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Computational Aerodynamic Analysis on Store Separation from Aircraft using Pylon

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ABSTRACT: *The prediction of the separation movements of the external store weapons carried out on military aircraft wings under transonic Mach number and various angles of attack is an important task in the aerodynamic design area in order to define the safe operational-release envelopes. A fighter aircraft carries various types of stores such as drop tanks, missiles, and bombs. Depending on the mission requirements, the stores are jettisoned either by gravity or by using ejection forces at various Mach numbers and altitudes in cruise, dive, or combat maneuver conditions. Wind-tunnel testing can be quite expensive and not possible at various flight conditions. CFD provides an effective approach to this problem. In the past, potential flow methods were used to predict the separation characteristics of stores released from fighter aircraft. These methods are limited to subsonic and supersonic flows. This analysis is applied for surface pressure distributions and various trajectory parameters during the entire store-separation event at various angles of attack. The efficiency of the applied computational analysis gives satisfactory results compared, when possible, against the published data of verified experiments.* ***This paper studies the separation of a generic store released from a typical wing pylon of a fighter aircraft at Mach number 0.95. A collection of computational fluid dynamic tools and techniques are being developed and tested for application to stage separation and abort simulation for next-generation launch vehicles.***

Keywords*: Pylon, Store, Angle of attack, Mach number.*

I. INTRODUCTION

The advancement of CFD has had a major impact on projectile design and development improved computer technology and state of the act numerical procedures enable solutions to complex. These dimensional 3d problems associated with projectile and missile aerodynamics. In general these techniques produce accurate and reliable numerical results for projectile and missile at small angle of attacks modern maneuvering projectile and missile and expected to experience moderate to large angle of attacks during flight accurate determination of high angle of attacks flow field for these configuration is critical. The work presented in this paper was initiated as part of our project program effort aimed at assuming the capabilities of Navier- Stokes solver currently available in various software like CFD, FLUENT and etc. The present research focus on the CFD and CFX solver for high angle of attack flows. The grid techniques involves generating numerical grids about each body component and the oversetting them on to a base grid to form the complete model with this ROBUST(octree) grid approach it is possible to determine the 3d floe field of the finned missile system and associated aerodynamic forces and moments at different angle at different parameters.

II. METHODOLOGY

External Store Separation:

The configuration consisted of a generic finned store and clipped delta wing with a 45 degree of leading edge sweep angle the store pressure data , velocity data temperature data over the wing and as long as store will be developed with the software ICEM CFX post processor. Pressure and flow visualization data will be developed with the obtained results at the angle of attacks -2 in the software CFX. Test conditions included mach number‘s 0.9 at normal Reynolds number of 2.4 × 106/ ft.

III. TEST ARTICLES

The test article includes a clipped delta wing (NACA 64A010) airfoil section with a detachable pylon and metric and finned generic store with 4fins and the fin design is incorporated with NACA 0008 airfoil section with 60 degree of leading edge sweep angle. All the pressure, temperature and velocity variations at each point can be obtained over the surface of wing and store with post processor.

IV. TEST CONDITIONS

Data will be obtained at mach number of 0.95 and 1.2 at a constant unit Reynolds number of 2.4 × 106/ ft the test conditions will be held by varying the store on the wing and store model attitudes i,e. tests will be conducted on two different way's

1. Non- separated store at mach 0.95
2. Separated store at mach 0.95

V. GEOMETRY

GEOMETRY MODELLING OF 2D WING AND 3-D WING:

The geometry of the 2-D and 3-D wing is selected and using this geometry the model has been created using ICEM CFD. This created geometry is checked for any defects using icons in the edit tool and go for meshing the geometry.

WING:

SELECTED AEROFOIL : NACA 64A010 45 degree of L.E
CHORD LENGTH : 8.5 inch
LENGTH: 8m (From Leading Edge)
: 7m (From Trailing Edge)
WIDTH : 5 m (From Leading Edge)
: 7m (From Trailing Edge)

PYLON:

LENGTH : 6.5inch at 0.766inch from L.E
THICKNESS : 0.294inch
RADIUS : 1.250inch from 0.585 distance from the tip
HEIGHT : 1.2inch from the mean chamber line of airfoil

STORE:

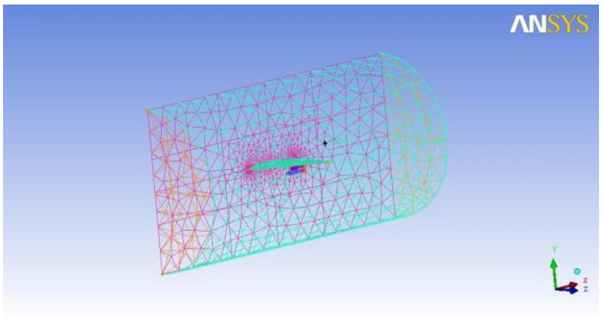
LENGTH : 6.667inch
RADIUS : 3.028inch at L.E of store
: 3.208inch at T.E of store

FIN:

AIRFOIL SECTION : NACA 0008 60 degree of L.E

GENERAL MESH REPORT FOR THE WING PYLON AND STORE

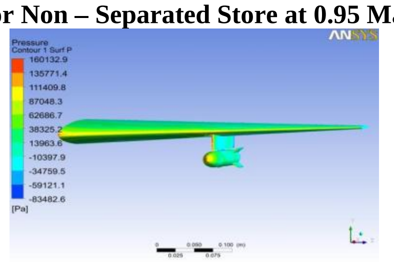
TOTAL NODES: 185449
TOTAL ELEMENTS: 250956

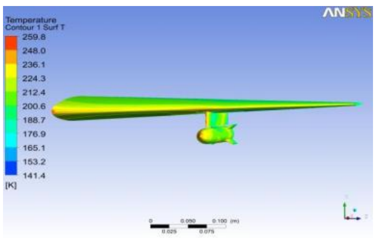


IV. COMPUTATIONAL ANALYSIS

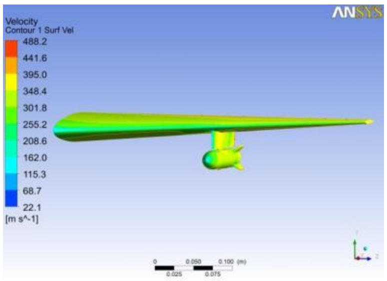
Mesh Report for non-separated store at mach 0.95 alpha -2

Contours for Non – Separated Store at 0.95 Machalpha -2

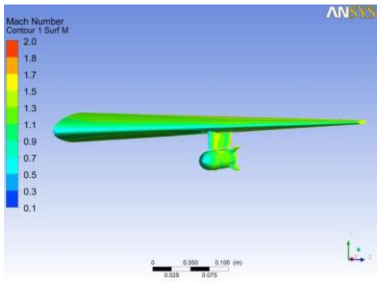




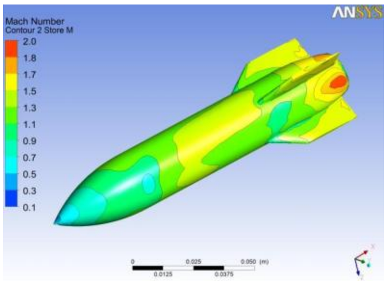
Pressure contour on surface **Temperature contour on surface**



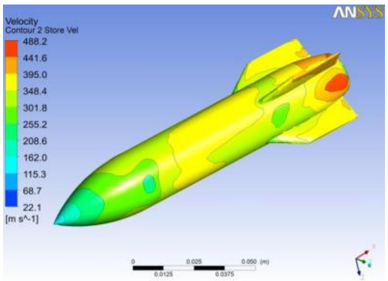
Velocity contour on surface



Mach number contour on surface



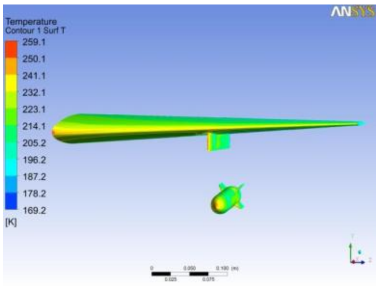
Mach number contour on store



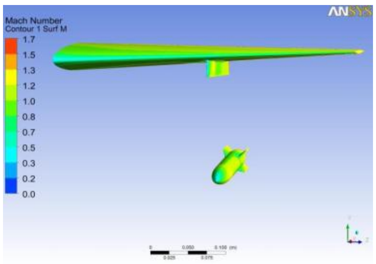
Velocity contour on store

Contours for Separated Store at 0.95 Mach And At Different Loctions at ALPHA -2

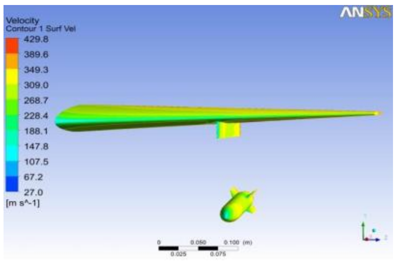
At psi 1.97
Pressure contours on surface



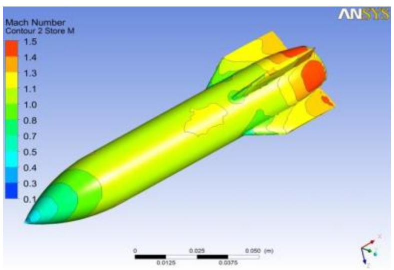
At psi 4.95
Temperature contours on surface



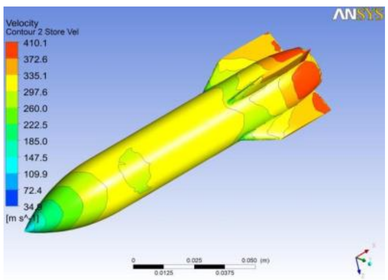
At psi 12.01
Mach number contour on surface



at psi 8.95
Velocity contour on surface



Mach number contour on store



Velocity contour on store

V. RESULTS OF SIMULATION

Force Momentum Data for Non – Separated Store

Wing Pylon Store		**M0.95d 0a-2**
Force_X	wing	326.62
Force_Y	wing	698.84
Force_Z	wing	-320.21
Pitching Moment	wing	-95.69
Force_X	pylon	20.59
Force_Y	pylon	-9.10
Force_Z	pylon	10.50
Pitching Moment	pylon	-22.54
Force_X	store	1.31
Force_Y	store	59.05
Force_Z	store	-31.62
Pitching Moment	store	-1.8438
Rolling Moment	store	-0.1078
Yawing Moment	store	1.5751
AOA		**-2**

Force Momentum Data For Separated Store

Separated Store		**M0.95d0 a-2**
Force_X	**wing**	**423.94**
Force_Y	**wing**	**712.00**
Force_Z	**wing**	**-251.64**
Pitching Moment	**wing**	**29.82**
Force_X	**pylon**	**22.41**
Force_Y	**pylon**	**-18.02**
Force_Z	**pylon**	**-25.00**
Pitching Moment	**pylon**	**2.62**
Force_X	**store**	**65.14**
Force_Y	**store**	**26.47**
Force_Z	**store**	**-32.44**
Pitching Moment	**store**	**-1.7600**
Rolling_Moment	**store**	**-0.1050**
Yawing_Moment	**store**	**1.5624**
Store Location		**0.0000**

VI. CONCLUSION

The Capabilities of CFD have matured to the point that it is an integral part of the store separation analysis process. The cost of CFD analysis is substantially lower than bothwind tunnel and flight tests, compliment wind tunnel testing makes goo fiscal sense where possible. A new technique has been proposed to simulate complex dynamic motion of stores with dynamic fin deflections. Store separation studies of a generic store released from the wing pylon of a fighter aircraft have been carried out using the commercial CFD. The results show that store separation is safe at Mach number from 0.95. The meshing capability of ICEM-CFD has been fully used to generate the aircraft store separation trajectory.

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