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Assessment of the Aerodynamic Effects of a Configuration with two Auxiliary Fuel Tanks and two Ofab-100-120 Bombs on the Aerodynamic Characteristics of a Combat Aircraft

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Abstract- This paper evaluates the aerodynamic effects of an external-store configuration consisting of two auxiliary fuel tanks and two OFAB-100-120 bombs on the aerodynamic characteristics of a combat aircraft using the computational fluid dynamics (CFD) method. A three-dimensional model of the aircraft with the investigated external stores was developed in SolidWorks and analyzed using ANSYS CFX. The computational study was performed at an altitude of H = 4 km for two Mach numbers, M = 0.4 and M = 0.8, over an angle-of-attack range from 0° to 21° with zero sideslip. The external stores modify the local flow field near the pylons and alter the pressure distribution over the wing. At M = 0.8, the flow field becomes more sensitive to the geometry of the external-store region because local supersonic regions and shock waves develop on the wing. The variation of the lift coefficient Cy with angle of attack is also affected. For the investigated external-store configuration, at M = 0.4, Cy increases approximately linearly from 0° to 15°, increases more gradually from 15° to 18°, and then decreases for α > 18°. At M = 0.8, Cy increases approximately linearly from 0° to 9°, increases gradually from 9° to 16°, and begins to decrease for α > 16°. Compared with the clean configuration, the angle-of-attack range favorable for maintaining lift is therefore reduced at M = 0.8. Although the external stores alter the pressure distribution, their overall effect on lift is relatively small within the investigated configuration. Their more pronounced aerodynamic effect is an increase in frontal drag caused by the area and geometry of the external-store elements exposed to the airflow. The results indicate that each external-store configuration should be evaluated separately when assessing aircraft aerodynamic characteristics and operational performance.

Keywords— combat aircraft, external stores, weapon carriage, CFD, drag, lift coefficient

I. INTRODUCTION

In practical operation, combat aircraft may perform missions with different external-store configurations. The installation of auxiliary fuel tanks and bombs introduces external stores outside the main aerodynamic surfaces, thereby disturbing the flow field, changing the pressure distribution, and potentially generating additional drag. These changes must be evaluated separately for each external-store configuration to avoid extrapolating conclusions from the clean aircraft configuration.

This paper focuses exclusively on a configuration comprising two auxiliary fuel tanks and two OFAB-100-120 bombs, with the objective of determining the changes in the pressure field and the variation of Cy with angle of attack at M = 0.4 and M = 0.8. The analysis is separated from the clean-configuration study in order to clarify the aerodynamic effects of the external stores.

II. MODEL AND COMPUTATIONAL METHOD

A 3D model of the aircraft with external stores was developed in SolidWorks and analyzed using ANSYS CFX. The investigated configuration consists of two auxiliary fuel tanks and two OFAB-100-120 bombs mounted beneath the wings. The computational domain was meshed with particular attention to mesh quality in the wing and pylon regions. The computational conditions were an altitude of H = 4

km, compressible flow at M = 0.4 and M = 0.8, angle of attack α from 0° to 21°, sideslip angle β = 0°, a fully rigid structure, and no heat transfer with the surroundings.

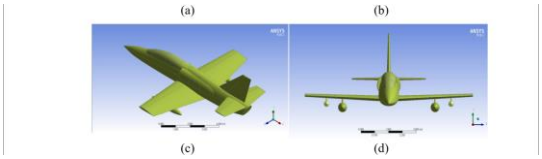

Figure 1. Combat aircraft model with two auxiliary fuel tanks and two OFAB-100-120 bombs.

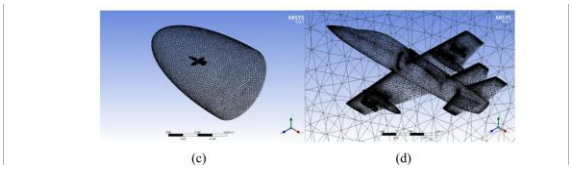

Figure 2. Computational mesh of the combat aircraft model with the investigated external-store configuration.

III. RESULTS AND DISCUSSION

1. Pressure Distribution

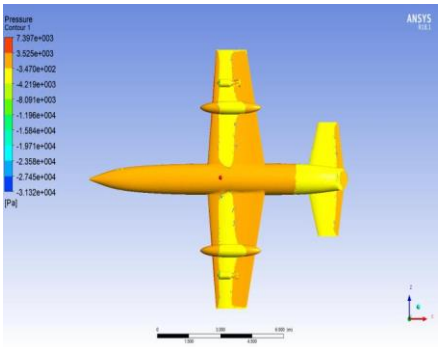

Figure 3. Pressure field of the aircraft with the external-store configuration at M = 0.4; α = 5°.

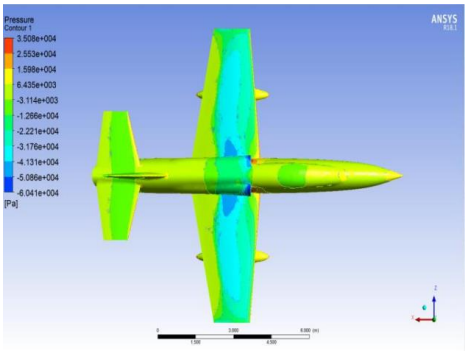

Figure 4. Pressure field of the aircraft with the external-store configuration at M = 0.8; α = 5°.

Installation of the external stores changes the local wing cross-sectional geometry at the pylon locations, disturbing the airflow and altering the pressure distribution on the lower wing surface. At M = 0.8, in addition to the effect of the external stores, local supersonic regions and shock waves also develop on the wing, making the flow field more sensitive to geometric changes in the external-store region.

2. Variation of the Lift Coefficient

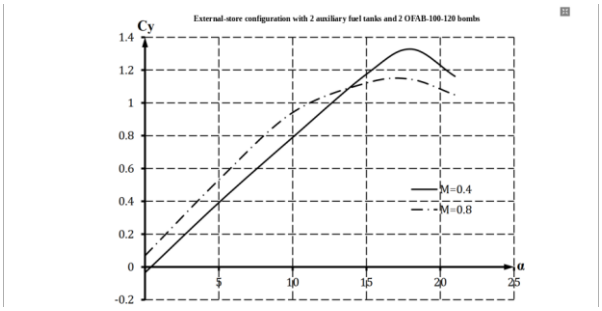

Figure 5. Variation of the lift coefficient Cy with angle of attack α for the external-store configuration.

At M = 0.4, the Cy–α curve for the external-store configuration still exhibits three regions: an approximately linear increase from 0° to 15°, a gradual increase from 15° to 18°, and a decrease for α > 18°. At M = 0.8, the variation shifts clearly toward lower angles of attack: Cy increases approximately linearly from 0° to 9°, increases gradually from 9° to 16°, and begins to decrease for α > 16°. Compared with the clean configuration, this indicates that the external stores reduce the angle-of-attack range favorable for maintaining lift at M = 0.8.

Although the external stores alter the pressure distribution, they do not produce a large change in lift for the investigated configuration. Their more pronounced effect is an increase in frontal drag caused by the area and geometry of the external-store elements exposed to the airflow.

IV. OPERATIONAL SIGNIFICANCE

The results show that the same aircraft may have different aerodynamic limits when the external-store configuration is changed. For the configuration with two auxiliary fuel tanks and two OFAB-100-120

bombs, particular attention should be paid to high-speed conditions, where compressibility and shock waves make the effects of the external stores more pronounced. Within the scope of the data presented in this paper, the changes in Cy and the critical angle-of-attack range determined by CFD are important indicators for evaluating the flight characteristics of the aircraft with external stores.

V. CONCLUSIONS

This study assessed the aerodynamic effects of a configuration with two auxiliary fuel tanks and two OFAB-100-120 bombs on a combat aircraft. The external stores modify the flow field and pressure distribution in the wing regions containing pylons and increase frontal drag. Their overall effect on lift is relatively small for the investigated configuration. However, at M = 0.8, the angle of attack beyond which Cy begins to decrease shifts from approximately 20° for the clean configuration to approximately 16° with the external stores. The results confirm that each external-store configuration should be evaluated separately when assessing the aerodynamic characteristics and operational performance of an aircraft.

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