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Aerodynamic Performance Enhancement of Missile Using Drill Bit Terminology & Mortar Structure

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ABSTRACT

Now a days Modern Mortar weapons are useful systems in Défense world. In earlier days, large scale of mortar missile is used to achieve long target but the process needs huge man efforts when it comes to large number of missiles with heavy weight & number of firings. Due to enhancement of missile with some techniques would reduce efforts and gives better results with minimum weight & less human exertion. The impact of air on the body of missile can be studied with the help of simulation software as well as the testing setup. The Setup is helpful to create atmospheric environment in the testing chamber which helps us to get better result. By using simulation results it is helpful to select right grooving pattern onto the missile body. Prototype testing can support the simulation results in the term of performance of missile body & the actual air drag study. Based upon the combine results we can able to conclude either due to change in drag surface, is this change converts into enhancement or creates more drag onto the surface. This study can helpful for all the researchers who is doing study on aerodynamics of mortar missiles & bullets used in military weapons.

Keywords: Drill bit, Enhancement of Missile, Mortar, Testing Chamber

INTRODUCTION

Now a days, missile development is highly increased for the military usage at various stage. The different technologies provided by the researcher makes missile more specific on target with efficient range and state of motion. The concept of stabilizing the flight of a projectile by spinning we observed that, the range of spinning object passing through the air is greater than that of the straight. & hence, we assume that, if we initially applying spinning force on missile body, it will drag maximum air & reduces air resistance on missile body. The following project concept is the combination of two different theories by using the profile structure of drill bit and using it on the nose of missile for reduction of air drag and increasing the speed of the missile body for high range. The flank angle in the drill bit is normally given for the removal of cutting material while the drilling operation is performed. The flute of drill bit performs the action of carrying the cutting material from the cutting edge till the end of groove. The missile used to have the mortar structure is having the complete flat structure and its end on external portion the groves are provided for the spinning action. The barrel has internal groves provided for the spinning action. Project concept is Combination of drill bit material removal theory & mortar barrel structure. By using material removal theory, we create a spiral path onto the nozzle of missile. Mortar barrel structure help to gives rotation of missile body at the time of attack. The air starts passing through the spiral grooves provided onto the nozzle & helps to reduce overall air drag. In this paper two models one existing and one proposed model were analysed in subsonic condition of Mach number 1 to 2.

Fig.1 Concept Image

- **Research Articles**

P. Sethunathan, R. N Sugendran, T. Anbarasan proposed Aerodynamic Configuration Design of a Missile. They explained aerodynamic characteristics of missile body using analytical method. They concluded that, an Anti-aircraft missiles performance can be inversely proportional to the Drag value. When diameter of missile decreasing and increasing Nose fineness ratio, the Drag value is reduced.[1]

Mach number is directly proportional to the Drag value. Whereas Drag value is inversely proportional to the Altitude [1]
Amandeep Singh "Aerodynamic analysis on missile design aerodynamic analysis on missile design" In this research paper, Researcher took trial on 5 specimens with different parameters, & then they verify the Mach number of the respected specimen. To verify this, researcher used ANSIS Software. & based upon the theoretical calculations as well as simulation, they conclude which the nature of parameters with respect to the speed of the missile body. Basically, larger the contact area then Maximum the drag surface.[3]

The author Aditya Rajan Iyer, Anjali Pant studied A Review on Nose Cone Designs for Different Flight Regimes. He describes quantitative method to compare the performance of various nose cone designs for different flow regimes.[5]
The Author Roman Kelvin studied a review on Aerodynamics Analysis and Range Enhancement Study of 81mm Mortar Shell (French Design). In this research paper he done the structure of missile & simulation by using ANSYS. In the research Paper of design and manufacturing process for a ballistic mis-sile by Sebastian Marian, Author describes the de-tailed explanation about ballistic missiles. Also, he explains the manufacturing process & Design phase of ballistic missiles. Hence from above literature survey, it is evident that the different designers studied the Aerodynamic characteristic of the missile and analysed the same in different method. The designers focused on existing missile body but in the proposed project the performance analysis of missile body is based on the grooves.

MATERIAL AND METHODS

This concept we verified in two different ways. One is based on Simulation which is done with Ansys workbench & for more confidence, the second way is with actual prototype.

The below image shows the boundary conditions given to the software to run this model. These parameters are decided with some research paper studies & with the approximate values with existing missiles.

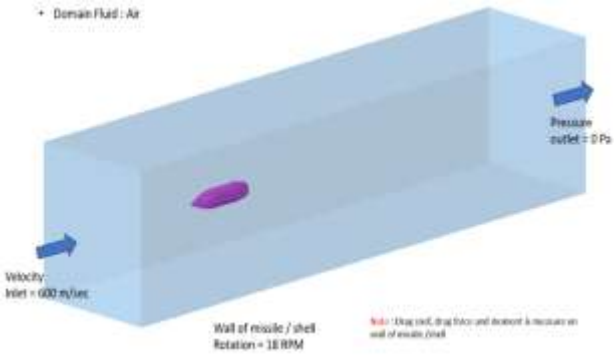

Fig.2 CFD Boundary Conditions

The second way to analyze the air drag is Prototype which is shown in below image. In a box container from front to end, string is attached to slide the missile body freely in front & backward direction. From front side one fan is attached to create atmospheric air drag. In the missile body 2 fans added to create thrust against the atmospheric air drag. Initially we maintain atmospheric air drag equal to missile thrust for neutralize the system. Then we'll replace the missile body with updated groove to check the position of missile. If missile gets stable then test sample is Pass. If missile is going to backward side, then test sample Fails.

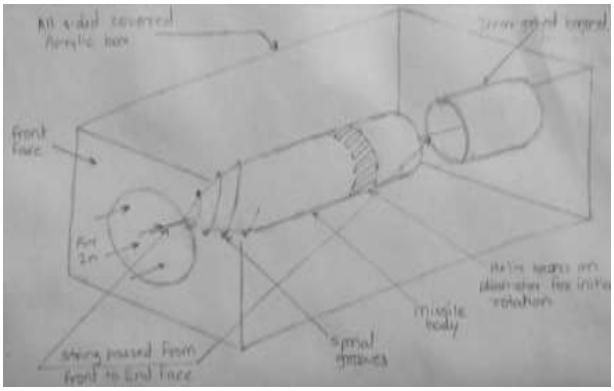

Fig.3 Conceptual Sketches

Below chart describes the material used to manufacture the testing setup & it also describes its purpose in the model.

Sr. no.	Description of material	Quantity	Application
1	Electronic Spices 4CH RC remote control 27MHz circuit PCB transmitter & receiver board with antenna Radio system	1	To control the Drone motor
2	A2212/13 KV2200 Brushless Motor BLDC Hex Rotor Multi-copter and RC Aircraft	1	To create atmospheric thrust
3	xcluma 30A ESC Welding T Plug Brushless Multicopter Motor Speed Controller RC BEC ESC T-rex 450	1	To control BLDC motor
4	QBM DC 3.7V 716 7x16mm Micro Coreless Motor with Propeller High-Speed Mini Drones (4 Motors + 4 Propellers) Mlini Drones., Alloy Steel	2	To Create Thrust Against Atmosphere
5	Li-ion Cell (2500mAh 9.25Wh) R41125202 with Cell Holder	2	To Operate Drone Motor
6	CCPM SERVO CONSISTENCY MASTER	1	To Adjust Speed of BLDC motor
7	Li-Po battery (400mAh 3.7V)	1	To Operate Transmitter
8	Li-Po Battery (2200mAh 12V)	1	To Operate BLDC motor
9	Li-Po Battery (2200mAh 12V) Charge Controller	1	To charge 12V Li-Po Battery
10	BLDC motor Blade	1	To provide air drag inside the testing setup
5	Acrylic Sheet (3 ft X 1 ft- 1 piece)	1	To Create Closed Testing Setup
6	6mm Plywood (3 ft X 1 ft- 3 pieces) (1ft X 1 ft- 2 pieces)	5	To Create Closed Testing Setup
7	Missile Specimen	3	1 sample is with existing parameters & remaining is with modified design
8	Launching Barrel	1	To gives initial rotating motion to the missile body
12	Misalliances		includes all accessories for installing the setup

Fig.4 Material Sheet

RESULTS

With the help of above two methods which used to analyse the performance of missile body, the results from Ansys are below
Based on the Pressure parameter, the results are below-

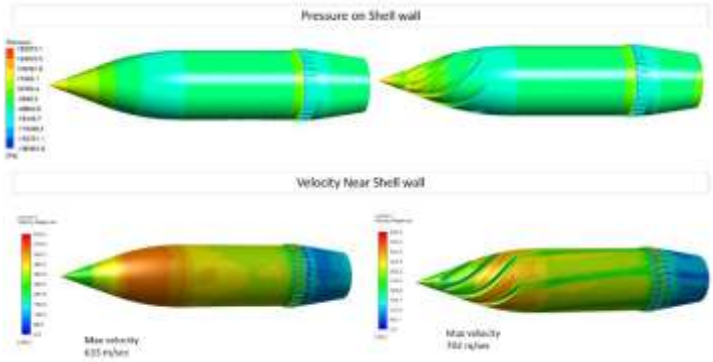

Fig.5Pressure measurement in CFD

Based on the Velocity measured in the middle region of the missile body, The results are below-

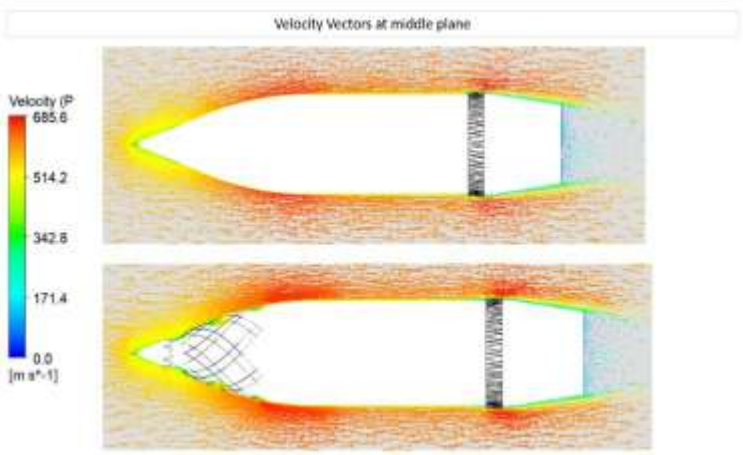

Fig.6 Velocity measurement in CFD

The below image shows Actual prototype which used for analysis purpose.

Fig.7 Prototype model

CONCLUSION

Based upon the simulation results, we observed there is no major change in Drag coefficient and drag force as fluid medium is air.

	Drag Coeff	% change	Drag Force (N)	% change	Moment (N-m)	% change
Body1	0.1622		455.5		1.25	
Body2	0.1620	-0.1	455.1	-0.1	0.22	-82.4

Missile body with groove has 82.4 % less moment than missile body without groove. it shows that for rotation of missile body with groove require less power as compared to missile body without groove. Based on the prototype results, when the atmospheric air drag tries to push back the missile body, missile body with groove tries to be stable on the same position for longer time as compared to missile body without groove.

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