock wave pattern and side wall reflections.

Figure 2: Visualization of flow around wrap-around fin, $\alpha = 1°$, Mach = 1.9

References

[1] Murmun S.M. *Cartesian-Grid Simulations of a Canard-Controlled Missile with a Spinning Tail*, 21st AIAA Applied Aerodynamics Conference, Orlando, FL, AIAA-2003-3670, pp. 1–12, 2003.